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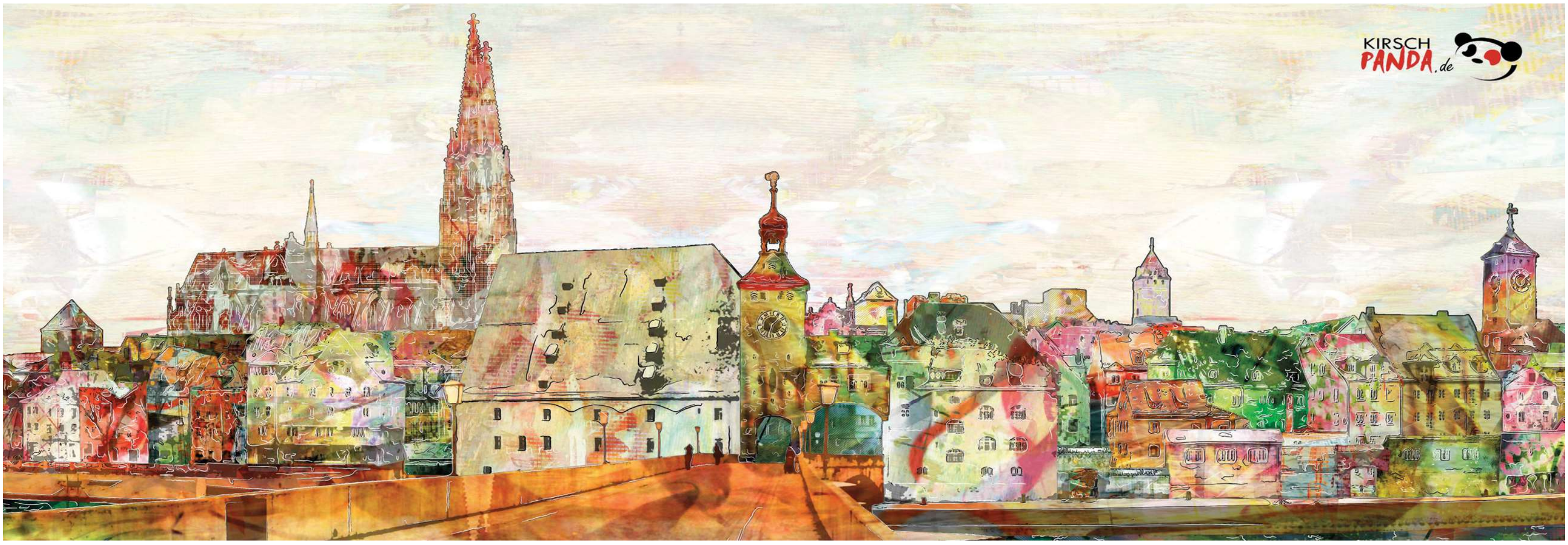

BOOK OF PROCEEDINGS

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International Real Estate Business School

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Dear Delegates at ERES 2016,

It is a pleasure for us to present you with this Book of Proceedings, consisting of selected scientific contributions of the 23rd ERES Conference in Regensburg, Germany.

ERES is working hard to increase the quality of the conference. Therefore, this year, for the first time, ERES offers a refereed section with discussions, preceded by a truly severe selection process. Out of 340 papers, 84 have been submitted to the refereed section. 46 truly excellent papers have been finally accepted; implying a rejection rate of 45 percent. They authors of 15 papers gave us the permission to publish their work in this Book of Proceedings.

We would like to thank the members of the conference committee for the refereed section for their insightful and timely contributions.

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We would also like to express our gratitude to the sponsors for their generous contributions.

Martin Hoesli
Head of Conference Committee

Steffen Sebastian
Secretary of Conference Committee
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Table of Content

No. 142
Real Estate Investment

The influence of noise on net revenue and values of investment properties: Evidence from Switzerland.

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In this study we use hedonic models to measure the influence of noise nuisance on rents, costs and values of investment properties in Switzerland. Country-wide data is provided by institutional real estate investors. The effects are measured for aircraft noise, road traffic noise and railroad noise. We show that negative effects appear between lower and upper tresholds which vary between different noise types and across residential and non-residential properties. Rents, costs and values are affected below the administrative tresholds given by the LSV and the negative impact ceases at an upper threshold. However high noise nuisance might influence investment decisions, i.e. offices are built instead of housing etc. These important effects are not given account in the data. In addition, directly measured reductions on market values are lower than the expected reductions based on empirical effects on rents and costs. The reasons for the different market value reductions may be found in the Swiss tenancy law. Rents for dwellings within existing rental agreements can only be adjusted in accordance with the change of the "reference interest rate" (Referenzzinssatz) and the CPI. The analysis shows that the average contract duration is dependent on the noise nuisance, which leads to a significant reduction of noise-induced losses within periods of increasing market rents.

Keywords: Hedonic prices, Investment property, Noise nuisance, GAM, Spline

Session: Real Estate Investment
H24, June 9, 2016, 3:30 - 5:00pm

THE INFLUENCE OF NOISE ON NET REVENUE AND VALUES OF INVESTMENT PROPERTIES: EVIDENCE FROM SWITZERLAND

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Keywords: Hedonic prices, investment property, Switzerland, noise nuisance, GAM, spline.

1 INTRODUCTION

In Switzerland, road and rail traffic as well as aircraft noise are important sources of nuisance in settlement areas. The fact that real estate markets value traffic noise has been shown by different empirical studies, e.g. Andersson et al. (2009), Day et al. (2007) and Kim et al. (2007). Nelson (2008) published a meta analysis of studies assessing the impacts of aircraft and road traffic noise. Most of the existing studies explore noise effects on prices of private properties and market rents for apartment.

So far, there is little knowledge on the effect of noise on investment properties. This part of the building stock contains multi-family houses as well as office buildings, shopping malls, mixed-used properties and others. With a house owner quota of only about 40 per cent, the major part of Swiss households rents a flat. In addition to the general importance of the rental market, the question of the impact of noise on investment properties becomes important because of

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First draft: April 2014. Drafts have been presented to the FOEN and to various institutional real estate owners/managers.

deadlines for noise remediation. In a couple of years Cantons and railway companies will have to compensate house owners for losses due to excessive noise nuisance.[1] Today there is only compensation for private properties and multi-family houses affected by aircraft noise around Zurich airport.

Estimating hedonic models for investment properties is a challenge, since noise nuisance can affect market rents, contract rents (i.e. historical market rents) and owner side costs as well as risk assessments (discounting factors in DCF appraisal). In addition there is no database with detailed and harmonised transaction data. For this study a uniquely large and well-described dataset of institutional properties has been compiled. It contains comparable information across all appraisal-relevant components of investment properties as well as the market values of these properties.

This study is based on the theory that noise affects both the gross revenue (reduction of rental income) as well as the owner-side costs (increased owner costs due to higher fluctuation, vacancies and maintenance costs). With the available data, noise effects can be measured on both the gross revenue as well as the owner-side costs. In addition, the data allow estimating the influence of noise nuisance directly on the market values.

In Switzerland, several studies estimating the influence of noise nuisance on market rents for rental apartments exist (for an overview see Table 1 and Fahrländer Partner, 2013). One single study measures the influence of aircraft noise on values of investment properties (see Bundesgericht, 2011). The observed reductions of the market values of around 1.5% per dB(A) are significantly higher than the measured reductions on apartment rents of approximatly 0.3% per dB(A). This supports the hypothesis formulated above that noise not only causes losses at the income side, but also leads to higher costs and higher risks for the owner.

1 According to the federal "Lärmschutzverordnung" LSV (Bundeskanzlei, 1986), the trigger for compensation is average noise dB(A) above the "Immissionsgrenzwert" IGW. These IGW differ by planning zones, noise source and between day and night.

Table 1: Hedonic pricing studies in Switzerland

Authors	Study area	Dependent variable	N	Price reduction per dB(A) (approximately, in %)		Threshold in dB(A)	
				Day	Night	Day	Night
Baranzini & Ramirez (2005)	Canton of Geneva	Market rents	13'064	0.28*		50	
Baranzini et al. (2006)	Canton of Geneva	Market rents	2'794	0.18-0.22*		50/55	
Baranzini & Schaerer (2007)	Canton of Geneva	Market rents	10'396	0.20-0.23*		50	
Schaerer et al. (2007)	City of Geneva	Market rents	3'327	0.17-0.20*		50	
	City of Zurich	Market rents	3'194	0.37-0.38*		55	
Banfi et al. (2007)	City of Zurich	Market rents	6'204	0.20*	0.31*	55	50
	City of Lugano	Market rents	547	0.50*	0.60*	55	50
ZKB (2010)				0.19*	0.19*	50[1]	40
	Switzerland	Market rents	635'504	0.26**	0.26**	50[1]	40
				0.11***	0.11***	50[1]	40
Bundesgericht (2011)	Switzerland	Values of investment properties	2'000	1.20***		45	
				1.80***		50	

[1] if night noise < 40dB(A); * Road traffic noise, **Rail noise, ***Aircraft noise.

This article is structured as follows: Section 2 introduces the underlying data. Section 3 presents the results of the empirical models used to examine the effect of noise on contract rents, owner-side costs and market values of investment properties. Discussion of the results is found in section 4. Section 5 concludes.

2 DATA AND SAMPLES

2.1 DATA OF INVESTMENT PROPERTIES

The analysis is based on country-wide data of investment properties provided by institutional investors. Market values as of 31 December 2012 as well as cashflows (rental incoms, vacancies and owner-side costs) for the year 2012 are available.[2] The data pool includes 3'027 properties with 8'824 addresses and 240'000 rental units. The total market value of the represented properties is around 51.7 Billion Swiss Francs. The data include residential and commercial properties as well as mixed-use properties. Information is available on three levels: Property, address and single rental unit.[3] Market values, owner-side costs and structural variables are

2 Cashflows of Migros Pensionskasse represent the period July 2012 to June 2013.

3 A single property can consist of several buildings or of several entrances into a building.

available on the property level. Locational data such as distances to points of interest and noise pollution is compiled for every single address (house entrance). Rental incomes and detailed information about the rental units such as floor space and number of rooms are available on the rental unit level (for variable descriptions see Appendix A).

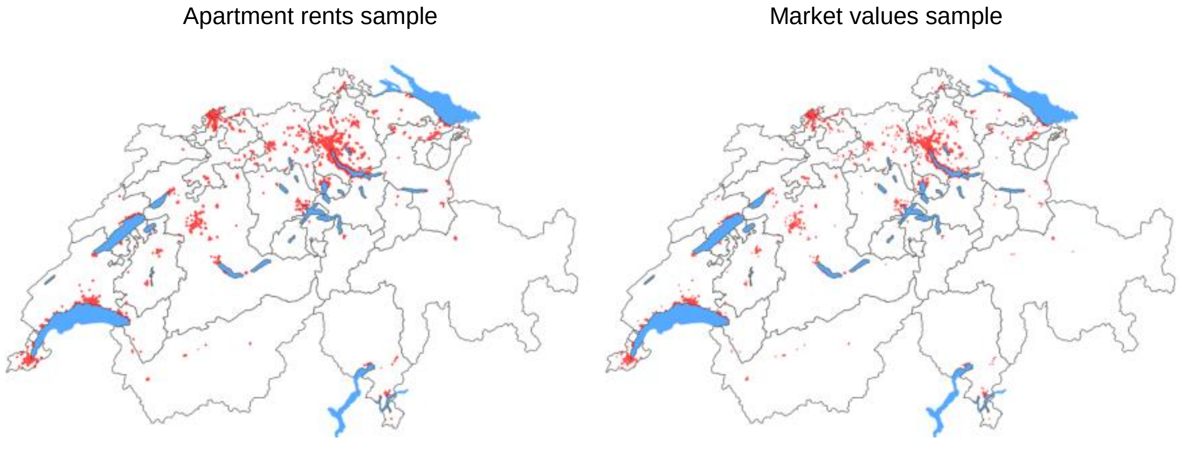
From the available data, samples with rental units as well as samples with properties are formed. With 2’362 observations the market value sample includes most of the pooled properties (Table 2). On the cost side, however, some records can not be harmonised or no owner-side costs are reported. The sample is thus reduced to 1’141 properties.

Table 2: Samples for econometric analysis

Sample	Number of properties	Number of addresses	Number of rental objects
Apartments	2‘066	5‘507	65‘301
Offices	752	878	4‘413
Retail	587	723	2‘126
Restaurants	166	166	220
Owner costs	1‘141		
Market values	2‘362		

In general, it can be stated that the samples are well distributed over the country (see Figure 1). An obvious concentration of observations exists in the urban areas with a significant rental market.

Figure 1: Spatial distribution of the samples



2.2 LOCATION VARIABLES

Hedonic models often use two location levels: the macro-location i.e. the village or city district and the micro-location, usually information of proximity to services, image of the neighbourhood, noise nuisance and others. While information of the general price level (macro-location) is used from the hedonic models of FPRE, the general assessment of the micro-location is derived from several parameters and proxies (see Appendix A).[4]

Noise exposure data is provided by the Federal Office for the Environment (FOEN). The noise database sonBASE was created in 2008 by the FOEN and contains noise data from different noise models. For this study, two different datasets are available. The first one, the grid data (10x10 meters) provides noise values at four meters above the ground. The second dataset includes the maximum noise value per building of the swissBUILDINGS3D building data set (provided by the Federal Office of Topography). The FOEN performs its own calculations for road traffic noise and railway noise. Data on aircraft noise is provided by the Federal Office of Civil Aviation (FOCA). For this study, the grid data from the calculation model 2009 and the building data set from the calculation model 2010 are available. This data allows assigning the noise exposure for each address. All the data is measured four metres above the ground (open windows) and is assigned to all floor levels. The data represent average noise levels dB(A) for the period 0600 to 2200 hours (day) and 2200 to 0600 hours (night).

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4 Fahrländer Partner (FPRE) provides hedonic models for market rents for daily use by owners, brokers and consultants. For the methodology see Fahrländer (2006).

3 MODELS AND RESULTS

To select the model variables, this study relies on Sirmans et al. (2005), Malpezzi (2002) and Wilhelmsson (2000) who evaluated the control variables which are most commonly used in hedonic studies. In a first step (section 3.1), impacts of different noise sources on different property types are expolored using nonparametric cubic splines (as shown in Fahrländer, 2006) in generalized additive models (Hastie & Tibshirani, 1990). Minimum thresholds of noise effects were detected in all cases, maximum limits only in some.

In a second step, log-linear hedonic models are developed to measure noise impacts on rents (section 3.2), owner costs (3.3) and market values (3.4) using OLS regressions. All models include fixed effects (macro-location price indicators) derived from the hedonic models of Fahrländer Partner (Fahrländer, 2006). In a third step, the empirically measured reductions on market values are compared to indirect reductions resulting from additional costs and reduced rents (3.5).

3.1 EXPLORATORY ANALYSIS OF NOISE IMPACT

To explore noise impacts, all the parameters describing the micro-location must be used to isolate the influence of noise nuisance. This can only be done with highly dissaggregated data representing the small-scale conditions at a certain address. For the explorative analysis of the impact of noise a generalized additive model with cubic regression splines is used to analyse the pattern of the impact of the different noise sources and levels on rents, costs and values. Since noise from different sources cannot be combined, every single noise source is tested seperatly.

The objective of these estimations is to find adequate thresholds for all models. The determination of the thresholds was performed manually for each combination of noise source and property type using spline plots as shown in Figure 2. The example shows the influence of rail noise at night on rents of apartments. The thresholds are later used to estimate partwise linear terms, with zero below the lower threshold, a linear slope between the lower and the upper threshold and a maximum for properties above the upper threshold.

Figure 2: Influence of rail noise at night on contract rents of apartments

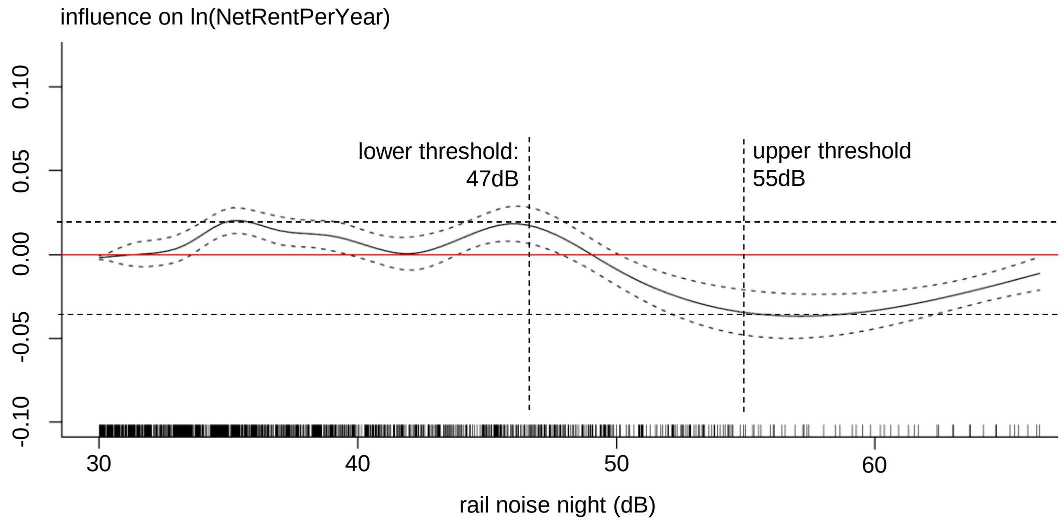


Table 3 shows the findings of the exploratory analysis. In the apartment rents model we found a maximum thresholds of noise impact at 57dB(A) (aircraft noise) and 55dB(A) (road and rail noise), the minimum and maximum thresholds are shown in the row "range". Apartment rents and market values of residential properties are sensitive to noise during the nights while office and retail rents are affected by daytime noise.

Table 3: Noise thresholds and affected observations

Model	Dependent variable	Period	N=	Aircraft noise		Road traffic noise		Rail noise	
				Range	Affected	Range	Affected	Range	Affected
Apartments	ln(rent) [CHF/a]	Night	65'301	50-57dB	1'301 (2.0%)	45-55dB	22'603 (34.6%)	47-55dB	2'658 (4.1%)
Offices	ln(rent) [CHF/a]	Day	4'413	>55dB	105 (2.3%)	>55dB	2'805 (63.6%)	>55dB	108 (2.4%)
Retail	ln(rent) [CHF/a]	Day	2'126	>50dB	26 (1.2%)	>55dB	1'425 (67.0%)	>40dB	335 (15.8%)
Restaurants	ln(rent) [CHF/a]	Night	220	no observations		>50dB	93 (42.3%)	>50dB	14 (6.4%)
Owner costs	ln(costs) [CHF/m2a]	Night	1'141	>50dB	30 (2.6%)	>45dB	451 (39.5%)	>47dB	20 (1.8%)
Market values									
Resid. properties	ln(value) [CHF/m2]	Night	1'945	>50dB	39 (2.0%)	>45dB	1'154 (59.3%)	>47dB	95 (4.9%)
Other properties	ln(value) [CHF/m2]	Day	417	>50dB	4 (1.0%)	>50dB	392 (94.0%)	>50dB	28 (6.7%)

3.2 NOISE IMPACT ON CONTRACT RENTS

Two different models have been estimated explaining the contractual rents of apartments. Both models are based on equation (1) where β_i represent the coefficients of contiuous and dummy variables and $\hat{\beta}_i$ vectors of coefficients of factor variables and interaction terms. The noise interaction terms include a $RangeDummy$ to separate the effects within the lower and upper thresholds.

$$
\begin{aligned}
&ln(NetRentPerYear) = \\
&\quad \propto + \beta_1 \cdot \ln(Macro) + \hat{\beta}_2(YearQuarter \times IsCentre) + \hat{\beta}_3(Exposition) \\
&\quad + \beta_4 \cdot IsCloseToLake + \hat{\beta}_5(ZoneType \times IsCentre) + \hat{\beta}_6(DomSegmentDemand) \\
&\quad + \hat{\beta}_7(SpatialType \times DistToLocalServices) + \hat{\beta}_8(NumServices600m \times IsCentre) \\
&\quad + \hat{\beta}_9(SpatialType \times LandscapeQuality) + \hat{\beta}_{10}(PublicTranspGroup \times IsCentre) \\
&\quad + \hat{\beta}_{11}(RangeDummy \times SpatialType \times AircraftNoiseNight) \\
&\quad + \hat{\beta}_{12}(RangeDummy \times SpatialType \times RoadNoiseNight) \\
&\quad + \hat{\beta}_{13}(RangeDummy \times SpatialType \times RailNoiseNight) \\
&\quad + \beta_{14} \cdot YearOfConstruction + \beta_{15} \cdot YearOfConstruction^2 \\
&\quad + \hat{\beta}_{16}(BuildingType) + \hat{\beta}_{17}(Condition) + \beta_{18} \cdot \ln(FloorArea) \\
&\quad + \hat{\beta}_{19}(FloorLevel \times IsCentre) + \hat{\beta}_{20}(NumRooms) + \varepsilon
\end{aligned} \tag{1}
$$

The first model does not include the spatial-type-interactions for the noise variables but country-wide coefficents for noise. All noise coefficients in this model turn out with a highly significant and negative impact. The second model includes interaction terms for different spatial types for road traffic noise and rail noise, as shown in Table 4.[5] The strongest price impact is found in rich communes (type 4), where each decibel road traffic noise above the threshold causes a rent decrease of approximately 0.33%. In suburban residental communes (types 5 and 6) the decrease is less (0.15% and 0.25% per decibel) but also highly significant. Apartment rents in big cities (type 1) and regional centres (type 2) are not significantly sensitive to road traffic noise. The rail noise coefficents are more difficult to estimate due to fewer observations with excessive rail noise. Significant coefficients can be estimated for large cities

5 Selected estimation results are shown in Appendix B.

and residential communes of regional centres, where rail noise clearly causes lower apartment rents.

Table 4: Coefficients for noise nuisance on contractual apartment rents

	Spatial type							
	Switzerland	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7
Max. Aircraft noise night (>50dB(A))	**-0.0017**							
Road traffic noise night (>45dB(A))	**-0.0009**	0.0005	-0.0005	**-0.0014**	**-0.0033**	**-0.0015**	**-0.0025**	-0.0009
Rail noise night (>47dB(A))	**-0.0009**	**-0.0019**	0.0000	0.0000	0.0012	**-0.0007**	**-0.0016**	0.0004

Bold: $p < 0.01$.

Type 1: Large urban centres; Type 2: Middle-size urban centres; Type 3: Other centres; Type 4: Rich communes; Type 5: Residential communes of large urban centres; Type 6: Residential communes of middle-size uban centres and other centres; Type 7: Other communes.

Similar models are estimated for office and retail rental units as well as for restaurants. In the models for offices, significant negative coefficents can be estimated only in rich communes (type 4, see Table 5). Estimations for retail contract rents and restaurants do not generate significant coefficients. These models are therefore not subject to further analysis in this article.

Table 5: Coefficients for noise nuisance on contractual office rents

	Spatial type							
	Switzerland	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7
Aircraft noise day (>55dB(A))	-0.0088							
Road traffic noise day (>55dB(A))	0.0025	0.0038	0.0040	0.0114	**-0.0279**	-0.0060	0.0067	0.0061
Rail noise day (>55dB(A))	0.0025	0.0006	0.0043	-0.0021	0.0187	0.0042		-0.0082

Bold: $p < 0.01$.

Type 1: Large urban centres; Type 2: Middle-size urban centres; Type 3: Other centres; Type 4: Rich communes; Type 5: Residential communes of large urban centres; Type 6: Residential communes of middle-size uban centres and other centres; Type 7: Other communes.

3.3 NOISE IMPACT ON OWNER-SIDE COSTS

This model includes data of the owner-side running costs. Since the various cost categories cannot be consistenty harmonised for the different data providers, this model is only estimated for the total annual running costs per square meter floor area, as shown in equation (2). The noise interaction terms include a $RangeDummy$ to separate the effects within the lower and upper thresholds.

$$
\begin{aligned}
ln(RunningCostsPerSQM) = & \\
& \propto + \hat{\beta}_1(ZoneType) + \hat{\beta}_2(PublicTranspGroup) \\
& + \hat{\beta}_3\ (RangeDummy \times AircraftNoiseNight) \\
& + \hat{\beta}_4\ (RangeDummy \times RoadNoiseNight) \\
& + \hat{\beta}_5\ (RangeDummy \times RailNoiseNight) \\
& + \beta_6 \cdot YearOfConstruction + \beta_7 \cdot YearOfConstruction^2 \\
& + \hat{\beta}_8(PropertyType) + \hat{\beta}_9(Condition) \\
& + \beta_{10} \cdot \ln(TotalFloorArea) + \beta_{11} \cdot AverageFloorAreaLiving + \varepsilon
\end{aligned}
\tag{2}
$$

The results of the estimation suggest that a positive interrelation between noise and owner-side costs exists (see Table 6). However, only the coefficient of the aircraft noise is statistically significant. The result can be interpreted as follows: each dB(A) aircraft noise above 50dB(A) causes 0.88% additional owner-side running costs.

Table 6: Coefficients for noise nuisance on owner-side costs

	Switzerland
Max. aircraft noise night (>50dB(A))	**0.0088**
Road traffic noise night (>45dB(A))	0.0044
Rail noise night (>47dB(A))	0.0011

Bold: $p < 0.01$.

3.4 NOISE IMPACT ON MARKET VALUES

Two models were estimated to assess noise impacts on market values. Both models are based on equation (3). The noise interaction terms include a $RangeDummy$ to separate the effects within the lower and upper thresholds.

$$
\begin{aligned}
&ln(MarketValuePerSQM) = \\
&\quad \propto \; + \beta_1 \cdot \ln(Macro) + \; \beta_2 \cdot (AverageContrDuration) \; + \; \hat{\beta}_3(Exposition) \\
&\quad + \beta_4 \cdot IsCloseToLake + \hat{\beta}_5(ZoneType) + \; \hat{\beta}_6(DomSegmentDemand) \\
&\quad + \hat{\beta}_7(DistToLocalServices \times IsCentre) + \; \hat{\beta}_8(NumServices600m \times IsCentre) \\
&\quad + \hat{\beta}_9(LandscapeQuality \times IsCentre) + \hat{\beta}_{10}(PublicTranspGroup \times IsCentre) \\
&\quad + \hat{\beta}_{11}(RangeDummy \times PropertyType \times AircraftNoiseNight) \\
&\quad + \hat{\beta}_{12}(RangeDummy \times PropertyType \times RoadNoiseNight) \\
&\quad + \hat{\beta}_{13}(RangeDummy \times PropertyType \times RailNoiseNight) \\
&\quad + \beta_{14} \cdot YearOfConstruction + \; \beta_{15} \cdot YearOfConstruction^2 \\
&\quad + \hat{\beta}_{16}(PropertyType) + \hat{\beta}_{17}(Condition) \\
&\quad + \beta_{18} \cdot \ln(TotalFloorArea) \; + \beta_{19} \cdot AverageFloorAreaAp + \varepsilon
\end{aligned} \tag{3}
$$

The first model shows the influence of the explanatory variables on all properties where no spatial or typological distinction of the properties is made. This model confirms the expected relation beween noise and market values (see Table 7). The general negative noise effect on market values of investment properties can therefore be confirmed from an empirical perspective. In the second model, the noise effect is differentiated according to property types. The estimation shows that market values of pure residential properties ("Residential") and residential properties with additional utilizations ("Residential +") are signifcantly affected by all three types of noise. For office and retail properties, a similar effect can not be shown. However, a negative noise effect is indicated by the negative coefficients.

Table 7: Coefficients for noise nuisance on property market values

	Property type						
	All types	Residential	Residential+	Office	Office+	Retail	Mixed
Aircraft noise	**-0.0038**	**-0.0040**		-0.0368			
Road traffic noise	**-0.0023**	**-0.0044**	**-0.0090**	-0.0039	-0.0060	-0.0006	-0.0034
Rail noise	**-0.0023**	**-0.0028**	-0.0011	-0.0005	-0.0067	-0.0025	-0.0006

Bold: $p < 0.01$.

3.5 Direct and indirect noise impact on market values

As shown above, we have developed statistical models to quantify the noise impact on revenues and costs of investment properties. In addition, a model is available to estimate the influence of noise on market values. These models now allow to compute the value reduction of properties at a given noise exposure in two ways:

- Apply noise coefficients from the market value model to calculate the value reduction.
- Apply noise coefficients of the income and cost models to calculate the reduced net income. Then capitalize the reduced net income to calculate the value reduction.

We apply these two calculation methods to a typical residential property from the sample of this study. The property contains 40 apartments and generates CHF 600’000 net annual rental income. At 55dB(A) aircraft noise, a value reduction of about 6.9% is expected due to the reduction of net rents, increased costs and higher risks (see Table 8). By contrast, the estimated reduction is only 2.0% when using the market value model.

Table 8: Example: direct and indirect noise impact on market values

	No aircraft noise	55dB(A) aircraft noise	60dB(A) aircraft noise
Net rental income [CHF/a]	600'000	594'922	592'902
Owner costs [CHF/a]	126'000	131'668	137'591
Net income [CHF/a]	474'000	463'254	455'312
Market value [CHF] as a function of costs and revenues[1]	11'850'000	11'029'853	10'840'757
Market value [CHF], using coefficients of the market value model	11'850'000	11'615'354	11'385'355
Reduction of market value, as a function of costs and revenues[1]		-6.9%	-8.5%
Reduction of market value, using coefficients of the market value model		-2.0%	-3.9%
Delta of reductions		4.9 PP	4.6 PP

[1]Net capitalization rate without noise: 4%, Net capitalization rate with noise: 4.2%.

This large difference is surprising because one would expect more or less the same market value reductions from the two calculation methods.[6] In the example, the net income is capitalized and therefore considered perpetual. In today's appraisals for investment properties the discounted cashflow method (DCF) is widely used. In DCF models, the assumptions about revenues and costs are not constant, but depending on market conditions and the property itself. A lower estimate for income potential of noise-affected properties is expected than for non-noise-exposured properties. In addition, higher costs and vacancies would probably be assumed. The direct reduction of market values would therefore be stronger than in this simple capitalization of the value components. The empirical results show the contrary (for discussion see section 4.2).

4 DISCUSSION

4.1 COEFFICIENTS AND THRESHOLDS

Since existing studies use different thresholds to measure noise impacts, we use a noise pollution of 55dB(A) to compare the effects measured in this study with results of existing studies. As shown in Table 9, we find similar noise impacts on apartment rents, with a wide range depending on the spatial type. Further we find less strong effects on market values.

Table 9: Comparison of the results with existing studies

	Noise impact at 55dB(A) pollution		
Apartment rents	**Aircraft noise**	**Road traffic noise**	**Rail noise**
Existing studies in Switzerland	-1.1%[1]	-0.9% to -3.5%	-1.3%[1]
This study: Country-wide results	-0.9%	-0.9%	-0.7%
This study : Large urban centres		not significant	-1.5%
This study: Residential communes of large urban centres		-1.5%	-0.6%
This study: Residential communes of middle-size uban centres		-2.5%	-1.3%

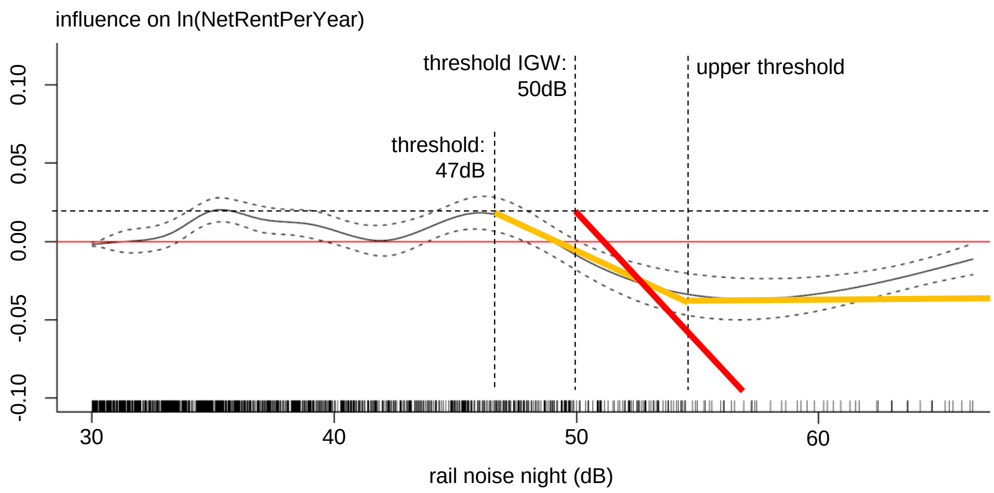
	Noise impact at 55dB(A) pollution		
Market values	**Aircraft noise**	**Road traffic noise**	**Rail noise**
Existing studies in Switzerland	-6.0% to -12.0%		
This study: Country-wide results	-2.0%	-4.3%	-2.2%

[1]Remark: Value comes from a single study.

6 Since appraisals usually also consider potential rents instead of contract rents i.e. the re-rental to a market rent in the future, the directly at the market value measured reduction should even be bigger than the one calulation with the net capitalization model.

As shown in section one, most of the existing studies use the “IGW” as a threshold to quantify noise effects on rents and prices. In this study we show that the different noise types have different thresholds that differ from the thresholds given by the LSV. Thresholds also vary across residential and non-residential properties. In our tests, this leads to different coefficients in comparison to IGW-based models even if we use identical data. Figure 3 shows schematically how the choice of the threshold affects the noise influence for residential rents using rail noise data. The higher the threshold is set, the greater the discount will be. This example illustrates that the IGW-based coefficients poorly estimate the actual noise impact whereas the coefficient estimated with the lower – empirical – threshold is accurate. In addition, the effect at a high noise level is overestimated in a model using only a lower threshold since data suggest the use of an additional upper threshold is necessary. It has to be assumed that existing Swiss studies using IGW-based thresholds are inaccurate.

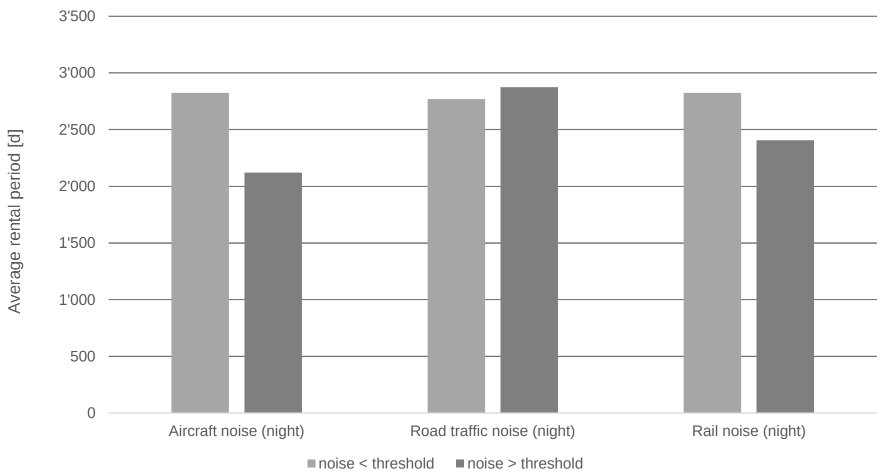
Figure 3: Variation of the coefficient using different thresholds (schematic)



4.2 SWISS TENANCY LAW AND AVERAGE RENTAL PERIOD

The reasons for the different market value reductions (as shown in section 3.5) may be found in the Swiss tenancy law. Rents for dwellings within existing rental agreements can only be adjusted in accordance with the change of the “reference interest rate” (Referenzzinssatz) and the consumer price index CPI. In case of a change of tenant, the rent can be adjusted to the market level. Typically, in an investment property the rental income is a mixture between older, indexed rents, and newer rents which are closer to the current market level. The rents observed in this study are therefore a mixture and they have – in a market with rising market rents for around 15 years – increased stronger than the reference interest rate and the CPI. It must therefore be assumed that the net income and thus the market value of a property increases with a higher tenant turnover. A proxy for tenant turnover is the average rental period within a property. The analysis of the available data shows that the average contract duration is also dependent on the noise nuisance, at least for aircraft and rail noise (see Figure 4).[7] Therfore, it is reasonable to assume that a tenant moves after a shorter period of time when he lives in a noise affected apartment compared to a situation without noise nuisance. With every change of tenant, the owner has the possibility to adjust the rent to the market level. Therefore the Swiss tenancy law may have the side effect of reducing noise-induced losses on gross revenue within periods of increasing market rents.

Figure 4: Average rental period and noise exposure



4.3 NOISE AND INVESTMENT DECISIONS

In this study, the influence of noise on values and value components of investment properties is analysed. Contracts of existing apartments, offices and retail spaces are used as empirical objects of investigation. What can not be examined, however, is the influence of noise on investment decisions. We assume – and this was also confirmed in interviews with several players in the market – that investors, developers and landowners optimise properties within the existing law considering noise nuisance. For example, in some cases apartments are not

7 Apartments with a high nuisance of road traffic noise are typically in the big cities, where market situation is extremely tense, expecially in the lower price segments.

built on the lower floors near heavily traveled roads, although it would be permitted in the corresponding zone and it would – if there was no noise – yield higher rental incoms than other uses. In extreme cases, entire buildings with offices, retail spaces or industrial uses are implemented as ”noise catchers” in order to create profitable residential uses in other parts of the building lot. The noise exposure leads, in such cases, already at the point of investment decision to a reduced value of the property. We further asume that long term strategies on renovation or repositioning of existing properties are affected by the noise as well. An excellent example of this behaviour can be observed at the Weststrasse in Zurich: In 2010, a massive reduction in road noise was achieved by a major traffic planning project (Kanton Zürich, 2011). In the decades before, only little investment was made anlong this road and the buildings were mostly inhabited by housholds with low incomes. Since the end of the project, major investments by the owners of the buildings were done and the social structure of households has changed significantly.

There is still a need for research in this area. Today, there is no transparency about noise-induced owner-side losses in cases where the investment decision is dependent on the noise situation. Scientific work on this issue would probably be based on the analysis of case studies, comparing investment projects in scenarios with and without noise, realising ”highest and best use” projects.

5 CONCLUDING REMARKS

This study quantifies the impact of noise nuisance on rents, costs and values of investment properties. We assume that this is only possible in the range of medium noise. The coefficients are probably only reliable in relatively homogeneous noise situations, since the study is based on averaged day and night values. In extreme situations (i.e. strong aircraft noise in the early morning) the actual price impacts are likely to be higher. Strong noise nuisance most likely affects investment decisions and the effects can therefore not be observed empirically. To do so, it would be necessary to assess the “highest and best use” for each property with the assumption that there was no noise pollution.

The data used in this study represent the last few years, a period marked by rising rents and tight supply. The measured noise coefficients are valid for this period and can vary with changing market conditions. We suspect that apartment seekers cannot fully cover their preferences (i.e. noise sensitivity) in the current market environment. Furthermore, there is evidence that noise sensitivity of people varies greatly due to the genetic predisposition.

This study does not allow any conclusions about the effects of noise on privately owned residential properties. There, the impacts may be different than in the investment property sector.

APPENDIX

A: VARIABLES AND EXPECTED IMPACTS

Table 10: Model on apartment rents: descriptive statisics and expected impacts

Variable	Description	Min	Max	Median	SD	Exp. impact
Dependent						
NetRentPerYear	Net rent per year [CHF/a]	3'352	76'392	15'216	6'156	
Macro-location and contract						
Macro	Price level FPRE [CHF/m^{2}a]	139	536	250	56	+
IsCentre	Is in a urban centre [dummy]					
SpatialType	Spatial type [factor]					
YearQuarter	Quarter of the contract [factor]	1995	2013	2011	4	+
Micro-location						
IsCloseToLake	Dist. to lake of max. 500m [dummy]					
Exposition	Expostion [factor]					
ZoneType	Building zone [factor]					
DomSegementDemand	Dominant segment of demand [factor][8]					
DistToLocalServices	Distance to a local supplier (shop, post…) [km]	0.0	2.2	0.3	0.2	-
NumServices600m	Number of local suppliers within 600m [num]	0	4	3	1.4	+
LandscapeQuality	Landscape quality index [index]	3.7	30.3	20.5	4.3	+
PublicTranspGroup	Public transport group [factor]					
AircraftNoiseNight	Max. aircraft noise night [dB(A)]	30	62	30	3.7	-
RoadNoiseNight	Road traffic noise night [dB(A)]	30	68	42	7.8	-
RailNoiseNight	Rail noise night [dB(A)]	30	66	30	5.5	-
Object and property						
YearOfConstruction	Year of construction [num]	1903	2013	1973	20.73	+
BuildingType	Type of building [factor]					
Condition	Condition of the building [factor]	1.0	5.0	3.0		+
FloorArea	Floor area of the apartment [m^2]	20	199	80	25.5	+
NumRooms	Number of rooms in apartment [num]	1.0	9.0	3.5	1.1	+
FloorLevel	Floor level [num]	-2	18	2	2.2	+

8 Segmentation of demand in the housing market as described in Fahrländer Partner & sotomo (2012).

Table 11: Models on costs and market values: descriptive statisics and expected impacts

Variable	Description	Min	Max	Median	SD	Exp. impact values	Exp. impact costs
Dependent							
RunningCostsPerSQM	Annual running costs [CHF/m²a]	21	129	44	27.1		
MarketValuePerSQM	Market value per m2 [CHF/m²]	885	49'123	3'402	3'125		
Macro-location and contract							
Macro	Price level FPRE [CHF/m²a]	52	2'496	202	175	+	
AverageContrDuration	Average contract run-time [d]	96	41'705	2'999	3'093	+	-
IsCentre	Is in a urban centre [dummy]						
SpatialType	Spatial type [factor]						
Micro-location							
IsCloseToLake	Dist. to lake of max. 500m [dummy]						
Exposition	Expostion [factor]						
ZoneType	Building zone [factor]						
DomSegementDemand	Dominant segment of demand [factor]						
DistToLocalServices	Distance to a local supplier (shop, post…) [km]	0.00	2.13	0.21	0.23	-	
NumServices600m	Number of local suppliers within 600m [num]	0	4	3	1.4	+	
LandscapeQuality	Landscape quality index [index]	3.7	30.3	21.5	4.4	+	
PublicTranspGroup	Public transport group [factor]						
AircraftNoiseNight	Max. aircraft noise night [dB(A)]	30	62	30	8.0	-	+
RoadNoiseNight	Road traffic noise night [dB(A)]	30	70	48	7.2	-	+
RailNoiseNight	Rail noise night [dB(A)]	30	66	30	6.2	-	+
Object and property							
YearOfConstruction	Year of construction [num]	1600	2013	1969	29.6	+	-
PropertyType	Type of property [factor]						
Condition	Condition of the building [factor]	1.0	5.0	2.0		+	-
TotalFloorArea	Total floor area property [m²]	90	56'350	2'573	5'537	+/-	-
AverageFloorAreaAp	Average apartment size [m2]	16	223	77	19.7	-	-

B: ESTIMATION RESULTS

Vectors of coefficients $\hat{\beta}_i$ (factor variables and interaction terms) are not completely shown in the following table due to their length. Instead the table shows a selection of combined characteristics. Noise coefficients are not shown since these are presented in section 3.

Table 12: Model on apartment rents: selected coefficients

	Global		*IsCentre*=1 (yes)		*IsCentre*=0 (no)		*SpatialType=4*	
Dependent: *ln(NetRentPerYear)*	Coeff	t value	Coeff	t value	Coeff	t value	Coeff	t value
Macro-location and contract								
ln(Macro)	**0.4087**	78.5	**-**	-	**-**	-	**-**	-
YearQuarter: 2000:4	**-**	**-**	**-0.2115**	-11.4	**-0.1708**	-5.7	**-**	-
YearQuarter: 2012:3	**-**	**-**	**0.0444**	3.4	**0.1014**	3.7	**-**	-
Micro-location								
IsCloseToLake: Yes	0.0030	1.0	-	-	-	-	-	-
Exposition								
ZoneType : Residential	-	-	**0.0000**	0-level	**0.0000**	0-level	-	-
ZoneType : Central/old town	-	-	**-0.0178**	-4.7	**0.0109**	2.9	-	-
DomSegementDemand : 2	0.0107	1.3	-	-	-	-	-	-
DomSegementDemand : 4	**0.0244**	2.9	-	-	-	-	-	-
DomSegementDemand : 8	**0.1035**	11.7	-	-	-	-	-	-
DistToLocalServices	-	-	-	-	-	-	**0.0375**	2.7
NumServices600m: 0	-	-	**0.0000**	0-level	**0.0000**	0-level	-	-
NumServices600m: 4	-	-	-0.0190	-2.6	**0.0192**	3.8	-	-
LandscapeQuality	-	-	-	-	-	-	**0.0031**	4.2
PublicTranspGroup: A	-	-	**0.0905**	13.4	-	-	-	-
PublicTranspGroup: B	-	-	**0.0835**	13.0	0.0051	1.7	-	-
PublicTranspGroup: C	-	-	**0.0714**	11.2	**0.0133**	4.8	-	-
Object and property								
YearOfConstruction	**-0.1253**	-24.7	-	-	-	-	-	-
YearOfConstruction^2	**0.00003**	25.2	-	-	-	-	-	-
BuildingType: 6-10 Apartments	**-0.0235**	-2.6	-	-	-	-	-	-
BuildingType: 11-15 Apartments	**-0.0277**	-3.1	-	-	-	-	-	-
BuildingType: > 15 Apartments	**-0.0520**	-5.9	-	-	-	-	-	-
Condition: 5.0	**0.0000**	0-level	-	-	-	-	-	-
Condition: 4.0	**-0.0399**	-10.1	-	-	-	-	-	-
Condition: 3.0	**-0.0880**	-22.5	-	-	-	-	-	-
ln(FloorArea)	**0.7150**	232.4	-	-	-	-	-	-
NumRooms: 2.5	**-0.0348**	-10.1	-	-	-	-	-	-
NumRooms: 3.5	**-0.0296**	-10.9	-	-	-	-	-	-
NumRooms: 4.5	**0.0000**	0-level	-	-	-	-	-	-
NumRooms: 5.5	**0.0183**	4.3	-	-	-	-	-	-
FloorLevel: Ground floor	-	-	**0.0000**	0-level	**0.0000**	0-level	-	-
FloorLevel: 3th floor	-	-	**0.0304**	9.3	**0.0391**	8.1	-	-
FloorLevel: 5th floor	-	-	**0.0471**	6.9	**0.0287**	3.0	-	-
Degrees of freedom: 64’983, adjusted R^2: 0.78								

Bold: $p < 0.01$.

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ABSTRACT

In this study we use hedonic models to measure the influence of noise nuisance on rents, costs and values of investment properties in Switzerland. Country-wide data is provided by institutional real estate investors. The effects are measured for aircraft noise, road traffic noise and railroad noise. We show that negative effects appear between lower and upper tresholds which vary between different noise types and across residential and non-residential properties. Rents, costs and values are affected below the administrative tresholds given by the LSV and the negative impact ceases at an upper threshold. However high noise nuisance might influence investment decisions, i.e. offices are built instead of housing etc. These important effects are not given account in the data. In addition, directly measured reductions on market values are lower than the expected reductions based on empirical effects on rents and costs. The reasons for the different market value reductions may be found in the Swiss tenancy law. Rents for dwellings within existing rental agreements can only be adjusted in accordance with the change of the “reference interest rate” (Referenzzinssatz) and the CPI. The analysis shows that the average contract duration is dependent on the noise nuisance, which leads to a significant reduction of noise-induced losses within periods of increasing market rents.

ZUSAMMENFASSUNG

In dieser Studie ermitteln wir mittels hedonischer Modelle den Lärmeinfluss auf Mieten, Kosten und Werte von Renditeliegenschaften in der Schweiz. Landesweite Daten wurden durch institutionelle Immobilieninvestoren zur Verfügung gestellt. Die Effekte werden für Flug-, Strassen- und Bahnlärm gemessen. Wir zeigen, dass Lärmeffekte zwischen unteren und oberen Schwellenwerten auftreten und sich zwischen verschiedenen Lärmarten und Nutzungen unterscheiden. Die Lärmwirkung beginnt teilweise bereits unterhalb des Immissionsgrenzwertes (IGW) und verstetigt sich bei einem – je nach Lärmart und Nutzung unterschiedlichen – oberen Schwellenwert. Lärm beeinflusst aber auch Investitionsentscheide. So werden an lärmbelasteten Lagen beispielsweise Büros anstelle von Wohnungen gebaut etc. Diese wichtigen Effekte können mit den vorliegenden Daten nicht berücksichtigt werden. Wir zeigen, dass direkt gemessenen Abschläge auf den Marktwerten niedriger sind als aufgrund der empirischen Mindererträge und Mehrkosten erwartet würde. Der Grund dafür ist im Schweizerischen Mietrecht zu finden. Wohnungsmieten mit bestehenden Verträgen können nur in Übereinstimmung mit dem Referenzzinssatz und der allgemeinen Teuerung angepasst werden. Da die durchschnittliche Vertragslaufzeit mit zunehmender Lärmbelastung abnimmt, wird der negative Lärmeffekt in Zeiten steigender Marktmieten deutlich kompensiert.

Effects of Uncertainty and Labor Demand Shocks on the Housing Market

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This paper investigates the simultaneous effects of uncertainty and local labor demand shocks on the U.S. housing market. We use binary uncertainty indicators and a Bartik (1991) index to quantify both uncertainty and labor demand shocks. Controlling for a broad set of variables in fixed-effects regressions, we find uncertainty shocks exhibit small adverse level effects, where housing prices and median sell prices decrease in the amount of 1.4% and 1.8%, respectively, and the percentage loss of houses selling increase by .52%-points. More importantly, however, when both shocks are introduced the effects of uncertainty shocks on the housing market dominate that of local labor demand shocks on housing prices, median sell prices, the share of houses selling for loss, transactions and homes sold as foreclosure. These results lends to the support for the presence of real options effects in the housing market.

Keywords: Bartik labor demand shocks, real options effects, time-varying uncertainty shocks, housing markets

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Effects of Uncertainty and Labor Demand Shocks on the Housing Market*

Abstract

This paper investigates the simultaneous effects of uncertainty and local labor demand shocks on the U.S. housing market. We use binary uncertainty indicators and a Bartik (1991) index to quantify both uncertainty and labor demand shocks. Controlling for a broad set of variables in fixed-effects regressions, we find uncertainty shocks exhibit small adverse level effects, where housing prices and median sell prices decrease in the amount of 1.4% and 1.8%, respectively. More importantly, however, when both shocks are introduced the effects of uncertainty shocks on the housing market dominate that of local labor demand shocks on housing prices, median sell prices, the share of houses selling for loss and transactions. Furthermore, the aforementioned uncertainty shock effects are the largest for the States that exhibit higher housing price volatilities. Our results indicate uncertainty shocks dampen housing price volatilities. Consequently, these results lends to the support for the presence of real options effects in the housing market.

- *JEL Classification: E4, E5, E2, R2, R3*
- *Keywords:* Bartik labor demand shocks; time-varying uncertainty shocks; real options effects; housing market.

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1 Introduction

Three well documented features of the recent Great Recession are the decline in housing prices, the increase in unemployment rate, and the increase in the presence of uncertainty in the U.S. Figure 1 shows the correlation between the U.S. housing price growth rate and some of the uncertainty measures in the recent literature over the period from 1990 to 2014 with the highlighted recession periods: there is a clear negative correlation between the housing price growth rate and the shown uncertainty measures.[1] Figure 2 also shows a strong negative correlation between the monthly U.S. unemployment rate and the Bartik index that proxies the U.S. labor demand shocks from 1990 to 2014. There are numerous recent papers that deal with the effects of uncertainty on aggregate economy as well as housing and labor markets separately.[2] This paper, however, examines the simultaneous effects of uncertainty and local labor demand shocks on the U.S. housing market.[3] More precisely, we seek to answer (i) how does uncertainty shock affect the housing market, (ii) how does a local labor demand shock alter the housing market if the shock occurs in a period of high uncertainty and (iii) how robust are the outcomes given the choice of the uncertainty proxy and the threshold level defining a period of high uncertainty?

We address these questions using monthly U.S. state-level data from 1990 to 2014. We use binary uncertainty dummies to indicate the periods of high uncertainty and a variation of Bartik (1991) index as local labor demand shocks to quantify the impact of these two shocks on the housing market. Our approach thus corresponds to models using two-state Markov-switching processes, where regime changes can be documented by an uncertainty index crossing various

[1] We use four different uncertainty measures in our analysis: the macroeconomic uncertainty by Jurado, Ludvigson and Ng (2015), the VIX by Bloom (2009), the policy uncertainty by Baker, Bloom and Davis (2012), and our measure, which is analogous to Baker et al (2012) but on a State level ("State" uncertainty).

[2] Just to mention a few, Christiano, Motto and Rostagno (2014) show that uncertainty adversely impacts the economy, while Dorofeenko, Lee and Salyer (2014) investigate the impact of uncertainty on the housing market. Leduc and Liu (2015) link uncertainty and the labor market by developing a model in which there is an option value channel due to uncertainty that arises from search frictions and an aggregate demand channel associated with rigid prices. Shoag and Veuger (2014) show empirically that the cross-sectional variation in uncertainty across states matches the distribution of employment outcomes between 2007 and 2009, and that uncertainty may amplify labor demand shocks. Jaimovich and Siu (2015) uncover the structural changes in the labor market in the past recessions.

[3] We specifically look at the average housing prices, the median selling prices, the share of houses selling for loss, the transactions and houses sold as foreclosure.

threshold values, which are based on the percentiles of the distribution of the uncertainty proxy. This approach differs from the one used in, for example, Bloom (2009), who defines periods of uncertainty as the proxy being 1.65 or more standard deviations above the mean. We use the macroeconomic uncertainty measure by Jurado et al (2015), as well as an uncertainty measure that is akin to the policy uncertainty proxy by Baker et al (2012) but on a State-level, the VIX which is also used by Bloom (2009), and the policy uncertainty by Baker et al (2012) to analyze the state level housing markets.

Controlling for a broad set of variables, including income, unemployment and the volatility index VIX, we find that uncertainty shocks decrease average housing prices in our baseline specification by 1.42% and increases the percentage loss of houses selling by .52%-points. These results are in contrast to Dorofeenko et al (2014), who show that an increase in their measure of uncertainty has an increasing effect on house prices due to the default premium on the housing developers. Furthermore, an increase in local labor demand shock, defined as the shock to a change in state-level employment relative to a change in national employment, increases house prices, median sell prices and transactions and decreases the share of houses selling for loss. However, when both shocks are introduced, the effects of an uncertainty shock dominate the labor demand shock on all of these variables. Moreover, the above results are robust to different threshold values that are ranged from 80th, 85th, 90th and 95th percentile of an uncertainty proxy. Furthermore, the aforementioned uncertainty shock effects are the largest for the States that exhibit higher housing price volatilities. Consequently, our results indicate uncertainty shocks dampen housing price volatilities. Our results, as in Bloom (2014), provide further evidence of real option value effects of waiting during a high period of uncertainty in the housing market.[4] One of the implications of our results is that in order for stimulus packages to work properly, highest priority should be given to the reduction of uncertainty.[5]

[4] See also Aastveit, Natvik and Sola (2013), in which structural Vector Autoregressions are used to document wait-and-see effects in monetary policy during periods of high uncertainty.

[5] Especially in light of the results of Stroebel and Vavra (2015) , who show that there is a causal relation between changes in housing prices and changes in retails prices and thus consumption.

2 Data, Bartik Index and Uncertainty Measures

2.1 Data

We use monthly state-level data from 1990:1 to 2014:12; the data and sources are described in detail in the Appendix. Zillow Real Estate Research data and Freddie Mac provide information on various aspects of the housing market, such as the housing price, median sales price, the share of houses sold for loss and turnover. These variables constitute the vector of dependent variables.

2.2 Bartik Index

The Bartik (1991) index and an uncertainty indicator are the two main variables for this paper. The Bartik index is a measure of the predicted change in demand for employment in a state given by the interaction between a state's initial industry mix and national changes in industry employment. The index compares the preexisting differences in the sectoral composition of employment across states with the broad changes in national employment, especially changes subject to a trend, asymmetrically impact states. In this paper, we follow Saks (2004) and Charles, Hurst and Notowidigdo (2013) to construct two (similar) variants of the Bartik index. We use the index of Saks (2004) as benchmark due to its transparency and straightforward interpretation:

$$bartik_{it} = \sum_j \frac{e_{ijt-1}}{e_{it-1}} \left(\frac{\tilde{e}_{ijt} - \tilde{e}_{ijt-1}}{\tilde{e}_{ijt-1}} - \frac{e_t - e_{t-1}}{e_{t-1}} \right) \tag{1}$$

where i=state, j=industry, t=month; $\tilde{e}_{ijt}$ = national industry employment outside of state i; e_{it}= state employment = $\sum_j e_{ijt}$; e_t= national employment = $\sum_i e_{it}$.

The first fraction reflects the share of industry j employment relative to the total employment in state i in $t-1$, the second fraction is the growth rate of industry j outside of state i and the third fraction reflects the change in national employment. Thus, the term in brackets reflects the change in industry j employment (outside state i) relative to changes in national employment. This term is weighted by the "importance" of industry j in state i in $t-1$. We use j=4 sectors across i=51 states in this analysis: manufacturing, private services, public services and construction and logging, as this provides sufficient variation on the state level.[6]

2.3 Uncertainty Measures

Various uncertainty proxies have been proposed in the recent literature. Often, theoretical models use Markov-switching or autoregressive processes to model stochastic volatility as a proxy for uncertainty measure. As shown in Figure 1, depending on the preferred proxy, the number of uncertainty shocks may differ considerably, although it is also possible that different proxies capture different aspects of uncertainty. The VIX is constructed as the square root of a weighted average of out-of-the-money put and call options forward prices for the next 30 days and measures the expected volatility of the S&P 500 index. The Policy Uncertainty proxy of Baker et al. (2012) is a composite index, consisting of newspaper coverage of policy-related economic uncertainty, the number of expiring federal tax code provisions and the variation of economic forecasters estimates. Jurado et al. (2015) estimate uncertainty as the conditional standard deviation "of the purely unforecastable component of the future value", which translates to removing the forecastable component of a multitude of aggregated and weighted financial and real variables before calculating their conditional standard deviation. Finally, the U.S. state level uncertainty proxy consists of the newspaper coverage of policy-related economic uncertainty from 2000:1 to 2014:12. As can be seen in Figure 1, there are considerable differences in fluctuations, and thus in the periods classified as uncertain.[7]

In order to count the number of uncertainty shocks, a definition of the threshold value is needed. Bloom (2009) suggests using "1.65 standard deviations above the mean, selected as the 5% one-tailed significance level treating each month as an independent observation". However, specifying the threshold in this manner does not leave any adjustment opportunity if the assump-

[6] The time series of the *bartik* index aggregated across states is displayed in Figure 2.
[7] See Strobel (2015) for potential reasons for this observation.

Table 1: Number of months defined as uncertain

	20 %		15%		10%		5%	
	$1-\alpha$	α	$1-\alpha$	α	$1-\alpha$	α	$1-\alpha$	α
	Percentile (P)	Normal (N)	P	N	P	N	P	N
Macro	124	104	103	96	80	86	58	76
Policy	192	188	174	175	156	162	138	148
State-level	36	27	27	21	18	18	9	13
VIX	240	222	225	217	210	206	195	197

Note: Number of months defined as uncertain from 1960:1 - 2011:12 for Macro Uncertainty, 1985:1 - 2015:2 for Policy Uncertainty, 2000:1 -2014:12 for state-level uncertainty and 1990:1 - 2015:2 for the VIX; the α one-tailed significance level is from the Normal Distribution and the series assume to follow i.i.d. as in Bloom (2009).

tion of Normality and independently and identically distributed uncertainty shocks does not hold. Table 1 shows the number of months defined as "uncertain" by various uncertain proxies. For example, using the Macro uncertainty measure, when α equals 5% then the Normal Distributional assumption leads to seventy-six uncertain periods instead of fifty-eight periods when one uses the corresponding percentiles of the actual distribution. We use the corresponding percentiles at various levels in our analysis to show the robustness of empirical results as well as to avoid the Normal i.i.d. assumption.[8]

3 Empirical Results

As we seek to investigate the presence of real options effects in the housing market, we interact uncertainty and labor demand shocks, while accounting for spatial dependence and endogeneity. To this end, we use the standard errors developed in Driscoll and Kraay (1998) to account for spatial dependence, heterogeneity and autocorrelation. We are unable to formally control for endogeneity issue between uncertainty measure and explanatory variables because uncertainty is by definition unobserved. In this manner, we follow the definition of uncertainty that Jurado et al. (2015, p.1177) use; "as the conditional volatility of a disturbance that is unforecastable from the perspective of economic agents". This endogeneity problem is further exacerbated due to the

[8] We tested for the Normality of the uncertainty proxies using the Jarque-Bera test, and the null of Normality was rejected for each proxy.

fact that uncertainty is ultimately subjective. The latter issue is, however, somewhat mitigated because we consider macroeconomic uncertainty, not firm or household-level uncertainty, and we do not include the proxies but use them to identify periods of increased uncertainty.

Our biggest concerns regarding endogeneity, however, are the feedback effects and simultaneity between the housing market and the covariates. To guard against feedback effects, we only include lagged explanatory variables. The VIX, due to its construction as expected volatility of the S&P 500 index, is unlikely to be strongly influenced by housing prices and Macro Uncertainty is constructed to avoid any dependencies on any single (or small number) of observable economic indicators. Policy Uncertainty and the state-level uncertainty measure, constructed using news paper coverage, might be affected in the same period. However, it seems rather unlikely, that housing prices today affect yesterday's news coverage. Additionally, a rich set of controls is included to avoid an omitted variable bias.

As in Bartik (1991), the local labor demand shocks $bartik_{it}$ are constructed to be exogenous given a constant labor supply. Binary uncertainty indicators are coded to be one if uncertainty is above a threshold value and zero otherwise. Our regression model is given by

$$y_{it} = x_{it-\tau}\vec{\gamma} + 1_{unc,it-\tau}\vec{\beta}_{1t-\tau} + bartik_{it-\tau}\vec{\beta}_{2t-\tau} + 1_{unc,it-\tau} \times bartik_{it-\tau}\vec{\beta}_{3t-\tau} + \alpha_i + u_{it} \quad (2)$$

where $x_{it-\tau}$ is a vector containing up to τ lags of the control variables, γ is the corresponding parameter vector, α_i is the state specific intercept, $1_{unc,it-\tau}$ and $bartik_{it-\tau}$ are $(1 \times \tau)$ vectors of lagged uncertainty indicators and labor demand shocks, respectively, and $\beta_{jt-\tau}$, $j = 1, 2, 3$ are the corresponding $(\tau \times 1)$ parameter vectors. An element of $\beta_{jt-\tau}$ reflects the impact of the respective lag, while the sum of the elements gives the long-run impact.[9] The coefficients of main interest are $\beta_{1t-\tau}$, $\beta_{2t-\tau}$ and $\beta_{3t-\tau}$. $\beta_{1t-\tau}$ reflects the impact of a regime-change from low to high uncertainty, $\beta_{2t-\tau}$ reflects the impact of a local labor demand shock on the housing market

[9] We experimented with different lag-lengths and use $\tau = 6$ lags as baseline specification, but the results are not sensitive to the number of lags as long as we use more than two and less than seven.

Table 2: Long-run Effects of Uncertainty, Bartik and Interaction term

Dependent Variable	$\mathbf{1}_{macro}$	Bartik	Bartik*$\mathbf{1}_{macro}$
Δlog(house price)	-.0142***	10.925***	-14.35***
	(.00344)	(3.8337)	(4.3892)
Δlog(median sell price)	-.0180**	32.627***	-31.68***
	(.00752)	(10.679)	(11.765)
Δ% selling for loss	.52575	-1133.**	994.94**
	(.37032)	(492.26)	(485.88)
Δturnover	-.0036	147.26**	-202.0**
	(.05451)	(66.317)	(79.781)

Note: Sample period from 1990 onwards. The long-run effects of uncertainty (95th percentile threshold), bartik and interaction term are presented with corresponding standard errors in brackets. * indicates significance at 10% level, ** indicates significance at 5% level, *** indicates significance at 1% level

and $\beta_{3t-\tau}$ states the (change in the) effect of a local labor demand shock due to a period of high uncertainty. As the months defined as high uncertainty differ across the proxies, the variation used to identify $\vec{\beta}_{1t-\tau}$ and $\vec{\beta}_{3t-\tau}$, the coefficients of uncertainty and the interaction term, differs as well.

Our empirical objectives are to show (i) the quantitative effect of uncertainty on the housing market, (ii) the change in the impact of local labor demand shocks on the housing market if they occur during periods of uncertainty and (iii) the sensitivity of the results with respect to varying threshold levels and different uncertainty proxies. Table 2 shows our benchmark regression results based on the Macro Uncertainty measure, $\mathbf{1}_{macro}$, from Jurado et.al. (2015). All the estimated $\vec{\beta}_j$ represent the long-run effect, i.e. the sum of the estimated elements of $\vec{\beta}_{jt-\tau}$.[10]

The second column of Table 2 shows the long-run impact, $\vec{\beta}_1$, of uncertainty on housing prices, median sell prices, the percentage loss of houses selling and turnover; we control for the federal funds rate, housing starts proxying for residential investment, income, industrial production, inflation, population, the S&P 500, the unemployment rate and the VIX. Moreover, for the regressions where turnover is the dependent variable, we include housing prices as control variable.[11] As opposed to the results in Dorofeenko et al (2014), uncertainty adversely affects house prices and

[10] We use 95th percentile as our cut off point for the Macro Uncertainty measure.
[11] We also control for autocorrelation and hetroskadascities in all our empirical regressions.

the median sell prices on average by 1.42% and 1.80%, respectively. Uncertainty itself, however, impacts neither turnover nor the share of houses selling for loss. The results for different threshold values (i.e. percentile cutoffs) are shown Figure 3. Regardless of the threshold value, the sign and the significance of the estimated $\vec{\beta}_1$ for the log house price and log median sold price do not change.[12]

The column three of Table 2 shows the long-run impact of labor demand shocks, proxied by the *bartik* index. The impact is highly significant for all dependent variables, even after controlling for state-level unemployment. For example, one standard deviation increase in the local labor demand shock (i.e. the *bartik* index, which is defined as change in state-level employment relative to a change in national employment), increases house prices, median sell prices and transactions on average by .14%, .43% and 1.92%-points, respectively and decreases the share of houses selling for loss by 14.77%-points. Due to linearity, the signs reverse in the case of adverse labor demand shocks - as observed in most states during the Great Recession period.[13]

The above results indicate that the uncertainty and labor demand shocks affect the housing market variables in opposite direction. To determine the quantitative effects of these two shocks on the housing variables, we introduce an interaction term, $\vec{\beta}_3$: the results are shown in the fourth column of Table 2. If the labor demand shock occurs during a period of high uncertainty then, for almost every dependent variable and threshold level, the effect of uncertainty shock dominates the labor demand shock: a clear sign change from the estimated $\vec{\beta}_2$being positive to the estimated $\vec{\beta}_3$ being negative. For the expositional purpose of the interaction term, Figure 4 shows the effects of labor demand shock with - and without uncertainty shock (e.g. Macro Policy uncertainty shock). The blue line (Bartik Normal Times) summarizes the long-run impact of labor demand shocks, $\vec{\beta}_2$, on the various dependent variables, while the red line (Bartik High Uncertainty) represents the impact of labor demand shocks in uncertainty times, i.e. $\vec{\beta}_2 + \vec{\beta}_3$. Figure 4 clearly shows

[12] All of the coefficients are significant at a 1% significance level.

[13] We report the impact of a standard deviation increase due to the scale of the bartik. Mean local labor demand decreases from 1990 until 2014 by .004%-points, while one standard deviation corresponds to .013%-points: E.g. for the log house price, an increase of 0.14% as 0.013×10.93.

Table 3: Long-run Effects of Uncertainty, Bartik and Interaction term: Other Uncertainty measures

Dep. Variable	1_{macro}	Bartik (B)	B*1_{macro}	1_{state}	B	B*1_{state}	1_{vix}	B	B*1_{vix}
$\Delta_{log(house\ price)}$	-.0142***	10.925***	-14.35***	-.0048***	15.315***	-17.63***	.00191	12.625***	-11.40
	(.00344)	(3.8337)	(4.3892)	(.00144)	(4.2199)	(4.4932)	(.00482)	(4.2128)	(7.1745)
$\Delta_{log(med\ sell\ price)}$	-.0180**	32.627***	-31.68***	-.0033	30.296***	-24.84**	-.0058	42.316***	-44.64***
	(.00752)	(10.679)	(11.765)	(.00405)	(11.723)	(12.330)	(.00930)	(12.339)	(16.513)
$\Delta\%$ selling for loss	.52575	-1133.**	994.94**	.48216**	-1229.**	1038.6*	.48033	-1584.0***	1517.5**
	(.37032)	(492.26)	(485.88)	(.23001)	(479.62)	(558.01)	(.54268)	(524.17)	(699.86)
$\Delta_{turnover}$	-.0036	147.26**	-202.0**	-.0577***	81.225*	-152.3***	.05951*	95.007*	-102.4
	(.05451)	(66.317)	(79.781)	(.02065)	(43.376)	(57.010)	(.03517)	(54.964)	(98.765)

Note: The long-run effects of uncertainty (95th percentile threshold), bartik and interaction term are presented with corresponding standard errors in brackets. * indicates significance at 10% level, ** indicates significance at 5% level, *** indicates significance at 1% level. We do not include policy uncertainty by Baker et al (2012) as the results similar to other measures and due to the space limitation.

that when uncertain periods occur then the effect of the labor demand shock is greatly muted. These dominating uncertainty shock effects lend some support to the real options effects in housing market: housing market participants "wait and see" when uncertainty shocks arrive.[14] Figure 5 is analogous to Figure 4, but with the State Policy uncertainty shock: the results are not overturned.

We note, however, our results are somewhat sensitive to the choice of the uncertainty proxy, which can be seen in Table 3. For example, the impact uncertainty shocks on the growth rates of housing prices, median sell prices is robust although slightly differs quantitatively: one exception is when the VIX is used to define periods of high uncertainty. This result is to be expected as the different uncertainty proxies indicate different periods of high uncertainty, and moreover the level variable VIX is included as control variable in all the regressions in Table 3.[15]

[14] See also Davis and Quintin (2014), who find that uncertainty about housing prices kept the default rate low relative to a situation without uncertainty.

[15] Although we do not show the results with the Policy Uncertainty shock is Table 3, the wait-and-see effects ($\vec{\beta}_3$) from the Policy Uncertainy are not as strongly associated if high threshold values (90th or 95th percentile) are used. The reason might be that when the 95th percentile threshold, the Policy Uncertainty proxy represents only the periods that are associated with the post 2011 period (this includles the period during the European Debt crisis). And hence, there is not enough sample size to test for the interaction terms. However, if the 85th percentile is taken as threshold value, the interaction effects become significant again, as more periods, especially the months before 2010, are classified as periods of high uncertainty.

Table 4: Long-run Effects of Bartik and Interaction term grouped by the magnitude of the housing price volatility over time.

Housing Price Volatility	low		medium		high	
	Bartik (B)	$B*1^{low}_{state}$	B	$B*1^{medium}_{state}$	B	$B*1^{high}_{state}$
Δlog(house price)	18.47**	-6.85	7.055***	-9.26	21.26***	-25.0***
	(7.802)	(7.131)	(2.596)	(6.253)	(6.899)	(8.905)

Note: The long-run effects of bartik and interaction term based on State-level uncertainty (95th percentile threshold) are presented with corresponding standard errors in brackets grouped by housing price volatility across states. * indicates significance at 10% level, ** indicates significance at 5% level, *** indicates significance at 1% level.

3.1 State Level Real Option Effects

To assess whether uncertainty shocks amplify housing price volatilities, and hence further provide empirical evidence for the real option effects, we analyze the uncertainty effects on three different groups that are sorted according to their housing price volatilities over time. Three groups represent all fifty one U.S. States with equal size. We refer these three groups as *low*, *medium* and *high.* We investigate the occurrence of real option effects for each one of the groups based on our regression model (2), using the 95th percentile of the State-level uncertainty proxy, so as to exploit the variation in uncertainty across States. The results for the three different groups are shown in Table 4.

The most striking difference between the three groups is with respect to the significance and the magnitude of the interaction effect ($\vec{\beta}_3$) for the *high* group. As one moves away from the low to high volatility group, the interaction term ($\vec{\beta}_3$) not only decreases in magnitude from -6.85 to -25 (i.e. one standard deviation increase in the interaction term decreases -0.09% to -0.32% in the log house price) but also becomes highly statistically significant. And if one also looks at the total effect of Bartik demand shock on the changes in log house price (i.e. $\frac{\partial \Delta log(house\ price)}{\partial bartik} = \widehat{\vec{\beta}}_2 + 1_{unc}\widehat{\vec{\beta}}_3$), the effect decreases with increasing housing price volatilities. We interpret these empirical results as an informal evidence that uncertainty shocks dampen housing price volatilities as the demand for houses decrease due to the wait and see (real option) effect in the housing market. Figure 6 shows the changes in turnover (transaction for houses) by groups over time: Figure 6 lends some

Table 5: Long-run Effects of Bartik and Interaction term grouped by the impact of the bartik in each State.

Bartik Index	low		medium		high	
	Bartik (B)	$B^*1^{low}_{state}$	B	$B^*1^{medium}_{state}$	B	$B^*1^{high}_{state}$
$\Delta_{\text{log(house price)}}$	9.835***	-5.16	52.98***	-16.1	104.9***	-102.**
	(2.328)	(5.947)	(9.703)	(14.43)	(21.13)	(45.07)

Note: The long-run effects of bartik and interaction term based on State-level uncertainty (95th percentile threshold) are presented with corresponding standard errors in brackets grouped by housing price volatility across states. * indicates significance at 10% level, ** indicates significance at 5% level, *** indicates significance at 1% level.

support that indeed the demand for housing does decrease for the group (States) that exhibit high house price volatilities.

For the robustness check, we also sort groups by the economic condition: sorting by the importance of local labor demand shocks. We calculate the impact of the *bartik* index based on our model (2) with housing prices as dependent variable, but running time-series regressions for each State. We only select States where the *bartik* has a significant impact (5% level) on housing prices, which results to 37 States. We then sort these 37 States into three almost equal size. Table 8 shows the long-run effects of Bartik and Interaction term grouped by the impact of the bartik in each State. Table 8 shows that uncertainty shocks affect and amplify house prices more in regions that have high income level. Consequently, the results in Table 8 again lend us empirical support that higher the effects of uncertainty shock the higher the real option effects in housing markets.

4 Conclusion

Our empirical results lend support for the real option effect of wait-and-see in the U.S. housing market and are in line with some of the predictions of Bloom's (2009) theoretical model. Using the State-level panel data from 1990:1 to 2014:12, we show (i) uncertainty has a small but highly significant impact on the level of housing prices, (ii) uncertainty diminishes the effects of (adverse) labor demand shocks and (iii) the results are robust to changes in the threshold defining times of high uncertainty but are somewhat sensitive to the choice of uncertainty proxy. We interpret this result as the different proxies capturing different aspects of uncertainty, with the proxy of Jurado et al. (2015) being well suited, due to its construction, to capture the spells of uncertainty that induce macro-level real options effects. These findings are important for policy makers, because since uncertainty can delay the potential impact of adverse real shocks due to real options effects, such as selling ones home for loss or as foreclosure, it might be possible to mitigate adverse effects of real shocks during periods of high uncertainty before they materialize.

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Table 6: Uncertainty Proxies

Variable	Availability	Source	Regional level
Macro Uncertainty	1960M1-2011M12	Jurado et al. (2015)	National
Policy Uncertainty	1985M1-2015M2	Baker et al. (2012)	National
State Uncertainty	2000M1-2014M12	Self constructed	State
Vix Uncertainty	1990M1-2015M2	FRED	National

Table 7: Dependent Variables

Variable	Availability	Source	Regional level
House Price	1975M1-2014M12	Freddie&Mac	State
Median Sold Price	1996M4-2014M12	Zillow Database	State
% Selling For Loss	1998M1-2014M12	Zillow Database	State
Total Turnover	1998M1-2014M12	Zillow Database	State

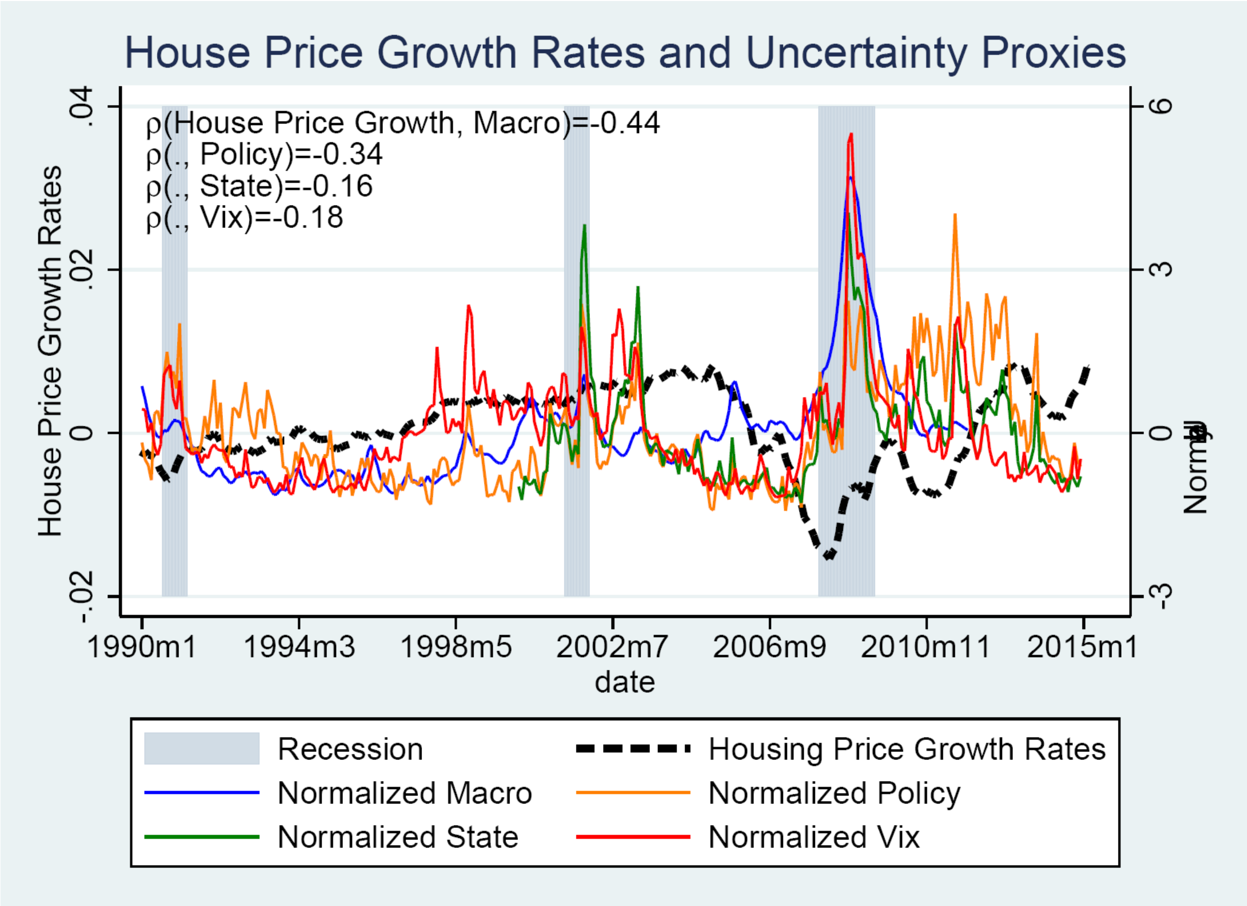
6 Data Appendix

The state-level uncertainty indicator was constructed as the monthly number of news-paper articles in a state containing either one of the keywords “economic uncertainty”, “economy uncertain” or “economy uncertainty” from 2000:1 until 2014:12 from the homepage www.newslibrary.com. In creating this index, we follow Baker et. al (2012). The data sources are given in the following tables.

Table 8: Control Variables

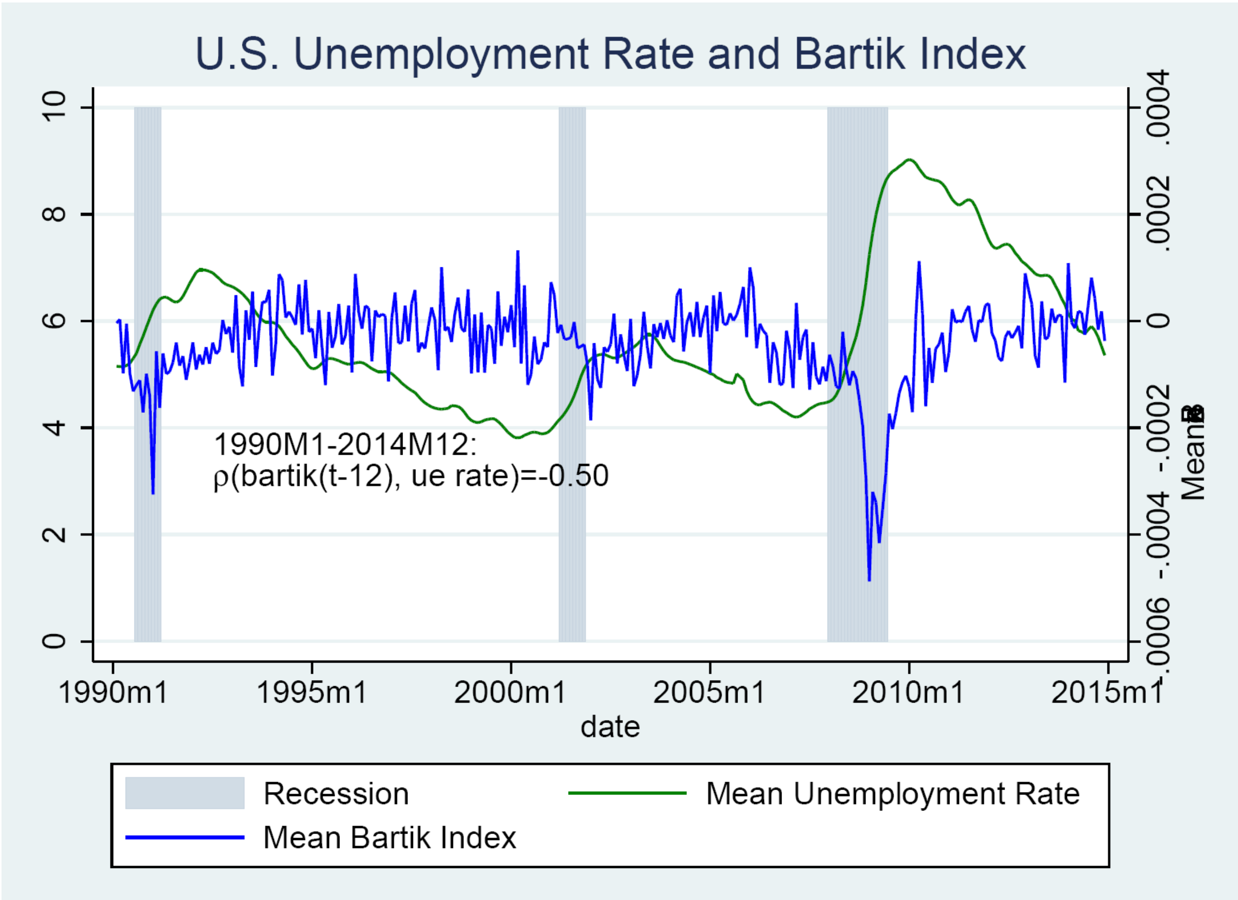
Variable	Availability	Source	Regional level
Federal Funds Rate	1954M7-2015M1	FRED	State
Housing Starts	1988M1-2015M1	FRED	State
Income	1950Q1-2014Q3	BEA	State
Industrial Production	1919M1-2015M1	FRED	National
Inflation Rate	1947M1-2015M1	FRED	National
Population	1972-2013	FRED	State
S&P 500	1970M1-2015M3	Datastream	National
Unemployment Rate	1976M1-2014M12	FRED	State

Figure 1



House Price Growth Rates and Uncertainty Proxies
ρ(House Price Growth, Macro)=-0.44
ρ(., Policy)=-0.34
ρ(., State)=-0.16
ρ(., Vix)=-0.18
House Price Growth Rates
.04
.02
0
-.02
6
3
0
-3
Normal
1990m1
1994m3
1998m5
2002m7
2006m9
2010m11
2015m1
date
Recession
Housing Price Growth Rates
Normalized Macro
Normalized Policy
Normalized State
Normalized Vix

Figure 2



U.S. Unemployment Rate and Bartik Index
1990M1-2014M12:
ρ(bartik(t-12), ue rate)=-0.50
0
2
4
6
8
10
-.0006
-.0004
-.0002
0
.0002
.0004
Mean
1990m1
1995m1
2000m1
2005m1
2010m1
2015m1
date
Recession
Mean Unemployment Rate
Mean Bartik Index

Figure 3

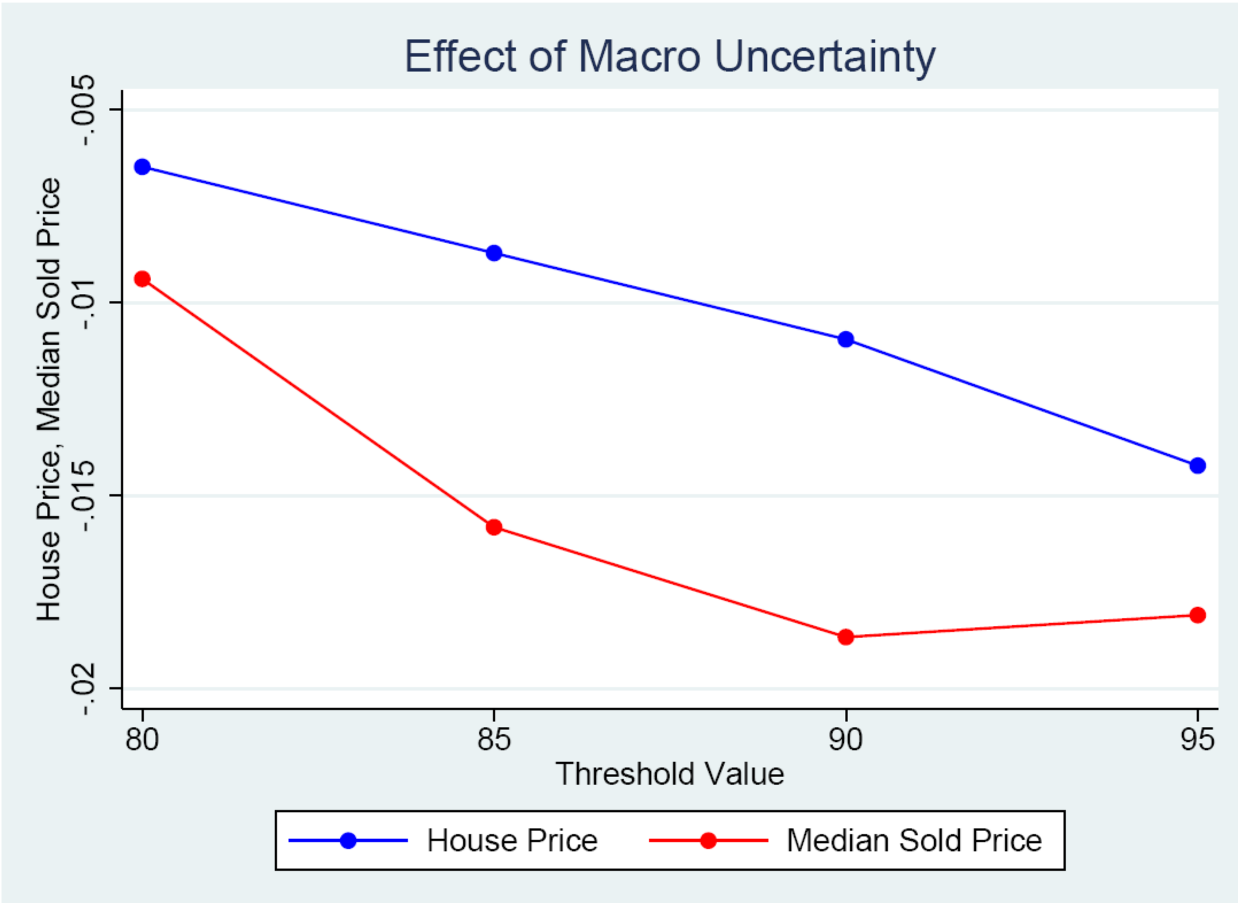
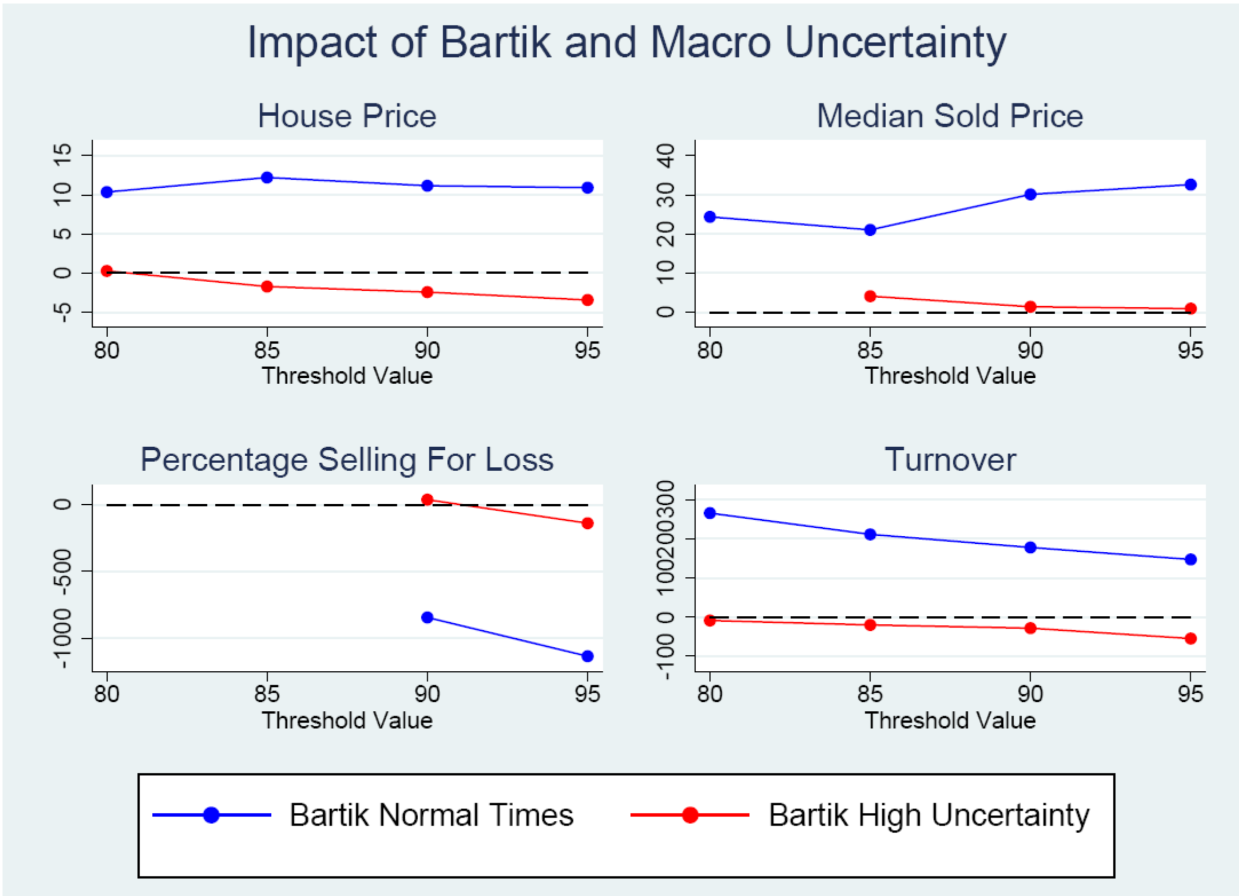
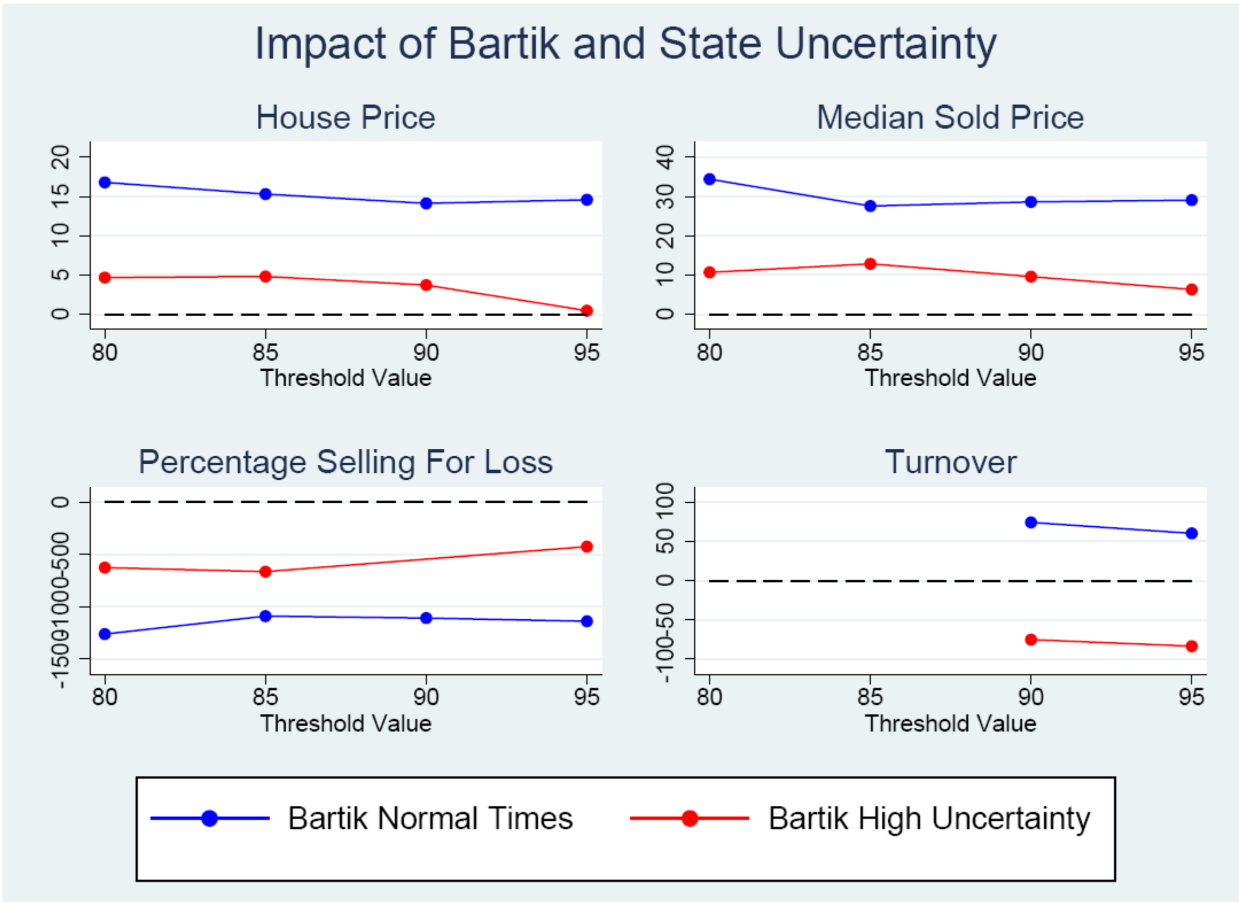

Effect of Macro Uncertainty
House Price, Median Sold Price
-.005
-.01
-.015
-.02
80
85
90
95
Threshold Value
House Price
Median Sold Price

Figure 4



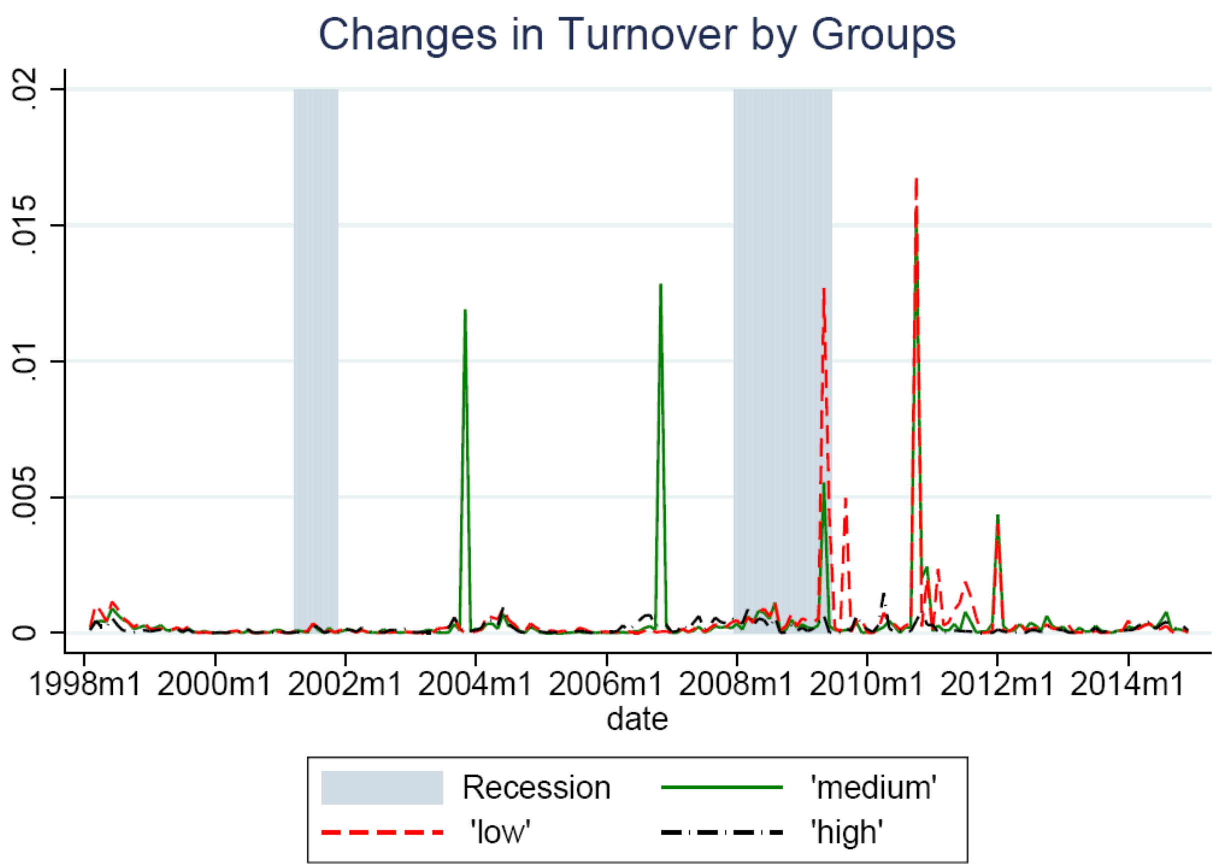
Impact of Bartik and Macro Uncertainty
House Price
Median Sold Price
Percentage Selling For Loss
Turnover
Threshold Value
80
85
90
95
-5
0
5
10
15
20
30
40
-1000
-500
-100
100
200
300
Bartik Normal Times
Bartik High Uncertainty

Figure 5



Impact of Bartik and State Uncertainty
House Price
Median Sold Price
Percentage Selling For Loss
Turnover
Threshold Value
80
85
90
95
0
5
10
15
20
30
40
-500
-1000
-1500
-50
-100
50
100
Bartik Normal Times
Bartik High Uncertainty

Figure 6



Changes in Turnover by Groups
0
.005
.01
.015
.02
1998m1
2000m1
2002m1
2004m1
2006m1
2008m1
2010m1
2012m1
2014m1
date
Recession
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Housing and Mortgage Acquisition with Favors in Transition Economies

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Keywords: housing, tenure choice, privatization, mortgages, transition economies

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Abstract

This paper employs an extensive household survey data set covering a wide range of transition countries to empirically characterize the housing choices of households. The paper provides a descriptive overview of the types of dwellings, housing tenure, mode of acquisition, and mortgage prevalence by country. The theoretical motivation for the empirical analysis incorporates both formal payment for housing and/or mortgage, and informal payment or the use of a favor (blat) as common in many transition economies. To explain the wide variation in housing and mortgage patterns across countries, empirical models of both acquisition mode (privatized, purchased or built without a bank mortgage, purchased or built with a bank mortgage, inherited or recieved as a gift, or other mode) and housing tenure choice (rent, own, other) are estimated using limited dependent variable methods. Furthermore, the prevalence of mortgage financing is analyzed. Data used in this study are from the European Bank for Reconstruction and Development (EBRD) Life in Transition Survey, LITS II, for the year 2010 covering 29 transition countries plus Kosovo.

JEL codes: R21, G21, P25, P36

Keywords: housing, tenure choice, privatization, mortgages, transition economies

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1 Introduction and Background

This paper employs an extensive household survey data set covering a wide range of transition countries to empirically characterize housing and mortgage choices and modes of acquisition by households. The paper provides a descriptive overview of the types of dwellings, housing tenure, mode of acquisition, and mortgage prevalence by country. Wide variations in housing situations are observed across transition countries. To explain these patterns, empirical models of both acquisition mode (privatized, purchased or built with mortgage from a bank, purchased or built without a mortgage, cooperative, inherited, or other mode) and housing tenure choice (rent, own, other) are estimated using limited dependent variable methods (dichotomous probit and multinomial probit models). These models are estimated conditional on the type of dwelling (detached house, semi-detached house, apartment/flat, part commercial/industrial, mobile home/tent/ger, improvised housing unit, etc.). Furthermore, the prevalence of mortgage financing and terms are analyzed. The survey includes a number of questions on mortgages, including the currency in which the mortgage is denominated, the type of interest rate (fixed, variable, etc.), monthly mortgage payment, amount borrowed, down payment, term of mortgage, and payment arrears. In addition, the survey provides information on the rental equivalent for owner-occupied houses. Household responses to these survey questions are used to model mortgage prevalence and choice based on household and country characteristics. Household income and sources of that income (wage and salary, self-employment, sales or bartering of farm products, pensions, state benefits, friends and family, etc.) are used as explanatory variables, along with other household characteristics and country fixed effects. Data used in this study are from the European Bank for Reconstruction and Development (EBRD) Life in Transition Survey, LITS II, for the year 2010.

Privatization has been investigated extensively since the seminal events in Russia and elsewhere in the 1990s. Boycko et al (1996) provides a fascinating look at that experience, placing an emphasis on the key role of property rights and the need to depoliticize firms in the face of strong opposition. Their essential observation is that ultimately firms owning assets in the Former Soviet system had to learn to be responsive to the market rather than to political influences. Restructuring of a planned economy requires privatization of urban land and real estate. So, in order to facilitate that restructuring urban land and buildings have to be privatized, complementing the privatization of plants and equipment. Without privatization of land and buildings, Boycko et al maintain that control rights over those complementary physical assets are divided between local politicians and firm managers resulting in a very inefficient ownership structure inhibiting transition. Another reason for privatizing land and real estate is that it provides a source of capital for firms to use in restructuring. By privatizing the housing stock owned by a state-owned enterprise, for example, capital is raised that can be used for investment in new equipment and machinery necessary to be competitive in world markets. Case studies of land and housing privatization in Bulgaria, the Czech Republic, and Poland are provided in Strong et al (1996). They chronicle the ways in which controls over rights to acquire and dispose of property and on the pricing of property assets were relaxed and/or removed, resulting in functioning housing markets.

Homeownership is affected by both economic and life-cycle factors faced by households. Economic factors such as the conditions in housing and mortgage markets are major determinants of homeownership. In a comparative perspective across countries, the tax treatment of owner-occupied housing also has an impact. Additionally, the life-cycle aspects of renting vs. owning are important as household composition transitions over time.

Barakova et al (2014) explain that wealth, followed by credit and income, are the primary constraints on homeownership. In their study they use data from the National Longitudinal Survey of Youth (NLSY) to examine the likelihood of homeownership during the period of the housing boom 2003-2007 in the United States. Unlike the borrowing constraints from income and credit, they find that the wealth constraint persists despite easier underwriting practices during this period.

Tenure choice, between renting and owning, is one classical aspect of the housing decision investigated by economists. An early study of the economic and life-cycle aspects of tenure choice is Henderson and Ionnides (1983). Hubert (2007) provides a very good over view of the major issues related to tenure choice, with an emphasis on the ways that imperfect information and frictions affect the workings of the housing market in particular. In a recent paper with an international perspective, Boehm and Schlottmann (2014) provide evidence on housing tenure transitions. They use both German and U.S. data to investigate how households may transition from renting to owning, and perhaps back to renting again. Their study finds that in housing and mortgage market conditions, as well as differences in the tax treatment of owner-occupied housing, account for observed differentials in tenure transitions.

Additional complexities arise in the context of both developing and transition countries. For example, Anderson (2001) investigates emerging housing markets in the former Soviet country of Moldova and finds that house prices are determined by traditional factors such as location and physical characteristics. But, he also finds that factors specific to the transition context of the country matter. Morais and Cruz (2009) investigate homeownership in Brazil taking into account the dual nature of the housing market in that country. With both formal and informal housing markets, households have the choice of which market in which to participate, as well as the tenure choice conditional on the market choice. Their evidence indicates that additional education increases the probability of a household choosing to participate in the formal housing market, either as a renter or an owner. Given that choice, they find that the probability of ownership is higher for non-afro descendents, male-headed households, and households working in the public sector. They also find that lower income households, younger households, recent migrants, and single mothers have higher probabilities of renting or owning housing in informal settlements. Ownership in the formal housing market is well predicted by wealth, age, household size, and marital status.

Furthermore, in a former Soviet context there is the system of informal favors chronicled by Ledeneva (1998) by which goods such as housing were allocated informally in place of reliance exclusively on the price mechanism. That system is known as blat, defined by Ledeneva as, "...the use of personal networks and informal contacts to obtain goods and services in short supply and to find a way around formal procedures." Blat represents a form of exchange that falls between gift and commodity, with its own distinctive norms of reciprocity and ethics. The presence of the blat system suggests that in transition countries once within the sphere of influence of the Soviet Union, factors that capture connections or social capital may help explain homeownership.

These studies suggest that the key factors to consider are economic, demographic or life-cycle, and informal. In the models that are estimated below all three types of explanatory variables are used. Economic factors include the respondent's income and its sources. While it would be helpful to include wealth measures as well, there are none available in the LITS II survey. Demographic and life-cycle factors used in the models include age, marital status, and length of residence in the current location. A key informal factor included in some of the models is membership in the Communist Party, or membership of the respondent's father in the Party. This factor captures the blat effect, or social capital measure, by which allocation of scarce housing resources may have been affected in Soviet times.

2 Model of Housing Acquisition with Favors

In this section a model of housing acquisition with favors is presented. While there are multiple aspects of acquisition that should be considered, this model focuses on the specific feature of transition economies related to favors or informal payments that were common in the early years of transition. The basic approach taken in this model is that in the housing market of a transition country the acquisition of a house may require both a formal payment and an informal payment or the use of a favor (blat). That informal payment may be required either in lump-sum form, in which case it has no efficiency effect, or in a form that is related to the quantity of housing, in which case an inefficiency is introduced. If the informal payment is related to the quantity of housing the payment acts like a tax on housing.

Suppose we have a household purchasing two goods x_1, x_2 where the first good is housing and the second good is a composite consumption good. The utility function is taken as Cobb-Douglas in form:

$$U = Ax_1^{\alpha}x_2^{(1-\alpha)} \tag{1}$$

The the goods prices are p_1 and p_2. The household budget function given income Y is then written as,

$$Y = p_1x_1 + p_2x_2. \tag{2}$$

In addition to the usual budget, suppose that the acquisition of housing requires an informal payment, which may be either a lump-sum amount, or a variable payment that depends on the quantity of housing. We can denote the informal payment or favor (blat) as,

$$B = b_0 + b_1x_1, \tag{3}$$

where b_0 is the lump-sum payment or favor required and $b_1 x_1$ is the variable payment that depends on the quantity of housing.

In a competitive market context with no informal payments required, the utility maximizing solution is derived using the Lagrangian,

$$L = A x_1^{\alpha} x_2^{(1-\alpha)} + \lambda[Y - p_1 x_1 - p_2 x_2] \tag{4}$$

and the usual first order necessary conditions are,

$$\frac{\partial L}{\partial x_1} = \alpha A x_1^{\alpha-1} x_2^{(1-\alpha)} - \lambda p_1 = 0 \tag{5}$$

$$\frac{\partial L}{\partial x_2} = (1-\alpha) A x_1^{\alpha} x_2^{-\alpha} - \lambda p_2 = 0 \tag{6}$$

$$\frac{\partial L}{\partial \lambda} = y - p_1 x_1 - p_2 x_2 = 0 \tag{7}$$

Equations (5) and (6) yield the traditional conditions that the marginal utility of each good must equal its price. Furthermore, the equations generate the condition,

$$\frac{\alpha A x_1^{\alpha-1} x_2^{(1-\alpha)}}{(1-\alpha) A x_1^{\alpha} x_2^{-\alpha}} = \frac{\alpha x_2}{(1-\alpha) x_1} = \frac{p_1}{p_2}, \tag{8}$$

which indicates that the marginal rate of substitution (MRS) must equal the price ratio.

Now, if we incorporate the informal payments for housing in the model we have another form of budget equation constraint and the Lagrangian becomes,

$$L = A x_1^{\alpha} x_2^{(1-\alpha)} + \lambda[y - p_1 x_1 - p_2 x_2] + \mu[B - b_0 - b_1 x_1]. \tag{9}$$

The Lagrangian multipliers λ and μ represent the marginal utility of income and favors (blat), respectively.

Differentiating with respect to the two inputs and the two Lagrangian multipliers yields the system of first order necessary equations,

$$\frac{\partial L}{\partial x_1} = \alpha A x_1^{\alpha-1} x_2^{(1-\alpha)} - \lambda p_1 - \mu b_1 = 0 \tag{10}$$

$$\frac{\partial L}{\partial x_2} = (1-\alpha) A x_1^{\alpha} x_2^{-\alpha} - \lambda p_2 = 0 \tag{11}$$

$$\frac{\partial L}{\partial \lambda} = Y - p_1 x_1 - p_2 x_2 = 0 \tag{12}$$

$$\frac{\partial L}{\partial \mu} = B - b_0 - b_1 x_1 = 0. \tag{13}$$

In this case equations (10) and (11) yield the condition for the optimal goods consumption,

$$\frac{\alpha A x_1^{\alpha-1} x_2^{(1-\alpha)}}{(1-\alpha) A x_1^{\alpha} x_2^{-\alpha}} = \frac{\alpha x_2}{(1-\alpha) x_1} = \frac{\lambda p_1 + \mu b_1}{\lambda p_2} \neq \frac{p_1}{p_2}. \tag{14}$$

This condition differs from equation (8) in that the MRS is now not equal to the simple input price ratio. Rather, the MRS must equal the price ratio altered to include the two Lagrangian multipliers and the marginal informal payment. Consequently, the household's MRS exceeds the ratio of goods prices. This expression indicates that the rate at which the household is able to substitute one good for another generally exceeds the rate at which it can economically substitute goods when informal payments or favors are included.

Two observations are important at this point. First, notice that the lump-sum portion of the informal payment, b_0, does not affect the optimality condition. While this term effectively reduces the income of the household it does not alter the efficient combination of goods desired. Second, notice that the marginal informal payment, b_1, does enter equation (14) and has an impact on the optimal housing consumption of the household. The marginal informal payment distorts the household's consumption decision. Efficiency requires that the household operate using the combination of goods where the ratios in equation (14) are equal. Due to the inequality in this expression we know that there is an inefficient allocation of resources. The household is diverted from pursuing the efficient allocation due to the informal payment required for housing.

This model provides several implications to test. First, households that are endowed with a larger stock of favors that can be used in acquiring housing are less constrained in their housing consumption. A household with no stock of favors to use in acquiring housing is limited to the cash market and is therefore unable to purchase a home which requires both a monetary payment and an informal payment or a favor. In the empirical models that follow, the prevalence of blat and its effects on housing allocation is proxied by survey respondent's membership in the Communist Party, or a family history of membership in the Party. While this is a crude and incomplete indicator, it captures an aspect of the transition context that is important.

3 Life in Transition Survey Data

Data employed in this study are from the European Bank for Reconstruction and Development (EBRD) Life in Transition Survey, LITS II, for the year 2010. The LITS survey provides a cross-section data set on a wide range of variables covering 29 transition countries plus Kosovo. The overall sample size is approximately 33,000 with about 1,000 responses per country, varying with country population size. The survey includes a number of questions on housing and mortgages as well as a wide range of other topics. For the purpose of the present analysis, the survey questions regarding housing in Section 2 of the survey are the primary source of data. Individual responses to the governance questions are used to examine citizens' views on government performance and informal payments, gifts (or bribes) related to the delivery of those public services.

The survey questions for which responses are analyzed are as follows:

- Question 201 asks whether the respondent owns a detached house, a flat, or other form of housing
- Question 202 asks whether the respondent is a renter or an owner
- Question 204 asks how the home was acquired (purchased with a mortgage, privatized, built with a mortgage, etc.)
- Question 205 asks whether the respondent has a mortgage
- Question 225b asks whether the respondent owns a second residence

Table 1 provides summary statistics for the variables used in analysis, including respondent characteristics of age, income, sources of income, marital status, and party membership. Age is measured in years. Income is self-reported on a ladder scale with ten steps. Hence, the income variable is an approximate measure of the household's decile position on the income distribution. Sources of income include salary, self-employment, farm production, pension, and state benefits. When these income source indicators are used in models, the left-out category is help from relatives or friends, or other income. Educational attainment captures the highest level of education completed. The scale used for this variable ranges from 1 (primary education) to 7 (masters or Ph.D. degree). Country fixed effects are included in the models as well, in which case the left-out country (due to the inclusion of a constant in the model) is Uzbekistan.

Summary statistics in Table 1 indicate that the mean age of respondents is nearly 52 years, and the mean reported position on the income distribution is between the fourth and fifth rungs of the ten-step income ladder. The majority of respondents earn income from a salary, 58 percent, with self-employment income reported by 20 percent, farm production income reported by 11 percent, pension income reported by 43 percent, state benefits reported by 10 percent, and help from friends and relatives or other income reported by 12 percent. Clearly, these income categories are not exclusive, as respondents may report more than one source of income. In terms of marital status, 62 percent of respondents are currently married. Seven percent of respondents are divorced. Widows account for 12 percent of the respondents. The omitted marital categories are never married and separated. The mean time respondents have lived in their current location is 41 years. Only 6 percent of respondents are members of the Communist Party, but 10 percent have fathers that were Party members.

Occupants of detached houses account for 53 percent of respondents, while 38 percent are living in flats. The remainder live in temporary housing, mobile homes, or shacks. In terms of how respondents' homes were acquired, 21 percent are privatized, 34 percent were purchased or built without a bank loan, 16 percent were purchased or built with a bank mortgage, and 26 percent were inherited or received as a gift.

4 Empirical Models

In this section probit model estimates are presented for home ownership, mode of acquisition, and mortgages. In each case, the dichotomous dependent variable is estimated as a function of survey respondent characteristics. Those characteristics include age, income, sources of income, marital status, length of residential tenure, access to credit markets, and measures of social connection (membership in the Communist Party). Country fixed effects are included in all models. Model estimates are reported in Tables 2-6.

4.1 Home Ownership

Table 2 reports the results of probit model estimation of homeownership of any type. The explanatory variables in these models include age and income along with their squared terms to permit nonlinearity in the estimated relationship. Source of income interaction terms are also included to distinguish ownership effects which may vary with the type of income the household receives. Marital status indicators and length of time the household has lived in the city control for family composition and tenure. Finally, two indictors reflecting social capital or a potential source of favors facilitating homeownership are included: an indicator of whether the survey respondent is a member of the Communist Party, and an indictor of whether the respondent's father was a Party member. The three models reported in Table 2 differ only in the inclusion of the Party membership variable.

Estimation results for the three models in Table 2 are virtually identical. Age influences homeownership in a positive way, with older respondents having a higher likelihood of owning a home. The marginal effect of age diminishes with age, however, as indicated by the negative coefficient for the age squared terms. The self-reported income level of the respondent has a positive effect on ownership as well, although the squared terms are not significant in this case, indicating a linear effect. Among the five income source indicators, self-employment and arm production income have positive effects on home ownership, while income from state benefits has a negative effect. Married couples are more likely to own a home, compared to respondents who are divorced or widowed (and compared to the left-out category of the never married). Finally, a respondent's tenure in a city, or the length of time in the city, has a significant positive effect on home ownership.

Testing for the effects of favors, or blat, that may have influenced homeownership in the transition economy setting, the Communist Party membership variables indicate that only the father's membership has an impact. Rather than increasing the likelihood of ownership, however, the father's membership variable has a negative coefficient which is marginally significant. Apparently, a legacy of family association with the Party has no strong effect on the mere question of whether the current generation owns a home of any type.

The following subsections report estimation of probit models in Table 3 of the type of home owned: detached house, flat, and second residence. In each case the dependent variable is dichotomous, taking the value of one if the respondent owns that type of house, zero otherwise.

4.1.1 Detached house

About 53 percent of the survey respondents report owning detached homes. The probit model for detached homes indicates that older citizens are significantly more likely to own detached homes because the age variable is positive and significant. The marginal effect of age declines with age, however, because the age squared variable is negative and significant. The effect of the income variable is negative, however, indicating that citizens with higher income are less likely to own detached homes. The squared income term is positive and significant, however, indicating a significant non-linear effect of income on ownership of detached homes. When evaluated at the mean income level, the combined income effects are negative. Not only does income matter, but the source of income is also important in explaining detached home ownership. If the source of income is from salary, the effect on ownership is negative. Citizens earning their income from salaries are less likely to own detached homes. Three other sources of income have a positive effect on ownership, however. If the source of income is self-employment, farm production, or pension, the likelihood of ownership is greater, other things being equal. Marital status is also important in explaining detached house owning, with married respondents more likely to own and divorced respondents less likely to own. Finally, the length of time that a respondent has lived in the city has a strong positive impact on detached home ownership.

4.1.2 Flat

Flats account for about 38 percent of the survey respondents' ownership. The probit model estimates for flat ownership indicate that older respondents are less likely to own this type of housing. The estimated coefficient for age is negative and significant while that for age squared is positive and significant. So, flat ownership declines with age at a declining rate. The estimated coefficients for income and its square are significant and positive and negative, respectively. Flat ownership rises with income at a decreasing rate. All four source of income indicators are also significant. Salaried respondents are more likely to own flats, but respondents with other sources of income are less likely, holding the amount of income constant. Marital status has an effect on flat ownership as well, with married respondents less likely and divorced respondents more likely to own flats, opposite the pattern for detached homes. Finally, the longer a respondent has lived in a city, the less likely the respondent is to own a flat. Given the opposite effect of length of time in the city for detached home owners, this result for flat owners indicates that residents start by owning a flat and later switch to owning a detached house.

4.1.3 Second residence

Ownership of a second residence only occurs for about 9% of the survey respondents, but the factors contributing to this form of homeownership are especially interesting. Age has a positive effect on second residence ownership, with the marginal impact declining with age. Income has a positive effect which grows stronger with higher income. Sources of income matter, with salaried, self-employed, and pensioners more likely to own second residences. Married, divorced, and widowed respondents are less likely to own second residents relative to those who are never married.

Because second residences are relatively unlikely to be owned, there is reason to believe that allocation of these residences may be subject to informal influences, (cashing-in blat). To test this possibility the first specification for second residences in Table 3 includes a dichotomous variable indicating whether the respondent is a member of the Communist Party. The estimated coefficient for this variable is positive and significant indicating that Party members are more likely to own second residences. The marginal effect is approximately 1.5 percent. The second specification reported in the table exchanges the Party membership variable for a similar indicator for the respondent's father. In this case the Party membership effect is even stronger. Survey respondents whose fathers where Party members are significantly more likely to own second residences. In this case, the marginal effect is nearly 3 percent. Aside from income, age, and other factors, the legacy of the informal favors provided in the former regimes of these transition countries resulted in greater second residence ownership for membership in the Party, or a family legacy of membership. While the precise nature of these second residences are not knowable based on the survey data, it is tempting to refer to this as a *dacha effect*–a home away from home.

4.2 Mode of Acquisition

Table 4, panels a and b, report estimates of probit models of house acquisition mode: privatized, purchased or built with a mortgage from a bank, purchased or built without a mortgage from a bank, and inherited or gift.

4.2.1 Privatization

Homes acquired through privatization are modeled in the first two columns of results in Table 4a. Older survey respondents are more likely to indicate that they acquired their homes via privatization since the age coefficient in both models is positive and significant. The age squared variable is negative and significant indicating that the marginal effect of age declines with age. Interestingly, income has no effect although three of the source of income indicators are significant. Self-employed respondents and those reliant on state benefits are all less likely to have acquired their homes through privatization. Pensioners are more likely.

Detached homes are significantly less likely to have been acquired through privatization while flats are more likely to have been acquired that way. Membership in the Communist Party has no effect on a survey respondent's likelihood of acquiring a home via privatization. But, if the respondent's father was a member of the Party, the likelihood of acquiring a home through privatization is significantly reduced.

4.2.2 Purchased or built without a mortgage from a bank

The third and fourth columns of Table 4a report results of probit model estimation for homes that were purchased or built without a mortgage from a bank. The effect of age on acquisition this way is positive, with a declining marginal effect. Older respondents are more likely to indicate that they acquired their homes through purchase or building without a mortgage from a bank. Income is a significant factor for this mode of acquisition, in contrast to the privatization case. The effect of income is positive, with higher income respondents more likely to indicate that they purchased or built their homes without a mortgage from a bank. The income effect is nonlinear, however, with the marginal effect declining with income. Two of the income source indicators are significant explanatory variables. Respondents with self-employment income and those with farm production income are more likely to have purchased or built their homes without a mortgage from a bank.

Detached homes are more likely to be acquired in this manner, while flats are less likely. Because this mode of acquisition does not use a bank mortgage it is important to include a control in the model to account for credit worthiness. While the LITS survey contains little information useful for this purpose, there is a question in the survey asking whether the respondent has a credit card. Inclusion of that variable in the model results in a negative and significant coefficient, indicating that credit card holders are less likely to have acquired their homes without bank mortgages.

Respondent Party membership in this case has a negative effect on this acquisition mode. Party members are less likely to purchase a home or build without a mortgage, which may indicate they are more likely to do so with a mortgage. In this case, it may be that blat provides access to credit. A father's Party membership has no effect, as indicated in the last column of results in the table.

4.2.3 Purchased or built with a mortgage from a bank

The first two columns of Table 4b reports model estimation results for homes acquired through purchase or building with a mortgage from a bank. For this mode of acquisition, age has a negative effect. Older respondents are less likely to have acquired their home through purchase or building with a bank mortgage. That marginal age effect is nonlinear, declining with age. Notice that this result is opposite to that for the purchase or building of a home without a bank mortgage. The effect of income in this acquisition mode is insignificant. Source of income does matter, however. Salary and state benefit income sources increase the likelihood of home acquisition by this mode. Self-employment, farm production, and pension income have the opposite effect, however. While marital status had no significant effect for acquisition without a bank mortgage, in this case married respondents are significantly more likely to acquire their home with a bank mortgage. Detached homes are less likely to be acquired in this manner.

Credit card holders are more likely to have acquired their homes with bank mortgages. The credit card variable apparently captures their ability to obtain credit more generally, including a mortgage.

Party membership has a significant effect, with the respondent's membership associated with an increase in the likelihood of acquisition with a bank mortgage. This result suggests, perhaps, that Party membership plays a role in loan qualification or credit availability. A father's membership has no effect in this case, however.

4.2.4 Inherited or gift

The final mode of acquisition analyzed is obtaining a house through inheritance or as a gift. The third and fourth columns of Table 4b report the results of probit model estimation for this mode of acquisition. Age has a negative and declining effect, so older respondents are less likely to indicate they acquired their home through inheritance or as a gift. Income has a negative effect as well, with higher income associated with a lower likelihood of acquisition by this mode. Among the source of income indicators, respondents with income from salary sources have a lower likelihood of inheriting or receiving a home as a gift. Those with income from farm production sources are significantly more likely to acquire their homes this way. Detached houses are more likely to be passed on this way, while flats are less likely.

A father's membership in the Communist Party has a positive effect on passing a home onward through inheritance or as a gift. In this way, the legacy of the system of favors in the former regime appears to live on.

4.3 Mortgages

The survey data indicate that only about 5% of respondents currently have a mortgage. Of course, that statistic ignores the possibility that respondents may have previously had a mortgage. Analysis here begins with the current mortgage holders only. Table 5 reports model estimates for current mortgage holders, regardless of the type of home owned. Three estimated models are reported differing only with the inclusion of Party membership variables.

Across the three models specifications, the age coefficient is not significant, but its square is negative and significant indicating that older respondents are less likely to be current mortgage holders. The income variable has a negative and significant coefficient while its squared term has a positive and significant coefficient. Hence, higher income respondents are less likely to currently hold a mortgage, and the effect is nonlinear. Source of income indicators do matter, with salary, self-employment, and state benefit income source coefficients being positive while farm production, and pension sources have negative effects on current mortgage holding. Among the marital status indicators, the married and divorced variables have positive and significant coefficients. Married and divorced respondents are more likely to be current mortgage holders, relative to widows and the never married.

Two housing type variables are included in the model to control for detached house and flat mortgage effects. The estimated coefficient on the detached house variable is negative and significant, indicating that detached home owners are less likely to currently have a mortgage. Flat owners are also less likely to currently hold mortgages.

Once again, to control for credit worthiness of the survey respondent the credit card variable is included in the model. The estimated coefficient for this variable is positive and statistically significant in all three models. Respondents with credit cards are more likely to currently hold a mortgage, reflecting their access and ability to obtain credit.

The Party membership variable has a positive and significant coefficient indicating that members are more likely to currently hold mortgages. Party membership may bring with it social connections that enhance access to credit and the ability to obtain a mortgage. The effect of a father's Party membership has no effect.

Table 6 provides estimates of models of detached home owners who also have mortgages. The results for these models are quite consistent with those in Table 5. The age effect is positive and significant in this case, with a nonlinear effect. Income has a negative effect, also with a nonlinear pattern. Credit card holders are more likely to have current mortgages on their detached homes. Party membership variables are not significant in these models, however.

5 Summary and Conclusions

This study provides an empirical analysis of homeownership in transition countries using the EBRD LITS II survey data of 2010. Models of homeownership, the type of homes owned, mode of acquisition, and use of mortgages are investigated.

Homeownership in general is more prevalent for older households, married couples, and those with higher incomes. When specific types of home ownership are analyzed, variations are revealed, however. Detached homes are more likely to be owned by older households and households that have lived in the community a longer time, but the income effect in this case is negative with higher income households less likely to own these homes. Married couples are more likely to own detached homes while divorced individuals less likely. The ownership patterns for flats are different. Older households are less likely to own flats while higher income households are more likely. Married couples are less likely to own flats and divorced respondents are more likely. Ownership of a second residence is less frequent and subject to additional influences. Older and higher income households are more likely to own second residences. Beyond those factors, the importance of social capital, informal payments, favors, or blat, are also evident. Membership in the Communist Party has a significant positive effect on second home ownership. Even more important is the survey respondent's father's Party membership. These results indicate a *dacha effect* that accompanies Party membership.

Mode of house acquisition is modeled as well, including acquisition by privatization, purchase or building with or without a bank mortgage, and acquisition by way of inheritance or gift. Analysis of privatization indicates that detached homes are less likely to have been acquired through this means while flats are more likely to have been acquire this way. Homes that are purchased or built have different patterns of explanatory variable effects, depending on whether a mortgage was used or not. for those purchased or built without a mortgage, age and income both have positive effects. For those purchased or built with a mortgage, age has a negative effect and income is not significant. Detached homes, in particular, are more likely to have been purchased or built without a mortgage, but less likely to have been acquired with a mortgage. Membership in the Communist Party reduces the likelihood of acquisition without a mortgage, but increases the likelihood of acquisition with a mortgage. Respondents with credit cards, as a proxy for their credit worthiness, are less likely to acquire homes without mortgages and more likely to acquire them with a mortgage. For homes acquired through inheritance or as a gift, age has a positive effect and income has a negative effect. Most interestingly, the legacy of family membership in the Communist Party has a positive effect with father's membership increasing the likelihood of acquisition by this means.

The prevalence of current mortgages is found to be lower among the elderly and higher income households, as would be expected. Credit card holders are found to be more likely to also have mortgages indicating their ability to access to credit.

Overall, this study has found several predictable patterns of economic and demographic factors that affect homeownership and mortgages in transition countries. Further analysis is limited by data availability in the EBRD LITS II survey, but there are several potential extensions. First, country-specific effects can be analyzed further. While country fixed effects are included in all of the models reported in this paper, additional attention can be paid to analysis of varying patterns of homeownership and mortgage reliance across countries. Second, additional attention should be paid to credit conditions and their variation across countries in the analysis of mortgages.

Table 1: Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Age	51.89	15.12	18.00	98.00
Income	4.45	1.69	1.00	10.00
Salary source of income	0.58	0.49	0.00	1.00
Self-employment source of income	0.20	0.40	0.00	1.00
Farm production source of income	0.11	0.32	0.00	1.00
Pension source of income	0.43	0.49	0.00	1.00
State benefits source of income	0.10	0.30	0.00	1.00
Married	0.62	0.49	0.00	1.00
Divorced	0.66E-01	0.25	0.00	1.00
Widowed	0.12	0.33	0.00	1.00
Length of time in city	41.40	19.93	0.00	97.00
Member of communist party	0.56E-01	0.23	0.00	1.00
Father member of community party	0.95E-01	0.29	0.00	1.00
Detached house	0.53	0.50	0.00	1.00
Flat	0.38	0.49	0.00	1.00
Second residence	0.87E-01	0.28	0.00	1.00
Mortgage currently	0.84E-01	0.28	0.00	1.00
Privatized	0.21	0.41	0.00	1.00
Purchased or built without a mortgage from a bank	0.34	0.47	0.00	1.00
Purchased or built with a mortgage from a bank	0.16	0.36	0.00	1.00
Inherited or gift	0.26	0.44	0.00	1.00

Note: E-0n indicates multiply coefficient by 10^{-n}.

Table 2: Probit Models of Home Ownership

Variable	Model 1	Model 2	Model 3
Constant	0.45** (0.21)	0.45** (0.21)	0.43** (0.21)
Age	0.47E-01*** (0.68E-02)	0.47E-01*** (0.68E-02)	0.47E-01*** (0.68E-02)
Age squared	-0.42E-03*** (0.65E-04)	-0.42E-03*** (0.65E-04)	-0.43E-03*** (0.65E-04)
Income	0.91E-01** (0.45E-01)	0.91E-01** (0.45E-01)	0.91E-01** (0.45E-01)
Income squared	-0.52E-02 (0.49E-02)	-0.51E-02 (0.49E-02)	-0.52E-02 (0.49E-02)
Income*Salary source of income	0.15E-01 (0.11E-01)	0.15E-01 (0.11E-01)	0.16E-01 (0.11E-01)
Income*Self-employment source of income	0.34E-01*** (0.12E-01)	0.34E-01*** (0.12E-01)	0.34E-01*** (0.12E-01)
Income*Farm production source of income	0.42E-01** (0.20E-01)	0.42E-01** (0.20E-01)	0.42E-01** (0.20E-01)
Income*Pension source of income	0.19E-01 (0.12E-01)	0.19E-01 (0.12E-01)	0.19E-01 (0.12E-01)
Income*State benefits source of income	-0.36*** (0.12E-01)	-0.36*** (0.12E-01)	-0.36*** (0.12E-01)
Married	0.86E-01* (0.47E-01)	0.84E-01* (0.47E-01)	0.89E-01* (0.47E-01)
Divorced	-0.34E-01 (0.78E-01)	-0.35E-01 (0.78E-01)	-0.27E-01 (0.78E-01)
Widowed	0.45E-01 (0.73E-01)	0.43E-01 (0.73E-01)	0.47E-01 (0.73E-01)
Length of time in city	0.56E-02*** (0.11E-02)	0.56E-02*** (0.11E-02)	0.56E-02*** (0.11E-02)
Member of communist party		0.52E-01 (0.86E-01)	
Father member of community party			-0.11* (0.60E-01)
Log likelihood	-2,389.48	-2,389.29	-2,387.80
Chi squared p-value	516.25*** 0.00	516.63*** 0.00	519.62*** 0.00
Observations	32,120	32,120	32,120

Notes: E-0n indicates multiply coefficient by 10^{-n}. Standard errors given in parentheses. $^{*} p < 0.10$, $^{**} p < 0.05$, $^{***} p < 0.01$. Country fixed effects included in all models.

Table 3: Probit Models of Type of House Owned

Variable	Detached House	Flat	Second Residence	Second Residence
Constant	-0.11 (0.95E-01)	-0.74*** (0.98E-01)	-2.50*** (0.14)	-2.50*** (0.14)
Age	0.17E-01*** (0.31E-02)	-0.13E-01*** (0.32E-02)	0.29E-01*** (0.46E-02)	0.28E-01*** (0.46E-02)
Age squared	-0.13E-03*** (0.29E-04)	0.92-E04*** (0.30E-04)	-0.24E-03*** (0.44E-04)	-0.23E-03*** (0.44E-04)
Income	-0.13*** (0.18E-01)	0.16*** (0.19E-01)	0.45E-01* (0.27E-01)	0.45E-01* (0.27E-01)
Income squared	0.94E-02*** (0.19E-02)	-0.89E-02*** (0.20E-02)	0.49E-02** (0.26E-02)	0.49E-02** (0.26E-02)
Income*Salary source of income	-0.18E-01*** (0.40E-02)	0.16E-01*** (0.43E-02)	0.35E-01*** (0.51E-02)	0.34E-01*** (0.51E-02)
Income*Self-employment source of income	0.23*** (0.42E-02)	-0.45E-01*** (0.45E-02)	0.61E-01*** (0.51E-02)	0.60E-01*** (0.51E-02)
Income*Farm production source of income	0.19*** (0.64E-02)	-0.26*** (0.85E-02)	-0.13E-01* (0.74E-02)	-0.13E-01* (0.74E-02)
Income*Pension source of income	0.15E-01*** (0.42E-02)	-0.24E-01*** (0.45E-02)	0.35E-01*** (0.54E-02)	0.35E-01*** (0.54E-02)
Income*State benefits source of income	-0.48E-02 (0.57E-02)	-0.34E-01*** (0.62E-02)	-0.31E-01*** (0.78E-02)	-0.31E-01*** (0.78E-02)
Married	0.18*** (0.20E-01)	-0.22*** (0.20E-01)	-0.46E-01* (0.27E-01)	-0.43E-01* (0.27E-01)
Divorced	-0.28*** (0.35E-01)	0.24*** (0.35E-01)	-0.99E-01** (0.49E-01)	-0.11** (0.49E-01)
Widowed	0.34E-01 (0.29E-01)	-0.35E-01 (0.30E-01)	-0.27*** (0.45E-01)	-0.26*** (0.45E-01)
Length of time in city	0.16E-02*** (0.46E-03)	-0.92E-03* (0.49E-03)	-0.35E-02*** (0.64E-03)	-0.35E-02*** (0.64E-03)
Member of communist party			0.10** (0.45E-01)	
Father member of community party				0.19*** (0.34E-01)
Log likelihood	-19,169.69	-17,399.68	-8,649.68	-8,636.25
Chi squared p-value	6,086.80*** 0.00	7,829.05*** 0.00	1,717.04*** 0.00	1,7423.90*** 0.00
Observations	32,120	32,120	32,120	32,120

Notes: E-0n indicates multiply coefficient by 10^{-n}. Standard errors given in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Country fixed effects included in all models.

Table 4a: Probit Models of House Acquisition Mode

Variable	Privatized	Privatized	Purchased or built without mortgage from bank	Purchased or built without mortgage from bank
Constant	-1.89*** (0.12)	-1.92*** (0.12)	-1.45*** (0.99E-01)	-1.44*** (0.99E-01)
Age	0.23E-01*** (0.38E-02)	0.24E-01*** (0.38E-02)	0.95E-02*** (0.31E-02)	0.93E-02*** (0.31E-02)
Age squared	-0.13E-03*** (0.35E-04)	-0.14E-03*** (0.35E-04)	-0.35E-04 (0.29E-04)	-0.35E-04 (0.29E-04)
Income	0.14E-01 (0.23E-01)	0.14E-01 (0.23E-01)	0.51E-01*** (0.19E-01)	0.51E-01*** (0.19E-01)
Income squared	-0.13E-02 (0.24E-02)	-0.13E-02 (0.24E-02)	-0.51E-02*** (0.19E-02)	-0.50E-02*** (0.19E-02)
Income*Salary source of income	-0.61E-03 (0.49E-02)	-0.35E-03 (0.49E-02)	-0.57E-02 (0.39E-02)	-0.56E-02 (0.39E-02)
Income*Self-employment source of income	-0.11E-01** (0.53E-02)	-0.11E-01** (0.53E-02)	0.15E-01*** (0.41E-02)	0.15E-01*** (0.41E-02)
Income*Farm production source of income	-0.51E-02 (0.72E-02)	-0.48E-02 (0.73E-02)	0.21E-01*** (0.53E-02)	0.21E-01*** (0.53E-02)
Income*Pension source of income	0.12E-01** (0.52E-02)	0.13E-01*** (0.52E-02)	0.16E-02 (0.42E-01)	0.13E-02 (0.42E-02)
Income*State benefits source of income	-0.30E-01*** (0.72E-02)	-0.30E-01*** (0.72E-02)	-0.17E-02 (0.57E-02)	-0.17E-02 (0.58E-02)
Married	-0.13E-01 (0.24E-01)	-0.10E-01 (0.24E-01)	0.37E-01* (0.20E-01)	0.34E-01* (0.20E-01)
Divorced	-0.18E-01 (0.40E-01)	-0.13E-01 (0.40E-01)	-0.61E-01* (0.35E-01)	-0.62E-01* (0.35E-01)
Widowed	0.21E-01 (0.36E-01)	0.22E-01 (0.36E-01)	0.16E-01 (0.30E-01)	0.13E-01 (0.30E-01)
Detached house	-0.35*** (0.37E-01)	-0.35*** (0.37E-01)	0.27*** (0.29E-01)	0.27*** (0.29E-01)
Flat	0.72*** (0.37E-01)	0.73*** (0.37E-01)	-0.96E-01*** (0.30E-01)	-0.97E-01*** (0.30E-01)
Credit card holder			-0.14*** (0.20E-01)	-0.14*** (0.20E-01)
Member of communist party	0.37E-01 (0.40E-01)		-0.74E-01** (0.33E-01)	
Father member of community party		-0.12*** (0.32E-01)		-0.27E-02 (0.26E-01)
Log likelihood	-12,022.67	-12,015.88	-18,995.25	-18,997.78
Chi squared p-value	9,136.91*** 0.00	9,150.49*** 0.00	3,107.10*** 0.00	3,102.05*** 0.00
Observations	32,120	32,120	32,120	32,120

Notes: E-0n indicates multiply coefficient by 10^{-n}. Standard errors given in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Country fixed effects included in all models.

Table 4b: Probit Models of House Acquisition Mode, continued

Variable	Purchased or built with mortgage from bank	Purchased or built with mortgage from bank	Inherited or Gift	Inherited or Gift
Constant	0.12 (0.12)	0.94E-01 (0.12)	0.39*** (0.10)	0.41*** (0.10)
Age	-0.90E-02** (0.40E-02)	-0.84E-02** (0.40E-02)	-0.30E-01*** (0.33E-02)	-0.31E-01*** (0.33E-02)
Age squared	0.65E-04* (0.38E-04)	0.62E-04* (0.38E-04)	0.15E-03*** (0.31E-04)	0.15E-03*** (0.31E-04)
Income	0.93E-02 (0.24E-01)	0.98E-02 (0.24E-01)	-0.50E-01*** (0.20E-01)	-0.51E-01*** (0.20E-01)
Income squared	0.99E-03 (0.24E-02)	0.92E-03 (0.24E-02)	0.28E-02 (0.20E-02)	0.29E-02 (0.20E-02)
Income*Salary source of income	0.12E-01** (0.51E-02)	0.12E-01** (0.51E-02)	-0.83E-02** (0.42E-02)	-0.87E-02** (0.42E-02)
Income*Self-employment source of income	-0.15E-01*** (0.52E-02)	-0.15E-01*** (0.51E-02)	0.62E-02 (0.43E-02)	0.61E-02 (0.43E-02)
Income*Farm production source of income	-0.97E-01*** (0.84E-02)	-0.97E-01*** (0.84E-02)	0.35E-01*** (0.54E-02)	0.34E-01*** (0.54E-02)
Income*Pension source of income	-0.28E-01*** (0.54E-02)	-0.27E-01*** (0.54E-02)	0.66E-02 (0.44E-02)	0.61E-02 (0.44E-02)
Income*State benefits source of income	0.17E-01*** (0.68E-02)	0.17E-01*** (0.68E-02)	0.98E-02* (0.60E-02)	0.97E-02 (0.60E-02)
Married	0.85E-01*** (0.25E-01)	0.90E-01*** (0.25E-01)	-0.11*** (0.21E-01)	-0.11*** (0.21E-01)
Divorced	0.81E-01* (0.43E-01)	0.84E-01** (0.43E-01)	0.45E-02 (0.38E-01)	-0.18E-02 (0.38E-01)
Widowed	0.14E-01 (0.39E-01)	0.18E-01 (0.39E-01)	-0.42E-01 (0.32E-01)	-0.44E-01 (0.32E-01)
Detached house	-0.33*** (0.32E-01)	-0.33*** (0.32E-01)	0.26*** (0.30E-01)	0.26*** (0.30E-01)
Flat	-0.29*** (0.34E-01)	-0.29*** (0.34E-01)	-0.44*** (0.32E-01)	-0.45*** (0.32E-01)
Credit card holder	0.44*** (0.22E-01)	0.44*** (0.22E-01)		
Member of communist party	0.14*** (0.43E-01)		-0.52E-01 (0.37E-01)	
Father member of communist party		-0.40E-01 (0.34E-01)		0.11*** (0.27E-01)
Log likelihood	-11,187.41	-11,192.21	-16,350.23	-16,342.43
Chi squared p-value	5,618.86*** 0.00	5,609.26*** 0.00	4,377.43*** 0.00	4,393.03*** 0.00
Observations	32,120	32,120	32,120	32,120

Notes: E-0n indicates multiply coefficient by 10^{-n}. Standard errors given in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Country fixed effects included in all models.

Table 5: Probit Models of Mortgages

Variable	Current mortgage	Current mortgage	Current mortgage
Constant	-0.49E-01 (0.17)	-0.36E-01 (0.17)	-0.50E-01 (0.17)
Age	0.43E-02 (0.59E-02)	0.39E-02 (0.59E-02)	0.43E-02 (0.59E-02)
Age squared	-0.23E-03*** (0.61E-04)	-0.23E-03*** (0.61E-04)	-0.23E-03*** (0.62E-04)
Income	-0.87E-01*** (0.32E-01)	-0.87E-01*** (0.32E-01)	-0.87E-01*** (0.32E-01)
Income squared	0.39E-02 (0.31E-02)	0.39E-02 (0.31E-02)	0.39E-02 (0.31E-02)
Income*Salary source of income	0.61E-01*** (0.72E-02)	0.61E-01*** (0.72E-02)	0.61E-01*** (0.72E-02)
Income*Self-employment source of income	0.16E-01** (0.65E-02)	0.16E-01** (0.65E-01)	0.16E-01** (0.65E-02)
Income*Farm production source of income	-0.14*** (0.14E-01)	-0.14*** (0.14E-01)	-0.14*** (0.14E-01)
Income*Pension source of income	-0.49E-01*** (0.74E-02)	-0.49E-01*** (0.75E-02)	-0.49E-01*** (0.74E-02)
Income*State benefits source of income	0.17E-01** (0.81E-02)	0.17E-01** (0.81E-02)	0.17E-01** (0.81E-02)
Married	0.13*** (0.31E-01)	0.13*** (0.31E-01)	0.13*** (0.31E-01)
Divorced	0.12** (0.52E-01)	0.12** (0.52E-01)	0.12** (0.52E-01)
Widowed	-0.19*** (0.66E-01)	-0.19*** (0.66E-01)	-0.19** (0.66E-01)
Detached house	-0.25*** (0.40E-01)	-0.25*** (0.40E-01)	-0.25*** (0.40E-01)
Flat	-0.15*** (0.42E-01)	-0.15*** (0.42E-01)	-0.15*** (0.42E-01)
Credit card holder	0.59*** (0.27E-01)	0.59*** (0.27E-01)	0.59*** (0.27E-01)
Member of communist party		0.11* (0.68E-01)	
Father member of communist party			-0.61E-02 (0.46E-01)
Log likelihood	-6,411.29	-6,409.91	-6,411.28
Chi squared p-value	5,739.32*** 0.00	5,742.07*** 0.00	5,739.34*** 0.00
Observations	32,120	32,120	32,120

Notes: E-0n indicates multiply coefficient by 10^{-n}. Standard errors given in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Country fixed effects included in all models.

Table 6: Probit Models of Detached Home Owners with Mortgages

Variable	Model 1	Model 2	Model 3
Constant	-1.52*** (0.22)	-1.52*** (0.22)	-1.53*** (0.22)
Age	0.31E-01*** (0.82E-02)	0.31E-01*** (0.82E-02)	0.31E-01*** (0.82E-02)
Age squared	-0.42E-03*** (0.84E-04)	-0.42E-03*** (0.84E-04)	-0.42E-03*** (0.84E-04)
Income	-0.13*** (0.40E-01)	-0.13*** (0.40E-01)	-0.13*** (0.40E-01)
Income squared	0.85E-02** (0.37E-02)	0.85E-02** (0.37E-02)	0.85E-02** (0.37E-02)
Income*Salary source of income	0.52E-01*** (0.89E-02)	0.52E-01*** (0.89E-02)	0.52*** (0.89E-02)
Income*Self-employment source of income	0.14E-01* (0.79E-02)	0.14E-01* (0.79E-02)	0.14E-01* (0.79E-02)
Income*Farm production source of income	-0.79*** (0.15E-01)	-0.79*** (0.15E-01)	-0.79*** (0.15E-01)
Income*Pension source of income	-0.26E-01*** (0.92E-02)	-0.26*** (0.92E-02)	-0.26*** (0.92E-02)
Income*State benefits source of income	0.17E-01* (0.98E-02)	0.17E-01* (0.98E-02)	0.17E-01 (0.98E-02)
Married	0.21*** (0.40E-01)	0.21*** (0.40E-01)	0.21*** (0.40E-01)
Divorced	0.58E-01 (0.70E-01)	0.57E-01 (0.70E-01)	0.59E-01 (0.70E-01)
Widowed	-0.14* (0.88E-01)	-0.15 (0.88E-01)	-0.14* (0.88E-01)
Credit card holder	0.42*** (0.34E-01)	0.42*** (0.34E-01)	0.42*** (0.34E-01)
Member of communist party		0.65E-01 (0.90E-01)	
Father member of communist party			-0.54E-01 (0.63E-01)
Log likelihood	-3,834.65	-3,834.40	-3,834.29
Chi squared p-value	2,697.63*** 0.00	2,698.14*** 0.00	2,698.36*** 0.00
Observations	32,120	32,120	32,120

Notes: E-0n indicates multiply coefficient by 10^{-n}. Standard errors given in parentheses. $^{*} p < 0.10$, $^{**} p < 0.05$, $^{***} p < 0.01$. Country fixed effects included in all models.

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The behaviors of flippers, rental investors and owner-occupiers in Singapore private housing market

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The present paper reveals the sources of housing market fluctuations by examining the interactions of three types of housing market participants: owner-occupiers, rental investors and flippers. We study their behaviors as a home buyer and as a home seller. It is found that flippers are the "smartest" group while rental investors outperform owner-occupiers in terms of fetching buying discounts and selling premiums. It is also found that, although flippers are able to adopt "good" trading pattern, their trading could trigger positive feedbacks of owner-occupiers and as a result lead to market over-pricing.

The interactions between owner-occupiers (who dominate the housing market by the number of participants) and flippers explain why and how flippers, as the smallest group by the number of participants, could drive the fluctuations of the whole housing market. We reiterate that studying the impacts of individual trading patterns on a housing market but ignoring the interactions among the participants may generate conflicting or misleading results.

The findings imply that transaction taxes, such as the stamp duties targeted at short term sellers, should always be implemented to control flippers' activities in order to stabilize housing market.

Keywords: housing market participants, trading patterns, positive feedback, interaction, transaction tax

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The behaviors of flippers, rental investors and owner-occupiers in Singapore private housing market

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Abstract

The present paper reveals the sources of housing market fluctuations by examining the interactions of three types of housing market participants: owner-occupiers, rental investors and flippers. We study their behaviors as a home buyer and as a home seller. It is found that flippers are the "smartest" group while rental investors outperform owner-occupiers in terms of fetching buying discounts and selling premiums. It is also found that, although flippers are able to adopt "good" trading pattern, their trading could trigger positive feedbacks of owner-occupiers and as a result lead to market over-pricing.

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1 Introduction

Financial literature has established several theories to explain the mis-pricing by examining the impacts of trading patterns on asset markets (Fama, 1965[22]; Gromb & Vayanos, 2010[29]; Rubinstein & Wolinsky, 1987[49]; Yavaş, 1994[63]; De Long, Shleifer, Summers & Waldmann, 1990[19]; Hong & Stein, 1999[33]; Grinblatt, Titman et al. 1995[28]; et al.). However, alternative theories often give inconsistent implications because of the existence of the interactions among different trading patterns, and empirical works also offer inconsistent findings (Hau, 2006[30]; Deng, Liu & Wei, 2014[20]). Housing literature directly applies these theories to study mis-pricing in a housing markets with an objective of understanding the sources of housing market volatilities (Fu, Qian & Yeung, 2013[27]; Fu & Qian, 2014[26]; Bayer, Geissler & Roberts, 2013[6], et al.). As a result, the related housing literature demonstrates similar problems.

Our concern, which will be further elaborated in this paper, is motivated by the difference between financial and housing markets. In a financial market, all participants are investors. Their trading decision is driven by investment motive, although they may adopt different trading patterns and have different levels of information. In theory, they are distinguished by flippers and non-flippers and they are physically unobservable. In a housing market, flippers, rental investors and owner-occupiers can be physically specified with their trading decisions either driven by investment, or consumption or both of them. Although their trading patterns and level of information are not observable, flippers and investors intuitively have more market information and are more likely to adopt "good" trading patterns than owner-occupiers.

Thus, cautions must be taken when the findings from financial markets are extrapolated to interpret the sources of housing market mispricing. Finance literature predicts that arbitrage and intermediary are the two good trading patterns that flippers are likely to adopt. These flippers are well informed and have "good" behaviors to help stabilize the market (Gromb & Vayanos, 2010[29]; Rubinstein & Wolinsky, 1987[49]; et al.). It also predicts that positive feedback (momentum trading) could also be some flippers' trading pattern. They are typically short term noise traders who are typically not well informed and mistakenly believe that they can do better than the average, leading the market to move away from the fundamental (De Long, et al., 1990[19]; Stiglitz, 1989[55]). Inconsistent empirical findings could be due to the adoption of different proxies to identify trading patterns (Hau, 2006[30]; Deng, Liu & Wei, 2014[20]).

In a housing market, short term noise traders are less informed or less experienced flippers (Fu, Qian & Yeung, 2013[27]; Fu & Qian, 2014[26]; Bayer, Geissler & Roberts, 2013[6], and Haughwout, Lee, Tracy & Klaauw, 2011[31];). By using different proxies to identify short term noise traders, they have found that noise traders adopt positive feedback pattern which destabilizes housing market. They conclude that these traders lead to housing market crisis by bidding aggressively. However, unlike financial market, such traders only makes up a small portion of all housing market participants (for example, in our sample, all flippers at the buying side only take 12% of total transaction volume, while less informed flippers are a fraction of it). Our question is how such a small portion of flippers could have the power to lead the whole market to move away from the fundamental. The current literature provides limited evidence or argument in this aspect.

In the present paper, we argue that housing flippers are better informed than owner-occupiers (refer to Subsection 3.1 for identification details). They are more likely to adopt "good" trading patterns to beat the market, while at the same time leading owner-occupiers and rental investors to adopt momentum trading pattern. Since owner-occupiers are the dominant market participants, their momentum behaviors result in the market drifting away from its fundamental.

To illustrate our argument more clearly, we present some observations from the Singapore private housing market (Refer to Appendix. A for a detail introduction of Singapore housing market). Firstly, we present the distribution of different participants across one market cycle. Table 1 illustrates that, more flippers bought a housing unit during a trough than during a peak; while they sold more aggressively during a peak than during a trough. We see otherwise for owner-occupiers and rental investors. This demonstrates the arbitrage pattern of flippers and partially justifies our argument that flippers are more likely to take "good" trading strategies compared to the other two participants.

Table 1: Proportions of Different Participants' Transaction Volumes during Market Cycle

Participants at buying side						
Property Cycle	Quarters	Owner-occupiers	Rental Investors	Flippers	Unidentified	Total
Peak	2007Q3-2008Q1	68.03	21.39	10.58	0	100
Trough	2008Q4-2009Q2	66.89	15.54	17.5	0.07	100
Whole Cycle	2007Q1-2009Q2	67.19	17.25	15.55	0.01	100
Participants at selling side[1]						
Property Cycle	Quarters	Owner-occupiers	Rental Investors	Flippers	Unidentified	Total
Peak	2007Q3-2008Q1	34.36	0.69	20.31	44.64	100
Trough	2008Q4-2009Q2	34.08	1.98	11.59	52.35	100
Whole Cycle	2007Q1-2009Q2	33.54	0.95	15.12	50.39	100

Note: Refer to Subsection 3.1 for the identification of market participants at buying side and at selling side.

Secondly, we present some observations derived from two different yet comparable housing markets in Singapore: Singapore private housing market and the HDB resale housing market (public resale housing market). Both markets are exposed to the same social and economic environment. But Fig 1 demonstrates that the private housing market is more volatile than the public resale housing market. One major difference between the two markets is that the participants are different. In the private housing market, flippers, investors and owner-occupiers co-exist, while in the public resale housing market, all property owners are owner-occupiers due to government regulations.

[1] Caution must be taken that, around half of the transactions at selling side are not able to be identified, as counted under the "Unidentified" column. However, the most of the "unidentified" should be sold by housing developers, and only a small part of the "unidentified" transactions are sold by owner-occupiers and rental investors. Besides, the selling by flippers is well identified. Thus, the large proportion of the "Unidentified" does not influence our conclusion on flippers' arbitraging pattern.

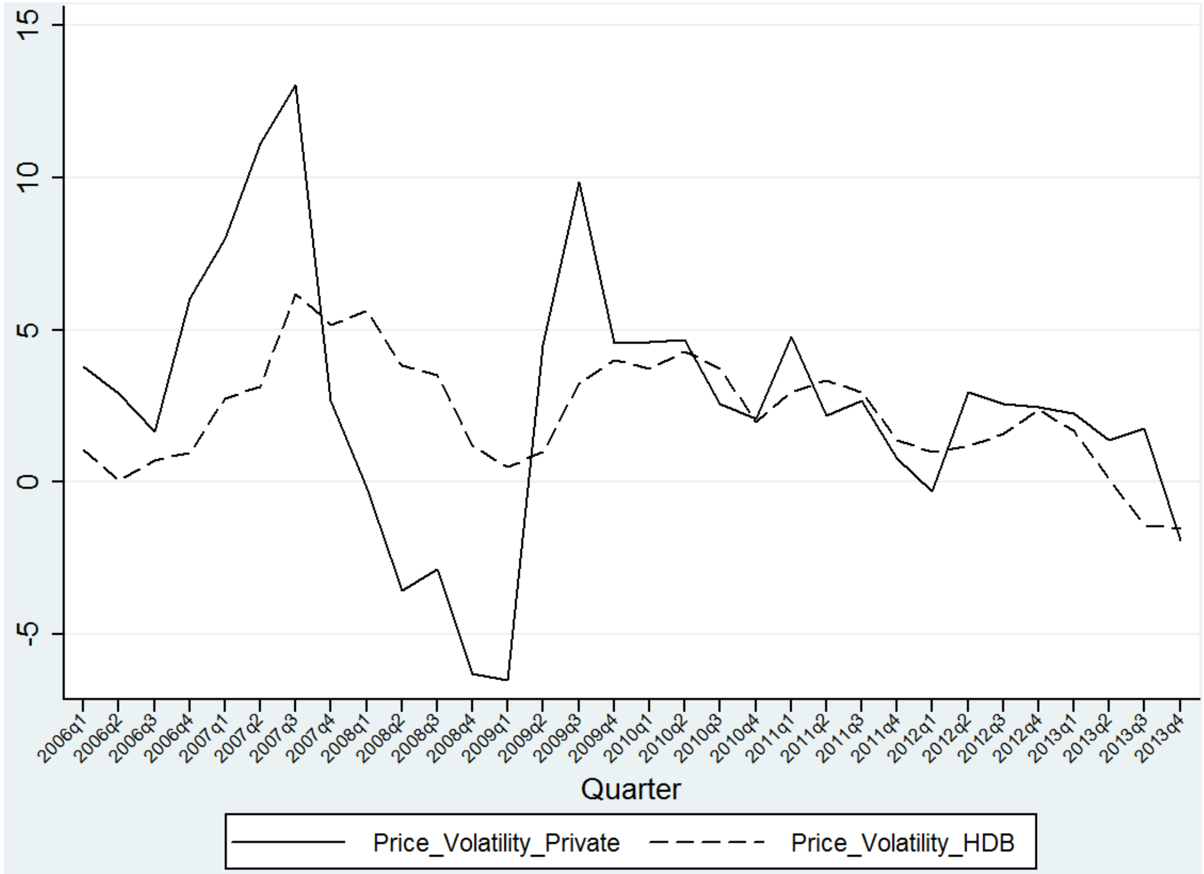

Figure 1: Price Volatility of Private and HDB Market:2006Q1-2013Q4[2]

Thirdly, there exist interactions among the three types of market participants. Between 2009 and 2013, Singapore government issued 8 rounds of anti-speculation police packages to curb the market. Transaction tax, home loan availability and limitation on foreign buyers are three major policy instruments. The policies mainly target at short-term property buyers, multiple property buyers and foreigners in the private housing market. However, Fig 2 shows that owner-occupiers are also affected, implying that owner-occupiers are likely to have taken positive feedback trading patterns, acting as followers of flippers.

[2]The Figure depicts the price volatility of private market and the HDB resale market, where volatility is measured as the quarterly price index change.

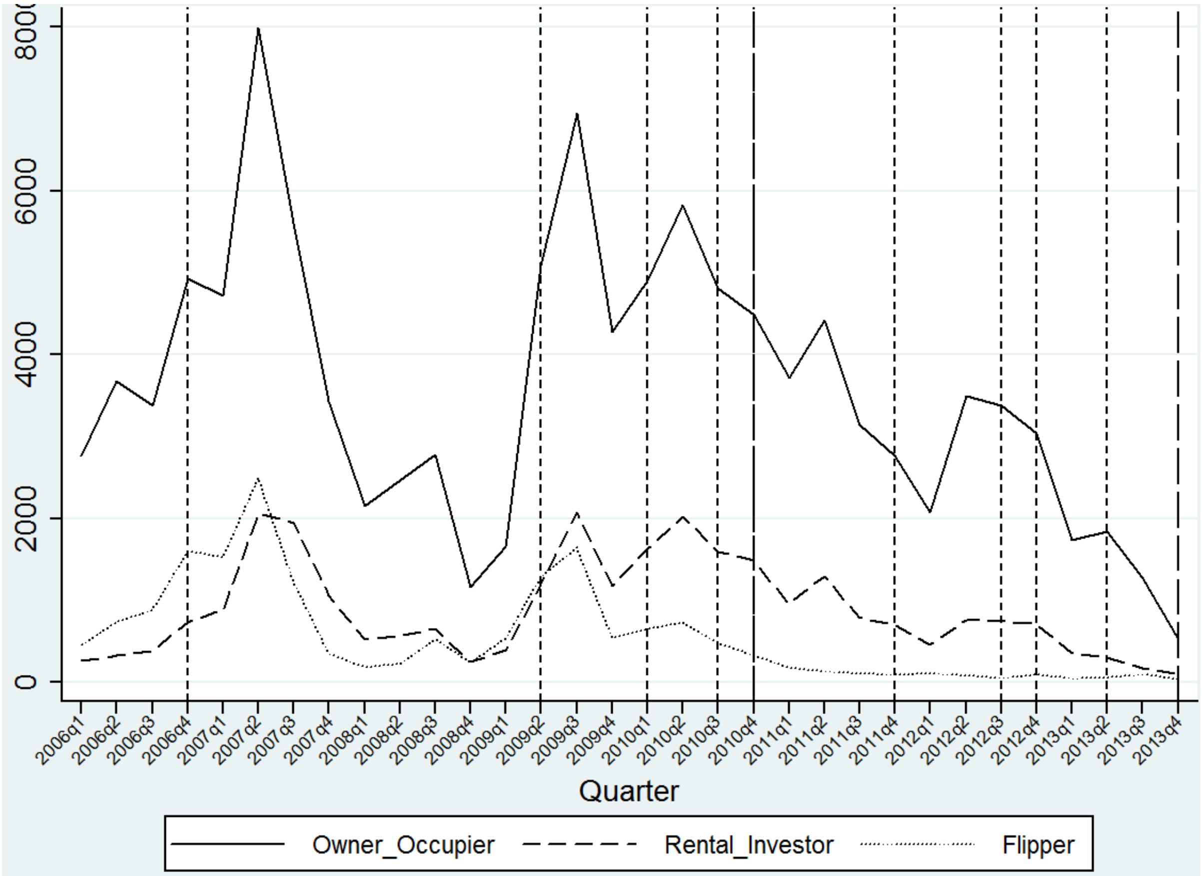

Figure 2: Transaction Volumes of Owner-occupiers, rental investors and flippers:2006Q1-2013Q4[3]

The above discussion gives rise to the following three research questions. Are flippers the "smartest", while rental investors outperform the owner-occupiers in terms of buying at a discount and selling at a premium? How do flippers lead a housing market to mis-pricing and what are the roles of rental investors and owner-occupiers in the formation of housing market fluctuations? How do flippers, rental investors and owner-occupiers interact over a property cycle?

The answers to the above questions make the following contributions to the literature. Firstly, we reveal the possible trading patterns of an owner-occupier, a rental investor and a flipper in a housing market after we physically identify them using a unique dataset derived from the Singapore private housing market. Thus, the source of housing market mis-pricing is clearly uncovered. The current literature refers flippers or non-flippers as the informed or non-informed buyers, while the latter is often ambiguously identified. Secondly, we empirically identify the interactions among owner-occupiers, rental investors and flippers by scrutinizing both their buying and selling behaviors, which provides an alternative but direct test to the positive feedback theory (De Long, Shleifer, Summers & Waldmann (1990)[19]). In the existing literature, studying sellers' behaviors is often ignored, thus it fails to identify the interactions among them. To our best knowledge, this is the first paper which has provided direct empirical evidence to the positive feedback theory and has

[3]Caution must be taken that, the volumes in the Figure 2 only represent those identified transactions, while many transactions are not identified after 2011Q4, which can also result in a downward trend in volumes of all three identified participants. However, the figure before 2011Q4 is sufficient to show the momentum of the three types of participants.

unambiguously explained how flippers spoil a housing market. Thirdly, our study period covers a completed housing cycle. Therefore the behavioral differences of owner-occupiers, investors and flippers are explored.

The findings lend empirical support to the theories of Xiong (2013) [60] and Piazzesi & Schneider (2009)[46]. We provide evidence that the interactions between the heterogeneous trading patterns are resulted from heterogeneous motivations and different degrees of "smartness"; while the different "smartness" can also imply different briefs. We improve the understanding of some empirical phenomena, for example, we can interpret the findings in Deng, Liu & Wei, 2014[20]. We reconcile some conflicting arguments and findings, such as literature shows that flippers generally adopt "good" trading patterns, but they are often blamed for market mis-pricing too (Stiglitz (1989)[55]; Fu, Qian & Yeung, 2013[27]; Fu & Qian, 2014[26]; Bayer, Geissler & Roberts (2013)[6], et al.).

Studying the behaviors of different market participants could help explain financial anomalies such as excess volatility of asset prices, mean reversion of stock returns and the Mehra-Prescott equity premium puzzle (De Long, Shleifer, Summers & Waldmann, 1990[19]) and could provide evidence for fund managers help investors avoid loss (Seiler and Seiler, 2010[51]). It can also provide evidence for public authority to design taxation policies to curb housing market fluctuations (Fu, Qian & Yeung, 2013[27]; Fu & Qian, 2014[26]; Deng, Liu & Wei, 2014[20]; Anenberg & Bayer, 2013[1]).

Housing policies designed for stabilizing housing markets usually target at certain types of housing market participants or certain types of trading patterns, for example, turn-over tax targets at short-term trading (flipping) based on the understanding that flipping leads to market instability and deterring flippers can stabilize the market. However, the fragmented and conflicting empirical findings and understanding caused by the unclear and non-comprehensive identification of market participants or trading patterns may lead governments to make less optimal policy decisions. Thus, for policy purpose, it is necessary to have a more accurate identification of housing market participants and to understand their trading patterns and behaviors.

The remaining of the article is as follows. Section 2 provides a literature review and summarizes the existing problems in both financial and housing literature. Section 3 introduces the data, the identification of housing market participants, the variable selection and the research design. Section 4 presents the empirical results. Section 5 concludes.

2 Literature Review

Two streams of the related literature are reviewed, including the finance literature that attempts to explain financial market mispricing by examining the trading patterns adopted by market participants and the housing literature which adopt the above mentioned finance theories to study housing market mispricing. The review identifies inconsistent theoretical predictions and the conflicting empirical findings caused by misleading terminologies, poor identification of trading patterns, and the ignorance of the differences between a housing market and a financial market.

2.1 Trading patterns and mispricing: theories and evidence from financial market

Arbitrage, intermediary, feedback trading (also called as momentum trading) and herding are the four trading patterns that might be adopted by financial market participants. Arbitrage and intermediary are often recognized as the "good" trading patterns that can stabilize the market, while feedback trading and herding may destabilize market.

The efficient market theory (Fama, 1965[22]) implicitly models the arbitrage as the large number of arbitrageurs who take infinitesimal positions against the mis-pricing and drive the prices towards fundamentals. Gromb & Vayanos (2010)[29] summarizes the arbitrage literature as well as the factors that limit arbitrage. Arbitrage can be either cross-asset arbitrage (arbitrage between different assets by choosing position in asset A to hedge the position in asset B, essentially it is a trading behavior to exploit the discrepancies between the prices of different assets at a given point of time) or inter-temporal arbitrage (arbitrage between different time points of an asset, which exploits the price discrepancy of an asset across time). The following factors prevent the arbitrageurs from trading the asset price towards fundamentals and providing liquidity to outside investors after an exogenous demand shock: 1) lower liquidity will result in higher price rise after an exogenous demand shock; 2) non-fundamental risk will reduce the correlation between the two assets (one asset of different time periods), the arbitrageurs will need to see more price discrepancy to take his position and as a result the price deviation from the fundamental will be larger; 3) holding costs (short-selling constraints or costs) stop arbitrage as arbitrageurs have to see price discrepancies large enough to compensate the holding costs; 4) leverage constraints and constraints on equity capital lower the ability of arbitrageurs to eliminate price discrepancies. In addition, Shleifer & Vishny (1997)[52] also mentions the agency problems those large institutional arbitrageurs face, which make them avoid the "extremely volatile arbitrage positions".

It is generally agreed in the literature that middlemen (or intermediary) can be market makers or matchmakers (Yavaş, 1994[63]). Rubinstein & Wolinsky (1987)[49] builds a searching model where middlemen (as market makers) buy from sellers and sell to buyers and raise the overall welfare through correcting the imperfection of time consuming matching between buyers and sellers. In addition, the middlemen should be at least more patient or have higher searching abilities than sellers and buyers, and seek to maximize the expected values of the discounted streams of profits through buying low selling high which is achieved through shortening their waiting time. In Spulber (1996)[54], middlemen or intermediary is defined as an agent buys from sellers and sell to buyers (acting as market makers) or help the match of buyers and sellers to facilitate their transactions (acting as match makers) and provide availability of goods or liquidity to the market.

Based on the definitions of middlemen mentioned above, middlemen can be those retailers and wholesalers in terms of commodities as well as financial intermediaries such as security and commodity brokers (Spulber, 1996[54]), and improve the market efficiency through their higher ability in detecting goods' true value and guaranteeing the goods' quality (Biglaiser, 1993[9]), decreasing the equilibrium search intensities (Yavaş, 1994[63]), correcting the imperfection of time-consuming matching between the buyers and sellers (Rubinstein & Wolinsky, 1987[49]), raising the quality of the match between consumers' preferences and the goods they consume (Johri & Leach,2002[37]).

Feedback trading (also called momentum trading) are commonly defined as the trading pattern of making transaction decisions based on assets' past returns. It is often blamed for market mis-pricing. De Long, Shleifer, Summers & Waldmann (1990)[19] develops a model of rational speculators and feedback traders, where speculators are defined as those transact based on information obtained, and noise traders do not rely on information while adopt positive feedback trading patterns: buy when price rises and sell when price falls. The authors argue that with the presence of positive feedback traders, rational speculators could also destabilize the price as those rational speculators know that the initial price increase (or down) will stimulate buying (selling) by positive feedback buyers and therefore they do not necessarily transact towards the price fundamental. Cutler, Poterba & Summers (1990)[18] assumes that the market has three types of participants: 1) transact based on rational forecasts of future returns; 2) transact based on fundamentals; 3) feedback traders whose demand depends on the past returns (positive-feedback, buy after market price rise; and negative-feedback, buy after price decline). It develops a speculative-dynamic model with feedback traders. Through model simulation, they find that heavier weight of short-horizon feedback trading leads prices back towards fundamental while also triggers later feedback demand and lead to price overreaction, raising price volatility around fundamentals. Hong & Stein (1999)[33] studies the behaviors of newswatchers and momentum traders. The newswatchers make forecasts based on private information observed on future fundamentals while not conditional on past prices. Momentum traders make forecasts conditional on past price changes and their forecast is the simple function of the past prices. They find that newswatchers create price under-reaction as information diffuse slowly across the newswatchers; and momentum-style arbitrage behaviors finally lead to price overreaction.

Herding is another trading pattern blamed for market mispricing. It is theoretically defined as the behavior of reversing a planned decision due to observing others' behaviors (Bikhchandani et al., 1992[10]; Bikhchandani & Sharna, 2000[11]; Avramov, Chordia & Goyal, 2006[5]; Chang & Dong, 2006[16]; Blasco, Corredor & Ferreruela, 2012[13];). Bikhchandani & Sharna (2000)[11] summarizes the literature on herding in financial market, indicating that herding should be distinguished from the "spurious herding" which is not the real herding but the similar decisions resulted from similar information sets. Herding can be further specified into rational herding and non-rational herding. Momentum investment pattern (also called positive feedback pattern) is one type of non-rational herding, and it is defined as buying recent winners (whose prices rose) and selling recent losers (whose prices dropped)(Grinblatt, Titman et al. 1995[28]). Rational herding assumes that agents are rational while herding is the result of either imperfect information (information cascade, for example; Avery & Zemsky, 1998[4]), concern for reputation (Scharfstein & Stein, 1990[50], for example) or compensation structures (Maug & Naik, 1996[42], for example). Bikhchandani & Sharna, 2000[11] finds that the empirical analysis of herding in the literature does not arise from the theoretical models while generally adopt statistical approach to estimate the clustering of decisions. In this regard, the herding behaviors are not clearly identified empirically.

The studies in this field are theoretical because it is difficult to empirically identify trading patterns. For a few empirical studies (Hau, 2006[30]; Deng, Liu & Wei, 2014[20]), different proxies and different terminologies whose definitions are often not exclusive of each other, are used to identify trading patterns which make it hard to comparing the findings.

For example, "speculators" or "speculative buyers" are used in some studies. They could be identified as arbitrageurs or non-arbitrageurs (feedback traders, for example). Friedman (1953)[25] argues that speculators (are informed and rational) can stabilize the market because they buy when prices are low and sell when prices are high, which counters the deviation of price from fundamental values. Hau (2006)[30] provides empirical evidence for Friedman's argument. The two researches implicitly define the speculators as arbitrageurs, purchasing when a property is under-priced and selling when a property is over-priced and trade the market towards fundamental.

Delong, Shleifer, Summers & Waldmann (1990)[19] defines rational speculators as those who trade based on information obtained. Stiglitz (1989)[55] divides the stock market traders into three extremes based on information accessibility: 1) the uninformed, those who understand that they cannot do better than the market and thus buy indexed mutual funds (buy the market); 2) the informed, who are insiders that have information advantages; 3) the noise traders, who are not informed while trade by themselves, who are assumed to create noises. He defines speculators as short-term traders, and split the speculators into noise speculators and arbitrageurs. The noise speculators are defined as those short-term traders who mistakenly believe that they can do better than the average; the noise speculators are assumed to lead the market away from fundamentals and the arbitrageurs who live off the noise speculators are assumed to smooth out the market.

We can see that in the above two articles, speculators are further split into the informed or rational speculators who conduct arbitrage behaviors and non-informed or irrational speculators who conduct non-arbitrage behaviors like feedback trading. Deng, Liu & Wei (2014)[20] follows the specification of Stiglitz (1989)[55] and their empirical results indicate that transaction taxes stabilize the immature market as flippers in the immature market is mostly non-informed and the tax deters flippers.

In summary, although investors' trading patterns are well defined in theoretical literature, empirically, different proxies are used to identify them, which has caused inconsistent or conflicting findings. In addition, both Delong, Shleifer, Summers & Waldmann (1990)[19] and Cutler, Poterba & Summers (1990)[18] imply that the key to understand different market participants' impacts on market is to identify the trading patterns of different participants and understand their interactions. However, the latter receives limited attention in the literature, which forms one motivation of the present paper.

2.2 Trading patterns and mispricing: theories and evidence from housing market

To study the sources of housing market volatility, a parallel stream of housing literature has been established. They adopt the theories and terminologies from the studies in financial markets. Thus, their work is more empirical than theoretical. The differences between housing and financial markets are typically not addressed. As a result, the existing literature from housing market shares the similar concerns arising from the finance literature.

Fu & Qian (2014)[26] studies the impacts of flippers and momentum traders on Singapore private housing market. A pre-sale transaction, sold before the construction is completed (excluding those sold by developers) is identified as the transactions made by the flippers; and momentum trading is measured by the ratio of number of transactions happened in a high-momentum month to the project size, where a high momentum month is defined as the 30% highest periods in terms of 3-month benchmark price index growth. It finds that short-term flippers aiming to tap gains from market price trends generate price overreactions most notably in sub markets with less informative prices. In other words, the motivation of the flippers is assumed to tap gains from market price appreciation, and they prefer the locations where market is thin and with less informative prices.

Adopting the similar identification of flippers to Fu & Qian (2014)[26], Fu, Qian & Yeung (2013)[27] distinguishes the flippers from other housing buyers, tests the impacts of Tobin's tax on Singapore housing market and finds that the withdrawal of stamp duty payment deferral raises price volatility by deterring more informed flippers while relatively less noisy flippers. Flippers are defined as those who sell properties before project completion. This identification is based on the institutional background of Singapore: in the pre-sale market, housing units have not been handed over to the buyers and the buyers have very low holding costs. In addition, the flippers are further specified into the informed and the non-informed. The authors assume that informed flipping buyers are more likely to transact in the under-priced projects and the non-informed are more likely to transact in the over-priced projects. The above identification actually follow the literature of arbitrage where informed flippers act as the arbitrageurs who find the under-priced housing properties. In addition, the authors find that the price volatility of the under-priced projects are raised after the policy while that of over-priced projects are reduced. Then, based on the assumption and the above findings, they conclude that when the informed flippers are deterred by the policy in (the under-priced) projects and therefore the price volatility is raised, and when the non-informed flippers are deterred by the policy in (the over-priced) projects and therefore the price volatility is reduced.

Their work gives rise to a new question. Flippers are defined by the sub-sales in the Singapore's presale housing market, and the sub-sales represent a very small portion of the whole housing market transactions (taking a proportion of only 9.33% in our dataset). The non-informed flippers is a fraction of these sub-sales. Thus, we question on how they could generate an impact on the whole Singapore private housing market. In addition, the empirical analysis considers the purchasing behaviors of the flippers, while their selling behaviors are not addressed. Understanding the selling behaviors is helpful to understand how flippers interact with other types of market participants.

Chinco & Mayer (2014)[17] more clearly distinguish the informed buyers from the non-informed buyers in single family housing markets of US Metropolitan Statistical Areas. It distinguishes the speculators from owner-occupiers, further specifies the speculators into the informed and the non-informed, and studies the impacts of the two types of speculators on the housing market. It finds that the increase in the mis-informed speculative buyers predicts the increase in future house prices and the implied-to-actual rent ratio's appreciation rate (a higher implied-to-actual rent ratio implies a higher excess return in addition to rental income, and thus more deviation of price away from the fundamental). It defines the second-house buyers as speculators; among which, the local ones are informed and the out-of-town ones are not informed, based on the assumption that the local have information advantage. In order to justify the specification and the different impacts of the two types of speculators on the market, the authors raise two difference between the informed and non-informed: 1) the informed are those local who have more knowledge about the local housing market and face less difficult principle-agent problem; evidences show that the misinformed generally fail to time the market and they are not able to fully enjoy the housing dividends; 2) the non-informed (the out-of-town) treat houses as pure financial asset and want to make a speculative bet.

Chinco & Mayer (2014)[17] aims to clearly distinguish the informed from the non-informed speculators. However, the identification of speculators as a second-home buyer may have resulted in some conflicting findings. For example, the authors claim that out-of-town second-home buyers treat housing as a pure financial asset, then intuitively they should be more professional. However, the authors find that they are actually less able to time the market compared to the local because they are the non-informed. The conflict may be due to an identification issue. The internal movers (defined as those who sell the original homes and buy and live in another home within the same city, as indicated in Anenberg & Bayer, 2013[1]) who are actually owner-occupiers; similarly, part of the out-of-town second-home buyers are also owner-occupiers as they buy for occupying purposes and without selling the previous homes. Intuitively, out-of-town second-home buyers has weaker bargaining power as they have an urgency to move into the purchased property; while in comparison, a local second-home buyer would have more bargaining power, as they could live in their original homes otherwise. The above can be an alternative explanation to why out-of-town second home buyers obtain less capital gains, the reason is that they are less flexible than the local internal movers, while both of the two are typically not speculators and instead they buy for occupying purposes. In addition, the authors does not explain how the non-informed raise the market price, the cause of which is that the authors cannot clearly tell what kind of (behavioral) characters of the non-informed that can raise the market prices. Levin & Wright (1997)[39] also argues that owner-occupiers as home movers can drive up the housing prices. For example. when home prices are going up, they will buy before selling and therefore add to the market demand of housing and finally add to the market price rising.

Fisher & LambieHanson (2012)[23] adopts similar identification as that of Chinco & Mayer (2014)[17] and studies the multi-family housing in Chelsea, Massachusetts US, while their findings conflict with that of Chinco & Mayer (2014)[17]. They find that local investors sell more quickly than the non-locals and have a higher propensity to flip. During the market downturn, the mortgage foreclosure risk of the local investors is around 1.8 times of owner-occupiers, while that of the non-locals is not significantly different from that of the owner-occupiers. The above conflict implies that the non-locals do not necessarily be “bad” guys that harm the market.

Haughwout, Lee, Tracy & Klaauw (2011)[31] studies the mortgage behaviors of different housing buyers in the US. It distinguishes the speculative investors from the owner-occupiers. It defines the speculative investors as individuals who at any point in the sample period have more than one first-lien mortgages and hold the first liens for more than 6 consecutive months. In addition, the authors further specify the investors based on their leveraging behaviors. The investors are specified into declared investors (who declare that they will not live in the purchased property when reporting the occupancy status for taking the loan) and undeclared investors. They take the declared investors as the informed (or experienced) and the undeclared investors as the non-informed (unexperienced). They find that the non-informed speculative investors bid more aggressively during the housing boom and pay a margin higher than that of the non-investors and declared investors; in addition, the default rate of the investors are much higher than the owner-occupiers in the bust period. In addition, the authors have mentioned that there are three participants with different purchasing motivations, i.e. owner-occupiers, rental investors and flippers, but they do not identify them.

Bayer, Geissler & Roberts (2013)[6] distinguishes the flippers from the owner-occupiers and rental investors and further specifies the flippers into the middlemen (the experienced) and the speculator (the inexperienced). With comprehensive housing transaction data with name and mortgage information for Los Angele, US, the authors identify the flippers as those individuals who buy and resale more than two housing properties within a short period of time. Further, the middlemen are those people who have more than 7 flips within the studied period, and speculators are those who have 2 to 6 flippers. In order to demonstrate the different buyers' purchasing motivations, the authors specify the housing returns into buyer's discount, market price growth during the holding period and seller's premium, and carefully remove the influence of housing renovation (which is not reflected by the data). They find that, compared with the speculator, middlemen can fetch a higher discount when purchasing, a higher premium when selling, and a relatively lower revenue from market price growth. In addition, the middlemen hold the properties for a substantially shorter period of time compared to the speculator. This is consistent with assumption that middleman's motivation is to fetch purchasing discount and selling premium while speculators focus on price appreciation. Thus, the middlemen is characterized as more experienced, more gifted in finding motivated sellers and buyers, and paying more attention to buying low & selling high; the speculators are less experienced, paying more attention to market price growth relative to the middlemen. The specification of the middlemen and the speculators is consistent with the literature where flippers are specified into the informed and non-informed (noisy traders): informed flippers buy lower and sell higher and therefore stabilize the market, while noisy traders create noises; or specified into the informed traders that stabilize the market and the feedback traders who trigger the later feedback traders. In this regard, the contribution of this article is explicitly defining the behavioral or trading patterns of different flippers and study their impact on the market.

Some concerns motivated by Bayer, Geissler & Roberts (2013)[6] are that firstly, it does not distinguish the group of rental investors who aim to fetch the rental income from owner-occupiers. Due to the ignorance of the role of rental investors, the paper is not able to reveal the whole picture of the housing market. Secondly, based on their identification, the article contributes to the literature that in a housing market, the speculators (who are not experienced) raise the market dynamics and reduce market efficiency; while the middlemen (who are experienced) can stabilize the market or at lease do not raise market dynamics. However, ignoring the selling behaviors of flippers and their interaction with other types of market participants, Bayer, Geissler & Roberts (2013)[6] is not able to clearly explain how speculators (non-arbitraging flippers), who take a very small portion of the market, drive the mis-pricing of the whole market.

In summary, researches such as Chinco & Mayer (2014)[17] and Fisher & LambieHanson (2012)[23] distinguish the housing investors (second-home owners) from owner-occupiers. They further split the investors into the informed (the local) and the non-informed (the out-of-town). This specification is ambiguous and leads to conflicting findings. Chinco & Mayer (2014)[17] argues that the non-informed (the out-of-town) treat houses as pure financial asset and want to make a speculative bet; simultaneously, the non-informed generally fail to time the market and they are not able to fully enjoy the housing dividends. In contrast, Fisher & LambieHanson (2012)[23] finds that during the market downturn, the mortgage foreclosure risk of the local investors (the informed as identified by Chinco & Mayer, 2014[17]) is around 1.8 times of owner-occupants, while that of the non-local is not significantly different from that of the owner-occupants. The above conflict implies that the non-local do not necessarily be the non-informed speculators, actually they could be owner-occupiers.

Because the trading patterns of second-home owners are difficult to characterize, many researches turn their focus to short-term flippers which can be clearly identified. Fu & Qian (2014)[26] finds that short-term flippers generate price overreactions most notably in sub markets with less informative prices based on the assumption that flippers' motivation is to tap gains from market price trends. In Fu, Qian & Yeung (2013)[27], flippers are further specified into the informed and the non-informed. The authors assume that the informed are more likely to transact in the underpriced projects and the non-informed are more likely to transact in the over-priced projects. The trading patterns of the flippers are assumed and not well justified. As a result, these papers are not able to solidly connect the trading patterns to flippers' impacts on housing markets.

Bayer, Geissler & Roberts (2013)[6] is the first article that gives a specific identification of flippers and simultaneously clearly demonstrates the trading patterns of the informed flippers (the middlemen) and the non-informed flippers (the speculators). The specification of the middlemen and the speculators is consistent with the literature where flippers are specified into informed and non-informed (noisy traders): informed flippers buy low and sell higher, arbitraging the market and therefore stabilize the market, while noisy traders create price noises.

All existing researches ignore the role of rental investors who aim to fetch the rental income in housing market. In addition, either investors or flippers only make up a very small part of the market. How such a small part of transactions can trigger the whole market fluctuations is still a question. Although Bayer, Geissler & Roberts (2013)[6] clearly demonstrates the trading patterns of flippers, it is not able to open the black box on how different market participants interact with each other and then impact on the housing market.

2.3 Understanding the roles of owner-occupiers, rental investors and flippers in housing market

Financial market has higher liquidity and lower transaction costs, is more transparent than housing market, and all participants are investors (including both short-term flippers and long-term investors); while in housing market, the majority of participants are owner-occupiers holding consumption and investing motivations although there are also short-term flippers and long-term rental investors. In Singapore, for example, although more than 80% of local residents live in public housing (which is also called HDB), the private housing market is also dominated by the owner-occupiers (who take around 69% of total purchasing transactions according to our dataset).

The three types of housing market participants (owner-occupiers, rental investors and flippers) are different in motivations, trading patterns, scales in the market and therefore their impacts on housing market are different. The difference between the three types of housing participants are well recognized by the government (for example, cooling measures on a housing market target at those non-owner-occupiers, and property taxes in Singapore are also higher for non-owner-occupiers), banks (mortgage lenders charge higher interest rates on mortgages to non-owner-occupiers as indicated by Robinson (2010)[46]) and real estate agents (When a potential buyer approach a broker, the common question the broker will ask first is whether the property is used for living or investing).

Table 2 summarizes the trading motivations, decision making and the implied trading patterns of the three types of market participants. The remaining of this subsection gives a detailed discussion.

Table 2: Trading motivation, decision making and the trading patterns of different market participants

	Flippers	**Rental Investors**	**Owner-occupiers**
Trading Motivation	Short-term capital gain	Long-term capital gain Long-term revenues	Long-term capital gain Consumption Social & psychological utilities
Decision Making	Finance constraint Holding cost Transaction cost Most experienced	Finance constraint Holding cost Transaction cost Experienced	Finance constraint Holding cost Transaction cost Moving cost Idiosyncratic preferences Less experienced
Trading Pattern	Arbitrage Intermediary		 Positive Feedback
Role in Market	Leader		Follower

Flipper

Flippers motivated by taping short-term capital gains are likely to be the most experienced and "smartest" group of participants in a housing market. Flippers are commonly defined as short-term traders. In both Fu & Qian (2014)[26] and Fu, Qian & Yeung, 2013[27], flippers are defined as those who sell properties before project completion. Fu & Qian (2014)[26] claims that the motivation of flippers is assumed to tap the gains from market price appreciation. In Fu, Qian & Yeung, 2013[27], flippers are further specified into the informed and the non-informed. The motivation of the informed flippers is to purchase the under-priced properties and tap the purchasing discount. Both papers implicitly assume that some flippers have the trading patterns as arbitrageurs while others have the trading patterns of positive feedback traders. Bayer, Geissler & Roberts (2013)[7] clearly distinguishes the flippers from the owner-occupiers and rental investors. Flippers are identified as those individuals who buy and resale more than two housing properties within a short period of time, holding the motivation of fetching capital gains from the transacted housing properties. According to the definition, flippers are more experienced as a whole. In addition, Bayer, Geissler & Roberts (2013)[7] further specifies the flippers into the middlemen (the more experienced) and the speculator (the less inexperienced). The middleman's motivation is to fetch purchasing discount and selling premium while speculators focus on price appreciation. Thus, the middlemen is characterized as more experienced, more gifted in finding motivated sellers and buyers, and paying more attention to buying low & selling high; the speculators are less experienced, paying more attention to market price growth relative to the middlemen.

As a short summary, flippers are short-term traders and respond fast to external shocks, more experienced, holding the motivation of taping short-term gains either through housing price appreciation or through buying low & selling high. As indicated in the literature, the flippers are more likely to take the trading patterns of arbitrage, intermediary and less like to positive feedback, compared to the other two types of participants, and flippers are more flexible and more likely to lead the market.

Rental Investor

Purchasing houses for renting is mostly an investment decision (Brown, Schwann & Scott, 2008[14]). Few literature has addressed the behaviors of landlords, while there are still some manifesting the incentives and characteristics of landlords. Obtaining a secure and long-term revenue stream as well as capital gains (house price rising) is the prominent motivation for being a rental investor. Australian Bureau of Statistics (1994)[45] carried out a survey on the incentives of investors in rental housing in Australia, finding that obtaining a secure long-term investment is the prominent attraction. In other words, as summarized by Yates (1996)[62] and Beer (1999)[8], capital gains, rental income as well as tax benefits make investment in rental housing a long-term investment and investors believe house prices will go up. In addition to that, saving for retirement, reducing taxable income, or renting houses out when owners live elsewhere are also important incentives. Thus, Yates (1996)[62] and Beer (1999)[8] argue that those part of investors are less likely to respond quickly to market condition changes.

Rental investors should face both risk in housing prices and rents. Sinai (2011)[53] indicates that both renters and homeowners are subscribed to financial uncertainty. Renters face volatility in future costs of housing services (rents). Homeowners face the uncertainty in housing costs, such as property taxes and maintenance costs. In addition, if the homeowner will move out and sell the house, it will also face volatility in asset value. The above findings imply that rental investors will face both risk in housing prices and rents. This is because housing prices and rents do not have to be consistent with each other (Blackley & Follain, 1996[12]). In addition, financial constraint is an important consideration of rental investors. Brown, Schwann & Scott (2008)[14] find that the accessibility to mortgage has significant influence on investing in private housing.

As a summary, rental investors are motivated by obtaining long-term capital gains, long term and stable revenues, and subject to the holding costs and financial constraint. In the literature, the trading patterns of rental investors are not discussed, while their motivations and decision making constraints imply that they should be less experienced and less flexible than flippers. Thus they are less likely to carry out arbitrage and intermediary trading patterns.

Owner-occupier

The motivations and decision making process of owner-occupiers are the most complicated among the three participants. Driven by both consumption and investment motivations, an owner occupied property is an illiquid and indivisible asset in the household asset portfolio (Arrondel & Lefebvre, 2001[2]; Yang, 2005[61]; Flavin & Yamashita,2008[24]; Lustig & Van, 2005[41];).

Owner-occupiers may face different budget constraints and housing transaction opportunities, transaction costs and the borrowing constraints compared to other participants (Ioannides & Rosenthal, 1994[36]). In addition, being an owner-occupier has a direct utility, which comes from the social, political and psychological values associated with owning a home (Arrondel and Lefebvre (2001)[3]; Megbolugbe & Linneman (1993)[43]). Hung and So (2012) [34] argues that home buyers with both occupying and investment motivations are willing to pay a higher price as a call (option) premium, which is generated from the fact that the home buyers are loss averse: they can hold the property and consume the housing services if house price is low and sell the property when house price is high. Flavin & Nakagawa (2008)[24] states that every adjustment of owner-occupied housing asset in household portfolio incurs an adjustment cost; when choosing a new house, the consumer takes into account the fact that the consumption of housing services will be constant at the new level until the subsequent stopping time, when it is again worthwhile to incur the adjustment cost. The fees associated with purchasing and selling a home also make up a source of transaction costs influencing house transaction decisions (Muth, 1974[44]).

In summary, owner-occupiers are motivated by long-term capital gain, obtaining consumption utility and social & psychological utilities. When making trading decisions, they would consider finance constraints, holding cost, transaction costs and the additional moving costs. In addition, they have idiosyncratic preferences for property attributes to satisfy their consumption. The above facts imply that most owner-occupiers trade less, are less flexible when trading, and they should be less experienced, and therefore they are less likely able to take arbitrage and intermediary trading pattern while more likely to take positive feedback pattern (as implied by Anenberg & Bayer, 2013[1]).

2.4 A Summary of the Literature Review

The related housing and finance literatures illustrate four fallacies: the misleading or conflicting definitions of the terminologies (especially when speculator, rational vs non-rational, the informed vs non-informed, are alternatively used), isolated and exclusive topics (such as arbitrage, intermediary, and positive feedback), the problematic empirical identifications in trading patterns and the ignorance on the interactions among different trading patterns in empirical works. These fallacies may have led to the conflicting or fragmented understanding on both markets. The related housing literature not only shares the same problems but also fails to address the difference between financial and housing markets, which motivates us to study housing market while taking housing markets' characters into consideration.

In addition, the literature for both financial and housing markets have already formed some understanding about trading patterns such as arbitrage, intermediary and positive feedback; and at the same time, numerous studies in housing literature have examined the characters of the three physically different participants, i.e. owner-occupiers, rental investors and flippers. The above motivate us to summarize the related literature and to link housing market participants' characters to their trading patterns.

Unlike in a financial market, flippers, rental investors and owner-occupiers in a housing market can be empirically well identified both as a buyer and as a seller, if data permits. Their roles in a housing market are also well recognized by governments, real estate agents and banks, etc, which allows us to study their interaction in terms of trading patterns. This may shed some light to the interactions of different trading patterns in a financial market.

3 Data, Identification of Housing Market Participants, Variable Selection and Research Design

This section includes two Subsections: 3.1 introduces the data sources as well as the identification of the three types of market participants; 3.2 presents the research design and variable selection for the empirical analysis.

3.1 Data and Identification of Housing Market Participants

We construct our working dataset based on six data sources: StreetSine, PowerSearch, REALIS and Datastream, Bloomberg and URA[4] and HDB[5] News Release. Datastream and Bloomberg provide the time series data for Singapore, such as GDP growth rate and CPI, and the URA and HDB NEWs Release provide the information about Singapore housing-related policies (which are summarized in Appendix. B& C).

Table 3 reports the three housing transaction related databases, including their data sources and coverage. StreetSine is the fundamental database we use. It provides almost all sale's transactions of private housing, more than 80% of rental transactions in the private housing market as well as the rental and sale transactions in the public HDB housing market during the investigation period. POWERSEARCH and REALIS are used to provide additional information and to increase the accuracy of data from StreetSine.

Table 3: The Three Housing Databases

Database Name: StreetSine
Data Sources and Owner: Transaction records reported by real estate agents, combined with records from URA and HDB. Owned by StreetSine Technology Group **Coverage:** Records for all sale transactions of private housing cover the period of 1995Q1 -2014Q1. Records for rental transactions of private housing cover the period of 2006Q1 -2014Q1. Records for resale transactions of HDB cover the period of 2001Q1 -2014Q1. Records for rental transactions of HDB cover the period of 2006Q1 -2014Q1.
Database Name: Powersearch
Data Sources and Owner: Transaction records collected from records revealed by URA and HDB. Owned by Hiwire Data & Security Pte Ltd **Coverage:** Records for the sale and rental tansactions of both private housing and HDB cover the period of 2002Q1-2014Q2.
Database Name: REALIS
Data Sources and Owner: It is a database of URA. **Coverage:** Recods for all the sale transactions of private housing, from 1995Q1-present, updated regularly.

Note: The data bases we use may have more contents in which those not available to us or not used in this article are not listed in the table.

[4]The Urban Development Board of Authority of Singapore, which provides mainly the private housing information: http://www.ura.gov.sg/

[5]Housing & Development Board, which is Singapore's public housing authority, mainly provides information on public housing: http://www.hdb.gov.sg/

The dataset includes both the sale and rental transaction records for the private housing market. There are generally 5 types of private housing properties in Singapore, condominium, apartment, the detached, the semi-detached and terrace, while transactions of condominiums and apartments are very active due to their relatively low total price and higher liquidity, and the two account for around 90% of total private housing transactions. Thus, in our dataset, we only include the condominiums and the apartments. Table 4 reports the variables in our cleaned dataset. The variables are for sale transaction records, while the rental transaction records are not reported as we only use them for identifying market participants.

Table 4: The Main Variables in the Composed Dataset

Variables:	
Transaction ID:	To distinguish each transaction record;
Full Address:	The address of each house unit, including street, block, floor and room no;
Postal Code:	Each building has one identical postal code;
Transaction Price :	Price of the traded housing unit (current price);
Contract Date:	Date when the transaction takes place;
Size:	Size of housing unit, in Square foot;
Floor	Storey level of each housing unit;
TOP	The Year when construction of the Building is finished (buyer can move in);
Property Age	The age of house when it is transacted (contract year minus TOP)
Purchaser Address Indicator	0 for HDB (The buyer previously lives in a Public house unit); 1 for Private (Lives in Private house before);
District	In Singapore, there are 28 districts;
Property Type	Dummy: 1 for Condo; 0 for Apartment;
Property Tenure	Dummy: 1 if the tenure is around 99 years, 0 if it is Freehold or around 999=0;
Type of Sale	New Sale (sold by developer before TOP); Sub sale (sold by house buyer before TOP); Resale (sold after TOP);
Project Name	The name of each project ;
Project Units	Total units within the project;
Singapore time series	Quarterly GDP rate; Quarterly CPI; Monthly interest rate (10 year government bond rate);
Housing Policies	The date when each policy takes effect;

Based on the constructed dataset, we identify owner-occupiers, rental investors and flippers from both the selling and buying sides. The constructed dataset includes the history of rental and sale transactions for each property unit within the investigation period. It is noted that although the sale's transaction records are comprehensive, the dataset only covers more than 80% of the rental transactions in the private housing market. Thus, rental investors are possibly under-represented as compared to owner-occupiers, but the identification of flippers is not influenced.

The identification strategy is developed based on the comprehensiveness of the transaction history of each particular unit, and it includes two parts: identification of participants as buyers and as sellers. On the buying side, we identify a transaction record as bought by a flipper if the property was then sold within a short period of time (we use 1 year as a threshold) or sold as a sub-sale[6]. We assume that within 1 year of holding period, the property owner is not likely to move into the property due to the cost of relocation. We identify a transaction record as bought by a rental investor if the property was then rented out within one year (after TOP); and the rest were bought by owner-occupiers. On the selling side, we look at any two consecutive sale's transaction records (ignoring the rental transactions), if a buyer in the first record is a flipper, then in the second record, the property was sold by the flipper. The identification of rental investor and owner-occupiers follows the same strategy. The strategy details are provided in the Appendix. D. It is noted that for both buying and selling identifications, there are sale's transactions which buyers or sellers are not able to be identified. This is because the original databases only covers a limited time period.

Table 5 presents the transaction history of a private housing unit. Taking transaction record No. 1 as an example, the property was transacted in August 2003 while it was transacted again in September 2006 as a sub-sale. It means that the buyer in record No.1 sold the property before moving into it, and therefore he or she was identified as a flipper. At the same time, in record No.2, the seller was previously a flipper. Let's take record No.5 as another example. The property was transacted in September 2009 and then sub-let within 1 year in Jan 2010, which means the buyer in record No.5 is a rental investor. As the buyer in the previous sale transaction (record No.2) is identified as a rental investor, then in record No.5, the property was sold by the rental investor. In addition, in record No.9, as the previous transaction is beyond our investigation period, we are not able to identify it.[7]

Table 5: Examples of Identification

No.	Full Address	Rent/Sale	Type of Sale	TOP	Contract date	Identi Buyer	Identi Seller
1	1 ESSEX * #**-02	Sale	NEW SALE	2006	8/29/2003	Flipper	N.A.
2	1 ESSEX * #**-02	Sale	SUB SALE	2006	9/25/2006	Rental Investor	Flipper
3	1 ESSEX * #**-02	Rent		2006	12/26/2007		
4	1 ESSEX * #**-02	Rent		2006	12/16/2008		
5	1 ESSEX * #**-02	Sale	RESALE	2006	9/28/2009	Rental Investor	Rental Investor
6	1 ESSEX * #**-02	Rent		2006	1/4/2010		
7	1 ESSEX * #**-02	Rent		2006	6/18/2010		
8	50 LOR*** #**-33	Rent		1998	4/29/2011		
9	50 LOR*** #**-33	Sale	RESALE	1998	9/25/2013	Rental Investor	N.A.
10	50 LOR*** #**-33	Rent		1998	11/22/2013		

Note: For the Full Address of the records, we have the address inform while cover it for confidentiality consideration.

We construct two sub-datasets for sale's transactions at buying side (buying dataset) and selling side (selling Dataset), respectively. The two sub-datasets provide the studied period from 2006Q1 to 2013Q4, which covers a complete property cycle. The following table briefly describes the two sub-datasets and the whole dataset during the studied period. The identified transactions as buyers

[6] A subsale is a sale transaction before TOP, when home buyers cannot move into or sublet the property.

[7] In addition, if the selling of a property was sold by developer (or "New Sale"), we treat the seller as unidentified as this article does not consider the behavior of housing developers.

account for 81.2% of all transactions while the rest are not able to be identified, out of which, 12% are flippers, 20% are rental investors and the rest is owner occupiers. At the selling side, the identified transactions as sellers account for 44.9% of all transactions, out of which, 25.19% are flippers, 7.08% are rental investors, the rest is owner occupiers. In this regard, sample selection bias exist, and more serious in the selling side. However, due to the data constraint, we are not able to correct sample selection bias.

Table 6 also reports the mean values and the standard deviations (which is in parentheses) of several key housing attributes. While the mean value of other housing attributes of the three participants are close, the mean house age of properties which flippers buy and sell is substantially lower than that of the other players. This is because flippers have preference for presale properties in order to lower holding costs.

Table 6: A Description of the Two Sub-datasets and Their Comparison with the Whole Dataset: 2006Q1-2013Q4

	Obs	**% of Identified Volume**	**Transaction Price**	**House Age**	**Size**	**Floor**	**Property Tenure**	**Property Type**
At buying side:								
Owner-occupier	91466	67.98	1407886	6.726181	1384.75	8.822765	0.4775312	0.7155315
			(1321973)	(8.638774)	(604.8915)	(7.656779)	(0.4994976)	(0.4511634)
Rental investor	26737	19.87	1420310	3.644364	1194.968	10.03086	0.4422655	0.6452573
			(1117956)	(8.315969)	(540.0117)	(8.837543)	(0.4966648)	(0.4784442)
Flipper	16346	12.15	1253413	0.1919376	1259.197	10.54876	0.483924	0.691146
			(1047832)	(6.600785)	(604.3689)	(8.977112)	(0.4997567)	(0.4620348)
Total	134549	100.00	1391696	5.328916	1332.116	9.272518	0.4713379	0.6987095
			(1254402)	(8.653016)	(597.8192)	(8.100192)	(0.4991796)	(0.4588203)
At selling side:								
Owner-occupier	50413	67.74	1229478	10.60841	1349.129	8.016583	0.5287908	0.7292099
			(943535.7)	(7.075269)	(530.1832)	(6.676619)	(0.4991753)	(0.4443722)
Rental investor	5266	7.08	1459983	7.559434	1208.349	9.993733	0.4562264	0.6532075
			(908346.4)	(7.598958)	(504.1454)	(8.768055)	(0.4981272)	(0.4759939)
Flipper	18744	25.19	1502950	1.612687	1258.612	11.10393	0.4612156	0.6781957
			(1211652)	(5.918924)	(601.3604)	(9.756939)	(0.4985067)	(0.4671808)
Total	74423	100.00	1314194	8.141301	1316.543	8.934053	0.5067571	0.7110801
			(1022544)	(7.852823)	(549.307)	(7.838712)	(0.4999577)	(0.4532636)
Whole dataset:	165764		1337143	3.683104	1255.907	9.164481	0.535197	0.7005876
			(1163843)	(8.597494)	(587.8084)	(7.850818)	(0.4987611)	(0.4580021)

Note: Standard deviations in parentheses.

3.2 Research design and variable selection

The empirical work takes two steps: firstly, we construct empirical hedonic models to find out if flippers are the "smartest" traders in a housing market, followed by rental investors and owner occupiers in terms of fetching price premiums at selling and obtaining price discount at buying. Secondly, we identify the leadership of flippers in directing the movement of transaction volume in a housing market using Poisson Dynamic Generalized Methods of Moments (GMM) model. We then test the positive feedback hypothesis by investigating the interactions of the three types of market participants both as a buyer and as a seller over a property cycle using both the GMM and hedonic models.

3.2.1 Identifying the "smartest" traders

We construct a hedonic model, which flippers, rental investors and owner occupiers are brought in as dummy variables. Hedonic models do not include property traders' characters while assume that market information is perfect and housing price is determined by a bundle of shadow prices of attributes of each housing property (Rosen, 1974[48]; Epple, 1987[21]). Turnbull & Sirmans (1993)[56] and Watkins (1998)[58] bring housing traders' characters into traditional hedonic models (by including character dummies) to see the characters' impacts on final transaction prices. This is despite that Lambson, McQueen& Slade (2004) [38] and Ihlanfeldt & Mayock (2012)[35] raise the concern that directly adding property traders' characters into hedonic models may generate biased results because the factors influencing bargaining powers might also influences their valuation for different housing attributes. In the present paper, we assume that all participants have the same valuation for housing attributes.

In terms of the buying discounts, we bring two dummies, $Rinvest\_b$ and $Flip\_b$, into a hedonic model, using the Buying Dataset (as shown in Equation 1). For the selling premiums, similarly, we bring $Rinvest\_s$ and $Flip\_s$ into a hedonic model using the Selling Dataset (as shown in Equation 2). (Refer to Subsection 3.1 for the two sub-datasets). The regression models are specified as follows:

$$\begin{aligned}\ln(price_j) =& Con_j + \alpha_1 Rinvest\_b_j + \alpha_2 Flip\_b_j \\ &+ \beta_1 Size_j + \beta_2 Size\_sq_j + \beta_3 Floor_j + \beta_4 Floor\_sq_j + \beta_5 \text{Property } Tenure_j \\ &+ \beta_6 \text{Property } Type_j + \beta_7 \text{Property } Age_j + \mathbf{D}_j * \theta + \varepsilon_j\end{aligned} \tag{1}$$

$$\begin{aligned}\ln(price_j) =& Con_j + \alpha_1 Rinvest\_s_j + \alpha_2 Flip\_s_j \\ &+ \beta_1 Size_j + \beta_2 Size\_sq_j + \beta_3 Floor_j + \beta_4 Floor\_sq_j + \beta_5 \text{Property } Tenure_j \\ &+ \beta_6 \text{Property } Type_j + \beta_7 \text{Property } Age_j + \mathbf{D}_j * \theta + \varepsilon_j\end{aligned} \tag{2}$$

where $Rinvest\_b_j$ and $Flip\_b_j$ are the dummies denoting the buyer of the transaction is rental investor and flipper, respectively; $Rinvest\_s_j$ and $Flip\_b_j$ are the dummies denoting the seller of the transaction is rental investor and flipper, respectively.

Table 7 summarizes the dependent variable, key explanatory variables which manifest the buying discount and selling premium of the two non-owner-occupier participants (with owner-occupier dummy omitted as base group), and the hedonic and controlled variables. In addition, we further divide the whole market cycle into booming, bust, and policy periods to see the influences of different market conditions on the relative "smartness" of the participants. It is important to note that, the booming period is defined as the period from 2006Q1 to 2007Q4, when the price index of Singapore private market rises consistently; the bust period is defined to be the period from 2008Q1 to 2008Q4, when private housing price index goes down consistently; since 2009Q1, the price index picks up again and a series of cooling measures are carried out by Singapore government since June 2009, we define the period after 2009Q1 as the policy period. Besides, the later empirical discussion will focus on the booming and bust periods, the same definitions will be adopted.

A concern may arise that flippers would probably tend to buy properties with poor maintenance and sell the property after renovation (Bayer, Geissler & Roberts, 2013[6]). By dividing the private housing market into resale sub-market and presale-submarket where every property is new and no renovating is allowed, we can test whether this concern matters.

Table 7: For testing the the "smartness" of the three participants when buying and selling

Dependent Variable	ln(price): the log of transaction price of each housing unit.
The key explanatory variables	
Rinvest_b	Dummy variable, 1 if the buyer is rental investor, 0 otherwise;
Flip_b	Dummy variable, 1 if the buyer is flipper, 0 otherwise;
Rinvest_s	Dummy variable, 1 if the seller is rental investor, 0 otherwise;
Flip_s	Dummy variable, 1 if the seller is flipper, 0 otherwise;
Hedonic Variables	
Size	The size of the transacted property, in sqft;
Size_sq	The square of the size;
Floor	The floor level of each transacted unit;
Floor_sq	The square of the floor;
Property Tenure	Dummy variable, 1 if the property's tenure is around 99 years, 0 if the property's tenure is more than 900 years or freehold; 0 if the property's tenure is more than 900 years or freehold;
Prooperty Type	Dummy variable, 1 if the property is condominium, 0 if it is an apartment;
Property Age	The age of the proeprty, calculated as the gap between contract year of the transaction and the TOP;
Controlled Variables	
District Dummies	Each District dummy indicates one district, 1 if it is in that district, otherwise 0;
Project Dummies	Each project dummy indicates one project, 1 if it is in thatproject, otherwise 0;
Quarter Dummies	Each quarter dummy indicates one quarter, 1 if it is in that quarter, otherwise 0;

3.2.2 Testing positive feedback hypothesis

Firstly, we adopt the Poisson Dynamic Generalized Methods of Moments (GMM) model introduced by Hausman, Hall & Griliches (1984)[32], Windmeijer (2006)[59] and Cameron & Trivedi (2013)[15] to identify the leadership of flippers in a housing market.

Based on the buying dataset (refer to Subsection 3.1), we examine how the number of transactions done by the flippers in an apartment or condominium project at time $t-k$ ($Vflip\_b_{it-k}$, with k indicating the lag of the monthly total number of transactions where flippers as buyers, for project i in period tk), influences on the number of transactions done by owner occupiers in the same development at time t ($Voccupier\_b_{it}$, the monthly total number of transactions where owner-occupiers are as buyers, for project i in the current month t), to see how owner-occupiers' buying transactions can be explained by flippers' past buying transactions and to demonstrate the leading role of flippers in relative to owner-occupiers. This is motivated by the literature which imply that flippers tend to be leaders and owner-occupiers follow the flippers when making purchasing decisions (As summarized in Table 2).

We use poison model because the dependent variable ($Voccupier\_b_{it}$) and the key explanatory variables ($Vflip\_b_{it-k}$) are count data which are commonly assumed to follow Poisson distribution. An exponential feedback process is included to manifest the autocorrelation pattern of owner-occupiers' trading patterns and to confront the zero (count number) problem. The conditional mean is specified as follows:

$$E\left[y_{it}\left|y_{it-1}, y_{it-2}, \ldots, \mathbf{x}_{it}, \mathbf{x}_{it-1}, \ldots\right.\right] = \alpha_i \exp\left(\rho_1 y_{it-1} + \rho_2 y_{it-2} + \ldots + \mathbf{x}_{it}^{'}\beta\right) \tag{3}$$

where y_{it} denotes the dependent variable, α_i is the constant, $\mathbf{x}_{it}$ is a vector of explanatory variables, and β is the vector of parameters for $\mathbf{x}_{it}$. By applying the conditional mean specification (1) into our empirical framework, the regression model can be specified as:

$$\begin{aligned} Voccupier\_b_{it} = & \exp(\rho_1 Voccupier\_b_{it-1} + \rho_2 Voccupier\_b_{it-2} + \rho_3 Voccupier\_b_{it-3} + \rho_4 Voccupier\_b_{it-4} \\ & + \beta_1 Vflip\_b_{it-1} + \beta_2 Vflip\_b_{it-2} + \beta_3 Vflip\_b_{it-3} + \beta_4 Vflip\_b_{it-4} \\ & + \mathbf{P}_{it}^{'} * \delta + GDP_t + Con_i) + \varepsilon_{it} \end{aligned} \tag{4}$$

In the regression model, we include the 1st to 4th lags of owner-occupiers' monthly trading volumes at project level ($Voccupier\_b_{it-1}$, ..., $Voccupier\_b_{it-4}$) to control the possible autocorrelation pattern, include the 1st to 4th lags of flippers' monthly trading volumes at project level ($Vflip\_b_{it-1}$, ..., $Vflip\_b_{it-4}$) as the key explanatory variables to see the relative roles of owner-occupiers and flippers. In addition, a vector of housing projects' stylized characters (including $ProjectUnits_i$, $Project\_Type_i$, $ProjectAge_{it}$, $Location_i$) as control variables and GDP_t is also included for controlling the economic condition in Singapore. All the related variables used in this part as well as their definitions are introduced in detail in Table 8.

Table 8: For testing the relative role of the three types of market participants

The key explanatory variables	
$Voccupier\_b_{it}$	The number of puschsing trading by owner-occupiers in project i in period t;
$Rinvest\_b_{it}$	The number of puschsing trading by rental investors in project i in period t;
$Flip\_b_{it}$	The number of puschsing trading by flippersin project i in period t;
$Voccupier\_s_{it}$	The number of selling trading by owner-occupiers in project i in period t;
$Rinvest\_s_{it}$	The number of selling trading by rental investors in project i in period t;
$Flip\_s_{it}$	The number of selling trading by flippers in project i in period t;
The lags of the three variables mentioned above are presented as t-k, for example, $Flip\_s_{it-2}$ means two-stage lag of $Flip\_s_{it}$.	
Project stylized characters	
$ProjectTenure_i$	Dummy variable, 1 if the project's tenure is around 99 years, 0 if the project's tenure is more than 900 years or freehold; 0 if the project's tenure is more than 900 years or freehold;
$ProjectUnits_i$	The total units in the project;
$Project\_Type_i$	Dummy variable, 1 if the project is condominium, 0 if it is an apartment;
$ProjectAge_{it}$	The age of the proeprty, calculated as the gap between contract year of the transaction and the TOP;
$Location_i$	Dummy variable, 1 if the project is located in the central area, 0 otherwise;
Other controlled variables	
GDP_t	Quarterly GDP growth; we assign same GDP rate (quarterly change) to all three months within that quarter.

It is important to note that we select the 1 to 4 stages of autocorrelation of $Voccupier\_b_{it}$ and include the 1-4th lagged $Vflip\_b_{it}$ considering the fact that housing search is a slow process and the backward scope of the potential buyers and sellers is around one quarter. Besides, our dataset for the two periods of market cycle (booming period: 2006Q1-2007Q4; bust period: 2008Q1-2008Q4) only covers a limited time spread, including too high stages of lags will result in sample loss. For robustness consideration, we repeat the regressions where 1 to 3 stages of autocorrelation of $Voccupier\_b_{it}$ and 1-3rd lagged $Vflip\_b_{it}$ are included. In addition, the project fixed effect is considered.

In addition to testing the influence of flippers on owner-occupiers' buying (as shown in Equation 4), we will further test: 1) the influence of flippers on rental investors' buying (Equation 5); 2) the influence of rental investors on owner-occupiers' buying (Equation 6).

$$\begin{aligned} Vrinvest\_b_{it} = &\exp(\rho_1 Vrinvest\_b_{it-1} + \rho_2 Vrinvest\_b_{it-2} + \rho_3 Vrinvest\_b_{it-3} + \rho_4 Vrinvest\_b_{it-4} \\ &+ \beta_1 Vflip\_b_{it-1} + \beta_2 Vflip\_b_{it-2} + \beta_3 Vflip\_b_{it-3} + \beta_4 Vflip\_b_{it-4} \\ &+ \mathbf{P}'_{it} * \delta + GDP_t + Con_i) + \varepsilon_{it} \end{aligned} \tag{5}$$

$$\begin{aligned} Voccupier\_b_{it} = &\exp(\rho_1 Voccupier\_b_{it-1} + \rho_2 Voccupier\_b_{it-2} + \rho_3 Voccupier\_b_{it-3} + \rho_4 Voccupier\_b_{it-4} \\ &+ \beta_1 Vrinvest\_b_{it-1} + \beta_2 Vrinvest\_b_{it-2} + \beta_3 Vrinvest\_b_{it-3} + \beta_4 Vrinvest\_b_{it-4} \\ &+ \mathbf{P}'_{it} * \delta + GDP_t + Con_i) + \varepsilon_{it} \end{aligned} \tag{6}$$

Based on the selling database, we repeat the same procedure to further identify the trading patterns. We investigate 1) the influence of flippers on owner occupiers' selling (as shown in Equation 7); 2) the influence of flippers on rental investors' selling (Equation 8); 3) the influence of rental investors on owner-occupiers' selling (Equation 9). It is important to note that, the selling behaviors of owner-occupiers and rental investors can only happen in the resale market. Therefore, we focus only on the resale records of the Selling Dataset to investigate their selling behaviors.

$$\begin{aligned} Voccupier\_s_{it} = & \exp(\rho_1 Voccupier\_s_{it-1} + \rho_2 Voccupier\_s_{it-2} + \rho_3 Voccupier\_s_{it-3} + \rho_4 Voccupier\_s_{it-4} \\ & + \beta_1 Vflip\_s_{it-1} + \beta_2 Vflip\_s_{it-2} + \beta_3 Vflip\_s_{it-3} + \beta_4 Vflip\_s_{it-4} \\ & + \mathbf{P}'_{it} * \delta + GDP_t + Con_i) + \varepsilon_{it} \end{aligned} \tag{7}$$

$$\begin{aligned} Vrinvest\_s_{it} = & \exp(\rho_1 Vrinvest\_s_{it-1} + \rho_2 Vrinvest\_s_{it-2} + \rho_3 Vrinvest\_s_{it-3} + \rho_4 Vrinvest\_s_{it-4} \\ & + \beta_1 Vflip\_s_{it-1} + \beta_2 Vflip\_s_{it-2} + \beta_3 Vflip\_s_{it-3} + \beta_4 Vflip\_s_{it-4} \\ & + \mathbf{P}'_{it} * \delta + GDP_t + Con_i) + \varepsilon_{it} \end{aligned} \tag{8}$$

$$\begin{aligned} Voccupier\_s_{it} = & \exp(\rho_1 Voccupier\_s_{it-1} + \rho_2 Voccupier\_s_{it-2} + \rho_3 Voccupier\_s_{it-3} + \rho_4 Voccupier\_s_{it-4} \\ & + \beta_1 Vrinvest\_s_{it-1} + \beta_2 Vrinvest\_s_{it-2} + \beta_3 Vrinvest\_s_{it-3} + \beta_4 Vrinvest\_s_{it-4} \\ & + \mathbf{P}'_{it} * \delta + GDP_t + Con_i) + \varepsilon_{it} \end{aligned} \tag{9}$$

The above tests are motivated by the implications from literature on different participants' behavioral patterns and their relative roles. While some may raise the concern on whether the owner-occupiers or rental investors have any influence on flippers. Thus, we carry out the similar testing procedure and will report the results in Appendix. F.

Secondly, we investigate the positive feedback process by looking into the interactions among flippers, rental investors and owner occupiers as buyers and as sellers. De Long, Shleifer, Summers & Waldmann (1990)[19] develops a model of "rational speculators" and "feedback traders" (or noise traders). The authors argue that with the presence of positive feedback traders, rational speculators could also destabilize the price as those rational speculators know that the initial price increase (or down) will stimulate buying (selling) by positive feedback buyers and therefore they do not necessarily transact towards the price fundamental. In other words, the interaction between the "rational speculators" and "feedback traders" will add to the mis-pricing. Besides, as implied by Bayer, Geissler & Roberts, 2013[6], the less experienced tend to be the noise traders or feedback traders while the experienced tend to carry out intermediary trading patterns. In this regard, in our framework, the flippers are more experienced and should behave more like the "rational speculators" in De Long, Shleifer, Summers & Waldmann (1990)[19], while the owner-occupiers are more likely to act as the feedback traders.

What is the positive feedback process? According to De Long, Shleifer, Summers & Waldmann (1990)[19], the positive feedback process is defined as buying in response to previous price rise and selling in response to previous price decreasing. In housing market, it is more flexible for a potential owner-occupier to change the buying plan than for a potential seller to change the selling plan which is subscribed to his or her living demand and moving costs. Therefore, we test the positive feedback process in terms of the buying behaviors of owner-occupiers.

Following the definition of De Long, Shleifer, Summers & Waldmann (1990)[19], the ideal empirical strategy for testing the positive-feedback process should reveal the procedure that the flippers raise the market prices and the owner-occupiers buy more in facing with market price rising. While directly testing this procedure have the following problems: 1) the price index cannot be precisely estimated due to the sparse contracts within a same project; 2) it is difficult for owner-occupiers to directly see the price index changes of the target project; 3) the price rise of a project may under-represent the flippers' impact on project price index rise[8]; 5) the observation of price rise does not necessarily happen after when the previous transactions have been closed, it happens even during the bargaining and bidding process[9].

Thus, we take an alternative way. As we focus on the interaction between flippers and owner-occupiers and the positive feedback process that adds to the market over-pricing, we would like to see the positive feedback behaviors of owner-occupiers when flippers have cashed out, namely, how owner-occupiers take over the stick from the flippers. As discussed above, the project price index change may not be a good indicator representing the source of positive feedback buying, instead we take the average quarterlized realized return of flippers $Flip\_Realized\_R_{it}$ (the quarterly average return rate of flippers at project level, refer to Table 9 for definition details). This is because flippers' returns is a very strong signal that can be sensed by the owner-occupiers: 1) flippers buy and sell within a short period of time and therefore their return rate can be clearly seen by the owner-occupiers; 2) even during the bargaining process before the deal is closed, the flippers tend to be "smarter" and show more bargaining power.

Therefore, if owner-occupiers take a positive feedback trading pattern when facing flippers' realized returns, we will be able to see the following two phenomena: 1) the flippers' selling will trigger the buying of owner-occupiers; 2) owner-occupiers would like to pay a higher price when seeing a higher realized return rate of flippers within the same project. The empirical analysis here includes the following two steps. Firstly, we will test how the purchasing behaviors of owner occupiers will respond to the selling of flippers. Secondly, we will test how flippers' realized return will influence the owner-occupiers' buying prices.

[8]As demonstrated in Bayer, Geissler & Roberts, 2013[6], flippers are able to fetch a price discount when buying and price premium when selling, which means that the flippers' returns should be higher than the market price index.

[9]For example, when many potential buyers are bidding for property A but the deal is closed yet, another potential owner-occupier buyer can sense the market and price condition as soon as he or she approaches the seller of property A and learn about the bidding situation.

In the first step, we will adopt the Poisson Dynamic GMM model as introduced above. In order to test the influences of flippers' selling behaviors on owner-occupiers' buying behaviors, we merge the Selling Dataset and the Buying Dataset. Considering the fact that, while the presale market only has flipper sellers, the resale market has owner-occupier sellers and rental investor sellers in addition to flipper sellers, we also investigate the resale market in addition to the whole market. The regression model is specified as follows (Refer to Table 8 under part 3.2.2 for the explanations of the variables in the model):

$$\begin{aligned} Voccupier\_b_{it} = & \exp(\rho_1 Voccupier\_b_{it-1} + \rho_2 Voccupier\_b_{it-2} + \rho_3 Voccupier\_b_{it-3} + \rho_4 Voccupier\_b_{it-4} \\ & + \beta_1 Vflip\_s_{it-1} + \beta_2 Vflip\_s_{it-2} + \beta_3 Vflip\_s_{it-3} + \beta_4 Vflip\_s_{it-4} \\ & + \mathbf{P}^{'}_{it} * \delta + GDP_t + Con_i) + \varepsilon_{it} \end{aligned} \tag{10}$$

In the second step, we adopt a hedonic method by bringing in the average realized return rate of flippers at project level $Flip\_Realized\_R_{it}$ (in project i quarter period t) as the key explanatory variable, to see its impacts on owner-occupiers' purchasing prices.

We combine the Buying Dataset with Selling Dataset to calculate the $Flip\_Realized\_R_{it}$ at quarter project level, and then merge the variable into the Buying Dataset. In this way, all the buying owner-occupiers within project i in quarter period t face the same average flippers' realized return rate $Flip\_Realized\_R_{it}$. In addition, we only keep the buying records of owner-occupiers for hedonic regressions. We fail to build up a panel dataset to see the influence of the lagged effects of $Flip\_Realized\_R_{it}$ due to the fact that co-occurrence of the selling of flippers and the buying of owner-occupiers do not happen in every quarter for a particular project. However, the cross-sectional relation is able to demonstrate the feedback relationship well, as it takes a relatively long period for closing a deal (at least 2-3 months). In a particular quarter project, even the owner-occupier buy before when the return of the flipper is realized (the deal of the flipper seller is closed), the owner-occupier can be well informed about how much return that flipper can realize when during the searching and bidding process.

The regression model can be specified as in Equation 11, where $\ln(price^{o}_{jit})$ denotes the log of transaction price of owner-occupier buying property j under project i in quarter period t; $Flip\_Realized\_R_{it}$ represents the quarterlized average realized return rate of flippers in project i (where property j is under project i); $\mathbf{D}_{jit}$ is a vector of dummy variables for property j under project i in quarter t, including $DistrictDummies$, $ProjectDummies$ and $QuarterDummies$, and θ is the vector of corresponding parameters. The explanation of the variables are presented in Table 9.

$$
\begin{aligned}
\ln(price^{o}_{jit}) =& Con_{ji} + \alpha_1 Flip\_Realized\_R_{it} + \beta_1 Size_{jit} + \beta_2 Size\_sq_{jit} + \beta_3 Floor_{jit} + \beta_4 Floor\_sq_{jit} \\
& + \beta_5 \text{ Property } Tenure_{jit} + \beta_6 \text{ Property } Type_{jit} + \beta_7 \text{ Property } Age_{jit} \\
& + \mathbf{D}^{'}_{jit} * \theta + \varepsilon_{ji}
\end{aligned} \tag{11}
$$

Table 9: For testing the the positive feedback trading process

The key explanatory variables	
Existence_Flip_b	Dummy variable, 1 if there are flippers purchasing in the particular project at particular quarter, otherwise 0;
Existence_Flip_s	Dummy variable, 1 if there is are flippers selling in the particular project at particular quarter, otherwise 0;
Flip_Realized_R	The average nominal realized return rate of flippers who sell the properties at the particular project in the particular quarter; where the nominal realized return rate is calculated as the ratio of the quaterlized realized nominal return of a flipper to the purchasing price.
Hedonic Variables	
Size	The size of the transacted property, in sqft;
Size_sq	The square of the size;
Floor	The floor level of each transacted unit;
Floor_sq	The square of the floor;
Property Tenure	Dummy variable, 1 if the property's tenure is around 99 years, 0 if the property's tenure is more than 900 years or freehold; 0 if the property's tenure is more than 900 years or freehold;
Prooperty Type	Dummy variable, 1 if the property is condominium, 0 if it is an apartment;
Property Age	Age of the proeprty, calculated as the gap between contract year of the transaction and TOP;
Controlled Variables	
District Dummies	Each District dummy indicates one district, 1 if it is in that district, otherwise 0;
Project Dummies	Each project dummy indicates one project, 1 if it is in thatproject, otherwise 0;
Quarter Dummies	Each quarter dummy indicates one quarter, 1 if it is in that quarter, otherwise 0;

In addition, in order to make a comparison between the response of different participants, we will report the responses of flippers and rental investors to flippers' realized return rate in terms of their purchasing prices. The similar regression models will be adopted, which are specified as follows, where $\ln(price^{r}_{ijt})$ is the price of rental investor buying property j under project i in quarter t, and $\ln(price^{f}_{ijt})$ is the the price of rental investor buying property j under project i in quarter t. [10]

$$
\begin{aligned}
\ln(price^{r}_{jit}) =& Con_{ji} + \alpha_1 Flip\_Realized\_R_{it} + \beta_1 Size_{jit} + \beta_2 Size\_sq_{jit} + \beta_3 Floor_{jit} + \beta_4 Floor\_sq_{jit} \\
& + \beta_5 \text{ Property } Tenure_{jit} + \beta_6 \text{ Property } Type_{jit} + \beta_7 \text{ Property } Age_{jit} \\
& + \mathbf{D}^{'}_{jit} * \theta + \varepsilon_{ji}
\end{aligned} \tag{12}
$$

$$
\begin{aligned}
\ln(price^{f}_{jit}) =& Con_{ji} + \alpha_1 Flip\_Realized\_R_{it} + \beta_1 Size_{jit} + \beta_2 Size\_sq_{jit} + \beta_3 Floor_{jit} + \beta_4 Floor\_sq_{jit} \\
& + \beta_5 \text{ Property } Tenure_{jit} + \beta_6 \text{ Property } Type_{jit} + \beta_7 \text{ Property } Age_{jit} \\
& + \mathbf{D}^{'}_{jit} * \theta + \varepsilon_{ji}
\end{aligned} \tag{13}
$$

[10] It is important to note again that we will run the cross-sectional regressions by controlling the quarter dummies as the dataset is insufficient for panel regressions.

4 Empirical Results

4.1 Flippers are the "Smartest" while Rental Investors Outperform Owner-occupiers

Existing housing literature has fragmentally provided a rough picture on the relative "smartness" of the three types of housing market participants. As summarized in Subsection 2.3, the flippers should be the "smartest" and more likely to take "good" trading strategies, and is seconded by rental investors then the owner-occupiers, which is implied from their different trading motivations and trading experiences. Bayer, Geissler & Roberts, 2013[6] has shown the relative "smartness" of flippers to the rest of the market by examining flippers' buying discount and selling premium. In our framework, we further distinguish the rental investors from the owner-occupiers to give a more comprehensive picture of the housing market.

Price discounts when purchasing

The results here suggest that both flippers and rental investors are able to fetch a price discount compared to owner occupiers when buying, while flippers substantially outperform the rental investors. There is a concern that flippers tend to buy poorly maintained properties and sell the property after renovating, which cannot be captured by our model while might be an alternative explanation instead of flippers' "smartness" for how flippers can buy at lower prices while sell at higher prices. Holding this concern, we split the market into presale market (where housing construction is not finished and no renovation is allowed, and the resale market). Results are consistent in both sub markets.

Column (1) and (5) of Table 10 present the result for the whole studied period (2006Q1 to 2013Q4). We can see that in both the presale market and resale market, flipper buyers pay around 3% (3.16% in presale market and 2.94% in resale market) lower than owner-occupier buyers, and the rental investors can fetch a less discount than flippers while still fetch a discount of 1.05% in the presale market and 0.665% in the resale market compared to owner-occupiers. All the results above are statistically significant at 1% level. We further divide the studied period into booming period (06Q1-07Q4), bust period (08Q1-08Q4) and the booming&policy period (09Q1-13Q4[11]). In the booming periods of 06Q1-07Q4 and 09Q1-13Q4, as shown in Column (2), (4), (6) and (8) of Table 10, flippers can generally get a price discount at more than 2% compared to the owner-occupiers, while rental investors can fetch a less discount at lower than 1%. However, in the bust period as shown in Colume (3) and (7) of Table 10, the rental investors can fetch a higher discount at more than 1% although the figure is still lower than the flippers. The above results indicate that, compared to owner-occupiers, the flippers can fetch a higher discount than rental investors, and both flippers and rental investors are more cautious when making purchasing decisions in the bust period than in booming period.

[11] When the market is picking up fast while the government carries out 8 rounds of anti-speculation policies to deter flippers and then rental investors.

Table 10: Price Discount of flippers and rental investors relative to owner-occupiers: Presale Market & Resale Market

Dependent VARIABLE: ln(Price)								
	Price Difference of Different Buypers: Presale Market				**Price Difference of Different Buypers: Resale Market**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	Whole Period	**Booming**	**Bust**	**Booming & Policy**	**Whole Period**	**Booming**	**Bust**	**Booming & Policy**
	06Q1-13Q4	06Q1-07Q4	08Q1-08Q4	09Q1-13Q4	06Q1-13Q4	06Q1-07Q4	08Q1-08Q4	09Q1-13Q4
Rinvest_b	-0.0105***	-0.00666***	-0.0115***	-0.00930***	-0.00665***	0.00133	-0.0178***	-0.00858***
	(0.00131)	(0.00225)	(0.00408)	(0.00159)	(0.00112)	(0.003)	(0.00454)	(0.00108)
Flip_b	-0.0316***	-0.0273***	-0.0243***	-0.0232***	-0.0294***	-0.0424***	-0.0508***	-0.0213***
	(0.00145)	(0.00208)	(0.00419)	(0.002)	(0.00254)	(0.00328)	(0.0114)	(0.00389)
Size	0.000853***	0.000840***	0.000916***	0.000861***	0.000723***	0.000681***	0.000810***	0.000766***
	(0.000023)	(0.0000306)	(0.0000205)	(0.0000397)	(0.0000147)	(0.0000186)	(0.0000246)	(0.0000167)
Size_sq	(0.00000000583)	(0.00000000716)	(0.00000000558)	(0.0000000107)	(0.00000000354)	(0.00000000402)	(0.00000000632)	(0.0000000045)
	-5.83E-09	-7.16E-09	-5.58E-09	-1.07E-08	-3.54E-09	-4.02E-09	-6.32E-09	-4.50E-09
Floor	0.00761***	0.00640***	0.00711***	0.00911***	0.00501***	0.00625***	0.00593***	0.00455***
	(0.000241)	(0.000394)	(0.000802)	(0.000285)	(0.000235)	(0.000494)	(0.000892)	(0.000257)
Floor_sq	-5.16e-05***	-2.28e-05**	-5.91e-05**	-9.37e-05***	-1.89e-05**	-4.05e-05**	-6.05e-05*	-9.50E-06
	(0.00000698)	(0.0000103)	(0.0000229)	(0.00000915)	(0.00000871)	(0.0000195)	(0.0000344)	(0.00000958)
Property Tenure	-0.0293	-0.614	0.715***	-0.115	2.217	0.0137	-2.040***	-0.322
		(255.5)	(0.194)	(359.7)	(125.5)	(334.6)	(0.405)	(240.3)
Property Type	0.0773	0.225	0.0977	-0.0326	0.0247***	-0.0342	-0.0559	0.0219***
	(0.073)	(0.162)	(0.0687)	(0.0246)	(0.00807)	(0.0334)	(0.101)	(0.0075)
Property Age	-0.0306***	-0.0669***	-0.0093	-0.000734	8.94E-05	0.0133***	0.00711	-0.00368**
	(0.00411)	(0.00923)	(0.0302)	(0.00376)	(0.00167)	(0.00324)	(0.00553)	(0.00179)
Constant	13.45	12.76	12.34***	13.22	12.99***	12.54	14.90***	13.71
		(253)	(0.0845)	(355.1)	(0.047)	(369.6)	(0.385)	(495.9)
Controlled	Quarter dummies, project dummies and district dummies							
Observations	56,644	22,261	4,357	30,026	77,873	22,837	5,108	49,928
R-squared	0.967	0.97	0.97	0.971	0.958	0.96	0.967	0.967

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

We further divide the presale market into newsale submarket where all properties are sold by developers, and the subsale submarket where all properties are sold by individuals before they are completed (before TOP), to address the concern that developers might give some discounts to home buyers and more flippers buy from the developers and therefore enjoy lower prices. The results are reported in Table 11. The results suggest that flippers can fetch a higher discount than rental investors when comparing to owner-occupier buyers, and the two are more cautious when buying during the bust period than in the booming period, which is consistent with that reported in Table 10.

Table 11: Price Discount of flippers and rental investors relative to owner-occupiers: Subsale Market & New sale Market

Dependent VARIABLE: ln(Price)								
	Price Difference of Different Buypers: Subsale Market				**Price Difference of Different Buypers: Newsale Market**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	Whole Period	**Booming**	**Bust**	**Booming & Policy**	**Whole Period**	**Booming**	**Bust**	**Booming & Policy**
	06Q1-13Q4	06Q1-07Q4	08Q1-08Q4	09Q1-13Q4	06Q1-13Q4	06Q1-07Q4	08Q1-08Q4	09Q1-13Q4
Rinvest_b	-0.00686***	-0.00467	-0.0158*	-0.00746***	-0.00830***	-0.00514**	-0.00999**	-0.00799***
	(0.00231)	(0.00446)	(0.00869)	(0.00238)	(0.0014)	(0.00237)	(0.00432)	(0.00182)
Flip_b	-0.0425***	-0.0351***	-0.0448***	-0.0290***	-0.0233***	-0.0200***	-0.0198***	-0.0184***
	(0.00308)	(0.00433)	(0.0104)	(0.00415)	(0.00148)	(0.00208)	(0.0043)	(0.00222)
Size	0.00109***	0.00117***	0.00107***	0.00105***	0.000821***	0.000791***	0.000880***	0.000836***
	(0.0000151)	(0.0000235)	(0.0000602)	(0.0000219)	(0.0000222)	(0.0000272)	(0.0000198)	(0.0000402)
Size_sq	-1.22e-07***	-1.32e-07***	-1.14e-07***	-1.19e-07***	-6.25e-08***	-5.59e-08***	-7.17e-08***	-6.85e-08***
	(0.00000000473)	(0.00000000672)	(0.0000000196)	(0.00000000732)	(0.00000000542)	(0.00000000619)	(0.00000000498)	(0.0000000103)
Floor	0.00693***	0.00710***	0.00433***	0.00760***	0.00684***	0.00307***	0.0128***	0.00913***
	(0.000388)	(0.000587)	(0.00142)	(0.000496)	(0.000288)	(0.000489)	(0.00103)	(0.000294)
Floor_sq	-4.94e-05***	-5.33e-05***	9.50E-06	-7.40e-05***	-2.04e-05**	7.81e-05***	-0.000235***	-8.44e-05***
	(0.00000949)	(0.0000119)	(0.0000321)	(0.0000146)	(0.00000904)	(0.0000143)	(0.0000352)	(0.00000962)
Property Tenure	-0.161*	-0.424***	-0.102**	0.151***	-0.563***	-0.363	0.108*	0.319***
	(0.0851)	(0.0508)	(0.0441)	(0.0163)	(0.197)	(0.358)	(0.0623)	(0.0597)
Property Type	0.00143	0.0757	0.172***	-0.0216	0.199	0.409	0.0332	-0.115***
	(0.0281)	(0.0461)	(0.0661)	(0.0302)	(0.195)	(0.333)	(0.0597)	(0.0445)
Property Age	-0.0463***	-0.0183**	-0.0141	0.0672***	-0.0171***	-0.0727***	-0.0695***	-0.00256
	(0.0097)	(0.00908)	(0.0283)	(0.00917)	(0.0041)	(0.0161)	(0.0107)	(0.00376)
Constant	13.66***	12.06***	12.49***	13.29***	14.05***	13.49	13.24***	12.80***
	(0.0893)	(0.0605)	(0.116)	(0.0716)	(0.214)		(0.0465)	(0.0736)
Controlled	Quarter dummies, project dummies and district dummies							
Observations	15,126	5,148	1,320	8,658	41,518	17,113	3,037	21,368
R-squared	0.966	0.967	0.97	0.975	0.973	0.976	0.974	0.975

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Price premium when selling

We compare the selling prices of rental investors and flippers to that of the owner-occupiers (what we call price premium), to see the relative "smartness" of the three types of participants. During the whole studied period (Column 1 of Table 11), flippers can sell at a price premium of 4.18% which is statistically significant at 1% level, while rental investors sell slightly lower (0.35%) than owner-occupiers. During the booming and bust periods as shown in Column (2) and (3), flippers can fetch a premium of over 3% while rental investors fail to do so. Besides, During the booming period, both flippers and rental investors are able to secure a price premium higher than that in the bust period (although the figures for rental investors in both periods are not statistically significant), which indicates that flippers and rental investors during the booming period take well advantage of the market sentiment to sell at higher prices than owner-occupiers. It is important to note that during the period between 2009Q1 and 2013Q4, the market is booming while intervened by intense government policies, therefore the results of this period is not our focus.

We only consider the resale market here in order to make the selling transactions by the three types of participants comparable. As we have mentioned before, in the presale market, all the sellers are identified as flippers as they sell while without living in the properties. Some common concerns arise for the resale market due to the fact that indoor maintenance of properties are unobservable by our data. As a result, one explanation for why rental investors can not fetch a price premium when selling is that the sublet properties are usually poorly maintained by the renters Wang and Grissom, et al (1991)[57]; and one alternative explanation for why flippers can fetch a price premium when selling is that flippers usually renovate the properties before selling for fetch a good price. While both concerns do not influence our results much. For the rental investors, it is true that properties that have been sublet are not easy to be sold at a price comparable to owner-occupied properties. According to the empirical result, the rental investors are still able to fetch a selling price only slightly lower than or even same as properties sold by owner-occupiers, which indicate the relative "smartness" of rental investors. For the flippers, we do observe some flippers buy poorly maintained properties, while it is unlikely that the flippers renovate more than owner-occupiers before selling.

A Summary

As a summary, we can see that flippers are able to fetch a higher price discount when buying and higher premium when selling compared to rental investors who also outperform the owner-occupiers. The results suggest that flippers is the "smartest" group second by rental investors. This is consistent with the implications from the literature as summarized in Subsection 2.3. In addition, we can see that the relative trading prices of the three participants during the booming and bust periods are different. Compared to owner-occupiers, the flippers and rental investors are

Table 12: Price Difference of Different Sellers: Resale Market

Dependent VARIABLE: ln(Price)				
	Price Difference of Different Sellers: Resale Market			
	(1)	**(2)**	**(3)**	**(4)**
	Whole Period	**Booming**	**Bust**	**Booming & Policy**
	06Q1-13Q4	06Q1-07Q4	08Q1-08Q4	09Q1-13Q4
Rinvest_s	-0.00350**	0.00883	-0.00171	-0.00613***
	(0.00167)	(0.0151)	(0.00999)	(0.00155)
Flip_s	0.0418***	0.0435***	0.0315***	0.0254***
	(0.0019)	(0.00344)	(0.00636)	(0.00221)
Size	0.000759***	0.000743***	0.000843***	0.000764***
	(0.0000115)	(0.0000147)	(0.0000268)	(0.0000182)
Size_sq	-6.28e-08***	-5.84e-08***	-8.23e-08***	-6.47e-08***
	(0.00000000306)	(0.0000000035)	(0.00000000699)	(0.00000000504)
Floor	0.00488***	0.00695***	0.00630***	0.00442***
	(0.000257)	(0.000602)	(0.000891)	(0.00028)
Floor_sq	-2.61e-05***	-8.23e-05***	-8.26e-05**	-1.65E-05
	(0.00000956)	(0.0000241)	(0.0000332)	(0.0000105)
Property Tenure	0.721***	-0.023	0.168	0.258***
	(0.067)	(0.129)	(0.358)	(0.0237)
Property Type	0.0218**	-0.0625	-0.011	0.0172*
	(0.00917)	(0.0556)	(0.266)	(0.00887)
Property Age	-0.00227	-0.00325	0.00272	-0.00202
	(0.00185)	(0.00401)	(0.00673)	(0.00204)
Controlled	Quarter dummies, project dummies and district dummies			
Constant	12.65***	12.48***	12.79***	13.20***
	(0.0403)	(0.058)	(0.268)	(0.0411)
Observations	61,269	14,861	4,235	42,173
R-squared	0.961	0.965	0.971	0.965

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

more able to take advantage of the market sentiment during the booming period than during the bust period, which justifies the necessity to treat the booming period and bust period differently.

4.2 Test the positive feedback hypothesis

In this Subsection we demonstrate the leadership of flippers in a housing market as well as test the positive feedback process as an interaction among flippers, rental investors and owner-occupiers. The findings well explain how flippers who take account of a very small part of the market share can trigger the mis-pricing of a whole housing market, and also provide a new understanding on how the cooling measures in Singapore which mainly targets at the flippers in the Singapore private housing market, has eventually frozen both the private and the public resale housing markets.

The results reconcile a conflict why flippers, as the "smartest" participants who are more likely to take good trading patterns such as arbitrage and intermediary, are often blamed for market mispricing by existing literature (Fu, Qian & Yeung, 2013[27]; Fu & Qian, 2014[26]; Bayer, Geissler & Roberts, 2013[6], et al.). The answer is that flippers trigger the positive feedback trading of owner-occupiers who are not that "smart" but dominate a housing market. As a result flippers' trading can lead to the mispricing of the whole market, and policy which attempts to deter flippers, can therefore freeze the whole market.

4.2.1 Identifying the leadership of flippers in a housing market

Table 13 reports the different roles of the participants in terms of buying behaviors. Column (1) of Panel A shows that, during the booming period, 1 more buying transaction of flippers are associated with 4.7% of more buying transactions of owner-occupiers in the next month within the same project (with parameter of V_flip_b-1 at 0.0477766 with statistical significance at 1%); while for four months later (V_flip_b-4) 1 more flippers' buying is associated with 0.9% less buying transactions of owner-occupiers. The results suggest that, during the booming period, flippers buying immediately heat the market sentiment of owner-occupiers and lead them to bring forward the purchasing decision while overdraw their later demand for housing. Results in Column (2) of Panel A suggest that the flippers buying transactions have long-lasting influences on rental investors' purchasing decisions: 1 more flippers' buying is associated with around 6.17% more rental investors' buying transactions next month while the figure for the later months is around 2%. Column (3) of Panel A shows that the rental investors' buying generally has little influences on owner-occupiers' buying decisions, while 1 more buying of rental investors is associated with 2% less buying of owner-occupiers four months later.

Panel B of Table 13 reports the results during the bust period. The results in the bust period are consistent with that during the booming period. However, we can see that the influence of flippers on rental investors' on owner-occupiers' buying decisions is stronger during the bust period. For example, 1 more flippers' buying transaction is associated with 17.9% more owner-occupiers' buying next month in the bust period (as shown in Column 1 Panel B) while the figure is 4.78% in the booming period (as shown in Column 1 Panel A).

One possible explanation is that in the bust period, owner-occupiers' buying transactions is relatively more sparse compared to that in the booming period, as a result, flippers buying lead to more owner-occupiers buying which shows a higher figure in terms of percentage volume increases. Another explanation for this difference is that the purchasing of flippers and rental investors are more cautious and can more precisely reveal the under-priced projects which also attract the owner-occupiers. The third but the more probable explanation is that during the bust period, the whole market is going down, while the flippers' buying raises the market sentiment of certain projects which attract the hesitating rental investors and owner-occupiers otherwise they have no where to go. The last two explanations are consistent with the finding in Subsection 4.1 which suggest that flippers and rental investors are "smarter" and they out-perform the owner-occupiers more in the bust period.

Table 14 reports the different roles of participants in terms of selling behaviors during the booming and bust periods. During both the booming and bust periods, the selling of flippers has no influence on the selling of rental investors (as shown in Column 2 of Panel A&B), and the selling of rental investors have no influences on the selling of owner-occupiers (as shown in Column 3 of Panel A&B). Particularly, the selling of flippers is associated with less owner-occupierselling. As shown in Column (1) of Panel A&B, 1 more selling by flippers is associated with 11.2% less of owner-occupiers' selling transactions 2 months later during the booming period and the figure for the bust period is 8.10%.

One reason for the insignificant relationship between selling behaviors of different participants is that owner-occupiers and rental investors are not flexible in selling their owned properties: for owner-occupiers, they are living in the properties for housing services and moving home generates high costs; for rental investors, their selling behaviors are restricted by tenancies. There do exist another type of owner-occupiers, which is the internal movers as studied by Anenberg & Bayer, 2013[1]. The internal movers are defined as those who sell the original homes and buy and live in another home within the same city. Due to the limitation of our dataset, we cannot identify and study how flippers selling can influence the selling of those internal movers' original homes. While based on our identification framework, buyers as owner-occupiers buy and live in the bought properties, they are owner-occupiers. We do not consider whether they already have a home before buying or how they sell their original homes.

In addition, the selling of flippers is associated with less owner-occupier selling. This cannot be explained by the inflexibility of owner-occupiers in selling. We argue that this is due to owner-occupiers' positive feedback trading patterns: they hold and stop selling while buy more in face with flippers' realized returns. Besides, the association between flippers' selling and owner-occupiers'

Table 13: The relative roles of different participants when buying during the booming and bust periods

Panel A- Booming Period: 2006Q1-2007Q4					
Dependent VARIABLE: **Voccupier_b**		**Vrinvest_b**		**Voccupier_b**	
	(1)		**(2)**		**(3)**
Voccupier_b-1	-0.0026533	Vrinvest_b-1	0.0718668***	Voccupier_b-1	0.0097988**
	(0.004367)		(0.0210043)		(0.004257)
Voccupier_b-2	0.005371	Vrinvest_b-2	0.0601103***	Voccupier_b-2	0.0080345**
	(0.0036953)		(0.0150633)		(0.0039212)
Voccupier_b-3	0.0100548***	Vrinvest_b-3	-0.0022403	Voccupier_b-3	0.009217***
	(0.0019499)		(0.0053072)		(0.0021087)
Voccupier_b-4	0.0135213***	Vrinvest_b-4	-0.0260861***	Voccupier_b-4	0.0115665***
	(0.0030894)		(0.0082136)		(0.0018949)
Vflip_b-1	0.0477766***	Vflip_b-1	0.061722***	Vrinvest_b-1	0.0122925
	(0.0075433)		(0.013935)		(0.0131206)
Vflip_b-2	0.0000637	Vflip_b-2	-0.0275802**	Vrinvest_b-2	0.0096404
	(0.0059562)		(0.0131395)		(0.0095235)
Vflip_b-3	-0.0061309	Vflip_b-3	0.0151112***	Vrinvest_b-3	0.0000935
	(0.0040743)		(0.0044042)		(0.0047407)
Vflip_b-4	-0.0094717**	Vflip_b-4	0.0276708***	Vrinvest_b-4	-0.0208092***
	(0.0046708)		(0.0050866)		(0.0085811)
Observations	19024	Observations	19024	Observations	19024
Panel B- Bust Period: 2008Q1-2008Q4					
Dependent VARIABLE: **Voccupier_b**		**Vrinvest_b**		**Voccupier_b**	
	(1)		**(2)**		**(3)**
Voccupier_b-1	0.0758868***	Vrinvest_b-1	0.2076247***	Voccupier_b-1	0.0795524***
	(0.0105691)		(0.0496505)		(0.011023)
Voccupier_b-2	0.036164***	Vrinvest_b-2	0.0339073	Voccupier_b-2	0.0472561***
	(0.0094031)		(0.0289577)		(0.0084986)
Voccupier_b-3	0.0165316	Vrinvest_b-3	0.0100341	Voccupier_b-3	0.0050661
	(0.0113094)		(0.021572)		(0.0053101)
Voccupier_b-4	0.0051274	Vrinvest_b-4	0.0642888***	Voccupier_b-4	0.0048072
	(0.0036226)		(0.0231807)		(0.0038441)
Vflip_b-1	0.1789179***	Vflip_b-1	0.2962647***	Vrinvest_b-1	0.0986428***
	(0.0344959)		(0.0751026)		(0.0305025)
Vflip_b-2	0.0316666	Vflip_b-2	0.1436522***	Vrinvest_b-2	-0.0349108
	(0.0426669)		(0.0440523)		(0.0330453)
Vflip_b-3	-0.0570243**	Vflip_b-3	-0.0109955	Vrinvest_b-3	-0.0452652**
	(0.0252304)		(0.0141206)		(0.0214254)
Vflip_b-4	-0.0140683	Vflip_b-4	-0.0544347***	Vrinvest_b-4	-0.0203276
	(0.012007)		(0.0192614)		(0.0155262)
Observations	16115	Observations	16115	Observations	16115
Controlled Variables	Project stylized factors including Project Tenure, Total units of project, Location, Project type and project age; GDP rate				

Standard errors in parentheses and adjusted for clusters in Project
*** p<0.01, ** p<0.05, * p<0.1

less selling is stronger during the booming period than that during the bust period, which indicates that the positive feedback trading pattern of owner-occupiers should be weaker during the bust period and owner-occupiers are also more cautious in the bust period than in the booming period. We will further test this positive feedback trading pattern of owner-occupiers in part 4.2.2.

Table 14: The relative roles of different participants when selling during the booming and bust periods

Panel A- Booming Period: 2006Q1-2007Q4					
Dependent VARIABLE:					
Voccupier_s		**Vrinvest_s**		**Voccupier_s**	
	(1)		**(2)**		**(3)**
Voccupier_s-1	0.1057648***	Vrinvest_s-1	0.4997749	Voccupier_s-1	0.1032278***
	(0.0084968)		(0.3756623)		(0.0082312)
Voccupier_s-2	0.0419441***	Vrinvest_s-2	0.8476314***	Voccupier_s-2	0.0361579***
	(0.0073752)		(0.3012402)		(0.0084219)
Voccupier_s-3	0.0105486	Vrinvest_s-3	0.9120471***	Voccupier_s-3	0.00757
	(0.0094957)		(0.3278582)		(0.0081712)
Voccupier_s-4	0.0270021***	Vrinvest_s-4	0.3635928	Voccupier_s-4	0.0144582
	(0.0100813)		(0.5915732)		(0.0094536)
Vflip_s-1	-0.0270248	Vflip_s-1	0.0245732	Vrinvest_s-1	0.1074124
	(0.0172219)		(0.1044337)		(0.1278171)
Vflip_s-2	-0.112123**	Vflip_s-2	-0.0885457	Vrinvest_s-2	-0.1135248
	(0.0438942)		(0.0784624)		(0.0730521)
Vflip_s-3	-0.0242505	Vflip_s-3	0.1714802	Vrinvest_s-3	-0.150717*
	(0.0225692)		(0.135295)		(0.0853478)
Vflip_s-4	-0.0112471	Vflip_s-4	-0.0022432	Vrinvest_s-4	-0.1461665
	(0.0359357)		(0.1343788)		(0.1613528)
Observations	12965	Observations	12965	Observations	12965
Panel B-Bust Period: 2008Q1-2008Q4					
Dependent VARIABLE:					
Voccupier_s		**Vrinvest_s**		**Voccupier_s**	
	(1)		**(2)**		**(3)**
Voccupier_s-1	0.1355227***	Vrinvest_s-1	-0.3103807	Voccupier_s-1	0.1369515***
	(0.0166534)		(0.4323555)		(0.0166413)
Voccupier_s-2	0.060987***	Vrinvest_s-2	-0.4359969	Voccupier_s-2	0.0583188***
	(0.0166756)		(0.8459105)		(0.0156635)
Voccupier_s-3	0.0437159***	Vrinvest_s-3	0.5544198	Voccupier_s-3	0.0411807***
	(0.0157497)		(0.3588693)		(0.0158489)
Voccupier_s-4	0.064496***	Vrinvest_s-4	0.3232824	Voccupier_s-4	0.0693307***
	(0.0148022)		(0.4221929)		(0.0150054)
Vflip_s-1	0.0127284	Vflip_s-1	0.0444674	Vrinvest_s-1	-0.1117139
	(0.0422637)		(0.2205419)		(0.1204886)
Vflip_s-2	-0.0809931**	Vflip_s-2	-0.0260109	Vrinvest_s-2	0.0973726
	(0.0344884)		(0.2764172)		(0.0874079)
Vflip_s-3	0.0002299	Vflip_s-3	0.0622927	Vrinvest_s-3	-0.007412
	(0.0254199)		(0.1381126)		(0.1206306)
Vflip_s-4	0.0438133	Vflip_s-4	-0.0779019	Vrinvest_s-4	0.1281754
	(0.0271107)		(0.1474593)		(0.1114611)
Observations	12063	Observations	12063	Observations	12063
Controlled Variables	Project stylized factors including Project Tenure, Total units of project, Location, Project type and project age; GDP rate				

Standard errors in parentheses and adjusted for clusters in Project
*** p<0.01, ** p<0.05, * p<0.1

4.2.2 The positive feedback process

In the previous section, the result suggests the positive feedback trading pattern of owner-occupiers. This section further demonstrates the positive feedback trading pattern of owner-occupiers as an interaction with flippers. Our argument is that, the selling behaviors of flippers will trigger the buying of owner-occupiers, thus the owner-occupiers take the positive feedback trading patterns (as defined by Delong, Shleifer, Summers & Waldmann, 1990[40]). Specifically, owner-occupiers are more eager to buy when observing the realized return of flippers (when flippers cash out): 1) the selling of flippers is associated with more buying of owner-occupiers; 2) a higher realized return of flippers is associated with a higher price paid by owner-occupiers when buying.

Results in Table 15 show that the selling of flippers is associated with more buying of owner occupiers in the booming market, while this relationship does not hold during the bust period. As shown in Column (1) of Table 15, 1 more flippers' selling is associated with 23.75% more of owner occupiers' buying 2 months later which is statistically significant at 1% level, while it is correlated with less buying of owner-occupiers after 3 months. This indicates that, during the booming period, the selling of flippers trigger the later more buying of owner-occupiers while this influence does not last long. While during the bust period, as shown in Column (2) of Table 15, more selling of flippers is associated with less later buying of owner-occupiers. By comparing the situation in the booming and bust period, we can see that the owner-occupiers are less cautious when buying in the booming period and show the positive feedback trading pattern.

Table 15: The association between flippers' selling and owner-occupiers' buying in the booming and bust periods

Dependent VARIABLE: Voccupier_b		
	(1)	**(2)**
	Booming Period: 2006Q1-2007Q4	Bust Period: 2008Q1-2008Q4
Voccupier_b-1	-0.0621585	0.0779129***
	(0.0879794)	(0.0148385)
Voccupier_b-2	0.0020304	0.0560446***
	(0.0070935)	(0.0115007)
Voccupier_b-3	0.0145293*	0.0606355***
	(0.0084613)	(0.0123955)
Voccupier_b-4	0.0293248**	0.0513281***
	(0.0116455)	(0.0094572)
Vflip_s-1	0.1378488	0.0059915
	(0.1120601)	(0.0439808)
Vflip_s-2	0.2375498***	-0.0749738**
	(0.0556742)	(0.0296795)
Vflip_s-3	-0.3987605*	-0.047311*
	(0.1922033)	(0.0283268)
Vflip_s-4	-0.2794386***	-0.013795
	(0.0945622)	(0.0206199)
Observations	15903	13379
Controlled Variables	Project stylized factors including Project Tenure, Total units of project, Location, Project type and project age; GDP rate	

Standard errors in parentheses and adjusted for clusters in Project
*** p<0.01, ** p<0.05, * p<0.1

Table 16 demonstrates how the buying prices of owner-occupiers respond to the existence of flippers' selling. For a particular quarter within a particular project, 1 more flippers' selling is associated with 0.5% increase in owner-occupiers' buying prices in the booming period; while this association during the bust period is not significant.

Table 16: The existence of flippers' selling on owner-occupiers' buying price

Dependent VARIABLE: ln(Price), the purchasing price		
	Booming Period 2006Q1-2007Q4	**Bust Period 2008Q1-2008Q4**
Flippers' Existence	**0.00564****	**0.00427**
	(-0.00224)	**(-0.0048)**
Controlled	Quarter, project , district dummies, hedonic variables and constant.	
Observations	29,266	6,542
R-squared	0.968	0.971

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 17 further shows how owner-occupiers respond to flippers' realized return rate in terms of their buying prices. For the purpose of comparison, we also test the price response of flippers and rental investors. Comparing the results in Column (1) to that in Column (4), we can see that, when seeing 100% of owner-occupiers quarterlized nominal return rate would like to pay 2.27% higher price when buying in the booming period (which is statistically significant at 1% level), while owner-occupiers show no price response during the bust period. In comparison, both rental investors and flippers show no significant price response to flippers' realized return when buying in the booming period; while in the bust period, rental investors are more cautious and even pay a lower price in response to flippers' higher realized returns. This makes up another evidence that flippers are less likely to take the positive-feedback trading patterns than owner-occupiers.

Although the scale of the responses of owner-occupiers' buying prices to flippers' selling as well as the realized return rate is small, it together with the more buying behavior associated with the selling of flippers in the booming period can well demonstrate the positive feedback trading pattern of owner-occupiers as interaction with the flippers. While this interaction does not exist during the bust period.

Table 17: The response of the three types of participants' buying prices to flippers' realized return over the market cycle

Dependent VARIABLE: ln(Price), the purchasing price of the three participants						
	Booming Period: 2006Q1-2007Q4			**Bust Period: 2008Q1-2008Q4**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Occupier	**RInvestor**	**Flipper**	**Occupier**	**RInvestor**	**Flipper**
Flip_Realized_R	**0.0227*** **	**0.00392**	**-0.00246**	**0.00218**	**-0.0746*** **	**-0.00352**
	(0.00732)	**(0.00275)**	**(0.00315)**	**(0.0341)**	**(0.00514)**	**(0.044)**
Size	0.000775***	0.00113***	0.00115***	0.00104***	0.00113***	0.00152***
	(0.0000233)	(0.0000571)	(0.0000225)	(0.0000552)	(0.0000672)	(0.000117)
Size_sq	-4.94e-08***	-1.18e-07***	-1.30e-07***	-1.09e-07***	-1.19e-07***	-3.23e-07***
	(0.00000000464)	(0.0000000162)	(0.00000000637)	(0.0000000179)	(0.0000000204)	(0.0000000416)
Floor	0.00555***	0.00660***	0.00699***	0.00199	0.00707**	0.0114***
	(0.000735)	(0.000823)	(0.000744)	(0.0018)	(0.00282)	(0.00279)
Floor_sq	-0.0000119	-0.0000188	-4.07e-05**	0.0000681	-0.0000548	-0.000120**
	(0.0000188)	(0.0000178)	(0.0000166)	(0.0000464)	(0.0000546)	(0.0000544)
Property Tenure	0.202*	0.140**	0.066	0.191*	0.159***	0.143*
	(0.107)	(0.0645)	(0.0499)	(0.116)	(0.0496)	(0.0763)
Property Type	0.000752	0.122	-0.00584	-0.323***	-0.0463	-0.214
	(0.0667)	(0.0754)	(0.0128)	(0.101)	(0.109)	(0.218)
Property Age	-0.0743***	-0.0453***	-0.0735***	-0.0168	-0.0406	0.0178
	(0.013)	(0.0157)	(0.02)	(0.0493)	(0.0251)	(0.0611)
Controlled	Quarter dummies, project dummies, district dummies and constant.					
Observations	5636	3155	3775	1078	353	205
R-squared	0.965	0.965	0.974	0.969	0.967	0.976

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.3 Summary of Empirical Results

The empirical results suggest that flippers are the "smartest" group second by rental investors (As shown in Panel A of Table 18), which is consistent with the implications of the existing literature on different participants' motivations and experiences. We also see strong evidence that more flippers' buying generates more buying of rental investors and owner-occupiers, and in this regard, the buying of flippers lead the market (Panel B of Table 18). Due to the inflexibility in selling of rental investors and owner-occupiers, the selling of flippers has no positive influence on the selling decisions of rental investors and owner-occupiers; besides, due to the positive feedback trading pattern of owner-occupiers, the owner-occupiers even sell less facing flippers' selling (Panel C of Table 18). The positive feedback process is that: flippers cash out and fetch returns, when seeing flippers' realized returns the owner-occupiers are eager to buy and pay a higher price (as shown in Panel D of Table 18), which is consistent with the theory of De Long, Shleifer, Summers & Waldmann, 1990[19].

Besides, the influence of flippers' buying on owner-occupiers' buying decisions is stronger during the bust period than the booming period, and simultaneously the buying discount of the flippers in the bust period is higher. In terms of selling, the flippers are able to fetch a higher price premium in the booming period than in the bust period, and this is because positive feedback trading of owner-occupiers only happen in the booming periods. In this article, we focus on the interaction between flippers and owner-occupiers, the behaviors of rental investors are very like that of owner-occupiers and we do not discuss the rental investors in detail.

Table 18: Summary of empirical results

	Booming Period		**Bust Period**	
Panel A: Relative Smartness of Participants				
Discount of flip & Rinvest when buying	+		+ +	
Premium of flip & Rinvest when selling	+ +		+	
Panel B: Relative roles when buying				
	Buying of Occupier	Buying of Rinvest	Buying of Occupier	Buying of Rinvest
Buying of flippers	+	+	+ +	+ +
Buying of rental investors			+	
Panel c: Relative roles when selling				
	Sellinging of Occupier	Selling of Rinvest	Sellinging of Occupier	Selling of Rinvest
Selling of flippers	- -		-	
Sellinging of rental investors				
Panel D: feedback of Occupier to flip				
Occupier's buying behavior	+			
Occupier's buying prices	+			

Note: "+" indicates positive effects and "-" is negative; number of "+" or "-" indicates the scale of the influence, e.g. the strength of "+ +" is stronger than "+"; No sign meand no influences.

As indicated by De Long, Shleifer, Summers & Waldmann, 1990[19], the positive feedback process includes two sides: one is buying when seeing price up, the other is selling when seeing price down. It is important to note that, here we only demonstrate that the owner-occupiers take the positive feedback trading pattern as buying when seeing market price up; while we cannot demonstrate the other side which is selling when market price down. This is due to the stylized characters of housing market which are different from financial markets. In housing market, individuals cannot take short positions. In addition, owner-occupiers as property owners also hold the consumption motivations and need to face high home moving costs which stop them from selling their properties. As a result, if owner-occupiers take positive feedback trading pattern, the most they can do is that they do not buy when seeing the price drop. This is why during the bust period the market freezes with much less transactions, and also can explain why less owner-occupiers choose to execute the mortgage default during the bust period (Haughwout, Lee, Tracy & Klaauw, 2011[31]).

The empirical results well explain the housing market cycle as well as the conflict how flippers as the the "smartest" group who are more likely to take "good" behaviors while add to the market mispricing. As shown in Figure 3. during the first trough period (left of the Figure), flippers buy more and sell less. The buying behaviors of flippers trigger the buying of owner-occupiers. Market price picks up during the booming period and then flippers begin to sell. Flippers' selling does not lead to the selling of owner-occupiers, instead the owner-occupiers positively feedback to flippers' realized return the push the market price up further towards the peak although at that time the flippers sell more buy less. When the market freezes and go into the bust period and again towards the trough (right part of the Figure), flippers again boost up the market by leading the buying of owner-occupiers.

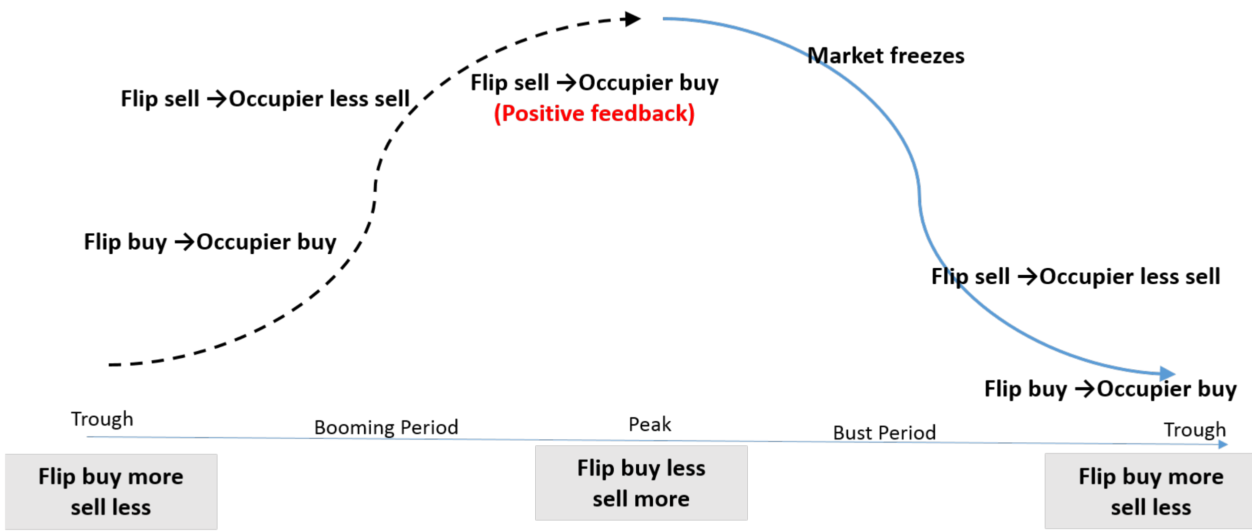

Figure 3: The interaction between flippers and owner-occupiers and the market cycle

One concern is that, our findings seem to conflict with some of the empirical findings in the US market. For example, we argue that flippers are the "smartest" who take "good" trading behaviors (arbitrage and intermediary) while owner-occupiers are relatively not "smart" and tend to take "bad" trading behaviors (positive feedback). While in Haughwout, Lee, Tracy & Klaauw (2011)[31] which studies the US market during the 2008 financial crisis, they find that the default rate of investors (including both the rental investors and flippers) is much higher than that of the owner-occupiers, which could imply that the investors are more noisy. While this is actually not the case. Firstly, default rate might not be an indicator of "smartness". For example, owner-occupiers are mostly motivated by consumption needs when making purchasing decisions, and moving home incurs high costs. Besides,home owners can hold the property and consume the housing services if house price is low and sell the property when house price is high (Hung and So, 2012 [34]). That is to say, "smartness" is not the cause of owner-occupiers' low default rate. Secondly, we do not deny the identification of the informed and non-informed flippers as well as the corresponding findings, while we argue that owner-occupiers' interaction with the flippers should also be considered. Thirdly, the Singapore private housing market and the US housing market are different. Private housing in Singapore can only be afford by the relatively high-income, while the flippers and rental investors there are even richer which imply that this group of people tend to be even "smarter". While in the US housing market, homes are affordable to average people. Thus, not all flippers and rental investors in the US housing market are the high income and the "smart". Besides, the unique feature of Singapore private housing market (high-income dominated) does not harm the applicability of our findings. As owner-occupiers dominate almost every market and the relative difference between the owner-occupiers and other participants always exist due to their different motivations.

5 Robustness Considerations

Some existing researches such as Fu, Qian & Yeung (2013)[27], Fu & Qian (2014)[26] and Bayer, Geissler & Roberts (2013)[6] argue that flippers take the feedback trading patterns. We argue that this is less likely, at least the flippers are less likely to take feedback-trading pattern than the owner-occupiers. In addition to the evidence provided in Table 17 (as discussed in 4.2.2), we can see that owner-occupiers are the dominant buyers of the properties sold by flippers, accounting for more than 67.8% of total properties sold by flippers, and rental investors take more than 20.85% (As shown in Appendix. E). If flippers are more likely to take positive feedback trading strategies, the dominant buyers from the flippers should be another group of flippers.

When comparing the "smartness" of the three participants in terms of selling premiums with Selling Dataset, a possible concern is that indoor maintenance is an unobservable factor that influences the transaction prices. To address this concern, we test the relative "smartness" of participants in alternative ways to consolidate the conclusions in Subsection 4.1. The results are consistent and are shown in Appendix. E. In addition, some may raise the concern that the properties bought by owner-occupiers, rental investors and flippers may be different, not only different in indoor qualities, but also different in neighbors. This is true in the US, but this is not true in Singapore private housing markets, it is common that within a same project, indoor quality the housing units is identical, and the three types of participants co-exist.

When studying the relative roles of different participants, we only report the results about how flippers influence rental investors and owner-occupiers which is suggested by the literature, while one may concern whether flippers are influenced by rental investors and owner-occupiers. The answer is generally no. We repeat the similar Poisson Dynamic GMM models and report the results in Appendix. F. The results suggest that flippers buying are not influenced by the buying of owner-occupiers and rental investors in the bust period while the influence is very small in scale during the booming period.

In addition, when studying the relative roles of different participants, we include the 1st to 4th stage of autocorrelations and 1st to 4th lagged key independent explanatory variables in the Poisson Dynamic GMM model, which is based on the consideration of sample time spread as well as the housing market characters. For robustness consideration, we repeat the regression with 1st to 3rd stage of autocorrelations and 1st to 3rd lagged key independent explanatory variables, and get the generally consistent results[12].

[12]Limited by the length of the article, we will not report in the appendix, please ask for it when you need to see it.

6 Conclusions and Implications

We physically specify housing market participants as owner-occupiers, rental investors and flippers. The three types of participants are physically distinguished from each other and their difference is well recognized by the literature, governments and the social public. We summarize the different motivations, decision making processes as well as the implied different trading patterns of the three types of participants with a comprehensive literature review. Consistent with the literature, we demonstrate that flippers are the "smartest" group while rental investors outperform owner occupiers in terms of fetching buying discounts and selling premiums.

While both literature and our findings from the Singapore private housing market suggest that the flippers are the "smartest" participant group and as a result tend to take "good" trading patterns such as arbitrage and intermediary (Bayer, Geissler & Roberts, 2013[6]), they are usually blamed for market mis-pricing (Fu, Qian & Yeung, 2013[27]; Fu & Qian, 2014[26], et al.). We justify the leadership of flippers in terms of buying behaviors in both the boom period and bust period of a property market cycle, and justify the positive feedback trading patterns (De Long, Shleifer, Summers & Waldmann, 1990[19], et al.) of owner-occupiers facing flippers' realized return during the boom market period. These findings reconcile the conflict mentioned above by showing that although flippers take "good" trading patterns while their trading triggers the positive feedback of owner-occupiers and as a result lead to market over-pricing. In addition, the interaction between owner-occupiers (who dominate the housing market) and flippers explains how flippers as a small group can drive the fluctuations of the whole housing market.

By investigating the interactions between flippers, rental investors and owner-occupiers across the market cycle, taking housing market character into consideration (consumption need and high home moving cost of owner-occupiers), as well as specifying the demand (buying) and supply (selling) sides across the market cycle, we can see how these different housing participants together drive the market fluctuation. In terms of rental investors, we find their "smartness" as well as behaviors are between the flippers and owner-occupiers while closer to the owner-occupiers. As rental investors is not the focus of this article, we leave the discussion in future research.

Taking advantage of the several housing markets' stylized characters which are different from financial markets, we avoid the problems of ambiguous identification of market participants in the financial literature as well as the existing housing literature. In addition, our findings have clear implications on the financial market. For example, we empirically justify how the interaction of different trading patterns influences the whole market while it is difficult to be empirically demonstrated in financial markets, we argue that studying the impacts of simple trading patterns while ignore the interaction with other patterns will generate misleading results.

Our findings shed light to or provide empirical evidences for several theoretical works. For example, Xiong (2013) [60] builds up a model of heterogeneous briefs of market participants which result in market mispricing; Piazzesi and Schneider (2009)[46] models that the housing market players with different beliefs have different valuations for the property, and the price dynamic is caused by their heterogeneous valuations about the housing properties. In our paper, we study the interaction between the heterogeneous trading patterns which are resulted from heterogeneous motivations and different degrees of "smartness"; while the different "smartness" can also imply different beliefs. In addition, this article adds to the understanding of some empirical phenomena. For example, Deng, Liu & Wei (2014)[20] finds that transaction tax stabilizes the immature market as flippers in the immature market is mostly non-informed and the tax deters flippers. Our findings can provide a more specific explanation for their empirical phenomenon: in mature market, more flippers are informed and therefore the "good" effect of arbitrage surpasses the "bad" effect of positive feedback trading pattern by the non-informed, and policies deterring flippers are not able to reduce market volatility; while in the immature market, more flippers are non-informed, the "good" effect of arbitrage cannot surpass the "bad" effect of positive feedback trading pattern by the non-informed, therefore deterring the flippers as a whole can stabilize the market. In this sense, the housing market is more like an immature stock market.

Our findings have strong policy implications. Anti-speculation policies deterring flippers and then later all the second-property buyers in Singapore are successful in terms of its effects. We propose that transaction taxes, especially the stamp duties for the short-term sellers, should always be there to deter the flippers. Despite the flippers are "smart" and take good trading patterns such as arbitrage and intermediary, their trading triggers the positive feedback of owner-occupiers which add to the market over-fluctuation. The "bad" effect of positive feedback surpass the "good" effects of "arbitrage" of flippers at least in residential housing market, where the majority of participants are owner-occupiers rather than professional investors. We anticipate that although the stamp duties as transaction taxes cannot remove the housing cycle, they can help avoid market over-fluctuation and add to the stability of the private housing market in Singapore, or even make it as stable as the HDB market (As shown in Figure 1). While in terms of financial markets, we echo the findings of Deng, Liu & Wei (2014)[20] that whether it is "good" to deter flippers depends on the proportion of the informed relative to the non-informed in the market. The difference between our study and that of Deng, Liu & Wei (2014)[20] lies in: 1) we clearly specify the flippers and owner-occupiers, while theirs only implicit assumes the institutional investors are informed and individual investors are non-informed; 2) we clearly demonstrate that flippers take good trading pattern (arbitrage) while owner-occupiers take positive feedback trading pattern, while theirs does not specify the trading patterns and just implicitly assume that the informed stabilize the market and the non-informed destabilize the market; 3) we clearly justify the interaction of the flippers and owner-occupiers as positive feedback process while theirs takes the informed and the non-informed as two parallel groups of participants.

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Appendices

Appendix .A An Overview of Singapore Housing Mmarket

In Singapore, private residential properties are homes to around 20% of Singaporeans as well as most of the foreigners, and condominium and apartment are the two dominant property types. Different from public housing (which is called HDB), the private properties are characterized as high quality and high price, which only can be afford by middle-to-high-income families and foreigners. Private housing market is a relatively free market, compared to the HDB housing market which are strictly regulated by the government for owner-occupying purposes. For example, HDBs bought either through BTO (Built to order or newsale) or resale are subscribed to a minimum of occupation period which is now 5 years before the owner can resale or sublet the property. In addition, only citizens and PR (permanent residents) are allowed to by HDBs, while private housing market is open to citizens, PRs as well as other foreigners.

New constructed properties are often launched for presale before the construction is completed (TOP). TOP is the Temporary Occupation Permit which is granted when the property project is completed and home buyers can move in. As shown in the table below, before TOP, if the property is sold by the developer, the type of the sale is called new sale; and it is called sub sale if the seller is individual home owners. In addition, before TOP, the buyer only needs to pay part of the total contract price. Shortly after the sales contract is signed, the buyer needs to pay a total of 20% of the contract price as deposit, stamp duty of (3% to 15% to the government, which depends on home buyers' characters required by government policies), and they should pay the rest of 80% based on the process of the completion of the project. Differently, in the resale market, which means a buyer buys a property from an individual home owner after TOP, 100% of the contract price as well as the stamp duty should be paid. It is important to mention that properties are usually newly launched around TOP (2 to 4 years in average), and that both buyer and developer defaults in Singapore are very rare.

Types of Sale	**Sellers**	**Completed or not**	**Payment**
New Sale	Developers	Before TOP (Most)	20%+c*Price+Stamp duty
Subsale	Individual owners	Before TOP	20%+c*Price+Stamp duty
Resale	Individual owners	After TOP	100%+Stamp duty

Figure A1 shows the quarterly price indexes (up panel) and the rental price indexes (down panel) of both the private housing and HDBs. We can see that the price index of the private fluctuates more than that of the HDBs, although the two go up consistently. In addition, the rental price indexes of the two also go up consistently while that of HDB rises faster when a series of anti-speculation policies are carried out since 2009.

Figure A1: Rental and Price Index for Private and HDB Residential Housing Market:2002Q1-2014Q1

Appendix .B Cooling Measures

1: Dec 15, 2006 A concession to defer stamp duty payment (which was imposed in Jun 1998).

2: 14 Sep 2009 Abolishing the Interest Absorption Scheme (IAS) and Interest-Only Housing Loans (IOL).

Table A1: Table for 3.

1) SSD for selling within 1 year after buying
1% for the first $180,000 of the consideration; 2% for the next $180,000; 3% for the balance.
2) LTV lowered from 90% to 80%;

3: Announced on 19 Feb 2010 and take effect on 20 February 2010

Table A2: Table for 4.

1) Increasing holding period for SSD from 1 year to 3 years.
1.1 for within 1 year: 1% for the first $180,000 of the consideration; 2% for the next $180,000; 3% for the balance. 1.2 for sold within 2 years: 2/3 of the full SSD; 1.3 for sold within 2-3 years: 1/3 of the full SSD;
2) LTV lowered from 80% to 70% for whom have 1 or more outstanding housing loans;
3) mimum cash paryment raised from 5% to 10% for whom have 1 or more outstanding housing loans.

4. 30th Aug 2010

Table A3: Table for 5.

1) Increasing holding period for SSD from 3 year to 4 years.
16% Sold with 1 year after buying; 12% Sold in the second year after buying; 8% Sold in the third year after buying; 4% Sold in the fourth year after buying.
2) LTV of 50% for housing loand to non-individual buyers;
3) LTV lowered from 70% to 60% for whom have 1 or more outstanding housing loans;

5. 14 January 2011

6. 7 Dec 2011, Take effect on 8 Dec 2011

Table A4: Table for 6.

1) ABSD	
10%	for foreigners and non-individuals;
3%	for Singaporeans and PRs buying second residential property;
Note: the existing BSD is:	
1\%	on first \$180,000 of purchase consideration;
2\%	on the next \$180,000;
3\%	for the remainder.

7. On 6th Oct 2012

The maximum tenure of all new residential property loans will be capped at 35 years. For those Loan tenure exceeds 30 years, or the loan period extends beyond the retirement age of 65 years, 40% for a borrower with one or more outstanding residential property loans3; and 60% for a borrower with no outstanding residential property loan.

MAS will also lower the LTV ratio for residential property loans to non-individual borrowers from 50% to 40%.

Table A5: Table for 8.

1) LTV lowered and mimum cash paryment raised			
	1st housing loan	2nd housing loan	3rd and more housing loan
LTV	no change	50% or 30% for extend age 65	40% or 20% for extend age 65
mimum cash paryment	no change	25%	25%
2) mimum cash paryment raised from 10% to 25% for whom have 1 or more outstanding housing loans.			
3) ABSD			
	1st buyer	2nd buyer	3rd and more
Citizen		7%	10%
PR	5%	10%	10%
Foreigner & non-individual	15%	15%	15%

8. On 12th Jan 2013

9. On 29th Jun 2013

1. Total Debt Servicing Ratio (TDSR) capped at 60% of borrower's income; The coverage of the TDSR framework will be more comprehensive than current practice. The TDSR will apply to loans for the purchase of all types of property, loans secured on property, and the re-financing of all such loans.

2. Loan tenure based on income weighted average age;

3. Interest rate of 3.5% used; When calculating a borrower's ability to repay using the total debt servicing ratio, banks will have to apply the prevailing market rate or 3.5 percent for housing loans and 4.5 percent on non-residential property loans, whichever is higher.

Appendix .C Other housing related policies like Property Tax Adjustments

.C.1 Property Taxes

1. 2006-2007 The Property Tax (Surcharge) Act was firstly enacted in 1974 to impose a surcharge, in addition to the property tax payable, for certain classes of properties held by foreign owners before 1 January 1974.

The Act and states that it will be in effect from 1 July 2006. On 22 January 2007, MOF repeals the Property Tax (Surcharge) Act.

2. Before Jan 2011

1. Owner-occupiers concessionary tax rate of 4%.
2. Non owner-occupied residential properties and other properties are taxed at 10%.

Table A6: For 3.

1) Progressive Property Tax Regime (PPTR) for owner-occupied properties	
0	First 6,000
4%	Next 59,000
6%	Above 65,000
2) Non owner-occupied residential properties and other properties are still taxed at 10\%	
3) Cessation of the 1994 GST Rebate	

3. After Jan 2011 and Before Jan 2014

Table A7: for 4.

1) Progressive Property Tax Rates For Non-Owner-Occupied Residential Properties		
Annual Value	Since Jan 1st 2014	Since Jan 1st 2015
First 30,000	10%	10%
Next 15,000	11%	12%
Next 15,000	13%	14%
Next 15,000	15%	16%
Next 15,000	17%	18%
Excess 90,000	19%	20%
Annual Value	Since Jan 1st 2014	Since Jan 1st 2015
First 8,000	0%	0%
Next 47,000	4%	4%
Next 5,000	5%	5%
Next 10,000	6%	6%
Next 15,000	7%	8%
Next 15,000	9%	10%
Next 15,000	11%	12%
Next 15,000	13%	14%
In excess of 130,000	15%	16%
2) Property tax refunds for unoccupied residential and non-residential properties will cease with effect from 1 January 2014.		

4. From Jan 2014

.C.2 HDB MOP

Table A8: Minimum Occupation Period Requirement for Resale \ Sublitting of HDB Flats[a]

	Before March 5th 2010	Before Aug 30th 2010	Aug 30th 2010 Onwards
Subsidized HDB Flats[b]	5 Years	5 Years	5 Years
Non-subsidized HDB Flats[c]taking Concessionary loan	2.5 Years	3 Years	5 Years
Non-subsidized HDB Flats with no Concessionary loan	1 Year	3 Years	5 Years

[a] The MOP is applicable to both sale and subletting.
[b] Subsidized HDB Flats include: 1) HDB flats bought directly from HDB; 2) DBSS flats bought from private developers; 3) resale flats bought with CPF Housing Grant.
[c] Non-subsidized HDB flats are those resale flats bought without CPF Housing Grant.

Table A9: Disallow Concurrently Owning An HDB flat and Private Residential Property

	Before Aug 30th 2010	Aug 30th 2010 Onwards
Investment in Private Residential Property After Purchase of Non-Subsidised Flat	No Restriction	5 Years
Disposal of Existing Private Residential Property After Purchase of Non-Subsidised Flat	Not Applicable	Within 6 months from Date of Purchase

Appendix .D Identification of different market participants

This identification strategy is developed based on the buying and selling of a particular unit with which the buying behaviors is identified as bought by a flipper, landlord or an investor. The identification is structured as follows.

.D.1 Identification Part1: Participants as Buyer

1. Flipper as buyer

1.1 For a particular house unit, two consecutive trades are observed, if the 2nd trade is SUBSALE, then the 1st trade is carried out by a Flipper.

1.2 For a particular house unit, two consecutive trades are observed. The first transaction is NEW SALE or SUB SALE, the second transaction is RESALE. There is no rental transaction between the two trades. Then if the interval between the second trade and TOP is smaller than or equal to 1 year, then the first trade is carried out by a Flipper.

1.3 For a particular house unit, two consecutive trades are observed, both of which are RESALE, the time interval between the two trades is shorter than or equal to 365 days and there is no rental transaction between the two trades. Then the first trade is the purchase by a Flipper.

2. Rental investor as buyer

2.1 For a particular house unit, two consecutive transactions are observed. The first transaction is NEW SALE or SUB SALE, the second transaction is rental transaction. If the interval between the rental transaction and TOP is smaller than or equal to 1 year, then the first trade is the purchase by a Rental Investor.

2.2 For a particular house unit, two consecutive transactions are observed, the interval between the first trade and the subsequent rental transaction is shorter than or equal to 365 days, then the first trade is the purchase carried out by a Rental Investor.

3. Owner-occupier as buyer

3.1 For a particular house unit, two consecutive trades are observed. The first transaction is NEW SALE or SUB SALE, the second transaction is RESALE. There is no rental transaction between the two trades. Then if the interval between the second trade and TOP is larger than 1 year, then the first purchase is carried out by an Owner-occupier.

3.2 For a particular house unit, two consecutive transactions are observed. The first transaction is NEW SALE or SUB SALE, the second transaction is rental transaction. If the interval between the rental transaction and TOP is larger than 1 year, then the first trade is the purchase by an Owner-occupier.

3.3 For a particular house unit, this is the last transaction observed and it is sale transaction. The transaction is NEW SALE or SUB SALE. If the interval between 2014 and TOP is larger than 1 year, the trade is the purchase by an Owner-occupier.

3.4 For a particular house unit, two consecutive trades are observed. The first trade is RESALE, there is no rental transaction between the two trades, and the interval between the two trades is longer than 365 days. Then the first trade is the purchase by an Owner-occupier.

3.5 For a particular house unit, two consecutive transactions are observed, the interval between the first trade and the subsequent rental transaction is longer than 365 days, then the first trade is the purchase by an Owner-occupier.

3.6 For the last trade of a house unit, if it is RESALE, and the interval between 31 April 2014 and the trade is longer than 365 days. Then the trade is the purchase carried out by an Owner-occupier.

4. Unidentified transaction records

4.1 For a particular house unit, this is the last transaction observed and it is sale transaction. The transaction is NEW SALE or SUB SALE. If the interval between 2014 and TOP is shorter than or equal to 1 year, then the trader carrying out the purchase cannot be identified.

4.2 For the last trade of a house unit, if it is RESALE, and the interval between 31 April 2014 and the trade is shorter than or equal to 365 days. Then the trader who bought this house cannot be identified.

.D.2 Identification Part2: Participants as Sellers

The identification of participants as sellers is very straightforward. With two consecutive sale transactions (the rental ones are ignored), if the buyer in the previous transaction is identified as a flipper, then the seller in the latter transaction is flipper. Identification of Owner-occupiers and rental investors follows the same strategy, and the rest are those cannot be identified.

Appendix .E Robustness test: flippers are the "smartest" while rental investors outperform the owner-occupiers

To more clearly see the "smartness" of the different participants, we further specify the transactions into three types: 1) the transactions where flippers are the sellers while owner-occupiers are the buyers (fto); 2) the transactions where flippers are sellers and rental investors are buyers (identiDD2); 3) the transactions where flippers are sellers and also sold to flippers (identiDD3). The identification is based on the combination of identification of participants as buyers and participants as sellers. For example, for a sales transaction record, if the seller in the transaction is identified as flippers, and the buyer in the transaction is identified as owner-occupiers, then this transaction is identified as flipper sells to owner-occupier.

The Table below shows distribution of buyers from flippers. Among the identified transactions, we can see that most properties of flippers are sold to owner-occupiers, which accounts for 67.5% of total properties sold by flippers. Caution must be taken that only a small part of the transactions are identified due to the limited period the sample data cover. However, as flippers buy and sell within a short period of time, the flippers are better identified than owner-occupiers and rental investors. In this regard, the large number of unidentified sample does not influence our conclusion that owner-occupiers are the dominant buyers from flippers.

Table A10: The distribution of buyers of properties from flippers: 2006Q1-2013Q4

	Freq.	Percent. (%)
Flip To Occupier	12399	67.5
Flip To Rinvest	3829	20.85
Flip To Flip	2140	11.65
Total	18368	100

We repeat the regressions as in 3.2.1, we can see that, face with flipper sellers, buyers as flippers are more able to fetch a lower price than rental investors and then owner-occupiers. In addition, flippers selling to owner-occupiers generally can fetch a price premium compared to the general transactions.

Table A11: Flippers Selling to Owner-occupiers, Rental Investors and Flippers

Dependent VARIABLE: ln(Price)								
	Presale Market				Resale Market			
	06Q1-13Q4	06Q1-07Q4	08Q1-08Q4	09Q1-13Q4	06Q1-13Q4	06Q1-07Q4	08Q1-08Q4	09Q1-13Q4
identiDD2	-0.00708***	-0.00101	-0.0203**	-0.00850***	-0.0116**	0.00158	-0.0505*	-0.00796
	-0.00246	-0.00505	-0.00932	-0.00254	-0.00482	-0.00954	-0.0283	-0.0061
identiDD3	-0.0449***	-0.0361***	-0.0527***	-0.0302***	-0.0225***	-0.0302***	0.0149	0.00419
	-0.00342	-0.00503	-0.0116	-0.00459	-0.00849	-0.00994	-0.0453	-0.0158
Controlled	Quarter dummies, project dummies and district dummies, as well as hedonic factors							
Constant	12.41***	11.76***	13.31***	13.23***	13.35***	12.25***	13.40***	13.82***
	-0.151	-0.0632	-0.0508	-0.0453	-0.178	-0.218	-0.916	-0.288
Observations	12,700	3,956	1,110	7,634	5,589	2,324	500	2,765
R-squared	0.967	0.967	0.972	0.975	0.971	0.976	0.983	0.976

identiDD2=1 if in the trading, flippers are sellers and rental investors are buyers; identiDD3=1 if flippers sell to flippers;
Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A12: Flippers Selling to Owner-occupiers and Others

Dependent VARIABLE: ln(Price)								
	Presale Market				Resale Market			
	06Q1-13Q4	06Q1-07Q4	08Q1-08Q4	09Q1-13Q4	06Q1-13Q4	06Q1-07Q4	08Q1-08Q4	09Q1-13Q4
fto	0.0145***	0.0129*	0.0395	0.00556	0.0206***	0.0183***	0.0299***	0.0142***
	-0.00438	-0.00737	-0.0258	-0.00596	-0.00223	-0.00417	-0.00819	-0.00243
Controlled	Quarter dummies, project dummies and district dummies, as well as hedonic factors							
Constant	13.28***	12.22***	13.36***	12.93***	11.96***	11.74***	13.29***	13.41***
	-0.176	-0.218	-0.91	-0.21	-0.164	-0.0634	-0.0481	-0.0759
Observations	5,605	2,324	500	2,781	13,137	3,956	1,110	8,071
R-squared	0.971	0.976	0.983	0.976	0.966	0.966	0.972	0.974

fto=1 if in the trading flippers are sellers and owner-occupiers are buyers, otherwise fto=0
Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Appendix .F Flippers Lead the Market in Terms of Trading Volume

.F.1 Robustness: Influences of other participants on flippers

When seeing the results on how flippers' buying and selling behaviors influences the buying and selling of other participants, many may eager to see the reverse: how flippers buying behaviors are influenced by other participants. We run the regressions with Poisson Dynamic GMM as discussed in 3.2.2, and the regression models are specified as follows.

$$\begin{aligned} Vflip\_b_{it} = &\exp(\rho_1 Vflip\_b_{it-1} + \rho_2 Vflip\_b_{it-2} + \rho_3 Vflip\_b_{it-3} + \rho_4 Vflip\_b_{it-4} \\ &+ \beta_1 Voccupier\_b_{it-1} + \beta_2 Voccupier\_b_{it-2} + \beta_3 Voccupier\_b_{it-3} + \beta_4 Voccupier\_b_{it-4} \\ &+ \mathbf{P}'_{it} * \delta + GDP_t) + \varepsilon_{it} \end{aligned} \tag{14}$$

$$\begin{aligned} Vflip\_b_{it} = &\exp(\rho_1 Vflip\_b_{it-1} + \rho_2 Vflip\_b_{it-2} + \rho_3 Vflip\_b_{it-3} + \rho_4 Vflip\_b_{it-4} \\ &+ \beta_1 Vrinvest\_b_{it-1} + \beta_2 Vrinvest\_b_{it-2} + \beta_3 Vrinvest\_b_{it-3} + \beta_4 Vrinvest\_b_{it-4} \\ &+ \mathbf{P}'_{it} * \delta + GDP_t) + \varepsilon_{it} \end{aligned} \tag{15}$$

$$\begin{aligned} Vflip\_s_{it} = &\exp(\rho_1 Vflip\_s_{it-1} + \rho_2 Vflip\_s_{it-2} + \rho_3 Vflip\_s_{it-3} + \rho_4 Vflip\_s_{it-4} \\ &+ \beta_1 Voccupier\_s_{it-1} + \beta_2 Voccupier\_s_{it-2} + \beta_3 Voccupier\_s_{it-3} + \beta_4 Voccupier\_s_{it-4} \\ &+ \mathbf{P}'_{it} * \delta + GDP_t) + \varepsilon_{it} \end{aligned} \tag{16}$$

$$\begin{aligned} Vflip\_s_{it} = &\exp(\rho_1 Vflip\_s_{it-1} + \rho_2 Vflip\_s_{it-2} + \rho_3 Vflip\_s_{it-3} + \rho_4 Vflip\_s_{it-4} \\ &+ \beta_1 Vrinvest\_s_{it-1} + \beta_2 Vrinvest\_s_{it-2} + \beta_3 Vrinvest\_s_{it-3} + \beta_4 Vrinvest\_s_{it-4} \\ &+ \mathbf{P}'_{it} * \delta + GDP_t) + \varepsilon_{it} \end{aligned} \tag{17}$$

The results indicate that, flippers' buying transactions are not influenced by the buying behaviors of owner-occupiers and rental investors during the bust period, and the influence from owner-occupiers buying in the booming period is very small in scale. While in terms of selling, we see both the selling of owner-occupiers and rental investors are significantly and positively associated with the later selling of flippers. While this should not be explained as that the flippers selling decision is influenced by the selling behaviors of owner-occupiers and rental investors. One reason is the the selling of owner-occupiers and rental investors may not reflect the market condition, they sell just because they do not want to hold the properties probably due to non investment-related reasons. Instead, we see they succeed their transactions is a signal that the market has more liquidity or more potential buyers are coming to buy, and as a result more flipper sellers can close their deals.

Table A13: Flippers are less influenced by owner-occupiers and rental investors when buying

Booming Period: 2006Q1-2007Q4			
Dependent VARIABLE: Vflip_ b			
Vflip_b-1	0.1054375***	Vflip_b-1	0.0871872***
	(0.0143937)		(0.0119453)
Vflip_b-2	0.0204105***	Vflip_b-2	0.0123808
	(0.0070187)		(0.0089498)
Vflip_b-3	0.0089818**	Vflip_b-3	0.0199562***
	(0.0045636)		(0.005008)
Vflip_b-4	0.0072453*	Vflip_b-4	0.0237917***
	(0.0044096)		(0.0049289)
Voccupier_b-1	-0.0100059	Vrinvest_b-1	0.0187953
	(0.0072831)		(0.0162717)
Voccupier_b-2	-0.0031795	Vrinvest_b-2	0.0068212
	(0.012052)		(0.0146007)
Voccupier_b-3	0.0083091**	Vrinvest_b-3	-0.0105398
	(0.0038682)		(0.009141)
Voccupier_b-4	0.0092969**	Vrinvest_b-4	-0.020869**
	(0.0045906)		(0.0089894)
Observations	19024	Observations	19024

Bust Period: 2008Q1-2008Q4			
Dependent VARIABLE: Vflip_ b			
Vflip_b-1	0.3900199***	Vflip_b-1	0.40237***
	(0.0526304)		(0.0600741)
Vflip_b-2	0.2049791***	Vflip_b-2	0.2270856***
	(0.0359155)		(0.039336)
Vflip_b-3	0.0066188	Vflip_b-3	-0.0265804
	(0.0446795)		(0.0232915)
Vflip_b-4	0.0310787***	Vflip_b-4	0.0205855
	(0.0114233)		(0.0277624)
Voccupier_b-1	0.0302479	Vrinvest_b-1	0.158487**
	(0.0308857)		(0.0801525)
Voccupier_b-2	0.0200412	Vrinvest_b-2	0.014595
	(0.0208371)		(0.0409063)
Voccupier_b-3	-0.0268668	Vrinvest_b-3	-0.0266618
	(0.02983)		(0.0435188)
Voccupier_b-4	-0.0164194	Vrinvest_b-4	-0.0032354
	(0.0101703)		(0.0337487)
Observations	16115	Observations	16115
Controlled Variables	Project stylized factors including Project Tenure, Total units of project, Location, Project type and project age; GDP rate		

Standard errors in parentheses and adjusted for clusters in Project
*** p<0.01, ** p<0.05, * p<0.1

Table A14: Influence of owner-occupiers and rental investors on flippers when selling

Booming Period: 2006Q1-2007Q4			
Dependent VARIABLE: Vflip_s			
Vflip_s-1	0.1060813***	Vflip_s-1	0.1301259***
	(0.0303922)		(0.0379166)
Vflip_s-2	0.1553269***	Vflip_s-2	0.150927***
	(0.0291482)		(0.0188302)
Vflip_s-3	-0.0739521*	Vflip_s-3	-0.0457945
	(0.043909)		(0.0414251)
Vflip_s-4	0.0323049	Vflip_s-4	0.0364743
	(0.0347165)		(0.031591)
Voccupier_s-1	0.0458119***	Vrinvest_s-1	0.2219828
	(0.0166565)		(0.1772689)
Voccupier_s-2	0.0646707***	Vrinvest_s-2	0.350593**
	(0.0169986)		(0.1410811)
Voccupier_s-3	0.0407161***	Vrinvest_s-3	-0.312084
	(0.0137903)		(0.193164)
Voccupier_s-4	-0.018011	Vrinvest_s-4	0.4752162***
	(0.0270886)		(0.1399116)
Observations	12965	Observations	12965
Bust Period: 2008Q1-2008Q4			
Dependent VARIABLE: Vflip_ s			
Vflip_s-1	-0.1937974*	Vflip_s-1	-0.2073137*
	(0.1024275)		(0.1111763)
Vflip_s-2	0.2584929**	Vflip_s-2	0.301044***
	(0.103285)		(0.1020335)
Vflip_s-3	0.1593141***	Vflip_s-3	0.1822481***
	(0.0575283)		(0.0644761)
Vflip_s-4	-0.1326649	Vflip_s-4	-0.176751**
	(0.0819103)		(0.0873722)
Voccupier_s-1	0.0367282	Vrinvest_s-1	0.1445283
	(0.0428332)		(0.2406768)
Voccupier_s-2	0.0205133	Vrinvest_s-2	-0.2223592
	(0.0318206)		(0.2716785)
Voccupier_s-3	0.046466	Vrinvest_s-3	0.4798476**
	(0.037793)		(0.2088182)
Voccupier_s-4	0.0785697**	Vrinvest_s-4	-0.0275126
	(0.0352953)		(0.3032067)
Observations	12063	Observations	12063
Controlled Variables	Project stylized factors including Project Tenure, Total units of project, Location, Project type and project age; GDP rate		

Standard errors in parentheses and adjusted for clusters in Project
*** p<0.01, ** p<0.05, * p<0.1

Governance and international investment: Evidence from real estate holdings

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The international business literature documents that higher quality corporate governance, at both the national level and the firm level, is associated with a greater likelihood to invest abroad and to take larger stakes when investing abroad. We examine a unique set of international real estate holdings and corporate governance data to evaluate the comparability of real estate investment to foreign direct investment (FDI) more broadly. Our results at both the national and firm level indicate that real estate transactions differ fundamentally from other types of FDI. Specifically, property nation governance, real estate firm headquarter nation governance, and firm level governance are negatively associated with the propensity to invest across borders. Further, firm level corporate governance is negatively related to the stake acquired in foreign property investment. These results are counter to the FDI literature.

Keywords: International Real Estate, Real Estate Investment, Foreign Investment, Corporate Governance, International Business

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Governance and international investment: Evidence from real estate holdings

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Abstract
The international business literature documents that higher quality corporate governance, at both the national level and the firm level, is associated with a greater likelihood to invest abroad and to take larger stakes when investing abroad. We examine a unique set of international real estate holdings and corporate governance data to evaluate the comparability of real estate investment to foreign direct investment (FDI) more broadly. Our results at both the national and firm level indicate that real estate transactions differ fundamentally from other types of FDI. Specifically, property nation governance, real estate firm headquarter nation governance, and firm level governance are negatively associated with the propensity to invest across borders. Further, firm level corporate governance is negatively related to the stake acquired in foreign property investment. These results are counter to the FDI literature.

Keywords: Corporate Governance; Real Estate Investment; International Real Estate; Foreign Investment

JEL Classification: F21; G11; G23; O16; O18; P52

Introduction

The foreign direct investment (FDI) literature documents a positive relation between both national and firm level corporate governance and the propensity to invest across borders. This is not surprising given that much of this investment is designed to lower production costs and/or take advantage of less restrictive regulatory environments (e.g. cheaper labor in the textile industry), or obtain access to natural resources (e.g. exploration in the oil and gas industry) while companies continue to sell their products in countries where they can command a relatively higher price. However, the positive relation may not necessarily apply to foreign investments that lack such obvious operational benefits. Foreign real estate investment, for example, faces operational disadvantages as it is more costly to build and operate income property outside established networks of known suppliers, consultants, contractors, and regulatory regimes without an offsetting rent premium for doing so. Rents are a function of supply and demand in the local space market. Yet, even though the industry has traditionally been considered a 'local business,' real estate ranks as the top industry for FDI in 2014 with $81 billion in investment announced; representing a 12% share of all FDI globally (fDi Report, 2015).[1] Real Capital Analytics reports $91 billion in property acquisitions in the U.S. alone by foreign investors in 2015, more than double that which was observed in 2014.[2]

In this paper we examine the role of national and firm level governance in the industry with the largest single portion of FDI market share, real estate investment. We compare the

[1] The report notes that this real estate investment is being driven by developers (i.e. companies whose business model is to profit from the real estate itself and not firms looking to establish industrial production operations in a given country.)
Financial Times, "Real estate and China dominate FDI flows", Jun. 4, 2015.
http://on.ft.com/1Qt9fA8. Accessed 8/21/15.
[2] *National Real Estate Investor*, "Foreign Buyers of U.S. Assets Show No Signs of Slowing Down", Mar. 16, 2016. http://nreionline.com/finance-investment/foreign-buyers-us-assets-show-no-signs-slowing-down. Accessed 3/25/16.

likelihood of investing abroad relative to the domestic case using a large global sample of commercial real estate investment portfolios with over 70,000 property observations, where roughly 12% are owned by real estate companies with headquarters located in a different country than the assets themselves. We are able to determine the nature of the relation between governance and foreign investment for an asset class that represents an unquestionably large percentage of the world's wealth.

Florance et al. (2010) provide a helpful illustration of the magnitude of this asset class. In 2009 there was 24 billion square feet of industrial space, nearly 23 billion square feet of multi-family space (excluding single-family homes and condos in the rental pool), more than 17 billion square feet of retail space, and over 12 billion square feet of office space in the U.S. Without counting things like specialty sports and entertainment venues, but including flex, health care, hospitality, and mixed use property, there was more than 84 billion square feet of commercial real estate space; whereas including sports and entertainment spaces places the number in excess of 100 billion square feet dedicated to commercial use in the U.S. alone.

Using 2009 data, industry and academic researchers estimate the value of U.S. commercial real estate at over $9 trillion (more if you include land and parking lots), or somewhere between $90 to $110 per square foot, on average. For some property types these values are only about half of replacement cost following a loss of at least $4 trillion from 2007 values. This compares to a total value for the New York Stock Exchange of $12.5 trillion in May of 2010 (Florance et al. 2010). Indeed, real estate as a whole makes up more than one third of the U.S. investable capital market; where stocks account for roughly 26%, bonds 24%, private debt 9%, and real estate represents approximately 41% (Geltner et al. 2014). "Evidence suggests that these proportions are typical of most other advanced economies, with real estate and private market shares being larger in less developed countries" (Geltner et al. 2014, p.14).

Given that much of commercial real estate is privately held, we utilize the observable portfolios of publicly listed real estate companies from across the globe. This includes firm headquarters in 38 separate countries with properties located in 84 different nations. This allows us to examine governance variables at the firm headquarter nation level in addition to the property nation level. Moreover, the publicly traded nature of the companies enables us to incorporate firm level governance measures as well.

Governance is of particular importance within the realm of publicly traded firms in the business of buying/building, operating, and selling institutional-grade real estate assets. Structurally, there is greater risk of manager self-dealing with such firms because the market for corporate control is virtually nonexistent. For example, the real estate investment trust form of incorporation in the U.S. prevents any five or fewer investors from collectively owning 50% or more of the firm.[3] Thus, it becomes very difficult to amass enough shares to exert control. Consequently, there has never been a successful hostile takeover attempt of such a firm in the U.S. since the structure was introduced in 1960. Given the lack of market discipline in the form of takeover threats, other governance mechanisms increase in importance and their effect can be more easily isolated with publicly listed real estate companies.

Related to expropriation risk more generally, Rossi and Volpin (2004) find that blockholders are more likely to choose publicly traded firms over privately held firms when investing abroad. The risk of expropriation to investment in real estate is arguably greater from

[3] Over the past two decades many countries have adopted/adapted the U.S. REIT model. While slight variation exists with respect to specific regulatory provisions across countries, the core REIT concept remains the same.

both the perspective of national government level expropriation and firm level self-dealing. As a result, the Rossi and Volpin (2004) results suggest that foreign real estate investment will be more likely when the threat of expropriation is lower. Johan et al. (2013) examine this in the context of a unique type of foreign investment, sovereign wealth funds, and find the opposite result concluding that sovereign wealth fund investment differs from other foreign investment. The international business literature reaches a similar conclusion in the case of FDI. For instance, Filatotchev et al. (2007) find that institutions that improve firm level governance are positively related to the size of the FDI stake. In related work, a link has been established between board characteristics and various strategic choices which include internationalization (e.g., Carpenter and Fredrickson, 2001 and Hoskisson et al., 2002). The literature notes that managers have shorter time horizons than institutions (Priem, 1990) and manager equity ownership means that their wealth is largely tied to the company. This view contends that managers are more risk-averse than investors. In the absence of appropriate corporate governance mechanisms, this may mean that managers avoid international investment due to risk-aversion. However, this argument seems somewhat ad-hoc insofar as it is also possible that risk seeking managers may look to foreign investment as a channel through which to engage in self-dealing in order to maximize the value of their stock-based compensation.

In our empirical analysis the null hypothesis is that the determinants of international real estate investment are similar to the determinants of international FDI with respect to governance. Specifically, given that corporate governance mechanisms can mitigate the risk of expropriation and align the risk-aversion of managers to their investors it may be that countries with relatively better governance will be more likely to attract and seek foreign investment. A rejection of this null would suggest that real estate investment is fundamentally different than other international investment types.

Our results indicate that property nation governance is negatively related to foreign investment. This suggests that foreign investment is actually less likely in nations with better corporate governance. Similarly, firm headquarter nation governance is negatively related to foreign investment as well. Finally, firm level corporate governance is negatively related to foreign investment and the size of the stake acquired in foreign transactions. Collectively and individually this is counter to the literature indicating a positive relation between foreign investment and governance and indicates that real estate is unique. Greater levels of governance quality, in any form, are associated with lower levels of foreign direct commercial real estate investment. The evidence suggests that good governance limits exposure to the operational disadvantages of foreign property holdings.

The remainder of this study proceeds as follows. In the next section we discuss related literature and state our general hypotheses. We subsequently describe our sample, detail the empirical methods employed, and follow with a discussion of the results. The final section concludes.

Literature Review and Hypothesis Development

Most academic work in international real estate utilizes returns data in a mean-variance framework to examine performance and diversification benefits to investor portfolios.[4] Liow et al. (2014) use stock returns indices from various developed countries to examine the correlation

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[4] See Worzala and Sirmans (2003) and Sirmans and Worzala (2003) for an extensive review of studies up through 2002. For the most part, the evidence up through 2002 suggests that international real estate provides diversification benefits which should be considered when making asset allocation decisions.

dynamics between securitized real estate markets. Similarly, Hoesli and Reka (2013) analyze the relations between local and global securitized real estate markets in terms of market comovement, volatility spillovers, and contagion using data for the U.S., the U.K., and Australia. Both studies find some evidence of correlation dependencies and spillover effects across markets.

Bardhan et al. (2008) estimate the impact of global financial integration on returns to local publicly traded real estate firms. They show that a country's economic openness is negatively related to a country's real estate security excess returns. From an asset price modeling perspective, Bond et al. (2003) examine the risk and return characteristics of publicly traded real estate companies from 14 countries and find that an orthogonalized country-specific market risk factor is highly significant in explaining returns. Pavlov et al. (2015) expand the international real estate asset pricing framework and find that various macroeconomic factors and credit market conditions help explain returns to real estate investment firms.

Eichholtz et al. (2011) look at the performance of firms engaged in international real estate investment relative to domestically focused firms. They outline the potential challenges of operating assets in a foreign country such as political risks, liquidity problems, informational disadvantages, and a loss of corporate focus. They further argue that the quintessential characteristic of real estate, its immobility, renders it especially vulnerable to expropriation in a foreign setting. They find evidence of underperformance to international real estate portfolios relative to domestic portfolios, but show that such differences have decreased over time for foreign property investors. Perhaps most relevant to our study, they further "show that the underperformance in the early years is driven by the institutional environment, the level of economic integration, and the real estate market transparency of the countries that the international companies invest in" (p. 171) and argue that improvements in these areas may have contributed to the dramatic rise in foreign real estate investment in recent years. This suggests that country level governance characteristics may be an important driver in international real estate investment decision making. However, no studies specifically investigate the governance aspects of foreign real estate investment.

More directly related to our investigation, recent work moves beyond portfolio performance and diversification benefits to examine international investment determinants. Lieser and Groh (2014) explore theoretically and empirically the characteristics that make commercial real estate investment relatively attractive within various countries using aggregated national commercial real estate investment activity level data. They examine over 60 determinants which broadly fall into six separate categories; (i) economic activity, (ii) real estate investment opportunities, (iii) depth and sophistication of capital markets, (iv) investor protection and legal framework, (v) administrative burdens and regulatory limitations, and (vi) the socio-cultural and political environment. Mauck and Price (2015) control for these same country specific characteristic determinants as they examine what makes investing in commercial real estate assets located in foreign countries different than investing in such assets domestically. They find strong evidence that real estate investment companies are more likely to take a smaller stake in larger properties when investing abroad. However, neither Leiser and Groh (2014) nor Mauck and Price (2015) consider the influence of governance on the inclusion of foreign properties in portfolio composition.

More generally, Filatotchev et al. (2007) examine the role of governance in FDI. Particularly relevant to our study, they note that "FDI strategy is thus driven by the interplay between the formal governance characteristics of the firm and its informal networks associated with FDI location." Thus, it is not only the governance of the firm that is of interest, but also the governance of the host and target nation. The authors further suggest that parent company share ownership in overseas affiliates is negatively related to insider ownership. This is based on upper echelon theory (Finkelstein and Hambrick, 1996) which suggests that directors influence strategic decisions such as investing across borders. Other work focusing on the agency perspective suggests a link between corporate governance (board characteristics in particular) and various strategic choices which include internationalization (e.g., Carpenter and Fredrickson, 2001 and Hoskisson et al., 2002). Managers have shorter time horizons than institutions (Priem, 1990). Manager equity ownership means that their wealth is largely tied to the company. This, it is argued, makes them more risk-averse than investors. High-commitment entry modes (i.e., foreign holdings and/or a large stake) increase the risk of adverse selection. Insiders are likely less able to monitor overseas ventures which increases the moral hazard problems of high-commitment entry. Higher quality governance may provide superior monitoring abilities and may therefore encourage high-commitment FDI such as cross-border investment.

The finance literature also examines the role of foreign investment in corporate governance. For instance, Aggarwal et al. (2011) find that increased foreign institutional ownership improves firm level corporate governance. In particular, institutions in nations with higher quality corporate governance influence the governance of firms in nations with relatively lower quality corporate governance. In short, higher quality national and firm level corporate governance have been shown to positively influence FDI. Thus, consistent with the extant FDI literature we form the following hypotheses:

H1) Properties located in nations with relatively higher corporate governance are more likely to attract foreign investment due to the decreased risks associated with adverse selection in foreign ownership.

H2) Firms located in nations with relatively higher corporate governance are more likely to seek foreign investment due to the relatively lower risk aversion associated with higher quality governance.

H3) Firm corporate governance is positively related to the propensity to invest across borders.

H4) National and firm corporate governance are positively related to the size of the stake owned in foreign assets.

Sample Characteristics

We obtain property level holding information from SNL Financial. This data is not dynamic and as such reflects only the holdings of publicly listed real estate investment companies across the globe as of the end of Q1 2014. This cross-sectional data includes asset type (e.g., office, retail, industrial, etc.), location details, and ownership percentage for each property within a given firm portfolio in addition to owner headquarters location information. We begin with a sample of all properties in the SNL database. Table 1 indicates that the sample includes 84 property nations and 38 real estate investment company headquarter nations. When we focus on only those firms with at least one foreign holding we still have a sample of 83 property nations and 30 firm headquarter nations.

[Insert Table 1 Here]

Table 1, Panel A, shows that the proportion of foreign properties by property nation varies from the full sample. In particular, 55.3% of all properties are in the U.S. with Canada (8.6%) and Japan (5.1%) as a distant second and third, respectively. However, in the foreign only sample Germany is the most represented nation with just over 25% of all foreign owned properties. The U.S. is second at 10.4% and all other nations each make up less than 10% of the foreign only sample individually.

Similarly, Table 1, Panel B, shows that over half of the full sample (55.5%) of property holdings involves U.S. headquartered firms. However, a much smaller proportion of the sample containing only foreign owned properties is held by these U.S. companies (12.1%).[5] Canada, Japan, and the U.K. are the next most common firm headquarter nations, collectively making up approximately 19% of the full sample. In the sample of foreign holdings only, the most common firm headquarter nations are (in order): Austria (18.26% of the sample), Singapore (13.85%), Hong Kong (12.84%), U.S. (12.11%) and Canada (11.03%). Collectively, the summary statistics in Table 1 indicate that nations which attract and/or invest heavily in real estate domestically differ from those which attract and/or invest heavily abroad.

Empirical Specification

Given that our hypotheses involve both the likelihood of foreign investment and the size of stake when investing abroad, we have two different censored dependent variables. Specifically, we have a binary indicator for whether a property is foreign owned in addition to the percent stake acquired in foreign investment. Biglaiser and DeRouen (2007) suggest that the international investment decision should be modeled as a two-stage decision: 1) in which country to invest

[5] To examine whether this group of firms is driving the results we run regressions which exclude the U.S in untabulated results and find that the results are generally consistent.

and 2) relatively how much to invest. A simple probit (binary dependent variable) or tobit (left censored dependent variable) ignores the two-stage nature of the investment decision and assumes that the independent variables have the same impact in both stages. A more general and flexible approach is the Cragg model (Cragg, 1971). The Cragg model specifies that the probability that the dependent variable is zero takes the form of a probit model, defined in equation (1), while positive observations of the dependent variable are defined as the truncated regression model specified in Equation (2) with a lower limit of zero. The Cragg model is used in the foreign investment literature in Knill et al. (2012). This nested approach is preferable because we can test all four hypotheses using a flexible model that does not impose restrictions on the variables included in each stage (i.e., each stage can have the same or completely different variables). Our Cragg model takes the general form:

$$Prob\ (Y_i^1 = 0 \big| X) = \Phi(-X\beta_1)^{-1} \quad (1)$$

$$f(Y_i^2 \big| Y_i^2 > 0) = \frac{1}{\Phi\left(\frac{X\beta_2}{\sigma}\right)} \frac{1}{\sqrt{2\pi\sigma}} * exp\left\{\frac{-1}{2\sigma^2}(Y_i^2 - X\beta^2)^2\right\} \quad (2)$$

where i = property and we incorporate the following variables,

FI	= binary for foreign investment;
% OWNED	= percentage ownership in a given property;
GOV	= national level governance;
FIRMGOV	= firm level corporate governance;
PROP	= property level variables;
ECON	= economic activity;
IPLEGAL	= investor protection and legal framework;
REIO	= real estate investment opportunities;
ADMIN	= administrative burdens and regulatory limitations;
CAPMKT	= depth and sophistication of capital markets;
SOCIO	= socio-cultural and political environment.

For the first stage dependent variable, Y_j^1, we use *FI* to capture whether a given property is a foreign holding. The indicator takes the value of one if the property is owned by a listed real estate investment company not domiciled in the same nation as the property and zero otherwise. We use *% OWNED* as the second stage dependent variable, Y_i^2, which is the percent of the asset owned by the firm. Thus, our regressions at both stages are at the property level, where the first stage includes all properties in each of the portfolios and the second stage includes only foreign owned properties. We cluster standard errors at the firm level and include property nation fixed effects in all specifications.[6]

GOV is the national level corporate governance based on data from Aggarwal et al. (2011). Aggarwal et al. (2011) gather firm level corporate governance data covering 41 governance attributes for 23 countries. They aggregate the data by firm based on how many of the 41 provisions a firm has adopted and then aggregate by country based on the average percentage adoption for firms in the country. The inclusion of this variable reduces our sample size from that reported in Table 1 from just over 70,000 observations to a little over 65,000 observations.

FIRMGOV is our proxy for firm level corporate governance. This includes one variable, *INST OWN %* which is the percent of the firm owned by institutions. The inclusion of this variable follows Filatotchev et al. (2007) and Price et al. (2015) who note that a higher percentage of institutional ownership corresponds to relatively better corporate governance. Of practical importance, this variable is the only firm level corporate governance indicator we have

[6] Results are robust to including headquarter nation fixed effects instead of property nation fixed effects as well as using robust standard errors with no clustering or fixed effects.

available for real estate firms outside the U.S. This data is gathered from the Thomson 13F database.

PROP is a vector of property specific variables and the inclusion of these indicators is motivated by their significance in Mauck and Price (2015). For the remaining explanatory variable vectors we follow Lieser and Groh (2014) and Mauck and Price (2015). For brevity, we do not specifically define each particular variable within the different vectors here. Rather, detailed information on the 65 variables considered in the analysis and their respective data sources can be found in Appendix A. Each variable is available at both the property nation level and the firm headquarter nation level. Additionally, we follow the empirical techniques of Lieser and Groh (2011, 2014) and Groh et al. (2010) in our construction of indices for each vector of determinants. By combining each multivariable vector into a single variable, we are able to avoid multicollinearity issues *within* the vector. While we refer to the above mentioned papers for the specifics on our index construction, we note that each variable is scaled such that it ranges from 1-100 and is based on the distance of that variable to a relative index.[7] In our case, the relative index is the maximum and minimum of the variable for all countries in our sample. The scaled variables within each vector are then equal-weighted to form a single index value. While Lieser and Groh (2011) note, "the composite presented here is the result of much structuring and optimization effort that probably does not leave room for significant improvement," (pp.195-196) we nonetheless seek to replicate their approach with updated data as closely as we are able.

ECON is a vector of variables related to the economic activity in the nation in which the property is located. This vector includes: *GDP*, *GDP PER CAPITA*, *GDP GROWTH*, *UNEMPLOYMENT*, and *INFLATION*.

[7] The formula used for scaling is (Variable 'X' – Min of Variable 'X')/(Max of Variable 'X' – Min of Variable 'X').

IPLEGAL is a vector of variables related to investor protection and legal framework in the property nation. This vector includes: *RE TRANSPARENCY*, *DISCLOSURE IND*, *SHAREHOLDER SUITS, LEGAL RIGHTS, PROPERTY RIGHTS, RULE OF LAW,* and *REG QUALITY*.

REIO is a vector of variables related to the real estate investment opportunities in the property nation. This vector includes: *INST PROPERTY*, *HOUSING STOCK*, *AGGLOMERATIONS*, *URBAN POP*, *URBAN POP GROWTH*, *TELECOMM* and *SERVICES TOTAL*.

ADMIN is a vector of variables related to administrative burdens and regulatory limitations in the property nation. This vector includes: *MARGINAL TAX, PROFIT TAX*, *CONST PERMITS PROC, CONST PERMITS TIME, CONST PERMITS COST*, *REG PROPERTY PROC, REG PROPERTY TIME, REG PROPERTY COST, START BUS PROC, START BUS TIME, START BUS COST*, *START BUS PAID IN*, *RESOLVE INSOLV TIME*, *RESOLVE INSOLV COST*, and *RECOVERY RATE*.

CAPMKT is a vector of variables related to the depth and sophistication of capital markets in the property nation. This vector includes: *MARKET CAP*, *TRADING VOL, IPO VOLUME, IPO COUNT, M&A VOLUME, M&A COUNT, CREDIT, CREDIT INF, BANK NON PERFORM, FDI,* and *REIT VOLUME.* *SOCIO* is a vector of variables related to the socio-cultural and political environment in the property nation. This vector includes: *HDI INDEX, CORRUPTION INDEX*, *CONT CORRUPTION*, *VOICE*, *POLITICAL STABILITY* and *GOV EFFECTIVENESS.* All of the above indices have been examined in the context of determinants of foreign real estate investment in Mauck and Price (2015) and are included as controls in this analysis. Summary statistics and correlations are reported in Table 2.

The summary statistics in Table 2 indicate that 11.5% of all properties in the sample are foreign owned. Additionally, the majority of properties are wholly owned by the firm as the median percent stake is 100%. The correlations in Panel B of Table 2 indicate a negative relation between a property being foreign owned and national governance at both the property and firm nation level as well as firm level corporate governance (i.e., the percentage of institutional ownership). This provides preliminary evidence against hypotheses 1-3.

[Insert Table 2 Here]

Cronbach's (1951) alpha is frequently used to determine if forming an index is reasonable, where a value greater than 0.70 indicates that an index is appropriate. In Table 3, we report the Cronbach alpha for each vector of variables. For all vectors except the property level variables, alpha is greater than 0.70. As such, we move forward with index construction for all vectors except the property level variables, which are left as is.

[Insert Table 3 Here]

While index construction eliminates multicollinearity *within* vectors, it is not possible for us to estimate the full model due to multicollinearity *across* vectors. For instance, the *ECON*, *REIO* and *CAPMKT* indexes are all correlated with each other at or above the 95% level. Similarly, *IPLEGAL*, *ADMIN*, and *SOCIO* all have an absolute value of correlation of 75% or greater. As such, we follow Mauck and Price (2015) and include pairs of these variables that are, in most cases, not so highly correlated. In this manner the separate specifications function as robustness checks.

Results

Our results are based on the Cragg model in Equations (1) and (2). Specifically, we conduct property level regressions in which the dependent variable is an indicator of foreign investment in the first stage. The indicator takes the value of one if the property is owned by a real estate investment firm not domiciled in the same nation as the property and zero otherwise. The second stage is a truncated regression in which the dependent variable is the percentage of the property owned by the firm. Explanatory variables are intended to identify if the determinants for foreign real estate investment differ from the determinants of foreign FDI. Given that many of the explanatory variables are related, multicollinearity is a potential issue (see Table 2, Panel B for unconditional correlations). We take several steps to address any such concerns. We incorporate a multivariate framework where we reduce each vector to a common component in the spirit of Lieser and Groh (2011, 2014), Groh et al. (2010), and Mauck and Price (2015). We also check (i) for sign consistency among the vector categories between the univariate and multivariate regressions, and (ii) to ensure that variance inflation factors are less than 10 in the multivariate regressions. While it would be preferable to examine property nation and firm headquarter nation variables simultaneously, it is not desirable to do so. Given that roughly 88.5% (11.5%) of the observations in the sample are domestic (foreign) holdings (see Panel A of Table 2), including property nation and firm nation variables in the same regression would result in a vast majority of observations where multiple explanatory variables would be identical and perfectly correlated. Consequently, we examine property nation determinants and firm headquarter nation determinants separately.

Property nation governance

We start by examining differences between foreign and domestic investment relative to property nation governance while controlling for the other dimensions in equation (1) (i.e. measures which capture economic activity, real estate investment opportunities, depth and sophistication of the capital markets, investor protection and the legal framework, administrative burdens and regulatory limitations, and the socio-cultural and political environment). Table 4 presents results with property nation level governance and either property nation or firm nation variables, depending on the specification.

In all 7 specifications of Panel A of Table 4 *GOV* is negatively related to the dependent variable (significant at the 1% level). Thus, the probit results indicate that property nations with relatively higher quality corporate governance are less likely to attract foreign investment. This is counter to hypothesis (1) based on the international business and finance literatures which predict a positive relation between governance and foreign investment. The national corporate governance measure from Aggarwal et al. (2011) is a percentage based on the number of provisions the average firm in a nation has adopted. In unreported results, we find that the average property nation governance proxy is 59.63% in domestic deals and 50.64% in foreign deals. The economic magnitude of our results suggest that a one standard deviation increase in property nation corporate governance is associated with between a 1% and 5% reduction in the likelihood of a property being foreign owned.

The unreported property type variables are generally consistent with Mauck and Price (2015). In addition to the property type variables, we include pairs of other dimensions related to real estate investment in Equation (1). The results are consistent with Mauck and Price (2015) and neither the inclusion of property level variables nor the inclusion of country level controls impacts the significance of the relation between *GOV* and the dependent variable.

In the truncated second stage of the regression in Panel B of Table 4, where the dependent variable is the percentage of the property owned by the firm, we find that *GOV* is not statistically significant. Thus, while property nation governance influences the decision to invest abroad, it is unrelated to the stake when doing so.

[Insert Table 4 Here]

Acquirer nation governance

Our analysis in Table 5 mirrors that of Table 4 except that Table 5 focuses on firm headquarter nation level governance. In all 7 specifications of Panel A of Table 5 *GOV HQ* is negatively related to the dependent variable (significant at the 1% level in 5 specifications and the 5% level in 2 specifications). Thus, the probit results indicate that firm headquarter nations with relatively higher quality corporate governance are less likely to pursue foreign investment. This is counter to hypothesis (2) based on the international business and finance literatures which predict a positive relation between governance and foreign investment. In unreported results, we find that the average firm headquarter nation governance proxy is 59.63% in domestic deals and 53.63% in foreign deals. The economic magnitude of our results suggest that a one standard deviation increase in firm headquarter nation corporate governance is associated with between about 1% and 6% reduction in the likelihood of a property being foreign owned. The inclusion of property and nation level controls does not impact the statistical significance of *GOV ACQ*.

In Panel B of Table 5 we find that *GOV ACQ* is statistically insignificant in all but the univariate regression. Thus, consistent with Table 4 the results indicate that firm national governance matters for the selection of a property but not for the size of the stake taken in a foreign property.

[Insert Table 5 Here]

Firm level corporate governance results

In Table 6 we switch our focus to firm level corporate governance. Our firm level corporate governance data is based on the percentage of the firm owned by institutions. *INST OWN %* is negatively (significant at the 1% level in 6 specifications and 5% level in 1 specification) related to likelihood of foreign ownership in Panel A of Table 6. This indicates that higher quality firm level corporate governance is negatively related to the propensity to invest across borders. This is inconsistent with hypothesis (3) and the international business and finance literatures. The economic significance of this result is such that a one standard deviation increase in the percentage of the firm owned by institutions is associated with between a 2.6% and 7.6% decrease in the likelihood of a property being foreign owned. This result holds when controlling for property and index controls as well as for national governance.

In Panel B of Table 6 we find that *INST OWN %* is negatively related to the size of the stake owned in the property in all 7 specifications (significant at the 5% level). This is counter to hypothesis (4) which suggests that the percent stake will be positively related to firm level corporate governance. The economic significance of this result indicates that a one standard deviation increase in the percentage of the firm owned by institutions is associated with between a 3.4% and 5.2% lower stake in foreign held properties.

[Insert Table 6 Here]

Conclusion

The literature has provided theory and evidence suggesting a positive relation between national and firm level corporate governance and the propensity to invest across borders. However, little is known about the role of corporate governance in foreign real estate transactions. Given that as of at least 2014 real estate was the single biggest area of foreign direct investment, filling this knowledge gap appears to be a worthwhile endeavor which we attempt in this paper.

On one hand, it may be that foreign real estate investment is not different than other types of FDI in meaningful ways and the examination of real estate only transactions serves as a robustness check of established relations. On the other hand, real estate may differ in meaningful ways from other forms of FDI. For instance, many of the motivations for FDI (i.e., lower production costs, access to natural resources, etc.) do not apply to real estate. Consistent with this latter explanation, we find a negative relation between national and firm corporate governance and the propensity to invest abroad. Similarly, firm corporate governance is negatively related to the stake acquired in foreign properties. Both results indicate that the relation between corporate governance and international real estate differs from other forms of FDI.

Appendix A Description of the variables

Variable	Description	Source
FI	The dependent variable. An indicator variable equal to one if the investment is from a firm domiciled in a different nation than the property and zero otherwise.	SNL Financial
% OWNED	The level of ownership in the property.	SNL Financial
GOV	National corporate governance index.	Aggarwal et al. (2011)
INST OWN %	The percentage of firm shares outstanding owned by institutions.	SNL Financial
SIZE	The size of the firm measured as the log of the prior year's total assets.	Hartzell et al. (2014)
LEVERAGE	The prior year's total debt scaled by one year lagged total assets.	Hartzell et al. (2014)
PROFIT	The prior year's EBITDA divided by one year lagged total assets.	Hartzell et al. (2014)
USA	An indicator equal to one if the property is located in the U.S. and zero otherwise.	SNL Financial
PROPERTY SIZE	The size of the property in square feet.	SNL Financial
HEALTH	An indicator equal to one if the property is classified as health care and zero otherwise.	SNL Financial
HOTEL	An indicator equal to one if the property is classified as hotel and zero otherwise.	SNL Financial
INDUSTRIAL	An indicator equal to one if the property is classified as industrial and zero otherwise.	SNL Financial
MAN-HOME	An indicator equal to one if the property is classified as manufactured home and zero otherwise.	SNL Financial
MULTI-FAM	An indicator equal to one if the property is classified as multi-family and zero otherwise.	SNL Financial
MULTI-USE	An indicator equal to one if the property is classified as multi-use and zero otherwise.	SNL Financial
OFFICE	An indicator equal to one if the property is classified as office and zero otherwise.	SNL Financial
RESIDENTIAL	An indicator equal to one if the property is classified as residential, single-family, or student housing and zero otherwise.	SNL Financial
RETAIL	An indicator equal to one if the property is classified as regional mall, shopping center, casino, cineplex theater, dockside casino, recreation, restaurant, track-affiliated casino or retail:other and zero otherwise.	SNL Financial
SELF-STORAGE	An indicator equal to one if the property is classified as self-storage and zero otherwise.	SNL Financial
SPECIALTY	An indicator equal to one if the property is classified as specialized (includes land, parking facility, prison, and timber) and zero otherwise.	SNL Financial
GDP	The GDP in millions of the nation in which the property is located.	World Bank (World Development Indicators)
GDP PER CAPITA	The GDP in millions divided by the population in millions of the nation in which the property is located.	World Bank (World Development Indicators)
GDP GROWTH	The average growth in GDP over the previous five years for the nation in which the property is located.	Heritage Foundation
UNEMPLOYMENT	The unemployment rate as a percent for the nation in which the property is located.	World Bank (World Development Indicators)
Variable	Description	Source

INFLATION	The annual average inflation rate as a percent for the nation in which the property is located.	Heritage Foundation
INST PROPERTY	Measured according to Liang and Gordon (2003) as equal to 45% * GDP.	World Bank (World Development Indicators)
HOUSING STOCK	Refers to the stock of permanent dwellings in the nation in which the property is located.	United Nations
AGGLOMERATIONS	The number of urban agglomerations with more than 1 million inhabitants.	United Nations
URBAN POP	The percent of the population living in areas defined as urban.	United Nations
URBAN POP GROWTH	The three-year geometric mean of urban population growth.	United Nations
TELECOMM	Telephone lines per capita.	World Bank (World Development Indicators)
SERVICES TOTAL	Services value added.	World Bank (World Development Indicators)
MARKET CAP	The capitalization of the nation's stock market.	International Monetary Fund (IMF)
TRADING VOL	The total trading volume of the domestic stock market for the year as a percent of GDP.	World Bank (World Development Indicators)
IPO VOLUME	The total proceeds amount of IPOs for the property nation in the year.	SDC Platinum
IPO COUNT	The number of IPOs for the property nation in the year.	SDC Platinum
M&A VOLUME	The total merger and acquisition deal value for the property nation for the year.	SDC Platinum
M&A COUNT	The number of merger and acquisition deals for the property nation for the year.	SDC Platinum
CREDIT	The domestic credit provided by the banking sector.	World Bank (World Development Indicators)
CREDIT INF INDEX	The credit information index which is ranges from 0 to 6 with higher values indicating more available credit information for the nation.	World Bank (Doing Business)
BANK NON PERFORM	The ratio of non-performing loans to total gross loans.	World Bank (World Development Indicators)
FDI	Net inflows of foreign direct investment.	Heritage Foundation
REIT VOLUME	The market volume of real estate investment trusts listed in the nation.	FTSE EPRA NAREIT Series
RE TRANSPARENCY	The real estate transparency index with lower values indicating greater transparency.	Jones Lang LaSalle
DISCLOSURE IND	The disclosure index ranges from 0 to 10 with higher values indicating greater disclosure.	World Bank (Doing Business)
SHAREHOLDER SUITS	The ease of shareholder suits index ranges from 0 to 10 with higher values indicating greater ease for shareholders to challenge transactions.	World Bank (Doing Business)
LEGAL RIGHTS	The index of legal rights ranges from 0 to 10 with higher scores indicating better designed collateral and bankruptcy laws.	World Bank (Doing Business)
PROPERTY RIGHTS	The property rights index provides a measure of the ability of individuals to accumulate private property.	Heritage Foundation
RULE OF LAW	The extent to which economic agents have confidence in the rules of society.	World Bank (Doing Business)
REG QUALITY	Regulator quality measures the ability of the government to function in way that promotes private sector development.	World Bank (Doing Business)

Variable	Description	Source
MARGINAL TAX	The highest marginal corporate tax rates.	World Bank (World Development Indicators)
PROFIT TAX	The tax rate on income.	World Bank (World Development Indicators)
CONST PERMITS PROC	The number of procedures needed to obtain a construction permit.	World Bank (Doing Business)
CONST PERMITS TIME	The time in calendar days needed to obtain a construction permit	World Bank (Doing Business)
CONST PERMITS COST	The cost as a percent of GDP to obtain a construction permit.	World Bank (Doing Business)
REG PROPERTY PROC	The number of procedures needed to register a property.	World Bank (Doing Business)
REG PROPERTY TIME	The time in calendar days needed to register a property.	World Bank (Doing Business)
REG PROPERTY COST	The cost as a percent of GDP to register a property.	World Bank (Doing Business)
START BUS PROC	The number of procedures needed to start a business.	World Bank (Doing Business)
START BUS TIME	The time in calendar days needed to start a business.	World Bank (Doing Business)
START BUS COST	The cost as a percent of GDP to start a business.	World Bank (Doing Business)
START BUS PAID IN	The paid-in minimum capital requirement an owner must deposit up to three months following incorporation.	World Bank (Doing Business)
RESOLVE INSOLV TIME	The number of years needed to close a business.	World Bank (Doing Business)
RESOLVE INSOLV COST	The cost of closing a business as a percent of the estate's value.	World Bank (Doing Business)
RECOVERY RATE	Cents on the dollar recovered by creditors through bankruptcy or insolvency.	World Bank (Doing Business)
HDI INDEX	The human development index is a measure of three dimensions of human development including: long and health life, being educated, and standard of living where higher scores indicate better human development.	Human Development Index
CORRUPTION INDEX	An index of the extent of corruption in the public and political sectors where countries with more frequent corruption score lower.	Transparency International
CONT CORRUPTION	A measure of the perception of the use of public power to be used for private gain where countries with more frequent corruption receive a lower score.	World Bank (Worldwide Governance Indicators)
VOICE	The extent to which citizens are able to participate in the selection of their government.	World Bank (Worldwide Governance Indicators)
POLITICAL STABILITY	The likelihood of government destabilization.	World Bank (Worldwide Governance Indicators)
GOV EFFECTIVENESS	The quality of public services and the independence of civil service from political pressure.	World Bank (Worldwide Governance Indicators)

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Table 1 Number of properties by nation

Panel A – Number of properties by property nation

Property Nation	Obs. Full	Full %	Obs. Foreign	Foreign %
Argentina	4	0.01	4	0.05
Aruba	1	0	1	0.01
Australia	1,831	2.59	209	2.57
Austria	404	0.57	9	0.11
Azerbaijan	2	0	2	0.02
Belgium	948	1.34	193	2.38
Brazil	398	0.56	31	0.38
Bulgaria	13	0.02	13	0.16
Burma	5	0.01	5	0.06
Cambodia	3	0	3	0.04
Canada	6,049	8.55	206	2.54
Chile	4	0.01	4	0.05
China	1,340	1.89	1,177	14.5
Colombia	1	0	1	0.01
Croatia	15	0.02	15	0.18
Cyprus	2	0	2	0.02
Czech Republic	157	0.22	157	1.93
Denmark	52	0.07	47	0.58
Egypt	1	0	1	0.01
Estonia	7	0.01	7	0.09
Fiji	3	0	3	0.04
Finland	294	0.42	39	0.48
France	1,984	2.81	560	6.9
Georgia	2	0	2	0.02
Germany	2,798	3.96	2,044	25.18
Ghana	1	0	1	0.01
Greece	76	0.11	6	0.07
Hong Kong	977	1.38	39	0.48
Hungary	86	0.12	86	1.06
India	256	0.36	61	0.75
Indonesia	60	0.08	60	0.74
Ireland	45	0.06	18	0.22
Israel	18	0.03	0	0
Italy	171	0.24	109	1.34
Japan	3,591	5.08	422	5.2
Jordan	1	0	1	0.01
Kuwait	2	0	2	0.02
Kyrgyzstan	1	0	1	0.01
Laos	1	0	1	0.01
Latvia	3	0	3	0.04
Lithuania	6	0.01	6	0.07

Luxembourg	25	0.04	24	0.3
Macau	6	0.01	6	0.07
Malaysia	112	0.16	110	1.36
Maldives	15	0.02	15	0.18
Mauritius	1	0	1	0.01
Mexico	410	0.58	114	1.4
Mongolia	1	0	1	0.01
Morocco	1	0	1	0.01
Namibia	8	0.01	8	0.1
Netherlands	672	0.95	148	1.82
New Zealand	163	0.23	104	1.28
Norway	81	0.11	16	0.2
Oman	2	0	2	0.02
Peru	7	0.01	7	0.09
Philippines	23	0.03	23	0.28
Poland	157	0.22	112	1.38
Portugal	22	0.03	22	0.27
Romania	101	0.14	101	1.24
Russia	85	0.12	75	0.92
Saudi Arabia	1	0	1	0.01
Serbia	9	0.01	9	0.11
Seychelles	2	0	2	0.02
Singapore	687	0.97	45	0.55
Slovakia	43	0.06	43	0.53
Slovenia	2	0	2	0.02
South Africa	1,436	2.03	6	0.07
South Korea	15	0.02	15	0.18
Spain	218	0.31	161	1.98
Sri Lanka	2	0	2	0.02
Sweden	2,273	3.21	86	1.06
Switzerland	543	0.77	7	0.09
Taiwan	7	0.01	7	0.09
Tanzania	1	0	1	0.01
Thailand	41	0.06	41	0.51
Turkey	81	0.11	19	0.23
USA	39,108	55.3	846	10.42
Ukraine	15	0.02	14	0.17
United Arab Emirates	1	0	1	0.01
United Kingdom	2,684	3.8	327	4.03
Uruguay	3	0	3	0.04
Vanuatu	1	0	1	0.01
Vietnam	40	0.06	35	0.43
Zambia	2	0	2	0.02
Total	70,720	100	8,117	100

Panel B – Number of properties by firm headquarter nation

Firm Nation	Obs. Full	Full %	Obs. Foreign	Foreign %
Australia	1,893	2.68	271	3.34
Austria	1,877	2.65	1,482	18.26
BVI	7	0.01	7	0.09
Belgium	987	1.4	232	2.86
Bermuda	243	0.34	243	2.99
Brazil	368	0.52	1	0.01
Canada	6,738	9.53	895	11.03
China	163	0.23	0	0.00
Cyprus	7	0.01	7	0.09
Denmark	14	0.02	9	0.11
Finland	286	0.4	31	0.38
France	1,714	2.42	290	3.57
Germany	804	1.14	50	0.62
Greece	80	0.11	10	0.12
Hong Kong	1,980	2.8	1,042	12.84
India	208	0.29	13	0.16
Ireland	28	0.04	1	0.01
Israel	45	0.06	27	0.33
Italy	78	0.11	16	0.20
Japan	3,203	4.53	34	0.42
Luxembourg	96	0.14	95	1.17
Malaysia	2	0	0	0.00
Mexico	296	0.42	0	0.00
Netherlands	947	1.34	423	5.21
New Zealand	59	0.08	0	0.00
Norway	65	0.09	0	0.00
Poland	65	0.09	20	0.25
Russia	10	0.01	0	0.00
Singapore	1,766	2.5	1,124	13.85
South Africa	1,488	2.1	58	0.71
Spain	102	0.14	45	0.55
Sweden	2,225	3.15	38	0.47
Switzerland	573	0.81	37	0.46
Turkey	67	0.09	5	0.06
USA	39,245	55.49	983	12.11
Ukraine	1	0	0	0.00
United Kingdom	2,985	4.22	628	7.74
Vietnam	5	0.01	0	0.00
Total	70,720	100	8,117	100

This table reports the number of properties in the sample by property nation (Panel A) and firm headquarter nation (Panel B) for both the full sample and foreign owned property sample.

Table 2 Summary Statistics and Correlation

Panel A: Summary Statistics

	Mean	Median	Min	Max	Std dev	N
FI	0.115	0.000	0.000	1.000	0.319	70720
% OWNED	93.730	100.000	0.000	100.000	18.838	69312
GOV	58.857	62.200	35.900	72.800	8.435	65671
GOV HQ	58.954	62.200	35.900	72.800	8.428	67638
INST OWN %	60.565	65.400	0.000	100.000	31.108	70720
SIZE	15.323	15.534	7.261	20.287	1.433	69409
LEVERAGE	0.574	0.525	0.000	7.979	0.352	66123
PROFIT	0.075	0.078	-0.303	1.620	0.057	65294
USA	0.553	1.000	0.000	1.000	0.497	70720
ECON	64.276	72.705	37.188	72.705	9.963	70642
IPLEGAL	71.505	72.768	42.728	86.047	6.017	69573
REIO	56.395	67.071	17.303	67.071	15.796	69549
ADMIN	15.964	16.143	8.183	37.327	3.511	69549
CAPMKT	62.517	85.402	14.361	85.402	26.634	69711
SOCIO	81.323	81.916	30.853	95.049	9.807	69595
ECON HQ	64.165	72.705	26.411	79.203	9.874	70579
IPLEGAL HQ	72.469	72.768	41.988	86.047	5.054	68419
REIO HQ	56.821	67.071	16.396	67.071	16.017	69642
ADMIN HQ	15.512	16.143	8.183	37.673	3.227	68543
CAPMKT HQ	62.660	85.402	14.361	85.402	26.549	70141
SOCIO HQ	82.500	81.916	10.698	95.049	7.637	68573

This table displays the summary statistics for the sample. Detailed variable definitions can be found in Appendix A.

Panel B: Correlation

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	FI	1																				
2	% OWNED	-0.15	1																			
3	GOV	-0.30	0.05	1																		
4	GOV HQ	-0.23	0.05	0.93	1																	
5	INST OWN %	-0.26	0.00	0.34	0.35	1																
6	SIZE	0.07	-0.07	0.17	0.10	0.18	1															
7	LEVERAGE	-0.09	0.11	0.17	0.19	0.01	-0.07	1														
8	PROFIT	-0.09	0.01	0.16	0.13	0.10	0.17	-0.22	1													
9	USA	-0.33	0.09	0.48	0.46	0.70	0.10	0.19	0.12	1												
10	ECON	-0.25	0.06	0.47	0.42	0.62	0.12	0.18	0.12	0.94	1											
11	IPLEGAL	-0.40	0.07	0.36	0.35	0.22	-0.19	0.10	0.02	0.24	0.19	1										
12	REIO	-0.28	0.08	0.30	0.26	0.56	0.31	0.09	0.16	0.77	0.69	0.00	1									
13	ADMIN	0.25	-0.07	-0.36	-0.36	0.01	0.16	-0.10	0.02	0.06	0.08	-0.80	0.20	1								
14	CAPMKT	-0.32	0.07	0.55	0.51	0.67	0.10	0.18	0.14	0.97	0.96	0.28	0.71	0.02	1							
15	SOCIO	-0.28	0.09	0.00	0.16	0.05	-0.26	0.12	-0.09	0.07	0.04	0.76	-0.13	-0.84	0.06	1						
16	ECON HQ	-0.28	0.04	0.45	0.44	0.69	0.09	0.17	0.12	0.92	0.93	0.25	0.67	0.02	0.92	0.10	1					
17	IPLEGAL HQ	0.06	-0.05	0.26	0.27	0.05	-0.11	0.03	0.02	0.08	0.17	0.72	-0.12	-0.57	0.17	0.44	0.17	1				
18	REIO HQ	-0.20	0.02	0.25	0.23	0.57	0.38	0.04	0.15	0.68	0.64	-0.06	0.87	0.25	0.63	-0.21	0.69	-0.09	1			
19	ADMIN HQ	-0.13	0.02	-0.27	-0.32	0.20	0.11	-0.04	0.02	0.19	0.11	-0.55	0.28	0.78	0.13	-0.57	0.13	-0.78	0.26	1		
20	CAPMKT HQ	-0.30	0.04	0.53	0.52	0.71	0.14	0.16	0.14	0.92	0.91	0.25	0.66	0.03	0.95	0.04	0.96	0.15	0.68	0.16	1	
21	SOCIO HQ	0.08	0.00	-0.03	0.01	-0.13	-0.19	0.06	-0.14	-0.07	0.02	0.51	-0.24	-0.69	-0.04	0.80	0.03	0.62	-0.23	-0.79	-0.05	1

This table displays the correlation table for the variables used in the sample. Detailed variable definitions can be found in Appendix A.

Table 3 Consistency analysis

Driver	N	Cronbach Alpha
1. Property	13	0.18
2. Economic Activity	5	0.88
3. Real Estate Investment Opportunities	7	0.87
4. Depth and Sophistication of Capital Markets	11	0.97
5. Investor Protection and Legal Framework	7	0.86
6. Administrative Burdens and Regulatory Limitations	15	0.93
7. Socio-cultural and Political Environment	6	0.93

This table displays the results for Cronbach's (1951) alpha, which measures if it is appropriate to combine variables into an index.

Table 4 Cragg regressions, property nation governance, and property, firm and national controls

Panel A: First Stage

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GOV	-0.007**	-0.002**	-0.004**	-0.005**	-0.004**	-0.005**	-0.004**
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
SIZE		0.017**	0.023**	0.018**	0.016*	0.017**	0.015*
		(0.006)	(0.007)	(0.006)	(0.006)	(0.006)	(0.007)
LEVERAGE		0.005	0.014	0.014	-0.003	-0.014	0.002
		(0.022)	(0.024)	(0.027)	(0.034)	(0.030)	(0.035)
PROFIT		-0.054	-0.097	-0.135	-0.183	-0.273	-0.149
		(0.088)	(0.115)	(0.132)	(0.168)	(0.182)	(0.175)
USA		-0.148	-0.025	-0.160*	-0.033	0.053	-0.039
		(0.091)	(0.098)	(0.077)	(0.103)	(0.084)	(0.086)
ECON		-0.004**					
		(0.001)					
IPLEGAL		-0.006*					
		(0.002)					
REIO			-0.003**				
			(0.000)				
ADMIN			0.001				
			(0.003)				
CAPMKT				-0.002**			
				(0.000)			
SOCIO				-0.006**			
				(0.002)			
ECON HQ					-0.003**		
					(0.001)		
IPLEGAL HQ					0.001		
					(0.002)		
REIO HQ						-0.002**	
						(0.001)	
ADMIN HQ						-0.008*	
						(0.003)	
CAPMKT HQ							-0.001*
							(0.001)
SOCIO HQ							-0.001
							(0.002)
PROPERTY VARS	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OBS	65,671	59,871	59,871	59,581	59,734	59,751	59,588
PSEUDO R^2	0.139	0.311	0.302	0.302	0.256	0.292	0.255

Panel B: Second Stage

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GOV	-0.189	-0.066	-0.096	-0.187	0.141	-0.019	0.241
	(0.251)	(0.276)	(0.234)	(0.378)	(0.228)	(0.224)	(0.226)
SIZE		-2.638*	-2.208	-2.312	-3.544*	-3.391*	-2.831*
		(1.120)	(1.224)	(1.247)	(1.378)	(1.392)	(1.400)
LEVERAGE		15.462*	21.173**	21.755**	18.041*	16.458	24.637**
		(7.031)	(7.384)	(7.218)	(7.511)	(8.999)	(8.377)
PROFIT		-55.987	-66.060	-63.037	14.464	-51.891	-24.273
		(46.008)	(44.527)	(47.748)	(58.169)	(47.163)	(41.895)
USA		2.042	-6.800	-7.423	-1.770	7.069	0.018
		(11.290)	(11.246)	(17.831)	(10.180)	(9.445)	(9.518)
ECON		0.543*					
		(0.250)					
IPLEGAL		-0.659*					
		(0.264)					
REIO			0.174				
			(0.109)				
ADMIN			1.636**				
			(0.610)				
CAPMKT				0.111			
				(0.108)			
SOCIO				-0.309			
				(0.407)			
ECON HQ					-0.666*		
					(0.332)		
IPLEGAL HQ					-0.309		
					(0.342)		
REIO HQ						-0.225*	
						(0.095)	
ADMIN HQ						0.055	
						(0.539)	
CAPMKT HQ							-0.292*
							(0.113)
SOCIO HQ							0.114
							(0.264)
PROPERTY VARS	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OBS	5,372	4,770	4,770	4,615	4,635	4,653	4,619

This table displays the results for Cragg regressions for which *FI* is the dependent variable in the first stage probit and *% OWNED* is the dependent variable in the second stage truncated regression. Detailed variable definitions can be found in Appendix A. The marginal effects are reported with standard errors clustered by firm in parentheses. Property nation fixed effects are included in all specifications. **, and * denote significance at the 1% and 5% levels, respectively.

Table 5 Cragg regressions, firm nation governance, and property, firm and national controls
Panel A: First Stage

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GOV HQ	-0.007**	-0.003**	-0.003*	-0.005*	-0.005**	-0.006**	-0.004**
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)
SIZE		0.016*	0.021**	0.024**	0.015	0.016	0.017*
		(0.007)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)
LEVERAGE		-0.016	-0.016	0.002	-0.050	-0.058	-0.040
		(0.032)	(0.038)	(0.040)	(0.042)	(0.042)	(0.041)
PROFIT		-0.006	-0.303	-0.305	-0.361	-0.473	-0.256
		(0.129)	(0.220)	(0.205)	(0.223)	(0.265)	(0.211)
USA		-0.165*	-0.064	-0.283*	-0.032	0.061	-0.041
		(0.070)	(0.123)	(0.119)	(0.070)	(0.063)	(0.053)
ECON		-0.007**					
		(0.001)					
IPLEGAL		-0.010**					
		(0.003)					
REIO			-0.004**				
			(0.001)				
ADMIN			0.006				
			(0.005)				
CAPMKT				-0.004**			
				(0.001)			
SOCIO				-0.012**			
				(0.003)			
ECON HQ					-0.006**		
					(0.002)		
IPLEGAL HQ					0.003		
					(0.002)		
REIO HQ						-0.002**	
						(0.001)	
ADMIN HQ						-0.016**	
						(0.004)	
CAPMKT HQ							-0.003**
							(0.001)
SOCIO HQ							-0.006*
							(0.003)
PROPERTY VARS	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OBS	67,637	61,816	59,735	61,162	60,901	60,901	60,763
PSEUDO R^2	0.0654	0.420	0.229	0.452	0.185	0.203	0.222

Panel B: Second Stage

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GOV HQ	-0.049	-0.076	-0.273	-0.231	0.237	-0.030	-0.166
	(0.283)	(0.165)	(0.156)	(0.173)	(0.181)	(0.182)	(0.180)
SIZE		-2.295*	-2.411*	-2.035*	-2.957*	-3.486**	-2.666
		(1.018)	(1.093)	(1.028)	(1.335)	(1.350)	(1.404)
LEVERAGE		27.127**	27.399**	29.639**	7.594	10.566	21.065**
		(7.088)	(8.737)	(7.838)	(7.636)	(7.798)	(7.705)
PROFIT		-66.584*	-73.869	-46.491	4.437	-49.013	-62.917
		(32.238)	(42.493)	(41.337)	(41.774)	(31.393)	(34.235)
USA		12.464*	-7.372	-0.096	6.122	9.453	13.086*
		(6.251)	(10.015)	(5.240)	(5.223)	(5.379)	(5.947)
ECON		0.547*					
		(0.221)					
IPLEGAL		-0.084					
		(0.151)					
REIO			0.220*				
			(0.100)				
ADMIN			1.634**				
			(0.595)				
CAPMKT				0.140			
				(0.078)			
SOCIO				0.111			
				(0.093)			
ECON HQ					-0.760**		
					(0.268)		
IPLEGAL HQ					-0.532		
					(0.336)		
REIO HQ						-0.294**	
						(0.101)	
ADMIN HQ						0.133	
						(0.677)	
CAPMKT HQ							-0.235
							(0.121)
SOCIO HQ							-0.365
							(0.352)
PROPERTY VARS	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OBS	7,383	6,611	4,638	6,102	5,703	5,703	5,694

This table displays the results for Cragg regressions for which *FI* is the dependent variable in the first stage probit and *% OWNED* is the dependent variable in the second stage truncated regression. Detailed variable definitions can be found in Appendix A. The marginal effects are reported with standard errors clustered by firm in parentheses. Property nation fixed effects are included in all specifications. **, and * denote significance at the 1% and 5% levels, respectively.

Table 6 Logit regressions, firm governance, and property and national controls

Panel A: First Stage

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
INST OWN %	-0.246**	-0.085**	-0.124**	-0.127**	-0.095*	-0.142**	-0.155**
	(0.048)	(0.022)	(0.031)	(0.029)	(0.038)	(0.044)	(0.035)
GOV		-0.004**	-0.003**	-0.003**			
		(0.001)	(0.001)	(0.001)			
GOV HQ					-0.004*	-0.003**	-0.003*
					(0.002)	(0.001)	(0.001)
SIZE		0.017**	0.023**	0.020**	0.019*	0.020*	0.018*
		(0.006)	(0.007)	(0.006)	(0.008)	(0.008)	(0.008)
LEVERAGE		-0.005	0.004	0.005	-0.066	-0.034	-0.047
		(0.018)	(0.027)	(0.029)	(0.041)	(0.035)	(0.040)
PROFIT		-0.024	-0.119	-0.163	-0.443	-0.326	-0.290
		(0.084)	(0.157)	(0.154)	(0.232)	(0.209)	(0.215)
USA		-0.162*	-0.025	-0.147*	-0.009	0.064	-0.038
		(0.070)	(0.087)	(0.073)	(0.069)	(0.057)	(0.054)
ECON		-0.003**					
		(0.001)					
IPLEGAL		-0.005**					
		(0.002)					
REIO			-0.002**				
			(0.000)				
ADMIN			0.003				
			(0.004)				
CAPMKT				-0.002**			
				(0.000)			
SOCIO				-0.006**			
				(0.002)			
ECON HQ					-0.004**		
					(0.002)		
IPLEGAL HQ					0.002		
					(0.002)		
REIO HQ						-0.002**	
						(0.001)	
ADMIN HQ						-0.010**	
						(0.004)	
CAPMKT HQ							-0.003**
							(0.001)
SOCIO HQ							-0.006*
							(0.003)
PROPERTY VARS	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OBS	70,706	59,735	59,871	59,581	60,901	60,797	60,763
PSEUDO R^2	0.103	0.360	0.315	0.309	0.196	0.232	0.224

Panel B: Second Stage

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
INST OWN %	-16.653*	-15.794*	-14.854*	-15.099*	-13.853*	-10.972*	-11.485*
	(7.654)	(6.508)	(6.469)	(6.528)	(6.806)	(5.487)	(5.317)
GOV		-0.065	0.108	0.144			
		(0.247)	(0.220)	(0.255)			
GOV HQ					0.190	0.145	0.179
					(0.198)	(0.122)	(0.171)
SIZE		-2.462*	-1.921	-2.034	-2.751*	-3.119*	-2.718*
		(1.199)	(1.185)	(1.284)	(1.275)	(1.295)	(1.361)
LEVERAGE		15.586	19.211*	24.930*	5.603	16.648*	23.336**
		(8.746)	(8.117)	(9.856)	(8.605)	(8.139)	(7.792)
PROFIT		-80.899	-65.677	-81.850	5.857	-89.293**	-61.692
		(44.684)	(43.900)	(48.340)	(41.086)	(32.709)	(33.870)
USA		8.155	-6.155	-8.289	6.119	8.833	13.024*
		(9.439)	(10.944)	(17.062)	(5.290)	(5.454)	(6.072)
ECON		0.652**					
		(0.227)					
IPLEGAL		-0.506*					
		(0.254)					
REIO			0.143				
			(0.101)				
ADMIN			1.584**				
			(0.613)				
CAPMKT				0.133			
				(0.105)			
SOCIO				-0.261			
				(0.404)			
ECON HQ					-0.654*		
					(0.262)		
IPLEGAL HQ					-0.630		
					(0.368)		
REIO HQ						-0.269**	
						(0.101)	
ADMIN HQ						0.068	
						(0.815)	
CAPMKT HQ							-0.248
							(0.141)
SOCIO HQ							-0.369
							(0.356)
PROPERTY VARS	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OBS	7,684	4,638	4,770	4,484	5,703	5,647	5,694

This table displays the results for Cragg regressions for which *FI* is the dependent variable in the first stage probit and *% OWNED* is the dependent variable in the second stage truncated regression. Detailed variable definitions can be found in Appendix A. The marginal effects are reported with standard errors clustered by firm in parentheses. Property nation fixed effects are included in all specifications. **, and * denote significance at the 1% and 5% levels, respectively.

The Value of Energy Efficiency and the Role of Expected Heating Costs

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The German Energy Savings Act (Energieeinsparverordnung) requires sellers on the housing market to provide detailed information on expected yearly energy consumption per square meter. This paper uses variation of energy use and heating costs from local fuel prices, climatic conditions, and fuel types to analyze the relationship between expected energy cost savings from energy efficient building structure and house prices in a data set of listing

prices from all regions of Germany. Furthermore, the role of building age for the value of energy efficiency is considered. Results suggest that agents are aware of the investment dimension of energy efficiency improvements, but not all

important aspects are taken into account.

Keywords: energy efficiency, hedonic analysis, house price capitalization, climate, heating fuel prices

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The Value of Energy Efficiency and the Role of Expected Heating Costs

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Abstract

The German Energy Savings Act (Energieeinsparverordnung) requires sellers on the housing market to provide detailed information on yearly energy consumption per square meter (energy performance, EP). This paper uses variation of energy use and heating costs from local fuel prices, climatic conditions, and fuel types to analyze the relationship between expected energy cost savings from energy efficient building structure and house prices in a data set of listing prices from all regions of Germany. Furthermore, the role of building age for the value of energy efficiency is considered. Results suggest that agents are aware of the investment dimension of energy efficiency improvements, but not all important aspects are taken into account.

Keywords: energy efficiency, house price capitalization, climate, heating fuel prices, hedonic analysis, real estate. JEL Codes: R21, R31, Q40

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1. Introduction

In the past years, concerns about growing political dependency on energy exporters and global warning have led policy makers and researchers to discuss an increase in energy efficiency as an integral part of the solution. In particular, an increase in the energy efficiency of the housing stock might pay off simply because the share of total final energy consumption is large. For example, in the year 2013 28.1% of total final energy consumption in Germany fell to households. Residential heating and warm water accounted for 23.5%. Virtually no energy was used for air conditioning in residential houses.[1]. Arguably, the potential for improvement is large, given the technological progress in building construction and materials. Some commentators argue that there is a lack of investment in retro-fitting (Bardhan et al., 2014; Dubin, 1992).

In theory, the willingness to pay (WTP) for energy efficiency equals the present discounted value of expected savings from energy expenditures. Existing literature that deals with energy efficiency in buildings has focussed on the question whether there is a correlation between house prices or rents and energy efficiency labels (Brounen and Kok, 2011; Deng et al., 2012; Fuerst et al., 2015; Harjunen and Liski, 2014; Högberg, 2013; Hyland et al., 2013; Walls et al., 2013, and Chapter 4 of this dissertation). To date, the channels that are responsible for this correlation have not been studied intensively. It is therefore difficult to assess whether said correlation stems from a marketing effect, unobserved quality bias, or the present discounted value of expected energy cost savings. This paper presents some stylised facts that might help answering this question.

The issue is closely related to the so-called "energy paradox" (Hausman, 1979; Jaffe and Stavins, 1994): Price differences do not fully reflect expected savings on energy costs for home appliances, automobiles, and other products. Up to date, there is an open debate about the interpretation of such results. In principle, inattention to energy costs could be rational if information acquisition is sufficiently costly or potential savings are small (Sallee, 2013), but it could also be a sign of consumer myopia (Gabaix and Laibson, 2006). In this respect, housing and auto-mobile markets are interesting objects to study because inattention to energy consumption can be relatively costly. However, two recent attempts to settle the issue interpret their results in fundamentally different ways (Allcott and Wozny, 2014; Busse et al., 2013). Without doubt, the answer depends on expectations about the future that are formed by the marginal buyer. Typically, papers in the area attempt to estimate reasonable discount rates, lifetime expectancies of goods, and expectations about future fuel prices in order to calculate a "true" value of expected energy cost savings that can be compared to the difference in product prices. This procedure involves several deliberate decisions to be made by the researcher. Altogether, this weakens any conclusions derived from estimation results.[2]

Since May 2014, the German "Energy Performance of Buildings Directive" (Energieeinsparverordnung, EnEV) requires that energy performance scores (EPS) have to be provided when residential dwellings are sold or rented out (§16ff EnEV). The EPS gives very detailed information about energy consumption per square metre and year. It can be calculated as energy requirement certificate (Energiebedarfsausweis, §18 EnEV) or energy consumption certificate (Energieverbrauchsausweis, §19 EnEV). The energy requirement certificate is based on the characteristics of the property (insulation, heating technology) and predicts energy use under standardised climatic conditions. The consumption certificate is calculated as mean past energy use normalised to the climatic conditions in Würzburg (before May 2014) and Potsdam (since May 2014)[3] and may be used only for existing buildings. The two variants are intended to be comparable. Beginning

[1] Source: Federal Ministry for Economic Affairs and Energy, see `http://www.bmwi.de/DE/Themen/Energie/Energiedaten-und-analysen/Energiedaten/energiegewinnung-energieverbrauch.html`

[2] Table 9 in Busse et al. (2013, p. 245) exemplifies this dilemma. It displays a range of plausible assumptions about discount rates and demand elasticities. As interpreted by the authors, this table supports their conclusion that myopia are absent. Allcott and Wozny (2014, p. 782, Fn. 9) use the same table to show that their own results *and* the results of Busse et al. (2013) support the presence of myopia.

[3] See EnEV and `http://www.dwd.de/klimafaktoren`.

in May 2014, sellers and landlords are obliged to provide EPS in advertisements and when the contract is concluded.

The present paper analyses a large and detailed data set of residential houses offered for sale on German online real estate market places from April to November 2015. The focus lies on sub-samples and functional forms that are best suited to address the question whether the correlation between house prices and EPS stems from expected energy cost savings. This allows to learn about the behaviour of agents in the housing market in complementary ways that are not subject to the present value dilemma. The value of saving one kilowatt hour per year and square metre ($kWh/[m^2 \cdot a]$) depends on the price of heating fuel. Hence, if buyers care about cost differences, they should take into account (persistent) differences in fuel costs. Furthermore, it is relatively easy to understand this mechanism. Fuel price differences can be quite large across fuel types, but are rather small across space. This makes rational inattention less likely in the first case and more likely in the second. Additionally, local climate influences heating costs, but EPS are climate-standardised. Hence, the Euro value of a unit change in EPS is higher in cold regions and lower in warm regions. Arguably, even though all information required (including explanations) is available online and free of charge, this mechanism is less simple: Local and reference climate have to be compared in a specific way. Finally, building age influences the net present value of energy cost savings through the building's remaining lifetime (i.e. time until retrofitting becomes optimal). This channel is closely related to the investment character of energy efficiency improvements.

As will be laid out below, exploiting these mechanisms allows to discuss the channels through which EPS influence prices. This identifies more precisely potential problems that hinder consumers from making more informed choices. If house sellers and buyers are fully informed, expected energy costs should be capitalised into house prices independently of the source of these costs. The results suggest that the investment character of energy efficiency improvements is well understood by agents on the market for residential real estate, but not all important aspects that influence potential energy costs are taken into account. Typically, these aspects are less salient to the house buyer/seller.

The next section briefly summarises related literature that deals with the valuation of energy efficiency in real estate and auto-mobile markets. Section 3 develops the theoretical relationship between the WTP for energy efficiency and prices or rents and discusses issues of identification. A description of the data is provided in section 4, followed by an exposition of the empirical strategy (section 5). Empirical results are presented, interpreted and compared to previous estimates in section 6. The paper closes with a discussion of implications for future research and policy.

2. Related literature

2.1. Capitalisation of energy performance certificates

The emerging strand of literature on capitalisation of energy efficiency labels into property prices follows up on an earlier series of papers that started in the 1980s (cf. Dinan and Miranowski, 1989; Halvorsen and Pollakowski, 1981, inter alia). For instance, Halvorsen and Pollakowski (1981) find significant responses of house prices with oil-fired heating systems to the 1973 oil price shock. More recently, the impact of *Energy Star®* and *Leadership in Energy & Environmental Design* eco-labels on prices of office buildings has been studied by Eichholtz et al. (2010, 2013) and Fuerst and McAllister (2011). For instance, a building needs to consume 15 to 30% less energy than a comparable building in order to be eligible for an *Energy Star®* label. For that label, all three studies report a premium for eco-labelled office space of 13 to 30% or approx. 1% per 1% reduction in energy costs. Eichholtz et al. (2013) show that the regression errors of labelled buildings are correlated with actual energy consumption, but it remains unclear what part of the premium can be attributed to potential energy savings. Furthermore, identification is based on observed housing characteristics.

Eco labels for residential housing markets have been studied in Australia, the US, Singapore, and Europe (Brounen and Kok, 2011; Cajias and Piazolo, 2013; Deng et al., 2012; Fuerst et al., 2015; Högberg, 2013;

Hyland et al., 2013; Kahn and Kok, 2014; Soriano, 2008). The type of labels differs across studies, but all authors find positive relationships. Again, identification is based on observables in ordinary least squares (OLS) or Heckman selection regressions and on propensity score weighting techniques. Kahn and Kok (2014) study 4321 eco-rated buildings in California and find a price difference to non-rated homes of approx. 2%. The authors find weak evidence that climate influences the size of the premium. Compared to that, Prius registrations (i.e. attitudes toward the environment) seem to be much more important. This suggests that part of the effect can be attributed to "green" marketing. However, only a tiny share of houses (4321 of approx. 1.6 million observations, or 0.3%) is eco-labelled in the sample. This makes it difficult to assess the external validity of the results.

The European Union's Directive on the Energy Performance of Building of 2010 obliges member states to adopt an energy efficiency certification scheme for residential buildings.[4] Ireland, England, and The Netherlands have introduced efficiency bands that typically rate buildings on a scale (e.g., from A to G). The Irish scheme has been studied by Hyland et al. (2013). The authors rely on OLS regressions and find a price discount for a regular house (rated E) of about 9.3% when compared to the most efficient buildings (rated A). Similar results were reported for The Netherlands (Brounen and Kok, 2011), England (Fuerst et al., 2015), and Wales (**?**).

In contrast to binary labels, efficiency bands have the considerable advantage that both efficient and inefficient homes are labelled. This changes the "default" from non-labelled to some intermediary grade which in itself might influence consumer choices (Allcott and Mullainathan, 2010). Even more information is provided by the German scheme of EPS that give an assessment of energy use in kilowatt hours per square metre and year ($kWh/[m^2 \cdot a]$). One goal of this paper is to show that participants in the market for real estate rely on such fine-grained information in calculating their willingness to pay for a house. In that case, 'notched' policies, i.e. binary labels, should be dismissed because they can lead to product design distortions (Newell and Siikamäki, 2013; Sallee, 2013, p. 32). EPS thus provide an opportunity to test more rigorously to what extent agents in the real estate market value energy efficiency *because of reduced heating costs*. Thus far, the German scheme has been studied by Cajias and Piazolo (2013), with a focus on returns of portfolios of green buildings, and in Chapter 4 of this dissertation. A comparable scheme was introduced in Sweden (Högberg, 2013).

With the exception of Eichholtz et al. (2013) and Harjunen and Liski (2014), existing studies have in common that they neglect the role of fuel types and local prices. To some extent, the effect of local climate has been studied by Kahn and Kok (2014), but in an ad-hoc fashion that does not allow to interpret estimates in the way intended in this paper. None of the papers has considered the role of building age. Another issue that is acknowledged but addressed only partly in other papers is identification of relevant coefficients. The identification problem is especially difficult to solve for at least two reasons: i) Properties observed before and after retrofits are not useful because it is very likely (but difficult to observe) that interior or structural quality increase as well. ii) Instrumental variables are problematic because most predictors of energy efficiency are either unobserved or related to the general quality of the house. The present paper seeks to exploit exogenous sources of variation that allow to identify coefficients if market participants react to to these sources.

2.2. Fuel economy on auto-mobile markets and consumer myopia

Comparable identification strategies have been applied in another strand of literature that is closely related to the present paper. It originates from the seminal contribution of Hausman (1979) and deals with the valuation of energy efficiency in consumer decisions more generally. Recently, the great potential of more energy-efficient technology coupled with an extraordinarily low cost-benefit ratio of information provision

[4]Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings

has aroused interest in the issue (Allcott and Mullainathan, 2010; **?**). To design optimal policies, it is crucial to understand whether observed choices are the outcomes of *irrational* or *rational* inattention (Allcott and Mullainathan, 2010; Gerarden et al., 2015; Sallee, 2013, inter alia). In other words: Are consumers myopic even in high-cost situations such as house or car purchases, or are they not?[5]

As noted in the introduction, three recent papers that study car sales on the auto-mobile market come up with conflicting answers: While Busse et al. (2013, p. 221) "find little evidence that consumers 'undervalue' future gasoline costs when purchasing cars", Allcott and Wozny (2014, p. 780) report that "auto consumers appear to be willing to pay only \$0.76 in purchase price to reduce discounted future gasoline costs by \$1.00." Besides differences in the identification strategy, these interpretations are based on assumptions about discount rates and expectations of consumers with respect to changes in gasoline prices, lifetime of the car, and travel distances. In a recent working paper, Sallee et al. (2015) use the relationship between (remaining) auto-mobile mileage and the present value of fuel cost savings as identification strategy. The authors argue that their results support the views of Busse et al. (2013). These mechanisms have analoga in the housing market and are studied in this paper.

3. Theoretical considerations

3.1. Economic theory

This paper relies on the hedonic pricing framework (Rosen, 1974). The per-period WTP for one square metre of a specific dwelling can be seen as a function of its structural (s) and locational (l) characteristics:

$$\text{WTP} = W(s,l) \tag{1}$$

Note that s may include energy performance as a *characteristic* of the house that has a specific value to the buyer. Previous authors have indeed included EPS in s and have estimated the WTP for EPS as a characteristic of the house. In that interpretation, EPS is a *value-increasing* factor that provides utility to the buyer of the house, e.g. because he or she cares about the environment and enjoys living in an efficient, modern home. On the other hand, EPS is *cost-reducing*: Arguably, it is possible to have a warm living room in any modern house, no matter how inefficient the insulation, but costs vary with energy efficiency. In this sense, the price of the warm living room is higher for inefficient homes, not its utility.

Assume that the WTP is constant over time. Furthermore, time is discounted by a factor $r > 0$. Since the individual cares about total expenditures, the monthly payment she is willing to make for the dwelling at time t can be decomposed as $R_t = \bar{R}_t + C_t \times (1-\text{LC}) \times \text{EPS}$, where C_t are energy prices, LC is a climate factor that reflects energy requirements due to a difference between local climate and the baseline ($\text{LC} = 0$) and $\bar{R}_t$ is net (implicit) rent. If net rents and the yearly growth rate of energy prices e are constant ($\bar{R}_t = \bar{R}$; $C_t = (1+e)^t C$), the willingness to pay given a remaining lifetime of the building T can be expressed as follows:

$$\sum_{t=1}^{T} \frac{W(s,l)}{(1+r)^t} = \sum_{t=1}^{T} \frac{R_t}{(1+r)^t} = \sum_{t=1}^{T} \frac{\bar{R} + (1+e)^t C \times (1-\text{LC}) \times \text{EPS}}{(1+r)^t}. \tag{2}$$

The expression for prices can be obtained easily from (2) by assuming that buyers care about the net present value of the dwelling so that $P = \text{NPV} := \sum_{t=1}^{T}(1+r)^{-t}\bar{R}$, with reservation price P. From (2), this

[5] For instance, there is evidence of uninformed consumer choices in low-cost situations if part of the price information is visible and part of it is hidden (see Chetty et al., 2009, inter alia).

leads to

$$P = \sum_{t=1}^{T} \frac{W(s,l)}{(1+r)^t} - C \times (1-\mathrm{LC}) \times \mathrm{EPS} \sum_{t=1}^{T} \left(\frac{1+e}{1+r}\right)^t = \sum_{t=1}^{T} \frac{W(s,l)}{(1+r)^t} - \delta(T) \times C \times (1-\mathrm{LC}) \times \mathrm{EPS}. \quad (3)$$

where $\delta(T) := \sum_{t=1}^{T}(1+e)^t(1+r)^{-t}$. Very importantly, (3) suggests that a log-log or semi-log specification will not capture price differences that are related to energy cost savings adequately. More precisely, rents or prices per square metre are linear in expected energy costs $C \times (1-\mathrm{LC}) \times \mathrm{EPS}$. Furthermore, previous studies have estimated $\delta(T) \times C \times (1-\mathrm{LC})$ rather than δ, which clearly depends on heating types, fuel costs, local climatic conditions, and the building age distribution in the sample.

It has been argued that a simple regression of P on EPS suffers from endogeneity if structural or locational attributes of the dwelling are correlated with EPS, but not captured adequately by the available variables. In particular, interior and structural quality might be correlated with EPS because newer homes tend to have higher EPS and better building materials; retro-fitting that aims at improving EPS might at the same time improve quality, an so on. Similar arguments have been made by Brounen and Kok (2011); Deng et al. (2012); Fuerst et al. (2015); Högberg (2013); **?**, inter alia. Observable quality characteristics from different data sets suggest that the issue should be taken seriously: Energy efficient buildings are younger and of higher quality (Deng et al., 2012; Eichholtz et al., 2013; Kahn and Kok, 2014).

Because e, r and T are not known, it is difficult to decide to what extent an estimate for δ falls short of (or exceeds) energy cost savings for the dwelling's residents. However, under the assumption that prices of different fuel types are expected to increase with the same rate, δ should be equal across fuel types in a regression of prices on expected energy costs, as long as building age is taken into account. Similarly, price variation over space and, because EPS is normalised, variation in local climate can be exploited in order to test whether participants in the market are aware of the relationship stated in Eq. (3). One obstacle in this way is the dependence of δ on T. Hence, in order to be able to compare estimates for δ from different sources of variation it is necessary to balance the building age structure of the sample. The functional form of δ is interesting in itself (cf. Sallee et al., 2015). According to its definition, δ should be greatest for young buildings and decrease strictly with building age, up to the point where buildings are retro-fitted.

3.2. Sources of variation

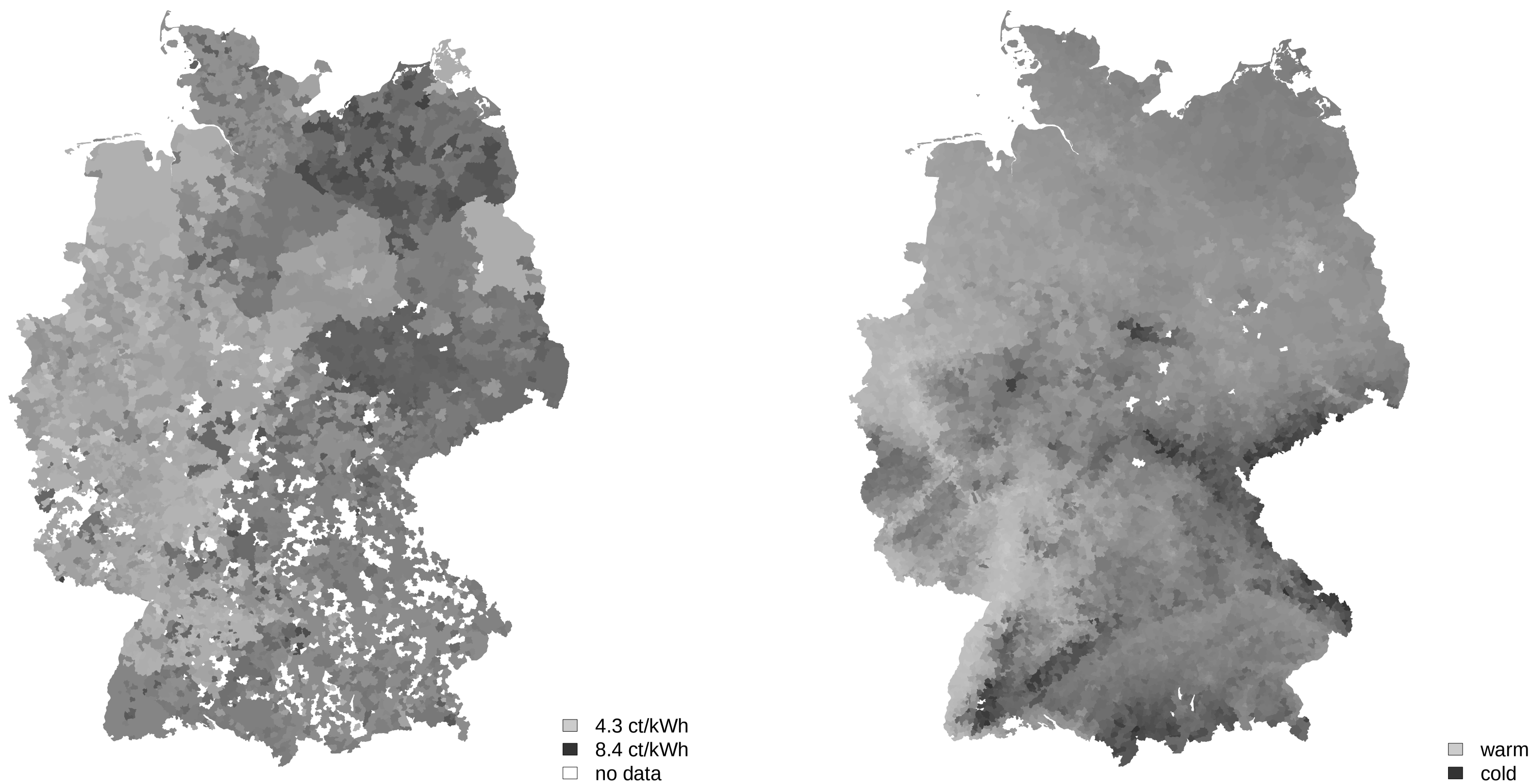
The theoretical argument laid out above explicitly takes into account that energy costs are related to fuel costs via C. Variations in fuel prices over time and space have been exploited by Allcott and Wozny (2014) and Busse et al. (2013) in their studies of the auto-mobile market. Note that in the present context time variation is less useful because it strengthens the reliance of the results on discount rates and remaining lifetimes, but the immobility of houses allows to use variation over space more effectively. Figure 1a shows substantial spatial variation of gas prices in Germany in October 2015.[6] To the extent that these differences are permanent, the implied heating cost differences are considerable.

[6]Local prices were calculated based on contract offers from a website for price comparison, *tarife.de*. All fixed payments were excluded and average prices on the ZIP code level were calculated as a weighted average of the five contracts most similar to the contract most common in the data set. This contract (i) does not pay a bonus upon signing, (ii) triggers an automatic contribution to "green" projects by the provider ("climate rate" [Klimatarif]), (iii) guarantees that prices are stable for at least 12 months, (iv) has a duration of 12 months, and (v) is not offered by a default provider. The results reported in the paper are robust to changing the calculation of local gas prices to the price of the default provider's default contract in each ZIP code, but this information is only available for a sub-set of approx. 4000 ZIP codes.

Figure 1: Gas prices and climate factors in German ZIP codes

(a) Gas prices

(b) Climate factors



Source: online contract offers; own calculation

Source: German Weather Service

Table 1: Heating costs and local deviations

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
Gas: global	0.00	6.24	9.49	10.09	13.26	27.85
Gas: local prices	-5.25	-0.80	-0.14	-0.04	0.59	8.02
Gas: local climate	-4.16	-0.73	-0.28	-0.36	0.05	5.58

Variation in climatic conditions (LC, see Figure 1b) over space is useful in the present context because EPS are climate-standardised. Obviously, energy use depends on local climatic conditions via EPS.[7] In terms of the model, LC is one factor that influences l in Eq. (1) (cf. Potepan, 1996, inter alia). Similarly, the normalised energy performance of a building could be one of the determinants of s, the structural quality of the building. In other words, a cross-sectional comparison of EPS across buildings might capture differences in building design, but EPS is related only indirectly to energy consumption. If other quality characteristics correlated with EPS are not controlled for adequately, this term will also reflect general building quality.

Table 1 summarises the distributions of projected yearly energy costs per square metre for gas-heated houses in the sample (excluding fixed payments). Local gas prices were calculated from a large data set of contracts for gas delivery offered via *tarife.de* in 2015Q4. Each contract is specific to a ZIP code area (see also Figure 1 and Footnote 6).

In gas-heated houses, residents have to spend 9.49 Euro$/[m^2 \cdot a]$ for heating at the median (EPS =167 $kWh/[m^2 \cdot a]$). In houses at the first and fourth quartiles of the EPS distribution (109 $kWh/[m^2 \cdot a]$ and 233 $kWh/[m^2 \cdot a]$, respectively), energy costs differ substantially (6.24 Euro$/[m^2 \cdot a]$ and 13.26 Euro$/[m^2 \cdot a]$). Looking at variation over space (local prices), the interquartile range is 1.39 Euro$/[m^2 \cdot a]$. If differences in climate are taken into account, the interquartile range of energy costs for gas-heated houses is half as large (0.78 Euro$/[m^2 \cdot a]$). In a typical house of 156 m^2, this still implies yearly cost differences across ZIP codes of 216.8 and 121.7 Euro per year.

Four main fuel types are used in Germany[8] gas (49.3%, including liquid gas and bio-gas), light heating oil (26.8%), district heating (13.5%), and electricity (2.9%). There are other forms such as wood pellet combustion, solar heating, geothermal heating and heat pumps, but these are not discussed further in the paper. Table 7 gives an overview of heating types in the full sample. The relatively large shares of "green" heating systems reflect the over-representation of newer buildings in real estate sales offers. Furthermore,

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[7] The German Weather Service provides climate factors (CF) for the 8,208 postal delivery zones of Germany, see `http://www.dwd.de/klimafaktoren`. Climate factors are defined as

$$\mathrm{CF}_i = \frac{G_r}{G_i}$$

with G_i the number of heating degree days at location i and G_r the number of heating degree days at the reference location in the test reference years. The climate factors are designed to normalise EPS that were calculated from past energy use. EPS calculated from engineering projections are also normalised and thus do not reflect differences in climate over time or space. Since May 1, 2014, the reference location is Potsdam.
Define

$$\mathrm{LC}_i = 1 - \frac{1}{\mathrm{CF}_i},$$

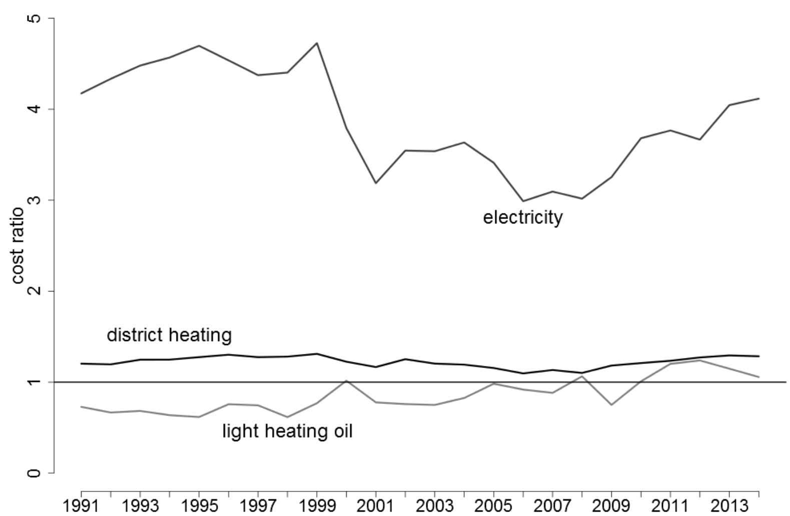
i.e. average energy use at location i is equal to $(1 - \mathrm{LC}) \times \mathrm{EPS}$. LC can be interpreted as the deviation from base climate where positive values indicate that the location has a milder climate during the winter.

[8] Figures reported by the German Association of Energy and Water Industries (BDEW), “Beheizungsstruktur des Wohnungsbestandes in Deutschland 2014”

district-heated houses seem to be under-represented in the sample.

Denote the costs per kWh of these four fuel types by C_g, C_o, C_e, and C_d. Taking gas as the baseline, Figure 2 plots the relative costs per kWh of each of these four fuel types. Whereas the price of light heating oil increased relative to the price of natural gas, the cost ratios of electricity and district heating to natural gas have been quite stable over the past 24 years. If consumers rely on this type of information to form their beliefs about the cost relationship between the four fuel types, this justifies imposing the restrictions $C_e = 3.88 \times C_g$ and $C_d = 1.22 \times C_g$, where 3.88 and 1.22 are the means of the cost-ratios over the 24-year period. These ratios should be reflected in the valuation of EPS if consumers expect them to be stable in the future.

Figure 2: Costs of different fuel types, relative to natural gas



Source: Federal Ministry for Economic Affairs and Energy; own calculations

3.3. Coherent behaviour

These numbers show that potential cost differences are large enough so that potential buyers should consider them in their decisions. The analysis of different sources of variation allows to take a different approach than previous papers because it is possible to test the coherence of individual behaviour with respect to the valuation of energy efficiency. Previous authors have attempted to directly answer the question whether present values of energy cost differences match price differences on the market. This presupposes that individuals calculate energy cost differences correctly even if cost differences stem from different sources (such as climate versus local prices). Eq. (3) shows that – if energy costs are calculated correctly and the age structure is accounted for – regression estimates of the "present value coefficient" $\delta(T)$ should be equal for different sources of variation. This can be seen as a test of the preconditions for correct present value calculations. If the data allow to reject the Null of equal coefficients, this allows to reject the hypothesis that home sellers take into account cost differences across space or heating types.

Note that this approach has at least three advantages over the "standard" approach: (i) It is not necessary to estimate or guess discount rates and remaining lifetimes. (ii) It is possible to test *statistically* the hypothesis of interest. This has not been done by any of the papers named in Section 2. Additionally, the Null corresponds to conventional economic theory. A departure from that theory should be justified on the basis of a strong result, not by acceptance of the Null. (iii) More generally, the assumptions made here differ from those in other papers; this allow to take a second look at the problem. The most important underlying assumption is stability over time of the geographical pattern of prices and local climate and of the price relationship between heating types.

The comparison of different sources of variation brings in another aspect that is highly relevant for the design of EPS certificates: Including climatic conditions into the present value calculation is relatively difficult because the relationship between climate and heating costs is highly technical. Similarly, information on local fuel prices is not necessarily salient to the house buyer because the local default provider will send a default contract to the house owner automatically. In contrast to local climatic variation the relationship between energy costs and prices is linear in the EPS. Finally, if market participants consider the impact of building age on the value of EPS, it is very likely that they understand the investment character of energy efficiency improvements. This can be the case even if they do not take into account more subtle variation (local fuel prices or climate) because it is relatively easy to understand that heating cost savings will not materialise instantaneously.

4. Data

The data analysed in this study come from all regions of Germany. National data sets have been studied by Brounen and Kok (2011, The Netherlands), Hyland et al. (2013, Ireland), and Fuerst et al. (2015, England).

This study uses listing prices of houses offered for sale on three large online real estate websites, *Immonet.de*, *ImmobilienScout24.de*, and *Immowelt.de*. The data were collected from April to November 2015. Due to the approach taken in this paper, it is important to use a short time window in order to rule out changes in price expectations within the sample period. Naturally, this reduces the number of observations, but the sample is still large enough to study separately sub-groups such as gas- and electricity-heated houses.

Listing price data have been used to study EPS certificates before (Hyland et al., 2013), with results comparable to other studies that rely on similar estimation methods and transaction prices (Fuerst et al., 2015). While transaction data are preferable, listing prices seem to be a very good substitute (Dinkel and Kurzrock, 2012; Henger and Voigtländer, 2014; Knight, 2002; Knight et al., 1994; Malpezzi, 2003; Merlo and Ortalo-Magné, 2004; Semeraro and Fregonara, 2013). One result that emerges from this literature is that mis-pricing houses systematically is quite costly for house sellers because it increases time on the market and decreases the final price (Knight, 2002; Knight et al., 1994; Merlo and Ortalo-Magné, 2004).

Two papers report hedonic regressions of matched listing and transaction data. In Knight et al. (1994), only one of four coefficients of housing characteristics is significantly different across regressions, even though t-values are very large (6.68 to 99.2). Coefficients in Semeraro and Fregonara (2013) hardly differ across regressions.[9] Closely related, three papers regress the relative difference between listing and transaction prices on covariates, but find no to marginal explanatory power of housing characteristics (Dinkel and Kurzrock, 2012; Henger and Voigtländer, 2014; Semeraro and Fregonara, 2013). Taken as a whole, this suggests that potential sellers – on average – do not systematically mis-price housing characteristics. If the reader is willing to accept this reasoning, results can be interpreted as being close to market outcomes. Otherwise, the regressions are still informative about seller behaviour.

The data contain information on offered prices, the ZIP code, EPS and type (projection or past use), and a long list of quality and structural attributes. The year of construction (YC) variable was used to form categories.[10] Additionally, a dummy variable was constructed that indicates whether retro-fitting had taken

[9] It is not possible to decide whether there are statistically significant differences because the authors only report significance levels and also do not indicate the type of covariance matrix that was used in their calculation.

[10] The youngest category (year of construction 2011 or later) was used as base category. For instance, category YC_1945 includes years of construction 1919 to 1945.

place within the last ten years (RETROFIT_LAST10).

Other attributes are LOT_SIZE, FLOOR_SIZE, number of ROOMS and TYPE of house (SEMIDETACHED, TOWNHOUSE_M (middle), TOWNHOUSE_E (end), OTHER, reference DETACHED) as well as HEATING technology (CENTRAL, SELF_CONT, FLOOR, reference OTHER or NA). Quality indicators are CONDITION (GOOD, NEW, POOR, reference REGULAR or NA), and QUALITY (HIGH, MED, SIMPLE, reference REGULAR or NA). Additional dummy variables are presence of a BASEMENT, a FITTED_KITCHEN, a TERRACE, a FIREPLACE, PARQUET_FLOORING, or a SAUNA. BROKERAGE indicates the rate (% of total sales price) the buyer has to pay to a real estate agent. Information on air conditioning is available as well, but the share of houses with air conditioning is negligible.

The data set was matched with with LC and local gas prices (GAS_PRICE), one of 409 districts (Kreise und kreisfreie Städte, and to one of $11,091$ counties (Gemeinden) via the ZIP code information. The latter matching was ambiguous: In rural areas, some ZIP codes were mapped to to several municipalities. In these cases, one municipality was chosen randomly. Three variables on the level of municipalities were added: The share of unemployed in the year 2014 among people younger than 25 years of age (UNEMP_YOUTH_2014), living space completed between 2008 and 2013 per inhabitant (LIVING_SP_COMPL_2008_2013_INH), and population density in the year 2013 (POP_DENSITY_2013).

Summary statistics for different sub-samples are reported in Tables 2 and 3. The first column, labelled gas (a), refers to the sub-sample of gas-heated houses that are available to use (not rented out), are not in a poor condition, have a projection type EPS and do not use a combination of fuel types. Buildings that have a poor condition were excluded from the analysis because this might reduce the value of energy efficiency greatly in case retrofitting is necessary in the near future. The other restrictions were imposed in order to homogenise the sample. Columns (2) to (4) refer to sub-samples of gas-, electricity-, and district heated houses and are restricted to ZIP codes with observations from at least two out of the three sub-samples. Furthermore, the samples were restricted to observations with EPS lower than 250, the threshold for efficiency band H (the lowest category). Whereas the two sub-samples for gas-heated houses are very similar (sub-sample (b) being part of sub-sample (a)), there are some substantial differences across the three groups: On average, district-heated houses in the sample are more expensive, more energy efficient, younger, and of slightly higher quality. Additionally, they are built on smaller lots – most likely because district heating is available only in larger agglomerations whereas electricity and gas heating is available in most parts of Germany. Gas- and electricity-heated houses seem to be more comparable, even though the latter are somewhat less expensive and older.

Sample sizes also differ considerably: Given the restrictions, $21,022$ ($5,532$) houses are gas-heated, $1,846$ are electricity-heated, and 971 are connected to district-heating.

5. Empirical strategy

As noted above, identification of the main coefficient is not straightforward because unobserved quality characteristics of the houses might correlate with energy efficiency. This paper therefore focuses on fuel price and climate variation across space and across heating types which–in interaction with EPS–can be considered exogenous to house prices.

The fundamental dilemma of the strategy is this: *If market participants take into account this type of variation*, it is useful for the identification of coefficients and allows to decide whether quality bias is present in the data. However, said *if* depends on the answer to the core question this paper tries to address. In a world where market participants do not care about e.g. geographical variation in prices, the strategy is not able to bring up an estimate for quality bias. Nevertheless, a comparison of the estimates from different sources of variation will help understand how market participants value energy efficiency.

Previous authors have identified another problem that is related to the availability of information on EPS. In the sample, 57.4% of all observations include this type of information, even though it is mandated by law

Table 2: Summary statistics of housing characteristics

	Sample:			
	gas (a)	gas (b)	electricity	district
	(1)	(2)	(3)	(4)
PRICE_SQM	1946.096	2124.133	1782.535	2360.222
	(1127.814)	(1133.379)	(1165.825)	(1068.983)
EPS	177.396	143.006	137.376	117.240
	(88.399)	(57.351)	(71.394)	(62.625)
TYPE_SEMIDETACHED	0.194	0.211	0.192	0.185
	(0.396)	(0.408)	(0.394)	(0.389)
TYPE_TOWNHOUSE_M	0.097	0.110	0.070	0.275
	(0.297)	(0.313)	(0.256)	(0.447)
TYPE_TOWNHOUSE_E	0.049	0.056	0.030	0.140
	(0.217)	(0.229)	(0.170)	(0.347)
TYPE_OTHER	0.085	0.078	0.102	0.073
	(0.279)	(0.269)	(0.303)	(0.260)
YC_1918	0.112	0.076	0.127	0.018
	(0.315)	(0.265)	(0.333)	(0.131)
YC_1945	0.123	0.098	0.107	0.033
	(0.329)	(0.297)	(0.310)	(0.179)
YC_1960	0.142	0.111	0.113	0.128
	(0.349)	(0.314)	(0.317)	(0.334)
YC_1970	0.127	0.121	0.111	0.124
	(0.333)	(0.326)	(0.314)	(0.329)
YC_1980	0.122	0.141	0.192	0.107
	(0.327)	(0.348)	(0.394)	(0.309)
YC_1990	0.059	0.078	0.084	0.023
	(0.236)	(0.268)	(0.277)	(0.149)
YC_2000	0.110	0.135	0.040	0.087
	(0.313)	(0.341)	(0.195)	(0.281)
YC_2010	0.104	0.113	0.078	0.183
	(0.305)	(0.316)	(0.268)	(0.387)
RETROFIT_LAST10	0.136	0.163	0.088	0.132
	(0.343)	(0.369)	(0.284)	(0.338)
LOT_SIZE	756.427	696.474	783.698	460.014
	(790.585)	(701.571)	(887.714)	(484.647)
SIZE_SQM	156.869	160.738	152.165	147.013
	(60.930)	(62.910)	(56.622)	(53.071)
ROOMS	5.607	5.622	5.633	5.118
	(1.881)	(1.892)	(1.869)	(1.503)
SELF_CONT_HEATING	0.020	0.014	0.085	0.001
	(0.141)	(0.116)	(0.279)	(0.032)
CENTRAL_HEATING	0.664	0.646	0.308	0.615
	(0.472)	(0.478)	(0.462)	(0.487)
FLOOR_HEATING	0.077	0.101	0.111	0.059
	(0.267)	(0.302)	(0.314)	(0.235)
QUAL_HIGH	0.014	0.019	0.008	0.023
	(0.116)	(0.136)	(0.087)	(0.149)
QUAL_MED	0.123	0.156	0.068	0.159
	(0.328)	(0.363)	(0.252)	(0.365)
QUAL_SIMPLE	0.009	0.006	0.008	0.002
	(0.094)	(0.075)	(0.087)	(0.045)
CONDITION_GOOD	0.230	0.255	0.155	0.273
	(0.421)	(0.436)	(0.362)	(0.446)
CONDITION_NEW	0.041	0.049	0.029	0.100
	(0.198)	(0.216)	(0.167)	(0.300)
SECOND_BATHROOM	0.499	0.567	0.349	0.635
	(0.500)	(0.496)	(0.477)	(0.482)
BASEMENT	0.495	0.507	0.401	0.469
	(0.500)	(0.500)	(0.490)	(0.499)
FITTED_KITCHEN	0.180	0.195	0.135	0.203
	(0.384)	(0.396)	(0.342)	(0.402)
SAUNA	0.048	0.066	0.042	0.046
	(0.214)	(0.249)	(0.200)	(0.210)
PARQUET_FLOORING	0.030	0.030	0.021	0.033
	(0.170)	(0.171)	(0.144)	(0.179)
FIREPLACE	0.113	0.127	0.098	0.080
	(0.316)	(0.332)	(0.297)	(0.272)
BROKERAGE	0.037	0.036	0.035	0.026
	(0.023)	(0.022)	(0.021)	(0.024)
N	21022	5532	1846	971

Standard deviations in parentheses.

Table 3: Summary statistics of locality variables

	Sample:			
	gas (a)	gas (b)	electricity	district
	(1)	(2)	(3)	(4)
GAS_PRICE	5.678	5.671	5.717	5.930
	(0.614)	(0.604)	(0.634)	(0.644)
LC	-0.035	-0.043	-0.015	-0.036
	(0.066)	(0.067)	(0.082)	(0.070)
POP_DENSITY_2013	775.279	824.798	533.713	1189.911
	(849.141)	(779.996)	(674.992)	(844.844)
UNEMP_YOUTH_2014	0.003	0.003	0.003	0.004
	(0.002)	(0.002)	(0.001)	(0.002)
LIVING_SP_COMPL_2008_2013_INH	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
N	21022	5532	1846	971

Standard deviations in parentheses.

to display EPS in online real estate offers. Part of the defiers might have included an EPS certificate in their offers, but without using the forms provided by the websites–in these cases, the certificate does not appear in the data. Others chose to hide it.

It has been argued that dwellings offered without information on energy efficiency are systematically different from other dwellings. These objects might have higher EPS and lower quality than comparable buildings. For example, an estate agent could suppress EPS information if it negatively affects the selling price. Drawing inferences from results based on the (fully) observed part of the sample to the unobserved part would not be possible if self-selection is driven by unobserved characteristics that also influence the selling price (Cameron and Trivedi, 2009, pp. 547–553). For that reason, use of a Heckman selection model is advocated (cf. Brounen and Kok, 2011; Hyland et al., 2013, and Chapter 4 of this dissertation). Hyland et al. (2013) and the paper in Chapter 4 exploit the regime change from voluntary to obligatory provision of EPS information, but only the latter study finds evidence of selection bias. Brounen and Kok (2011) develop a news indicator that measures the sentiment towards “energy label" and related terms in newspaper articles as an exogenous predictor for the selection process. They find a significantly negative coefficient for the inverse Mills ratio. However, the shares of observations with EPS information provided was much smaller in these papers (18% in Brounen and Kok (2011), 5% in Hyland et al. (2013), and 18% in Chapter 4).

This paper does not estimate a selection model for the following reason: If EPS information influences prices, it will be more likely that non-reporters are forced to re-negotiate the price once EPS information is presented. The strategy would thus lead to longer time on the market and the need for price re-negotiation (Knight, 2002) because potential buyers will have a chance to check the EPS certificate even if it is not presented in the offer. This suggests that there are other (more banal) reasons why some offers do not contain EPS information. For example, it can be hidden in the text below the offer that describes the property; some real estate agents might believe that EPS information is not important to the seller. Finally, data entries that do not contain EPS information might have other defects such as wrong or missing information. It would then bring in new problems if a selection model was built around these observations. In any case the results will be representative for the relatively high share of 57.4%.

6. Estimation results

Eq. (3) was estimated by OLS. The functional form of W has to be selected based on prior knowledge and intuition. More precisely, for an observation i from ZIP code $z(i)$, district $d(i)$ and heating type $h(i)$,

$$P_i = X_i\beta + \gamma_1 C_{h(i),z(i)} + \gamma_2 LC_{z(i)} + \delta_1 C_{h(i)} \times EPS_i + \delta_2 C_{h(i),z(i)} \times EPS_i + \delta_3 LC_{z(i)} \times EPS_i. \quad (4)$$

Table 4: Local gas price regressions

	Dependent Variable:			
	PRICE_SQM			
	(1)	(2)	(3)	(4)
GAS_PRICE	10.095	32.620		13.864
	(33.480)	(42.601)		(74.040)
EPS_GAS_P	-0.235***	-0.239***	-0.239***	-0.262***
	(0.019)	(0.022)	(0.023)	(0.078)
EPS_GAS_LOCAL_P	-0.329**	-0.386*	-0.016	-0.040
	(0.122)	(0.155)	(0.163)	(0.345)
EPS_GAS_P:POP_DENSITY_2013	0.064**	0.080**	0.070*	0.133
	(0.020)	(0.023)	(0.027)	(0.068)
LAND_PRICE				0.289**
				(0.098)
LAND_PRICE_NA				13.489
				(117.869)
District-FE	yes	yes	no	-
ZIP code-FE	no	no	yes	-
N	21022	15853	11420	2516
adj. R^2	0.687	0.684	0.812	0.289
residual SE	630.9	636.6	463.5	740.7
p-value EPS_GAS_P = EPS_GAS_LOCAL_P	0.438	0.173	0.084	0.545

Detailed results for models (1) and (4) can be found in Table 8 in the Appendix; the same set of covariates was used for all models. Model (4) regresses price differences of matched observations on differences in covariates. ZIP-code cluster-robust standard errors in parentheses; p-values: ***: $< .001$, **: $< .01$, *: $< .05$.

P_i is the square metre price of house i, EPS_i is its energy performance score, and X_i is a vector of covariates (housing and locality characteristics). $C_{h(i)}$ is mean fuel price for heating type $h(i)$, and $C_{z(i),h(i)}$ is the deviation in ZIP code $z(i)$ from that mean. Similarly, $LC_{z(i)}$ captures deviation of local climate from the reference climate.

The coefficients of main interest are δ_1, δ_2, and δ_3. δ_1 measures the reaction of the price per square metre to a change in EPS due to an improvement of the house or a change of heating type (holding constant LC and local heating prices) while δ_2 and δ_3 capture the reaction to a change in EPS due to a change of location of the house (holding constant EPS). Subsequent sections will concentrate on variation in $C_{h(i),z(i)}$ (Section 6.1), in $LC_{z(i)}$ (Section 6.2), and in $C_{h(i)}$ (Section 6.3). Finally, Section 6.4 focusses on variation in remaining lifetimes of buildings. To that end, Eq. (4) will be enhanced to allow δ to vary across building age groups, holding constant heating type. In theory, δ decreases with building age because the present value of energy efficiency depends on the remaining lifetime T of the building (see Eq. 3).

6.1. Local variation in gas prices

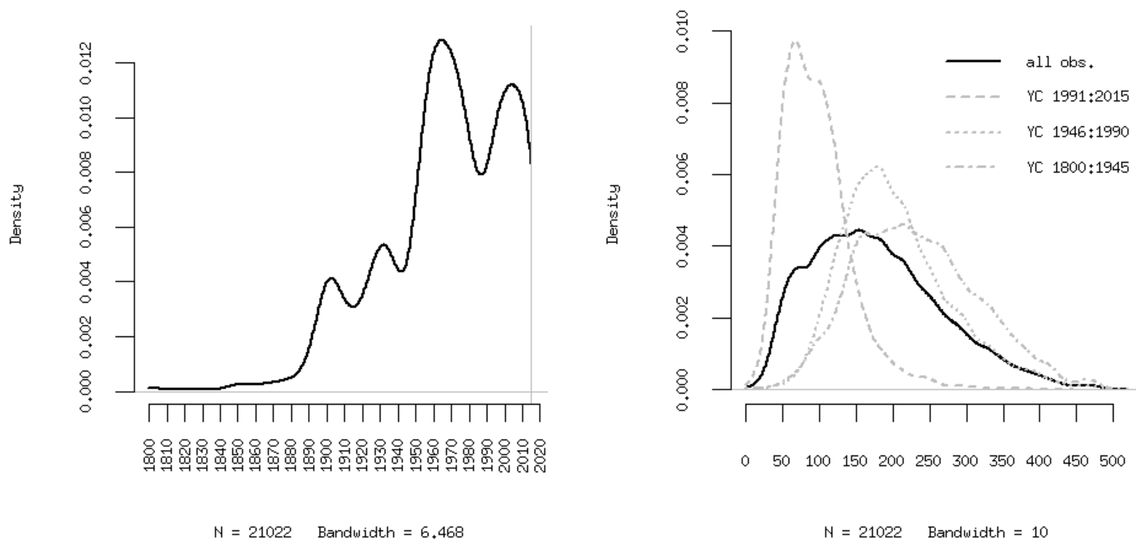
Results for the sub-sample of gas-heated houses with a projected EPS are reported in Table 4. Covariates were included but are not displayed here.[11] All models in this section focus on the effects of local gas prices and do not include main or interaction terms for local climate.

In column (1), Eq. 4 was estimated for the whole sub-sample of 21022 observations. The adjusted R^2 is fairly high, given that a linear model was estimated where fits are usually worse than for log-log or log-linear functional forms (Goodman, 1978). The coefficients of main interest are EPS_GAS_P and EPS_GAS_LOCAL_P (δ_1 and δ_2 in Eq. 4). Both are highly significant and have the expected sign. Furthermore, they are of the same magnitude, with a p-value of 0.438 for the Null of equal coefficients. A one Euro increase in heating costs due to a change in the average price of gas translates into a decrease of the listing price of 23.5 Euro (EPS_GAS_P) while the same change in heating costs due to a local price change reduces

[11] Table 8 displays results including all covariates except district-FE for models (1) and (4) of Table 4.

Figure 3: Kernel density estimates for Year of Construction and EPS

(a) Year of Construction (b) Energy Performance



listing prices by 32.9 Euro. As an additional control, the model includes an interaction term of EPS_GAS_P and population density in the year 2013.[12] The control was added because the recent construction boom in Germany was more pronounced in urban areas and might have led to a greater supply of energy efficient homes in these areas. The results seem to support this argument: A one standard deviation change in population density reduces the effect of a one Euro increase in heating costs on prices by 6.4 Euro. Finally, local gas prices do not seem to have an effect on house prices.

Figures 3a and 3b show kernel density estimates for the year of construction and EPS variables in the sub-sample analysed in Table 4. While most houses in the sample were constructed after the Second World War, a substantial share of buildings are older. Secondly, there are two pronounced peaks, around 1960 and 2000. Figure 3b compares the distributions of EPS for the the whole sample and for three vintage groups separately. Clearly, younger buildings have much higher energy efficiency, and the distribution shifts to the right from the group of middle- to the group of old-age buildings. This points to a source of bias that should be accounted for in the analysis: If the vintage structure of buildings across space changes, so will the distribution of EPS and the value of energy efficiency (via T). For that reason, the model in column (2) of Table 4 uses a balanced sample, where balancing was done on the year of construction dummies and local gas prices.[13] The results are robust to that change, with a slight upward shift of the coefficient of

[12]Population density was re-scaled to have mean zero and a unit standard deviation so that the other EPS coefficients are easier to interpret.

[13]More precisely, the range of possible values for local gas prices (GAS_PRICE) was divided into ten bins of equal width, whereby observations from the 1%- and 99%-quantiles of the GAS_PRICE variable were dropped to avoid sparse fields. Then, one bin was chosen as the reference. Within each bin, the distribution of the year of construction dummies of the reference bin was imposed by randomly dropping observations in year of construction categories with too many observations, up to the point where the year of construction distribution within that bin was the same as the year of construction distribution of the reference bin. This was repeated for all ten bins. To obtain valid standard errors, the procedure was repeated 250 times. Within each repetition, the model was estimated by OLS and ZIP-code clustered standard errors were computed. These standard errors were used to make 50 draws from a normal distribution centred at the coefficient estimate with standard deviation equal to the estimated standard errors. The reported coefficients and standard errors are the empirical means and standard deviations of these $250 \times 50 = 12,500$ simulated estimates.

EPS_GAS_LOCAL_P.

Model (3) repeats this exercise, but with ZIP code FE instead. This further reduces the number of observations because ZIP codes with less than six observations were dropped. Although it would be possible to keep all ZIP codes with more than one observation, the higher threshold makes it less likely that in the simulation procedure all observations from a single ZIP code are dropped. On the upside, the R^2 jumps to a remarkably high value of 0.812. While the main effect remains stable, the coefficient of EPS_GAS_LOCAL_P is now much smaller and insignificant. However, the relatively large standard error leads to acceptance of the Null of equal coefficients, just as in models (1) and (2), but at a much smaller p-value (0.084). Unfortunately, it is impossible to tell whether the change in the coefficient stems from better control of local prices or the difference in the sample.

As a second potential solution to the problem of building age distribution, model (4) uses a matching approach. One reason behind the missing significance of EPS_GAS_LOCAL_P in model (3) might be that in many cases local gas price differences are very small and/or not stable over time. For that reason, the sample was restricted to ZIP codes that are adjacent to a ZIP code with gas prices lower by at least one Eurocent per kWh. Each observation from a high-price ZIP code was then matched to an observation from the adjacent low-price ZIP code on the year of construction variable (inexact matching, R package `Matching`, see **?**). For each match, the difference in listing prices was regressed on the differences of all covariates. In order to capture local land price differences, land prices were proxied by ZIP-code-FE estimates from a regression similar to model (3) that was run on a sample of observations with heating types other than gas heating (LAND_PRICE and dummy LAND_PRICE_NA if missing). The procedure ensures that building age structure is independent of gas prices, so that $\delta_1(T)$ and $\delta_2(T)$ are indeed estimated for the same T. The results are similar to model (3), although standard errors are much larger, cf. also Table 8 in Appendix A. This suggests that local gas price differences are neglected by sellers of gas-heated residential real estate.

6.2. Variation in gas prices and climate

In a second step, the focus lies on local variation in climate. The approach described in Fn. 13 was applied, but with local climate (LC) instead of local gas prices. Results are displayed in Table 5.

Table 5: Climate and local gas price regressions

	Dependent Variable:			
			PRICE_SQM	
	(1)	(2)	(3)	(4)
LC	-1426.438*		-1381.087*	-1091.623
	(565.823)		(579.421)	(1067.778)
EPS_GAS_P	-0.239***	-0.222***	-0.243***	-0.453***
	(0.025)	(0.029)	(0.026)	(0.078)
EPS_GAS_LC_P	-0.578	-0.053	-0.461	-1.668
	(0.290)	(0.375)	(0.317)	(1.140)
EPS_GAS_P:POP_DENSITY_2013	0.056*	0.070*	0.074**	-0.114
	(0.023)	(0.026)	(0.026)	(0.085)
GAS_PRICE			-14.331	
			(47.403)	
EPS_GAS_LOCAL_P			-0.223	
			(0.179)	
District-FE	yes	no	yes	yes
ZIP code-FE	no	yes	no	no
N	15607	11327	14856	5150
adj. R^2	0.682	0.812	0.683	0.668
standard error	621.2	458.2	613.0	641.2
p-value EPS_GAS_P = EPS_GAS_LC_P	0.120	0.327	0.247	0.140
p-value EPS_GAS_P = EPS_GAS_LOCAL_P	-	-	0.459	-

ZIP-code cluster-robust standard errors in parentheses; see the description in the text. The set of control variables that is displayed in Table 8 in the appendix are included; full results available upon request; p-values: ***: $< .001$, **: $< .01$, *: $< .05$.

Model (1) in Table 5 reproduces model (2) from Table 4. The coefficient on the interaction of average heating costs with local deviations from the reference climate (EPS_GAS_LOCAL_P) is more than twice as large in magnitude as the main effect, but its standard error error is much higher. It is only marginally significant and the Null of equal coefficients is not rejected (p-value 0.12). Furthermore, a cooler local climate significantly decreases listing prices (higher LC). Similarly to model (3) from Table 4, the use of ZIP code FE in model (2) of Table 5 shrinks the coefficient of the climate interaction effect. It is now much smaller and insignificant. However, the number of observations is reduced substantially. It is thus possible that the effect observed in model (1) is due to insufficient control of local land prices.

In order to compare more directly the effects of local climate and gas prices, both interaction terms were included in model (3). The balancing procedure thus has to take into account both dimensions (LC and GAS_PRICE). For that reason, a more coarse partitioning of 4×4 bins was used, leading to a total of 16 bins within which the building age distribution had to be made equal to the reference bin's building age distribution. Compared to model (1), this reduces the number of observations slightly, from 15,607 to 14,856. Since there is a moderate bivariate correlation between LC and GAS_PRICE of 0.419, identifying variation is lower and standard errors on both coefficients increase. Nevertheless, both coefficients remain relatively stable in terms of magnitude.

Finally, model (4) re-estimates model (1), but for the sub-sample of buildings constructed in the years 1991 or later. The idea behind this is that year of construction is only an imperfect predictor of remaining lifetime. Even though there is one variable that indicates the year of the last retro-fitting or reconstruction, this information is missing for many of the older buildings in the sample. As a consequence, there is considerable unobserved variation of building condition for (very) old buildings. This is reflected in the much wider range of EPS for older buildings, see Figure 3b. Conversely, it is unlikely that buildings constructed within the last 25 years had been retro-fitted already. The technical lifetime of an energy efficiency investment in Germany is 30 to 55 years, depending on the building part (Hoier and Erhorn, 2013, p. 32). Instead of the year of construction dummies from model (1) in Table 8, five dummies (five-year periods) were included as controls instead and these dummies were used in the balancing procedure of the conditional year-of-construction distribution. As a result, the coefficient of EPS_GAS_P almost doubles in size, and a quick comparison with the other models shows that this difference is significant at least on the 5%-level. The coefficient of EPS_GAS_LOCAL_P also increases substantially, but remains insignificant. Taken as a whole, this result suggests that EPS information is more valuable in newer buildings, most likely because of the longer investment horizon – the time until refurbishments become necessary and EPS can be altered. A second reason might be that there is a higher likelihood that older houses with very high EPS are improved if energy prices increase, which also reduces the expected investment horizon.

6.3. Fuel types

Variation in heating costs that was exploited in sections 6.1 and 6.2 is relatively subtle. For an average house in the sample, yearly cost savings amount to approximately 100 to 200 Euro if these differences are considered (interquartile ranges). More pronounced differences exist across different fuel types. Compared to gas heating (gas combustion on-site), district heating (waste heat delivered through a local network) was 22% more expensive on average in the last 24 years. Electricity heating is almost four times as expensive as gas heating (see Figure 2).

In this section, a sub-sample of gas-, district-, and electricity-heated houses is analysed. The sample was restricted to ZIP codes for which there were observations of at least two of the three heating types. In total, there are 11,367 observations (gas: 8,050, electricity: 2,050, district: 1,067). In order to make the sub-groups more comparable in terms of EPS, the sample was restricted further to observations with EPS lower than 250, reducing sample size to 8,349 (gas: 5,532, electricity: 1,846, district: 971). 250 is the threshold for grade H efficiency, see Figure 4 in Appendix B. The rationale behind this restriction is as follows: On a per-unit basis, the value of energy efficiency in a building with a very high EPS should be lower because

Table 6: Fuel type regressions

	Dependent Variable:			
	PRICE_SQM			
	(1)	(2)	(3)	(4)
FUEL_GAS_EPS	-1.855***	-1.747**	-2.437*	
	(0.337)	(0.600)	(0.966)	
FUEL_ELECTRIC_EPS	-1.853***	-2.684**	-2.717	
	(0.428)	(0.888)	(1.904)	
FUEL_DISTRICT_EPS	-0.610	-0.665	-2.393	
	(0.902)	(0.842)	(1.917)	
FUEL_ELECTRIC	-55.578	649.888	972.201	
	(622.637)	(1058.074)	(1919.083)	
FUEL_DISTRICT	206.273	608.017	1954.334	
	(817.809)	(944.938)	(1269.961)	
EPS_GAS_P:YC_1992_1999				-0.196
				(0.134)
EPS_GAS_P:YC_2000_2007				-0.404**
				(0.135)
EPS_GAS_P:YC_2008_2015				-0.479*
				(0.195)
N	8349	4094	2188	4112
adj. R^2	0.705	0.709	0.702	0.676
residual SE	623.0	629.0	630.8	659.6
p-value $Z = 0$	0.192	0.1252	0.48544	-

ZIP-code cluster-robust standard errors in parentheses; see the description in the text. The set of control variables that is displayed in Table 8 in the appendix are included; full results are available upon request. All models include district fixed effects. p-values: ***: $< .001$, **: $< .01$, *: $< .05$.

the gains of improving energy efficiency of that building are relatively high, reducing average fixed costs of an investment in energy efficiency. Consequently, the time remaining until the next investment in energy efficiency should be much lower than for low-EPS buildings of the same vintage.

Summary statistics can be found in columns (2) to (4) of Tables 2 and 3. There are some pronounced differences between the types: Prices per square metre are highest for district-heated and lowest for electricity-heated homes. EPS and the age structure also differ substantially, as well as quality indicators. For that reason, a flexible functional form was chosen where coefficients of all housing characteristics were estimated separately for each fuel type.

Results for the most important variables are displayed in columns (1) to (3) of Table 6. Model (1) includes the same set of controls as model (1) of Table 8. The main effects for having district or electricity heating installed (instead of gas) are insignificant. Most likely, this is due to the large number of controls included that are interacted with these two dummies.[14] Instead of focussing on expected heating costs, the regression includes EPS separately for the three fuel types. The estimated coefficients are the sample analogues of $\delta(T) \times C$ in Eq. (3). While the coefficients for EPS are highly significant for gas and electricity-heated houses, this does not hold for district-heating. It is much smaller in magnitude and insignificant. When comparing the EPS coefficient of gas-heated houses divided by the average gas price ($-1.855/5.69 = 0.326$) to estimates for the coefficient of EPS_GAS_P in the full sample (e.g. Table 4, -0.235), it turns out that the former is considerably larger in absolute value, which is in line with expectations. This difference disappears when adding observations with EPS greater than 250 to the sample (not displayed here).

As described in Section 3.1, long-run relationships between fuel costs suggest that $(C_e - C_g)\delta = 2.88 C_g \delta$ and $(C_d - C_g)\delta = 0.22 C_g \delta$. Dividing the first by the second term implies that the ratio of these estimated differences equals $2.88/0.22 \approx 13.1$ which is a linear restriction that can be tested in a standard Wald test. In contrast to testing ratios of coefficients directly, this has the advantage that (quality) biases of the estimated

[14]There are several substantial differences in the valuation of housing characteristics across fuel types. These are not discussed here for brevity.

EPS coefficients cancel out if the relationship between the omitted variables and EPS are the same across heating types.[15] In the table, the test statistic is denoted by Z, and the Null of $Z = 0$ is tested against the alternative of $Z \neq 0$. The p-value of 0.192 shows that it is quite difficult to rule out coherent valuation of EPS in a statistically sound way, even although the pattern of EPS coefficients does not seem to match the pattern of relative fuel prices.

Pronounced difference in the building age distributions of the three types might be responsible for this result. For that reason, the same procedure as described in Fn. 13 was applied. The distribution of the year-of-construction dummies in the sub-sample of district-heated houses was imposed on the other two groups by randomly dropping observations in year-of-construction groups with too many observations. The resulting sample consists of 2,344 gas-, 779 electricity- and 971 district-heated houses. Column (2) reports (simulated) coefficients and standard errors. Compared to model (1), the number of observations is halved, a consequence of the strong differences in building age structures. EPS coefficients of gas and district heated houses remain unchanged (the latter for obvious reasons), but the value of energy efficiency increases in electricity-heated houses, from -1.853 in model (1) to -2.684 in model (2). This points to the direction that higher costs of electricity (per kWh) translate into a higher value of EPS. Consequently, the Null of coherent valuation cannot be ruled out.

Taking this idea one step further, model (3) focusses on buildings constructed in the years 1991 to 2015. The building age structure is balanced using the same procedure as in model (2), for five year-of-construction dummies (1991–1995, 1996–2000, etc.). This reduces the sample to $1,332$ gas-, 304 electricity-, and 552 district-heated houses. Unfortunately, the smaller number of observations and the balancing procedure reduce estimation precision considerably, leaving statistically significant only the EPS coefficient of gas-heated houses. However, the three coefficients are now strikingly similar in terms of magnitude. This suggests that older buildings suppress EPS substantially, as had been found earlier for the sub-sample of gas-heated houses alone (see model (4) in Table 5). Furthermore, part of this effect seems to stem from buildings with very high EPS. At first glance, the results do not support the idea that heating fuel type influences the capitalised value of energy efficiency as measured by EPS. When looking at the test results for $Z = 0$, this impression cannot be confirmed. It will thus be necessary to add more observations in order to obtain more precise estimates.

6.4. Remaining lifetime of buildings

Thus far, the results make it difficult to see clearly whether the valuation of energy efficiency follows reasonable patterns. This section adds one further dimension by focussing on the investment motive behind energy efficiency improvements. Clearly, if retro-fitting becomes necessary for some reason other than an improvement in energy efficiency, the latter can be done incidentally. This splits fixed costs of the investment and therefore increases its profitability. As already discussed above, investors will therefore care for T, the remaining lifetime of the building.

In order to be able to use variation in T while reducing data errors as much as possible, estimation focusses on the sub-sample of gas-heated houses constructed in one of the three eight-year periods 1992–1999, 2000–2007, and 2008–2015. EPS coefficients are then estimated for each of these three periods separately. In Appendix C, it is shown that these three coefficients are made comparable by imposing a uniform distribution of years of construction within each age group.[16] Under this condition, it is possible to obtain estimates for T and $d = (1+e)/(1+r)$ from the data. It must be noted that data requirements are enormous–and much higher than what is available for this paper–because coefficient standard errors

[15] More precisely, let $\text{EPS} = \gamma_0 + \gamma_1 Q + \nu$ for all three fuel types, with an omitted variable Q. Denote fuel type by f. If $P = \delta_0 + (\delta_1 C_f)\text{EPS} + \delta_2 Q + \eta$, and P is regressed on EPS, testing ratios of differences is valid, but testing ratios directly is not: $E[\widehat{\delta_1 C_f}] = \delta_1 C_f + \delta_2 \gamma_1$, and the second term cancels out when differencing.

[16] This is done in a procedure similar to the one described in Fn. 13.

are inflated strongly in the calculation of T and d. Estimates for these two parameters are presented for expositional purposes, but should be interpreted cautiously.

Column (4) of Table 6 contains coefficient estimates for the linear regression. The three EPS_GAS_P coefficients are in the correct order, pointing to a strong decline of EPS as remaining lifetimes become shorter. In the youngest group , an increase of energy costs by one Euro$/[m^2 \cdot a]$ reduces listing price per square metre by 48 Euro$/m^2$. This number drops to 41 Euro$/m^2$ in the middle group and declines further to 20 Euro$/m^2$ (insignificant) in the oldest group. The corresponding estimate for T, 45 years, is remarkably close to the average lifetime of energy efficiency investments in Germany (30–55 years, see Hoier and Erhorn 2013). The estimated value for d, 0.882, implies an interest rate r of 13.4% if gas prices are expected to be constant ($e = 0$). This is a low value, given that interest rates for construction loans were around 2% in 2015.[17]. Nevertheless, this is a common result: In a meta-study, **?** reports internal discount rates of 5–35% for energy efficiency investments (see also Jaffe and Stavins, 1994, p. 122 and Fn. 17) It might be related to financing constraints of house buyers.

6.5. Discussion of results

Taken as a whole, the results suggest that energy efficiency is taken into account in an economically meaningful way by sellers of residential houses in Germany. This does not mean that the value of potential cost savings is always and everywhere calculated correctly, providing support for the idea of "rational inattention" (Sallee, 2013). After controlling for local house prices more rigorously, variation in gas prices or local climate did not influence the value of EPS (sections 6.1 and 6.2). However, from a statistical point of view, the estimates are not precise enough to rule out correct valuation with respect to local conditions.

One important finding of this paper is that building age alters the value of EPS considerably. Earlier papers have estimated one single coefficient for samples that typically include buildings of all vintages and heating fuel types – although some have looked at sub-samples of different house types (Fuerst et al., 2015; Hyland et al., 2013). The coefficients that are most comparable to estimates from earlier studies are the estimates for EPS_GAS_P in Table 4, indicating that a one Euro increase in expected yearly heating costs per square metre decreases listing prices by approx. 23.5 Euro$/m^2$. At sample means, a change from an A-rated building ($30 \leq$ EPS < 50) to an E-rated building ($160 \leq$ EPS < 200) increases expected heating costs by approximately 7.95 Euro/$[m^2 \cdot a]$. The decrease in prices amounts to 186.8 Euro, or 9.6% of the sample mean. This is very close to the values reported in other studies, e.g. 9.3% in Hyland et al. (2013) or 10.2% in Brounen and Kok (2011).[18] Note that both studies use a selection model because EPS is not reported in all observations. The suspected upward bias of EPS in OLS estimation does not seem to be great.

Once the sample is restricted to younger buildings, the estimated coefficient doubles in size, cf. model (4) in Table 5. More precisely, for buildings constructed within the last eight years, the premium of A- over E-rated buildings increases to 19.6%, cf. model (4) in Table 6. Clearly, from the perspective of an investor or construction company, this latter figure is much more important than how EPS is capitalised *on average*, i.e. in the whole sample. If a house owner wants to improve energy efficiency of the building substantially, it is very likely that the building is re-constructed rather than renovated. The results presented here suggest that the premium will be much higher in that case. They are thus much closer to the policy-relevant question of how to foster energy efficiency investments in an efficient manner.

It must be noted that this paper faces the same quality bias as other studies (e.g. Brounen and Kok, 2011; Fuerst et al., 2015; Hyland et al., 2013; Kahn and Kok, 2014). Exogenous variation from local climate or gas prices does not seem to be important to house sellers and can thus not be used to identify the EPS coefficient.

[17]Interest rates on construction loans with a duration of 1 to 5 years to private households (new customers) were below 2% throughout the year 2015, see the interest rate statistic of Deutsche Bundesbank from February 3, 2016.

[18]Fuerst et al. (2015) report coefficient estimates for A or B rated buildings and find a premium over E-rated buildings of 5.7% for the full sample.

However, part of the analysis relies on differences of potentially biased coefficients. Under the assumption that quality bias is equally strong for houses of different vintages, differences of the estimates in column (4) of Table 6 are identified. These were used to calculate estimates for the investment horizon, T, and the discounting factor, d. T and d can be used to calculate the present value of saving one Euro on energy costs per year and square metre – $100\times$ the EPS coefficient of a building from the youngest group. Setting $T = 41$ and $d = 0.882$, it is 7.4 Euro$/m^2$, which is much lower than the coefficient estimate of 47.9 Euro$/m^2$. This is only suggestive of positive quality bias because of high uncertainty in the calculation of T and d, but it calls for a more rigorous identification of the capitalisation of energy efficiency in future work.[19]

7. Conclusion

This paper has investigated several channels that influence how sellers on the housing market value energy efficiency in residential buildings. The results have shown that agents are able to consistently use very precise information such as EPS instead of labels or efficiency bands. Agents also seem to be aware of the investment horizon of energy efficiency investments. Overall, the investment dimension of EPS seems to be understood quite well.

The results are less clear about more subtle differences such as local gas prices or climatic conditions. Furthermore, regressions that relied on different fuel types did not produce a consistent pattern with respect to EPS coefficients. Whether this is a sign of irrational or rational inattention cannot be answered conclusively at this point. Anyhow, if there are problems of correct valuation in these dimensions, they could easily be tackled by including estimates of expected heating costs in EPS certificates. These estimates should be based on local fuel prices and climate.

Future research should provide other ways of identifying the EPS coefficient. Given the difficulties to assess whether estimated premia reflect energy cost savings, survey evidence would help greatly to further understanding in this area. A second shortcoming of this study is its use of listing instead of transaction prices. There are sound theories and empirical evidence showing that systematically mis-pricing housing characteristics is very costly to house sellers and should thus be avoided. Nevertheless, the use of listing prices is a source of potential bias. It would thus be very interesting to see whether the results are robust to using transaction data such as in Fuerst et al. (2015).

The results add to the body of literature and corroborate conclusions drawn in earlier studies. Despite unresolved difficulties related to identification, it seems clear that EPS certificates in principle help to increase transparency in and are valued by real estate markets. In that sense, it would be desirable to refine existing EPS schemes and establish a tighter connection between EPS and energy cost savings. This is of prime importance if the goal is to reduce energy use (and CO_2 emissions) in residential buildings. If premia are related to "green" marketing alone, simple (binary) labels are not very useful because this will spur investment in marketing and pseudo-efficient rather than truly efficient design (Newell and Siikamäki, 2013; Sallee, 2013). For instance, taxation of energy consumption will be more effective if heating cost savings translate into an increase in the value of energy efficient houses.

The Ukraine crisis has put Europe in mind of its dependency on resource imports. Besides its implications for climate change, an energy efficient building stock is thus critical for Europe's political independence in the future. For this reason alone, it is worth while to study more thoroughly how markets react to the existing policy instruments.

[19] As an example for the sensitivity of T and d consider a change of the coefficient of the youngest group from 0.48 to 0.52 ($1/5$ standard error). This yields $T = 73$ and $d = 0.938$ and a present value of 15.0 Euro$/m^2$.

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Appendix A Additional tables

Table 7: Heating types in the sample

	GAS	LIQUID_GAS	BIOGAS	OIL	GEOTHERMAL
PROJECTION	24751	200	70	14343	1015
PAST_USE	25940	248	29	9733	471
TOTAL	50691	448	99	24076	1486
	HEAT_PUMP	DISTRICT	ELECTRIC	NIGHT_STORAGE	SOLAR
PROJECTION	1477	1231	3522	419	1377
PAST_USE	441	1020	1772	158	785
TOTAL	1918	2251	5294	577	2162
	PELLETS	COAL	MULTI		
PROJECTION	1489	211	1612		
PAST_USE	939	122	1016		
TOTAL	2428	333	2628		

Table 8: Local gas price regressions, extended results

	Dependent Variable:	
	PRICE_SQM	
	(1)	(2)
TIME	6.582**	0.861
	(2.468)	(9.015)
YC_1918	-579.160***	-365.737
	(45.327)	(215.952)
YC_1945	-464.579***	-568.723**
	(44.393)	(187.010)
YC_1960	-465.985***	-544.617**
	(41.752)	(167.214)
YC_1970	-402.248***	-518.493**
	(41.641)	(172.321)
YC_1980	-397.912***	-449.309**
	(41.438)	(161.846)
YC_1990	-325.582***	-437.808**
	(44.437)	(163.918)
YC_2000	-263.901***	-348.634*
	(39.237)	(168.342)
YC_2010	-107.955**	-10.965
	(39.005)	(192.605)
RETROFIT_LAST10	22.197	-26.226
	(17.785)	(62.181)
TYPE_SEMIDETACHED	-154.624***	-228.629***
	(18.320)	(68.522)
TYPE_TOWNHOUSE_M	-176.928***	-473.944***
	(28.595)	(76.046)
TYPE_TOWNHOUSE_E	-198.212***	-15.969
	(33.581)	(123.289)
TYPE_OTHER	-26.531	-113.542
	(21.807)	(76.187)
LOT_SIZE	0.067**	0.109
	(0.023)	(0.062)
log(LOT_SIZE)	186.198***	
	(24.154)	
log(SIZE_SQM)	-465.196***	
	(42.513)	
ROOMS	-21.380**	6.953
	(6.740)	(33.260)
SELF_CONT_HEATING	-51.142	280.246
	(41.494)	(169.543)
CENTRAL_HEATING	-57.670***	49.052
	(14.006)	(53.273)
FLOOR_HEATING	80.747*	128.457
	(31.503)	(113.868)
QUAL_HIGH	657.162***	1310.517
	(92.783)	(942.285)
QUAL_MED	153.846***	242.668***
	(23.263)	(63.314)
QUAL_SIMPLE	-194.874***	35.145
	(43.324)	(144.015)
CONDITION_GOOD	138.249***	64.620
	(16.735)	(61.202)
CONDITION_NEW	100.339*	-167.473
	(41.189)	(175.070)
SECOND_BATHROOM	40.509**	-33.686
	(13.587)	(48.049)
BASEMENT	58.605***	106.817
	(13.181)	(62.076)
FITTED_KITCHEN	92.543***	81.762
	(16.187)	(50.515)
SAUNA	183.704***	603.691***
	(35.012)	(167.231)
PARQUET_FLOORING	180.833***	103.554
	(54.460)	(207.708)

Continued on next page

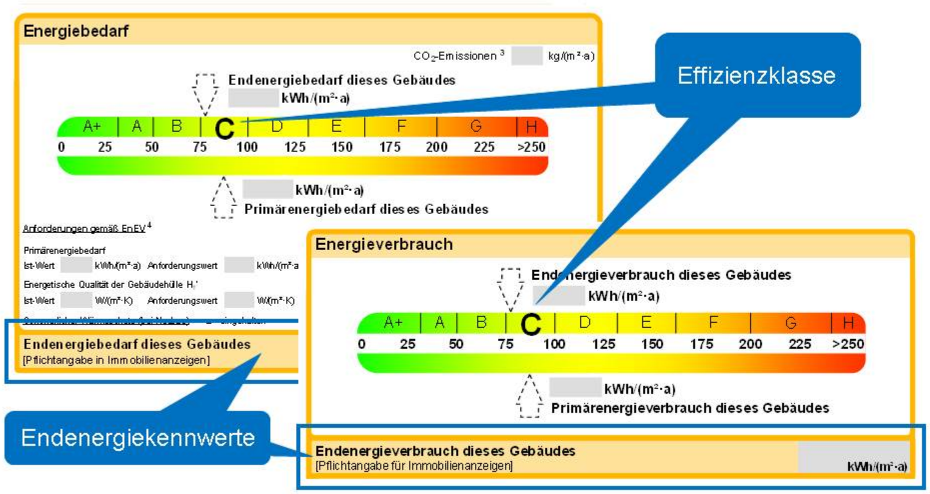
Table 8 – *Continued from previous page*

	(1)	(2)
FIREPLACE	97.882***	206.728*
	(21.703)	(84.841)
BROKERAGE	363.658	1816.049
	(367.522)	(1171.355)
UNEMP_YOUTH_2014	-56273.831***	39363.159
	(8829.115)	(20957.093)
LIVING_SP_COMPL_2008_2013_INH	170166.140***	30620.203
	(25993.719)	(60151.629)
LOT_SIZE:POP_DENSITY_2013	0.118***	-0.038
	(0.025)	(0.044)
log(LOT_SIZE):POP_DENSITY_2013	48.998***	
	(6.893)	
LAND_PRICE		0.289**
		(0.098)
LAND_PRICE_NA		13.489
		(117.869)
SIZE_SQM		-3.095**
		(1.039)
GAS_PRICE	10.095	13.864
	(33.480)	(74.040)
EPS_GAS_P	-0.235***	-0.262***
	(0.019)	(0.078)
EPS_GAS_LOCAL_P	-0.329**	-0.040
	(0.122)	(0.345)
EPS_GAS_P:POP_DENSITY_2013	0.064**	0.133
	(0.020)	(0.068)
N	21022	2516
adj. R^2	0.687	0.289

ZIP-code cluster-robust standard errors in parentheses. District-FE are included in model (1). Model (2) is a regression of matched differences, where (inexact) matching is on year of construction and EPS across zip code areas with large gas price differences to a neighbouring zip code area. p-values: ***: $< .001$, **: $< .01$, *: $< .05$.

Appendix B German energy efficiency certificates

Figure 4: Energy labels for real estate offers in Germany



Source: BBSR/Energieeinsparverordnung[a]

[a] The label in the background ("Endenergiebedarf") is based on a standardised projection of energy use. It containts a scale (A+ to H) that indicates EPS in steps of 25, and the exact EPS (see the blue label "Endenergiekennwerte"). Additionally, information on energy-related building characteristics is provided below the scale; this information is not available in the data set. The label up front is based on past use. It is structured similarly, but does not contain additional information.

Appendix C Notes on the estimation of T and d from the data

For $k, m, T \in \mathbb{N}_0$, $T > mk$, define

$$\delta^{(m,k)} := \sum_{i=mk}^{(m+1)k-1} p_i \sum_{t=1}^{T-i} d^t, \tag{5}$$

where $d > 0$, $p_i \geq 0 \forall i$, and $\sum_{i=mk}^{(m+1)k} p_i = 1$. Think of $\delta^{(m,k)}$ as the absolute value of the slope coefficient in a regression of house prices per square metre on expected energy costs if the sample consists of houses with remaining lifetimes $T - mk, T - mk - 1, ..., T - (m+1) + 1k$ at shares p_i $(i = mk, ..., (m+1)k - 1)$.

Assume that the sample is balanced, i.e. $p_i = 1/k \; \forall i$. Then, for $m > 0$,

$$\begin{aligned}
\delta^{(m-1,k)} - \delta^{(m,k)} =& \frac{1}{k}\left(\sum_{i=(m-1)k}^{mk-1}\sum_{t=1}^{T-i} d^t - \sum_{i=mk}^{(m+1)k-1}\sum_{t=1}^{T-i} d^t\right) \\
=& \frac{1}{k}\sum_{i=mk}^{(m+1)k-1}\left(\sum_{t=1}^{T+k-i} d^t - \sum_{t=1}^{T-i} d^t\right) \\
=& \frac{1}{k}\sum_{i=mk}^{(m+1)k-1}\sum_{t=T-i+1}^{T-i+k} d^t \qquad (6) \\
=& \frac{d^k}{k}\sum_{i=mk}^{(m+1)k-1}\sum_{t=T-i+1}^{T-i+k} d^{t-k} \\
=& \frac{d^k}{k}\sum_{i=mk}^{(m+1)k-1}\sum_{t=T-i+1-k}^{T-i} d^t \\
=& \frac{d^k}{k}\sum_{i=(m+1)k}^{(m+2)k-1}\sum_{t=T-i+1}^{T-i+k} d^t \qquad (7)
\end{aligned}$$

From (6) and (7), it follows that $\delta^{(m-1,k)} - \delta^{(m,k)} = d^k(\delta^{(m,k)} - \delta^{(m+1,k)})$, and hence

$$\frac{\delta^{(m-1,k)} - \delta^{(m,k)}}{\delta^{(m,k)} - \delta^{(m+1,k)}} = d^k \qquad (8)$$

and, from (6),

$$\begin{aligned}
\delta^{(m-1,k)} - \delta^{(m,k)} =& \frac{d^T}{k}\sum_{i=mk}^{(m+1)k-1}\sum_{t=T-i+1}^{T-i+k} d^{t-T} \\
=& \frac{d^T}{k}\sum_{i=mk}^{(m+1)k-1}\sum_{t=1}^{k} d^{t-i}
\end{aligned}$$

which can be solved for T easily if d and the left hand side are known.

Under the assumptions that (i) participants in the market are aware of the present value concept and (ii) buildings can be categorised by remaining lifetimes–e.g. by year of construction–, this allows to calculate d, and then T directly from the data. Even though this does not identify r and e, it at least yields the ratio $d = (1+e)/(1+r)$ of expected cost changes $(1+e)$ to the discounting factor $(1+r)$, and the expected remaining lifetime of a new building.

Cure Rates on Defaulted Junior Lien Mortgage Debt

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Junior lien mortgage debt proliferated during the housing market run up as borrowers used piggyback loans to buy homes or extract home equity. Defaulted second liens now trade in the distressed debt market at large discounts. In this paper, we examine the previously unstudied second lien cure rate topic and find that the size and status of the associated senior mortgage is an important cure rate predictor as are other borrower debt usage characteristics revealed in credit bureau data. Results should be of interest to distressed debt investors, lenders, and policymakers alike.

Keywords: mortgage, default, junior lien, cure

Session: Residential Mortgage
H25, June 9, 2016, 11:00am - 12:30pm

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Abstract

Junior lien mortgage debt proliferated during the housing market run up as borrowers used piggyback loans to buy homes or extract home equity. Defaulted second liens now trade in the distressed debt market at large discounts. In this paper, we examine the previously unstudied second lien cure rate topic and find that the size and status of the associated senior mortgage are important cure rate predictors as are other borrower debt usage characteristics revealed in credit bureau data. We link our results to the finance literature on informed, and uninformed, investors. Results should be of interest to distressed debt investors, lenders, and policymakers alike.

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1. Introduction

Second mortgage liens proliferated during the housing market run-up from 2000-2007. In the case of non-agency first mortgage loans originated during this time period, Goodman *et al.* (2010) finds that 50% of first mortgage borrowers also had a second lien. Second liens have also been implicated as a contributing factor to the severity of the recent financial crisis (Jagtiani & Lang 2010; LaCour-Little *et al.* 2011). Furthermore, borrowers with second mortgage liens are more likely to make lower down payments when purchasing their homes (Lee *et al.* 2012). In light of the large role that second liens play in the mortgage landscape, understanding these loans is an important topic in financial research. Most previous literature has focused on the determinants of second loans default. Here we are interested in a different but related issue – the recovery, or cure, rates on loans secured by second liens once borrowers have defaulted. The goal of this study is to understand the factors, both in terms of magnitude and direction, that lead to a cure on a previously defaulted on second mortgage loan. To the best of our knowledge this is the first study to examine this important topic.

In an earlier version of this paper we characterized defaulted, but unresolved, mortgage debt as "zombie loans", defined as mortgages more than 60 days past due ("dpd"), but which have yet to enter the foreclosure process[1]. In varying contexts, such loans have received much media attention over the years (Fackler 2004; Brown 2011; Colchester & Margot 2012; Curan 2014). In our study here, after controlling for state- and loan vintage-specific factors, we find strong evidence that the single most important indicator that a borrower will cure a junior lien default is

[1] Others have characterized such loans as "limbo loans", see for example, Allen *et al.* (2015)

that the borrower cures the senior lien. We also find that lower amounts of outstanding revolving debt and senior mortgage debt lead to a higher likelihood of a second lien cure. This result seems intuitive, as borrowers with smaller amounts of other outstanding debt may have more funds available with which to cure defaulted junior lien debt. On the other hand, we also find that borrowers with larger loan sizes, measured by the junior mortgage debt, are more likely to cure the junior loan defaults. These borrowers may be both wealthier and more motivated to pay off higher loan amounts, particularly in recourse environments.

We contribute to the literature in several ways. First, we use a unique, proprietary dataset that contains detailed account information for all forms of consumer debt, including installment, revolving, junior and senior mortgage liens. Second, we contribute to the mortgage literature by investigating the determinants of junior lien cure rates – an area with little, if any, research to date. Third, we provide evidence suggesting that informed investors, using the study's main model to guide loan purchases, can dramatically increase investment returns. Finally, we provide valuable information for investors and practitioners that may help direct costly loan modification efforts to borrowers most likely to successfully cure their defaulted junior lien debt.

The paper proceeds as follows: We briefly discuss the limited literature in Section 2. We then discuss the creation of the dataset and describe our methodology in Section 3. Results are reported in Section 4, including some rough calculations of potential investor returns, with concluding remarks in Section 5.

2. Literature Review

The literature on second loans is relatively nascent. The research most closely related to ours focuses on two main areas: the determinants of second lien defaults and the relation between first and second lien defaults.

The first strand of research on second liens examines the causes of second loan defaults. Agarwal *et al.* (2006) shows that first and second liens have differential default rates. Goodman *et al.* (2010) examines the growth of the market and finds that approximately 50% of non-agency first mortgages also had a second loan. Also included in this strand are papers that examine so-called piggyback loans - a subcategory of second loans where both a first and second lien are originated simultaneously[2]. Goodman *et al.* (2010) finds that piggybacks have higher default rates than loans not originated concurrently with the senior loan. LaCour-Little *et al.* (2011) finds that subprime piggyback loans are associated with higher foreclosure and default rates.

The other strand of second loan research investigates the relation between defaults of first and second liens. In a study of strategic default, Jagtiani and Lang (2010) find that borrowers approach the decision to strategically default differently for first versus second liens. Specifically, some borrowers choose to default on the first mortgage, but continue to make timely payments on second loans. This strategy recognizes the "blocking power" of the second lien holder to stall a foreclosure by the senior lien holder. To explain, if the combined (first plus

[2] Piggyback loans, also referred to as "simultaneous close" loans were typically used to allow a borrower to afford a larger loan than would not otherwise be possible. For example, an "80/10/10" loan required only a 10% down payment by the borrower. But a second lien of another 10% could be applied to the 20% "down payment" requirement to avoid paying private mortgage insurance (PMI) on a conforming conventional first mortgage.

second liens) loan-to-value ratio exceeds 100%, the second lien holder is effectively holding a naked position in the asset. At the same time, the second lien hold retains a title claim. Before the property can change ownership, the second must release their lien or the title will not clear. As such, while the negative equity position leaves the second lien holder without a valuable claim on the asset, the ability to "block" the senior lien holder from clearing title represents its own value. Hence, the "blocking power" of the second can be used to compel an otherwise unmotivated first lien holder to the bargaining table[3].

Using a dataset of loans originated from 2002-2007, Eriksen *et al.* (2013) investigates whether second liens play a role in first mortgage defaults. They find evidence suggesting that second lien lenders are hesitant to pursue foreclosure. This allows borrowers to make separate default decisions for primary and secondary debt. Similarly, Lee *et al.* (2012) finds that 20-30% of borrowers will choose to keep current on their second liens, even while their first lien is delinquent.

There is also a broad literature in finance on returns realized by informed, and uninformed, investors. Generally, informed investors are characterized as institutional professionals while uninformed investors are households, sometimes called retail investors[4].

Although related to the existing literature, our study here looks at loans secured by second liens from a different perspective. Instead of examining the reasons for default, we identify the factors

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[3] In many of the loan modification and short sale programs promoted by the federal government starting in the 2009 time period, junior lien holders were provided with modest payoffs in return for releasing their lien claim to allow the first loan to be modified or the collateral property to be sold.

[4] While acquiring a portfolio of distressed debt is unquestionably an institutional trade, it is possible today for retail investors to acquire individual defaulted mortgage debt, see, for example, www.loanmarket.net.

that are predictive of cures. We believe we are the first to study this topic. The results of our analysis should be helpful to policymakers, investors, and financial institutions.

Data and Methodology

To address the question of cure rates on previously defaulted junior lien we employ a unique, proprietary dataset that is comprised of the loan characteristics for borrowers who have defaulted on their second loan. By focusing on a sample in which all borrowers have previously defaulted on the junior lien, we are able to analyze the factors that contribute to cure rates. We define default to mean the second mortgage loan was at least 60 days delinquent. Details concerning the construction of this dataset are discussed next.

We begin with a large dataset from the credit bureau Equifax extracted at three distinct points in time, 2009, 2011, and 2013. All data extracts are as of March 31 of the individual year. Because the credit bureau data reports loan performance data over the previous two years, we have information covering six loan performance years. After a set of data cleaning routines to deal with missing values and the like, we have an intermediate data set with total of 135,575 observations. To this, we combine the loan performance data by zip code to geographic data by zip code from CoreLogic and the Home Price Index (HPI) by core based statistical area (CBSA) from the Federal Housing Finance Agency (FHFA). We delete 3,152 observations because of difficulties matching zip code to CBSA, resulting in 132,423 observations. After conversations with Equifax executives, we also delete 20 observations because the automated valuation model (AVM) confidence score was less than 0.6, deemed less than reliable. Finally, we delete 83 observations with a vintage greater than 30 years. Therefore, our final sample has 132,320 observations. These data are nationally representative, including all fifty states and the District

Columbia, with the largest numbers coming from the largest states (California, Florida, and New York).

Insert Table 1

Table 1 reports the descriptive statistics for our sample. *Jr Cure Flag* and *Sr Cure Flag* are dichotomous variables assigned the value of one if the junior or senior mortgage lien, respectively, is cured as of the observation date, and zero otherwise. Recall that all of the sample borrowers have previously defaulted on their second mortgage loans, and many have defaulted on their senior mortgage as well. Table 1 shows that 46% of our sample borrowers have cured their junior mortgage liens and 38% have cured their senior mortgage liens over the two year time windows examined.

To understand the factors that influence the likelihood of a cure, we perform logistic regressions with *Jr Cure Flag* as the dependent variable using right-hand side variables that have been shown in previous studies to be related to mortgage cures. Since much of the literature concentrates on the senior mortgages, it is interesting to see how these variables relate to previously defaulted junior liens. Our primary regression specification is as follows:

$$\begin{aligned}
&Jr\ Cure\ Flag_t \\
&= \alpha + \beta_1 Balance\ Open\ Installment\ _t + \ \beta_2 Balance\ Open\ Revolving_t \\
&+ \ \beta_3 Balance\ Sr\ Mortgage_t \\
&+ \ \beta_4 Balance\ Jr\ Mortgage_t + \beta_5 Mortgage\ 30\ dpd_t + \beta_6 Mortgage\ 60\ dpd_t + \beta_7 Mortgage\ 120\ dpd_t \\
&+ \beta_8 Foreclosure\ rate + \beta_9 Piggyback + \beta_{10} CLTV_t + \beta_{11} Wealth_t \\
&+ \beta_{12} Wealth * Recourse_t + \ \varepsilon\ _t \qquad (1)
\end{aligned}$$

Recent literature suggests that debt other than the primary mortgage influences borrower liquidity and repayment behavior (Elul *et al.* 2010; Jagtiani & Lang 2010; Eriksen *et al.* 2013). Since our dataset includes the complete debt portfolio of the sample borrowers, we are able to observe the effect of outstanding debt on the borrower's ability to cure the junior lien. *Balance Open Installment* and *Balance Open Revolving* are the natural logarithms of all unpaid installment loans and revolving debt, respectively, for each borrower–year observation. We expect a negative relation between other outstanding debt obligations and the likelihood of curing the junior lien.

Similarly, *Balance Sr Mortgage* and *Balance Jr Mortgage* are the natural logarithms of senior and junior mortgage, respectively. Since senior mortgage debt would typically be the homeowner's largest liability, we expect a large outstanding senior mortgage balance to be negatively associated with a junior lien cure. However, we do not have an expectation about the relation between the junior mortgage balance and junior mortgage cure rates. On the one hand, borrowers may be more motivated to repay a larger junior loan amount to avoid action by creditors in a recourse environment. On the other hand, a larger outstanding junior lien balance may seem more difficult to repay after controlling for wealth or liquid assets.

Mortgage 30 dpd, Mortgage 60 dpd, and *Mortgage 120 dpd* are dichotomous variables assuming the value of one if the senior mortgage is between 30 and 59 days past due, between 60 and 119 days past due, or more than 120 days past due, respectively[5]. We expect borrowers to be motivated to cure their junior liens that are delinquent for longer periods of time. Accordingly, we expect a positive relation between *Mortgage 30 dpd, Mortgage 60 dpd,* and *Mortgage 120*

[5] State law specifies mortgage foreclosure process and timelines.

dpd and *Jr Cure Flag.* From Table 1, we see that 13.5% of the senior liens are 30-59 days past due, 5.2% are 60-119 days past due, and 18.4% are 120 or more days past due.

Foreclosure rate is the natural logarithm of the rate of foreclosures for mortgages of the zip code in which the borrower's property is located for 2009, obtained from CoreLogic. *Piggyback* is a dichotomous variable assigned the value of one if the junior lien and senior lien were issued within 30 days of each other. Because senior loans with associated piggybacks tend to perform worse than loans without a simultaneous close second (LaCour-Little *et al.* 2011; Lee *et al.* 2012; Eriksen *et al.* 2013), we expect a negative relation between *Piggyback* and *Jr Cure Flag.*

CLTV represents three different levels of combined loan to value (CLTV) amounts in separate models. *CLTV100up, CLTV150up,* and *CLTV200up* take the value of one if the ratio of original loan amount of the junior lien plus the original loan amount of the senior lien to AVM[6] is at least 100%, 150%, and 200%, respectively. CLTV is widely used in the literature to correctly account for the impact of negative equity (Elul *et al.* 2010; LaCour-Little *et al.* 2011; Eriksen *et al.* 2013; Bond *et al.* 2015). Bond *et al.* (2015) find that CLTV and state-specific subrogation laws influence the borrower's ability to refinance mortgage loans. We expect a positive coefficient for lower CLTV values and a negative or insignificant coefficient for higher CLTV values since borrowers have less incentive to cure the loan if their combined outstanding loan balances are considerably higher than the value of their property.

Ghent and Kudlyak (2011) find that being in a recourse state lowers borrowers' sensitivity to negative equity, suggesting that borrowers are more likely to default in nonrecourse states.

[6] The credit bureau data provided an AVM value for the collateral property at each point in time.

However, this result is only significant for high wealth borrowers, with AVM as the proxy for wealth. The positive association between AVM and default in nonrecourse states is significant in observations with AVM of $300,000 and greater. Accordingly, we include variables representing both wealth and wealth interacted with a recourse state dichotomous variable. In our main model, *Wealth* is represented by *AVM300up*, a dichotomous variable assigned the value of one if the AVM is at least $300,000 and zero otherwise. *Recourse* is not included in the model as a stand-alone variable because we include state fixed effects and recourse laws are state-specific. We also use several alternate definitions of wealth, including a continuous variable *AVM*, the natural logarithm of AVM, and *HighPrice* a dichotomous variable assuming the value of one if the sum of the senior and junior liens' original balances is greater than two times the average home sale price for the zip code and year, and zero otherwise.

To control for differences in state bankruptcy and foreclosure laws, we also include state fixed effects. Beyond house price movements captured by our estimate of *CLTV*, unobserved time-varying factors such as differences in the market conditions are controlled for by using loan vintage fixed effects (i.e. mortgage origination year dummy variables).

3. Results

Insert Table 2

Before any multivariate analysis, we first consider the univariate relations among our main study variables via the correlation matrices reported in Table 2. The results show Spearman's correlations above the diagonal and Pearson's below. At a univariate level, we find that larger amounts of debt are negatively related to the cure on a second mortgage lien. All four loan balance variables (*Balance Open Installment*, *Balance Open Revolving*, *Balance Sr Mortgage*, and *Balance Jr Mortgage)* are negatively correlated with *Jr Cure Flag.* We also see positive relations between the length of time the senior mortgage payment is overdue and curing the junior lien. *Mortgage 30 dpd*, *Mortgage 60 dpd,* and *Mortgage 120 dpd* are all positively correlated with *Jr Cure Flag.* Although these results confirm our *a priori* expectations, they must be interpreted with caution since they are only univariate correlations. Our logistic regression analysis that follows should provide a clearer understanding of the factors associated with junior lien cure rates.

Insert Table 3

Our main model, examining the factors that influence the cure of a second mortgage lien, is reported in Table 3. Coefficients and standard errors are presented in Panel A. Average marginal effects of highly significant (1%) variables in the main model are presented in Panel B. We estimate three specifications of the logistic regression model. In all models, wealth is proxied by the *AVM300up* dichotomous variable. We change the variables controlling for the degree to which the combined loan amount is underwater in Models 1, 2, and 3. The first model includes the *CLTV100up* dichotomous variable. Since research has shown that the degree of negative equity matters (Wyman 2010; Seiler *et al.* 2012; Guiso *et al.* 2013), Models 2 and 3 increase the threshold for a borrower to be deemed “underwater” to 150% and 200%, respectively. As expected, we see significant negative coefficients on *Balance Open Revolving* and *Balance Sr Mortgage.* These results suggest that borrowers with higher amounts of outstanding revolving debt and a higher outstanding balance on the senior mortgage are less likely to cure their junior mortgage lien. More specifically, a 1% increase in *Balance Open Revolving* and *Balance Sr Mortgage* results in reducing the probability of curing the junior lien by 0.012 and 0.002, respectively. Although our main interest here is cure rates on defaulted second loans, these results are consistent with prior research on causes of mortgage default showing that borrowers with larger senior mortgage balances are more likely to default on the senior mortgage (Eriksen *et al.* 2013)[7]. Interestingly, we find a positive relation between *Balance Jr Mortgage* and *Jr Cure Flag*. In other words, borrowers with a higher outstanding balance on their junior mortgage debt are more likely to cure them.

Moving on to the variables representing the amount of time that the senior mortgage payments are overdue, we find increasing levels of significance for the positive coefficients as the days past due increases. All coefficients are highly significant at the 1% level. This result is consistent with expectations as borrowers may be more motivated to take corrective actions to cure a defaulted junior lien, as lenders get closer to initiating foreclosure action.

We find little to no significance for the coefficient on the wealth variable, but a strong negative coefficient for the interacted variable, *AVM300up*Recourse,* as evidenced in all three models of Table 3. Although we are looking at curing the junior lien, this result is somewhat counter to the Ghent and Kudlyak (2011) finding of a positive association between wealth and likelihood to default on senior mortgage in recourse states. Our results suggest that wealthy borrowers are less likely to cure their junior liens in a recourse state, which is consistent with the “blocking power”

[7] This result differs from much of the pre-crisis literature which tended to show smaller first mortgage loans bore greater default risk and may be connected with the phenomenon of riskier borrowers taking on excessive debt via reduced the documentation programs that proliferated during the 2004-2006 time period.

argument made in other studies. Specifically, wealthier individuals have the resources to hire attorneys to encourage a long and drawn out standoff between the first and second lien holder. The result is an increased willingness to negotiate an eventual settlement at an amount below the unpaid balance (UPB) of the loan.

When looking at the degree to which the loan is underwater, there is a positive and highly significant coefficient of *CLTV100up* in Model 1, indicating that if the borrower has any amount of negative equity (a CLTV of at least 100%) he is more likely to cure the junior loan. From the average marginal effects calculations shown in Panel B, borrowers with negative equity have a 1.5% higher chance of curing their junior liens than borrowers without negative equity. However, this result does not hold for Models 2 and 3, when the degree the loan is underwater increases to 150% (*CLTV150up)* and 200% (*CLTV200up)*, respectively. Neither coefficient is significantly different from zero, possibly reflecting the fact that borrowers have less incentive to cure their second liens when their mortgages are severely underwater and, presumably, lenders have reduced incentives to pursue foreclosure. It seems that when borrowers have a large amount of negative equity, curing the junior lien is a less attractive choice, perhaps because the most important contributor to the negative is the first, not the second. However, the single most important factor in determining which borrowers will cure their junior mortgage loans is identifying which ones have cured their senior lien. The coefficient on *Sr Cure Flag* is positive and highly significant in all three models. If a borrower has cured his senior mortgage, then he is 42% more likely to cure the junior lien than those who have not.

Insert Table 4

In Table 4, we use an alternative wealth measure that is continuous instead of the dichotomous variable used in Table 3. The results of the new specification are very similar to previous results. We find positive coefficients on *Balance Open Revolving* and *Balance Sr Mortgage,* again suggesting that higher levels of revolving debt and large senior liens reduce the likelihood the junior mortgage lien will be cured. We also find that the longer the senior mortgage payments are past due, the more likely the junior lien will be cured. In all, the results are very consistent with Table 3, with one exception. When we interact the continuous *AVM* wealth measure with the *Recourse* dummy, the coefficient is not significant (although it is still negative). That is, by changing the wealth measure from a dichotomous variable to a continuous metric, we find results suggesting that being a wealthy borrower in a recourse state does not change the likelihood of the junior lien being cured. Since this result is in conflict with our results from Table 3, we perform an additional analysis with a different wealth measure that may be informative.

Insert Table 5

In Table 5, we introduce an alternative wealth measure, to help resolve the disagreement in our models presented in Tables 3 and 4. AVM may not be the best measure of wealth, since different locations have different average property values. To explain, a borrower with a $300,000 property in Kansas may not have the same level of wealth as a borrower with a $300,000 property in New York City. Accordingly, we create a measure of wealth based on average property sale price in the borrowers' zip code and year. This measure, *HighPrice,* takes the value of 1 if the borrower's AVM is greater than twice the average sales price in the zip code, and zero otherwise. We also interact this wealth measure with the *Recourse* dummy. Our previous results for outstanding loan balance, time the senior mortgage payment is past due, degree to which the mortgage is underwater, are robust to this alternative specification. We now find highly significant results for both the *HighPrice* wealth measure and the *HighPrice*Recourse* interacted variable. Our results suggest that wealthy borrowers are more likely to cure their junior liens, but that effect is diminished if the borrower is in a recourse state.

Insert Table 6

Next, we consider the possibility that our results may be sensitive to the accuracy of the AVM in Table 6. At the suggestion of Equifax executives, we limit our sample to observations that have an AVM confidence score greater than 0.6. Since AVM plays an important role in all of our wealth measures, we now conduct a robustness check for sensitivity to AVM confidence score. We use our main model, Table 3, Model 1, by confidence score quartile. We find that our results are not related to AVM confidence score, discounting AVM heteroskedasticity as a deterministic explanatory variable in our model.

Insert Table 7

In Table 7, Model 14, we allow for a non-linear relation between debt balances and junior lien cure, by including the squared terms of *Balance Open Installment*, *Balance Open Revolving*, *Balance Sr Mortgage*, and *Balance Jr Mortgage*, represented as *Balance Open Installment^2*, *Balance Open Revolving^2*, *Balance Sr Mortgage^2*, and *Balance Jr Mortgage^2*, respectively. All the squared terms are significant except for *Balance Open Installment^2*, which provides further confirmation that installment debt does not contribute to the cure of a junior lien. In the original model (Table 3, Model 1), *Balance Open Revolving* had a negative coefficient. As in the main model, *Balance Sr Mortgage* has a significant negative coefficient, but its squared term has a positive coefficient, which implies that the negative relation between the senior lien balance and the junior lien cure is at a decreasing rate. Although *Balance Jr Mortgage* is no longer significant, it is still positive. Furthermore, the squared term for *Balance Jr Mortgage* is positive and significant, confirming the results of the original model. In Model 15, we also interact the wealth term, *AVM300up* with *Sr Cure Flag*. Both *Sr Cure Flag* and the interacted term are positive and highly significant, suggesting that wealth magnifies the positive contribution of curing the senior mortgage to curing the junior lien.

Insert Table 8

As a final robustness check, we winsorize all continuous variables at 1% and 99%. The results, presented in Table 8, remain unchanged.

Insert Table 9

Applying the Model

Having determined the factors that influence cure rates of second liens, we now seek to evaluate the economic value of the model. Loutskina and Strahan (2011) finds that informed investors are better able to evaluate risk and therefore generate higher profits. Accordingly, they argue that informed investors tend to focus on the jumbo mortgage market and on higher-risk borrowers. The current sample of previously defaulted, second liens certainly qualifies as a high-risk segment of the secondary loan market. Since there is some evidence that low-quality loans are more likely than high-quality loans to be sold on the secondary market (Keys *et al.*, 2010), having a model to provide information about which loans to purchase, should be especially valuable for any distressed debt investor. So, in this simple setup, investors with our model results are informed, while those without are not.

Table 9 illustrates returns for informed and uninformed investors using the loan cohort of 2009, in both tabular and graphical form. Estimated payoffs per loan are calculated by multiplying the balance of the junior lien as of March 31, 2009 by the probability of cure from the main model (Model 1 of Table 3) multiplied by 0.80, to reflect that the full loan balance may not be recovered[8]. Estimated returns are calculated by subtracting 1 from the estimated payoff divided by the estimated loan cost. The estimated loan cost is calculated by multiplying the loan cost per dollar (ranging from 0.05 to 0.40) by the March 2009 loan balance. We assume that uninformed investors are unable to discern loan quality and buy all loans in the 2009 cohort, while informed investors use the information from the model to choose only the 2009 cohort loans that have either a 50% or 80% probability of curing, depending on their risk appetite.

We find that if the investor buys loans for five cents on the dollar, both uninformed and informed investors are able to earn very large positive returns, although informed investors outperform uninformed investors by a wide margin. At this low price, uninformed investors earn an average return of 482%, but informed investors who purchase loans with greater than 50% chance of curing earn an average return of 1111%. If the investor only buys loans with greater than 80%

[8] So, for example, an investor could provide some amount of principal reduction for the borrower (here we assume 20%) as an inducement to bring the loan current.

probability of curing, the return increases to 1336%. During the 2008 financial crisis, investors were fleeing any sort of mortgage risk but since the recovery in the real estate markets, we have been told by market participants that prices are closer to 0.40 on the dollar. Using this higher cost, uninformed investors would experiences losses with an average return of -27%, while informed investors would still have healthy 51% and 80% returns using loan cure probabilities greater than 50% and 80%, respectively. Although we are focusing on second liens, these results are similar to the Jiang *et al.* (2014) finding that investors in the secondary mortgage market have better performance than banks in the primary market due to increased information. Using superior information, the investors in the secondary mortgage market are more able to select better credits.

4. Conclusion

Loans in default remain a great concern for borrowers, lenders, and policymakers alike. Understanding the factors that contribute to cure rates on defaulted junior lien is, therefore, an important issue. Using a unique and proprietary dataset of borrowers who have defaulted on their junior liens, we find strong evidence that borrowers who cured the senior loan are significantly more likely to cure their junior liens than those who have not. Since resources attempting to cure second loans in default may be limited, efforts aimed at curing these loans may most efficiently be directed toward borrowers who have already cured their senior liens. Additionally, those that have lower balances on revolving debt and higher outstanding junior lien balances are more likely to cure their loans. Consistent with previous literature, our results also demonstrate the value of information in distressed debt markets. As expected, application of a predictive model such as we present, increases investment returns. We reserve the topic of senior loan cure rates for a subsequent research project.

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Tables

Table 1: Descriptive Statistics

This table provides descriptive statistics for study variables. *Jr Cure Flag* and *Sr Cure Flag* are dichotomous variables that take the value of one if the junior or senior mortgage lien, respectively is cured as of the observation date and zero otherwise. *Balance Open Installment* and *Balance Open Revolving* are the natural logarithms of all unpaid installment loans and revolving debt, respectively for each borrower – year observation. *Balance Sr Mortgage* and *Balance Jr Mortgage* are the natural logarithms of senior and junior mortgage, respectively. *Mortgage 30 dpd, Mortgage 60 dpd,* and *Mortgage 120 dpd* are dichotomous variables that take the value of one if the senior mortgage is between 30 and 59 days past due, between 60 and 119 days past due or 120 and over days past due, respectively. *Foreclosure rate* is the natural logarithm of the rate of foreclosures for mortgages of the zip code in which the borrower's property is located for 2009, obtained from CoreLogic. *Piggyback* is a dichotomous variable that takes the value of one if the junior lien and senior lien were issued within 30 days of each other. *AVM300up* is a dichotomous variable that takes the value of one if the AVM is at least $300,000 and zero otherwise. *CLTV100up*, *CLTV150up*, and *CLTV200up* take the value of one if the ratio of original loan amount of the junior lien plus the original loan amount of the senior lien to AVM is at least 100%, 150%, or 200%, respectively. There are 132,320 observations for all variables.

Variables	Mean	SD	Min	Max
Jr Cure Flag	0.460	0.498	0	1.000
Sr Cure Flag	0.380	0.485	0	1.000
Balance Open Installment	6.409	4.978	0	15.590
Balance Open Revolving	7.478	3.810	0	13.970
Balance Sr Mortgage	11.650	1.475	0	16.120
Balance Jr Mortgage	10.620	1.373	0	16.120
Mortgage 30 dpd	0.135	0.342	0	1.000
Mortgage 60 dpd	0.052	0.222	0	1.000
Mortgage 120 dpd	0.184	0.388	0	1.000
Foreclosure rate	0.031	0.029	0	0.259
Piggyback	0.031	0.172	0	1.000
AVM300up	0.218	0.413	0	1.000
CLTV100up	0.597	0.490	0	1.000
CLTV150up	0.203	0.402	0	1.000
CLTV200up	0.081	0.273	0	1.000

Table 2: Pearson/Spearman correlation matrix

This table provides correlations for study variables with Spearman's correlations reported above the diagonal and Pearson's correlations reported below the diagonal. *Jr Cure Flag* and *Sr Cure Flag* are dichotomous variables that take the value of one if the junior or senior mortgage lien, respectively is cured as of the observation date and zero otherwise. *Balance Open Installment* and *Balance Open Revolving* are the natural logarithms of all unpaid installment loans and revolving debt, respectively for each borrower – year observation. *Balance Sr Mortgage* and *Balance Jr Mortgage* are the natural logarithms of senior and junior mortgage, respectively. *Mortgage 30 dpd*, *Mortgage 60 dpd*, and *Mortgage 120 dpd* are dichotomous variables that take the value of one if the senior mortgage is between 30 and 59 days past due, between 60 and 119 days past due or 120 and over days past due, respectively. *Foreclosure rate* is the natural logarithm of the rate of foreclosures for mortgages of the zip code in which the borrower's property is located for 2009, obtained from CoreLogic. *Piggyback* is a dichotomous variable that takes the value of one if the junior lien and senior lien were issued within 30 days of each other. *AVM300up* is a dichotomous variable that takes the value of one if the AVM is at least $300,000 and zero otherwise. *CLTV100up*, *CLTV150up*, and *CLTV200up* take the value of one if the ratio of original loan amount of the junior lien plus the original loan amount of the senior lien to AVM is at least 100%, 150%, or 200%, respectively. There are 132,320 observations for all variables.

	Jr Cure Flag	*Sr Cure Flag*	*Balance Open Installment*	*Balance Open Revolving*	*Balance Sr Mortgage*	*Balance Jr Mortgage*	*Mortgage 30 dpd*	*Mortgage 60 dpd*	*Mortgage 120 dpd*	*Foreclosure rate*	*Piggyback*	*AVM300 up*	*CLTV100up*	*CLTV150up*	*CLTV200up*
Jr Cure Flag	1	0.5058	-0.0462	-0.2573	0.0034	-0.0292	0.1287	0.1185	0.209	0.0128	0.0041	-0.0158	0.0178	0.0191	0.018
Sr Cure Flag	0.5058	1	-0.0047	-0.1024	-0.0157	-0.0375	-0.0013	0.026	-0.0159	-0.028	-0.014	-0.0032	-0.0341	-0.0337	-0.0245
Balance Open Installment	-0.0387	-0.002	1	0.1896	0.0847	0.0564	0.0246	0.0036	-0.133	-0.057	-0.0064	0.0219	0.0675	-0.0114	-0.0264
Balance Open Revolving	-0.2019	-0.062	0.1591	1	0.1856	0.2767	-0.0969	-0.0801	-0.2867	-0.0795	-0.0194	0.2022	-0.0332	-0.0666	-0.066
Balance Sr Mortgage	-0.012	-0.0072	0.0245	0.1008	1	0.3827	-0.0204	0.004	0.0746	-0.0504	-0.0095	0.4987	0.1812	0.0784	0.0302
Balance Jr Mortgage	-0.0025	0.0054	0.0194	0.1799	0.1038	1	-0.0342	-0.0134	0.0269	-0.0124	0.0274	0.4368	0.1221	0.0753	0.0262
Mortgage 30 days past due	0.1287	-0.0013	0.028	-0.0652	-0.0033	-0.0217	1	0.0523	-0.0837	-0.0194	-0.0061	-0.0196	-0.0047	-0.0141	-0.0118
Mortgage 60 dpd	0.1185	0.026	0.0065	-0.0613	0.0077	-0.0131	0.0523	1	-0.0239	-0.0013	0.0093	-0.0066	0.0084	0.0007	-0.0004
Mortgage 120 dpd	0.209	-0.0159	-0.1273	-0.2822	0.0045	-0.0013	-0.0837	-0.0239	1	0.1177	0.0713	0.0023	0.1131	0.1511	0.126
Foreclosure rate	0.0038	-0.0318	-0.0465	-0.0555	-0.0346	-0.002	-0.0257	-0.003	0.1153	1	0.0058	-0.1686	0.2515	0.3213	0.2379
Piggyback	0.0041	-0.014	-0.0083	-0.0195	-0.0449	-0.0021	-0.0061	0.0093	0.0713	0.0062	1	0.0191	0.0118	0.0368	0.032
AVM300up	-0.0158	-0.0032	-0.0162	0.1575	0.248	0.3033	-0.0196	-0.0066	0.0023	-0.1545	0.0191	1	-0.2044	-0.1791	-0.1318
CLTV100up	0.0178	-0.0341	0.0591	-0.0256	0.1408	0.125	-0.0047	0.0084	0.1131	0.2032	0.0118	-0.2044	1	0.4149	0.2442
CLTV150up	0.0191	-0.0337	-0.0123	-0.0621	0.0637	0.0686	-0.0141	0.0007	0.1511	0.3097	0.0368	-0.1791	0.4149	1	0.5887
CLTV200up	0.018	-0.0245	-0.0252	-0.0629	0.0371	0.0293	-0.0118	-0.0004	0.126	0.2523	0.032	-0.1318	0.2442	0.5887	1

Table 3: Determinants of Jr Cure - Main Model

This table reports the results of logistic regressions with *Jr Cure Flag* as the dependent variable and wealth measured by *AVM300up*. Panel A reports the coefficients and standard errors. Panel B reports average marginal effects for highly significant (1%) variables..*Jr Cure Flag* and *Sr Cure Flag* are dichotomous variables that take the value of one if the junior or senior mortgage lien, respectively is cured as of the observation date and zero otherwise. *Balance Open Installment* and *Balance Open Revolving* are the natural logarithms of all unpaid installment loans and revolving debt, respectively for each borrower – year observation. *Balance Sr Mortgage* and *Balance Jr Mortgage* are the natural logarithms of senior and junior mortgage, respectively. *Mortgage 30 dpd, Mortgage 60 dpd,* and *Mortgage 120 dpd* are dichotomous variables that take the value of one if the senior mortgage is between 30 and 59 days past due, between 60 and 119 days past due or 120 and over days past due, respectively. *Foreclosure rate* is the natural logarithm of the rate of foreclosures for mortgages of the zip code in which the borrower's property is located for 2009, obtained from CoreLogic. *Piggyback* is a dichotomous variable that takes the value of one if the junior lien and senior lien were issued within 30 days of each other. *AVM300up* is a dichotomous variable that takes the value of one if the AVM is at least $300,000 and zero otherwise. *CLTV100up, CLTV150up,* and *CLTV200up* take the value of one if the ratio of original loan amount of the junior lien plus the original loan amount of the senior lien to AVM is at least 100%, 150%, or 200%, respectively. *Recourse* is a dichotomous variable that takes the value of one if the loan is in a recourse state and zero otherwise. State and loan vintage fixed effects are included. Standard errors in parentheses; *** p<0.01, **p<0.05, * p<0.1

Panel A: Coefficients and standard errors

Variable	(1) CLTV 100% AVM dummy	(2) CLTV 150% AVM dummy	(3) CLTV 200% AVM dummy
Balance Open Installment	-0.000401	9.61e-05	0.000128
	(0.00142)	(0.00141)	(0.00141)
Balance Open Revolving	-0.0772***	-0.0773***	-0.0773***
	(0.00196)	(0.00196)	(0.00196)
Balance Sr Mortgage	-0.0154***	-0.0108**	-0.0103**
	(0.00504)	(0.00498)	(0.00496)
Balance Jr Mortgage	0.0400***	0.0448***	0.0454***
	(0.00554)	(0.00550)	(0.00547)
Mortgage 30 dpd	1.175***	1.176***	1.176***
	(0.0203)	(0.0203)	(0.0203)
Mortgage 60 dpd	1.350***	1.352***	1.352***
	(0.0321)	(0.0321)	(0.0321)
Mortgage 120 dpd	1.531***	1.535***	1.536***
	(0.0193)	(0.0194)	(0.0194)
Foreclosure rate	0.350	0.502	0.548
	(0.359)	(0.363)	(0.362)
Piggyback	-0.0605	-0.0652	-0.0650
	(0.0405)	(0.0405)	(0.0405)
AVM300up	0.0570*	0.0398	0.0359
	(0.0334)	(0.0335)	(0.0333)
*AVM300up*Recourse*	-0.0983**	-0.105***	-0.104***
	(0.0396)	(0.0397)	(0.0397)
CLTV100up	0.0919***		
	(0.0163)		
CLTV150up		0.0295	
		(0.0195)	
CLTV200up			0.0265
			(0.0270)
Sr Cure Flag	2.616***	2.615***	2.614***
	(0.0151)	(0.0151)	(0.0151)
Constant	-2.517**	-2.603**	-2.614**
	(1.053)	(1.055)	(1.055)
Observations	132,320	132,320	132,320
State FE	YES	YES	YES
Vintage FE	YES	YES	YES
Pseudo R-squared	0.286	0.286	0.286
Area Under ROC Curve	0.844	0.844	0.844

Panel B: Average Marginal Effects for highly significant (1%) variables in the main model

Variable	Model 1
Balance Open Revolving	-0.012
Balance Sr Mortgage	-0.002
Balance Jr Mortgage	0.006
Mortgage 30 dpd	0.189
Mortgage 60 dpd	0.217
Mortgage 120 dpd	0.246
CLTV100up	0.015
Sr Cure Flag	0.420

Table 4: Determinants of Jr Cure - Continuous wealth measure

This table reports the results of logistic regressions with *Jr Cure Flag* as the dependent variable and wealth measured by *AVM*. *Jr Cure Flag* and *Sr Cure Flag* are dichotomous variables that take the value of one if the junior or senior mortgage lien, respectively is cured as of the observation date and zero otherwise. *Balance Open Installment* and *Balance Open Revolving* are the natural logarithms of all unpaid installment loans and revolving debt, respectively for each borrower – year observation. *Balance Sr Mortgage* and *Balance Jr Mortgage* are the natural logarithms of senior and junior mortgage, respectively. *Mortgage 30 dpd, Mortgage 60 dpd,* and *Mortgage 120 dpd* are dichotomous variables that take the value of one if the senior mortgage is between 30 and 59 days past due, between 60 and 119 days past due or 120 and over days past due, respectively. *Foreclosure rate* is the natural logarithm of the rate of foreclosures for mortgages of the zip code in which the borrower's property is located for 2009, obtained from CoreLogic. *Piggyback* is a dichotomous variable that takes the value of one if the junior lien and senior lien were issued within 30 days of each other. *AVM* is the natural logarithm of AVM. *CLTV100up*, *CLTV150up*, and *CLTV200up* take the value of one if the ratio of original loan amount of the junior lien plus the original loan amount of the senior lien to AVM is at least 100%, 150%, or 200%, respectively. *Recourse* is a dichotomous variable that takes the value of one if the loan is in a recourse state and zero otherwise. State and loan vintage fixed effects are included. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

VARIABLES	(4) CLTV 100% AVM cont	(5) CLTV 150% AVM cont	(6) CLTV 200% AVM cont
Balance Open Installment	-0.000417	0.000166	0.000199
	(0.00142)	(0.00141)	(0.00141)
Balance Open Revolving	-0.0777***	-0.0775***	-0.0775***
	(0.00196)	(0.00196)	(0.00196)
Balance Sr Mortgage	-0.0192***	-0.0123**	-0.0114**
	(0.00522)	(0.00514)	(0.00511)
Balance Jr Mortgage	0.0354***	0.0428***	0.0439***
	(0.00573)	(0.00569)	(0.00563)
Mortgage 30 days past due	1.175***	1.176***	1.176***
	(0.0203)	(0.0203)	(0.0203)
Mortgage 60 dpd	1.350***	1.352***	1.352***
	(0.0321)	(0.0321)	(0.0321)
Mortgage 120 dpd	1.529***	1.534***	1.535***
	(0.0193)	(0.0194)	(0.0194)
Foreclosure rate	0.518	0.554	0.587
	(0.368)	(0.370)	(0.369)
Piggyback	-0.0629	-0.0665	-0.0659
	(0.0405)	(0.0405)	(0.0405)
AVM	0.0563**	0.0294	0.0241
	(0.0258)	(0.0260)	(0.0257)
*AVM*Recourse*	-0.0380	-0.0392	-0.0386
	(0.0274)	(0.0274)	(0.0274)
CLTV100up	0.107***		
	(0.0174)		
CLTV150up		0.0323	
		(0.0211)	
CLTV200up			0.0243
			(0.0288)
Sr Cure flag	2.616***	2.615***	2.614***
	(0.0151)	(0.0151)	(0.0151)
Constant	-3.112***	-2.927***	-2.883***
	(1.095)	(1.097)	(1.097)
Observations	132,320	132,320	132,320
State FE	YES	YES	YES
Vintage FE	YES	YES	YES
Pseudo R-squared	0.286	0.286	0.285
Area Under ROC Curve	0.844	0.844	0.844

Table 5 Determinants of Jr Cure - Zip-code adjusted wealth measure

This table reports the results of logistic regressions with *Jr Cure Flag* as the dependent variable and wealth measured by *HighPrice*. *Jr Cure Flag* and *Sr Cure Flag* are dichotomous variables that take the value of one if the junior or senior mortgage lien, respectively is cured as of the observation date and zero otherwise. *Balance Open Installment* and *Balance Open Revolving* are the natural logarithms of all unpaid installment loans and revolving debt, respectively for each borrower – year observation. *Balance Sr Mortgage* and *Balance Jr Mortgage* are the natural logarithms of senior and junior mortgage, respectively. *Mortgage 30 dpd*, *Mortgage 60 dpd*, and *Mortgage 120 dpd* are dichotomous variables that take the value of one if the senior mortgage is between 30 and 59 days past due, between 60 and 119 days past due or 120 and over days past due, respectively. *Foreclosure rate* is the natural logarithm of the rate of foreclosures for mortgages of the zip code in which the borrower's property is located for 2009, obtained from CoreLogic. *Piggyback* is a dichotomous variable that takes the value of one if the junior lien and senior lien were issued within 30 days of each other. *HighPrice* a dichotomous variable takes the value of one if the sum of the senior and junior liens' original balances is greater than two times the average home sale price for the zip code and year, and zero otherwise. *CLTV100up*, *CLTV150up*, and *CLTV200up* take the value of one if the ratio of original loan amount of the junior lien plus the original loan amount of the senior lien to AVM is at least 100%, 150%, or 200%, respectively. *Recourse* is a dichotomous variable that takes the value of one if the loan is in a recourse state and zero otherwise. State and loan vintage fixed effects are included. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Variable	(7) CLTV 100% Zip-adj wealth	(8) CLTV 150% Zip-adj wealth	(9) CLTV 200% Zip-adj wealth
Balance Open Installment	-0.000426	0.000113	0.000139
	(0.00142)	(0.00141)	(0.00141)
Balance Open Revolving	-0.0772***	-0.0775***	-0.0776***
	(0.00195)	(0.00195)	(0.00195)
Balance Sr Mortgage	-0.0166***	-0.0130***	-0.0128***
	(0.00495)	(0.00491)	(0.00491)
Balance Jr Mortgage	0.0389***	0.0424***	0.0427***
	(0.00542)	(0.00539)	(0.00538)
Mortgage 30 dpd	1.175***	1.176***	1.176***
	(0.0203)	(0.0203)	(0.0203)
Mortgage 60 dpd	1.351***	1.352***	1.352***
	(0.0321)	(0.0321)	(0.0321)
Mortgage 120 dpd	1.529***	1.532***	1.533***
	(0.0193)	(0.0194)	(0.0194)
Foreclosure rate	0.220	0.441	0.486
	(0.362)	(0.364)	(0.362)
Piggyback	-0.0614	-0.0673*	-0.0673*
	(0.0405)	(0.0405)	(0.0405)
HighPrice	0.116***	0.123***	0.128***
	(0.0383)	(0.0388)	(0.0387)
*HighPrice *Recourse*	-0.140***	-0.142***	-0.144***
	(0.0436)	(0.0437)	(0.0436)
CLTV100up	0.0922***		
	(0.0160)		
CLTV150up		0.0242	
		(0.0199)	
CLTV200up			0.0178
			(0.0276)
Sr Cure flag	2.616***	2.615***	2.615***
	(0.0151)	(0.0151)	(0.0151)
Constant	-2.491**	-2.564**	-2.571**
	(1.053)	(1.054)	(1.054)
Observations	132,320	132,320	132,320
State FE	YES	YES	YES
Vintage FE	YES	YES	YES
Pseudo R-squared	0.286	0.286	0.286
Area Under ROC Curve	0.844	0.844	0.844

Table 6: Determinants of Jr Cure - Robustness check - Main Model by AVM Confidence Score Quartile

This table reports the results of logistic regressions by AVM confidence score quartile with *Jr Cure Flag* as the dependent variable and wealth measured by *AVM300up*. *Jr Cure Flag* and *Sr Cure Flag* are dichotomous variables that take the value of one if the junior or senior mortgage lien, respectively is cured as of the observation date and zero otherwise. *Balance Open Installment* and *Balance Open Revolving* are the natural logarithms of all unpaid installment loans and revolving debt, respectively for each borrower – year observation. *Balance Sr Mortgage* and *Balance Jr Mortgage* are the natural logarithms of senior and junior mortgage, respectively. *Mortgage 30 dpd, Mortgage 60 dpd*, and *Mortgage 120 dpd* are dichotomous variables that take the value of one if the senior mortgage is between 30 and 59 days past due, between 60 and 119 days past due or 120 and over days past due, respectively. *Foreclosure rate* is the natural logarithm of the rate of foreclosures for mortgages of the zip code in which the borrower's property is located for 2009, obtained from CoreLogic. *Piggyback* is a dichotomous variable that takes the value of one if the junior lien and senior lien were issued within 30 days of each other. *AVM300up* is a dichotomous variable that takes the value of one if the AVM is at least $300,000 and zero otherwise. *CLTV100up, CLTV150up,* and *CLTV200up* take the value of one if the ratio of original loan amount of the junior lien plus the original loan amount of the senior lien to AVM is at least 100%, 150%, or 200%, respectively. *Recourse* is a dichotomous variable that takes the value of one if the loan is in a recourse state and zero otherwise. State and loan vintage fixed effects are included. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

	(10)	(11)	(12)	(13)
VARIABLES	cs_quart=1	cs_quart=2	cs_quart=3	cs_quart=4
Balance Open Installment	-0.00218	0.00445*	-0.00458	-0.00106
	(0.00267)	(0.00270)	(0.00325)	(0.00285)
Balance Open Revolving	-0.0705***	-0.0850***	-0.0752***	-0.0786***
	(0.00359)	(0.00376)	(0.00456)	(0.00398)
Balance Sr Mortgage	-0.0115	-0.00799	-0.0313***	-0.0164
	(0.00970)	(0.00959)	(0.0116)	(0.00999)
Balance Jr Mortgage	0.0282***	0.0567***	0.0259**	0.0438***
	(0.0103)	(0.0108)	(0.0126)	(0.0112)
Mortgage 30 dpd	1.141***	1.137***	1.226***	1.226***
	(0.0372)	(0.0390)	(0.0469)	(0.0412)
Mortgage 60 dpd	1.370***	1.325***	1.344***	1.370***
	(0.0604)	(0.0619)	(0.0738)	(0.0633)
Mortgage 120 dpd	1.493***	1.515***	1.572***	1.564***
	(0.0370)	(0.0366)	(0.0443)	(0.0386)
Foreclosure rate	-0.226	0.137	0.976	1.036
	(0.650)	(0.666)	(0.849)	(0.812)
Piggyback	-0.0162	-0.0275	-0.0762	-0.119
	(0.0793)	(0.0779)	(0.0935)	(0.0769)
AVM300up	-0.0496	0.0324	0.0727	0.130**
	(0.0786)	(0.0611)	(0.0704)	(0.0641)
*AVM300up*Recourse*	-0.0134	-0.118	-0.0342	-0.151*
	(0.0893)	(0.0728)	(0.0851)	(0.0775)
CLTV100up	0.0858***	0.102***	0.130***	0.0675**
	(0.0309)	(0.0315)	(0.0376)	(0.0328)
Sr Cure flag	2.624***	2.630***	2.663***	2.582***
	(0.0283)	(0.0291)	(0.0350)	(0.0304)
Constant	-1.867	-14.98	-0.791	9.134
	(1.426)	(532.5)	(1.631)	(637.5)
Observations	37,670	36,364	25,466	32,810
State FE	YES	YES	YES	YES
Vintage FE	YES	YES	YES	YES
Pseudo R-squared	0.285	0.287	0.292	0.285
Area Under ROC Curve	0.844	0.846	0.846	0.844

Table 7: Determinants of Jr Cure - Robustness check - Non-linear Effects

This table reports the results of logistic regressions with *Jr Cure Flag* as the dependent variable and wealth measured by *AVM300up*. *Jr Cure Flag* and *Sr Cure Flag* are dichotomous variables that take the value of one if the junior or senior mortgage lien, respectively is cured as of the observation date and zero otherwise. *Balance Open Installment* and *Balance Open Revolving* are the natural logarithms of all unpaid installment loans and revolving debt, respectively for each borrower – year observation. *Balance Sr Mortgage* and *Balance Jr Mortgage* are the natural logarithms of senior and junior mortgage, respectively. The squared terms of *Balance* variables are included to allow for non-linearity. *Mortgage 30 dpd, Mortgage 60 dpd,* and *Mortgage 120 dpd* are dichotomous variables that take the value of one if the senior mortgage is between 30 and 59 days past due, between 60 and 119 days past due or 120 and over days past due, respectively. *Foreclosure rate* is the natural logarithm of the rate of foreclosures for mortgages of the zip code in which the borrower's property is located for 2009, obtained from CoreLogic. *Piggyback* is a dichotomous variable that takes the value of one if the junior lien and senior lien were issued within 30 days of each other. *AVM300up* is a dichotomous variable that takes the value of one if the AVM is at least $300,000 and zero otherwise. *CLTV100up*, *CLTV150up*, and *CLTV200up* take the value of one if the ratio of original loan amount of the junior lien plus the original loan amount of the senior lien to AVM is at least 100%, 150%, or 200%, respectively. *Recourse* is a dichotomous variable that takes the value of one if the loan is in a recourse state and zero otherwise. State and loan vintage fixed effects are included. Standard errors in parentheses; *** p<0.01, **p<0.05, * p<0.1

Variable	(14) CLTV 100% AVM dummy	(15) CLTV 100% AVM dummy
Balance Open Installment	0.0139	0.0140
	(0.0102)	(0.0102)
Balance Open Revolving	0.196***	0.196***
	(0.00709)	(0.00710)
Balance Sr Mortgage	-0.101***	-0.101***
	(0.0170)	(0.0170)
Balance Jr Mortgage	0.0152	0.0144
	(0.0167)	(0.0167)
Balance Open Installment^2	-0.00125	-0.00126
	(0.000962)	(0.000963)
Balance Open Revolving^2	-0.0269***	-0.0270***
	(0.000677)	(0.000677)
Balance Sr Mortgage^2	0.00698***	0.00700***
	(0.00120)	(0.00120)
Balance Jr Mortgage^2	0.00298***	0.00305***
	(0.00110)	(0.00110)
Mortgage 30 dpd	1.108***	1.108***
	(0.0204)	(0.0204)
Mortgage 60 dpd	1.282***	1.282***
	(0.0322)	(0.0322)
Mortgage 120 dpd	1.444***	1.444***
	(0.0195)	(0.0195)
Foreclosure rate	0.232	0.223
	(0.363)	(0.362)
Piggyback	-0.0574	-0.0573
	(0.0407)	(0.0408)
AVM300up	0.0471	-0.00241
	(0.0352)	(0.0375)
*AVM300up*Recourse*	-0.0778*	-0.0835**
	(0.0401)	(0.0404)
CLTV100up	0.0548***	0.0551***
	(0.0170)	(0.0170)
*Sr Cure flag*AVM300up*		0.138***
		(0.0351)
Sr Cure flag	2.593***	2.564***
	(0.0153)	(0.0170)
Constant	-2.731**	-2.730**
	(1.094)	(1.095)
Observations	132,320	132,320
State FE	YES	YES
Vintage FE	YES	YES
Pseudo R-squared	0.295	0.295
Area Under ROC Curve	0.848	0.848

Table 8: Determinants of Jr Cure - Robustness check - Continuous variables winsorized at 1% and 99%

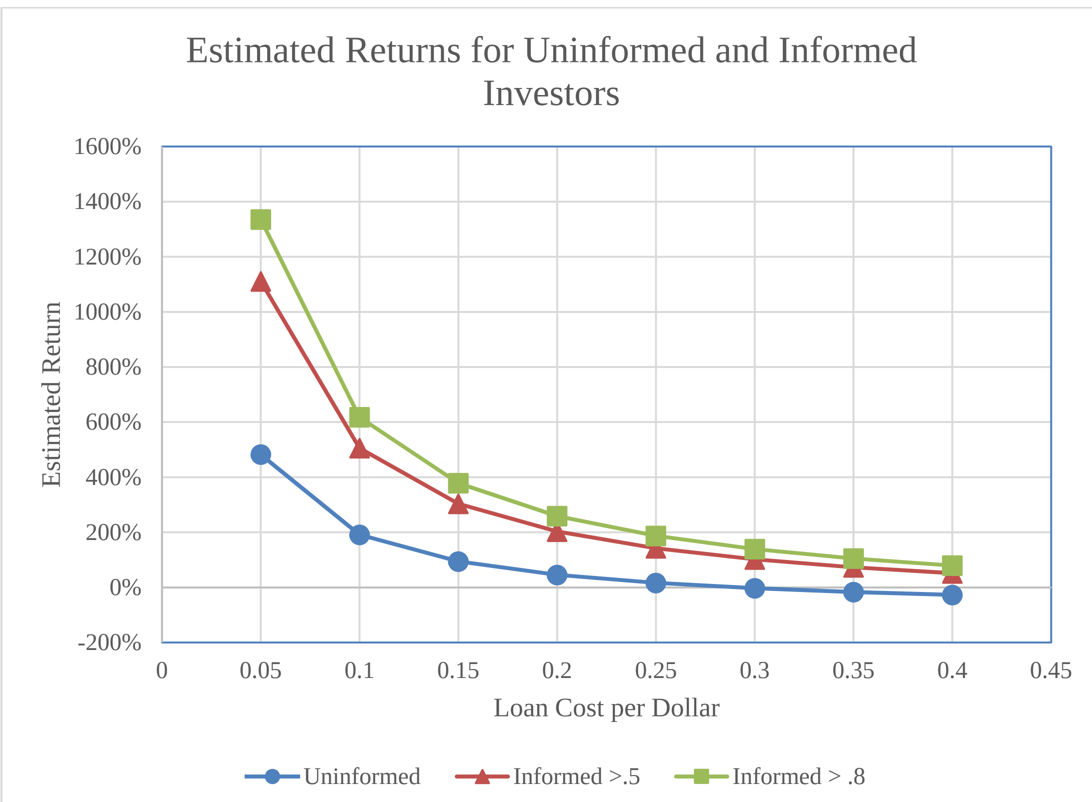
This table reports the results of logistic regressions by AVM confidence score quartile with *Jr Cure Flag* as the dependent variable and wealth measured by *AVM300up*. *Jr Cure Flag* and *Sr Cure Flag* are dichotomous variables that take the value of one if the junior or senior mortgage lien, respectively is cured as of the observation date and zero otherwise. *Balance Open Installment_w* and *Balance Open Revolving_w* are the natural logarithms of all unpaid installment loans and revolving debt, respectively for each borrower – year observation, winsorized at 1% and 99%. *Balance Sr Mortgage_w* and *Balance Jr Mortgage_w* are the natural logarithms of senior and junior mortgage, respectively winsorized at 1% and 99%. *Mortgage 30 dpd*, *Mortgage 60 dpd*, and *Mortgage 120 dpd* are dichotomous variables that take the value of one if the senior mortgage is between 30 and 59 days past due, between 60 and 119 days past due or 120 and over days past due, respectively. *Foreclosure rate_w* is the natural logarithm of the rate of foreclosures for mortgages of the zip code in which the borrower's property is located for 2009, obtained from CoreLogic and winsorized at 1% and 99%. *Piggyback* is a dichotomous variable that takes the value of one if the junior lien and senior lien were issued within 30 days of each other. *AVM300up* is a dichotomous variable that takes the value of one if the AVM is at least $300,000 and zero otherwise. *CLTV100up*, *CLTV150up*, and *CLTV200up* take the value of one if the ratio of original loan amount of the junior lien plus the original loan amount of the senior lien to AVM is at least 100%, 150%, or 200%, respectively. *Recourse* is a dichotomous variable that takes the value of one if the loan is in a recourse state and zero otherwise. State and loan vintage fixed effects are included. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Variable	(16) CLTV 100% AVM dummy	(17) CLTV 150% AVM dummy	(18) CLTV 200% AVM dummy
Balance Open Installment_w	-0.000380	0.000109	0.000139
	(0.00142)	(0.00141)	(0.00141)
Balance Open Revolving_w	-0.0772***	-0.0774***	-0.0775***
	(0.00197)	(0.00197)	(0.00197)
Balance Sr Mortgage_w	-0.0140***	-0.00920*	-0.00874*
	(0.00507)	(0.00500)	(0.00498)
Balance Jr Mortgage_w	0.0483***	0.0567***	0.0578***
	(0.00809)	(0.00797)	(0.00791)
Mortgage 30 dpd	1.175***	1.176***	1.176***
	(0.0203)	(0.0203)	(0.0203)
Mortgage 60 dpd	1.349***	1.351***	1.351***
	(0.0321)	(0.0321)	(0.0321)
Mortgage 120 dpd	1.530***	1.533***	1.534***
	(0.0193)	(0.0194)	(0.0194)
Foreclosure Rate_w	0.396	0.582	0.630
	(0.385)	(0.389)	(0.387)
Piggyback	-0.0651	-0.0702*	-0.0701*
	(0.0405)	(0.0405)	(0.0405)
AVM300up	0.0520	0.0327	0.0290
	(0.0337)	(0.0337)	(0.0336)
*AVM300up*Recourse*	-0.101**	-0.109***	-0.109***
	(0.0397)	(0.0397)	(0.0397)
CLTV100up	0.0915***		
	(0.0165)		
CLTV150up		0.0278	
		(0.0196)	
CLTV200up			0.0255
			(0.0270)
Sr Cure flag	2.618***	2.617***	2.616***
	(0.0151)	(0.0151)	(0.0151)
Constant	-2.633**	-2.763***	-2.779***
	(1.053)	(1.054)	(1.054)
Observations	132,320	132,320	132,320
State FE	YES	YES	YES
Vintage FE	YES	YES	YES
Pseudo R-squared	0.286	0.285	0.285
Area Under ROC Curve	0.844	0.844	0.844

Table 9: Estimated Returns for Uninformed and Informed Investors

This table reports the mean estimated returns for uninformed investors and informed investors using the study's main model. The estimated payoff for each loan is calculated as the balance of the junior lien as of March 31, 2009, multiplied by the probability of cure (from Model 1 of Table 3) multiplied by 0.80 (assuming 80% of the loan balance is recovered). Estimated returns are calculated by subtracting 1 from the estimated payoff divided by estimated loan cost. The estimated loan cost is calculated by multiplying the loan cost per dollar (ranging from 0.05 to 0.40) by the March 2009 loan balance. The table assumes that uninformed investors buy all loans in the 2009 cohort and that informed investors buy only loans in the 2009 cohort that have a higher than 50% or 80% probability of curing.

	Mean Estimated Return							
Loan Cost per Dollar	**0.05**	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**	**0.35**	**0.40**
Uninformed investor	482%	191%	94%	46%	16%	-3%	-17%	-27%
Informed investor								
Invests only if prob cure>50%	1111%	506%	304%	203%	142%	102%	73%	51%
Invests only if prob cure>80%	1336%	618%	379%	259%	187%	139%	105%	80%



No. 159
Residential Mortgage

On the Effect of Student Loans on Access to Homeownership

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This paper estimates the effect of student loan debt on subsequent homeownership

in a uniquely constructed administrative data set for a nationally representative cohort aged 23 to 31 in 2004 and followed over time, from 1997 to 2010. Our unique data combine anonymized individual credit bureau data with college enrollment histories and school characteristics associated with each enrollment spell, as well as several other data sources. To identify the causal effect of student loans on homeownership, we instrument for the amount of the individual's student loan debt using changes to the in-state tuition rate at public 4-year colleges in the student's home state. We find that a 10 percent increase in student loan debt causes a 1 to 2 percentage point drop in the

homeownership rate for student loan borrowers during the first five years after exiting school. Validity tests suggest that the results are not confounded by local economic conditions or non-random selection into the estimation sample.

Keywords: Credit Constraints, Homeownership, Student Loans

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ON THE EFFECT OF STUDENT LOANS ON ACCESS TO HOMEOWNERSHIP*

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March 1, 2016

Abstract

This paper estimates the effect of student loan debt on subsequent homeownership in a uniquely constructed administrative data set for a nationally representative cohort aged 23 to 31 in 2004 and followed over time, from 1997 to 2010. Our unique data combine anonymized individual credit bureau data with college enrollment histories and school characteristics associated with each enrollment spell, as well as several other data sources. To identify the causal effect of student loans on homeownership, we instrument for the amount of the individual's student loan debt using changes to the in-state tuition rate at public 4-year colleges in the student's home state. We find that a 10 percent increase in student loan debt causes a 1 to 2 percentage point drop in the homeownership rate for student loan borrowers during the first five years after exiting school. Validity tests suggest that the results are not confounded by local economic conditions or non-random selection into the estimation sample. (*JEL* D14, I22, R21)

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1 Introduction

Over the past ten years, the real amount of student debt owed by American households more than doubled, from about $450 billion to more than $1.1 trillion, with average real debt per borrower increasing from about $19,000 to $27,000.[1] During the same period, the U.S. homeownership rate declined markedly amidst the housing market bust and the financial crisis: from 69 percent in 2005 to 64 percent in 2014.[2] The declines in homeownership have been the largest (both in relative and absolute terms) among young households—a population segment that owes the preponderance of the outstanding student loan debt. For example, the homeownership rate for households between ages 24 and 32 declined by 9 percentage points (from 45 to 36 percent) between 2005 and 2014, nearly twice as large as the 5 percentage point drop in homeownership for the overall population. Against this backdrop, market commentary has suggested that increases in student loan debt might be a key factor pushing homeownership rates down in recent years through effects on borrowers' ability to qualify for a mortgage and their desire to take on more debt.[3] Corroborating this claim, recent surveys have found that many young individuals view student loan debt as a major impediment to home buying.[4]

Estimation of the effect of student loan debt on homeownership is complicated by the presence of other factors that influence both student loan borrowing and homeownership decisions. Researchers have previously attempted to isolate the effect by controlling for a set of observable student characteristics (Cooper and Wang (2014) and Houle and Berger

[1]Figures are based on authors' calculation from the NYFed CCP/Equifax data set. Nominal amounts are deflated by CPI-U into constant 2015:Q2 dollars.

[2]Source: Current Population Survey.

[3]For some examples, see "CFPB Director: Student Loans Are Killing the Drive to Buy Homes," *Housing Wire*, May 19, 2014; "Denied? The Impact of Student Loan Debt on the Ability to Buy a House" by J. Mishory and R. O'Sullivan at www.younginvincibles.org.

[4]See, for example, Stone et al. (2012) or "What Younger Renters Want and the Financial Constraints They See," Fannie Mae, May 2014.

(2015)). These studies found only very small negative effects. However, the covariates recorded in available data sets may not adequately control for every important omitted factor, resulting in biased estimates. For example, students preparing for a career with a high expected income might borrow more to fund their college educations and also might be more likely to own a home in the future. To address the endogeneity of student loan debt, in their study of the effects of student loan debt on the future financial stability of student loan borrowers Gicheva and Thompson (2014) use the national average levels of student loan borrowing as an instrument. They find a more meaningful effect size, but identification in their approach may be confounded by other aggregate trends.[5]

In the context of the existing literature, this paper makes two key contributions. First, we use a uniquely constructed administrative data set that combines anonymized individual credit bureau records with Pell Grant and federal student loan recipient information, records on college enrollment, graduation and major, and school characteristics. The core credit bureau data—onto which the other anonymized data sources are merged—are based on a nationally representative sample of individuals who were 23 to 31 years old in 2004 and span the period 1997-2010. The administrative nature of our data likely provides us with more accurate measures of financial variables than self-reported data sets.

Second, we exploit a quasi-natural experiment to estimate the causal effect of changes in student loan debt on the homeownership rate over the first 60 months after the final school exit (where observable factors are measured at the time of the school exit). This eliminates the bias from unobservable factors that might affect estimates identified based solely on observable characteristics. The experiment is generated by increases in average

[5] Other studies, which are mostly based on trend analysis, include Brown et al. (2013), Akers (2014), Mezza et al. (2014); and analyses by TransUnion (Kuipers and Wise (2016)) and Zillow (http://www.zillow.com/research/student-debt-homeownership-10563/).

in-state tuition at public 4-year universities in subjects' states of residence prior to enrolling in post-secondary education (henceforth, home states).[6] In particular, increases in in-state tuition at public 4-year universities increase the amount of student loan borrowing, as a large fraction of post-secondary students attend public universities in their home states. Moreover, since home-state tuition changes are not determined by the choices of any individual student, we claim that these tuition price changes do not affect homeownership decisions through any channel other than increases in student loan debt. This claim is supported by a number of validity tests presented in Section 4.4. Mainly, we show that the estimated effect is not due to endogeneity of the instrument to local economic conditions, and provide evidence that selection along the extensive margin of college attendance cannot explain the results.

We find that the estimated effect from the procedure based only on observable controls is negative but very small, similar to the results from existing studies. In contrast, our estimates based on the quasi-natural experiment indicate a substantially larger reduction in homeownership due to student loan debt. Namely, a 10 percent increase in student loan debt causes a decrease of about 1 to 2 percentage points in the homeownership rate of student loan borrowers immediately upon school exit, relative to a mere 0.1 percentage point decline derived from the procedure based only on observable controls. The causal effect estimated using the natural-experiment framework shows little indication of diminishing across the 60 month window, although the precision of the estimates decreases with time.

To be sure, this paper estimates the effect of a *ceteris paribus* change in debt levels, rather than the effect of a change in access to student loan debt, on future homeownership. In particular, if student loans allow individuals to access college education—or, more broadly, acquire more of it—student loan debt could have a positive effect on homeownership, as long

[6] Relatedly, Bleemer et al. (2014) use state-level tuition measures to instrument for student debt in the context of its effect on parental co-residence.

as the return to this additional education allows individuals to sufficiently increase their future incomes. Given that changes in access to student loan debt could impact the decision to go to college, the type or quality of college attended, and the total educational attainment, such a research question is quite different from the question asked in this paper. Rather, the question we address is: "All else equal, if one were to obtain a certain level of education but at a somewhat lower price (and, consequently, with less debt), how would one's access to homeownership be affected?" Our exercise is similar in spirit to a thought experiment in which a small amount of student loan debt is forgiven upon exiting school, without any effect on individuals' past decisions on post-secondary education acquisition.

The rest of our paper is organized as follows. Section 2 briefly reviews the institutional background of the student loan market and examines the main theoretical channels through which student loan debt likely affects access to homeownership. Section 3 gives an overview of the data set and defines variables used in the analysis. Section 4 analyzes the effect of changes in student loan debt on homeownership using "selection on observables" as well as instrumental variable frameworks, and conducts several validity tests for our instrument. Section 5 interprets and caveats our main findings. Section 6 concludes.

2 Background and Mechanism

2.1 Institutional Background

Student loans are a popular way for Americans to pay the cost of college. Among bachelor's degree recipients who graduated in 2012, 70 percent had accumulated some student debt and 18 percent owed $40,000 or more.[7]

[7] SOURCE: College Board, *Trends in Higher Education: Student Aid* `http://trends.collegeboard.org/student-aid/figures-tables/cumulative-debt-bachelors-recipients-sector-time`.

Every student has access to federal student loans, which generally do not involve underwriting and can charge below market rates[8]. The amount of such loans students can borrow is capped by Congress, however. Federal student loans are also not dischargeable in bankruptcy, reducing the options of borrowers in financial distress.[9] Student borrowers frequently exhaust their available federal loans before moving on to generally more expensive private loans, often with a parent as co-signer.[10] Historically, the typical student loan is fully amortizing over a 10-year term with fixed payments. Deferments and forbearances can extend this term, as can enrollment in alternative repayment plans, such as the extended repayment plan (available for borrowers with high balances) and income-driven repayment plans (which have become more common in recent years and are available for borrowers with elevated debt-to-income ratios), and through loan consolidation.[11]

Student loan debt can impose a significant financial burden on some borrowers. Despite the inability to discharge federal loans through bankruptcy, 14 percent of recipients with outstanding federal student debt were in default as of October 2015.[12] Student borrowers are often young and at a low point in their life cycle earnings profile. The financial difficulties may be more severe for students who fail to graduate. Of the federal student loan borrowers who entered repayment in 2011-12 without a degree, 24 percent defaulted within two years.[13]

[8] Graduate students taking PLUS loans—as well as parents taking Parent PLUS loans—must pass a credit check.

[9] In 2005 the bankruptcy code was amended, making private student loans also not routinely dischargeable in bankruptcy.

[10] The share of loans with a co-signer increased significantly after the financial crisis, from 67 percent in 2008, to over 90 percent in 2011. SOURCE: CFPB, *Private Student Loans*, August, 2012.

[11] SOURCE: `https://studentaid.ed.gov/sa/repay-loans/understand/plans`.

[12] SOURCE: U.S. Department of Education, Federal Student Aid Data Center, Federal Student Loan Portfolio.

[13] SOURCE: U.S. Department of Treasury calculations based on sample data from the National Student Loan Data System.

2.2 Theoretical Mechanism

Most young home buyers must borrow the money to buy their first house. We conjecture that three underwriting factors provide a channel through which student loan debt can affect the borrower's ability to obtain a mortgage. First, the individual must meet a minimum down payment requirement that is proportional to the house value. While a 20 percent down payment is typical for many buyers, with mortgage insurance (whether purchased from a private company or a government agency such as the Federal Housing Administration (FHA)) the down payment can be significantly less.[14] Second, the individual must satisfy a maximum debt-to-income (DTI) ratio requirement, with the ratio of all her debt payments not to exceed a percentage of her income at the time the loan is originated. Third, the individual must satisfy a minimum credit score requirement. As these underwriting factors worsen for any individual (i.e. less cash available for a down payment, higher DTI ratio and lower credit score), she will be more likely to be rejected for a loan, or face a higher interest rate or mortgage insurance premium.

It is not hard to see how—all else equal—having more student loan debt can mechanically affect one's entry into homeownership through these three channels. First, a higher student loan debt payment affects the individual's ability to accumulate financial wealth that can then be used as a source of down payment. Second, a higher student loan payment increases the individual's DTI ratio, potentially making it more difficult for the borrower to qualify for a mortgage loan. Third, student loan payments can affect borrowers' credit scores. On the one hand, the effect can be positive: timely payments of student loan debt may help borrowers to improve their credit profiles. On the other hand, potential delinquencies adversely affect credit scores, thereby hampering borrowers' access to mortgage credit. At

[14] The FHA requires a down payment as low as 3.5 percent of the purchase value.

the same time, other non-underwriting factors might have effects as well. For example, from a behavioral perspective, if individuals exhibit debt aversion and wish to repay at least some of their existing debt prior to taking on new debt in the form of a mortgage, larger student loan debt burdens can further delay their entry into homeownership.

Various factors might influence how the effect of student loan debt on homeownership changes in the years after leaving school. Since cumulative balances are generally the largest immediately upon entering repayment (see Figure 15 in Looney and Yannelis (2015)), there are at least three reasons to believe that the ceteris paribus effect of higher student loan debt on homeownership access might be the largest immediately upon school exit. First, given that the income profile tends to rise over the life cycle and student loan payments are fixed, the DTI constraint should ease over time, as should the budget constraint, thereby allowing the individual to potentially accumulate assets for a down payment at a faster rate. Second, once all debt is repaid, the student loan debt component of debt payments in the DTI constraint disappears entirely. Of course, the past effects of student loan payments on accumulated assets are likely to be more persistent if student loan payments significantly impaired the individual's ability to save at a rate comparable to that of an individual with less student debt for a period of time. Third, any effect of debt aversion induced by a higher student loan debt burden at school exit should diminish over time as the balance is paid down.

However, there may also be countervailing effects. In particular, the propensity for homeownership is generally relatively low among those newly out of school and increases with age. Hence, the number of marginal home buyers may peak many years after the final school exit, suggesting that the effect of student loan debt might be increasing as the debtor ages. Also, individuals may exhibit habit formation in their housing tenure choice.

A marginal home buyer who is induced into renting by her debts may become accustomed to renting, in which case the apparent effect of student loan debt on homeownership could persist for many years.

3 Data

Our data are pooled from several sources.[15] Mezza and Sommer (2015) discusses the details of the data, checks the representativeness of the merged data set against alternative data sources, and provides caveats relevant for the analysis.

By way of summary, the data set starts with a nationally representative random sample of credit bureau records picked and provided by TransUnion, LLC, for a cohort of 34,891 young individuals who were between ages 23 and 31 in 2004, and spans the period 1997 through 2010. Individuals are followed biannually between June 1997 and June 2003, and then in December 2004, June 2007, and December 2008 and 2010. The data contain all major credit bureau variables, including credit scores, tradeline debt levels, and delinquency and severe derogatory records. In order to capture information on enrollment spells and the institutional-level characteristics associated with each spell, in the next step individual educational records through 2007 are sourced from DegreeVerify (for degrees) and Student Tracker (for enrollments) programs by the National Student Clearinghouse (NSC). Next, additional individual-level information on enrollment for spells funded by federal student loans, the amount of federal student loan borrowed during and the institutions associated with these enrollment spells, as well as information on Pell Grants received, is sourced from

[15] All the merges of individual-level information have been performed by TransUnion, LLC, in conjunction with the National Student Clearinghouse, and the Department of Education. The merges have been done based on a combination of Social Security number, date of birth, and individuals' first and last names. None of the variables used to merge individuals across sources is available in our data set.

the National Student Loan Data System (NSLDS) and merged onto the data for federal student loan and Pell Grant recipients. The NSC and NSLDS educational institution identifiers allow us to further merge institutional records from the Integrated Postsecondary Education Data System (IPEDS), such as tuition, sector (e.g., public, private for-profit and not-for-profit, open admission), and SAT and ACT scores that are summarized at a school level. Finally, information on the state of permanent residence at the time when individuals took the SAT standardized test—sourced from the College Board—is merged for the subset of individuals who took this test between 1994 and 1999, at a time when most of the individuals in our sample exited high school.[16]

Since our analysis aims to estimate the effect of a marginal change in cumulative student loan debt on future homeownership once all educational and college-funding decisions have been made, we collapse our panel into a cross-sectional data set where all explanatory variables are measured approximately at the time of the final school exit, and estimate their effect on the individuals' homeownership status observed at different time windows following school exit. An individual in our sample is thus characterized by variables such as age at the final school exit, cumulative student loan balance and credit scores at the time of that exit, highest degree ever obtained, and total days spent in school. Most variables are constructed using a single data source. However, for some variables we combine information from multiple data sources to increase measurement accuracy. In what follows, we describe how each variable used in our analysis is constructed, and discuss the final estimation data set after any sampling restrictions have been applied.

[16]The SAT test is not mandatory nor is it required by all institutions and, as such, not all potential college entrants take it.

3.1 Dependent Variable

Given that we are not able to observe the individual's homeownership status, we infer it from whether the individual has at least one open mortgage account in the TransUnion data N months following the final school exit. The credit data contains the opening and closing dates for each mortgage tradeline in a year/month format, meaning that the individual's homeownership status is observed at a monthly frequency. In our analysis, we treat the individual's homeownership status as an absorbing state, so that if an individual is observed to be a homeowner at a given point after the final school exit, the individual will be treated as a homeowner at all future times. For individuals with a mortgage tradeline prior to school exit, the binary dependent variable takes on a value of one at $N = 0$.

The obvious limitation of using mortgage tradeline information to infer the individual's homeownership status is that we will not be able to identify homeowners who are either cash-buyers or have already paid off their mortgage loans in full prior to June 1997.[17] However, given that individuals in our sample are between ages 23 and 31 in 2004, the population of such "unidentified" homeowners in our sample is likely to be small.

3.2 Independent Variables

Student loan balances: Ideally, student loan balances would be measured at the time of the final school exit. Unfortunately, given that TransUnion data are available only at particular points in time, generally this will not be the case unless school exit coincides with the exact dates for which we observe TransUnion records. Theoretically, after the final school exit, the cumulative student loan balance should increase only if accrued interest on the outstanding

[17] Individuals who have had a loan between June 1997—the earliest wave of TransUnion data available to us—and school exit will be treated as homeowners in our analysis.

balances or penalties (such as debt collection fees) exceed payments.[18] Practically, in our data, the student loan balance observed in the TransUnion wave just after the final school exit could be higher than that measured in the wave just before school exit because a borrower might have accumulated more student loan debt between the wave preceding the school exit and the school exit itself. Thus, to measure the balance at school exit as closely as possible, we use the maximum level of student loan debt observed in TransUnion in the waves immediately adjacent to the final school exit.[19]

Credit scores, credit card debt, and auto debt: Similarly to student loan balances, generally these variables are not observed at the exact time of the final school exit.[20] To avoid reverse causality, we use their most recent value observed in TransUnion before the final school exit.

Missing credit score: This indicator variable takes on a value of one if the individual does not have a credit score reported in TransUnion in the wave preceding the final school exit; zero otherwise.

Credit lag: This variable measures how many days before the final school exit the lagged credit variables—credit score, credit card, and auto debts—were measured in TransUnion.

Ever Pell and cumulative Pell Grants received: These variables indicate whether the individual ever received Pell grants to finance their post-secondary education and the total amount received, respectively.

Highest degree attained: We construct a set of seven mutually exclusive binary indicators

[18]For example, student loan borrowers do not have to start repaying their student loans right away after school exit, in general. The waiting period after school exit and before repayment begins is known as the grace period, and typically lasts six months. Subsidized Stafford federal loans do not accrue interest over the grace period, whereas other types of federal student loans do.

[19]As such, student loan balances are expected to be measured with error. The instrumental variable approach should deal with this measurement problem. Results are robust to whether we use the maximum value or a lagged value of student loan balances.

[20]The credit score used in this analysis is the TU TransRisk AM Score and it ranges from 270 to 900 points

for the highest degree ever attained. We group degrees into the following categories: (1) dropouts (i.e, those with at least some college but no attained degree), (2) associate's or certificate degree holders, (3) bachelor's degree holders, and (4) holders of a master's degree or more. Moreover, for some individuals, we observe a certain degree (such as a bachelor's degree) that is followed by another degree of unknown type. In such instances, when an associate's degree/Certificate or bachelor's degree are observed and are followed by a degree of unknown type, we assign individuals into the categories (5) at least an associate's degree or a certificate and (6) at least a bachelor's degree, respectively. Finally, those with just a degree of unknown type are grouped into a category (7) with a degree of unknown type.[21]

Majors: College majors are available only for those with completed degrees. We aggregate them into 15 different categories, described in detail in Mezza and Sommer (2015). If a major is missing but a degree was received, a "missing major" indicator takes on a value of one; zero otherwise.

School sectors: We construct a set of five non-mutually exclusive binary indicators capturing all school sectors with which an individual was ever associated while in school: (1) public 4-year, (2) public 2-year, (3) private 4-year not-for-profit, (4) private 2-year not-for-profit, and (5) private for-profit. To determine the school sectors in our data set, we need unique school level identifiers associated with each enrollment spell observed for a given individual in the sample. In theory, the NSC enrollment records should be sufficient to identify all enrollment spells and, consequently, allow us to observe all sectors attended. In practice, the NSC coverage is not perfect, largely due to school non-participation in the NSC Student Tracker and DegreeVerify programs (for detailed discussion, see Mezza and Sommer (2015)

[21] The NSC collects the graduation date and degree information from schools that report into the DegreeVerify program. Unfortunately, some graduation dates are reported without the type of degree associated with it. When a degree of unknown type is observed in the NSC, but borrowing from the federal government for a subsequent degree is observed in the NSLDS, we use this additional information to infer the degree.

or Dynarski et al. (2013)). Hence, in order to supplement the NSC enrollment data, we use enrollment information from the NSLDS for enrollment spells funded by federal student loans.

Age at final school exit: This variable captures the individual's age when the person exited school for the last time. To construct this variable, we use the maximum age at school exit based on the NSC and the NSLDS data.

Cumulative days in school: This variable counts the total days of enrollment in post-secondary education. The cumulative time spent in school is derived from enrollment histories that are constructed using the combined NSC and NSLDS enrollment records.

Pre-college state of residence (or home state): To construct the state of residence prior to the first postsecondary enrollment spell, we proceed in three steps. First, for individuals who took the standardized SAT test, we use these individuals' state of legal residence at the time when they took the test, reported in the College Board data. In our sample, 31 percent of students have their home state identified in this manner. Second, for individuals for whom this information is not available, we use the first state of residence observed in the TransUnion credit records as long as this information is available for the period that precedes the first college enrollment observed in the sample. An additional 12 percent have their home state identified this way. Finally, for the remainder of the sample, we impute the home state using data on the state in which the school associated with the first enrollment spell is located.

This last step can certainly appear problematic given that it could reflect an endogenous location choice associated with state-level college cost or college quality. However, a case can be made for why the state of the first college attended might be highly correlated with the individuals' pre-college state of residence. In particular, in the nationally representative

2003-04 Beginning Postsecondary Students Longitudinal Study, only 11 percent of first-time, non-foreign college entrants attended a post-secondary institution not in their state of legal residence, with the state of legal residence defined as the student's true, fixed, and permanent home.[22] Under this definition, if the student moved into a state for the sole purpose of attending a school, that state does not count as the student's legal residence. In our sample, 26 percent of students whose home state was identified by the SAT or their credit record attended an out of state school.[23] These students represent 11 percent of our total sample, accounting for the entire expected population of out-of-state students, and suggesting that among the remaining students the state of first college attendance is extremely likely to be their home state. We therefore do not believe that misidentification of home state is a significant issue.

Home state and year fixed effects: The state controls are associated with the home state described above while the time controls are associated with the year in which the person left school for the last time.

Unemployment rate, average weekly wages and house prices at the state level: The unemployment rate is sourced from the yearly Local Area Unemployment Statistics series by the Bureau of Labor Statistics (BLS) and captures the unemployment rate in the individual's home state for the year when the person exited school for the last time. The average weekly wages are sourced from the Quarterly Census of Employment and Wages by the BLS and capture the average weekly wages in the home state for the quarter when the person exited school for the last time. Finally, the house value index is sourced from Zillow and captures the median house value (measured in dollars) in the home state for the month when the

[22]Source for the definition: https://fafsa.ed.gov/fotw1415/help/fahelp46.htm.

[23]While the College Board data for SAT-takers is available only for a subsample of our total population, its coverage is likely skewed toward higher academically achieving individuals who are more likely to attend out-of-state selective institutions.

person exited school for the last time.

3.3 Candidate Instrumental Variable

Our candidate instrument for cumulative student loan balances at the final school exit is based on the average in-state tuition at public 4-year schools in the state where an individual lived before enrolling in college for the first time.[24] To construct the instrument, we proceed in three steps. First, we count the number of days that the individual spent enrolled in school per academic year.[25] Second, we assume that individuals pay the average in-state tuition at public 4-year institutions associated with the state of their pre-college residence (defined in Section 3.2), proportionally adjusted for the number of days spent in school in that academic year. Third, we add up these tuition costs across time—up until the final school exit in the sample—to capture the student loan balance accumulation over the course of post-secondary studies. Importantly, given that the time spent in school can also be correlated with omitted variables that might be associated with the homeownership decisions, we control for cumulative time spent in school separately.[26]

3.4 Estimation Data Set

In this subsection, we describe the final subsample used in the analysis. First, we focus on the population of college-going individuals with existing NSC enrollment records: 18,748 individuals. Second, to estimate the effect of student loan debt on homeownership once

[24]The data on the average in-state tuition at public 4-year school by state and academic year (starting with the academic year 1993-94) are available on the NCES's *Digest of Education Statistics* website: https://nces.ed.gov/programs/digest/. Average in-state tuition reflects the average undergraduate tuition and required fees.

[25]The academic year is assumed to start in July of a given year and end in June of the subsequent year.

[26]To give a concrete example, consider an individual who enrolls in college in July 1995 and stays enrolled until June 1996, and re-enrolls in school in July 1998 until March 1999. For this individual, the value of the instrument will be given by the summation of the in-state tuition in the academic years 1995-96 and 1998-99, proportionally adjusted by the fraction of the academic year spent in school each year.

education decisions have been made, we concentrate on individuals who have likely finished all of their post-secondary education. Given that enrollment spells sourced from the NSC and NSLDS are available to us only up to early 2008, we drop 5,383 individuals who were still in school after 2005.[27] Additionally, given that we only observe student loan balances (as well as other debt holdings and credit scores) starting in June 1997, we drop 1,008 individuals who left school prior to that date. Moreover, we drop 4 individuals who were not residing in any of the 50 U.S. states or the District of Columbia before starting college, as well as additional 150 individuals whose home states cannot be determined based on our methodology described in Section 3.2. Next, we drop 172 individuals whose earliest enrollment record corresponds to the date a degree was obtained, rather than an actual enrollment record.[28] Furthermore, we drop 403 individuals who had open student loans at the moment they exited school for the last time but whose balances were missing in their credit records at that time. Finally, we drop 443 individuals who last exited school in 2005 but whose homeownership status cannot be determined with certainty 60 months after their final school exit because their credit files are not available to us in 2010. This leaves 11,185 individuals, of whom 5,610 had non-zero student loan balances and comprise our estimation sample. Summary statistics of this estimation sample are reported in Table 1.

[27]While individuals who left school during or before 2005 could still go back to school after 2008, we ignore this possibility.

[28]Some schools participate in the NSC DegreeVerify program, but not in the Student Tracker program. Additionally, schools participating in both programs usually report graduation dates retroactively (frequently reporting back several years prior to their enrollment in the DegreeVerify), but report enrollment spells starting from the moment they enroll in the Student Tracker program (or just a few months prior).

4 Estimation

Student loan debt is correlated with homeownership, but this relationship is not stable over time following school exit. Figure 1 plots the probability of ever having taken on a mortgage loan against the number of months since school exit for different debt levels. In the top left panel, we compare students who attended college without taking on debt to those who did borrow. Debt-free individuals have higher homeownership rates directly out of school, but are overtaken by students who borrowed within three years after school exit. In the bottom left panel of Figure 1, we refine student borrowers into three categories based on amount borrowed: less than \$15,000, between \$15,000 and \$30,000, and between \$30,000 and \$50,000. Comparing these groups, we can see that students who borrow the most are always most likely to be homeowners. Students who borrow moderate amounts start off less likely to own than non-borrowers, but eventually catch up. From these plots one might be tempted to conclude that, at least in the medium run, higher student loan debt leads to higher homeownership rates.

Determining how student loan debt affects homeownership is not so straight forward, however. Individuals with differing amounts of student loan debt may also differ in other important ways. Notably, they may have different levels of education, which is itself highly correlated with homeownership (possibly through an effect on income). The top right panel of Figure 1 restricts the sample to individuals with a bachelor's degree. Within this group, those without student loan debt always have higher homeownership rates than borrowers, and this difference is increasing with time since exiting school. In the bottom right panel, we can see that splitting the sample of borrowers further into groups by amount borrowed presents a similar picture. Students who borrowed more than \$15,000 had the highest homeownership rates among the general college going population five years out of school, but have the lowest rates among the subset with a bachelor's degree. As such, simple correlations clearly do not capture the whole picture.

4.1 Selection on Observables

Further factors that are correlated with both student loan debt and homeownership (and may be driving the observed relationship between these two variables of primary interest) include the type of school attended, the use of Pell grants, and the individual's credit history, for example. We attempt to identify the causal effect by regressing an indicator for homeownership on log student loan debt, controlling for a rich set of credit bureau and education variables, including state and year fixed effects. Results for the OLS and probit estimators are presented in Tables 2 and 3. Across both linear probability and probit models—and in line with results from Cooper and Wang (2014) and Houle and Berger (2015)—we find a very small but statistically significant effect, with a one percent increase in student loan debt leading to an approximately 0.02 percentage point decrease in the probability of homeownership 24 months out of school. Estimates are similar across the range of specifications in columns 1-5 in Tables 2 and 3.

Figure 2 plots estimates of the marginal effect of student loan debt against the number of months since the Final School Exit for the linear probability and probit models, respectively. These estimates are derived from the regressions using the vector of controls in columns 3 in Tables 2 and 3 for the OLS and probit specifications, respectively. Interestingly, nearly the full strength of the effect is apparent immediately. A one percent increase in student loan debt is associated with a reduction of approximately 0.01-0.015 percentage points in the probability of homeownership in the same month the individual is recorded as leaving school.

Moreover, the estimated effect is relatively stable within the 60-month window, though the precision of the estimated effect decreases over time and becomes insignificantly different from zero 45 months out of school.

4.2 Instrumental Variable Estimation

While the estimators used above control for some important covariates, there may still be unobservable variables biasing the results. The quality of school the student attended, the amount of parental contributions, and the individual's expected future income could all influence both student loan borrowing and the probability of future homeownership. The covariates we have may not adequately control for these or other omitted factors. To reliably identify the causal effect of student loan debt, we need a source of variation that is exogenous to all other determinants of homeownership.

We propose that the average tuition paid by in-state students at public, 4-year universities in the subject's home state provides quasi-experimental variation in eventual student loan balances. This variable cannot be affected by choices the individual subjects make. Rather, changes in the tuition rate depend in part on political battles over funding and expenditure decisions by the state universities. A large fraction of students attend public universities in their home state, so the loan amounts they require to cover costs vary directly with this price.[29]

Changes in tuition are not truly randomly assigned, however. A potential concern with the validity of this variable as an instrument is correlation with changes in state level economic conditions. Demand for secondary education or the supply of government subsidies may be related to local shocks that influence home purchase decisions. Later we will show

[29]As discussion in Section 3, 89 percent of first-time, non-foreign college entrants attended a post-secondary institution in their home state.

that the results are robust to the inclusion of labor market and housing market controls. We also test whether the instrument is correlated with homeownership for individuals who did not attend college, as these individuals should therefore be unaffected by the instrument if it is valid. We find no evidence of any relationship for this group, suggesting that the main results are isolating a causal effect of tuition changes.

Another potential concern with the instrument is that it may affect homeownership through channels other than student loan debt. As the price of education changes, students may demand more or less of it. We will show, however, that effects of the instrument on the extensive margin of college attendance or borrowing are unlikely to be driving the main results.

4.3 Instrumental Variable Estimation Results

As mentioned in Section 3, we construct the instrument as the log of yearly in-state tuition at public 4-year universities, weighted by the number of days each academic year the subject spent attending school. We additionally control for the log of the number of days spent attending school, so the identifying variation comes entirely from the change in price. First stage results from regressing log student debt on the instrument and other controls are presented in Table 4. Across specifications, a one percent increase in the tuition measure is associated with an approximately 1.3 percent increase in student loan debt. The estimates are strongly statistically significant.

Turning now to the second stage, we find a considerably stronger effect of student loan debt on homeownership than in the earlier specifications without the instrument. Results for the 2-Stage Least Squares (2SLS) and IV-Probit estimators are presented in Tables 5 and 6. Across both linear probability and probit models, we find a statistically significant effect, with a one percent increase in student loan debt leading to an approximately 0.1-0.2 percentage point decrease in the probability of homeownership 24 months out of school.

Figure 3 plots estimates of the marginal effect of student loan debt against the number of months since the Final School Exit for the 2SLS and IV-probit models, respectively. These estimates are derived from the instrumental variable regressions using the vector of controls reported in columns 3 in Tables 5 and 6. As in the previous estimates, the full effect is evident immediately upon school exit. A one percent increase in student loan debt is associated with a reduction of approximately 0.16-0.23 percentage points in the probability of homeownership in the same month the individual is recorded as leaving school.

4.4 Validity Tests

Our identifying assumption that the instrument is exogenous to unobserved determinants of homeownership is not directly testable. We can, however, test for some plausible sources of endogeneity. For example, in-state tuition rates may be correlated with local housing and labor market conditions, which in turn affect homeownership rates. To see that such omitted variables are unlikely to bias our estimates, compare columns 4 and 5 in Table 6. Column 5 includes yearly home-state level economic controls: namely, the unemployment rate, log of average weekly wages and log median house price from the subject's home state measured at the time of the Final School Exit. Column 4 omits these local controls, but includes only observations for which these variables are available to facilitate comparison. The estimated coefficient on student loan debt is stable across the two specifications, suggesting that local economic conditions are not driving the results. However, there could be some other unobserved home state-level variation that is correlated with both homeownership rates and changes in tuition. In this case, homeownership rates should be correlated with tuition changes even among individuals who did not attend college. If the instrument is valid, in contrast, it should have no estimated effect on the homeownership rates of college non-attendees.

To test validity along these lines, we estimate the effect of the log of yearly in-state tuition on the probability of ever having owned a home each year from age 18 to 30 for individuals who never attended college. The relevant tuition figure is taken from the first academic year in which the individual had turned 18 by the preceding July. Results are presented in Table 7. We cannot reject the hypothesis that there is no partial correlation between the tuition measure and probability of homeownership for this group. Since the instrument only affects outcomes for college attendees, this rules out a certain class of arguments against validity.

Another potential challenge to validity comes from the use of a log specification in student loan debt—students without any debt are excluded from the regressions. If tuition increases affect the extensive margin of student loan debt and if these marginal borrowers have a notably different propensity to own than the inframarginal individuals, then the results may be contaminated by this non-random selection. Data on education variables, including the instrument itself, is more likely to be mismeasured for students without any loans, so we cannot estimate a consistent relationship between the instrument and a dummy for the presence of any student loans.[30] However, Table 8 shows that the reduced form effect of the instrument on homeownership is strongly negative and significant even with the full sample of college attendees, leading us to conclude that bias due to selection along the extensive margin of student loans is not driving our findings.

[30] As described in Section 3.2, records on degrees, school sectors, and enrollment spells are more accurately measured for student loan borrowers, as their NSC records are augmented with corresponding NSLDS data. By definition, for those who did not borrow, the NSLDS data do not exist.

A further issue of sample selection is that tuition rates may affect the relationship between debt and homeownership through the composition of the student population. Table 9 presents some evidence that college attendance rates fall with increases in tuition in our data. In particular, the table shows the results of regressing the probability of attending college against the log of yearly in-state tuition, taken from the fall semester after the individual turned 18. We find a statistically significant effect, with a one percent increase in tuition causing a 0.08 percentage point decrease in college attendance. This could be a concern if the instrument is inducing a compositional shift in the estimation sample—i.e., if individuals on the margin of college attendance have very different propensities to become homeowners than inframarginal individuals. However, the estimated effect of the instrument on attendance is not large enough to explain the main result, no matter the propensities of the marginal group. As seen in Table 8, a one percent increase in tuition (conservatively) reduces the homeowning population by approximately 28 individuals per 10,000 college goers two years after exiting school. About 40 percent of the sample population does not attend college, so this translates to a reduction of approximately 17 individual homeowners per 10,000 individuals in the general cohort. The same increase in tuition reduces college attendance by only 8 individuals per 10,000, so even in the most extreme possible scenario in which all marginal attendees have a 100 percent probability of homeownership (rather than the 12 percent seen directly out of school in our sample), endogenous sample selection cannot explain the findings. Rather, because marginal college attendees tend to have lower ability and socioeconomic status than the average student, we would expect their propensity to own to be slightly lower than the general population of students. If anything, this suggests compositional effects may be biasing our estimates toward zero.

We noted previously that the full effect of student loan debt on homeownership was apparent immediately upon exiting school. Approximately 10 percent of the sample bought a home before leaving school, so it is reasonable to expect an effect even while the student is still attending. If student loan debt poses a credit constraint, however, we would expect to observe a particular pattern. Whether the main channel is through DTI ratios, credit scores or down payments, the constraint should become more binding as the student progresses through her education and debt accumulates. Similarly, the influence of debt aversion should grow. Therefore, the earlier in a student's educational career we look, the weaker the estimated effect of her (eventual) student loan debt on homeownership should be.

To test if this expected pattern holds in the data, we plot the estimated marginal effect of student loan debt against the number of months prior to Final School Exit for the 2SLS and IV-probit models in Figure 4. For the period approximately two to three years prior to school exit, there is not a statistically distinguishable effect of student loan debt on homeownership. With about a year to go, depending on the model, a significant effect becomes apparent and continues to strengthen until the student finishes school. This fits the intuitive story that the effect should be small or zero when debt balances are.

4.5 Additional Outcomes

Student loan borrowers may experience the burden of their debt in other areas than the binary outcome of homeownership. If DTI ratios or down payment constraints are binding, borrowers may substitute toward smaller mortgages in response to higher student debt levels. Alternatively, if student debt delays the home purchase decision to a point in the life cycle at which the borrower has a greater demand for housing, mortgage balances could conceivably rise with student debt. In the first column of table 10, we present the results from regressing the (logged) loan amount of the first mortgage we observe for each individual against their student loan debts and the usual vector of controls. Only borrowers who obtain a mortgage within 5 years of leaving school are included in this regression. The estimated partial correlation is positive and statistically significant, implying a 10 percent increase in student loan debt is associated with approximately 0.3 percent higher mortgage balances.

This naive estimate is likely to be biased by omitted variables similar to those that bias estimates of the effect of student loan debt on homeownership. We apply the same instrumental variable solution, and present results in the second column of Table 10. This point estimate suggests that student loan debt causes lower average mortgage balances among the population of homeowners. The standard errors are very large, however, and the result is not close to statistically significant. Because mortgages are substantially larger than student loan balances (approximately 8 times larger in our sample) we cannot rule out meaningful effect sizes in either the positive or negative direction.

One channel through which we hypothesize student loan debt could affect homeownership is through the borrower's credit score. Increased debt balances can worsen credit scores directly, as well as potentially lead to delinquencies which have a further derogatory effect. The sign of the effect is ambiguous, however, as taking out and subsequently repaying student loans may help some borrowers establish a good credit history and thus improve their scores.

Borrowers whose credit scores place them in the subprime category, traditionally defined as those with a credit score below 620, may be more likely to have their loan applications denied. However, some subprime borrowers may still be able to obtain credit with FHA or other mortgage insurance. Prior to 2008, the first percentile of FICO scores was approximately 500 on FHA insured loans.[31] Borrowers with a score below this level would have tremendous difficulty getting approved for a loan (in 2010, the Department of Housing and

[31] SOURCE: Data provided by McDash Analytics, calculation by authors.

Urban Development set the minimum credit score for FHA loans at 500 by rule). We therefore define a further "deep subprime" category of borrowers whose scores are low enough to effectively deny them access to FHA loans.

In the first and third columns of Table 11 we present the results of a probit estimation, regressing borrowers' probability of falling into the subprime and deep subprime categories against their student debt and the usual vector of controls. We use cutoffs in the individual's TU TransRisk AM Score of 620 and 500 to define the categories. The sample is limited to observations between 0 and 60 months after school exit, with multiple observations per individual included. The second and fourth columns present the results from the IV regression. In both cases the instrumented estimates are larger than those from the simple regression, suggesting that a 10 percent increase in student loan debt causes over a 0.6 percentage point increase in the probability a borrower falls into the subprime category, and over an 0.8 percentage point increase in the probability of being deeply subprime. The estimated effect on becoming subprime is significant only at the 10 percent level, while the effect on becoming deeply subprime is significant at the traditional 5 percent level. While the effect of student loan debt on risk category is meaningful in magnitude, it is unlikely to be enough to fully explain the 1 to 2 percentage point decrease in homeownership the same increase in student loan debt implies.

The finding that increased student loan debt raises the probability of having very poor credit suggests that the burden of debt may be causing some borrowers to become delinquent on their loans. We estimate the effect of student loan debt on the probability the borrower is reported 90 days or more delinquent on a student loan payment. Results are presented in Table 12. The simple probit estimate in the first column suggests a 10 percent increase in debt is associated with a 0.1 percentage point increase in delinquencies, similar in magnitude to the probit estimates on credit categories. In the second column, we use the instrument to deal with endogeneity of student loan debt and find a larger effect—a 10 percent increase in debt is estimated to raise delinquency rates by over 0.7 percentage points.

A caveat with the findings on risk categories and mortgage amounts is that these outcomes are not independent of each other or of the homeownership decision. For example, some of the estimated effect on subprime status may occur through the channel of lowered homeownership rates. Relatedly, marginal homeowners may demand different sized mortgages than homeowners whose tenure choice is insensitive to student loan debt. A single instrument is not enough to separately identify the direct effect of student debt on multiple outcomes, all of which could be channels through which the others are influenced.

5 Discussion

The previously presented results indicate that increased student loan debt causes a substantial reduction in the probability of homeownership for any given time frame within a five year window after exiting school. This negative effect is dominated, however, by the rapid and steady increase in the probability of homeownership as the individual ages across this same period. Using the estimates from the IV-probit model, we can simulate the effect of an increase in debt on the rate of homeownership among our sample population across the five year post-college window. In Figure 5, we plot the observed homeownership rate profile over time alongside a counterfactual simulation in which each student loan borrower in our data is burdened with a 10 percent increase in student loan debt at the Final School Exit.

As previously shown in Figure 3, the marginal probability is nearly constant over the estimation window, so the simulated counterfactual in Figure 5 looks like a parallel downward shift of the plotted data, decreasing the homeownership rate by approximately one percentage point at every time period. Because homeownership is increasing almost linearly in time since school over the five year window, this is equivalent to a parallel shift to the right. A 10 percent increase in student loan debt delays the time it takes the cohort of borrowers to reach a given homeownership rate by approximately three months.

The data we currently have access to cannot answer the important question of how the relationship between debt and homeownership changes past the five year window. As borrowers age, their incomes generally increase and student loan balances fall, which may lead us to expect that the relationship between an individual's initial debt levels and homeownership should weaken over time. While our estimates lose precision as the time since school exit increases, we do not see any indication of an attenuating effect. If former students exhibit habit formation in their housing tenure decisions, marginal homeowners may be induced to rent for many years by the effect of student loan debt on their housing decisions immediately after college.

6 Conclusions

In summary, this paper estimates the effect of student loan debt on subsequent homeownership rates. We instrument for the amount of the individual's debt using changes to the in-state tuition rate at public 4-year colleges in the student's home state. We find that a 10 percent increase in student loan debt causes a 1 to 2 percentage point drop in the homeownership rate of student loan borrowers for the first five years after exiting school. Validity tests suggest that the results are not confounded by local economic conditions or non-random selection into the estimation sample.

Our findings have implications for several recent trends and policy proposals. Tuition rates continue to rise, so the amounts students will need to borrow may increase in the future. Increased debt levels could continue to depress homeownership rates for future cohorts of college students. Measures taken to reduce tuition—or to curb borrowing beyond what is necessary to fund attendance—could fight this trend. Similarly, our results provide a measure of how effective student loan forgiveness programs could be at increasing the homeownership rate of young adults. Limiting or expanding students' *access* to education loans in general, however, would have ramifications that are beyond the scope of this study. In particular, if student loans allow individuals to access college education—or, more broadly, acquire more of it—student loan debt could have a positive effect on homeownership, as long as the return to this additional education allows individuals to sufficiently increase their future incomes.

In extrapolating our results to the present day, we also have to consider some significant recent changes to mortgage market. Students in our sample left school between 1997 and 2005; their first few years post-college took place in a relatively easy environment for mortgage credit. Since the housing and financial crisis, underwriting standards have tightened substantially. It is possible that student loan debt acts as an even greater drag on homeownership now that lenders are more sensitive to DTI ratios and low down payments. The growing popularity of income-driven repayment plans further complicates the picture, as it is not immediately clear how these plans moderate the link between initial student loan debt and homeownership. On the one hand, enrollment in income-driven repayment plans reduces the ratio of student loan payments relative to income, thereby relaxing the DTI constraint. On the other hand, it can extend the repayment period significantly relative to a 10-year plan, thereby potentially increasing the total interest paid by the student loan borrower over the life of the loan. We hope that further studies using even more recent data will be able to shine additional light on the issue.

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Table 1: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Homeownership Rate					
0 Months After School Exit	5,610	0.1			
12 Months After School Exit	5,610	0.16			
24 Months After School Exit	5,610	0.23			
36 Months After School Exit	5,610	0.31			
48 Months After School Exit	5,610	0.37			
60 Months After School Exit	5,610	0.43			
Student Loan Debt and Enrollment Measures					
Student Loan Debt (in $1,000 dollars)	5,610	19.1	24.77	0.05	318.88
Instrument: Tuition Measure (in $1,000 dollars)	5,610	14.21	8.27	0.55	87.23
Cumulative Days In School	5,610	1420.84	666.34	56	4,407
Age At Final School Exit	5,610	24.69	2.72	18.29	32.88
Degree Controls					
Associate's/Certificate	5,610	0.06			
Bachelor's	5,610	0.28			
Master's or More	5,610	0.03			
At Least Associate's/Certificate	5,610	0.003			
At Least Bachelor's	5,610	0.15			
Degree of Unknown Type	5,610	0.05			
Pell Grant Controls					
Ever Pell	5,610	0.56			
Average Pell (in $1,000)	5,610	1.26	1.34	0	4.31
School Sector Controls					
Ever Public 4-Year	5,610	0.65			
Ever Public 2-Year	5,610	0.44			
Ever Private 4-Year Not-for-profit	5,610	0.35			
Ever Private 2-Year Not-for-profit	5,610	0.01			
Ever Private For-profit	5,610	0.13			
Credit Controls					
Lagged Credit Score	5,610	565.6	206.43	0	848
Credit Lag	5,610	390.65	204.97	1	731
Missing Credit Score	5,610	0.06	0.24	0	1
Lagged Auto Debt	5,610	2.15	5.82	0	58.46
Lagged Credit Card Debt	5,610	1.42	3.28	0	63.41
Year of Exit from School					
1997	5,610	0.06			
1998	5,610	0.08			
1999	5,610	0.1			
2000	5,610	0.11			
2001	5,610	0.13			
2002	5,610	0.16			
2003	5,610	0.16			
2004	5,610	0.14			
2005	5,610	0.05			
Yearly State Controls*					
Unemployment Rate (Home State)	5,610	5.1	1.11	2.3	8.42
Log Avg. Weekly Wages (Home State)	5,610	6.54	0.17	6.02	7.16
Log Median House Price (HomeState)	4,794	11.89	0.43	11.03	13.18

Note*: Yearly home-state controls measured at school exit.

Table 2: Selection on Observables: OLS

Variable	(1)	(2)	(3)	(4)	(5)
Log Student Loan Debt	-0.0139**	-0.0282***	-0.0200***	-0.0209***	-0.0212***
	(0.00661)	(0.00723)	(0.00654)	(0.00724)	(0.00718)
Log Cumulative Days In School	0.0606***	0.0106	-0.000647	0.00665	0.00720
	(0.0102)	(0.0123)	(0.0117)	(0.0118)	(0.0116)
Age At Final School Exit	0.0439***	0.0406***	0.0395***	0.0394***	0.0395***
	(0.00327)	(0.00329)	(0.00331)	(0.00371)	(0.00376)
Associate's/Certificate		0.161***	0.131***	0.132**	0.132***
		(0.0452)	(0.0437)	(0.0491)	(0.0491)
Bachelor's		0.150***	0.112**	0.0997*	0.0996*
		(0.0496)	(0.0470)	(0.0520)	(0.0521)
Master's or More		0.204***	0.136**	0.130*	0.130*
		(0.0647)	(0.0651)	(0.0759)	(0.0762)
At Least Associate's/Certificate		0.224	0.191	0.173	0.172
		(0.139)	(0.138)	(0.138)	(0.136)
At Least Bachelor's		0.215***	0.157***	0.138**	0.138**
		(0.0532)	(0.0501)	(0.0550)	(0.0546)
Degree of Unknown Type		0.156**	0.110*	0.0884	0.0877
		(0.0610)	(0.0566)	(0.0613)	(0.0610)
Ever Pell		0.0383*	0.0317	0.0300	0.0299
		(0.0200)	(0.0190)	(0.0213)	(0.0212)
Average Pell		-0.0443***	-0.0270***	-0.0257***	-0.0258***
		(0.00689)	(0.00675)	(0.00738)	(0.00735)
Ever Public 4-Year		0.0427***	0.0336**	0.0258	0.0259
		(0.0157)	(0.0158)	(0.0174)	(0.0175)
Ever Public 2-Year		0.0227	0.0228	0.0211	0.0212
		(0.0138)	(0.0137)	(0.0132)	(0.0132)
Ever Private 4-Year Not-for-profit		0.0498***	0.0423**	0.0355*	0.0354*
		(0.0167)	(0.0159)	(0.0179)	(0.0179)
Ever Private 2-Year Not-for-profit		0.0125	-0.00837	-0.00398	-0.00446
		(0.0431)	(0.0416)	(0.0434)	(0.0432)
Ever Private For-profit		-0.00222	0.0164	0.0296*	0.0303*
		(0.0176)	(0.0164)	(0.0168)	(0.0170)
Lagged Credit Score			0.000499***	0.000524***	0.000523***
			(4.70e-05)	(5.08e-05)	(5.04e-05)
Credit Lag			5.22e-06	1.74e-05	2.13e-05
			(5.97e-05)	(6.84e-05)	(7.01e-05)
Missing Credit Score			0.323***	0.342***	0.341***
			(0.0335)	(0.0383)	(0.0380)
Lagged Auto Debt			0.00934***	0.00913***	0.00913***
			(0.00101)	(0.00108)	(0.00107)
Lagged Credit Card Debt			0.00404**	0.00448**	0.00448**
			(0.00194)	(0.00222)	(0.00222)
Unemployment Rate (Home State)					0.00212
					(0.0136)
Log Avg. Weekly Wages (Home State)					-0.132
					(0.200)
Log Median House Price (Home State)					-0.0161
					(0.0591)
Constant	-1.289***	-0.929***	-1.162***	-1.232***	-0.182
	(0.0930)	(0.105)	(0.121)	(0.123)	(1.397)
College Major Controls	NO	YES	YES	YES	YES
Home State/Year FE	YES	YES	YES	YES	YES
Observations	5,610	5,610	5,610	4,794	4,794
R-squared	0.110	0.146	0.187	0.181	0.182

Note: Standard errors in parentheses (clustered at home-state level).

Table 3: Selection on Observables: Probit

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Log Student Loan Debt	-0.0132**	-0.0259***	-0.0174***	-0.0182**	-0.0186**
	(0.00630)	(0.00687)	(0.00671)	(0.00767)	(0.00763)
Log Cumulative Days In School	0.0758***	0.0225*	0.00661	0.0136	0.0141
	(0.0101)	(0.0122)	(0.0117)	(0.0125)	(0.0124)
Age At Final School Exit	0.0431***	0.0403***	0.0392***	0.0395***	0.0396***
	(0.00300)	(0.00288)	(0.00287)	(0.00323)	(0.00325)
Degree Controls	NO	YES	YES	YES	YES
College Major Controls	NO	YES	YES	YES	YES
School Sector Controls	NO	YES	YES	YES	YES
Pell Grant Controls	NO	YES	YES	YES	YES
Credit Controls	NO	NO	YES	YES	YES
Home State Yearly Controls	NO	NO	NO	NO	YES
Home State/Year FE	YES	YES	YES	YES	YES
Observations	5,610	5,610	5,610	4,794	4,794
Pseudo R-squared	0.106	0.140	0.179	0.170	0.170

Note: Standard errors in parentheses (clustered at home-state level).

Table 4: IV Estimation: 1st Stage

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Instrument: Tuition Measure	1.227***	1.273***	1.279***	1.308***	1.337***
	(0.201)	(0.167)	(0.167)	(0.195)	(0.198)
Log Cumulative Days In School	-0.143	-0.401**	-0.418***	-0.435**	-0.459**
	(0.193)	(0.153)	(0.152)	(0.177)	(0.183)
Age At Final School Exit	0.0701***	0.0387***	0.0311***	0.0319***	0.0330***
	(0.00570)	(0.00428)	(0.00458)	(0.00521)	(0.00536)
Associate's/Certificate		-0.187*	-0.168	-0.166	-0.169
		(0.104)	(0.103)	(0.104)	(0.105)
Bachelor's		0.169	0.188*	0.174	0.169
		(0.110)	(0.105)	(0.111)	(0.111)
Master's or More		0.0211	0.0785	0.0642	0.0521
		(0.141)	(0.141)	(0.152)	(0.154)
At Least Associate's/Certificate		-0.381**	-0.331*	-0.312	-0.326
		(0.189)	(0.193)	(0.204)	(0.205)
At Least Bachelor's		0.758***	0.798***	0.800***	0.787***
		(0.110)	(0.104)	(0.105)	(0.107)
Degree of Unknown Type		-0.325***	-0.296**	-0.274**	-0.283**
		(0.112)	(0.111)	(0.113)	(0.115)
Ever Pell		0.0811**	0.0731**	0.0894***	0.0897***
		(0.0307)	(0.0311)	(0.0325)	(0.0324)
Average Pell		-0.00147	-0.0122	-0.0117	-0.0130
		(0.0104)	(0.0112)	(0.0129)	(0.0128)
Ever Public 4-Year		-0.0205	-0.0148	-0.0247	-0.0233
		(0.0288)	(0.0287)	(0.0324)	(0.0319)
Ever Public 2-Year		-0.206***	-0.207***	-0.211***	-0.211***
		(0.0250)	(0.0244)	(0.0282)	(0.0286)
Ever Private 4-Year Not-for-profit		0.257***	0.263***	0.265***	0.265***
		(0.0325)	(0.0315)	(0.0358)	(0.0365)
Ever Private 2-Year Not-for-profit		-0.0304	-0.0186	0.0180	0.0238
		(0.0789)	(0.0803)	(0.0756)	(0.0766)
Ever Private For-profit		0.195***	0.168***	0.163***	0.170***
		(0.0458)	(0.0431)	(0.0455)	(0.0448)
Lagged Credit Score			-0.000565***	-0.000584***	-0.000587***
			(9.58e-05)	(0.000109)	(0.000109)
Credit Lag			-4.10e-05	-6.42e-05	-9.94e-05
			(8.29e-05)	(9.49e-05)	(9.76e-05)
Missing Credit Score			-0.509***	-0.503***	-0.506***
			(0.0641)	(0.0733)	(0.0743)
Lagged Auto Debt			-0.00370**	-0.00409*	-0.00407*
			(0.00182)	(0.00205)	(0.00202)
Lagged Credit Card Debt			0.0129***	0.0138***	0.0138***
			(0.00275)	(0.00308)	(0.00315)
Unemployment Rate (Home State)					0.0493*
					(0.0254)
Log Avg. Weekly Wages (Home State)					-1.089**
					(0.535)
Log Median House Price (Home State)					0.314**
					(0.145)
Constant	-1.191	0.882	1.518**	1.584*	4.852
	(0.860)	(0.723)	(0.735)	(0.865)	(4.336)
College Major Controls	NO	YES	YES	YES	YES
Home State/Year FE	YES	YES	YES	YES	YES
Observations	5,610	5,610	5,610	4,794	4,794
R-squared	0.370	0.477	0.484	0.482	0.484

Note*: Standard errors in parentheses (clustered at home-state level).

Table 5: IV Estimation: 2nd Stage 2SLS

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Log Student Loan Debt	-0.269***	-0.208***	-0.183***	-0.169***	-0.181***
	(0.0590)	(0.0523)	(0.0506)	(0.0531)	(0.0585)
Log Cumulative Days In School	0.320***	0.155***	0.128***	0.125***	0.135***
	(0.0621)	(0.0441)	(0.0438)	(0.0463)	(0.0508)
Age At Final School Exit	0.0590***	0.0456***	0.0429***	0.0425***	0.0430***
	(0.00473)	(0.00324)	(0.00308)	(0.00346)	(0.00360)
Degree Controls	NO	YES	YES	YES	YES
College Major Controls	NO	YES	YES	YES	YES
School Sector Controls	NO	YES	YES	YES	YES
Pell Grant Controls	NO	YES	YES	YES	YES
Credit Controls	NO	NO	YES	YES	YES
Home State Yearly Controls	NO	NO	NO	NO	YES
Home State/Year FE	YES	YES	YES	YES	YES
Observations	5,610	5,610	5,610	4,794	4,794
R-squared		0.029	0.092	0.104	0.092

Note*: Standard errors in parentheses (clustered at home-state level).

Table 6: IV Estimation: 2nd Stage IV-Probit

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Log Student Loan Debt	-0.187***	-0.154***	-0.130***	-0.113**	-0.115**
	(0.0327)	(0.0391)	(0.0402)	(0.0444)	(0.0473)
Log Cumulative Days In School	0.237***	0.124***	0.0957***	0.0884**	0.0906**
	(0.0319)	(0.0326)	(0.0343)	(0.0382)	(0.0408)
Age At Final School Exit	0.0440***	0.0379***	0.0358***	0.0361***	0.0363***
	(0.00230)	(0.00247)	(0.00246)	(0.00269)	(0.00270)
Degree Controls	NO	YES	YES	YES	YES
College Major Controls	NO	YES	YES	YES	YES
School Sector Controls	NO	YES	YES	YES	YES
Pell Grant Controls	NO	YES	YES	YES	YES
Credit Controls	NO	NO	YES	YES	YES
Home State Yearly Controls	NO	NO	NO	NO	YES
Home State/Year FE	YES	YES	YES	YES	YES
Observations	5,610	5,610	5,610	4,794	4,794

Note*: Standard errors in parentheses (clustered at home-state level).

Table 7: Probability of Homeownership for Non-College Goers

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Age	18	19	20	21	22	23	24	25	26	27	28	29	30
Instrument: Tuition Measure	-0.00597	0.00523	0.0184	0.0529	0.0237	0.0483	0.0387	0.0243	0.0171	0.0420	0.0497	0.0399	0.115
	(0.0171)	(0.0242)	(0.0306)	(0.0361)	(0.0449)	(0.0505)	(0.0503)	(0.0607)	(0.0650)	(0.0680)	(0.0598)	(0.0703)	(0.108)
Home State/Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	8,927	8,927	8,927	8,927	8,927	8,927	8,927	8,927	8,927	8,927	8,835	8,723	7,940
R-squared	0.007	0.006	0.008	0.010	0.013	0.016	0.020	0.020	0.020	0.020	0.019	0.020	0.023

Note*: Standard errors in parentheses (clustered at home-state level).

Table 8: Reduced Form—All College Goers

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Instrument: Tuition Measure	-0.361***	-0.315***	-0.274***	-0.282***	-0.288***
	(0.0463)	(0.0420)	(0.0406)	(0.0439)	(0.0450)
Log Cumulative Days In School	0.376***	0.314***	0.266***	0.274***	0.280***
	(0.0456)	(0.0419)	(0.0412)	(0.0444)	(0.0453)
Age At Final School Exit	0.0361***	0.0343***	0.0326***	0.0325***	0.0325***
	(0.00206)	(0.00229)	(0.00248)	(0.00261)	(0.00261)
Degree Controls	NO	YES	YES	YES	YES
College Major Controls	NO	YES	YES	YES	YES
School Sector Controls	NO	YES	YES	YES	YES
Pell Grant Controls	NO	YES	YES	YES	YES
Credit Controls	NO	NO	YES	YES	YES
Home State Yearly Controls	NO	NO	NO	NO	YES
Home State/Year FE	YES	YES	YES	YES	YES
Observations	11,628	11,628	11,628	10,262	10,262

Note*: Standard errors in parentheses (clustered at home-state level).

Table 9: Probability of College Attendance

Variable	**Coefficient**
Instrument: Tuition Measure	-0.0839**
	(0.0407)
Home State/Year FE	YES
Observations	25,790
R-squared	0.035

Note*: Standard errors in parentheses (clustered at home-state level).

Table 10: Log of First Observed Mortgage Balance

Variable	**(OLS)**	**(IV)**
Log Student Loan Debt	0.029**	-0.037
	(0.013)	(0.106)
Log Cumulative Days In School	0.110***	0.163
	(0.040)	(0.0419)
Age At Final School Exit	-0.020***	-0.020***
	(0.006)	(0.007)
Degree Controls	YES	YES
College Major Controls	YES	YES
School Sector Controls	YES	YES
Pell Grant Controls	YES	YES
Credit Controls	YES	YES
Home State/Year FE	YES	YES
Observations	2,410	2,410

Note*: Standard errors in parentheses (clustered at home-state level).

Table 11: Risk Categories

Variable	Subprime (Probit)	Subprime (IV Probit)	Deep Subprime (Probit)	Deep Subprime (IV Probit)
Log Student Loan Debt	0.012***	0.066*	0.007*	0.085**
	(0.004)	(0.040)	(0.004)	(0.035)
Log Cumulative Days In School	-0.047***	-0.089***	-0.038***	-0.098***
	(0.010)	(0.030)	(0.009)	(0.027)
Age At Final School Exit	-0.007***	-0.008***	-0.005***	-0.006***
	(0.002)	(0.002)	(0.002)	(0.002)
Degree Controls	YES			
College Major Controls	YES			
School Sector Controls	YES			
Pell Grant Controls	YES			
Credit Controls	YES			
Home State/Year FE	YES			
Observations	15,135			

Note*: Standard errors in parentheses (clustered at home-state level).

Table 12: Student Loan Delinquencies

Variable	**(Probit)**	**(IV Probit)**
Log Student Loan Debt	0.011***	0.074***
	(0.003)	(0.024)
Log Cumulative Days In School	-0.007	-0.055***
	(0.006)	(0.030)
Age At Final School Exit	-0.003**	-0.005***
	(0.001)	(0.001)
Degree Controls	YES	
College Major Controls	YES	
School Sector Controls	YES	
Pell Grant Controls	YES	
Credit Controls	YES	
Home State/Year FE	YES	
Observations	15,095	

Note*: Standard errors in parentheses (clustered at home-state level).

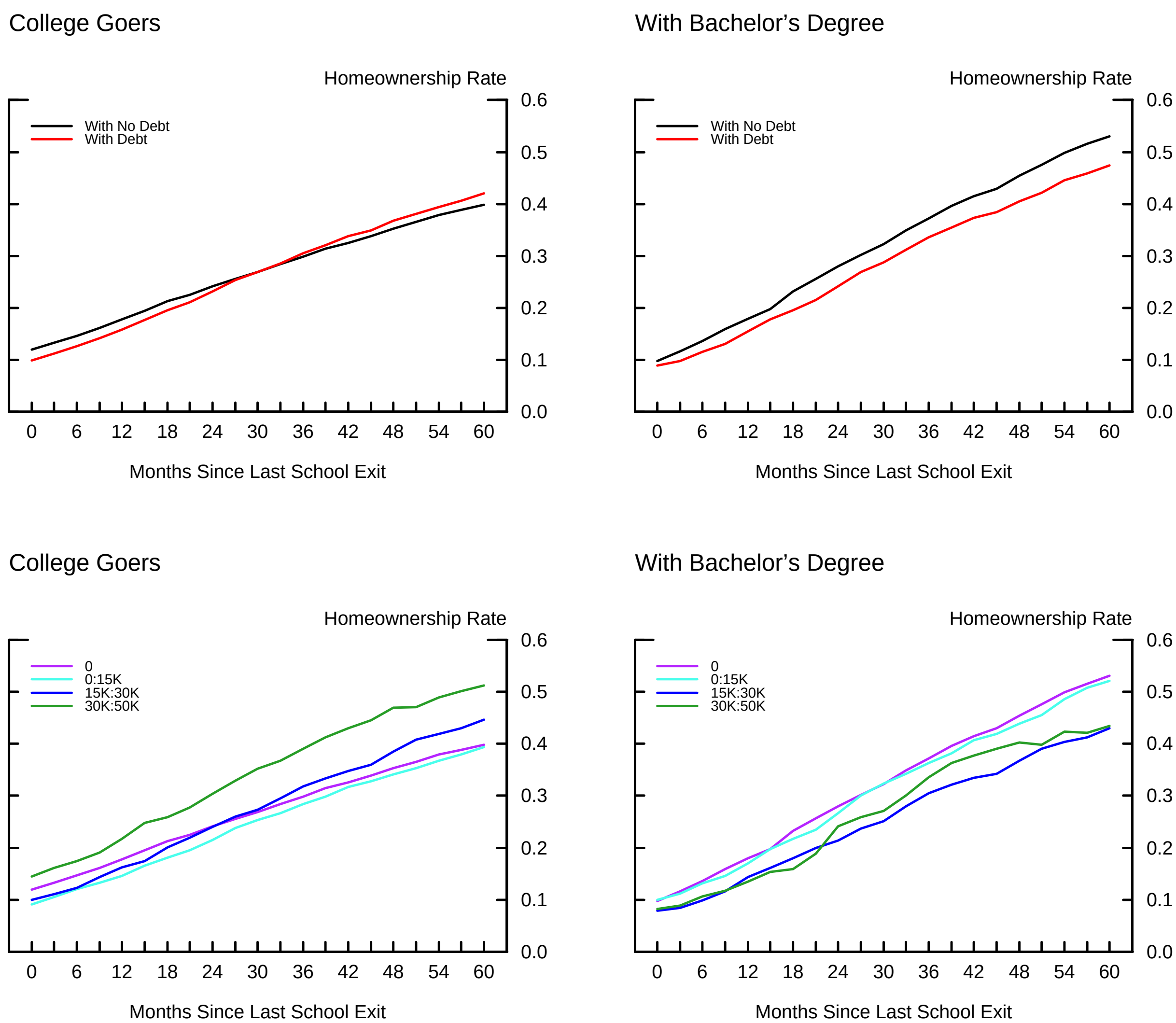

Figure 1: Homeownership Rates by Months Since Leaving School, Debt Level and Education

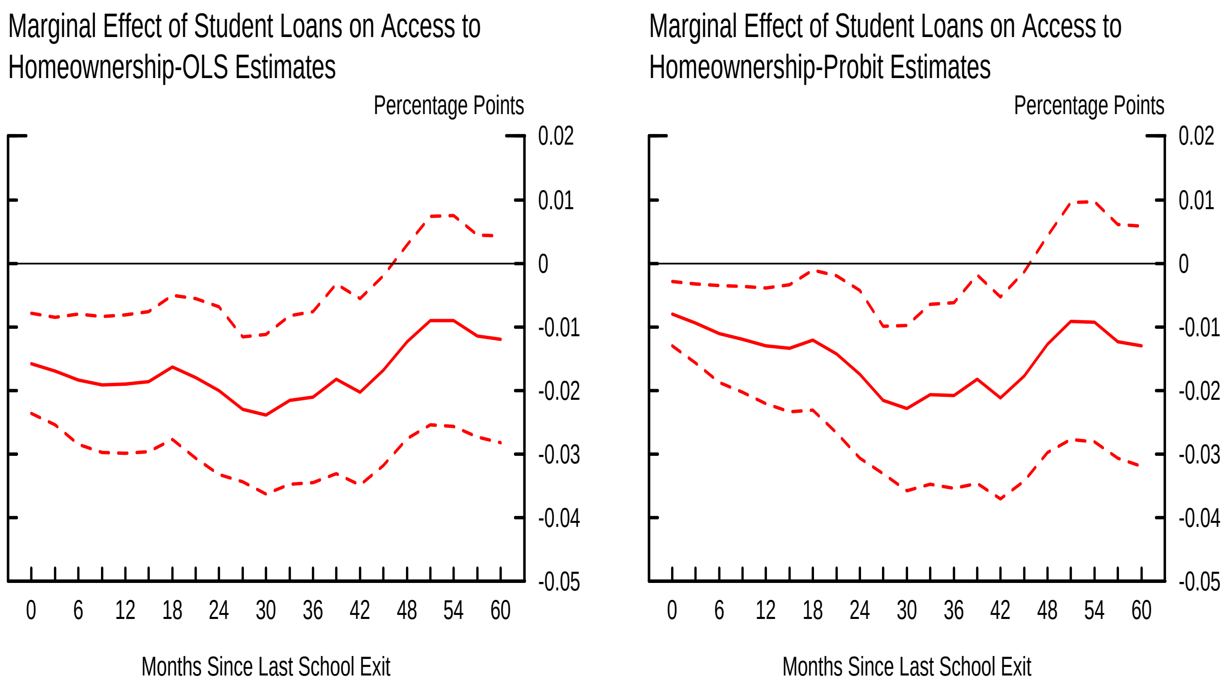

Figure 2: Estimation Coefficients: OLS vs Probit

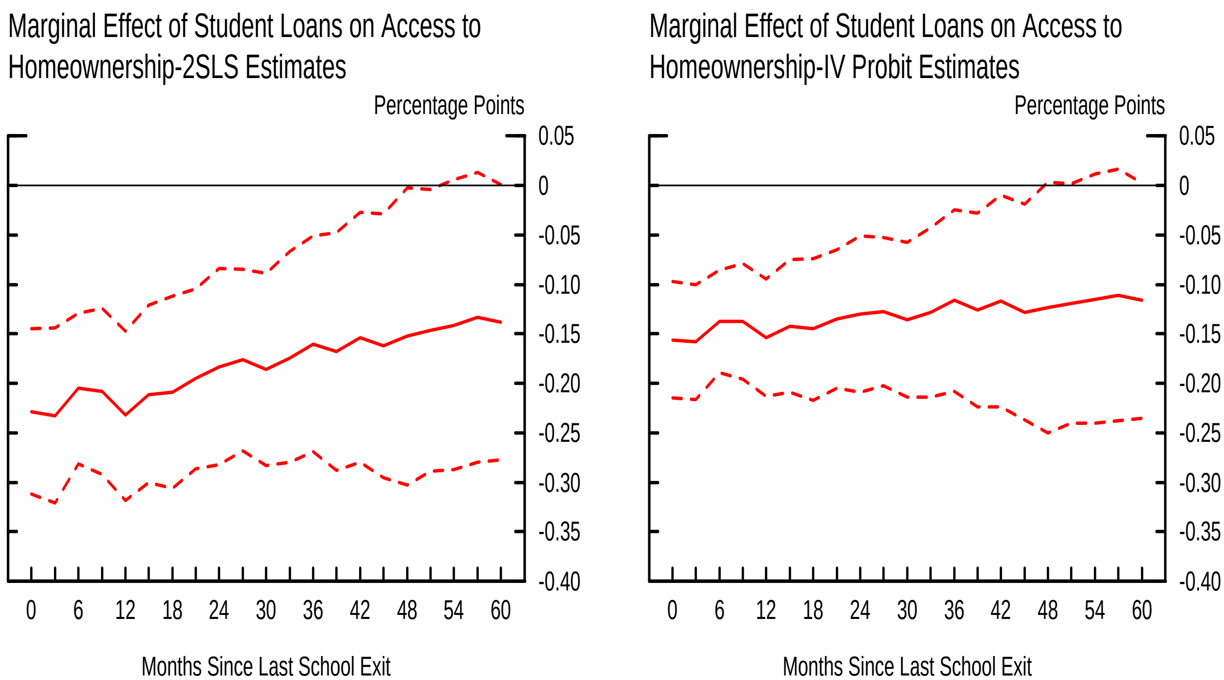

Figure 3: Estimation Coefficients: 2SLS vs IV Probit

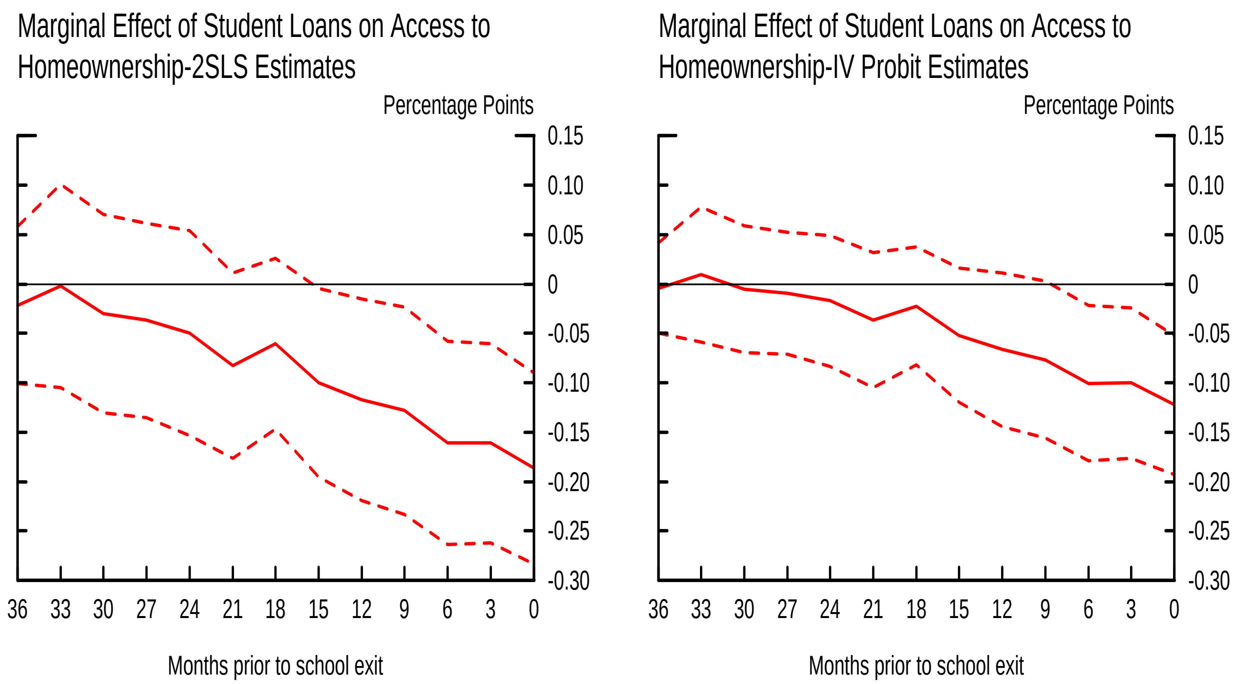

Figure 4: Estimation Coefficients Prior to Exiting College: 2SLS vs IV Probit

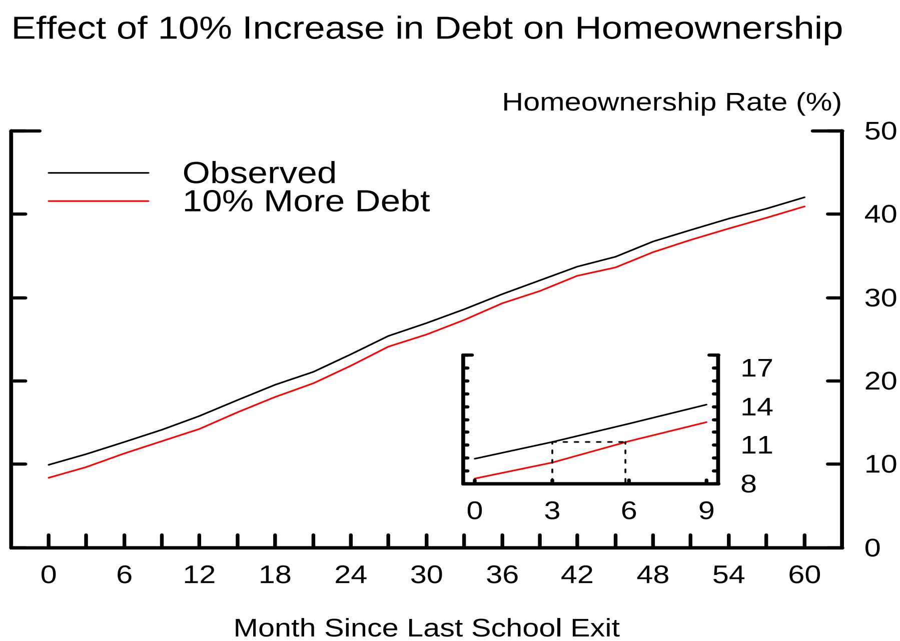

Figure 5: Simulation of Counterfactual Homeownership Rate

Function Follows Form

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Urban policy molds urban form. This paper suggests that urban form also molds urban policy. Urban form frames the political economy of whether to relocate the city center's jobs and shops. In that sense, city functions follow urban form. This view rivals the ''form follows function'' that has become proverbial in architectural theory. Extensions to this analysis of the suburbanization of employment and shopping address the city's topography, the convexity of its skyline, the possibility of sprawl and the effects on jurisdictional merger.

Keywords: City Shape, City Skyline, City Convexity, City Skewness, Sprawl

Session: Environmental Impacts on Property
H26, June 9, 2016, 11:00am - 12:30pm

Function Follows Form

– May 20th, 2016 –

Kristof Dascher

Abstract: Ever since Victor Gruen opened *Northland* in a Detroit suburb, thousands of shopping centers and office parks have sprung up along city peripheries. This paper traces demand for decentralizing urban shops and jobs (urban "functions") back to the city's original shape (urban "form"). In that sense, *function follows form.* This view rivals the standard urban paradigm, which focuses on how policy shapes urban form. This view also rivals the *form follows function* that has become proverbial in architectural theory. Extensions to the analysis address the convexity of the city's skyline, the possibility of suburban sprawl and the effects of urban form on jurisdictional merger.

Keywords: Economic Geography, City Shape, City Skyline, City Skewness, Suburban Shopping, Sprawl
JEL-Classifications: R12, D72, R52

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1 Introduction

Ever since Victor Gruen opened *Northland*, the first modern mall, in a Detroit suburb, thousands of shopping centers and office parks have sprung up along many cities' peripheries (e.g. Lampugnani (1985), Garreau (1991), Glaeser/Kahn (2010), Hardwick (2010)). It is tempting to argue that all these shopping malls and office parks are the inevitable consequence of the car. At the same time, this decentralization of shops and jobs is not ubiquitous; many cities have not decentralized at all. Clearly decentralization also depends on whether city voters support it. This paper presents an analysis of urban demand for decentralization. By this analysis, urban demand for decentralizing a city's shops and jobs (i.e. two essential urban "functions") derives from, and hence can even be predicted by, the city's physical shape (i.e. urban "form"). This latter causality motivates the paper's title.

A two-paragraph-summary of the paper reads as follows. Consider a city that decides on whether to decentralize jobs and shops out to the city's periphery. In principle, any resident's preference regarding this decision might be read off her properties' "average location". A resident with an average property near the city center will not easily give up on that center; the opposite must be true for a resident whose average property is close to the periphery; and a resident with no property at all might well be indifferent. *If we knew* city residents' average properties, then we could assign residents their policy preferences. We could even go on to predict the city's decentralization decision. Unfortunately, only, average properties are not observable. And so neither are residents' preferences.

But the city form is. The city's form is reflected by the distribution of commuting distance, sample data from which often are available. This form puts natural constraints on the properties residents can possibly own (or combine). After all, resident properties must nest into the city's given form. Detailed "nesting constraints" emerge once we inspect the city's form closer. The most binding of those happens to vary with a simple index of the city's physical form, i.e. the commuting distribution's *skewness*, irrespective of the property assignment. Urban skewness literally puts bounds around resident interests. If urban skewness is positive enough then a majority holding on to the traditional center is inevitable. Conversely, if this skew is sufficiently negative then decentralization sets in. The city's skew reveals urban form's hidden grip on local politics. Or to provide yet another window on this theme, one concept that is graphic predicts another that is political.

And so while urban form is an interesting field in its own right (Lynch (1960), Baranow (1980), Roeck et al. (2013)), this paper argues that city morphology has uses that go beyond the descriptive. Besides, reading restrictions on a city's various political interests off its physical form also complements a prominent view due to Louis Sullivan. According to Sullivan (1896), "...it is the pervading law of all things organic and inorganic, ...that the life is recognizable in its expression". Among architectural theorists Sullivan's view has become the proverbial *form follows function*. This paper's suggesting that the built environment impact on the polity's decision on where to locate a city's commerce and business provides an explanation of how instead building contours (form) determine buildings' uses (function), or more briefly of how ...function follows form.

This reversal of ideas conflicts quite fundamentally with the standard urban paradigm. While understanding the impact of policy on form has been central to urban economics (e.g. Bertaud/ Brueckner (2005), Brueckner (2005), Bento/Franco/Kaffine (2006), Baum-Snow (2006), de Lara et al. (2013)), the issue of repercussions of urban form on urban policy appears to have attracted much less attention – even as, say, the role of urban compactness for the viability of urban public transport (e.g. Bertaud (2003)) or the impact of existing infrastructure on subsequent zoning (Garcia-López et al. (2015)) have been of interest. In part this is for good reason. A young city's policy is unlikely to be informed by its form. But for any mature city this seems more difficult to justify. It is hard to imagine that structures respond quicker to policy than policy responds to structures.

Fogelson (2003) devotes an entire chapter of his book on America's "downtown" to "the specter of decentralization" during the first half of the 19th century. If traffic congestion was a force behind the decline of the traditional central business district, "the other phenomenon to which downtown businessmen and property owners attributed decentralization was residential dispersal." (p. 231) Clearly residential dispersal contributes to downtown's decline if city residents are owner-occupiers always. With owner-occupiers, the city's physical form easily reveals the city's political economy. More homes at the urban fringe also mean more voters in favor of business decentralization. This connection between urban form and urban political economy, however, is much less straightforward once homes no longer map into voters one-to-one. And so this paper may also be seen as an attempt to understand the impact of form on function in more general property settings.

We extend our analysis to how the city's form even naturally follows the city's topography. Let a city be stretched out on a peninsula, or hemmed in by nearby mountains. Most of that city's housing must be near the city's center. This city's form is skewed to the periphery. Fitting in our building block of function following form, voters will turn down any proposal to decentralize. Metaphorically, New York is compact because its geography discourages (political support for) the decentralization of its business and shopping. Alternatively, a city that is able to expand in any direction will naturally find much of its housing on its periphery, and so a majority of its voters will support decentralization. We might want to speculate that it is the difference in topography that has European cities decentralize less than US cities do (Europe as a whole being more mountainous than the US).

We will also see that while it is city's *skew* that helps us assess the urban political economy of decentralization, it is the city skyline's *convexity* that assists in predicting marginal changes in this political economy. The urban skyline is our second graphic tool for uncovering the city's political economy. Since the urban skyline is a variant of the city's population gradient, this also assigns additional weight to the literature on the population density gradient (e.g. McDonald (1989), Kim (2007)). Quite intuitively, building height restrictions (whether imposed by soil instability or by urban planning and zoning) take away from the city center's "resilience". If the city is not permitted to add population to its "leading rings", then anything that adds extra layers of "lagging rings" at the periphery will always strengthen decentralization supporters' ranks.

Our framework also indicates applications in the fields of jurisdictional fragmentation and urban sprawl. If policy makers are aware of urban form's grip on local politics then urban form feeds into decisions on jurisdictional merger. Central cities must fear annexing their suburbs if this, by reducing skew, will make decentralization more probable. For a similar reason central cities may refrain from imposing building height restrictions, may zone large tracts of the urban periphery for park use only, or may impose growth controls. Regarding sprawl, if cities differ in their form (which they do not in the present paper) any form-inspired decision to decentralize business and commerce in one city begins to attract migrants to that city's periphery. Original city form becomes another determinant of urban sprawl, entering the list of determinants identified in the literature (e.g., Glaeser/Kahn (2010), Burchfield et al. (2006)).

The paper has seven sections. Section 2 outlines the basic model. Section 3 extracts the political economy of decentralization from the city's form, by introducing computable and useful bounds on urban voter shares (Proposition 1). Section 4 puts these voter shares down to a graphic aspect of the city's form. This section finds that we may estimate urban voter shares from the city's skewness (Proposition 2). Section 5 offers a comparative statics treatment of the city's form, analyzing the effects of variations in topography and technology on urban form, and hence on city functions. For instance, we find that being linear and exhibiting a convex skyline also makes a city less likely to decentralize (Proposition 3). Section 6 addresses a number of extensions (on concerns with city openness, housing ownership, and welfare), and section 7 concludes.

2 Model

Consider the following simple variant of the closed city model as developed by Wheaton (1973), Pines/Sadka (1986) and Brueckner (1987). A monocentric and, for much of the analysis, circular city extends at most $\widetilde{r}$ units of distance out from the center. Each resident occupies one unit of housing (an "apartment") and commutes to the city center (CBD) to work and shop. Round trip commuting costs for a resident living at distance r are tr, so that Ricardian rent becomes $q(r) = t(\widetilde{r} - r)$. Landlords are resident, not absentee, because a closed city's landlords can hardly be influential if they are absentee. City population equals 1. There is no agricultural hinterland.[1]

Apartments are built by profit maximizing investors. One unit of capital k poured into a building site of unit area yields $h(k)$ units of floor space, where $h' > 0$ and $h'' < 0$ (Brueckner (1987)). If p is the price of capital, investors choose k so as to satisfy the $q(r)h_k(k) = p$ necessary for maximum profit. The optimal capital will clearly depend on rent q and capital price p, and so can be written as $k(t(\widetilde{r} - r), p)$. Let $h(r)$ be shorthand for the corresponding optimal building height $h(k(t(\widetilde{r} - r), p))$. In equilibrium the city boundary $\widetilde{r}$ is determined by the requirement that the urban housing market clear:

$$1 \;=\; \int_0^{\tilde{r}} a(r)h(r)\,dr, \tag{1}$$

where $a(r)$ is land available at r units of distance away from the CBD.

Since we have set housing consumption equal to 1, building height or (residential) skyline $h(r)$ also equal the city's population density. At the same time $f(r)$, as defined by the product of population density with land,

$$f(r) \;=\; a(r)h(r), \tag{2}$$

approximates the number of commuters populating the unit-width ring at distance r. I.e., $f(r)$ is the city's commuting density function, with $F(r)$ the corresponding cumulative distribution function.[2] We follow Arnott/Stiglitz (1981) in referring to f as the city's form or *shape.* To be sure, both city shape and city skyline are graphic.[3] Sections 2 through 4 proceed with the Arnott/Stiglitz notion of shape; the city's skyline makes its appearance in section 5.

Believing the impact of shape on policy to outpace the impact of policy on shape, we now freeze $f(r)$ at what it is in equilibrium (1). Up until section 5, *the city shape that the standard closed city*

[1] Our analysis below could also be cast in an open city framework. We briefly explore the open city later (section 6). There we will indicate that an open city is naturally more inclined to decentralize.

[2] We assume a is continuous in r. As h is (differentiable and hence) continuous in r, so are f and F.

[3] At the same time, the skyline is more graphic or visual than shape is. In our model, the skyline of residential structures (i.e. excluding office buildings) reveals itself to the eye of the distant observer while the city's shape only reveals itself to the statistician constructing histograms of commuting distance.

model concludes with is the city shape that our analysis begins with.[4] Now, while $f(0) = f(\widetilde{r}) = 0$ (because at $r = 0$ there is no land while at $r = \widetilde{r}$ there is no housing), not much is known beyond this, especially if the city is fully circular. It is true that increasing distance from the CBD has rent, and hence building height $h(r)$, fall. Yet it is also true that increasing distance from the CBD has circumference, and hence ring areas, rise. City shape f may be anything, i.e. increasing in r and/or decreasing in r.[5]

City apartments are owned by resident landlords. Each landlord owns (no housing or land other than) two apartments located anywhere in the city. One of these apartments he occupies himself, the other he rents out to his single tenant.[6] Now, to best introduce the model's various nesting constraints, we briefly rephrase the model's key concepts within a discrete framework. We partition the city into n equidistant rings of width $\widetilde{r}/n$ each. Let ring i residents travel costlessly to commuting nodes at $r_i = (i - 1/2)\,(\widetilde{r}/n)$, from where they go on to the CBD at cost tr_i. (Soon we will shrink ring width again so that the costless-within-ring-travel assumption becomes redundant.) Housing's stock in ring i, denoted s_i, approximately equals $f(r_i)$.

Now imagine a landlord who resides in ring i himself yet rents out his extra, second property in ring j. Such an assignment implies a sum of commuting costs and rental income equal to $-tr_i + q(r_j)$, where $q(r_j)$ is rent at distance r_j. Let ω subsume any other benefit common to all landlords, such as the wage or some local public good that does not distance-decay. Then landlord utility is $\omega + t(\widetilde{r} - r_i - r_j)$. Landlord utility is independent of whether the landlord resides in i and his tenant in j, or vice versa, and so we always will conveniently put the landlord into that of his properties that suits our exposition best.

The paper's central policy metaphor is the *ring road*. A ring road is a rival to the traditional Central Business District (CBD). Locations along it connect almost as well to one another as locations in the traditional core do.[7] And so let a costless ring road be proposed to city residents, by some interested party (identified shortly). A ring road would shift the city's center of attraction from its inherited position (the CBD) out to the urban boundary $\widetilde{r}$ (the ring road), in a single instant and with t unchanged.[8] Instead of travelling r_i to the center of the city in order to work and shop, every resident in ring i now commutes $\widetilde{r} - r_i$ to the city's periphery to work and shop,

[4] Section 6 then includes, and allows for variation in, exogenous (non-policy dependent) determinants of city shape f in the analysis.

[5] Only in the two polar cases do we see clearer. In a city that is both linear (e.g. peninsular) and height-control free, f must be decreasing; while in a city that is circular and single story only, f should be increasing. This perspective we take up again in section 6.

[6] Adding an extra group of owner-occupiers would add a group of voters whose incentives vis-à-vis the ring road proposal introduced below are obvious (those close to the center are against the ring road, those far from the center vote for it), while adding an extra group of landlords owning three properties each would add a group of voters whose voting behavior follows a pattern similar to the voting behavior of the two-property-landlords prominent below. In that sense, the property assignment chosen here spans the paper's key idea. We briefly return to this issue later (section 6).

[7] Vienna provides an early prominent example of a ring road, so much so that its ring road is actually referred to as the "Ring". Victor Gruen, inventor of the modern US style shopping mall, appears to have modeled his malls on Vienna's ring (Gladwell (2014), Hardwick (2010)).

[8] While a simultaneous shift of course is unlikely, any shift from the CBD to the city periphery might be helped along by coordination. Rauch (1993) points to the role of business park developers in coordinating industry relocation, while the shopping center industry attests to the importance of retail space developers in coordinating movements in retail (e.g. Brueckner (1993)). Sometimes it is even the city's government that provides this coordination. For example, Vienna's ring road was where suddenly one could find "the new exchange, the university, a civic and national government section around the new town hall and parliament house, a museums section, the opera house" (Girouard (1989)).

in those office parks and shopping malls strewn along the ring road that permits its users to circle the city on it at no cost. The ring road proposal is approved if it captures a majority of the vote.

Implementing the ring road surely must be one of the most fundamental policy decisions a city can possibly ever take.[9] It is important to see why tenants will be indifferent to this proposal, and hence may be ignored throughout. Tenants' cost of living, or $tr + q(r)$, equals $t\widetilde{r}$. This marginal commuting cost does not change as long as the distance between center and periphery does not. We conclude that it is only landlords who will vote. Landlord-voters are divided over which decision to take, depending on their specific properties' locations (not known to us). Landlord utility becomes $\omega - t(\widetilde{r} - r_j - r_i)$ with the ring road instead of $\omega + t(\widetilde{r} - r_j - r_i)$ without it. The attendant change in utility is $2t(r_i + r_j - \widetilde{r})$. This change is strictly negative if $r_i + r_j < \widetilde{r}$, or if

$$i \; + \; j \; \leq \; n. \tag{3}$$

Landlords whose property location indices satisfy inequality (3) will oppose the CBD's displacement. These we label as (landlord) opponents. All the other landlords can be counted on to support it, and become the model's (landlord) proponents as soon as indifferent landlords become negligible (which they do next).

3 Extracting Bounds from the City's Shape

We cannot derive landlord opposition to the ring road for the true yet unknown landlord property portfolios nesting into the city's shape. Yet we *can* derive fictitious landlord portfolios from the exogenous city shape that generate minimum landlord opposition to the ring road. The observable minimum opposition to the ring road thus computed provides a conservative estimate of the unobservable true opposition. Let us briefly preview the steps this section takes. First we identify the portfolios that give rise to the weakest conceivable opposition for each nesting constraint. Next we select that nesting constraint that reveals the largest of these minimum opposition figures. Finally we study the effect changing city's skewness has on this largest minimum resistance. For example, there we look for shapes robust enough to withstand the ring road proposal's temptation.

Consider the stock of apartments in the first ring, s_1, first. All of these apartments are tied up in matches involving landlords who suffer from the ring road – with the exception of those matches involving a tenant in ring n. Matches involving apartments both in rings $i = 1$ and $j = n$ fail necessary condition (3). Apartment stock s_1 would be a good first estimate of landlord opponents were it not for the fact that every resident in ring n could be tenant to a landlord in ring 1 (rather than to a landlord in any of the remaining rings). Making allowance for this observation, really only $(s_1 - s_n)$ apartments may safely be traced back to landlord opponents. Further, these latter $(s_1 - s_n)$ units might involve landlords and tenants only ever from the first ring, acting to depress further the number of landlord opponents we can be sure of. Hence our first lower bound becomes $(s_1 - s_n)/2$.[10]

[9] In turning the city's spatial setup on its head this decision not just is a fundamental one; its underlying political economy in part also parallels that of introducing a toll or of neglecting radial roads (section 6).

[10] The smallest number of landlord opponents conceivable obtains if landlords and tenants share equally in $(s_1 - s_n)$, yielding the $(s_1 - s_n)/2$ mentioned above. On the one hand, if $(s_1 - s_n) < \sum_{j=2}^{n-1} s_j$ then each of the $(s_1 - s_n)$

Put differently, $(s_1 - s_n)/2$ is a *lower bound* to the set of all conceivable landlord opponent figures that could involve the first ring. This latter set contains the true number of landlord opponents. Of course, if the city shape is such that $s_1 < s_n$, then $(s_1 - s_n)/2$ is negative. In this specific case $(s_1 - s_n)/2$ is not a very good lower bound. A lower bound of zero landlord opponents is an obviously better choice. Yet this need not bother us. There are many more lower bounds on offer. For example, apartments in the first two rings, $(s_1 + s_2)$, give another conservative estimate of landlord opponents if we allow for (i) all $(s_{n-1} + s_n)$ tenants being matched up with some landlord in the first two rings and (ii) all remaining apartments in the first two rings to be matched up with one another. Making these two adjustments points to $((s_1 + s_2) - (s_{n-1} + s_n))/2$ as lower bound to the set of all conceivable landlord opponent figures that could involve the first two rings.[11]

Already we have identified two nesting constraints that offer some minimum opposition to the ring road consistent with the city's shape. This idea can be generalized. Including all j first, as well as last, rings, any partial sum $l^o(j) = \sum_{i=1}^{j}(s_i - s_{n+1-i})/2$, with $j = 1, \ldots, n/2$, is a lower bound to the number of landlord opponents. Returning to our initial continuous setup, we refine the city's partition into rings by both increasing n and j such that j/n stays constant. The resulting sequence of partial sums converges to

$$l^o(b) \;=\; \Big(\int_0^b f(r)dr - \int_{\tilde{r}-b}^{\tilde{r}} f(r)\,dr\Big)\Big/2,$$

where we have adopted $b = (j/n)\,\widetilde{r}$.

Because integrating $f(r)$ over $[\widetilde{r}-b, \widetilde{r}]$ is the same as integrating $f(\widetilde{r}-r)$ over $[0, b]$, we may usefully rewrite $l^o(b)$ as

$$l^o(b) \;=\; \int_0^b \Big(f(r) - f(\widetilde{r}-r)\Big)\,dr\Big/2 \;=\; \int_0^b D(r)dr\Big/2, \tag{4}$$

with $b \in [0, \widetilde{r}/2]$. Here the second equation in (4) defines the *ring difference* at r, $D(r) = (f(r) - f(\widetilde{r}-r))$. Each such ring difference $D(r)$ juxtaposes commuters living in the "leading ring", at r, with commuters living in its antagonist "lagging ring", at $\widetilde{r} - r$. Equation (4) casts lower bound $l^o(b)$ as a sum of those ring differences.[12] It is clear that most we must be interested in the largest of all these lower bounds $l^o(b)$. It is this bound that is the most successful at extracting political information from the given city shape. To identify it, it remains to maximize $l^o(b)$ with respect to b. This last step is taken shortly, when stating Proposition 1.

A nearly identical argument applies towards bounding from below the number of those landlords who are certain to strictly benefit from, and hence support, the project. To see this note that all s_n

remaining apartments in ring 1 could be occupied by a landlord who is successfully matched up with a tenant in rings $2, \ldots, n-1$. The resulting number of landlord opponents would surely exceed our presumed minimum of $(s_1 - s_n)/2$. On the other hand, if $\sum_{j=2}^{n-1} s_j < (s_1 - s_n)$ then only $\sum_{j=2}^{n-1} s_j$ apartments could be occupied by landlords in ring 1 matched up with some tenant from rings $2, \ldots, n-1$. The remainder would have to be occupied by both landlords and their tenants. The resulting opponent figure, or $(\sum_{j=2}^{n-1} s_j + (s_1 - s_n))/2$, would also exceed our $(s_1 - s_n)/2$. So it is true that we can be confident of $(s_1 - s_n)/2$ landlords to oppose the ring road. – As an aside, if the n-th ring was populated by owner-occupiers only then the minimum number of landlord opponents associated with the first ring would be $s_1/2$, and hence larger always. We make use of this observation in section 6.

[11] It may be helpful to briefly note that the simple (non-cumulative) ring difference $(s_2 - s_{n-1})/2$ cannot be another lower bound. Apartments in the second ring may also house landlords who own their second property in the last, n-th, ring and who hence are strictly better off by adopting the ring road. This disqualifies $(s_2 - s_{n-1})/2$ as lower bound.

[12] Our notation for ring difference D surely will not be mistaken for population density, which is written h. Note that ring differences will resurface when introducing city skewness below (in section 4).

units are tied up in matches that incite their owners to support the ring road – with the exception of those involving a tenant in ring 1. Put differently, replacing the inequality in (3) by $i+j \geq n+2$ and fixing i at n implies $j \geq 2$. To assess minimum conceivable support let every resident in ring 1 be linked to someone in ring n (rather than to someone in any of the other rings). This is another conservative scenario, and in it only $(s_n - s_1)$ apartments point to landlords who would benefit from the policy proposal. Further, suppose, pessimistically, that all of these $(s_n - s_1)$ apartments join landlords and tenants from ring n only. Then $(s_n - s_1)/2$ emerges as our first lower bound on the number of landlord proponents.

Here, too, there are many more lower bounds. For example, another lower bound derives from consulting both the two last and first rings, and comes to $((s_n + s_{n-1}) - (s_1 + s_2))/2$. Generally, if the last, as well as first, j rings are included, the lower bound on landlord proponents can be written as $l^p(j) = \sum_{i=1}^{j} (s_{n+1-i} - s_i)/2$, where $j = 1, \ldots, n/2$. Casting the partial sum of landlord proponents extracted from the first b ring differences in terms of arbitrarily small ring width, and recalling $b = (j/n)\widetilde{r}$ as well as the concept of ring difference D, gives

$$l^p(b) \;=\; \int_0^b \Big(f(\widetilde{r} - r) - f(r)\Big)\, dr \Big/ 2 \;=\; \int_0^b \Big(-\, D(r)\Big)\, dr \Big/ 2, \tag{5}$$

again where $b \in [0, \widetilde{r}/2]$. Note that $l^p(b) = -l^o(b)$. The largest of all these latter lower bounds is found by maximizing the integral with respect to b. Equivalently we may minimize this integral's negative, i.e. $l^o(b)$, and proceed with the negative of the minimum value obtained. This final step also is taken when stating Proposition 1, i.e. now.

Proposition 1: (Extracting Voter Share Estimates from the City's Shape)

(i) (Lower Bounds, and Existence): Lower bounds on the number of landlord opponents, $\underline{l}^o$*, and on the number of landlord proponents,* $\underline{l}^p$*, are identified as*

$$\underline{l}^o \;=\; \max_{b \in [0,\, \tilde{r}/2]} \left[\int_0^b D(r)\, dr \Big/ 2\right] \qquad \text{and} \qquad \underline{l}^p \;=\; -\min_{b \in [0,\, \tilde{r}/2]} \left[\int_0^b D(r)\, dr \Big/ 2\right],$$

respectively, and exist always.
(ii) (Positive Bounds): Both lower bounds $\underline{l}^o$ *and* $\underline{l}^p$ *are nonnegative.*
(iii) (Upper Bounds): Opponents' number l^o *is bounded as in* $\underline{l}^o \leq l^o \leq 1/2 - \underline{l}^p$*; while proponents' number,* l^p*, is bounded via* $\underline{l}^p \leq l^p \leq 1/2 - \underline{l}^o$*.*
(iv) (Useful Bounds): Lower bounds $\underline{l}^o$ *and* $\underline{l}^p$ *are zero both (i.e. useless) if and only if the density of commuting distance* f *is symmetric.*
(v) (Sufficient Bounds): If $\underline{l}^o > 1/4$ *(alternatively if* $\underline{l}^p > 1/4$*) then a majority of landlord opponents (landlord proponents) reject (push through) the ring road.*
(vi) (Special Bounds): If f *is decreasing in* r *on* $[0, \widetilde{r}/2]$*, then* $\underline{l}^o = F(\widetilde{r}/2) - 1/2$ *and* $\underline{l}^p = 0$*, while if* f *is increasing in* r *on* $[0, \widetilde{r}/2]$ *then* $\underline{l}^o = 0$ *and* $\underline{l}^p = 1/2 - F(\widetilde{r}/2)$*.*

Part (i) provides estimates of the impact of the city's "physical sphere" (differences between housing stocks in antagonist rings) on its "political sphere" (lower bounds on landlord opposition or landlord consent), a transmission that operates as silently as it is fundamental. These estimates can always be computed. Part (ii) notes that lower bounds must be non-negative since the maximizers involved in computing either bound equal 0 at worst, reducing the corresponding integral to zero then. Part (iii) adds that the lower bound on landlord proponents of the ring road also converts into an upper bound on landlord opponents, and vice versa.[13]

Part (iv) emphasizes that, with the exception of the improbable case where f is symmetric, at least one of the two lower bounds must bind. For this reason alone our pair of lower bounds must be useful. Finally, and most importantly, the ring road proposal is rejected under majority rule with certainty as soon as $\underline{l}^o$ exceeds one fourth of the housing stock, *irrespective* of the city's specific apartment portfolio assignment (Part (v)). Lower bounds become particularly useful once they exceed the one-fourth threshold. But they should also be useful even when this is not true. Note that if we eventually allowed for construction, Part (v) would also point to the possibility of a long run *lock-in*. A city with a shape such that $\underline{l}^o > 1/4$ holds on to its center. Yet this in turn just affirms that shape.

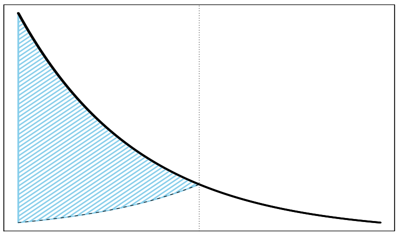
Fig. (1) illustrates lower bounds $\underline{l}^o$ and $\underline{l}^p$. In each of the Figure's panels the horizontal axis gives commuting distance r from the CBD, while the vertical axis gives commuting density $f(r)$.[14] (Axes are not scaled identically across panels.) The vertical line at each panel's center rises up above "midtown" $\widetilde{r}/2$, about which the graph of $f(r)$ is "folded over" (reflected) in order to obtain, and illustrate, ring differences $D(r)$ at all distances between 0 and $\widetilde{r}/2$. I.e., ring differences are represented by the vertical distances between the two graphs (lines) shown left of $\widetilde{r}/2$. Note how the commuting density is increasing over at least some subset of the support in most panels. In a circular city this easily arises whenever the increase in built-up area from adding yet another ring outweighs the diminishing population density that is typical of many (though not all) cities.

We turn to the stylized city shapes (a) through (c) first. Panel (a) shows what we might dub a "classical city". With its true distribution documented by de Lara et al. (2013, cf. Fig. 3), Paris quite closely (though not perfectly) resembles this "classical city". Panel (b) depicts a "hat city" that reflects the fact that the CBD needs land, too. Panel (c) illustrates an "edge city" (if a monocentric one), across which most commuters travel long distances. We note that panels (a) and (c) illustrate the special cases set out in Proposition 1's Part (vi). − Lower bounds can be inferred from consulting corresponding shaded areas. In panels (a) and (b), the lower bound on opponents amounts to half the shaded area *below* the density's graph (blue on screen); whereas in panel (c) the lower bound on *proponents* amounts to half the shaded area *above* the density's graph (in red).

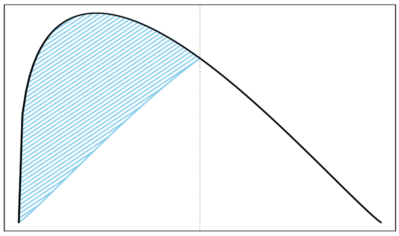
Panel (d) adds an "inverted-U city" to our little city morphology. Moscow, for example, appears to exhibit just this shape (Bertaud/Renault (1997), cf. Fig. (1b)). The "inverted-U" city is different from the three preceding stylized city shapes. Neither is one of the two lower bounds zero, nor are lower bounds just as easily read off the shaded areas. In panel (d), and following the principles outlined above, the lower bound on opponents is equivalent to half the area obtained after subtracting the smaller, and doubly, shaded (orange) area from the larger, singly shaded, (blue) one. While early ring differences are negative, later ring differences are overwhelmingly

[13]Since the interval $[\underline{l}^o, 1/2 - \underline{l}^p]$ contains the true l^o for any given city, this interval's size effectively indicates the precision of our lower bound $\underline{l}^o$. (A similar point applies to $\underline{l}^p$.) For city shapes for which this interval is small our lower bound supplies a more precise estimate than for city shapes for which this interval is large.

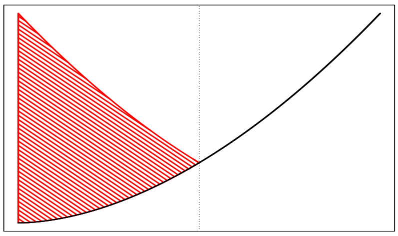
[14]These commuting densities merely serve to illustrate our lower bounds, rather than simulate equilibrium commuting densities obtained from the housing market equilibrium set out in eq. (1).



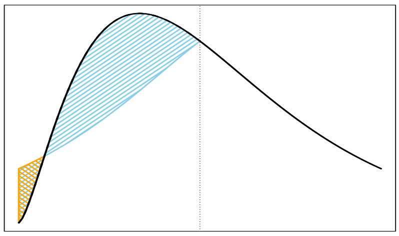
(a) Classical City



(b) Hat City



(c) Edge City



(d) Inverted-U City

Figure 1: Extracting Lower Bounds from City Shape

positive. Including those later, and positive, differences in our lower bound (i.e. a cumulative sum) is preferable even if that comes at the cost of also including those earlier, and negative, differences.

Panel (d)'s "inverted-U city" illustrates the principles underlying our lower bound on landlord *proponents*, too. Here this latter lower bound occurs where D vanishes, or where f and its reflection $f(\widetilde{r} - r)$ intersect in the Figure.[15] The resulting lower bound is half the cumulative sum of all ring differences from the city center up to the intersection, or half the panel's doubly shaded (or orange) area above the density's graph.[16] Generally we should expect city shapes to be the more informative the more asymmetric they are. A city of symmetric shape, i.e. in which ring differences are zero always, reveals next to nothing of its politics to the observer. The following section will revisit this idea, replacing asymmetry with skew. Also, note how in panels (a) through (d) there always is at least one of the two lower bounds that is active (i.e. strictly positive), as predicted by Proposition 1's Part (iv).

Figure 1's panel (a) also illustrates one scenario where landlord opponents are decisive. Its shaded area is well in excess of half the area below the graph of commuting density. This city *cannot help but* turn down the ring road proposal. Not a single constellation of landlord portfolios exists that could collapse the anti-ring-road majority that is the inescapable consequence of that city's

[15] Minimizing $\int_0^b D(r)dr/2$ requires an interior solution, denoted b^*, to satisfy $f(b^*) = f(\widetilde{r} - b^*)$.

[16] In their policy simulation, Bertaud/Brueckner (2005) show how the introduction of a floor-to-area restriction (FAR) reduces that city's skew. The city shape observed prior to the policy's implementation (Fig. 7) resembles our "inverted-U city".

shape.[17] The same cannot be said for the "hat city" in Figure 1's panel (b). Alternatively, if $\underline{l}^p$ exceeds 1/4 then it is the landlord proponents of the ring road who will prevail. Panel (a) provides one example.

4 The Skewness of the City's Shape

Different city shapes may give rise to similarly sized bounds. It may not so much be the entire commuting distribution that matters to the urban majority but one particular aspect of it. Perhaps a simple suitable indicator of asymmetry, rather than the previous section's more intricate bounds $\underline{l}^o$ and $\underline{l}^p$, could provide an assessment of the city's political economy, also. This section pursues these ideas. We suggest the commuting distribution's *skewness* as an indicator that (i) itself bounds lower bounds from below and (ii) is visually appealing at that. Ultimately it is skewness (form) that drives decisions on the ring road proposal (function): Function follows form (Proposition 2 later).

To start us on this idea we offer an alternative definition of skewness σ, i.e.,

$$\sigma \; = \; \int_0^{\tilde{r}/2} D(r) \left(\widetilde{r}/2 - r \right) dr. \tag{6}$$

Here σ is a weighted sum of those ring differences $D(r)$ introduced in the previous section, with a given ring difference's (positive) weight equal to the two underlying rings' common distance to midtown.[18] We justify σ by pointing to its visual appeal. In formula (6), early ring differences (associated with distances close to 0) receive large weights while late ring differences (associated with distances close to $\widetilde{r}/2$) only benefit from small weights. That an indicator of skewness should reward early ring differences makes sense. Surely how the very distant first and last ring compare to each other frames our perception of the commuting density's (i.e. city shape's) skewness by more than how the two adjacent rings right on either side of midtown $\widetilde{r}/2$ compare to each other. Generally, for a city shape to exhibit strong positive skew, two properties contribute. First, ring differences should more often than not be positive (true for our stylized "classical city", "hat city" and "inverted-U-city" (Figure 1 again), though not true in our "edge city"). And second, these positive ring differences better occur early (close to the CBD) rather than late (close to midtown). The "inverted-U city" displays visibly smaller skew than our "hat city" precisely because it lacks those early positive ring differences.[19] We argue that these properties support our choice of σ as one plausible indicator of skewness.

[17] In that sense we *do* expect to find the interests of a majority of Parisians (or Parisian landlords at least) to always go "back to the center", as suggested by Alexandre Gady, a historian of Paris, who argues: "Paris – it's beautiful. But it's a doll's house! And that's one reason the Parisian élite is so conservative. They live in the doll's house. ... The blindness of the élites is to reproduce a model of returning to the center, always back to the center ..." (as quoted by Gopnik (2014))

[18] In its reliance on $\tilde{r}$, the length of the commuting distribution's support, σ differs from the various definitions of skewness found in the literature. Let ρ denote the commuting distribution's mean, that is $\rho = \int_0^{\tilde{r}} f(r) r dr$. Next note that σ may be rewritten as $\int_0^{\tilde{r}} f(r)(\widetilde{r}/2 - r)dr$, which in turn simplifies to $\widetilde{r}/2 - \rho$. Hence σ simply is midtown distance to the CBD minus mean distance to the CBD. This is not the same as any of the standard definitions of skewness.

[19] Additional shapes could be drawn to illustrate how σ conforms with our intuition on skewness. Symmetric distributions, for instance, are characterized by skewness being equal to zero (as they should be). For symmetric distributions, ring differences D are all zero and hence so is skewness.

At the same time, and as the paper's next proposition, σ also allows us to bound city politics. City skewness connects the graphic with the political, by exploiting both concepts' common mutual connection with the physical. A compact statement of this idea runs through the following short sequence of inequalities:

$$\sigma \;=\; \int_0^{\widetilde{r}/2} D(r)\left(\widetilde{r}/2 - r\right) dr \;\;\leq\;\; \max_{b\in[0,\,\widetilde{r}/2]} \left[\int_0^{b} D(r)\left(\widetilde{r}/2 - r\right) dr\right] \tag{7}$$

$$\leq\;\; \max_{b\in[0,\,\widetilde{r}/2]} \left[\int_0^{b} D(r)\left(\widetilde{r}/2\right) dr\right] \tag{8}$$

$$=\;\; \widetilde{r}\max_{b\in[0,\,\widetilde{r}/2]} \left[\int_0^{b} D(r)\, dr \Big/ 2\right] \;=\; \widetilde{r}\,\underline{l}^o, \tag{9}$$

Inequality (7) exploits the fact that the integral over weighted ring differences is greatest if the integral's upper limit is chosen freely, rather than being invariably fixed at $\widetilde{r}/2$. And equation (9) makes use of the simple fact that a monotonic transformation of the maximand does not affect the maximization procedure's solution. This leaves us with inequality (8). Recall that generally f need not be monotonic in r. But then ring differences $D(r)$ cannot be signed. A ring difference may be anything: positive, zero, or even negative. So replacing $(\widetilde{r}/2 - r)$ by $\widetilde{r}/2$, as we do when going from the r.h.s. of (7) to the r.h.s. of (8), not necesssarily increases the integral.

And yet increase is precisely what that integral does. As the formal proof in the Appendix shows, inequality (8) is true indeed. Its proof really relies on one single important insight. By definition, the upper limit of the integral b on the r.h.s. of (7) is chosen to render the expression in square brackets as large as possible. Let r^* denote the underlying maximizer. In the resulting integral, i.e. in

$$\int_0^{r^*} D(r)\left(\widetilde{r}/2 \,-\, r\right) dr, \tag{10}$$

ring differences may well alternate in sign, but *late* ring differences at distances just short of r^* must be positive. Why else would they have been included in the sum (10)? Yet these late, and positive, ring differences close to r^* are also those where replacing $(\widetilde{r}/2 - r)$ with $\widetilde{r}$ has greatest impact. After all, the change in weight applied when going from the r.h.s. of (7) to the r.h.s. of (8) is r, and hence is largest if r is close to r^*. So intuitively positive ring differences come to enjoy a greater extra in weight than negative ring differences do. On balance replacing weights serves to increase the overall sum.[20] To summarize, replacing $(\widetilde{r}/2 - r)$ by $\widetilde{r}/2$ *does* contribute to raising the r.h.s. of (7), and so inequality (8) *is* true.

We summarize the overall inequality implied by the succession of inequalities (7) through (9), and combine it with $\underline{l}^o \leq l^o$ (Proposition 1), in Proposition 2's first part. There we state that landlord opposition to the ring road proposal is bounded from below by skew σ adjusted for "city size" $\widetilde{r}$, or $\sigma/\widetilde{r}$. The more skewed the city is the more confident we can be of the ring road proposal's meeting landlord resistance. Proposition 2's first part also states that the negative of adjusted city skew bounds landlord proponents from below.[21] We conclude that in sufficiently positively skewed cities (Figure 1's panel (a), (b) and (d))), part (i)'s first inequality may be useful, while in

[20] The formal proof in the Appendix generalizes this intuitive idea to city shapes for which ring differences' signs alternate more often than just once (i.e. finitely many times).

[21] The formal proof is similar to that just presented. A sketch appears in the Appendix.

sufficiently negatively skewed cities (Figure 1's panel (c)) we exploit the second inequality instead. Either way one of the proposition's two inequalities must be helpful except when the city's shape f is symmetric.

Proposition 2: (Function Follows Form)
(i) (Physical and Visual): Adjusted city skew $\sigma/\widetilde{r}$ *bounds landlord opponents via* $\sigma/\widetilde{r} \leq l^o$*, and bounds landlord proponents as in* $-\sigma/\widetilde{r} \leq l^p$*.*
(ii) (Function Follows Form): If $\sigma/\widetilde{r} > 1/4$ *(or* $-\sigma/\widetilde{r} > 1/4$ *alternatively) the center retains its retail and employment function (the periphery takes over jobs and shops).*

Proposition 2's Part (ii) sets out the paper title's causality from city shape (form) to buildings' residential vs. commercial uses (function). On the one hand, if $\sigma/\widetilde{r}$ exceeds 1/4 then this is not just true for $\underline{l}^o$ but *a fortiori* also for l^o. On the other hand, if $-\sigma/\widetilde{r}$ exceeds 1/4 then so does l^p. Buildings in the city traditionally house retail and office uses. If city skew is strong enough then traditional uses are certain to be preserved, while if city skew is sufficiently negative then uses are sure to be reversed, i.e. city center buildings become residential and it becomes peripheral structures' turn to take over the retail and office function.[22] Of course, for "amorph cities", with $\sigma/\widetilde{r}$ in the closed interval $[-1/4, 1/4]$, equilibrium policy cannot be assessed further.

5 Shape Origins and Skyline Convexity

This section traces the city's shape back to urban (i) topography and (ii) technology. To best discuss these ultimate determinants of urban form (and hence, by virtue of Proposition 2, urban functions), we make two stylized additions to the model. First, land supply is capped in lagging, though not in leading, rings. Only fraction α represents developable land available in lagging rings. Below, an exogenous drop in α roughly represents the transition to a more "linear" city. And second, residential housing only begins at $\widehat{r}$, rather than at 0, where $\widehat{r} \geq 0$ generally and $\widehat{r} = 0$ initially. Differences in $\widehat{r}$ may reasonably be thought to reflect differences in CBD size, cross-sectional variation in federal zoning (e.g., prohibiting residential uses near the CBD) or the presence of a green belt. We might add that much of World War II aerial bombing afflicted central city, rather than peripheral, housing (starting with Germany's bombing of Warsaw and Rotterdam, e.g. Lampugnani (1985), Brakman et al. (2004)), and hence may fit the increase in $\widehat{r}$ analyzed below. Besides, changes in α and $\widehat{r}$ are not purely cross-sectional only. A climate change induced rise in the sea level, for instance, will also induce variation in coastal contours, and hence variation in α.

[22] To pick up on an earlier footnote, shape and skyline coincide in peninsula (linear) cities. Intuitively, New York and San Francisco appear to have both: positively skewed skylines-shapes and strong, confident CBDs. According to Proposition 2, this is not a coincidence but an implication of the city's shape. We further pusue this idea in the following section. We also briefly comment on the evidence in Burchfield et al. (2006) according to which there is "almost no correlation between the extent to which residential development is scattered and that to which employment is decentralized" by noting that Proposition 2 relies on the skew of the commuting distribution, rather than on the extent to which development is scattered.

Now, ring differences, housing market equilibrium, and our lower bound become

$$D(r,\widetilde{r},\alpha) = 2\pi\Big(rh(r) - \alpha(\widetilde{r}-r)h(\widetilde{r}-r)\Big), \tag{11}$$

$$1 = 2\pi\Big(\int_{\hat{r}}^{\tilde{r}/2} rh(r)\,dr + \int_{\tilde{r}/2}^{\tilde{r}} \alpha r\,h(r)\,dr\Big), \tag{12}$$

$$\underline{l}^o(\alpha,\widehat{r}) = \max_b \int_{\hat{r}}^{b} D(r,\widetilde{r},\alpha)\,dr\Big/2 \tag{13}$$

respectively. For completeness we add that changes in $\underline{l}^p(\alpha,\widehat{r})$ simply go into the opposite direction of any changes in $\underline{l}^o(\alpha,\widehat{r})$, and so there is no explicit discussion of these former changes below.

Changes in α or $\widehat{r}$ have direct effects on our lower bound on landlord opponents that are easily gauged from consulting (13). But there are also indirect effects, operating through the adjustment of $\widetilde{r}$ implied by having to maintain equilibrium in the housing market (12). Fortunately, there is no need to account for the adjustment in the optimum upper limit entering $\underline{l}^o$, denoted b^*. By its definition (in (6)), $\underline{l}^o$ is a (maximum) value function, and so its derivatives with respect to α and $\widehat{r}$ may be approached with the envelope theorem in hand. We thus have

$$\frac{d\underline{l}^o(\alpha,\widehat{r})}{d\alpha} = \int_0^{b^*}\Big(\frac{\partial D(r,\widetilde{r},\alpha)}{\partial\alpha} + \frac{\partial D(r,\widetilde{r},\alpha)}{\partial\widetilde{r}}\,\frac{\partial\widetilde{r}}{\partial\alpha}\Big)\,dr\Big/2, \tag{14}$$

$$\frac{d\underline{l}^o(\alpha,\widehat{r})}{d\widehat{r}} = \int_0^{b^*}\frac{\partial D(r,\widetilde{r},\alpha)}{\partial\widetilde{r}}\,\frac{\partial\widetilde{r}}{\partial\widehat{r}}\,dr\Big/2. \tag{15}$$

These derivatives inform us about changes in the lower bound on landlord opponents, and so we do not know how actual landlord opponent numbers change. Nonetheless we will think of an increase in $\underline{l}^o$ joint with a simultaneous decrease in $\underline{l}^p$ as indicating that decentralization is becoming less "likely".

Both derivatives feature the common partial derivative $\partial D/\partial\widetilde{r}$. This derivative is positive if the skyline h is convex (Lemma 2, in the Appendix). An increase in $\widetilde{r}$ (as implied by a shock to α or $\widehat{r}$) raises rent throughout the city, yet has two opposing effects on ring differences D. On the one hand, population in each leading ring, at r, grows because buildings rise in height when rents go up. On the other hand, population in each lagging ring, at $\widetilde{r}-r$, grows because that ring now has shifted out, and hence commands a greater area. If the city skyline is convex, then the extra floor space obtained from building higher up near the center exceeds the extra floor space provided by even more bungalows at the city's periphery.[23] Note that historically, skylines have often been found to be convex. Bertaud (2003, p. 12) shows a number of population density plots that best are approximated by strictly convex densities (Paris, Bangkok, Jakarta). The negative exponential that often is successfully fitted to empirical population densities in the literature (e.g. Mcdonald (1989), Bertaud/Malpezzi (2014), Duranton/Puga (2015)) is strictly convex.[24]

Consider a city with a convex skyline (Proposition 3). First, a circular city will be more inclined to decentralize than a slightly less circular one. Taking land away from lagging rings has the urban boundary shift out, so that rents rise throughout the city. Because leading rings add more population than lagging rings do (given convexity), ring differences, and our lower bound on landlord

[23]For now we take skyline convexity as given. But one might wish to relate the skyline's convexity to its proximate causes. Building height restrictions surely do not contribute to convexity (and in fact may cause the skyline to be concave rather than convex.)

[24]We add that, Kim (2007), however, also supplies evidence according to which density gradients in US urban areas may have "flattened", i.e. become less convex.

opponents, rise. As an application, and somewhat speculatively, Europe may have decentralized jobs and shops less than the US because its more rugged topography presses its cities into more of a linear mold. And second, a city embraces decentralization less when its CBD expands. As housing shifts out to the city periphery, rents rise throughout the city. Due to the skyline's convexity, this will again raise population in leading rings by more than it will raise that in lagging rings. The lower bound on landlord opponents increases. Skyline convexity emphasizes the importance of being able to build up in the city's leading rings in response to central housing loss if a city is to retain its traditional center. Building height requirements often prevent such adjustment (Bertaud/Brueckner (2005), Glaeser (2011)).

Proposition 3: (The Origins of Form, and Function)
Consider a city with a convex skyline. Let α fall, marking a transition from a more circular to a more linear city, or let $\widehat{r}$ rise, driving residential housing away from the center. In either case, our lower bound on landlord opponents $\underline{l}^o$ rises, and our lower bound on landlord proponents $\underline{l}^p$ falls.

6 Extensions

The paper's model rests on a closed-city-resident-landlords framework. Resident landlords' political interests we unveil by inspecting the city's shape. City shape's skew turns out to be an urban property endowed with the merits of (i) data availability and (ii) predictive power. Admittedly, exposing this property relies on a number of debatable assumptions. Not all cities are closed; landlords may own more, or less, than two apartments; landlords may vary by the extent to which they own multiple properties; decentralization need not be beneficial if commuting costs also rise; building a ring road may seem a very special case of an urban policy; and so forth. In any event, note that our assumptions give conditions sufficient for the paper's propositions. Mild deviations from these assumptions not necessarily overturn them. In fact, mild variations may even strengthen these propositions.

Consider the role of the closed city assumption. Treating the city as closed if really it is open biases our results. If the city is open then constructing a ring road opens up a host of new property developments on land that was out of reach previously. This land will be attractive to the mobile among other cities' residents, and a competitive housing industry will develop residential housing on it. If rents earned from all of this extra housing accrue to the city's indigenous landlords then these indigenous landlords obviously have an – added – incentive to decentralize, and this continues to be true if indigenous landlords only appropriate a fraction of these gains. Moreover, we still may treat mobile, indifferent tenants as abstaining from the ring road poll. An open city must be particularly skewed if it is to withstand this extra temptation and stick to its traditional center.

We have argued that the one landlord–one tenant assignment exposes the city shape's role for urban political economy at minimum cost. Relaxing this assumption can enrich the model in interesting ways, too. E.g., suppose that a fraction $1 - \alpha$ of all housing belongs to owner-occupiers, while the remaining share α is owned by landlords owning two properties each. Suppose further that owner-occupiers only, and exclusively, live in apartments located beyond $r_1 > \widetilde{r}/2$. This probably is a fair assumption for many cities' suburban housing. Owner-occupiers' interest in decentralization is obvious, but those $\alpha/2$ landlords' political interests are not. Suppose the last ring were inhabited by owner-occupiers only. Consulting (3), now all housing in the first ring can safely be assumed to point to landlord opponents. When constructing the first lower bound, no correction other than dividing by 2 is called for. Ultimately it merely is the skewness of the city's shape over the "intermediate rings" that matters.

Our analysis has focused on replacing the CBD with a string of shopping districts and office parks along the ring road, in one swipe. One might object that this is too radical a policy. But our analysis may apply to other urban transportation policies, too. We might, for example, analyze an increase in t brought about by a tax on commuting or a neglect of radial roads. Taking the first derivative of landlord utility $\omega + t(\widetilde{r} - r_i - r_j)$ with respect to t gives $(\widetilde{r} - r_i - r_j)$. A landlord votes *for* the tax on commuting precisely if $i + j \leq n$, which just repeats the familiar condition (3) We conclude that our $\underline{l}^o$ also is a lower bound on landlords supporting an increase in t. When tenants have less political clout than landlords this observation could be useful. Not all landlords vote for the commuting tax. But those who do clearly do so for the rise in rent implied (as in Borck/Wrede (2005)). Likewise, $\underline{l}^p$ may be a lower bound on landlords endorsing a commuting subsidy.

Average commuting cost ρ could be considered one useful measure of welfare. The city decentralizes for sure if $-\sigma/\widetilde{r} > 1/4$ (Proposition 2, Part (ii)), or if $\rho > (3/4)\widetilde{r}$ equivalently given that $\sigma = \widetilde{r}/2 - \rho$. Decentralization transforms each distance r into $\widetilde{r} - r$, and hence also transforms average commuting cost ρ into $\widetilde{r} - \rho$. Yet if average commuting cost ρ exceeds $(3/4)\widetilde{r}$ initially, then average post-decentralization commuting cost must fall short of $\widetilde{r}/4$. Building costless ring roads, on which commuters later travel at no cost, makes negatively skewed cities better off. At the same time, ring roads are certainly not costless, and neither is travel on a ring road. Suppose, for instance, that t rises to $t' > t$ as the city decentralizes. If aggregate commuting costs equal $t\rho$ before, they amount to $t'(\widetilde{r} - \rho)$ after, decentralization. Whether society is better off depends on whether $t'/t < (\widetilde{r} - \rho)/\rho$. This may, or may not, hold. Welfare reducing decentralization is a possible outcome of an extended model.

Throughout the paper we have held population fixed. If we allow for immigration, extra layers of peripheral rings will form, and rents throughout the city will rise. Again it is the city skyline's convexity that helps predict how ring differences, and hence landlord interests, respond. Building height restrictions, in particular, will prevent the central city housing height adjustment that may counter the extra political weight that the proposition of decentralization inevitably attracts.

7 Conclusions

While city policy obviously shapes urban form, this paper argues that urban form also shapes city policy. The more skewed a city's shape, the less conceivable a majority of residents that prefer replacing the traditional center at the CBD by a succession of office parks and shopping malls along a ring road. This theory also relates to two long-standing themes in both architectural theory and economics. It connects to architectural theory because it completes the relationship between function and form. As Frank Lloyd Wright notes (quoted in Saarinen (1954)), "Form follows function – that has been misunderstood. ... Form and function should be one, joined in a spiritual union.” And it connects to mainstream economics. Economics as a field is weary of generalizing an aggregate’s properties on towards the aggregate’s component members lest it commit a “fallacy of division”. By linking the built environment (a society aggregate) to the preferences of at least a majority of its landlords (a decisive subset of society’s members) we provide an example of where inferring dominant residents’ properties does seem justified after all. Whenever the city’s shape “leans towards” the city center (a majority of) resident landlords are inclined to maintain, and hence “lean towards”, the city center. Conversely, if the city “leans towards” the periphery (a majority of) resident landlords are inclined to develop, and hence “lean towards”, the periphery. No fallacy is involved when assessing a city’s politics by its shape.

8 Literature

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9 Appendix

Proof of Proposition 1:

Part (i) (Lower Bounds, and Existence): Consider a landlord who resides in ring i yet rents out the extra property in ring j. This is a "match" $\{i, j\}$. Let matrix B collect the frequencies with which matches $\{i, j\}$ occur. For example, $b_{1,3}$ is the number of times a landlord owning, and living in, an apartment in the first ring also owns an apartment in ring 3. Note that, with this definition, the sum of all entries in row i plus the sum of all entries in column i just yield the apartment total in ring i.

$$B = \begin{pmatrix} b_{1,1} & b_{1,2} & b_{1,3} & \dots & b_{1,n-2} & b_{1,n-1} & b_{1,n} \\ b_{2,1} & b_{2,2} & b_{2,3} & \dots & b_{2,n-2} & b_{2,n-1} & b_{2,n} \\ \vdots & \vdots & \vdots & & \vdots & \vdots & \vdots \\ b_{n-1,1} & b_{n-1,2} & b_{n-1,3} & \dots & b_{n-1,n-2} & b_{n-1,n-1} & b_{n-1,n} \\ b_{n,1} & b_{n,2} & b_{n,3} & \dots & b_{n,n-2} & b_{n,n-1} & b_{n,n} \end{pmatrix}. \tag{16}$$

In view of condition (3), B's counter diagonal (comprising all the elements on the diagonal stretching from the bottom left corner to the top right hand corner) collects all those matches that leave landlords indifferent to the ring road. In contrast, entries above (below) B's counterdiagonal collect all those matches that involve landlord opponents (landlord proponents).

Since $(s_1 - s_n)/2$ is an obvious first lower bound, let us make precise the second lower bound discussed in the main text instead, or $(s_1 + s_2 - (s_{n-1} + s_n))/2$. In (16), s_1 and s_2 are the sums of all entries given in the first row and column and second row and column, respectively. It is clear that this sum overstates the number of landlord opponents; some of its elements are found on, or below, our counterdiagonal. The implied error amounts to

$$\Big(b_{n,1} + b_{n-1,2} + b_{n,2}\Big) \; + \; \Big(b_{1,n} + b_{2,n-1} + b_{2,n}\Big). \tag{17}$$

This error collects a subset of all the matches linking apartments in the last two rings to apartments in the first two rings, indicating landlords that do not oppose the ring road at all. We take care of these by subtracting *all* apartments in the last two rings from $(s_1 + s_2)$, i.e. by subtracting $(s_{n-1} + s_n)$. Similar reasoning applies to subsequent lower bounds on landlord opponents, or to any lower bound on landlord proponents.

As shown in the main text, the desirable lower bound on landlord opponents and the desirable lower bound on landlord proponents are the maximum of $l^o(b)$ and that of $l^p(b)$, respectively. Being integrals of continuous functions, $l^o(b)$ and $l^p(b)$ are differentiable on the compact interval $[0, \widetilde{r}/2]$. Hence both these maxima always exist. □

Part (iv) (Useful Bounds): The proof is by contradiction. Thus suppose both lower bounds are useless. I.e., suppose

$$\max_{b \in [0, \widetilde{r}/2]} \left[\int_0^b D(r)\, dr \right] = 0 \qquad \text{and} \qquad \min_{b \in [0, \widetilde{r}/2]} \left[\int_0^b D(r)\, dr \right] = 0.$$

From the first equation we gather that $\int_0^b D(r)dr \leq 0$ for all $b \in [0, \widetilde{r}/2]$ (else $\underline{l}^o$ would need to be positive, contradicting our assumption); whereas from the second equation above we infer that $\int_0^b D(r)dr \geq 0$ for all $b \in [0, \widetilde{r}/2]$ (else $\underline{l}^p$ would have to be positive, contradicting our assumption). Joining these latter two inequalities gives

$$\int_0^b D(r)\, dr = 0$$

for all $b \in [0, \widetilde{r}/2]$. This implies that the integral in the last equation is a constant function of b. Hence its derivative with respect to b, or $D(b)$, must equal zero for all b. So f is symmetric. Finally, if f is symmetric both bounds obviously are useless (zero). □

Part (vi) (Special Bounds): If f is decreasing (increasing) on $[0, \widetilde{r}/2]$, then $\widetilde{r}/2$ maximizes $l^o(b)$ ($l^p(b)$). □

Proof of Proposition 2:

Part (i) (Physical and Visual): Following the discussion in the main text, to complete the proof it remains to show that inequality (8) is true. We introduce some auxiliary notation first. Let the signs of ring differences $D(r)$ alternate on $[0, r^*]$. Consider all those intervals on which D retains its sign. We pair off these intervals into groups of two. That is, we divide $[0, r^*]$ into n consecutive intervals (or rings) $[0, r_1^*]$, $[r_1^*, r_2^*]$, …, $[r_{n-1}^*, r^*]$ such that the i-th such interval (ring) decomposes into one subset on which $D < 0$, denoted $[r_{i-1}^*, \widehat{r}_i]$, and another on which $D > 0$, written $[\widehat{r}_i, r_i^*]$. We also adopt $r_0^* = 0$ and $r_n^* = r^*$.

Now, by the mean value theorem of integration, there must be numbers c_i' and c_i'', satisfying $\widetilde{r}/2 \geq c_i' \geq c_i'' > 0$ as well as $c_i' \geq c_{i+1}'$ for all i, such that

$$\begin{aligned}
\max_{b \in [0, \widetilde{r}/2]} \left[\int_0^b D(r) \left(\widetilde{r}/2 - r\right) dr \right] &= \sum_{i=1}^{n} \left[\int_{r_{i-1}^*}^{\widehat{r}_i} D(r) \left(\widetilde{r}/2 - r\right) dr + \int_{\widehat{r}_i}^{r_i^*} D(r) \left(\widetilde{r}/2 - r\right) dr \right] \\
&= \sum_{i=1}^{n} \left[c_i' \int_{r_{i-1}^*}^{\widehat{r}_i} D(r)\, dr \;+\; c_i'' \int_{\widehat{r}_i}^{r_i^*} D(r)\, dr \right] \\
&\leq \sum_{i=1}^{n} \left[c_i' \int_{r_{i-1}^*}^{\widehat{r}_i} D(r)\, dr \;+\; c_i' \int_{\widehat{r}_i}^{r_i^*} D(r)\, dr \right] \\
&= \sum_{i=1}^{n} c_i' \int_{r_{i-1}^*}^{r_i^*} D(r)\, dr. \qquad (18)
\end{aligned}$$

Lemma 1 (following this proof) shows that $\int_{r_{n-j}^*}^{r^*} D(r) dr \geq 0$ for any $j = 1, \ldots, n$. That is, summing over any j last ring differences gives a non-negative number. We continue with the r.h.s. of (18) making repeated use of this. I.e.,

$$\begin{aligned}
\sum_{i=1}^{n} c_i' \int_{r_{i-1}^*}^{r_i^*} D(r)\, dr &= \sum_{i=1}^{n-1} c_i' \int_{r_{i-1}^*}^{r_i^*} D(r)\, dr \;+\; c_n' \int_{r_{n-1}^*}^{r^*} D(r)\, dr \\
&\leq \sum_{i=1}^{n-1} c_i' \int_{r_{i-1}^*}^{r_i^*} D(r)\, dr \;+\; c_{n-1}' \int_{r_{n-1}^*}^{r^*} D(r)\, dr \\
&= \sum_{i=1}^{n-2} c_i' \int_{r_{i-1}^*}^{r_i^*} D(r)\, dr \;+\; c_{n-1}' \int_{r_{n-2}^*}^{r^*} D(r)\, dr \;\leq\; \ldots \;\leq\; c_1 \int_0^{r^*} D(r)\, dr
\end{aligned}$$

Note how successive inequalities repeatedly exploit Lemma 1, for increasingly larger values of j. It remains to add that

$$c_1 \int_0^{r^*} D(r)\, dr \;\leq\; \int_0^{r^*} D(r)(\widetilde{r}/2)\, dr \;\leq\; \max_{b \in [0, \widetilde{r}/2]} \left[\int_0^b D(r) \left(\widetilde{r}/2\right) dr \right]$$

Putting all consecutive inequalities in this paragraph together completes the proof of inequality (8). (The proof of the second inequality in Part (i) proceeds along similar lines.) □

Lemma 1:

For all $j = 1, \dots, n$, it is true that

$$\int_{r^*_{n-j}}^{r^*} D(r)\, dr \;\geq\; 0. \tag{19}$$

Ring differences in any last j rings sum to a non-negative number.[25]

Proof of Lemma 1: The proof makes use of the notation introduced in the proof of inequality (8) in the main text. We first show that $\int_{r^*_{n-1}}^{r^*} D(r)dr \geq 0$. As our point of departure, recall that surely

$$0 \;\leq\; \int_{r^*_{n-1}}^{r^*} D(r)(\widetilde{r}/2 - r)dr$$

because otherwise r^* could not be the optimizer. (The n-th ring should not have been included in $\underline{l}^o$.) But then

$$\begin{aligned} 0 \;&\leq\; c'_n \int_{r^*_{n-1}}^{\widehat{r}_n} D(r)\, dr \;+\; c''_n \int_{\widehat{r}_n}^{r^*} D(r)dr \\ &\leq\; c'_n \int_{r^*_{n-1}}^{\widehat{r}_n} D(r)\, dr \;+\; c'_n \int_{\widehat{r}_n}^{r^*} D(r)dr \;=\; c'_n \int_{r^*_{n-1}}^{r^*} D(r)\, dr \end{aligned}$$

Since $0 < c'_n$ this proves $\int_{r^*_{n-1}}^{r^*} D(r)dr \geq 0$. Next we show that $\int_{r^*_{n-2}}^{r^*} D(r)dr \geq 0$. Following similar reasoning as above, clearly

$$0 \;\leq\; \int_{r^*_{n-2}}^{r^*} D(r)(\widetilde{r}/2 - r)dr$$

But then

$$\begin{aligned} 0 \;&\leq\; c'_{n-1} \int_{r^*_{n-2}}^{\widehat{r}_{n-1}} D(r)\, dr \;+\; c''_{n-1} \int_{\widehat{r}_{n-1}}^{r^*_{n-1}} D(r)dr \;+\; c'_n \int_{r^*_{n-1}}^{r^*} D(r)\, dr \\ &\leq\; c'_{n-1} \int_{r^*_{n-2}}^{\widehat{r}_{n-1}} D(r)\, dr \;+\; c'_{n-1} \int_{\widehat{r}_{n-1}}^{r^*_{n-1}} D(r)dr \;+\; c'_{n-1} \int_{r^*_{n-1}}^{r^*} D(r)\, dr \;=\; c'_{n-1} \int_{r^*_{n-2}}^{r^*} D(r)\, dr \end{aligned}$$

Since $0 < c'_{n-1}$ this proves $\int_{r^*_{n-2}}^{r^*} D(r)dr \geq 0$. Proceeding along these lines proves Lemma 1. □

Lemma 2: If building height $h(r)$ is convex then the following inequality holds:

$$\frac{\partial D(r, \widetilde{r}, \alpha)}{\partial \widetilde{r}} \;>\; 0.$$

Proof of Lemma 2: We note three properties of the building height (or skyline) function h. First, $h(r)$ also depends on $\widetilde{r}$. A greater urban boundary $\widetilde{r}$ increases pressure on rent, and this in turn raises building height. Second, $h(\widetilde{r} - r)$ does not depend on $\widetilde{r}$. A greater urban boundary $\widetilde{r}$ does not increase pressure on rent in a ring $\widetilde{r} - r$ that sees its relative position (its position relative to the urban boundary) unchanged. And third, the increase in building height implied by the urban boundary shifting out by one unit of distance equals the change in building height induced by approaching the CBD by one unit of distance, or:

$$\frac{\partial h(r)}{\partial \widetilde{r}} \;=\; -\frac{\partial h(r)}{\partial r}. \tag{20}$$

[25] This property also is illustrated by the simple example of Figure 1's panel (d) where positive ring differences dominate negative ring differences.

Differentiating $D(r, \widetilde{r}, \alpha)$ as in (11) with respect to $\widetilde{r}$, accounting for the first two Ricardian rent properties just listed and also dividing by 2π gives

$$\frac{1}{2\pi}\,\frac{\partial D(r, \widetilde{r}, \alpha)}{\partial \widetilde{r}} \;=\; \frac{\partial h(r)}{\partial \widetilde{r}}\, r \;-\; \alpha\, h(\widetilde{r} - r). \tag{21}$$

Now, by the convexity of h, we have

$$\frac{\partial h(r)}{\partial r}\, r \;<\; \frac{\partial h(\widetilde{r} - r)}{\partial r}\, r \;<\; h(\widetilde{r}) \;-\; h(\widetilde{r} - r)$$

for $r \in [0, \widetilde{r}/2]$. Combining this with the fact that $h(\widetilde{r}) = 0$, making use of the third of Ricardian rent's properties listed in (20) and exploiting $1 \geq \alpha$ gives

$$\frac{\partial h(r)}{\partial \widetilde{r}}\, r \;>\; \alpha h(\widetilde{r} - r).$$

This proves that either expression in (21) is strictly positive. □

Proof of Proposition 3: Implicitly differentiating (12) reveals the partial derivatives of $\widetilde{r}$ with respect to parameters α and $\widehat{r}$. These derivatives' signs are

$$\frac{\partial \widetilde{r}}{\partial \alpha} \;<\; 0 \qquad \text{and} \qquad \frac{\partial \widetilde{r}}{\partial \widehat{r}} \;>\; 0.$$

Assuming convexity of h, we infer the corresponding sign of $\partial D / \partial \widetilde{r}$ by making use of Lemma 2. Finally, we write down the obvious property that

$$\frac{\partial D(r, \widetilde{r}, \alpha)}{\partial \alpha} \;<\; 0. \tag{22}$$

Combining the various derivatives' signs then reveals that

$$\frac{d\underline{l}^o(\alpha, \widehat{r})}{d\alpha} \quad < \quad 0 \qquad \text{and} \qquad \frac{d\underline{l}^o(\alpha, \widehat{r})}{d\widehat{r}} \;>\; 0$$

The corresponding signs for the implied changes in $\underline{l}^p$ are simply the negative of the signs given above. □

Housing Market Stability, Mortgage Market Structure and Monetary Policy: Evidence from the Euro Area

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This paper investigates how the monetary policy stance and the mortgage market structure affect the non-fundamental house price movements in 11 Euro Area countries. Based on a three stage approach, the empirical evidence suggests that a one-time monetary easing shock can significantly trigger house price boom in euro area countries with a liberal mortgage market and can explain over 20% of the forecasting error variance of non-fundamental house price run-ups in Ireland and Spain. In countries with more regulated mortgage markets, the monetary policy stance does not significantly affect the non-fundamental house price. Policy makers may focus on limiting mortgage equity withdrawals, Loan-to-Value ratios and monitoring tax policies in order to minimize the side effects of accommodative monetary policies on housing market stability for euro area countries, especially for peripheral countries which are more likely to be subjected to a too loose monetary policy stance.

Keywords: House prices, Taylor Rate, Non-fundamental house price, Mortgage market structure

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Preliminary Version.

Abstract

This paper investigates how the monetary policy stance and the mortgage market structure affect the non-fundamental house price movements in 11 Euro Area countries. Based on a three stage approach, the empirical evidence suggests that a one-time monetary easing shock can significantly trigger house price boom in euro area countries with a liberal mortgage market and can explain over 20% of the forecasting error variance of non-fundamental house price run-ups in Ireland and Spain. In countries with more regulated mortgage markets, the monetary policy stance does not significantly affect the non-fundamental house price. Policy makers may focus on limiting mortgage equity withdrawals, Loan-to-Value ratios and monitoring tax policies in order to minimize the side effects of accommodative monetary policies on housing market stability for euro area countries, especially for peripheral countries which are more likely to be subjected to a too loose monetary policy stance.

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1 Introduction

> *"[…] Even more so in a monetary union where vulnerability identified in each country can be addressed with macro-prudential policy, allowing for the appropriate heterogeneity, while countries remain subject to a single monetary policy. […], macro-prudential policy provides monetary policy with additional room for manoeuvre to better focus on ensuring price stability. "*
>
> *-- Vítor Constáncio. Speech ECB 2015*

Over the last decades, one can observe a certain 'de-linking' of short-term house price dynamics from fundamental factors such as income. The non-fundamental house price dominates the short term movement in house prices and leads to massive boom and bust cycles as came apparent in several real estate bubbles. As a large fraction of national wealth, residential investment is a crucial part of general business conditions. Besides that, housing also serves as collateral for loans. The fluctuations of house values would remarkably affect the performance of leveraged financial institutions. Therefore, the fluctuation of house prices may be dangerous and costly, and may even be the source of economic vulnerabilities and crises (Reinhart and Rogoff, 2008, Reinhart and Reinhart, 2008).

The relationship between monetary policy and asset market stability is always an open question. Compared to professional investors in the stock market, homeowners might have a less sophisticated understanding of the economy and hence might view a one-time rise in home prices – resulting from a decline in interest rates – as evidence of a more persistent upward trend. As a result, the housing market might be particularly vulnerable to bubbles. This issue is of particular importance for a monetary union where all countries are subject to a common monetary policy. Rubio and Carrasco-Gallego (2015b) show that because the domestic demand growth was extremely strong at the periphery but very weak at the core, monetary policy was too loose for the periphery and too tight for the rest. Such differences in the monetary policy stance might lead to varying housing market movements in the EMU countries (Seyfried, 2010). As we experienced in the first decade of the twenty first century, although inflation has been muted in most countries, real house prices have very different development. Some Eurozone countries, such as Spain and Ireland, experienced unprecedented boom times, which are arguably contributed to the too loose monetary policy stance. By contrast, in other countries, such as Germany and Austria, very little price movement was observed over the same time horizon.

Moreover, a common monetary policy also limits the use of monetary policy for stabilisation purposes. As bubbles may appear only in some of the member countries, the "lean against the wind" strategy might be effective for preventing the bubble in these countries but at the cost of a recession or at least slower growth in some of the other countries (Allen and Rogoff, 2011). So the "lean against the wind" strategy is difficult to operationalize in the euro area. Policymakers may thus have to choose policy instruments at the national level – macro-prudential policies. Hence, the evaluation of the effectiveness of macro-prudential policies for preventing housing bubbles in the euro area is another purpose of this paper.

However, most of the related researches are based on major OECD countries (see. e.g., Tsatsaronis and Zhu (2004); Giuliodori (2004); Calza et al. (2013); Sá et al. (2014); Iacoviello and Neri (2010); Bauer (2014)). The results from studies focusing on OECD countries may not be directly applicable to euro area countries. One reason could be the heterogeneous banking systems in OECD countries. For instance, in the U.S., market-based financial intermediates hold more than 60% of mortgage (Shin, 2009), while deposit banks are still the dominant mortgage holders in most European countries. Consequently, the traditional bank lending channel may be less effective in the U.S., as the emergence of the market-based financial intermediaries makes banks dependent on insured deposits for funding. Apart from that, euro area countries are subjected to fixed exchange rate. Rubio (2014) shows that as long as the countries are not small and homogeneous enough, fixed or managed exchange rates may amplify the response of house price to a policy shock. Therefore, OECD countries might not be an appropriate sample for the studies on the impact of the monetary policy stance on housing market stability for EMU countries.

The analysis for the EMU countries has received increasingly attentions. Based on DSGE model Rubio (2014) how that the heterogeneous mortgage market structure leads to a different response to monetary policy shocks. Under a similar theoretical framework, Rubio and Carrasco-Gallego (2015a) show that the common monetary policy would be associated with the increase in the liquidity at the periphery and can explain the increase in the house price and stronger credit growth in the peripheral economies in the pre-crisis period. However, empirical evidence is still limited. Focusing on EMU countries, Maclennan et al. (1998) find that countries with fixed interest rate, low loan to value ratios, high transactions costs, and a smaller own-occupied sector tended to experience lower house price change. Annett (2006) show a significant impact of monetary policy on house prices of EMU countries only appears in France, Ireland, Belgium, Finland, and Spain, but not for the panel.

Our paper differs from the aforementioned literature in three ways. First, we are interested on the impact of monetary policy on the non-fundamental run-ups. Literature shows that the interest rate may impact house prices by altering the home buyers' costs of capital (Goodman and Thibodeau, 2008), by affecting the credit channel (Aoki et al., 2004, Iacoviello, 2005, Bernanke and Blinder, 1992) and by changing the investors' risk appetite (Adrian and Shin, 2008, Adrian et al., 2012). A decrease in the homebuyers' borrowing cost is not necessary to relate to an unsustainable house price overshooting. The non-fundamental house price movements would increase market vulnerability and therefore deserve more attention from policymakers.

Second, we use the deviation from Taylor rule rate to proxy the monetary policy stance. Allen and Rogoff (2011) show that the ECB's monetary policy was essentially too loose compared to Taylor rule rate for some countries while being appropriate for the others. So interest rate stance could be different at the core and periphery, due to the heterogeneous local economy conditions among EMU countries. Using short term interest rate as the proxy of monetary policy stance may not be able to capture such difference.

Third, we examine whether macro-prudential policy could help policymakers to eliminate the side effect of an accommodative monetary policy on housing market stability, especially for peripheral countries, which are more likely to be subjected to a too loose monetary policy. We adopt the interacted Panel VAR model to quantify the impact of institutional factors on the responses of the non-fundamental house price run-ups to a monetary easing shock. This approach compares the impact of monetary policy without splitting the country samples and allows for a time varying mortgage market characteristics.

Our results show that the monetary policy stance can significantly trigger non-fundamental house price overshooting in euro area countries with liberal mortgage markets. Peripheral countries are more sensitive to the interest rate gap shock. Mortgage market characteristics also play a more critical role in the transmission of monetary policy at the periphery. A one-time positive shock to interest rate gap can explain over 20% of the forecasting error variance of non-fundamental house price run-ups in Ireland and Spain. In housing markets with a less liberalized mortgage market, we see limited responses of the non-fundamental house price component to the interest rate shock. Thus, policy makers may focus on limiting mortgage equity withdrawals, Loan-to-Value ratios and avoiding exaggerated use of tax policies to promote homeownership in order to minimize the side effects of accommodative monetary policies on housing market stability for those peripheral countries which are more likely to be subjected to a too loose monetary policy.

2 Literature review

Our paper is built upon several strands of literature. Concerning the interdependence between monetary policy and house price movements, many studies found that monetary policy significantly affects house prices, especially when it is too dovish. Indeed, house price booms are typically preceded by a period of loose monetary policy (Dokko et al., 2011, Seyfried, 2010, Ahearne et al., 2008, Simo-Kengne et al., 2013, Taylor, 2007, Greiber and Setzer, 2007, Jarocinski and Smets, 2008, Antipa and Lecat, 2009, Escobari et al., 2013). Monetary policy can affect the house price through several channels. The primary one is the interest rate channel. Given the price stickiness, an increase in nominal interest rates translates into an increase in the users' cost of capital, which in turn leads to a reduction in investment spending and a decrease in the housing demand (Goodman and Thibodeau, 2008). Besides that, studies by Bernanke and Blinder (1992) as well as Disyatat (2011) show that a monetary policy shock can transmit to the housing market through the credit channel. For example, a shock tightening monetary policy can hit the banks and decrease their loan supply by decreasing the borrowers' net worth (Aoki et al., 2004, Iacoviello, 2005) and/or by inducing banks to tighten the reserve requirements (Bernanke and Blinder, 1992). Furthermore, monetary policy can affect house prices by changing the investors' risk perceptions. Lower interest rates may result in lower risk premiums either due to the decrease in perceived risk or because of the increase in risk tolerance (Adrian and Shin, 2008, Adrian et al., 2012).

A key issue is the identification of a monetary policy shock. Most of the literature uses the short-term and/or long-term interest rates. Other literature, such as Sá et al. (2014), imposes sign restrictions on the impulse responses to identify a monetary policy shock. A third strand of literature uses the Taylor rule rate. Proposed by Taylor (1993), the Taylor rule is used to stipulate how much the central bank should change the nominal interest rate in response to changes in inflation and GDP or other economic fundamentals. Gerlach and Schnabel (2000) demonstrate that interest rate policies in the European countries moved very closely with output gaps and inflation as suggested by the Taylor rule. Thus, the Taylor principle does apply to the European countries as well. Using Taylor's rule as a benchmark, Seyfried (2010) found that monetary policy was too loose in several countries including Ireland, Spain and the United States prior to the bust of the respective housing bubbles. In addition, Seyfried (2010) states that monetary policy was appropriate or slightly restrictive for France and Germany where we did not see any housing bubbles in the same period. Using a Panel logit framework, Bauer (2014) estimates the likelihood of a house price correction in 18 OECD countries. Using the Canadian housing market as an example, the results show that a sharp interest rate tightening can trigger a house price correction. Hott and Jokipii (2012) regress the non-fundamental house price change of 14 OECD countries on the deviation of Taylor rule rate and find a strong link between housing bubbles and low interest rate. The impact would be stronger when the interest rate is "too low for too long".

Even though monetary policy is a major determinant of house price movements, other factors may still remain highly relevant. It is worth noting that the reaction of house price inflation is found to differ across regions with a common monetary policy (Barigozzi et al., 2014, Rubio, 2014). Even though its importance is obvious, there is still little empirical evidence on how country-specific factors affect housing markets, in particular how monetary policy transmission and the mortgage market structure are related to the non-fundamental house price component. Some studies assessed the drivers behind country and region specific differences in real estate markets and explored the importance of mortgage market heterogeneity for the transmission of monetary policy. For example, Based on OECD countries, Adams and Füss (2010) found that varying housing market dynamics can be traced back to differences in the national regulatory setting and mortgage market features. Muellbauer and Murphy (1997) as well as Iacoviello and Minetti (2003) argue that financial liberalization of mortgage markets supported a significant increase of house price sensitivity to short term interest rates for U.S. and U.K. Milcheva and Zhu (2015) studies 17 OECD countries and show that countries with more developed mortgage market are more sensitive to international house price comovement. More flexible mortgage market structures provide a better monetary policy transmission is further supported by Calza et al. (2013), who found that economies with a more flexible mortgage market are more responsive to monetary impulses based on DSGE models. Rubio and Carrasco-Gallego (2015c) as well as Rubio (2014) focus on the leverage of households. They show that the loan to value ratio is an important determinant of house price increases. Based on a two-country monetary union DSGE model, Rubio and Carrasco-Gallego (2015a) study how a house price shock in the periphery and a technology shock in the core countries are transmitted to the both economies. Using European countries as the sample, Maclennan et al. (1998) find that countries that experienced lower house price change are characterized with fixed interest rate, low loan to value ratios, high transactions costs, and a smaller own-occupied sector.

We want to bring together the different strands of the literature concerning the linkage between monetary policy, country-specific mortgage market structures and housing market developments. Our paper differs from previous studies in three ways: first, we focus on the non-fundamental house price run-ups. Second, we use deviation from the Taylor rate as the proxy of interest stance. Third, we explore the role of time-varying mortgage market characteristics. For example, in the early 2000s, many countries increased the maximum loan-to-value ratio. Later, during the crisis, the maximum loan-to-value ratio decreased slightly in those countries. Therefore, we expect to see variations in the VAR coefficients. Based on an interacted panel VAR model, we are able to compare the importance of a monetary policy shock to housing market stability in countries with different mortgage markets without splitting the country samples.

3 Econometric modelling

To estimate the relationship between the non-fundamental house price and the monetary policy stance as well as the influence of the mortgage market, we use a three-stage estimation strategy. First, we estimate the non-fundamental house price run-ups, which are defined as the residuals of the observed house price change and the respective fundamental part. The fundamental house price change is predicted using local housing demand and supply factors. In the second stage, we use the deviation of the short term interest rate from the Taylor rate level in each country in order to proxy for the monetary policy in the individual countries. In the third stage, we investigate the impact of monetary policy on house price run-ups using an interacted panel VAR setting, conditional on the mortgage market development in each country.

3.1 Non-Fundamental House Price Run-ups

We first estimate the non-fundamental part of the house price in each country. Monetary policy can affect the house price by changing the users' cost which impacts the fundamental value of housing assets. However, additional deviation may still be caused by investors' speculative behaviors and optimistic expectations. As the non-fundamental deviations may result in market instability as well as asset price fluctuations, we are particularly interested in the monetary policy's impact on the non-fundamental price run-ups.

As equation (1), following Dipasquale and Wheaton (1994), Case and Shiller (2003), Goodman and Thibodeau (2008), Gallin (2006) Muellbauer and Murphy (2008) as well as Koetter and Poghosyan (2010), a country's demand for housing (Q^D) can be defined as a function of households' income (*Y*), the price of rental housing service (*R*) and the market size, which is measured as population (*POP*).

The price of rental housing service equals users' cost (ρ), which is positively related to mortgage rate (*Mr*), asset depreciation (*d*), and the property tax rate (*tr*). Further, it is negatively related to the product of expected capital gains $E\{p\}$ and house value (*V*). From the supply side, the aggregate quantity of house supply can be a function of asset price (*V*) and supply shift (*G*).

$$\begin{aligned} \ln Q^D &= \alpha_1 \ln Y + \alpha_2 \ln R + \alpha_3 \ln POP \\ \ln R &= V[Mr + d + tr - E\{p\}] \\ \ln Q^S &= \alpha_4 \ln V + \sum_{j=1}^{J} \alpha_{5,j} G_j \end{aligned} \tag{1}$$

In the product market equilibrium, $\ln Q^D = \ln Q^S$. Solving Equation (1), we obtain:

$$\ln V = \vartheta_1 \ln Y + \vartheta_2 \ln \rho + \vartheta_3 \ln POP + \sum_{j=1}^{J} \vartheta_{4,j} G_j \tag{2}$$

The fundamental house price (P^f) is the long-term equilibrium price based on Equation (2). In the empirical part, we define the non-fundamental house price run-ups as the deviation of the observed house price change (P) from the respective fundamental price change. We estimate the fundamental price for each country individually. According to Equation (2), changes in the fundamental house price in country *i* at period *t* are based on the changes in a set of local demand and supply determinants, including *GDP*, inflation (*CPI*), population (*POP*), disposal personal income (*Income*), housing permits (*Permit*) and the mortgage rate (*Mr*). Since the depreciation rates as well as the property tax rates remain unchanged over time in many countries, they are captured by the constant term (α_i) in our regression estimation. Considering the endogeneity problem between demand/supply factors and the house price, we use the lagged variables to estimate the fundamental price:

$$\begin{aligned} \Delta \ln P_{i,t} = \alpha_i &+ \sum_{p=1}^{4} \beta_{1i,p} \Delta \ln GDP_{i,t-p} + \sum_{p=1}^{4} \beta_{2i,p} \Delta \ln CPI_{i,t-p} + \sum_{p=1}^{4} \beta_{3i,p} \Delta \ln POP_{i,t-p} + \sum_{p=1}^{4} \beta_{4i,p} \Delta \ln Income_{i,t-p} \\ &+ \sum_{p=1}^{4} \beta_{5i,p} \Delta UE_{i,t-p} + \sum_{p=1}^{4} \beta_{6i,p} \Delta \ln Permit_{i,t-p} + \sum_{p=1}^{4} \beta_{7i,p} \Delta \ln Mr_{i,t-p} + e_{i,t}^{hp} \end{aligned} \tag{3}$$

where α_i and β_i are the coefficients for country *i*. The estimation of the fundamental price includes up to 4 lags.[1] The fundamental price change is the predicted price change ($\Delta \ln \hat{P}_{i,t}$) whereas the non-fundamental price run-ups are defined as the residuals ($e_{i,t}^{hp}$). Considering that the elasticity on house price with respect to fundamental factors can vary across countries, we estimate Equation (3) by OLS estimator separately for each country.[2][3]

3.2 Deviation from Taylor Rule Rate

In order to proxy for the central banks' monetary policy stance, we estimate the deviation of the short-term interest rate from its Taylor rule level. The Taylor rule level of the interest rate in each country is estimated by constructing both inflation and output gaps. We then use the deviation of the GDP from its filtered value as an estimate of the output gap. The Taylor rule level of the short-term interest rate is defined as:

$$r_{i,t} = \gamma_{0,i} + \gamma_{1,i}(\pi_{i,t} - \pi_i^*) + \gamma_{2,i}(y_{i,t} - y_{i,t}^*) + e_{i,t}^{TR}, \quad (4)$$

where $r_{i,t}$ is the short-term interest rate, $\gamma_{0,i}$ is the neutral (nominal) rate of interest in country *i*. $\pi_{i,t}$ is the actual inflation rate in country *i* at period *t* and the starred value indicates the target, which is set at 2 percent. ($y_{i,t} - y_{i,t}^*$) is the output gap, with $y_{i,t}$ for the log transformed GDP in country *i* at period *t*. $y_{i,t}^*$ is the filtered series using the Hodrick-Prescott filter (with a smoothing parameter of 1600). $e_{i,t}^{TR}$ is the difference between the short-term interest rate and the Taylor rate (TR).

Svensson (1999) suggests that the TR equation is the optimal reaction function for a central bank which targets information in a simple backward-looking two-equation model of the economy and γ_1 and γ_2 are convolutions of policymakers' preferences as well as the parameters in the IS and the Phillips curves. Taylor (1993) suggests that $\gamma_0 = 4$, $\gamma_1 = 1.5$ and $\gamma_2 = 0.5$ for the U.S. market. However, Gerlach-Kristen (2003) suggests that these values may not apply for all countries. Therefore we estimate the coefficients (γ_s) separately for each country. Considering the potential endogeneities in Equation (4), we use the GMM estimator including up to 4 lags of inflation and output gaps as instrument variables. The fitted value ($\hat{r}_{i,t}$) is TR and the residuals $e_{i,t}^{TR}$ are the deviation from TR, which represents a measure of the monetary policy stance.[4]

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[1] Up to 8 lags are tested. All specifications yield very similar results.
[2] Using weighted least squares to account for the outliers during the boom periods generates robust results. We also estimate the residuals based on contemporaneous demand and supply factors using GMM estimator (instrument variables are set as lagged demand/supply variables up to 4 periods),, the results are also robust.
[3] Detailed graphs on fundamental change and observed change are available in online appendix.
[4] Detailed information about the fitted Taylor rule rate are available in online appendix.

3.3 Impact of Monetary Policy Stance on House Price

At this stage, we combine the estimated non-fundamental price change and the deviation from the Taylor rate into the panel data setting and incorporate the credit supply into the regression in order to perform an interacted panel VAR model as follows:

$$X_{i,t} = \Psi_i + \sum_{p=1}^{4} \Phi_p X_{i,t-p} + \Psi^M M_{i,t} + \sum_{p=1}^{4} \Phi_p^M M_{i,t} X_{i,t-p} + \sum_{p=1}^{4} \Upsilon_p Z_{t-p} + \sum_{p=1}^{4} \Upsilon_p^M M_{i,t} Z_{t-p} + \varepsilon_{i,t} \qquad (5)$$

where $X_{i,t}$ is a 5 by 1 vector of the non-fundamental house price change, the deviation from Taylor rule rate and the change in domestic total credit to households, account balance, and sentiment in country *i* at period *t*: $X_{i,t} = [e_{i,t}^{hp} \quad \Delta credit_{i,t} \quad e_{i,t}^{TR} \quad account_{i.t} \quad senti_{i,t}]'$.[5] Since we are interested in the impact of variable M_i on the interdependence of endogenous variables, we keep everything else fixed. Ψ_i is the country-specific intercept. Φ_p is the 5×5 matrix of autoregressive coefficients. The maximum lag is selected as 4 based on BIC criteria. $M_{i,t}$ is the mortgage market indicator for country i at period t, and is standardized to be between 0 and 1. It measures the relative mortgage market development of country i at period t to the rest of the other countries and other periods. Ψ^M is the coefficient for mortgage market indicators. When index $M_{i,t}$ keeps constant over time, in order to avoid any singular matrix, Ψ^M is set as zero. Φ_p^M is the coefficient vector for the interaction term ($M_{i,t} X_{i,t-p}$). The interaction term measures the impact of mortgage market developments on the interdependence of the endogenous variables without splitting the sample.

Z_t is a 3 by 1 vector for three global/regional variables in period *t* presented in Section 4. They are the same for all countries. They are also interacted with mortgage market indicators. Υ_p is a 5 by 3 vector of coefficients for variable Z, and Υ_p^M is a 5 by 3 vector of coefficients for the interaction with mortgage market indicator.

$\varepsilon_{i,t}$ is the 5×1 vector of error terms and $\varepsilon_{i,t} \sim N(0, \Omega)$, where Ω is a 5 by 5 matrix. This model extends the standard panel VAR model with fixed effects and takes into account both the intercept and slopes heterogeneity. We estimate the coefficients in Equation (5) using OLS equation by equation.

The impulse response is essentially based on estimated coefficients $\Phi_{i,p}$, $\Phi_{i,p}^M$ and Ω. The Cholesky decomposition order is the deviation from Taylor Rate non-fundamental, change in

[5] Using the credit gap generates totally robust results. It is calculated as the difference between the credit to GDP ratio in each country and the corresponding Hodrick-Prescott filtered credit to GDP ratio (with a smoothing parameter of 1600).

housing credit, account balance, non-fundamental house price change and sentiment. The results are totally robust with other order sequences. Because $\Phi_{i,p}^{M}$ may vary across countries, the responses also vary across countries, and the variation of the responses depend on the countries' mortgage market characteristics. We follow Sá et al. (2014) and report the results for $M_{i,t} = 0.75$ as the more liberal mortgage market, and $M_{i,t} = 0.25$ as the less liberal mortgage. So the impulse response function is based on the coefficients $\Phi_{p}^{High} = \Phi_{p} + 0.75\Phi_{p}^{M}$ for more liberal mortgage markets, while it is based on the coefficients $\Phi_{p}^{Low} = \Phi_{p} + 0.25\Phi_{p}^{M}$ for less liberal mortgage markets.

4 Data

The sample includes the following 11 countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Spain, and Portugal. For the Taylor Rate estimation, we use a larger time horizon for some countries as we used the maximum available time series. Thus, Taylor Rate estimation is based on data that goes back until the 1980s for some countries. However, we had to cut the panel to between the first quarter of 1992 and the fourth quarter of 2012 due to the restricted availability of house price data. House price indices are collected from BIS and are based on national sources. BIS data was not available for Greece and Portugal so we use data from Oxford Economics.

As the main focus of the paper is to analyze how the monetary policy stance and the mortgage market structure influence non-fundamental house price developments, we consider country-specific factors that can be regarded as fundamental demand and supply drivers of house prices. These country-specific variables include the real gross domestic product (GDP), the credit from domestic banks to the private nonfinancial sector as a share of the GDP, the consumer price index inflation (*CPI*), total population (*POP*), the unemployment rate (*UE*), disposal personal income (*Income*), housing permits (*Permit*), the mortgage rate (*Mr*), account balance, and exchange rate. GDP, CPI, UE, account balance, sentiment data, and exchange are taken from OECD. Mortgage rates are taken from national sources or the ECB. Credit, population, housing permits data and exchange rate are taken from BIS, Oxford Economics and Datastream, respectively. In our model, these country-specific variables are expressed in growth rates.

We also include three global factors. The European current unit/Euro to US dollar exchange rate is from OECD database. European current unit was adapted by the 11 countries since 1979 and was later replaced by Euro. The oil price is taken from Datastream. It is a good indicator of global economic cycles and inflation expectations whereas financial leverage is a good measure of financial risk appetite globally. During the financial crisis we have observed global deleveraging (see (Shin, 2009), Adrian et al. (2012)) which affects the credit supply by reducing interbank flows and hence bank balance sheet size. We follow Bruno and Shin (2014) and measure global financial leverage as the sum of equity and total liabilities of US broker-dealers divided by their equity. The broker-dealer balance-sheet data comes from the US Flow of Funds. Broker-dealer leverage is closely negatively associated with the VIX index of implied S&P stock market volatility and can therefore be also associated with risk appetite of investors internationally. Precise definitions and sources of all variables are provided in Table A1.

Table A2 provides an overview of the countries' mortgage market indicators. The higher the mortgage market indicator, the more liberal is the respective mortgage market. A liberal mortgage market is characterized by predominated variable mortgage rate, the possibility of mortgage equity withdrawal, a high loan-to-value ratio, the existence of secondary mortgage market as well as high government participation. The data for mortgage rate type, mortgage equity withdrawal, maximum loan-to-value ratio and government participation comes from Tsatsaronis and Zhu (2004), IMF (2008), and IMF (2011). Regarding the degree of mortgage securitization in the mortgage sector, we follow Sá et al. (2014) and use the de-jure qualitative securitization index constructed by Hoffmann and Nitschka (2008). This index equals to one if countries have a fully liberalized MBS market and zero if secondary mortgage market is not permitted by national law or regulation. Although this securitization index does not reflects institutional changes in the ability to securitize mortgage assets, it could avoid the potential endogeneity issues with de-facto measures of mortgage backed securitization. Precise definitions of mortgage market development indicators are provided in Table A2.

5 Results

5.1 Non-fundamental House Price Run-ups

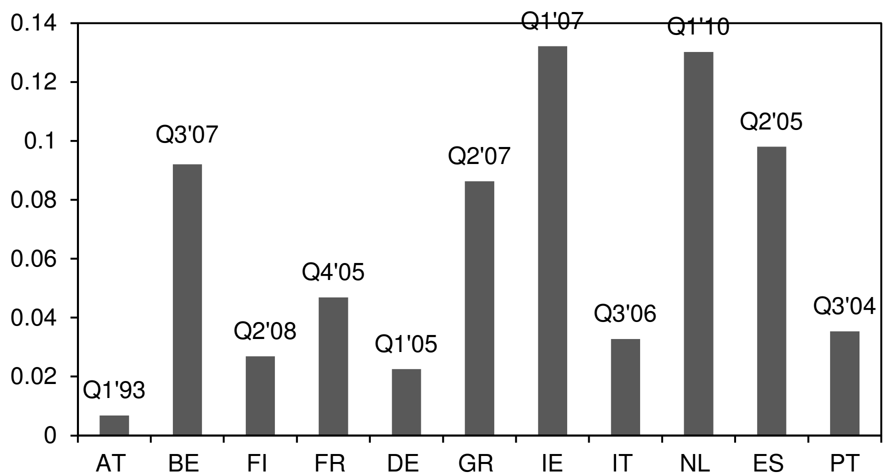
In a first step, we analyse the non-fundamental house price run-ups. Table A3 reports the F tests for the joint significance of the lagged fundamental factors. Total population can significantly explain the house price in 6 out of 11 countries. Other factors, such as the mortgage rate and personal income, play a significant role in many countries as well. With the exception of Belgium, Germany and Austria, the 7 fundamental variables can predict more than 50% of the house price variance.

Figure 1 illustrates the maximum cumulative deviation from the fundamental values for the 11 countries.[6] The labels show the respective quarters when the maximum deviation occurred. The time of the booms shows that most of the countries faced the maximum deviation from the fundamental values in the mid to late 2000s and before Q3 2007. Stable countries such as Germany (DE) and Austria (AT) are characterized by low deviations of the house price change from the fundamental change while instable countries such as Ireland (IE) can be characterized

[6] In order to simplify the illustration, the initial values of the fundamental house price are assumed to be the observed house price for each country. However, we do not use these initial values in the panel VAR model as we rather use the change in the fundamental values.

by a rather large gap between the overall house price change and the underlying fundamental change which in turn suggests a large non-fundamental change in house prices. In the case of Ireland, for example, we observe a 13% maximum cumulative deviation from the underlying fundamental level in the first quarter of 2007. For comparison, the maximum cumulative deviation from the fundamental value in Germany was only 2%.

Figure 1: Maximum Cumulative Percentage Deviation from Fundamental Values



Note: the graph shows the maximum cumulative deviation of house price from fundamental values for 11 euro area countries from 1992Q1 to 2012Q4. The label shows the quarter when the maximum cumulative deviation occurred.

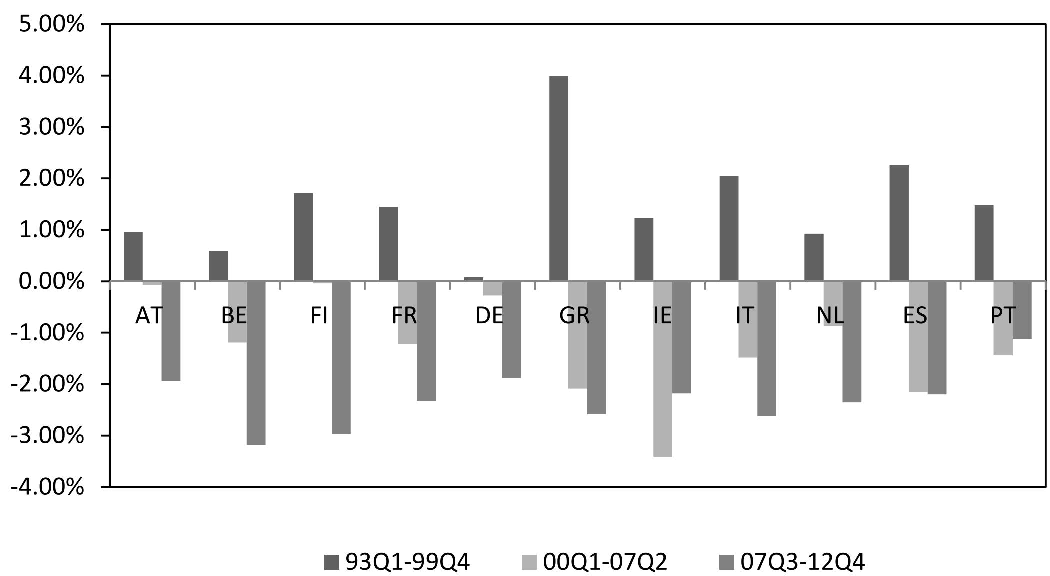
5.2 Deviation from Taylor Rule Rate

Table A4 presents the read out of the GMM model that we used to estimate the historic Taylor Rule. We see that the coefficients are quite similar to the ones found by Taylor (1993). It is worth noting that we observe different degrees as well as different directions of the deviation of the actual interest rate from the respective Taylor Rate. These are crucial in determining the monetary policy stance. In general, when the Taylor Rate is larger than the actual interest rate, we conclude loose monetary policy while we conclude restrictive monetary policy in the case of the Taylor Rate being smaller than the actual interest rate.

Figure 2 provides an overview of the average interest rate gaps in the 11 countries, split into three time periods. The first time period lasts from Q1 1993 until Q4 1999, the second from Q1 2000 until Q2 2007 and the third refers to the time between Q3 2007 and Q4 2012. Monetary policy was restrictive before 2000, as we observe positive average interest rate gaps for all countries. Contrary, monetary policy became more relaxed in the beginning of 2000. Thus, there are negative interest rate gaps for all the European countries after 2000.

When analysing the European countries, we must account for the fact that they have a common monetary policy as set by the ECB. In general, it can be stated that the ECB does not aim to conduct a policy that is optimal for a particular country but that is optimal for the EMU as a whole. As long as the ECB tries to set a policy rate that is appropriate for the entire EMU and as long as economic fundamentals and mortgage market structures differ among the European countries (which appears to be an endogenous problem), the ECB's monetary policy would be too loose for some countries while being too restrictive for others. In Ireland and Spain, for example, we see that interest rates were too low as compared to the Taylor Rate during the housing boom period. Contrary, monetary policy seems to have been more restrictive for other countries such as Austria, Germany or Finland where we did not see any severe misalignments between the house price and its underlying fundamental value.

Figure 2: Average Interest Rate Gaps



Note: the graph shows the average difference between the short-term interest rate and Taylor Rule rate for 11 countries in three periods: from 1992Q1 to 1999Q4, from 2000Q1 to 2007Q2 and from 2007Q3 to 2012Q4. The three stages for Greece is divided as from 1992Q1 to 2000Q4, from 2001Q1 to 2007Q2, and from 2007Q3 to 2012Q4.

5.4 Transmission of Monetary Policy

At the third stage of our estimation approach, we combine the estimated non-fundamental price change and the deviation from the Taylor Rate to perform an interacted panel VAR model. Since Chow test suggests a significant structure break in Q3 2007 (Table 1), our estimation is from 1993Q1 to 2007Q2. After the crisis, ECB adopted conventional monetary policies. Figure 3 shows the impulse responses to the respective shocks. In order to derive conclusions about the role of the mortgage market structure, we compare the response of the country with a developed mortgage market ($M_{i,t}$ = 0.75, in red) with the response of the country with a less developed mortgage market ($M_{i,t}$ = 0.25, in black). The mortgage market development is measured as the average value of five mortgage market indicators: mortgage rate type, the availability of Mortgage Equity Withdrawal (MEW), the maximum Loan-to-Value (LTV) ratio, the degree of mortgage securitization, and government participation index. We forecast the impact from the first until the twentieth quarter after the shock. The results are based on a 90% confidence interval.

Table 1: Structural Break Tests

Note: Chow test is applied to Equation (5) to investigate whether significant structural break exists in 2007Q3. With 330 parameters, 4180 observations, the critical value for Chow statistic is 1.10, 1.14 and 1.20 for 10%, 5% and 1% significance level. With 330 parameters, 1900 observations, the critical value for Chow statistic is 1.10, 1.15 and 1.22 for 10%, 5% and 1% significance level. With 330 parameters, 2280 observations, the critical value for Chow statistic is 1.11, 1.15 and 1.22 for 10%, 5% and 1% significance level. ***, **, *and* * *denote significance at the1%, 5%, and 10% level, respectively.*

	Chow Test
Model 1: 11 Euro Area Countries	2.57^{***}
Model 2: 6 Core Area Countries	1.31^{***}
Model 3: 5 Peripheral Countries	2.18^{***}

First, we analyse the impact of a one standard deviation interest rate easing shock (a negative interest rate shock) based on all Euro area countries. As shown in Figure 3-1, for the interest rate shock, there is a significant difference in the response of the two mortgage market structures. For the country with a more liberal mortgage market, a negative interest rate shock of one standard deviation leads to a maximum increase in the non-fundamental house price of 0.2% in the third quarter after the shock, which is much more severe as compared to the close to zero response in the country with a less liberal mortgage market. However, the impact of a one standard deviation interest rate easing shock is not persistent as it disappears after two to three years. Thus, the impact is mostly relevant in the short-term perspective.

The variance decomposition of non-fundamental house price run-ups, as shown in Table 2, provides further evidence that a more liberal mortgage market is associated with a stronger impact of a monetary impulse. The explained variance triggered by a one standard deviation monetary easing shock rises from 0.39% to 7.38% of total forecasted non-fundamental house price change, as $M_{i,t}$ increases from 0.25 to 0.75.

Figures 3-2 and 3-3 illustrate the impact of an interest rate easing shock by splitting the core and periphery Euro area countries. Core area countries include Austria, Belgium, Finland, France, Germany, and the Netherlands. Countries in periphery area include Ireland, Italy, Greece, Spain, and Portugal.

For the core area countries, there is no statistically significant difference in the response of house prices to the monetary easing shock. There is a close to zero response for all countries, irrespective of the individual mortgage market structure. The variance decomposition (Table 2, Model 2) confirms this observation as the explained variance of non-fundamental house price movements is 2.32% and 0.39% for the more and less liberal countries, respectively.

However, for the peripheral countries, there is a significantly higher response of house prices in the countries with more liberal mortgage markets between the first and the fifth quarter after the shock. For the countries with more liberal structures, we observe an increase of up to 0.4% in the third quarter. These findings are undermined by the explained variance as illustrated in Table 2, Model 3. For the countries with more liberal mortgage market, the one standard deviation monetary easing shock can explain 20.52% of the non-fundamental house price movement. By contrast, in less liberal countries, we observe only 2.83%.

Figure 3: Impacts of 1 Standard Deviation Interest Rate Easing Shock on Non-Fundamental House Price to in Countries with Developed Mortgage Market (in Red) and with Less Developed Mortgage Market (in Black)

Figure 3-1 Euro Area Countries

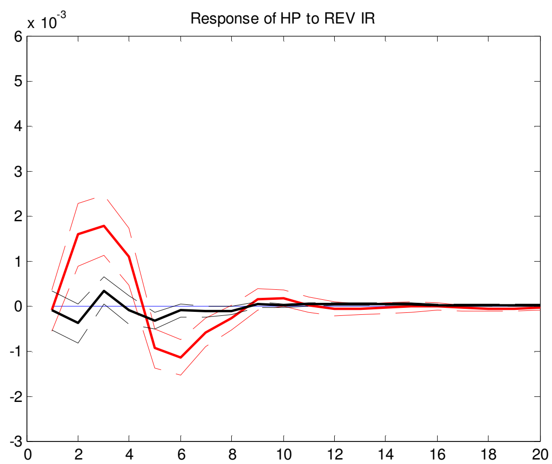


Figure 3-2 Core Countries

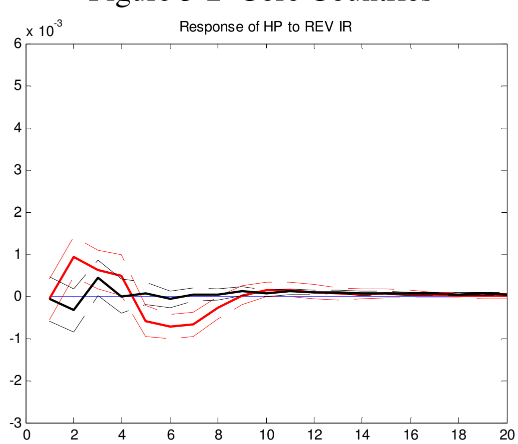
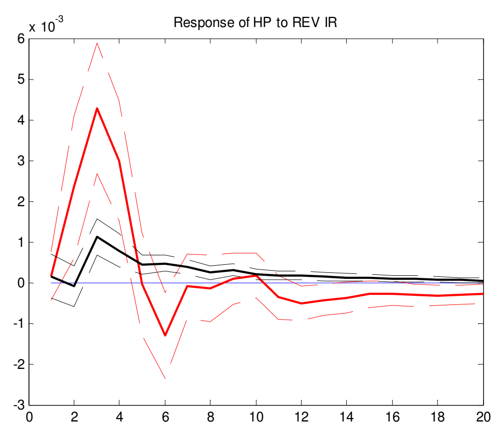


Figure 3-3 Peripheral Countries



Note: The estimation period is from Q1 1992 to Q2 2007.The graphs show the responses of non-fundamental house price to a 1 standard deviation positive shock to the reverse of interest rate (monetary easing). Red solid lines show the response in the developed mortgage market ($M_{i,t} = 0.75$). Red dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses. Black solid lines show the response in less *developed mortgage market ($M_{i,t} = 0.25$). Black dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses.*

Table 2: Explained Variance of Non-Fundamental House Price by 1 Standard Deviation Monetary Easing Shock at T=20

Note: The table shows the percent of explained variance of non-fundamental house price run-ups triggered by one-standard deviation of monetary easing shock. The absolute forecasted error variance (in bps) is in parenthesis. The estimation period is from Q1 1992 to Q2 2007 based on Equation (5) with individual mortgage market characteristics interaction variables. We only report the results when $M_{i,t} = 0.75$ and $M_{i,t} = 0.25$.

	High $M_{i,t} = 0.75$	Low $M_{i,t} = 0.25$
Model 1: 11 EU Countries	7.38%	0.39%
REV IR shock to NF HP	(0.010)	(0.000)
Credit shock to NF HP	2.50%	1.89%
	(0.003)	(0.002)
Capital inflow shock to NF HP	3.62%	0.64%
	(0.005)	(0.001)
Sentiment Shock to NF HP	1.73%	0.37%
	(0.002)	(0.000)
NF HP shock to NF HP	84.77%	96.70%
	(0.111)	(0.107)
Model 2: 6 Core Countries	2.32%	0.39%
REV IR shock to NF HP	(0.003)	(0.000)
Credit shock to NF HP	1.63%	3.25%
	(0.002)	(0.003)
Capital inflow shock to NF HP	1.50%	1.23%
	(0.002)	(0.001)
Sentiment Shock to NF HP	3.88%	0.88%
	(0.005)	(0.001)
NF HP shock to NF HP	90.67%	94.25%
	(0.117)	(0.095)
Model 3: 5 Peripheral countries	20.52%	2.83%
REV IR shock to NF HP	(0.036)	(0.003)
Credit shock to NF HP	4.91%	2.42%
	(0.009)	(0.002)
Capital inflow shock to NF HP	11.39%	0.77%
	(0.020)	(0.001)
Sentiment Shock to NF HP	3.90%	0.56%
	(0.007)	(0.001)
NF HP shock to NF HP	59.29%	93.42%
	(0.103)	(0.092)

Figure 4 illustrates the cumulative 1-year and 3-year impact of a one standard deviation shock to the interest gap for the core and peripheral countries. Figures 4-1 and 4-2 show the cumulative response as well as the explained variance, respectively.

Starting with the cumulative responses, we observe that the peripheral countries show stronger responses in both the 1-year and 3-year perspective. There is a larger difference after the first four quarters as compared to the first twelve quarters. This provides further evidence that the difference between the countries' responses is mostly in the short-term. Thus, cumulative responses align in the medium and long term. It comes apparent that the peripheral countries show stronger responses for both the 1-year and 3-year horizon as compared to the core countries. For example, there is a cumulative 1-year response of 1.3% and 1.1% in IR and ES, respectively, while core countries like AT and DE show a close to zero or even negative response. There is a similar pattern for the cumulative 3-year response, even though the difference between core and peripheral countries becomes smaller as mentioned above. For the core area countries, NL is the country with the highest percent of explained variance. In the 3-year perspective, 5% of the house price movement can be explained by the monetary easing shock. However, the explained variance is very small in the core countries. Contrary, the interest rate shock can explain a higher percent of the house price movement for the peripheral countries. The interest rate shock can explain approx. 27% and 23% of the changes in house price for IR and ES, respectively.

Figure 4: Impact of Interest Rate Gap on Non-Fundamental House Price Change in 11 Euro Area Countries in 2000s

Figure 4-1: Cumulative Response

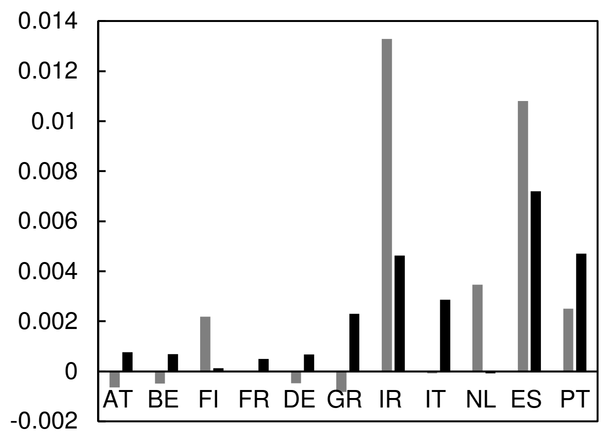
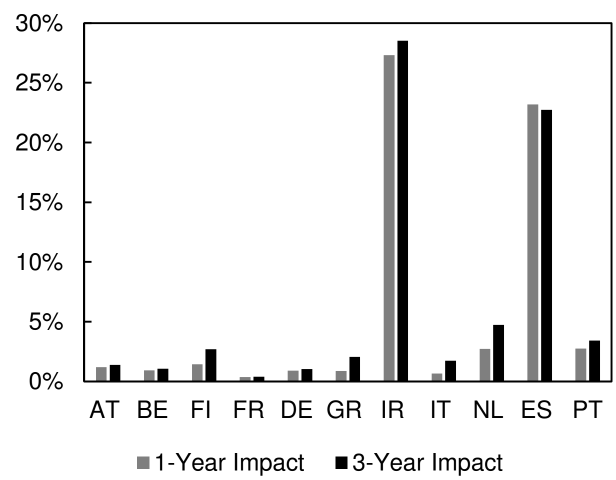


Figure 4-2: Explained Variance



Obviously, the cumulative response and explained variance differ among the countries. While the housing markets in AT, BE, FI, FR and DE remain stable after the shock, housing markets in IR and ES, where the mortgage market is more liberalised, show substantially higher responses. The channel can work as follows: increase in the gap to Taylor rule rate may result in a decrease in the perceived risk or an increase in the risk tolerance and inject more liquidity into the system. Mortgage market liberalization allows for a higher leverage in the mortgage market, which increases the risk-taking capacities of households, financial institutions and investors. Therefore, it facilitates excessive risk-taking in the housing market. As a result, households, financial institutions and investors may overreact to a one time increase in house prices triggered by monetary policy easing.

On average, the responses in the peripheral countries are more serious than in the core countries.

Such difference could be due to the different domestic demand in the core and periphery. As shown by Rubio and Carrasco-Gallego (2015b), the domestic demand growth was extremely strong at the periphery but very weak at the core. In countries with stronger domestic demand, liberalized mortgage market is more likely to facilitate excessive risk-taking behaviours of investors or homeowners.

5.4 Individual Mortgage Market Indicators

In order to derive more detailed implications about how the mortgage market structure effects the non-fundamental house price, we have a closer look at the individual components of the mortgage market indicator and how these effect the transmission of an external interest rate shock.

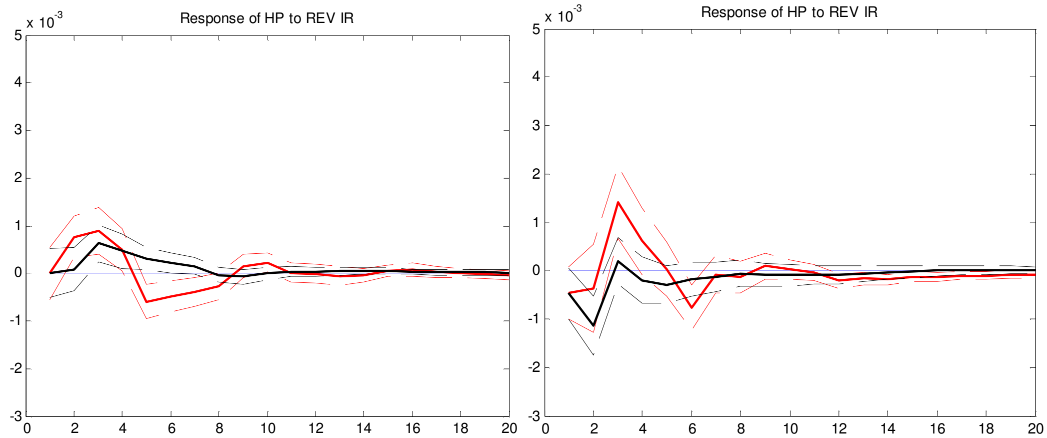
We also forecast the responses to a one-standard deviation monetary easing shock from the first until the twentieth quarter after the shock. We compare the responses of liberal and less liberal mortgage markets based on individual indicators. In the liberal market (in red), $M_{i,t}$ is set as 0.75 for the corresponding indicator and in the less liberal market (in black), $M_{i,t}$ is set as 0.25 for the corresponding indicator.

We first examine mortgage rate type. Mortgage contracts can be distinguished between variable and fixed rate mortgages: variable rate contracts are those in which the lending rate floats with, or is frequently adjusted to, a short-term market interest rate; fixed rate contracts are those in which the lending rate remains constant throughout the duration of the contract.

As illustrated in Figures 5, there is no significant difference in the response to monetary impulse in the two markets dominated by fixed and variable mortgage rate in both the core and peripheral countries. Also the variance decomposition as shown in Table A5, Model 4, indicates that there is only limited impact on the non-fundamental house price. Based on OECD countries, Calza et al. (2013) show that mortgage rate type yields considerably stronger impact of the monetary impulse on home price, compared to loan to value ratio and mortgage equity withdrawals. However, based on our analyses, variable mortgage rate is not the predominated factor in triggering the destabilization effects of monetary policy on the housing market for euro area countries.

Figure 5: Impacts of Interest Rate Type on Responses to Monetary Impulse

Core Periphery



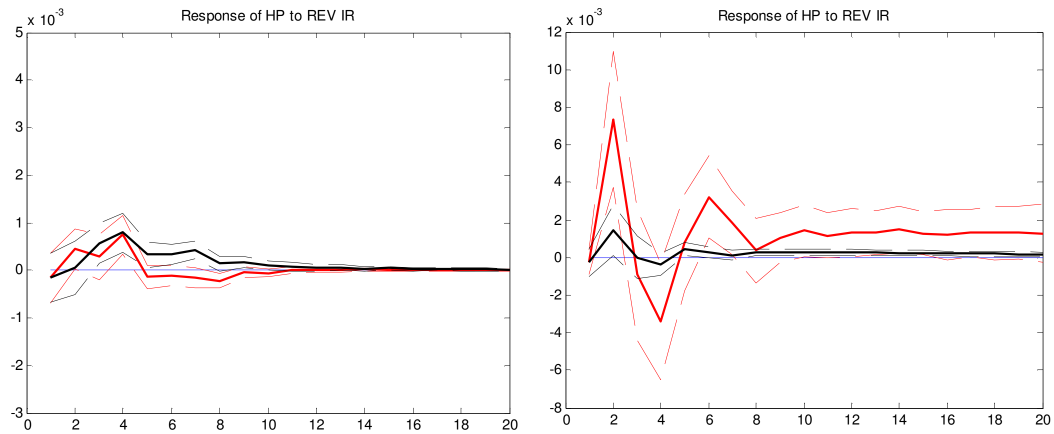
Note: The estimation period is from Q1 1992 to Q2 2007.The graphs show the responses of non-fundamental house price to a 1 standard deviation positive shock to the reverse of interest rate (monetary easing). Red solid lines show the response in the mortgage market with variable mortgage rate ($M_{i,t}^{MR} = 0.75$ *). Red dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses. Black solid lines show the response in less developed mortgage market, i.e., with predominated fixed mortgage rate(* $M_{i,t}^{MR} = 0.25$ *). Black dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses.*

Next, we analyse the effect of MEW. An important feature of the mortgage market structure is whether or not households have the possibility to withdraw equity from the mortgage due to an increased value of the underlying real estate. Home equity withdrawals can be used to finance consumption and home investments, for example. Literature shows a close relationship between mortgage equity withdrawals and the boom and bust cycles of housing markets (Mian and Sufi, 2011).

As illustrated in Figure 6, at the core there is no statistically significant difference in the reaction to an interest rate shock between countries with liberal and less liberal mortgage markets. Also the variance decomposition (Table A5, model 5) shows that the impact of the monetary policy shock is still limited for the core countries. Contrary, as illustrated in Figure 6, for the peripheral countries an interest rate shock has a more severe impact (up to 0.7% in the second quarter after the shock) on the non-fundamental house price component when there is the possibility of MEW, while the effect remains close to zero in the more conservative market. The variance decomposition (Table A5, model 5) shows that the monetary policy shock can explain over 36.49% of the movement in non-fundamental house prices in peripheral countries with a liberal mortgage market.

Figure 6: Impacts of MEW on Responses to Monetary Impulse

Core Periphery



Note: The estimation period is from Q1 1992 to Q2 2007.The graphs show the responses of non-fundamental house price to a 1 standard deviation positive shock to the reverse of interest rate (monetary easing). Red solid lines show the response in the mortgage market with MEW ($M_{i,t}^{MEW} = 0.75$). Red dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses. Black solid lines show the response in less developed mortgage market, i.e., with limited MEW ($M_{i,t}^{MEW} = 0.25$).Black dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses.

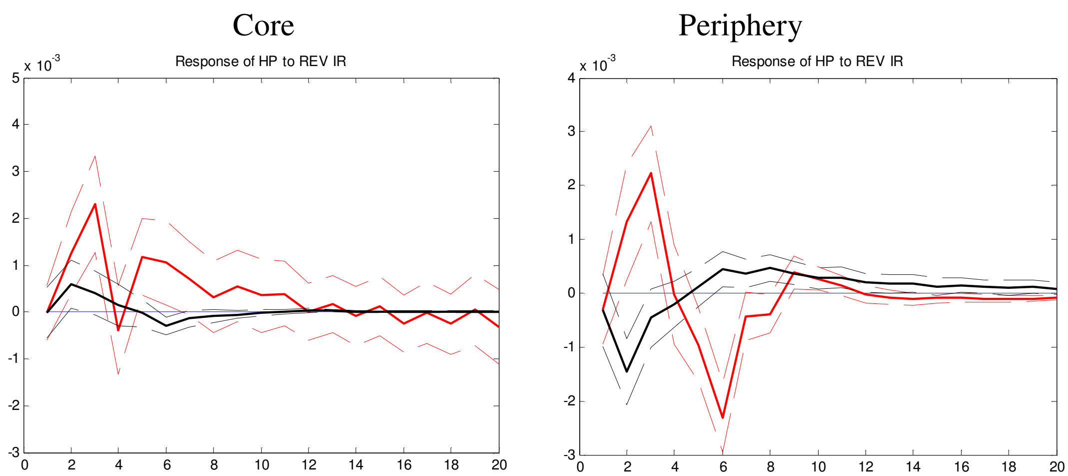
Moreover, we examine the relevance of the maximum LTV ratio in the mortgage market. The LTV is relevant because an extended LTV implies relaxed credit constraint to borrowers. Especially first time home buyers may benefit from high LTVs. With a higher LTV, the borrower requires less equity which simplifies the borrowers' access to mortgage loans. This facilitates the transmission of a monetary policy shock via the balance sheet channel and risk-taking channel.

As shown Figure 7, in the core countries, while the non-fundamental house price shows a positive response in both markets, the reverse of the interest rate shock impacts prices significantly stronger in the market with a higher maximum LTV ratio in the second quarter after the shock. In the peripheral countries, as illustrated in Figure 7, there is a significantly higher response (up to 0.2% increase in house prices) to the monetary policy shock in the countries with high LTV ratios until the fourth quarter after the shock. As shown in Model 6, Table A5, the explained forecasting error variance is 7.22% for the mortgage market with a higher maximum LTV ratio in the core countries, while it is 10.02% for the mortgage market with a higher LTV ratio in the peripheral countries. For the countries with lower maximum LTV ratios, the explained variance remains small in both the core and peripheral countries.

Thus, we found that the LTV plays a crucial role in determining housing market as it supports a boom in the non-fundamental house price component after an interest rate shock in both the core and peripheral countries. This finding is consistent with previous literature about the LTV ratio's relevance as a macro-prudential policy tool that may be used to adjust housing market stability. As Mendicino and Punzi (2014) show in a DSGE model, LTV ratios can be used as a tool of macro-prudential policy in order to mitigate the procyclicality arising from the interlinkages on mortgage markets. Rubio and Carrasco-Gallego (2015c) also use a DSGE model to show that

LTV ratios can be used as a macro-prudential tool to improve financial stability.

Figure 7: Impacts of LTV on Responses to Monetary Impulse



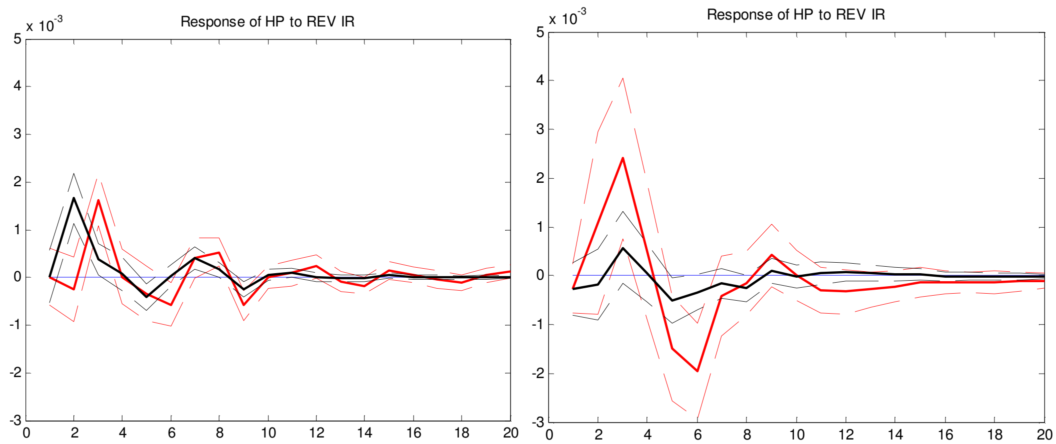
Note: The estimation period is from Q1 1992 to Q2 2007.The graphs show the responses of non-fundamental house price to a 1 standard deviation positive shock to the reverse of interest rate (monetary easing). Red solid lines show the response in the mortgage market with a high LTV ($M_{i,t}^{LTV} = 0.75$ *). Red dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses. Black solid lines show the response in less developed mortgage market, i.e., with a low LTV (* $M_{i,t}^{LTV} = 0.25$ *).. Black dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses.*

Furthermore, we take a closer look at the role of mortgage securitization. Mortgage securitization is designed to increase banks' liquidity and capacity of loan supply (Altunbas et al., 2009). However, due to moral hazard and adverse selection, it may reduce the banks' incentives to screen and monitor their borrowers in a period of booming housing markets. Consequently, mortgage securitization may lead to a deregulation of the mortgage market and support an overheating of housing markets (Allen and Carletti, 2006, Duffee and Zhou, 2001, Gorton and Pennacchi, 1995). Shin (2009) and Rajan (2005) point out that the larger risk-taking capacity of the shadow banking system leads to an increased demand for new assets in order to fill the expanding balance sheets and leverage. This, consequently, results in an increasingly important role of securitization for financial stability.

As illustrated in Figures 8, different from studies based on OECD countries, we do not observe significant difference in the reaction to a monetary policy shock based on MS for the European countries. The explained variance of the non-fundamental house price remains small in all cases (Table A5, Model 7). The reason could be that most EMU countries do not allow for, or only allow for limited mortgage securitization and banks in EMU still primarily reply on deposits to guarantee mortgage.

Figure 8: Impacts of MS on Responses to Monetary Impulse

Core Periphery



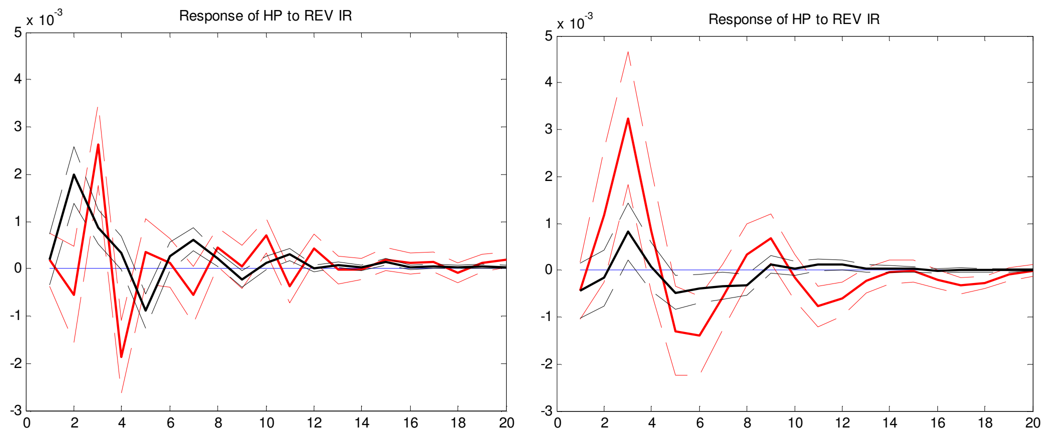
Note: The estimation period is from Q1 1992 to Q2 2007.The graphs show the responses of non-fundamental house price to a 1 standard deviation positive shock to the reverse of interest rate (monetary easing). Red solid lines show the response in the mortgage market with a high degree of MS ($M_{i,t}^{MS} = 0.75$). Red dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses. Black solid lines show the response in less developed mortgage market, i.e., with limited MS ($M_{i,t}^{MS} = 0.25$).. Black dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses.

As the last mortgage market indicator, we focus on Government Participation. GP includes subsidies to selected groups such as first time buyers and low-income buyers that influence the demand side of the housing market. In addition, the GP index reflects subsidies to buyers through savings account contributions as well as tax deductibility of housing expenses. Thus, the GP index describes to what extent the government supports affordable income, promotes homeownership and encourages home purchasing for lower income households.

At the core (Figure 9), there is a significantly lower impact of monetary policy in the second and fourth quarter after the shock for more liberal countries. The interest rate shock can explain 8.38% of the forecasting error variance in core countries with high GP (Table A5, Model 8). For the peripheral countries, the more liberal countries show a significantly higher response in the third quarter after the shock. The explained variance of the non-fundamental house price, as shown in Table A5, Model 8, is 6.96% for the peripheral countries with high GP. Policies like tax deduction may lead to over-reaction of homeowners to the housing market in both core and peripheral countries.

Figure 9: Impacts of GP on Responses to Monetary Impulse

Core Periphery



Note: The estimation period is from Q1 1992 to Q2 2007.The graphs show the responses of non-fundamental house price to a 1 standard deviation positive shock to the reverse of interest rate (monetary easing). Red solid lines show the response in the mortgage market with a high level of GP ($M_{i,t}^{GP} = 0.75$). Red dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses. Black solid lines show the response in less developed mortgage market, i.e., with a low level of GP($M_{i,t}^{GP} = 0.25$).. Black dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses.

5.5 Additional Results and Robustness Checks [7]

5.5.1 Account Balance and Sentiment

In addition to interest rate stance and housing credit, Sá et al. (2014), Diamond and Rajan (2005) Fratzscher et al. (2010) and Ferrero (2012) show that the account balance as well as the exchange rate may affect housing cycles, too. A negative account balance shock can be interpreted as an unexpected increase in foreign demand for domestic assets. Such an increase in foreign demand may lead to booms in domestic assets' prices. The negative relationship with the current account balance can be explained by the "global saving glut" hypothesis (Bernanke, 2005). Additionally, literature suggests that housing booms can be largely associated to investors' sentiment. For example, Case and Shiller (1988) and Ling et al. (2015) show that sentiment can affect homebuyers' investment decisions. Therefore, we add the two variables to the Panel VAR model: Account Balance and Consumer Sentiment.

Consisting with Sá et al. (2014), we find that mortgage market development can amplify the response to capital inflow shock, but only in the peripheral countries. As shown in Figure A4, there is no significant influence of capital inflow in the core countries and there is also no difference between liberal and less liberal mortgage market structures. In the peripheral countries, however, there is a significant impact on house prices between the second and fourth quarter after the interest rate shock with the liberal markets showing a more pronounced response of up to 0.2% increase in non-fundamental house prices. For the sentiment, we cannot find a very strong impact

[7] Detailed impulse response for each robustness check is available on online appendix.

on the response to a negative interest rate shock.

5.5.2 Constant Maximum Loan to Value Ratio

As the de-facto measure of leverage in the housing market, maximum loan to value ratio may suffer from the endogeneity problem, as households and financial institutions may respond to monetary easing by increasing the leverage. As most of the euro countries did not really have a restriction on the maximum LTV before 2012, we use the constant maximum LTV ratio (before 2000) in the robustness test. As shown in Table A5, Model 9, the forecasting error variance of the non-fundamental house price by a monetary policy shock in countries with a deregulated mortgage market indeed drops. However, it is still significantly higher as compared to countries with a regulated mortgage market where the impact of monetary policy remains marginal.

5.5.3 Exogenous Monetary Policy Shock

Further concern is the endogeneity between interest rate shock and credit supply shock. We follow the approach in den Haan et al. (2007) and Milcheva (2013). We compare the effect on non-fundamental house price changes stemming from a monetary policy shock with the effect on non-fundamental house price changes stemming from an credit supply shock, when the value of the credit supply is set equal to the value observed during the 'monetary easing', and values for the remaining variables are then obtained by iterating on the VAR. The former is the effect of monetary policy shock on the house prices. The latter measures the responses to a monetary policy induced credit supply shock, which is also referred to as the 'bank lending channel' effect. The difference between the impulse response functions of the two kinds of shocks is equal to the response to a monetary policy shock when the response of the credit to GDP ratio is restricted to zero in every period. It can be interpreted as the response of house price to an exogenous monetary policy shock when the credit supply is held constant. As shown in Table A6, Model 10, the explained variance by an interest rate shock in the mortgage market with high LTV and MS ratios only slightly drops by 2% at T=20. This implies that the bank lending channel does not play a very significant role in the transmission of a monetary policy shock.

5.5.4 Alternative Estimators for Fundamental Values

Koetter and Poghosyan (2010) and Kholodilin et al. (2007) define the non-fundamental house price as the deviation from the equilibrium trend price. Based on this definition, Equation (3) can be rewritten as:

$$\ln P_{i,t} = \alpha_i + \beta_{1i} \ln GDP_{i,t} + \beta_{2i} \ln CPI_{i,t} + \beta_{3i} \ln POP_{i,t} + \beta_{4i} \ln Income_{i,t} + \beta_{5i} UE_{i,t} + \beta_{6i} \ln Permit_{i,t} + \beta_{7i} Mr_{i,t} + e^{hp}_{i,t} . \quad (7)$$

Considering the non-stationarity of the series, we use Dynamic Ordinary Least Squares Estimator (DOLS) (Stock and Watson, 1993) to solve Equation (7). Unlike Koetter and Poghosyan (2010) and Kholodilin et al. (2007), we do not estimate Equation (7) in a panel setting, because we do not want to impose any restrictions on the long-term relationship between house price and fundamental variables to make them keep constant across countries. The estimated residuals are defined as the non-fundamental house price values. Based on Table A6, Model 12, the impact of monetary policy remains totally robust.

We also include additional fundamental variables such as percent of population between 20 to 44 years old as well as the rent price in the 17 countries. The results are also totally robust.

5.5.5 Alternative Estimators for Taylor Rule Rate

Instead of the traditional Taylor rule rate as shown in Equation (4), Gerlach-Kristen (2003) suggests considering adding interest rate smoothing into the TR estimation, which means that the estimates of the TR not only relate to the current levels of inflation and to the output gap but also to the lagged short-term rate. Hence, the traditional TR rate can be modified as:

$$r_{i,t} = (1-\gamma_{3,i})[\gamma_{0,i} + \gamma_{2,i}(\pi_{i,t} - \pi^*_{i,t}) + \gamma_{2,i}(y_{i,t} - y^*_{i,t})] + \gamma_{3,i} r_{t-1} + e^{TR}_{i,t} , \quad (8)$$

where $\gamma_{3,i}$ is the coefficient for the smoothing term. Empirically, Equation (6) is estimated as:

$$r_{i,t} = \tilde{\gamma}_{0,i} + \tilde{\gamma}_{1,i}(\pi_{i,t} - \pi^*_{i,t}) + \tilde{\gamma}_{2,i}(y_{i,t} - y^*_{i,t}) + \tilde{\gamma}_{3,i} r_{t-1} + e^{TR}_{i,t} , \quad (9)$$

using GMM estimator with up to 4 lags of $\pi_{i,t}$, $y_{i,t}$ as the instrument variables. Equation (8) can be converted to Equation (9) with the relationships that: $\gamma_{0,i} = \tilde{\gamma}_{0,i} / (1-\tilde{\gamma}_{3,i})$, $\gamma_{1,i} = \tilde{\gamma}_{1,i} / (1-\tilde{\gamma}_{3,i})$ and $\gamma_{2,i} = \tilde{\gamma}_{2,i} / (1-\tilde{\gamma}_{3,i})$. Based on Table A6, Model 13, the response of the non-fundamental house price is even larger than in the baseline model. The monetary policy shock explains over 70% of forecasting error variance of non-fundamental house price run-ups in deregulated housing market.

6 Conclusions

This paper provides empirical evidence for the impact of monetary policy and mortgage market regulation on the housing markets using a sample of 11 euro area countries. In order to identify the relationship between the non-fundamental house price, monetary policy and the mortgage market structures' influence, we use a three-stage estimation approach. First, we estimate the non-fundamental run-ups as the deviation of the observed house price change from the respective fundamental price change. Second, we implement the Taylor Rule concept in order to proxy for the monetary policy stance. In the final stage, we analyze the impact of monetary policy on the non-fundamental house price using an interacted panel VAR setting, conditional on the mortgage market development in each country.

The empirical evidence presented in this paper suggests that a negative shock to the deviation from the Taylor rule rate can significantly trigger boom and bust cycles in housing markets by impacting the non-fundamental house price in the euro area. Moreover, the transmission of monetary policy shocks is not equal among all the countries. Country-specific mortgage market conditions are crucial for determining how external shocks transmit to the respective housing markets. Those housing markets with more liberal mortgage markets, as represented by variable mortgage rate, availability of mortgage equity withdrawals, a high Loan to Value ratio, a high degree of mortgage securitization and a high degree of government participation, are more vulnerable to external shocks emerging from interest rate movements. The home price in peripheral countries tends to be more sensitive to mortgage market characteristics. The monetary policy shock can explain over 20% of the forecasting error variance of non-fundamental house price run-ups in Spain and Ireland.

Our findings can yield implications for macro-prudential policy and the design of mortgage markets for a monetary union where monetary policy might be too loose for some countries while being too restrictive for others. Since monetary policy might have adverse side effects as it may destabilize housing markets, regulations on housing finance can close this gap in the central banks' toolbox. Countries with a high maximum loan to value ratio and a high degree of government participation may need to closely monitor the housing market in times of relaxed monetary policy as the side effect of accommodative monetary policy may be amplified. For peripheral countries, policymakers should also keep a close eye on the markets that allow for mortgage equity withdrawals. On the other hand, policy makers may consider macro-prudential policies as a way to prevent adverse housing bubbles triggered by the monetary easing or interest rate gap. Further studies may extend the current work by proofing the causality between the monetary policy and housing market stability as well as the causal relationship between the deregulation in the banking system and the housing market stability.

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Appendix
Table A1: Data sources and definitions

Variable	Source	Description
Real house prices	BIS	House price indices are collected from BIS and are based on national sources. BIS data was not available for Greece and Portugal so we use data from Oxford Economics.
Real GDP	OECD	
Households Credit-to-GDP ratio	BIS	Credit from domestic banks to the households as a share of GDP. Data for Austria starts from Q4 1995. Data for Greece starts from Q4 1994. Data for Ireland starts from Q1 2002. The missing data are interpolated using credit from domestic banks to nonfinancial private sectors.
Inflation	OECD	CPI inflation rate
Population	Oxford Economics	Total population
Population between 20 and 44 years old	World bank	In percent of total population
Short-term interest rate	OECD	
Unemployment rate	OECD	
Consumer Sentiment	OECD	
Mortgage rate	ECB, national sources	From 2003 to 2012, we use the households borrowing costs for purchasing a new home from the European Central Bank (ECB). In order to interpolate the above data back to 1990, we use the mortgage rate collected from national statistical offices of above countries. For the remaining countries we also use the mortgage rate available from national sources. When mortgage rate data is not available, we use the ten-year government bond yield in those countries that have mixed-rate mortgage rates as predominant mortgage contracts. For countries where a variable mortgage rate is more widely used, we choose the one-year government bond yield instead.
Building permits	OECD, Eurostat, Oxford Economics, national sources	Volume index. Data for Belgium, Finland, Germany and Spain are from national sources. Data for Austria, France, and Ireland are from OECD. We also use Eurostat building permit index to interpolate when OECD housing permit volume data are incomplete. For Greece, the Netherlands, and Italy, housing permit data are not available. We use housing starts instead. Housing starts data are from Oxford Economics.
Account Balance	OECD	Countries' Current Account Balance, in percent of GDP.
Financial leverage	US Flow of Funds	The sum of equity and total liabilities of US broker-dealers divided by their equity
Oil Price	OECD	Price of crude oil.
ECU-Euro to US dollar rate	OECD	Exchange rate for 11 countries.
Mortgage Rate Type	Literature	Before 2003: Tsatsaronis and Zhu (2004) and Maclennan et al. (1998); between 2003 and 2012: IMF (2011).
Mortgage equity withdrawal	Literature	Before 2003: Tsatsaronis and Zhu (2004); between 2003 and 2005: IMF (2008);between 2006 to 2012: IMF (2011).
Maximum Loan to Value ratio	Literature	Before 2003: Tsatsaronis and Zhu (2004); between 2003 and 2012: IMF (2011).
Mortgage Securitization	Literature	Hoffmann and Nitschka (2008).
Government Participation	Literature	IMF (2011) and Maclennan et al. (1998).

Table A2: Mortgage Market Indicators

	Mortgage Rate Type (Fixed 0, Variable 1, mixed 0.5)	Mortgage equity withdrawal (MEW) (Yes 1, No 0, Limited 0.3)	Maximum loan-to-value (LTV) ratio	Mortgage Securitization (Yes, 1, No 0, Limited 0.3)	Index of government participation	Mortgage Market liberalization (average of the five indicators)
Before 2000						
AT	0	0	0.8	0.3	0.19	0.02
BE	0	0	0.85	0	0.25	0
FI	1	1	0.75	0.3	0.29	0.70
FR	0	0	0.8	0.3	0.31	0.14
DE	0	0	0.6	0.3	0.25	0.00
GR	0.5	0	0.7	0	0.19	0.18
IE	1	0.3	0.9	1	0.25	0.77
IT	0.5	0	0.5	0	0.25	0.01
NL	0	1	0.75	0.41	0.50	0.63
ES	1	0.3	0.8	0.80	0.31	0.58
PT	1	0	0.8	0	0.19	0.58
After 2000						
AT	0	0	0.80	0.3	0.19	0.02
BE	0	0	0.97	0	0.25	0.05
FI	1	1	0.95	0.3	0.29	0.77
FR	0	0	0.96	0.3	0.31	0.20
DE	0	0	0.76	0.3	0.25	0.06
GR	0.5	0	0.78	0	0.19	0.21
IE	1	0.81	0.98	1	0.25	0.89
IT	0.5	0	0.74	0	0.25	0.10
NL	0	1	1.14	1	0.50	0.96
ES	1	0.3	0.96	1	0.31	0.70
PT	1	0	0.9	0	0.19	0.70

Source: Maclennan et al., 1998; Tsatsaronis and Zhu (2004); IMF (2008); IMF (2011); Hoffmann and Nitschka (2008);.

Table A3: F Test and R^2 for House Price Fundamental Values

Note: Estimation for the period Q1 1992 to Q4 2012. Dependent variable is the quarterly log difference of house prices. Equation (3) is estimated using OLS. F test statistics report the redundancy of each predictor (4 lags) in Equation (3) for each country. R2 is the determinant of coefficients for each country. ***, **, *and* * *denote significance at the1%, 5%, and 10% level, respectively.*

Country	Pop	Permit	Income	GDP	Unemp. Rate	CPI	Mortgage Rate	R^2
AT	0.278	0.193	0.588	0.290	0.518	1.125	0.268	0.266
BE	0.524	1.399	-0.160	0.508	-0.060	0.147	0.392	0.282
FI	0.273	3.898^{***}	1.270	0.403	2.188^{*}	1.944	3.279^{**}	0.686
FR	31.954^{***}	0.466	0.001	4.942^{***}	2.645^{**}	0.659	1.734	0.843
DE	1.017	0.498	0.447	1.290	-0.276	3.429^{***}	0.592	0.314
GR	2.573^{**}	1.352	-0.067	-0.087	0.987	1.080	0.318	0.688
IE	3.894^{***}	1.864	1.027	2.001^{*}	1.053	1.076	1.643	0.697
IT	1.979	1.450	6.769^{***}	0.349	1.302	1.177	1.319	0.771
NL	6.025^{***}	0.127	0.630	13.397^{***}	1.515	1.418	2.302^{**}	0.779
ES	24.491^{***}	5.465^{***}	5.654^{***}	0.950	0.568	0.984	3.664^{**}	0.855
PT	5.941^{***}	1.648	2.049	2.118	2.650^{**}	1.308	1.332	0.614

Table A4: Coefficients for TR

Note: Estimation for the period Q1 1980 to Q4 2012, with the exception of Greece, which is from Q1 1992 to Q4 2012. Dependent variable is the quarterly short-term interest rate. Equation (4) is estimated using GMM estimator. R2 is the determinant of coefficients for each country. ***, **, *and* * *denote significance at the1%, 5%, and 10% level, respectively.*

Country	γ_0	γ_1	γ_2	R^2
AT	3.49*** (0.22)	1.58*** (0.28)	0.27 (0.24)	0.39
BE	4.38*** (0.25)	1.47*** (0.12)	-0.01 (0.27)	0.54
FI	4.40*** (0.26)	2.64*** (0.22)	-0.89*** (0.16)	0.59
FR	4.69*** (0.22)	1.18*** (0.07)	0.43* (0.23)	0.67
DE	4.28*** (0.15)	1.50*** (0.12)	0.11 (0.12)	0.61
GR	2.73*** (0.49)	1.89*** (0.16)	0.17 (0.21)	0.63
IE	5.12*** (0.39)	0.89*** (0.19)	-0.04 (0.21)	0.21
IT	4.29*** (0.29)	1.31*** (0.06)	0.14 (0.24)	0.78
NL	3.97*** (0.22)	0.11 (0.25)	0.81*** (0.20)	0.14
ES	3.64*** (0.36)	1.46*** (0.08)	0.48* (0.27)	0.70
PT	3.50*** (0.50)	1.12*** (0.06)	-0.39 (0.33)	0.85

Table A5 Explained Variance of Non-Fundamental House Price by 1 Standard Deviation Monetary Easing Shock at T=20

Note: The table shows the percent of explained variance of non-fundamental house price run-ups triggered by one-standard deviation of monetary easing shock. The absolute forecasted error variance (in bps) is in parenthesis. The estimation period is from Q1 1992 to Q2 2007 based on Equation (5) with individual mortgage market characteristics interaction variables. We only report the results when $M_{i,t} = 0.75$ *and* $M_{i,t} = 0.25$.

	High $M_{i,t} = 0.75$	Low $M_{i,t} = 0.25$
Model 4: Interest Rate Type:	1.78%	0.78%
Core	(0.003)	(0.001)
Periphery	2.93%	1.09%
	(0.004)	(0.002)
Model 5: Mortgage Equity Withdrawals:	0.97%	1.51%
Core	(0.001)	(0.001)
Periphery	36.49%	3.01%
	(0.101)	(0.003)
Model 6: Maximum LTV:	7.22%	0.58%
Core	(0.011)	(0.001)
Periphery	10.02%	2.29%
	(0.014)	(0.004)
Model 7: Securitization:	3.40%	3.08%
Core	(0.004)	(0.003)
Periphery	5.64%	0.81%
	(0.014)	(0.001)
Model 8: Government Participation:	8.38%	3.88%
Core	(0.011)	(0.004)
Periphery	6.96%	1.28%
	(0.019)	(0.002)

Table A6: Explained Variance of Non-Fundamental House Price by 1 Standard Deviation Monetary Easing Shock at T=20

Note: The table shows the percent of explained variance of non-fundamental house price run-ups triggered by one-standard deviation of monetary easing shock. The absolute forecasted error variance (in bps) is in parenthesis. dWe only report the results when $M_{i,t} = 0.75$ *and* $M_{i,t} = 0.25$.

	High $M_{i,t} = 0.75$	Low $M_{i,t} = 0.25$
Model 9: Constant Maximum LTV	7.72%	0.49%
Core	(0.012)	(0.000)
Periphery	4.77%	3.85%
	(0.007)	(0.005)
Model 10: Exogenous IR Shock	2.57%	0.32%
Core	(0.003)	(0.000)
Periphery	20.99%	2.25%
	(0.037)	(0.002)
Model 11: Alternative Fundamental Estimation:	9.66%	5.48%
Core	(0.432)	(0.101)
Periphery	15.16%	4.47%
	(0.573)	(0.070)
Model 12: Alternative Taylor Rate Estimation	1.00%	2.42%
Core	(0.001)	(0.002)
Periphery	20.48%	2.43%
	(0.035)	(0.003)

Figure A1: House Price Changes and Fundamental Changes

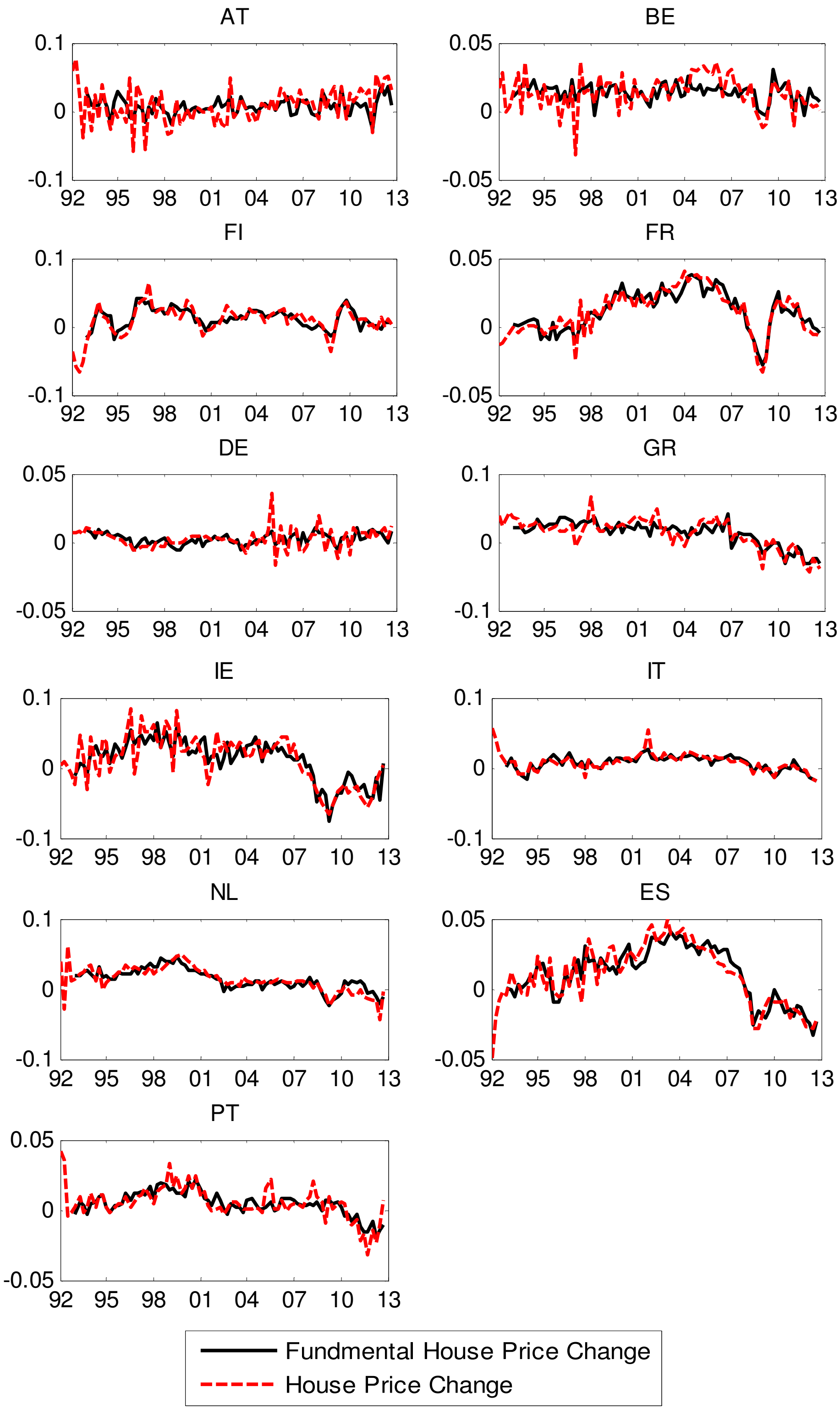


Figure A2: Interest Rate and Estimated Taylor Rate

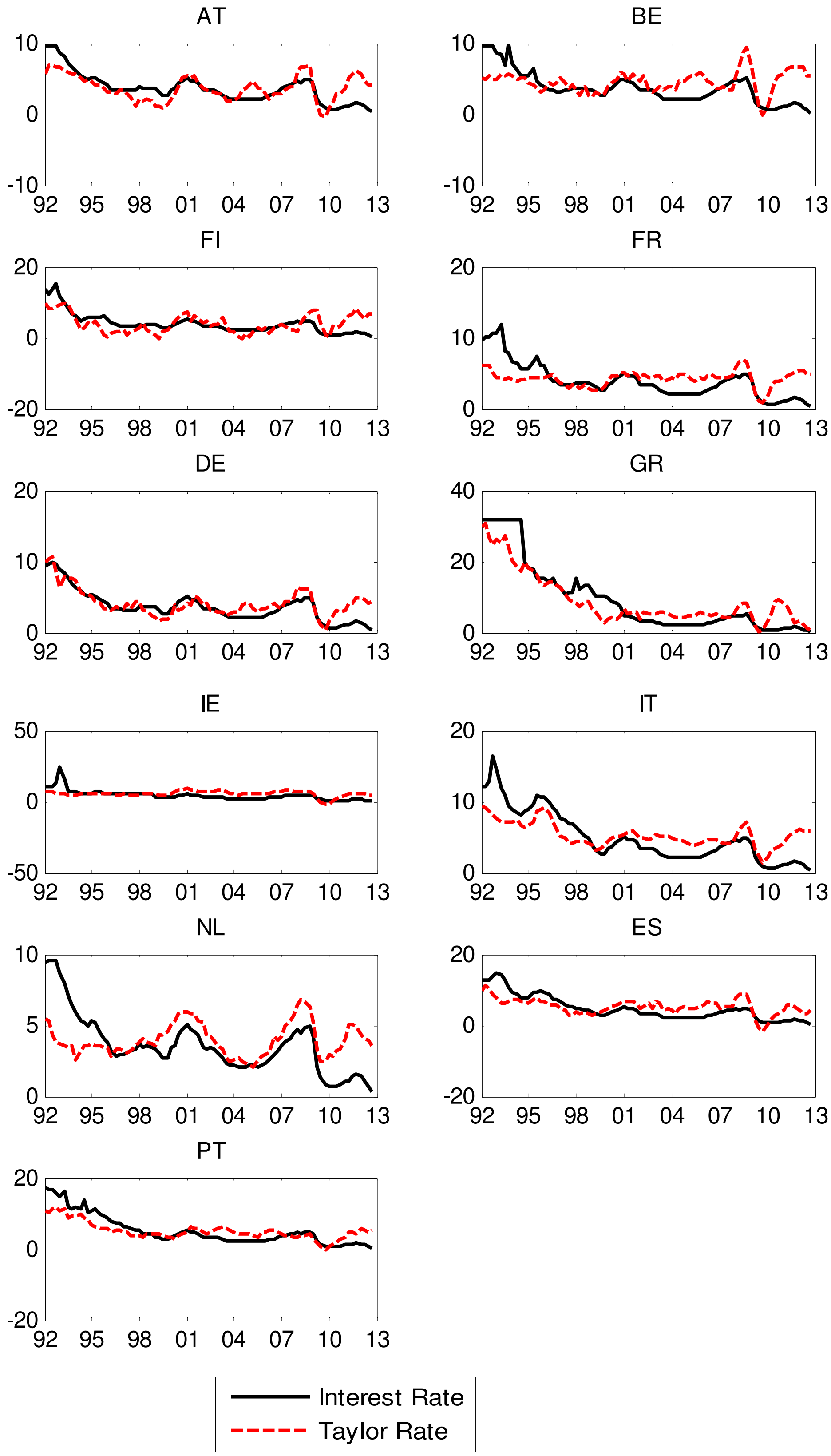


Figure A3: Robustness Tests

Figure A3-1: Capital Inflow_Core

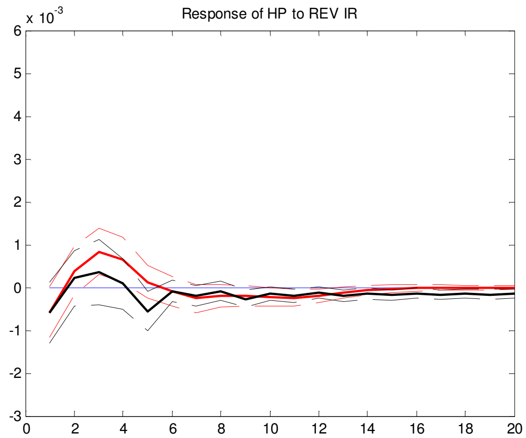


Figure A3-2: Capital Inflow_Periphery

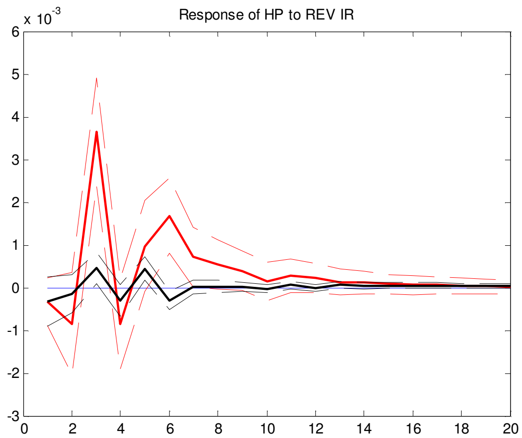


Figure A3-3: Sentiment_Core

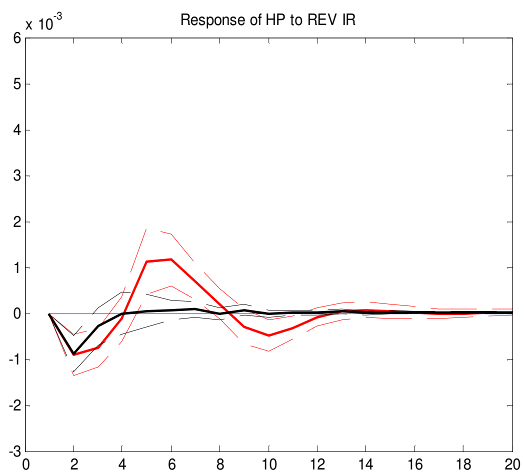


Figure A3-4: Sentiment_Periphery

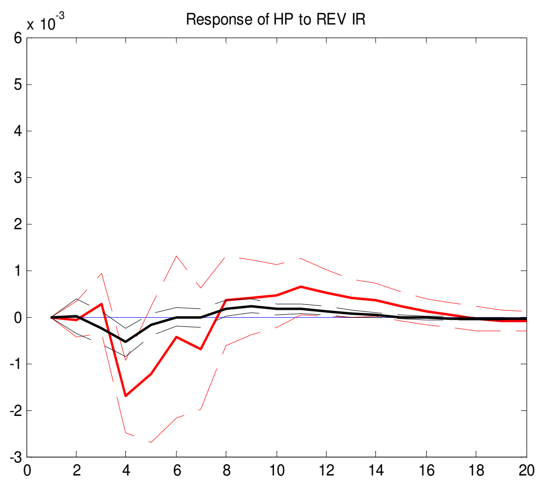


Figure A3-5: Constant LTV_Core

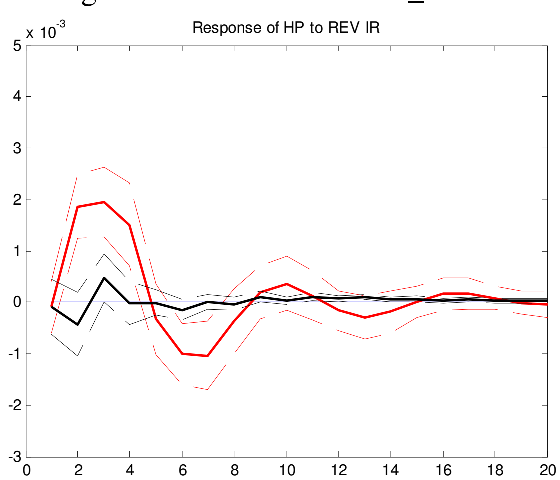


Figure A3-6: Constant LTV_Periphery

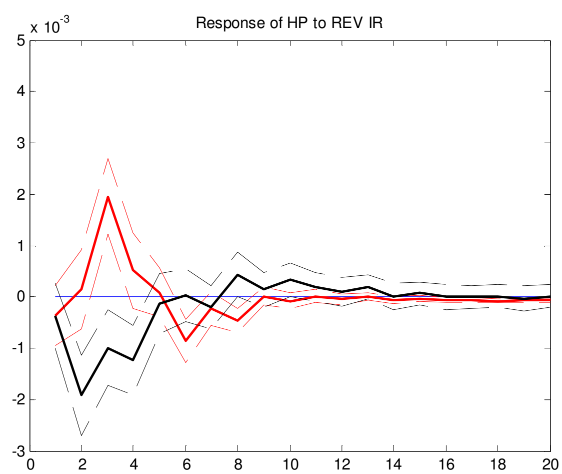
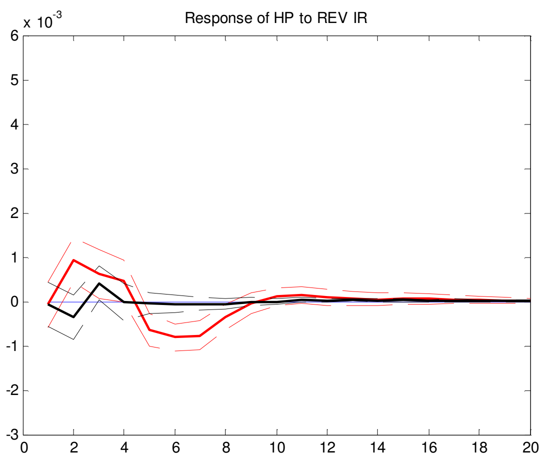


Figure A3-7: Exogenous IR_Core

Figure A3-8: Exogenous IR_Periphery



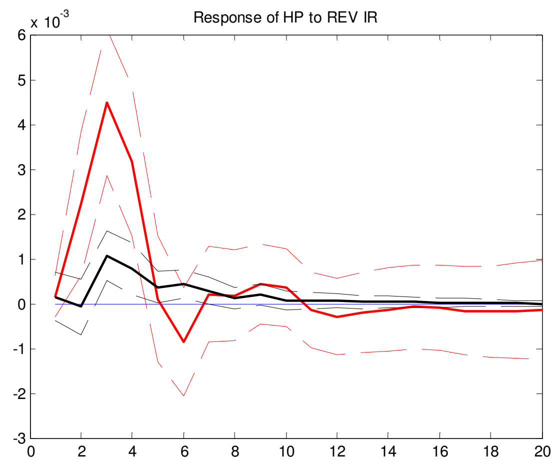
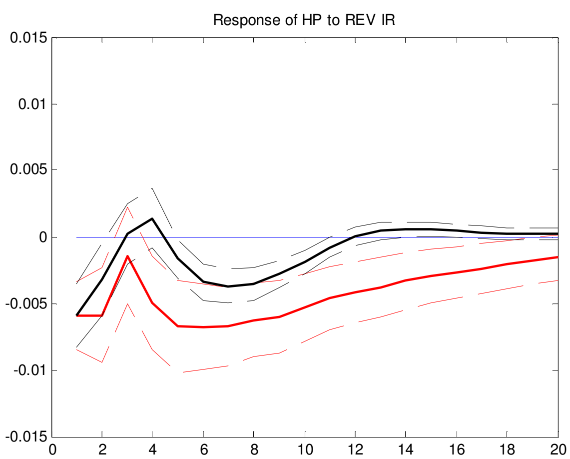


Figure A3-7: Alternative FH_Core

Figure A3-8: Alternative FH_Periphery



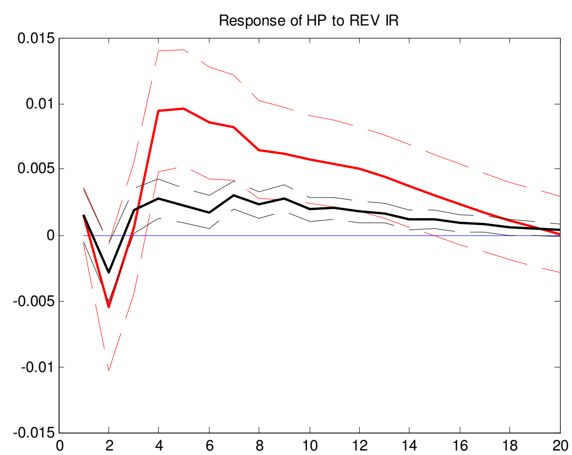
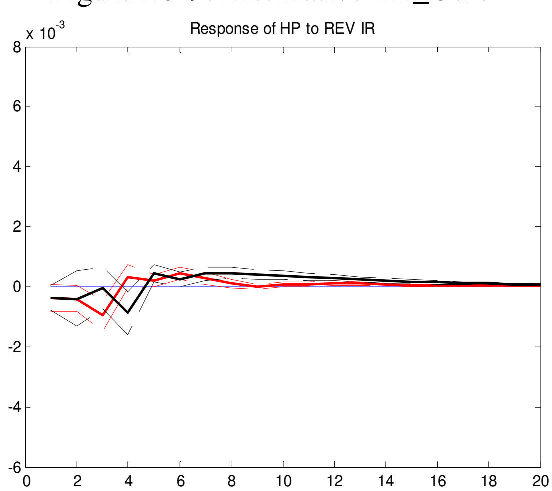
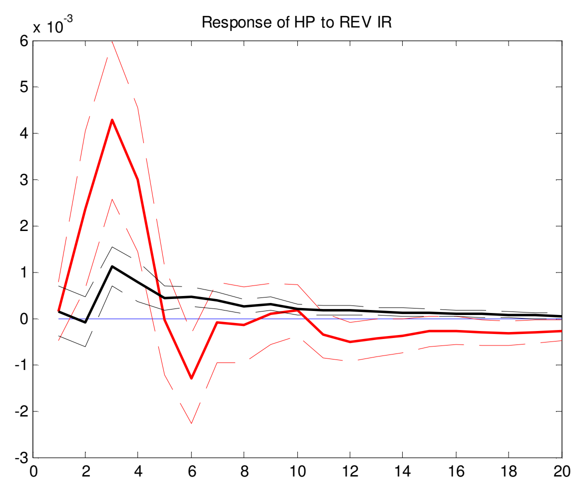


Figure A3-9: Alternative TR_Core

Figure A3-10: Alternative TR_Periphery





Note: The graphs show the responses of non-fundamental house price to a 1 standard deviation positive shock to the reverse of interest rate (monetary easing). Red solid lines show the response in the developed mortgage market ($M_{i,t} = 0.75$ *). Red dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses. Black solid lines show the response in less developed mortgage market*

($M_{i,t} = 0.25$).Black dotted lines show the upper and lower bounds for bootstrapped 90% confidence intervals to the corresponding responses.

Efficient Land Use with Congestion: Determining Land Values from Residential Rents

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In this paper, we propose a model of the residential rental market that meets the functional requirements of the underlying land market. A crucial aspect in the model is the incorporation of land quality represented by the floor area ratio (FAR),one of the most important land use regulation measures. Embedded in a hedonic setting, the model is tested empirically using apartment rent data from the canton of Zurich in Switzerland. From our empirical results we derive two main reasons for a monocentric structure of land prices. First, the central location's attractiveness makes land prices more expensive. Second, on a regulatory basis, the FAR works as a multiplier for land prices. Because the FAR is high in central areas, land prices are inflated accordingly. As a by-product of the model test, we find a capitalization rate for land of 8.1%.

Keywords: Land Values, Determining, Efficient Land Use

Session: Residential Real Estate
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Efficient Land Use with Congestion: Determining Land Values from Residential Rents

Roland Füss* Jan Koller†

January 27, 2016

Abstract

In this paper, we propose a model of the residential rental market that meets the functional requirements of the underlying land market. A crucial aspect in the model is the incorporation of *land quality* represented by the *floor area ratio* (FAR), one of the most important land use regulation measures. Embedded in a hedonic setting, the model is tested empirically using apartment rent data from the canton of Zurich in Switzerland. From our empirical results we derive two main reasons for a monocentric structure of land prices. First, the central location's attractiveness makes land prices more expensive. Second, on a regulatory basis, the FAR works as a multiplier for land prices. Because the *FAR* is high in central areas, land prices are inflated accordingly. As a by-product of the model test, we find a capitalization rate for land of 8.1%.

JEL classification: $C1$, $R3$, $R5$.
Keywords: Apartment rent; land use regulation; floor area ratio (*FAR*); land prices; monocentric structure.

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1 Introduction

A dwelling is characterized by its physical structure and its location. The physical extension of the structure is naturally a necessary requirement for living in the dwelling. The location, however, which constitutes the access to local public amenities, is principally a point in space. For that reason, including locations as points in hedonic models has widely been applied in the hedonic pricing literature. The general approach is to include a broad set of physical and local attributes in the "hedonic function", which assigns a price to a dwelling, given its composition of attributes. The underlying idea is that all attributes are associated with a decreasing marginal rate of utility. In most applications, the amenities are implicitly treated as if they were available on a perfect market, i.e., as if they could be composed and decomposed arbitrarily. This also means that attributes are available for an implicit market price in any amount.

For the physical structure of the house, this market model is realistic in the long term, hypothesizing that supply for physical structure is rather elastic. However, it is inadequate for the determination of the location price of a dwelling because location is restricted in a given area. In particular, the *amount* of location, i.e. land, is scarce and is therefore not available in any amount. Despite that fact, most empirical applications account for the *amount of land* only in a spatially invariant way. A typical approach is to include the size of the lot and regional dummy variables separately. The underlying hypothesis is that a household pays a local fixed price for the amenities associated with the location and a variable, but global, price for land. The main shortcoming of this model is that the price for a location is independent of the amount of the location. Especially in an area where location relative to physical attributes is expensive, it is important to account for the size of the location (i.e., the area of the land). To emphasize this point, note that the value of a specific location can be regarded as the value of access to public goods surrounding that location. Thus, using more land means crowding out other households from access and consumption of public goods.

As a consequence, the location price must be weighted by the amount of location, i.e., the size of the land that is *necessary* to provide a unit of dwelling. When a unit of dwelling is measured in sqm of floor area, then the maximum permitted *floor area ratio* (FAR) is the ultimate measure for the square meters of land that are necessary to provide one square meter of floor area. The density of dwellings is often not random, but rather the result of interdependent land use planning, dwelling prices, and land prices. The result of this interdependence is typically a higher building density at central locations. For the real estate builder, a higher permitted dwelling density means more dwellings *per sqm* of building land. We thus refer to the FAR as *land quality*.

For the real estate developer, who sells and leases residential floor area, the FAR is a limiting device of the floor area he can produce on a given lot of land. Given an exogenous rent for the amenities associated with the location of the real estate developer's land lot, the FAR works as a multiplier of the total floor area rental profit. Assuming an efficient rental market, the FAR will somehow be capitalized into the land value. In the absence of externalities, i.e., when the public good associated with the location are non-rival, then the FAR will *ceteris paribus* be proportional to land values. If, however, a higher residential density is associated with negative externalities (e.g., congestion), then the effect of the FAR on land prices will not be proportional. In terms of the model, this means that the marginal effect will be FAR^{ρ}, with $\rho < 1$.

In this paper, we formulate a theoretical model that relates residential apartment rents to the underlying land values. Following the principles mentioned above, the model includes location amenities, land size, and land quality. The land quality, in particular, is measured by the FAR, augmented by a congestion effect ρ. As a side effect of the hedonic model specification, our approach can account for spatial heterogeneity in a concise way and allows an estimation of the hedonic prices of attributes. In this paper, however, we have a variety of different goals. First, we demonstrate how the model can be used to determine local *land values* using data of *apartment rents*. While in practical applications the appraisal of land using rental prices has been a common approach, it has gained only little attention in the academic literature. To fill this gap, we use apartment rent data from a Multiples Listing Service (*MLS*) to determine implicit local land *rents*. As a by-product of the transformation into land *values*, a capitalization rate can be determined. This allows us, finally, to make a smooth price prediction for land in the form of a land value surface, which is the cornerstone for a series of practical applications and future research. Indeed, the land value surface reveals a highly monocentric pattern for the regional housing market in our study. As a direct consequence of our model, this pattern has *two* main sources: The first and extensively studied determinant is the high attractiveness of centrally located floor area. The second determinant, which has gained less attention, is the density of local floor area.

Our paper contributes to the literature in several ways. The most important is the theoretical model of efficient land use, resulting in a methodological approach of determining land values from residential rent data. Using apartment rents has several advantages and interesting features. Most notably, the density of apartment rent observations are typically high where land transaction are infrequent, which enables land value prediction in sparse local land markets. An interesting feature is the estimation of a capitalization rate resulting from transforming rent data into land prices. Second, we support the theory of monocentric land values. Further, we can demonstrate that this pattern is the result of high *attractiveness* in central locations and land use planning that pursues higher *densities* in central locations. The potentially monocentric structure of urban areas has been of major interest in the urban and housing economics literature. Therefore, the question of *what* is monocentric is particularly important. Based on the broad literature of urban rent models, we expect that *land values* are monocentric. These land values depend on and are highly influenced by the *land quality* since it determines the builders' rent potential. Our empirical findings support the idea that both location attractiveness and land quality exhibit monocentric structures. The land values, as the product of these two factors, exhibits a significant monocentric structure.

The rest of the paper is organized as follows. In section 2, we give a brief overview of the related literature. Section 3 contains the theoretical model. Section introduces the methodology 4. The empirical results are presented in section 5. Finally, section 6 concludes the study and summarizes the most important results.

2 Literature Review

There are plenty of contributions including location-related variables in the hedonic model. A recent example is Kiel and Zabel (2008), who include a broad set of attributes from different region levels. They find that all levels (MSA, town, street) have a significant effect on the price of houses. More flexible models also allow spatial variation in the marginal effects of physical attributes. A good taxonomy of different methodologies for modelling spatial heterogeneity is given in Helbich, Brunauer, Vaz, and Nijkamp (2013).

The purpose of this paper is *not* to account for spatial heterogeneity to attain unbiased hedonic prices. Our intention is to develop a model to determine land prices using residential rental data. However, these tasks turn out to be two sides of the same coin. Similarly to Fik, Ling, and Mulligan (2003), we strongly advocate the interaction of physical attributes with location in principle. The main difference to our study is that these authors do not consider *land quality*, which is a central part of our analysis. Further, we restrict the interaction with *lot area*, while Fik, Ling, and Mulligan (2003) try different specifications. Finally, our study is completely different concerning the purpose of the land size interaction. Indeed, our goal is to actually estimate the underlying land, not just account for potential heterogeneity induced by price differences.

The idea of land price interaction is conceptually similar to Parsons (1990), who suggested weighting location amenities in hedonic models with lot size. The reason is that attributes related to location are regarded as public goods. In turn, more land implies more *residential potential* to consume the public good. This view, however, requires the efficient land use assumption. We make this assumption explicit in our model. In the empirical application, we use data on rental dwellings. These properties, owned by real estate investors, are likely to meet the efficient land use assumption, while it might be questionable in the case of owner-occupied dwellings.

There are few studies that have used the implicit location value approach, i.e., regressing prices on physical attributes and interpreting the residual as the location value. The main difference in these studies is the way these location values capitalize into *per sqm* land prices and the specification of the functional form in the spatial dimension. Two recent studies estimating land prices with a spatially non-parametric equation are Rossi-Hansberg, Sarte, and Owens (2010) and Kolbe, Schulz, Wersing, and Werwatz (2012). The former estimates the land price impact of a *residential urban revitalization program* implemented in Richmond, Virginia. They find that the program increased land prices by 2-5% per annum. Similarly to our study and conceptually inherited from Parsons (1990), they use *per sqm* values, i.e., weighting location-related amenities by lot size. The same approach is applied in Kolbe, Schulz, Wersing, and Werwatz (2012), who use the *per sqm* value of these residuals to predict *location values*.[1] Cheshire and Sheppard (1995) use a similar specification of the *per sqm* location value. With a data sample of only about 900 observations, the authors chose a more structured functional form, allowing for multiple radial asymmetries.

To our knowledge, Kolbe, Schulz, Wersing, and Werwatz (2012) is the only study comparing the estimated location values to land value benchmarks. In particular, they use expert-based land values and location ratings. In contrast, we compare the estimated land values with *actual* land transaction data. Further, none of the studies above explicitly account for land quality in terms of the *floor area ratio* (FAR).[2]

[1] In this paper, we denote location value as the (total) location value per apartment, while the *per sqm* value is denoted as *land value*.

[2] In particular, the way how Kolbe, Schulz, Wersing, and Werwatz (2012) account for quality remains unclear.

3 A Simple Land Value Model

3.1 Land Use Regulations, Floor Area Ratio, and Efficient Land Use

In most countries, the use of land is regulated by local or national planning authorities to some extent. Quigley and Rosenthal (2008) give an extensive list and taxonomy of regulatory and non-regulatory instruments for land use planning.[3] The common goal of many of these instruments is to regulate the population density in an area. In the literature many empirical and theoretical studies exist about land use regulation and housing prices[4], while only a very few studies exist that consider the floor area ratio (FAR) as the central residential planning instrument. For instance, Barr and Cohen (2014) analyze the structure and the development of the FAR gradient in New York City from 1890 to 2009 and find that it exhibits a monocentric pattern. A theoretical contribution by Joshi and Kono (2009) suggests using both minimum and maximum FAR regulations. In contrast to the FAR measure, population density has been extensively studied from the theoretical perspective.[5] A central issue has been the externality effects resulting from increased population density.

In this paper, the central focus is on the residential real estate developer's land use problem. We will include the congestion issues associated with a high urban density. Particularly, the real estate developer's intention is to produce as much residential floor area as possible on his own land. In that simplified context, the relevant regulatory instruments can be limited to those directly affecting the residential floor area permitted to be built per sqm of land. The most obvious way to impose such a restriction is to

[3]Non-regulatory instruments are measures that regulate settlement indirectly. For instance, the absence of public services and infrastructure leads to a low building density without regulatory measures.

[4]As Quigley and Rosenthal (2008) point out, a main issue in this field is the complexity of the actors involved with often ambiguous interest. Thus, identifying a *causal* structure is, especially in a temporal context, a very difficult task.

[5]For instance, Wheaton (1998) provides a theoretical analysis of land use with and without congestion. As such it is clearly the conceptual approach closest to our.

define a maximum floor area ratio (FAR). This measure is defined as the total floor area divided by the land lot area. Denoting floor area by X and land area by L, FAR is defined as:

$$FAR \equiv \frac{\text{floor area}}{\text{land area}} = \frac{X}{L}. \tag{1}$$

As a regulatory instrument, the local government can impose restrictive values on the *floor area ratio* for every lot of land. We are only interested in the maximum value, denoted by FAR_{max}. This measure allows introducing a cap on the local building density. We demonstrate that for real estate developers, the FAR is a central figure working as a multiplier with respect to the rents gained from the land lot. In that respect, the FAR is the developer's *land quality*, which differs from the size of the lot, denoted as *land quantity*.

In our theoretical model, we make a weak assumption of efficient land usage, i.e. the building exploits the land within its regulatory restrictions. Hence, it follows that

$$FAR = FAR_{max} \tag{2}$$

for every lot of land. We refer to this equality as *efficient land use condition.* Note that in an urban area the assumption is rather weak regarding the fact that the owners of apartments are rent-seeking real estate investors.[6] For the apartment builder, it follows that for an additional *sqm* of living area, $1/FAR_{max}$ of building land is required. The land use efficiency assumption implies that this relationship is always exactly fulfilled, i.e. no land is wasted and the maximum restriction is not violated. In order to build an

[6]Rental apartments exclude owner-occupied apartments by definition. For this reason, the owners of rental apartments are real estate investors, who own apartments for financial purposes. Typically, these kinds of real estate holders exploit land efficiently. A debate related to the topic of this paper is the valuation of land under the *efficient use* (also *best use)* assumption, originally initiated by Smith (1979) and his *rent gap theory.* For the interested reader we refer to Hammel (1999) for a detailed discussion of the *rent gap theory* and its critics. The central and most important aspect for this study is that the actual use of the land, i.e. the apartments built on the land are not *too* far away from the *best use assumption.*

apartment with living area X (*size*), the builder thus requires total land area $L = \frac{X}{FAR}$. In a competitive developers' market, the efficient land use assumption is plausible even in the context of negative externalities of population or building density.[7]

3.2 Threefold Nature of Apartment Size

The price of an apartment can be attributed to two kinds of amenities: physical attributes and local amenities. Location attributes are by definition bound to the physical location of the apartment. The local amenities include, for instance, local taxation advantages, the households relevant school districts, proximity to goods and services as well as transport connections.

Different from the physical structure, each house has its own location. From the households' perspective, the location of the land does not have a physical extension. In particular, the amenities provided externally in the form of public goods, associated with a particular location, are available almost independent of the size of the land. However, buying more land crowds out other potential bidders for the same location. It follows that the price of the location must somehow depend on the *location quantity*, i.e, the *size* of the land, which constitutes the location. As a consequence, the price of the location depends on the lot size. Thus, the rental price must include a location value depending on the size of the lot of land.[8]

The competitiveness of locations has its roots in the land market. We demonstrate how the value of amenities is reflected in the land price. Our model is based on and inherits

[7] Wheaton (1998), for instance, argues that local rent maximization is not necessarily the aggregate rent maximization.

[8] Note that a particular lot of land does not only constitute location. It has also physical characteristics, of which the most important is the size of the lot. It is associated with two major non-location amenities. On the one hand, it is the restriction on the ground floor of the apartment. If apartments have only one floor, it is a direct restriction of the apartment size. On the other hand, it should be noted that besides the lot size, the distinction between physical and locational is also ambiguous for other attributes. For instance, the floor of an apartment has physical as well as location characteristics. Living on a higher floor increases the view but also the (potentially challenging) route from the building entrance to the apartment. However, such property characteristics are neglected in our analysis. In the following, we restrict the focus on the size of the apartment and the land.

the conceptual ideas from Parsons (1990). Consider a real estate developer ("developer", henceforth) who owns a lot of land with total area L_T. The land exhibits constant local amenities. The developer can divide the land into m lots of equal size. Local amenities associated with living on a lot of the developer are constant and denoted by A. There is a construction firm from which the developer can borrow structure X, which costs $c(X)$. The developer can rent out each of the m composite bundles (consisting structure and land) for a rent $r(X, A, L)$. In this setting, the developer face the profit maximization problem

$$max_{X,m} \left\{ r\left(X, A, L\right) m - c(X)m \right\}. \tag{3}$$

Assume there exists an equilibrium characterized by a bundle $\{A^*, X^*, L^*\}$ with $L^* = \frac{L_T}{m^*}$, where A^* is the equilibrium level of location-related attributes, and X^* the equilibrium structure attribute. The rent in equilibrium is therefore $r(X^*, A^*, L^*)$. The number of equally sized land lots m^* follows directly from $m^* = L_T/L^*$.

Now suppose there is a potential renter who wants to rent an apartment on a lot of land that is a multiple (λL^*) of the standard lot size. In addition, he prefers a structure $\tilde{X}$. The builder would only sell the bundle $\{\tilde{X}, \tilde{A}, \tilde{L}\}$ if

$$\begin{aligned} &\left[r(X^*, A^*, L^*) - c(X^*)\right](m^* - \lambda) + r(\tilde{X}, \tilde{A}, \lambda L^*) - c(\tilde{X}) \\ &\geq \left[r(X^*, A^*, L^*) - c(X^*)\right] m^*. \end{aligned} \tag{4}$$

If the cost and rent functions are linear, this condition can be simplified to

$$r(\tilde{X}, \tilde{A}, \lambda L^*) \geq r_X \tilde{X} + \lambda r_A A^* + \lambda r_G L^*. \tag{5}$$

Under market competition, this must hold with equality and corresponds to the rent price of the bundle with the large lot size. The price of the bundle with the standard lot size ($\lambda = 1$) is $r(X^*, A^*, L_A^*) = r_X X^* + r_A A^* + r_G L^*$.

Without loss of generality, we can set L^* to unit size (1 *sqm*, for instance). Then, λ is the lot size in *sqm*. By rearranging the pricing equation, we can write the general rental price function as

$$r(X, A, \lambda) = X r_X + \lambda A r_A + \lambda r_G. \tag{6}$$

This corresponds to the result from Parsons (1990). For this reason, Parsons suggests weighting local amenities by lot size. We now include the efficient land use condition represented by Equation (2), which states that the lot size under efficient land use is $\frac{X}{FAR}$. The term Ar_A is the rent for a unit size location. Since we have set the unit size to 1 square meter, we can replace it with r_L, denoting the per sqm land rent. Therefore, the apartment rent can be written as

$$r(X, A) = r_X X + r_G \frac{X}{FAR} + r_L \frac{X}{FAR} \tag{7}$$

By taking the first derivative, the marginal effect of an additional *sqm* in apartment size can be determined:

$$\frac{\partial r(X, A)}{\partial X} = r_X + r_G \frac{1}{FAR} + r_L \frac{1}{FAR}. \tag{8}$$

That is, the marginal rent of an additional unit in apartment size is composed of three components. The first component is the price for an additional square meter of structure (r_X), which is regarded as a globally constant structure price. The second component is the rent price for physical land (r_G). As the structure rent, the value of this *garden* attribute is independent of the location.[9] Finally, the third rent component, r_L, is the rental price for the local amenities per land unit, reflected in the land price. The land

[9]Note that the term *garden* stems from the fact that the second term is associated with a building's surroundings, not with the unusable land below the structure.

price therefore consists of prices for two kinds of amenities: physical amenities associated with the *garden* and amenities associated with the location. Only the last term is directly associated with and, therefore, depends on the apartment's location. In this study, we are interested in the land value, i.e., estimating r_L for a set of locations. In the next step, we present our identification strategy to derive local land values from rental data.

3.3 Short-Term Dynamics vs. Long-Term Equilibrium

In order to determine local land values, Equation (7) is estimated in a hedonic regression. With respect to the interpretation of the results, we briefly outline the relationship between our exogenous and endogenous variables. Considering the third term in Equation (8) and assuming an apartment size $\bar{X}$, the total location price per dwelling is

$$r_d = r_L \frac{\bar{X}}{FAR}. \tag{9}$$

Depending on the temporal scope we expect different and ambiguous effects. First, consider a fast and substantial increase in the FAR in the whole urban area. This would increase the supply of floor area and therefore decrease the corresponding rent temporarily. From this perspective, land prices r_L are exogenous, while the location prices of dwellings $r_L \frac{X}{FAR}$ are endogenous. However, this change in the floor area rent will be capitalized into the equilibrium land value. Hence, it follows that rental prices are exogenous to the land values in the long run. This non-dynamic equilibrium can be analyzed cross-sectionally. In the empirical part, we estimate land rents using a global hedonic function with time dummy variables, i.e., it is a quasi-cross-sectional analysis where the estimated land rent prices are averages. Given a particular homogeneous region, the long-term demand for residential location floor area is assumed to be highly elastic and therefore constant. With an endogenous land price, it is convenient to rewrite (9) as

$$r_L = \frac{r_d}{\overline{X}} FAR^{\rho}, \tag{10}$$

by augmenting the floor area ratio with a congestion parameter ρ. A change in the FAR directly capitalizes into land values. The parameter ρ is the elasticity of the land price with respect to FAR:

$$\frac{\partial r_L / r_L}{\partial FAR / FAR} = \rho. \tag{11}$$

For instance, let us consider two lots of land with the same local amenities, e.g., due to the proximity. Lot A has a FAR that is twice that of lot B. In the case with congestion, the FAR has a decreasing marginal effect. Formally, we model this non-proportionality as FAR^{ρ}. The congestion affects the demand for residential floor area in a negative way, an aspect which is illustrated in Figure 1.

[INSERT FIGURE 1 HERE]

4 Empirical Methodology

4.1 Estimation Strategy

In the previous section, we demonstrated that the value of land has a physical and location-related component. Assume the residential area is partitioned into R^k subareas, where $k = 1...K$. The subareas are constituted by homogeneous local amenities, i.e. apartments exhibit the same local amenities within subareas. The resulting hedonic equation is

$$r_i = \alpha + r_G L_i + r_Y Y_i + r_X X_i + r_L^k I(s_i \in R_k) L_i + \varepsilon_i, \tag{12}$$

where Y_i is a vector containing general physical attributes (excluding apartment size) and r_Y is the vector of corresponding rent prices. The location $s_i = \{lat_i, lon_i\}$ is defined by the geographical coordinates of the apartment. The total rental price is a sum of the price for general physical attributes $p_Y Y_i$, the price for the physical apartment size $p_X X_i$, and the rent price for location k, given by $r_L^k I(s_i \in R_k) L_i$. Note that the $I(s_i \in R_k)$ is the indicator function mapping the location to aggregate regions.

In terms of rental market heterogeneity, this model states that there is only *spatial* heterogeneity in prices for locations. Spatial heterogeneity in hedonic pricing models has at least two different aspects. First, the heterogeneous structure of residuals leads to inconsistent estimates of pricing coefficients. Second, the residuals can be regarded as the price of unobserved property factors. With our model specification, we can account for the spatial heterogeneity by finding the homogeneous area. However, it does not necessarily ensure consistent estimates of the hedonic pricing equation, but rather allows estimating the location values, which determine implicit land prices.

In order to estimate location prices, we need to differentiate between the physical and the location land price. This can be reached by including the interaction of homogenous areas with land size:

$$r_i = \alpha + r_G L_i + r_X X_i + r_L^{k,r} (L_i \times I(s_i)), \tag{13}$$

where $I(s_i)$ denotes the indicator variable reflecting whether apartment i is located in area k. The coefficients $r_L^{k,r}$, $k = 1 \dots K$, are the estimates for regional land rents. Note that the superscript r in $r^{k,r}$ indicates that the estimation coefficients are *relative* rents since the intercept of the land rents cannot be identified from the interaction with region dummies. The absolute land rent is therefore $r_L^k = \delta + r_L^{k,r}$. This relationship is discussed in the next section.

4.2 Transformation of Land Rents into Land Values

In this section, we demonstrate how absolute land values (p_L^k) can be estimated from relative, regional land rents ($r_L^{k,r}$). Obviously, such a transformation must include a shift in levels (because rental prices are determined in relative terms) as well as a capitalization rule, which transforms rents into land prices. In order to keep the model simple, we assume there is a single (and constant) capitalization rate d for all regions. The whole transformation can thus be formulated as

$$p_L^k = \frac{r_L^{k^r} + \delta}{d} = \frac{\delta}{d} + \frac{1}{d} r_L^{k,r}, \tag{14}$$

where δ is the level coefficient to transform the relative rent into an absolute rent and d is the capitalization rate. The term $\frac{\delta}{d}$ is therefore the level factor transforming the relative land price into the absolute land price. One possible approach is to make assumptions about the δ and d and for land price predictions. However, in order to test the validity of our implicit land price model, we use observed regional land price data to roughly estimate the coefficients. We have to note that the main purpose of our estimation is to verify the model. In addition, the estimated value of the capitalization rate is only a by-product of this test.

5 Empirical Results

5.1 Data and Study Area

In the canton of Zurich, the land use regulation is subsidiary to a national land use plan. The building law allows for a wide range of measures to *establish a foundation for human development.*[10] This variety of instruments makes the consideration of regulatory measures impossible. We restrict our attention to the most important, and for our analysis

[10]Written in the building law of the canton of Zurich, *Planungs- und Baugesetz*, §18, Abs.1.

sufficient, regulatory measure, the *floor area ratio* (FAR). It is defined as the *total living area* S_T divided by *total lot area* L_T:[11] Typically, in *core areas*, i.e., in city centers a higher building density is allowed compared to rural areas. The data source of the FAR is the *parcel data record* provided by the statistical office of the canton of Zurich. The GIS data contains the location and shape of all land parcels in the canton of Zurich and the corresponding building rights and regulations. Using the coordinates of the rental data, the apartments' underlying land and its building rights can be determined.

The rental price data we use stems from a Multiple Listings Service (*MLS*) for apartment offerings from 2002 to 2014. Using rental data has the advantage that there is a very large number of observations, while property and vacant land transactions are sparse in the Zurich urban area. In fact, an overwhelming majority of households are renters. The share of owner-occupiers, for both houses and apartments, is about 7% in the central city. The advantage of the usage of rental data is that rental dwellings more often change hands, which results in a larger amount of data. In fact, our data contains more than 40,000 observations from 2002 to 2014 including a wide set of apartment characteristics, as shown in Table A.1 in the Appendix. The apartments come with a street address, which enables us to find coordinates using a geocoding service.[12]

Figure 2 shows a map of the canton of Zurich with the spatial dispersion of the observations represented by the dots, where light and dark colors represent low and high rents, respectively. The smallest jurisdictions are 171 communes, illustrated by solid shapes and listed in Table A.2 in the Appendix. The largest city in the canton is Zurich city, with a population of 383,708 at the close of 2013, the second largest city is Winterthur. In terms of population (105,461), it is only about a quarter of the size of Zurich.[13] The population in these two cities accounted for almost 35% of the total canton's population

[11]Defined in the *Planungs- und Baugesetz* §254 and in more detail *Bauordnung der Stadt Zürich 2012*.

[12]We used Googles geocoding API to translate street addresses into global coordinates. These coordinates are than transformed into Swiss Grid coordinates using transformation functions provided by Swisstopo.

[13]With regard to these population figures, the two cities are defined by the jurisdictions (or communes, respectively) of Zurich and Winterthur.

(1,421,895) at the end of 2013. In our data, 36% of the observations stem from Zurich and Winterthur, i.e., the data represents the dispersion of residents. Moreover, when comparing the data to BFS's 2012 nationwide household survey, we find that the rent prices of the apartments have representative mean values. For instance, the average rent price of an apartment with three rooms was 1,442 CHF, and 2,354 CHF for an apartment with four rooms.[14]

[INSERT FIGURE 2 HERE]

For testing the quality of our land model, we compare the estimated implicit land values to regional averages of land price transactions. The corresponding data is based on communal land registry offices, where all property transactions must be registered. For confidentiality reasons, only averages of these transaction prices are provided by the Zurich Statistical Office.[15]

5.2 Testing and Calibrating of the Model

In Section 3, we outlined how the relative rental price is transformed into absolute land prices. In order to identify the capitalization rate and the level coefficient in Equation (14), we need to make use of regional land prices. In this section, we test and calibrate the model in two steps. In the first step, we estimate the model of relative implicit land rents p_k^r in Equation (13). In the second step, these estimates are compared to observed regional land prices as suggested in Equation (14). We run a regression of regional (aggregate) average land prices on our implicit relative land rents for the same regions to derive the coefficients δ and d.

As mentioned above, the sparsity of vacant land transactions is one of the main reasons for the use of residential data to determine land values. For the same reason,

[14]The corresponding average rent prices in the BFS survey were 1,419 and 2,137 CHF. See BFS Strukturerhebung (2012) for more information.

[15]See Statistisches Amt des Kantons Zürich (2014).

however, we use averages of regional land transaction prices to test the predictive power of our model. A higher level of aggregation (i.e., larger regions) of land transaction prices has the advantage of better estimates of the mean land prices. The disadvantage is, however, that we get fewer (aggregate) observations to test the predictive power. This trade-off is restricted by the availability of data. We have access to regional mean prices for two regional aggregation levels: communes (171 communes) and consensus land use planning regions (12 regions). On the level of communes, the number of land transactions ranges from 0 to 26, with an average of 2.6 transactions per commune and year. On the level of consensus land use planning regions, the corresponding range is from 16 to 72, with an average of 40.5 transactions. Average land price transactions for communes are not suitable because we do not have observations for every commune in every year. For this reason, we decided to use the pre-defined consensus land use planning regions to calibrate the model and test its predictive power.

The regression result of the first step is listed in Table A.3 in Appendix A. Besides the hedonic rental prices for different apartment characteristics, the coefficients represent the implicit relative land prices for regions 1 to K. In the next step, we compare the implicit relative land rents to the observed absolute mean land prices of the regions. Figure 3 shows the scatter plot of the two variables.

[INSERT FIGURE 3 HERE]

The strong linear dependence indicated by the graphical inspection is reflected in a high correlation coefficient of 0.904 between the actual land prices and predicted land values. Further, we report the results for the fitted values according to Equation (14). Note that the number of observations in this regression is only N=72. The results of the linear regression of effective land prices on implicit land rents are summarized in Table 1.

[INSERT TABLE 1 HERE]

We conclude that for this level of aggregation, our prediction of aggregate land price data is relatively accurate. As a by-product of the goodness-of-fit test, we report the level and slope coefficients in Table 1. The slope estimate of 12.304 corresponds of to the inverse of the capitalization rate. The capitalization rate is therefore $1/12.304 = 8.127\%$, which is a comparably high value.[16] The high accuracy of the land prediction model makes it feasible for practical application.

A further parameter identified in the estimation is the global congestion parameter ρ. We estimate a value of 0.65, which means that the FAR is associated with negative externalities. The goodness-of-fit of the overall regression (in terms of R^2) is shown in Figure A.1 in the Appendix, where our estimate is the value that maximizes the regression R^2. A congestion parameter of 0.65 means that the effect of the FAR on land prices is diminishing, for instance, the effect for $FAR = 2$ is $2^{0.65} = 1.569$.

5.3 Land Value Surface

In the previous section, we have shown that the implicit land price model fits land price transaction data well. As a by-product of this test, we have estimated coefficients that allow us to predict land prices from implicit land rents. Using these results, we can estimate a land value surface by smoothing the predicted (implicit) land values. For that purpose, we spatially generalize the rent function (12) and get[17]

$$r_i = \alpha + \phi L_i + \beta X_i + r(s_i) L_i + \varepsilon_i. \tag{15}$$

In particular, we run a non-parametric local regression of land price predictions (at individual level) on the longitude and latitude values. In particular, the estimation is based on the Nadaraya-Watson local constant estimator:

[16]Indeed, this capitalization rate can well be compared to rent-discount rates used to evaluate the net asset value (NAV) in real estate funds. For funds invested in residential real estate, the average discount rate for Swiss real estate funds were around 5% from 2004 to 2014.

[17]We follow the notations of Clapp and Wang (2006) for the specification of the hedonic model.

$$\hat{r}(loc_h) = N^{-1} \sum_{i=1}^{N} K_h, i(loc_j) r_i, \qquad (16)$$

where

$$K_{h,i}(loc_j) = \frac{K_h(loc_j - loc_i)}{N^{-1} \sum_{i=1}^{N} K_h(loc_j - loc_i)} \text{ and } K_h(u) = h^{-1} K\left(\frac{u}{h}\right). \qquad (17)$$

We use a Gaussian Kernel function $K(.)$, with a bandwidth h determined by cross-validation. As a result, we get a smooth surface of relative residential rents. Based on Equation (14), these estimates are transformed into land value estimates. The corresponding smooth land value surface is illustrated in Figure 4.

[INSERT FIGURE 4 HERE]

In this section, we demonstrate how the predicted land values of the canton of Zurich can be explained by major land attributes. First, note that the land price surface does, to some degree, smooth out the micro location. Therefore, it is primarily associated with macro location values. According to Kubli, Lüscher, Salvi, Schellenbauer, Schellenberg, Moser, Rey, and Bischoff (2008), the macro location is indeed the most important determinant of land prices in this area. In addition, our findings are largely in line with the finding of Kubli, Lüscher, Salvi, Schellenbauer, Schellenberg, Moser, Rey, and Bischoff (2008). The corresponding land attributes are distance to CBD, tax level, and proximity to the lake. Since the proximity to the lake is a matter of the larger environmental situation, we regard it as a macro location attribute as well. A graphical inspection of Figure 4 reveals evidence of a multi-radial monocentric land price. The center is located next to the lake, very close to the CBD. As the contour lines indicate, the decrease in land prices along the lakeside is much flatter compared to all other directions.

5.4 Dual Monocentric Structure

We have argued from a theoretical perspective that the land use efficient lot size is a promising measure for determining land values and showed empirically that the predicted land values fit the empirical data well. In particular, interacting the land efficient lot size has been successful for land price determination. In this section, we restrict the analysis to the larger urban area around the city of Zurich to demonstrate the monocentric structure of implicit land prices in this area. Since a main focus of this paper is on the land use regulation, we will illustrate the role of this regulation in the resulting monocentric pattern. Methodologically, the fitting of monocentric models is not necessary since the visual evidence of the value gradients is obvious.

The predicted land value is the product of *location value per sqm* and land quality. We can decompose these two factors and analyze them visually. First, we focus on the central location's attractiveness. This fact is reflected in the left panel of Figure 5, which shows a non-parametric surface of the *location value*, i.e. the part of the apartment that reflects the value of the location. The monocentric structure is distorted and irregular. However, the CBD has the highest value and location prices are decreasing in all directions. Clearly, the lakeside is the main source of the irregularity of the location value. In summary, location values exhibit a monocentic structure, even without controlling for non-monocentric location amenities such as the proximity to the lake.

Second, the fact that floor area ratios are higher in central areas increases land rents in the center. Since these two location characteristics, location attractiveness and FAR, are correlated, the implicit land prices exhibit considerable variation. Indeed, the building regulation aims at a high FAR in central locations, where the location value is already high. The obvious reason for this policy is to reduce prices for dwellings at favorable, central locations.

[INSERT FIGURE 5 HERE]

Finally, the predicted land values as the product of location quality and land quality is shown in Figure 6. The interaction of location value and location quality is embodied in this surface. The monocentric structure of land quality has clearly shaped the land price patterns into oval gradients. However, the pattern of the location values dominates the high value locations along the lakeside. In addition, the location value determines the center of the monocentric structure in land prices. Indeed, the highest land price is not in the CBD, but slightly more northward next to the lake. In that point, very high local amenities meet a relatively high floor area ratio, making it the most valuable land in the canton of Zurich.

[INSERT FIGURE 6 HERE]

6 Conclusion

The main goal of this paper is to propose a simple model that meets the functional characteristics of the land market. Based on a concept of the underlying value of locations, we demonstrated that location does not, in principle, have a spatial extension and the "amount of the location" is, at first glance, meaningless. However, the product on the "market for locations" inevitably comes in the form of land, which does have a spatial extension. When we assume that land is exploited efficiently, an additional unit of apartment surface requires $1/FAR$ units of land. Then, for a constant FAR, it can be shown that the marginal price for the apartment size has three rent components: the presumably constant rents for structure and physical land, as well as the land rent inherent location value.

We were interested in the location value component. Thus, we formulated a location interaction model that can be estimated for pre-defined regions. One of the main features of this model is the consideration of the *land use efficient lot size*, accounting for the apartments' underlying land quality. Applying the model in a hedonic setting to a large amount of rental data in the canton of Zurich, we estimated local residential land values. The transformation of rent components into land prices is a linear function, which includes the capitalization rate as a coefficient. Using consensus submarkets ("Raumplanungsregionen") in the canton of Zurich, we demonstrated that our model is highly reliable in predicting land prices. In particular, the correlation coefficient of predicted values and observed land prices is 0.905, and the relative prediction error is 18.9%. This high prediction accuracy makes the model suitable for practical application. For instance, it provides a basis for predicting land values in places where land transactions are infrequent or even absent. This is particularly good news since land transactions tend to be low in urban areas, where rent observations are very frequent.

As a by-product of the goodness-of fit test of our model, we estimated a capitalization rate of 8.13%. This finding is interesting from an asset pricing perspective. Particularly, it can serve as a benchmark capitalization rate for residential real estate investments. However, compared to the capitalization rate of residential real estate funds, our estimation is relatively high.

In a final step, we utilize our findings from the model test to estimate a land value surface. The number of observations allowed us to use a non-parametric approach to predict land values for any location. Concentrating on the larger urban area around the city of Zurich, we found a monocentric pattern in the predicted land values. This pattern is the result of two main urban patterns: First, the *monocentric location value* pattern is the result of higher amenities in central locations. Second, the *monocentric land quality* pattern is the result of land use regulation, i.e., the result of the higher permitted floor area ratios in central areas. When estimating land values, and especially when the location values stem from regression residuals, land quality should be accounted for.

A Appendix

Table A.1: Data Description

This table shows the apartment characteristics of rental dwellings for the canton of Zurich by category, i.e. by rental price, structure, location, and time. The data set contains more than 40,000 observations provided by a Multiple Listing Service (MLS) for apartment offerings from 2002 to 2014.

Category	**Variable**	**Description**
Rental price	Rental price	Gross rental price in Swiss Francs per month
Structure	Area	Living area of the apartment in m2
	Rooms	Number of rooms. Living rooms counting for 1.5 rooms
	Special view	Binary variable, indicating whether the apartment has special view
	Lift	Binary variable, indicating whether the apartment has a lift
	Parking	Binary variable, indicating whether the apartment offers a parking opportunity
	Garage	Binary variable, indicating whether the apartment has a parking garage space
	Duplex	Binary variable, indicating whether it is a duplex apartment
	Attic	Binary variable, indicating whether it is a attic apartment
	Flat roof	Binary variable, indicating whether it is a attic apartment
	Studio	Binary variable, indicating whether it is a studio apartment
	Single	Binary variable, indicating whether it is a single apartment
	Furnished	Binary variable, indicating whether the apartment is furnished
	Terrace	Binary variable, indicating whether the apartment has a terrace
	Single	Binary variable, indicating whether it is a single apartment
	Loft	Binary variable, indicating whether it is a loft apartment
Location	Address	Street address of the apartment
Time	Availability	Date of availability of the apartment

Table A.2: Regions (Jurisdictions) in the Canton of Zurich

This table lists the 171 communes of the canon Zurich, which are the smallest jurisdictions in Switzerland.

ID	Name	ID	Name	ID	Name	ID	Name
1	Aeugst a.A.	56	Embrach	115	Gossau	192	Egg
2	Affoltern a.A.	57	Freienstein-Teufen	116	Grüningen	193	Fällanden
3	Bonstetten	58	Glattfelden	117	Hinwil	194	Greifensee
4	Hausen a.A.	59	Hochfelden	118	Rüti	195	Maur
5	Hedingen	60	Höri	119	Seegräben	196	Mönchaltorf
6	Kappel a.A.	61	Hüntwangen	120	Wald	197	Schwerzenbach
7	Knonau	62	Kloten	121	Wetzikon	198	Uster
8	Maschwanden	63	Lufingen	131	Adliswil	199	Volketswil
9	Mettmenstetten	64	Nürensdorf	132	Hirzel	200	Wangen-Brüttisellen
10	Obfelden	65	Oberembrach	133	Horgen	211	Altikon
11	Ottenbach	66	Opfikon	134	Hütten	212	Bertschikon
12	Rifferswil	67	Rafz	135	Kilchberg	213	Brütten
13	Stallikon	68	Rorbas	136	Langnau a.A.	214	Dägerlen
14	Wettswil a.A.	69	Wallisellen	137	Oberrieden	215	Dättlikon
21	Adlikon	70	Wasterkingen	138	Richterswil	216	Dinhard
22	Benken	71	Wil	139	Rüschlikon	217	Elgg
23	Berg a.I.	72	Winkel	140	Schönenberg	218	Ellikon a.d.Th.
24	Buch a.I.	81	Bachs	141	Thalwil	219	Elsau
25	Dachsen	82	Boppelsen	142	Wädenswil	220	Hagenbuch
26	Dorf	83	Buchs	151	Erlenbach	221	Hettlingen
27	Feuerthalen	84	Dällikon	152	Herrliberg	222	Hofstetten
28	Flaach	85	Dänikon	153	Hombrechtikon	223	Neftenbach
29	Flurlingen	86	Dielsdorf	154	Küsnacht	224	Pfungen
30	Andelfingen	87	Hüttikon	155	Männedorf	225	Rickenbach
31	Henggart	88	Neerach	156	Meilen	226	Schlatt
32	Humlikon	89	Niederglatt	157	Oetwil a.S.	227	Seuzach
33	Kleinandelfingen	90	Niederhasli	158	Stäfa	228	Turbenthal
34	Laufen-Uhwiesen	91	Niederweningen	159	Uetikon a.S.	229	Wiesendangen
35	Marthalen	92	Oberglatt	160	Zumikon	230	Winterthur
36	Oberstammheim	93	Oberweningen	161	Zollikon	231	Zell
37	Ossingen	94	Otelfingen	171	Bauma	241	Aesch
38	Rheinau	95	Regensberg	172	Fehraltorf	242	Birmensdorf
39	Thalheim a.d.Th.	96	Regensdorf	173	Hittnau	243	Dietikon
40	Trüllikon	97	Rümlang	174	Illnau-Effretikon	244	Geroldswil
41	Truttikon	98	Schleinikon	175	Kyburg	245	Oberengstringen
42	Unterstammheim	99	Schöfflisdorf	176	Lindau	246	Oetwil a.d.L.
43	Volken	100	Stadel	177	Pfäffikon	247	Schlieren
44	Waltalingen	101	Steinmaur	178	Russikon	248	Uitikon
51	Bachenbülach	102	Weiach	179	Sternenberg	249	Unterengstringen
52	Bassersdorf	111	Bäretswil	180	Weisslingen	250	Urdorf
53	Bülach	112	Bubikon	181	Wila	251	Weiningen
54	Dietlikon	113	Dürnten	182	Wildberg	261	Zürich
55	Eglisau	114	Fischenthal	191	Dübendorf		

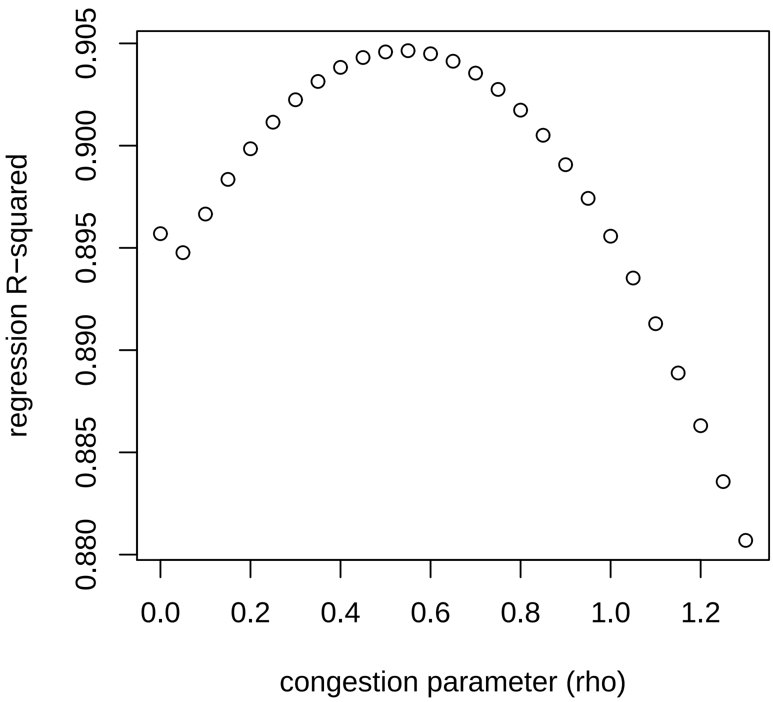
Table A.3: Estimation Results of Hedonic Regression with Interaction Terms

This table shows the regression results of the model of relative implicit rents in Equation (13). Besides the hedonic rental prices for different apartment characteristics, the coefficients represent the implicit relative land prices for region 1 to K, which are reflected in the interaction terms between *region dummies* and *efficiency lot size*.

variable	coefficient	id×eff_land		id×eff_land		id×eff_land		interactions (id x eff_land)	
(Intercept)	-284.07	reg_id 2	-1.07	reg_id 83	-1.53	reg_id 138	0.23	reg_id 212	-1.64
SURFACELIVING	15.19	reg_id 3	-0.96	reg_id 84	-1.85	reg_id 139	4.07	reg_id 216	-0.85
as.numeric(floor)	0.92	reg_id 4	-0.6	reg_id 85	-0.34	reg_id 141	2.42	reg_id 217	-2.46
NUMBEROFROOMS	34.42	reg_id 5	-0.87	reg_id 86	-1.29	reg_id 142	0.74	reg_id 219	-3.06
Special view	4445.33	reg_id 7	-1.22	reg_id 88	0.16	reg_id 151	3.36	reg_id 221	-0.76
LIFT	156.33	reg_id 9	-1.16	reg_id 89	-1.37	reg_id 152	2.73	reg_id 223	-1.41
PARKING	-57.73	reg_id 10	-1.3	reg_id 90	-1.71	reg_id 153	-0.56	reg_id 224	-1.07
GARAGE	19.16	reg_id 13	-1.2	reg_id 91	-1.68	reg_id 154	2.17	reg_id 227	-0.79
APP_TYPE1	6.35	reg_id 14	-0.05	reg_id 92	-1.17	reg_id 155	1.06	reg_id 228	-2.84
APP_TYPE2	108.39	reg_id 23	-0.09	reg_id 94	-0.73	reg_id 156	1.31	reg_id 230	-1.2
APP_TYPE3	467.45	reg_id 27	-2.73	reg_id 96	-1.17	reg_id 157	-1.03	reg_id 231	-1.54
APP_TYPE4	157.49	reg_id 30	-1.59	reg_id 97	-0.87	reg_id 158	1.44	reg_id 242	0.03
APP_TYPE5	85.36	reg_id 31	-1.17	reg_id 98	0.78	reg_id 159	1.45	reg_id 243	-1.3
APP_TYPE6	-394.28	reg_id 35	-3.21	reg_id 99	-1.35	reg_id 160	2	reg_id 244	-0.35
APP_TYPE7	486.97	reg_id 37	-2.23	reg_id 100	-1.63	reg_id 161	2.6	reg_id 245	-0.55
APP_TYPE8	500.76	reg_id 51	-1.06	reg_id 101	-2.2	reg_id 171	-3.04	reg_id 246	-0.02
APP_TYPE9	110.65	reg_id 52	-0.2	reg_id 111	-6.03	reg_id 172	-0.79	reg_id 247	-1.15
APP_TYPE10	277.58	reg_id 53	-1.22	reg_id 112	-1.54	reg_id 173	-1.16	reg_id 248	1.96
YEAR_BUILT	0.00	reg_id 54	-0.22	reg_id 113	-0.87	reg_id 174	-0.88	reg_id 249	0.4
YEAR2003	-53.4	reg_id 55	-1.28	reg_id 115	-1.46	reg_id 176	-0.62	reg_id 250	-0.21
YEAR2004	-103.74	reg_id 56	-0.89	reg_id 116	-1.28	reg_id 177	-0.56	reg_id 251	-0.37
YEAR2005	-128.5	reg_id 58	-1.67	reg_id 117	-1.13	reg_id 178	-0.81	reg_id 261	2.75
YEAR2006	-155.85	reg_id 59	-0.75	reg_id 118	-1.9	reg_id 191	-0.07		
YEAR2007	-128.86	reg_id 62	-1.26	reg_id 120	-1.66	reg_id 192	-0.01		
YEAR2008	-41.41	reg_id 63	-2.19	reg_id 121	-1.15	reg_id 193	-0.16		
YEAR2009	16.19	reg_id 64	-1.06	reg_id 131	0.59	reg_id 195	0.79		
YEAR2010	48.52	reg_id 66	-1.22	reg_id 132	0.76	reg_id 196	-1.13		
YEAR2011	71.09	reg_id 67	-1.58	reg_id 133	1.55	reg_id 197	-0.28		
YEAR2012	83.13	reg_id 68	-1.86	reg_id 135	4.02	reg_id 198	-0.78		
YEAR2013	140.05	reg_id 69	-0.67	reg_id 136	0.17	reg_id 199	-1.34		
YEAR2014	151.32	reg_id 72	-0.14	reg_id 137	3.05	reg_id 200	-0.69		

Figure A.1: R^2 in Dependence of the Congestion Parameter

This figure illustrates the development of the goodness of fit of the overall regression in terms of R^2 derived from Equation (14) based on various levels of the global congestion parameter (ρ). At a congestion parameter of 0.65 the effect of the FAR on land prices is decreasing. The graph demonstrates the negative externalities of the FAR.



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B Tables

Table 1: Regression Results for Land Price Prediction

This table shows the regression results of regional (aggregated) average land prices on implicit relative land rents for the same regions. The number of observations is $N = 72$. MAE and MRE stand for mean absolute error and mean relative error, respectively.

Estimation Results	Value
Intercept	749.182
Slope	12.304
Statistics	
R-squared	0.81811
Correlation Coefficient	0.9045
MAE (mean absolute error)	122.19
MRE (mean relative error)	0.1887
Relative error $>$ 15%	0.4692
Relative error $>$ 25%	0.2769

C Figures

Figure 1: Demand for Floor Area in the Short and Long Term

This figure shows the relationship between land price and the quantity of land. In a homogeneous, regional housing market the short-term demand for residential floor is assumed to be unit elastic, while the long-term demand is perfectly elastic. The introduction of congestion by accounting for the price elasticity of land with respect to the floor area ratio (FAR) affects the long-term demand negatively. It follows that a change in the FAR directly capitalizes into land values due to its decreasing marginal effect.

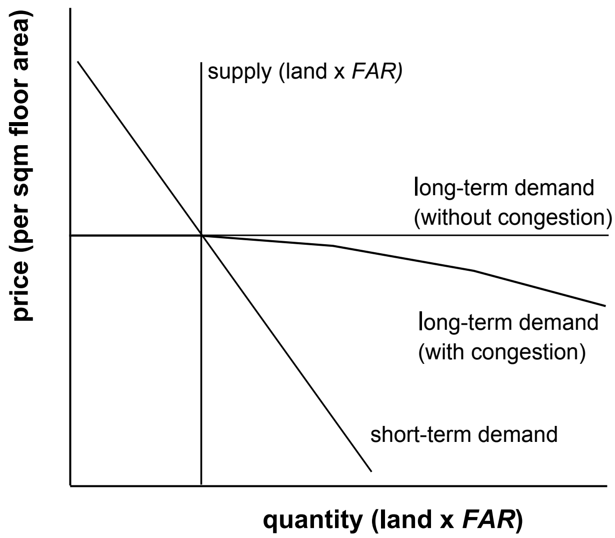


Figure 2: Map of Canton of Zurich

This figure shows the spatial dispersion of the observations for the canton Zurich. The light and dark colored dots represent low an high rents in the data sample, respectively. The solid shapes of the map indicate the 171 communes within the canton's boundaries. The dispersion of the observations reflects the dispersion of the residents, with a total population of approx. 1.4m at the end of 2013.

Figure 3: Predicted versus Observed Land Transaction Prices

This figure compares the implicit relative land rents to the observed absolute mean land prices of the canton Zurich. The predicted implicit relative land prices are the fitted values based on the estimation results from Table A.3 in the Appendix. The strong linear relationship between the predicted predicted versus actual land prices is reflected in a correlation coefficient of 0.904.

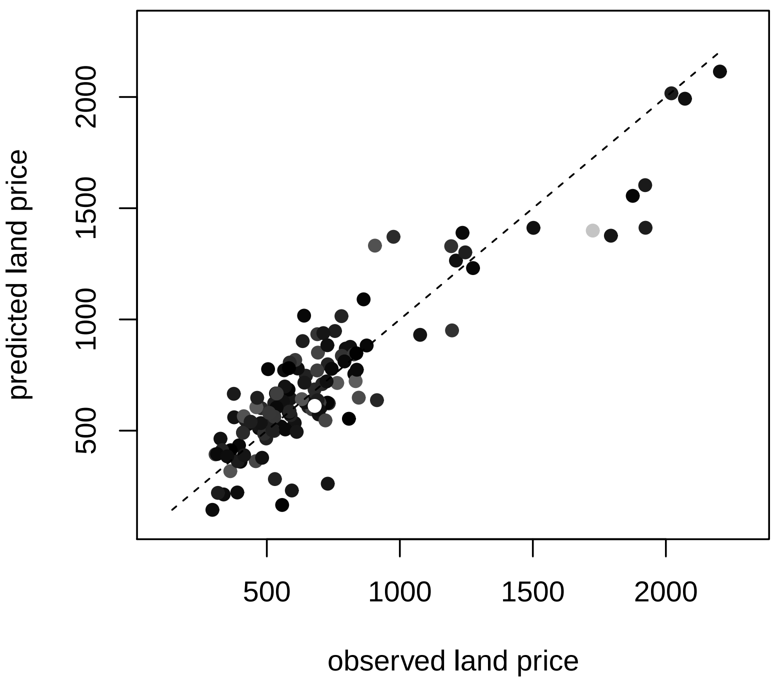


Figure 4: Non-parametric Estimates of Predicted Land Values

This figure shows the estimation results for the land value surface based on smoothed predicted (implicit) land values. In the non-parametric local regression land price predictions are regressed on the longitude and latitude. The estimation is based on the Nadaraya-Watson local constant estimator. According to Equation (14) the estimates are transformed into land value estimates, which results in a smooth surface of relative residential rents.

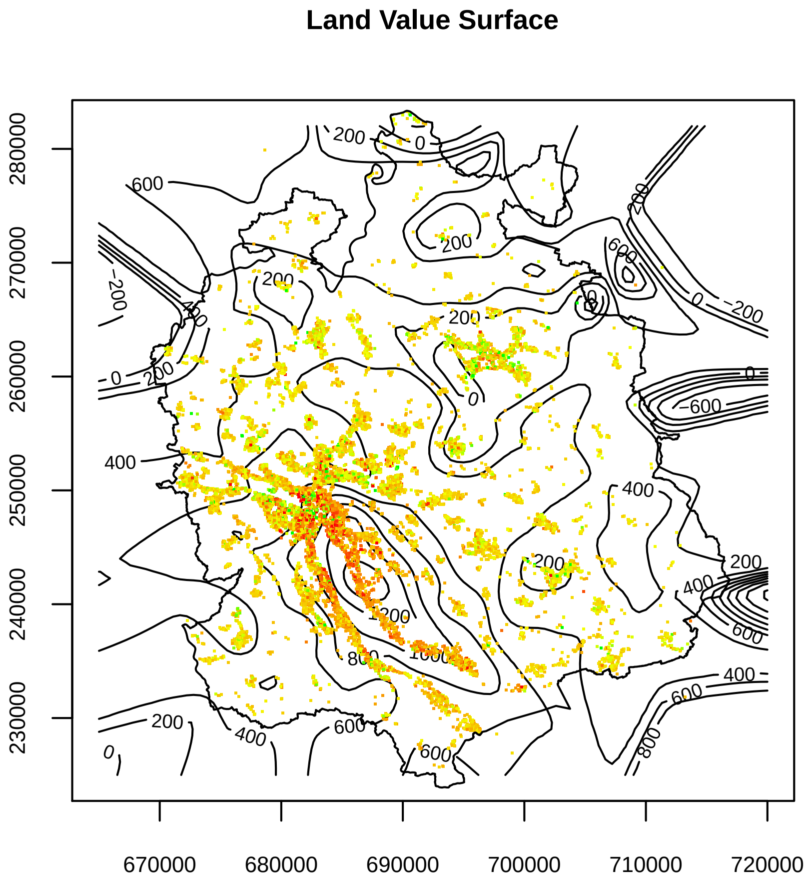


Figure 5: Non-parametric Estimates of Location Value and Land Quality

This figure shows the non-parametric surface of the location value in the left-hand-side graph, while the right-hand-side graph shows the land quality measured in terms of the *floor area ratio* (FAR). The location value reflects the central location's attractiveness with the highest value in the CBD, from which location prices decrease in all directions. Because of higher FARs in central areas, land prices increase in the CBD.

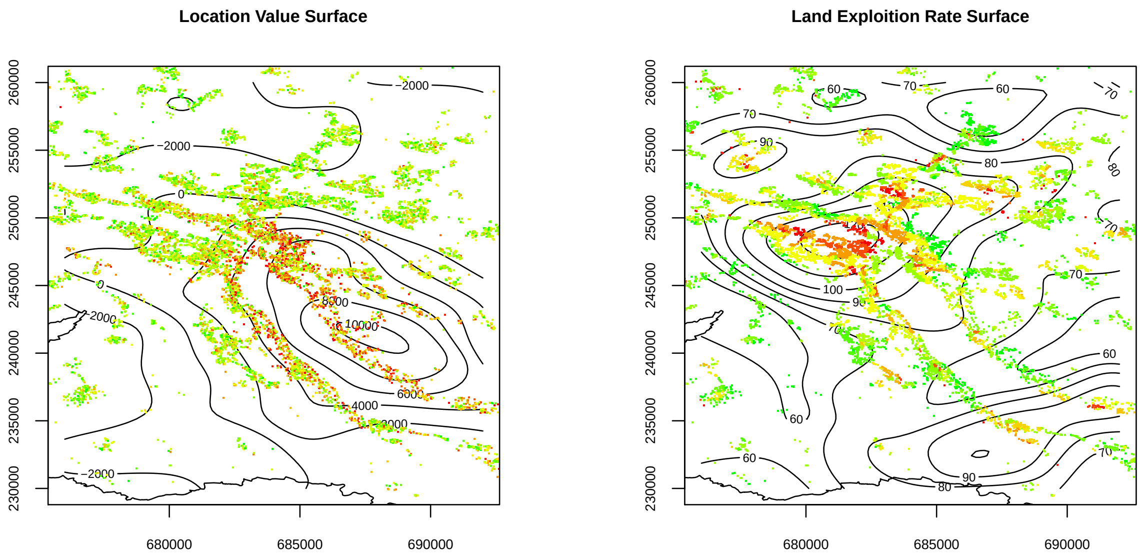
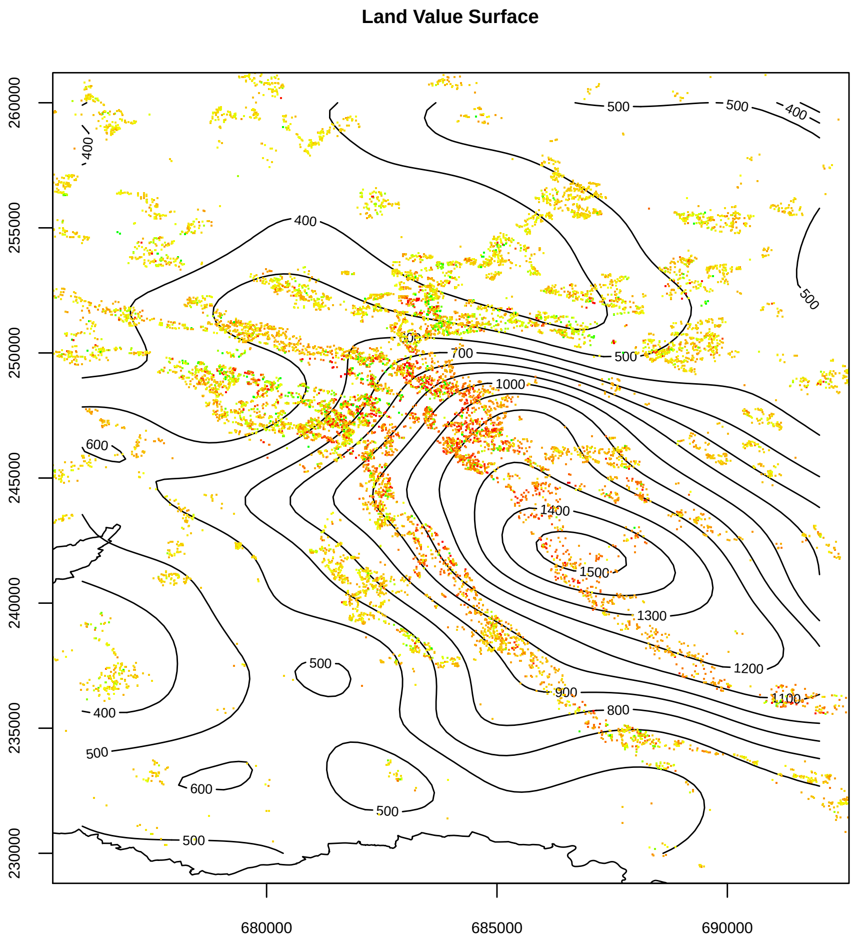


Figure 6: Non-parametric Estimates of Predicted Land Values

This figure shows the predicted land values as the product of location quality and land quality. The oval gradients of land prices reflect the monocentric structure of land quality in the larger area of the city of Zurich. High location values can be observed along the lakeside as well as more in the north next to the lake, i.e. high floor area ratios reflect high local amenities.



Shareholder Activism in REITs

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We examine shareholder activism – specifically, its determinants, wealth effects, and real consequences – in Real Estate Investment Trusts (REITs). Conventional wisdom suggests that shareholder activism in REITs occurs less frequently than in other publicly-traded firms. This belief is plausible because most REITs are thought to be protected against hostile takeovers and because the potential for undervaluation in REITs is thought to be limited. The potential gains to shareholder activists who advocate for governance, operational, or strategic changes are thus thought to be smaller when targeting REITs. We find, however, that the conventional wisdom does not hold. Specifically, we show that REITs are as likely to be targeted by shareholder activists as other public firms. We also find that the average short-term gains around activist events in REITs are significantly positive and similar to the gains experienced by other public firms. The rest of our results can be summarized as follows. We find that REIT activist targets are more likely to be subsequently taken over than other comparable REITs and that only the activist targets that are ultimately taken over experience significantly positive long-term returns, on average. We do not find evidence of any significant changes in performance, leverage, payout, or investment in the REIT activist targets that are not ultimately taken over. Collectively, our results are best described as consistent with the view that the positive short-term gains to shareholder activism in REITs reflect the expectation of an increased takeover likelihood of activist target firms.

Keywords: Shareholder Activism, REITs, Corporate Governance, Wealth Effects, Takeover Targets

Session: Listed Real Estate
VG004, June 10, 2016, 2:15 - 3:45pm

Shareholder Activism in REITs

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This version: January 2016

Abstract (Working Version)**:**

We examine shareholder activism – specifically, its determinants, wealth effects, and real consequences – in Real Estate Investment Trusts (REITs). Conventional wisdom suggests that shareholder activism in REITs occurs less frequently than in other publicly-traded firms. This belief is plausible because most REITs are thought to be protected against hostile takeovers and because the potential for undervaluation in REITs is thought to be limited. The potential gains to shareholder activists who advocate for governance, operational, or strategic changes are thus thought to be smaller when targeting REITs. We find, however, that the conventional wisdom does not hold. Specifically, we show that REITs are as likely to be targeted by shareholder activists as other public firms. We also find that the average short-term gains around activist events in REITs are significantly positive and similar to the gains experienced by other public firms. The rest of our results can be summarized as follows. We find that REIT activist targets are more likely to be subsequently taken over than other comparable REITs and that only the activist targets that are ultimately taken over experience significantly positive long-term returns, on average. We do not find evidence of any significant changes in performance, leverage, payout, or investment in the REIT activist targets that are not ultimately taken over. Collectively, our results are best described as consistent with the view that the positive short-term gains to shareholder activism in REITs reflect the expectation of an increased takeover likelihood of activist target firms.

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Shareholder Activism in REITs

"No recent development has influenced firms' strategic and financial decision-making as profoundly as the surge in shareholder activism following the global financial crisis." [1]

1. Introduction

In recent years, shareholder activists, predominantly represented by activist hedge funds, have been playing an increasingly important role in the corporate governance landscape. These shareholders, dissatisfied with some aspect of a company's management or operations, try to bring about change within the company, and, in some cases, agitate firms for a change in corporate control. Examples of activist campaigns include demands for major operational or capital structure changes, changes in business strategy, seeking strategic alternatives, oppositions to proposed corporate transactions, or changes in corporate governance, such as elimination of takeover defenses (Brav, Jiang, Partnoy, and Thomas, 2008; Greenwood and Schor, 2009; Gantchev, 2013).

The research on the wealth effects of activism generally agrees that the activism is beneficial to the activist investors. Several recent studies have shown that activists generate significant abnormal returns both in absolute terms and in comparison to non-activist investing (Brav, et al., 2008; Clifford, 2008; Becht, Franks, Mayer, and Rossi, 2008). Perhaps because of this success, the funds under management in activist hedge funds have increased from about $12 billion in 2003 to about $112 billion in 2014, with more than 10 activist and multiple-strategy funds managing over $10 billion each (J.P.Morgan, 2015). The number of campaigns has also

[1] The activist revolution: Understanding and navigating a new world of heightened investor scrutiny, J.P.Morgan publication, January 2015.

increased over time. While Bebchuk, Brav, Jackson and Jiang (2013) report 757 interventions by activist hedge funds in 1994-2000, they report 1,283 such interventions in the more recent 2001-2007 period.

Although shareholder activists seem to play a prominent role in shaping the operation of public corporations today, conventional wisdom seems to be that the activists take only a back stage in affecting REITs.[2] This common belief is plausible for at least two reasons. First, managers in a typical REIT are thought to be well protected against hostile bids, making activist attacks less likely.[3] Capozza and Seguin (2003) argue that because REITs are subject to the IRS's "five or fewer" rule that prohibits five or fewer shareholders from owning 50% or more of a firm, all REIT management teams are essentially fully protected from removal by a hostile bidder. Additionally, REITs routinely use so-called excess shareholder provisions, under which voting rights and dividend payments are automatically suspended should a single shareholder's stake exceed some prescribed hurdle, typically 10% (Chan. Erickson and Wang, 2003). Finally, most REITs are incorporated in Maryland, where state law protects them from unsolicited takeover bids.

The second reason for the plausibility of the view that shareholder activism is less prevalent in REITs is the notion that REITs are less likely to be undervalued as a result of inaccurate cash flow forecasts or governance deficiencies. Unlike many firms whose most significant assets are off their books (e.g., human capital or technological advantages), REITs derive their value from real estate assets. In a REIT, at least 75% of the assets must be real estate

[2] For example, a Wall Street Journal article from 12/2/2014 titled "Activist Explores a New Frontier: Property" portrays a fund manager Jonathan Litt and his $100 million hedge fund, Lands and Buildings, as "the REITs sector's only regular activist investor." It quotes Litt saying that "There are just not a lot of people looking to be activist in the space." The article also notes that "Activism isn't new to REITs, but it is rare."
[3] See "Activists Come Back to REITs" Wall Street Journal, 2/13/2008.

related and at least 75% of the gross income must be derived from real estate rents or interest on mortgages on real properties. REITs are thus thought to have assets that are easier to value than the assets of firms in other industries as most cash flows depend on relatively predictable changes in rent growth.[4] Additionally, because REITs are required to pay out 90% of annual income as dividends, the agency costs of free cash flow (Jensen, 1986) are thought to be less severe in REITs than in other public firms. Indeed, the researchers who find no relation between REIT governance measures and performance explain their findings by the fact that REITs operate in a strict regulatory environment that in itself limits managerial entrenchment (Bianco, Ghosh, Sirmans, 2007; Bauer, Eichholtz, Kok, 2010). This implies that it might be difficult to derive additional value from improved governance in REITs. For both these reasons, shareholder activists may have less opportunity for economic gain by pushing for operational or governance changes in REITs in comparison to other public firms.

Nevertheless, anecdotal evidence suggests that REITs are not immune from shareholder activism. A prominent case discussed in the media over the past year is that of CommonWealth REIT, in which two activist investors, Corvex Management LP and Related Fund Management LLC, succeeded in the fight to remove the company's entire board.[5] The activists accused managing trustees of excessive compensation and mismanagement that caused CommonWealth to trade below the value of its office-property portfolio. Other recent cases of shareholder activism include Bulldog Investors pressuring Javelin Mortgage Investment Group to significantly repurchase stock;[6] Midvale hedge fund seeking to oust the management and replace

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[4] See “Activist Explores a New Frontier: Property” Wall Street Journal, 12/2/2014.
[5] See “Corvex, Related Call for Earlier CommonWealth REIT Special Meeting” Wall Street Journal 3/25/2014.
[6] See “Bulldog Targets REITs For Shakeup After Javelin Win” Bloomberg, 1/16/2014. http://www.bloomberg.com/news/2014-01-16/bulldog-targets-reits-for-shakeup-after-javelin-win-mortgages.html

the board of Anworth Mortgage Asset Corp;[7] and Orange Capital hedge fund urging Strategic Hotels and Resorts to sell the company.[8,9]

In this research, we first examine the extent to which REITs are likely to become an activist target. Our results indicate that, in contrast to the conventional wisdom, REITs are as likely to be targeted by shareholder activists as other publicly traded firms. This result is important because it warrants further investigation of shareholder activism in REITs. We then address several other questions. Are the gains that accrue to REIT shareholders similar to the gains accrued by shareholders of other types of activist targets? What are the determinants of the likelihood of an activist campaigns in REITs? What are the sources of gains attributed to the activist campaign? Are there measurable real consequences to shareholder activism in REITs?

Our results can be summarized as follows. We document that, similar to other public firms, the most frequent campaigns in REITs are described as seeking to maximize shareholder value. The top two "value" demands of the activists are (i) the sale, merger, or liquidation of the target company or (ii) the review of strategic alternatives. The top "governance" demand is to obtain board seats for the activist. A typical REIT target of shareholder activism in our sample has lower relative valuations (market-to-book of assets), lower accounting performance (return on assets), higher cash, and lower prior abnormal returns. Our REIT targets thus can be described as relatively cheap "value" firms with weaker performance. We also find that equity REITs are targeted more often than mortgage REITs.

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[7] See "Activist U.S. Fund Seeks Board Ouster at Anworth REIT" Bloomberg, 4/17/2014. http://www.bloomberg.com/news/2014-04-17/activist-u-s-fund-seeks-board-ouster-at-anworth-reit-mortgages.html

[8] See "Orange Capital, LLC Urges Immediate Sale of Strategic Hotels & Resorts in Letter sent to the Board of Directors" Business Wire available via Factiva, 2/19/2013.

[9] Additional examples of older activist campaigns are discussed in "Activists Come Back to REITs" Wall Street Journal, 2/13/2008.

With respect to the gains from activism, we find that, similar to other public firms, shareholders of REITs experience significantly positive average short-term gains around the announcements of activist campaigns. However, we report that the average long-term gains measured in the period from one month prior to one year after the event are not statistically significant with REITs. Thus, an activist campaign in a typical REIT does not seem to result in a long-term gain for shareholders. This result suggests that it is unlikely that we observe any measurable improvements in long-term operating performance in a typical REIT target and we, indeed, do not find such improvements. We also fail to find significant changes in leverage, investment or payout around activist events or any relation between these changes and the abnormal returns.

In the last part of our paper we examine the hypothesis that the significant short-term gains around activist events are the result of the market expectation of an increased likelihood of takeover. Under this hypothesis, the market believes that activist targets are more likely takeover candidates, because activists tend to force target firms into a takeover (Greenwood and Schor, 2009). Consistent with this hypothesis, we find that, among REIT firms, activist targets are more likely to be taken over, after controlling for other observable REIT characteristics. Additionally, we find that the long-term returns for the subset of REITs that are ultimately acquired are significantly positive. Our results are thus best described as consistent with the view that the short-term gains to REITs from shareholder activism reflect market expectations about increased takeover likelihood.

Our research contributes to the literature in at least two ways. First, to our knowledge, there is no systematic study that examines the effects of shareholder activism in REITs. The research in mainstream finance excludes REITs from their samples because REITs have their own unique regulatory requirements and our search of the real estate literature on the topic of shareholder activism returned no results. However, research that aids the understanding of how shareholder activists affect REITs seems important given that REITs are increasingly becoming used as preferred vehicles for investors seeking real estate exposure. Additionally, an increasing number of countries have introduced or are contemplating REIT-like structures to facilitate capital flows to the real estate sector (Eichholtz and Kok, 2007).

Second, by examining a relatively homogeneous group of firms, we aim to remedy some of the criticism of the existing research on shareholder activism in public firms. Specifically, Coffee and Palia (2014) point out that the control group, i.e. the group of similarly situated firms that do not experience shareholder activism, is not well specified in the existing studies on shareholder activism as it is not similar enough to the treatment group. Our control group is less likely to suffer from this criticism as all REITs have to oblige by the same regulatory requirements. Additionally, because REITs are relatively transparent, we can obtain more reliable measures of their characteristics, such as valuation through Tobin's Q (Capozza and Seguin, 2003), or investments (Hartzell, Sun, and Titman, 2006). These reasons provide some motivations for using REITs as a useful laboratory.

The rest of this paper is organized as follows. In the next section, we summarize the literature on the recent wave of shareholder activism in public firms other than REITs; in Section 3, we summarize our data; in section 4, we present our preliminary results and outline future research agenda; and in section 5, we conclude.

2. Shareholder Activism in Public (non-REIT) Firms

Shareholder activism in the U.S. dates back to the early 1900s but the role and identity of the activist investors have changed as legal and regulatory regimes have shifted. In the early 1990s, activists were predominantly financial institutions, such as banks, mutual funds, or insurance companies. In the 1940s to 1970s, they were mostly individual investors. The 1980s saw again increased involvement by institutional investors, mainly public pension funds. The 1980s also saw the rise of corporate raiders. In the 1990s, labor union pension funds played a major role in shareholder activism. Finally, in the early 2000s hedge funds and private equity funds assumed prominence in the activist arena (Gillan and Starks, 2007).

Here we focus on the research that examines the most recent wave of activism, the wave that started early in the last decade with the rise of hedge funds as corporate activists. Hedge funds are better positioned than traditional mutual and pension funds in pursuing activist agendas because they are not subject to regulations that govern mutual and pension funds. Hedge funds can hold highly concentrated positions in a small number of companies, and they can use leverage and derivatives to extend their reach. Additionally, highly incentivized hedge fund managers face few conflicts of interests because they are not beholden to the management of the firms whose shares their hold.

Research documents that hedge fund activists tent to target companies typically described as “value” firms, with low market value relative to book value, but profitable and with sound operating cash flows and return on assets (Brav et al., 2008). Target firms also tend to have lower payouts, more takeover defenses, and CEOs who are paid considerably more than peer CEOs. Relatively few targeted companies are large-cap, most have high institutional ownership and high trading liquidity. (Brav et al., 2008).

The literature on activism wealth effects generally agrees that activism is beneficial to the activist hedge funds. Several recent studies have shown that activists generate significant abnormal returns both in absolute terms and in comparison to non-activist investing. Brav, et al. (2008) report that the average hedge fund activist in 2001-2006 earned a 14.3% higher return than a size-adjusted value-weighted portfolio of stocks. Clifford (2008) demonstrates that hedge funds earn significantly higher holding-period returns from activist investing compared to their passive holdings. Becht, et al. (2008) show that activist investments of a U.K. hedge fund significantly outperform the market. Gantchev (2013), however, questions the size of the return reported in these studies because they do not account for the costs associated with activism. He estimates that these costs reduce activist returns by more than two-thirds. He further reports that the net return for an average activist is close to zero and that only the top quartile of activists in his sample earn higher returns on their activist holdings than on their non-activist investments.

The research on the wealth effects in targeted companies generally agrees that, in the short-term and the long-term, activist campaigns bring about significantly positive shareholder gains (Bebchuk, Brav, and Jiang, 2014; Brav et al., 2008; Clifford, 2008; Greenwood and Schor, 2009; Klein and Zur, 2009). This same research, however, often disagrees about the sources of these gains. In their literature review, Coffee and Palia (2014) summarize evidence on four potential sources of these gains: improvements in operating performance, capture of takeover premium, wealth transfers, and reduction in managerial agency problems. They conclude that the evidence is decidedly mixed, especially when it comes to improvements in operating performance or the reduction in managerial agency problems. While some studies report improvements in operating performance from the period prior to until after activism (Brav, et al., 2008; Bebchuk, et al., 2014), other studies find no such improvements (Klein and Zur, 2009).

Additionally, although many studies report changes in real variables, such as increased payouts and leverage, changes in investment, or CEO turnover after activism, most studies find no relation between these changes and shareholder returns around activism.

If improvements in operating performance or governance changes generally do not drive the positive shareholder gains observed around activist events, then those gains may be capturing an increase in the expected takeover premium. Greenwood and Shor (2009) find positive abnormal returns for targets that are ultimately acquired and zero for those that remain independent after the activist event. They also find that activist targets are more likely to be taken over than similarly situated firms. They conclude that the shareholder gains around activist events can be largely explained by the ability of activists to force target firms into a takeover. Similarly, Brav et al. (2008) find that the short-term abnormal returns around the activist event are highest when the stated objective is to sell the company.

Overall, the clearest evidence is that there appears to be a positive stock price reaction to activist event announcements. What is less clear is whether this reaction can be attributed to changes in operating performance, changes in real variables, or changes in the acquisition likelihood.

3. Data Sources and Sample Description

We obtain our initial data on shareholder activist campaigns from the FactSet SharkRepellent database. SharkRepellent provides a comprehensive sample of activist events for all publicly listed US firms starting in 2006. Specifically, SharkRepellent includes data on all schedule 13D filings containing activism-related Item 4 (Purpose of Transaction), as well as all 13D filings filed by the members of SharkWatch50 group; the data on proxy fights; the data on exempt solicitation campaigns; and finally the data on any other publicly-announced stockholder campaigns. The SharkWatch50 group is the group of fifty most prominent activists specified by SharkRepellent.[10]

The SharkRepellent data includes information on the date the campaign was announced, the identity and the type of the activist investors, the stake the activists hold in the target company, as well as several other descriptive items such as the demands of the activists, the success, the status and the end date of the campaign and others. We initially obtain the data on all 4,431 activist campaigns in the database in 2006-2014. We then exclude the campaigns that where launched solely by corporations to avoid confusing corporate crossholding and acquisitions with shareholder activism from portfolio and individual investors. Activism by labor unions and religious groups is also excluded as these groups may have different incentives than portfolio investors (Guercio and Woidtke, 2014). We retain all campaigns launched by hedge funds, investment advisers, mutual funds, pension funds, and other institutions. This reduces the sample to 4,145 campaigns. We then match all events to CRSP and Compustat and keep only those events where we can find identifying information in both databases. This further reduces the sample to 3,590 events. One hundred and one (101) of those events are launched against REITs. REITs are identified using the CRSP Ziman REIT database.

Table 1, Panel A, and Figure 1 show the distribution of events over time. We present the information for all events as well as for events where the activist investor, or at least one activist in the group of activist investors, is identified by SharkRepellent as a hedge fund. We also present the information separately for non-REIT and for REIT targets. For non-REIT targets, the

[10] SharkRepellent uses several criteria to identify the members of this group. The group composition changes whenever SharkRepellent considers the change appropriate.

number of activist campaigns first increases from 2006 to 2007, then decreases until 2009, and since then steadily increases and by 2014 almost reaches the 2006 levels. The trend is similar for REIT targets except the decrease in the number of campaigns in 2009-2011 seems to be more pronounced. This is understandable given the uncertainty surrounding real estate and mortgage sectors during and after the financial crisis.

SharkRepellent assigns all activist campaigns into several categories. In Panel B of Table 1, we present the count of campaigns by their primary type category, as defined by SharkRepellent. The campaigns that aim to maximize shareholder value are the most frequent campaign types. Among campaigns launched for REITs, 33% aim to maximize shareholder value and for non-REITs this proportion is 29%. The other most common campaign types in REITs are the campaigns against a merger, campaigns that seek board representation, and campaigns that seek to obtain/change the control of the board.

Shark Repellent also collects information on the specific demands of the activists, if there are any, and the success of those demands. We present summary statistics for the demands in Table 1, Panel C. Among 101 REIT activist campaigns, 80 have some information on specific demands. SharkRepellent categorizes the demands in terms of “value” and “governance.” The top two value demands for REITs and non-REITs are (i) the sale, merger, or liquidation of the target company and (ii) the review of strategic alternatives. The most frequent governance demand is to seek board seats for the activists. In REITs, value demands are more frequent than governance demands, and in non-REITs, governance demands are more frequent. Examining the success rates, we observe that activists tend to be less successful in obtaining their demands in REITs in comparison to non-REITs. Thirty five percent (35%) of the activists in REITs that express some demands observe success in satisfying at least one of those demands. In non-REITs this proportion is 50.5%.

In Table 2, we summarize other activist campaign characteristics and some characteristics of the target firms separately for REITs and non-REITs. In the vast majority of the campaigns, we observe a single activist in the activist group: the average number of activists in the group is 1.16 in REITs and 1.2 in non-REITs. Forty eight (48) percent of the activist campaigns in REITs are launched by hedge funds. This proportion is 52% in non-REITs. It is worth noting, that some non-hedge fund activist investors are among the top activists in SharkRepellent. For example, Bulldog Investors, which SharkRepellent categorizes as investment adviser and not a hedge fund, is one of the top 50 most active activist investors in the database. On average, activists hold 7.1% (8.8%) of target shares in REITs (non-REITs). An average campaign lasts approximately 171 (161) days and about 23% (20%) of the campaigns in REITs (non-REITs) involve proxy fights. With $378 million in market capitalization, the median target REIT firm is larger than the median target non-REIT firm with the size of $265 million. Target REIT firms are less likely to have a classified board (36% vs. 45%), and they are more likely to be incorporated in Maryland (74% vs. 5%). The incidence of poison pills is similar in REIT vs. non-REIT targets (30% vs. 27%). In summary, in most respects, the activist campaigns launched against REIT targets appear similar to those launched against non-REIT targets.

To judge whether REITs are targeted by shareholder activist to a different degree than other public firms, we match our event data from SharkRepellent to Compustat such that the Compustat data is from the fiscal year ending prior to the event. We include only US firms that have available data on total assets and market capitalization.[11] We then match the Compustat panel to the CRSP Ziman REIT database to obtain REIT identification. The characteristics of the Compustat panel firms are summarized in Table 3.

As evidenced from that table, REIT firms are different from non-REIT firms in a number of characteristics. Specifically, as expected, REITs have lower valuations as measured by the ratio of the market value of assets to book value of assets (an approximation of Tobin's Q calculated as the market value of equity plus book value of assets minus book value of equity and deferred taxes divided by the book value of assets), much lower amounts of cash on hand (scaled by assets), much higher dividend yield, much higher leverage, and no R&D investment. REITs also tend to be larger when size is measured as the log of the market value of equity. However, there seem to be little difference in the frequency with which REITs are targeted by activist investors. Specifically, REIT firms experience at least one activist campaign in 4.8% of firm-years while the frequency in non-REITs is 4.7% per firm-year. When only campaigns by activist hedge funds are considered, REIT firms are targeted in 2.35% firm-years while non-REIT firms in 2.67% firm-years. The difference between the activist frequencies is not statistically different when comparing REITs and non-REITs.

4. Empirical Results

4.1 The Likelihood of an Activist Campaign

The data in Table 3 suggest that the likelihood of an activist campaign in any given year does not differ for REITs and non-REITs. We first extend this analysis and examine whether this

[11] We have not yet matched the panel of Compustat firms to CRSP, though we plan on doing so to be able to control for prior stock performance.

likelihood differs after controlling for observable determinants of an activist campaign. Table 4 presents the results of a probit model with the dependent variable equal to 1 if the firm is the subject of at least one activist campaign in any given year and equals zero otherwise. The dependent variable in columns (1) and (2) considers all types of activist campaigns; in columns (3) and (4) only the campaigns launched by hedge funds are considered. Columns (1) and (3) report coefficient estimates, columns (2) and (4) report marginal effects. All regressions use robust standard errors clustered by firms and include fiscal year indicators.

The estimates and marginal effects are of similar statistical significance across all columns and suggest that the likelihood of being a target in an activist campaign first increases then decreases with size, decreases with market-to-book ratio and sales growth, increases in cash-to-assets ratio and R&D-to-assets, and decreases in dividend yield. These results are similar to those reported in Brav et al. (2008), although they estimate their probit model on the sample of activist targets and matching firms, where the match is performed based on industry, size, and book-to-market. Most importantly, the coefficient on the indicator that identifies REIT firms is insignificant suggesting that the likelihood of being a target of an activist campaign does not differ for REIT firms after controlling for the observable determinants of such likelihood.

In Table 5 we also report results of the probit models estimating the likelihood of an activist campaign in REITs only. In columns (1) and (2) we use the same control variables as in Table 4. In columns (3) and (4) we include additional variables, some of which are REIT specific. Specifically, we include abnormal stock performance in the prior fiscal year. The abnormal performance is calculated as the buy-and-hold stock return minus buy-and-hold value weighted CRSP-Ziman REIT index. We also include measures of insider ownership (ownership of officers and directors), institutional ownership and institutional ownership concentration, measured as the Herfindahl–Hirschman Index of institutional ownership, an indicator for whether the REIT is organized as an UPREIT, an indicator for incorporation in Maryland, and an indicator for whether the REIT is not self-managed (i.e., externally managed). The data on insider ownership come from Capital IQ, intuitional ownership from Thomson Reuters' database of 13f holdings, REIT specific data from SNL Financial. The dependent variable equals 1 if the REIT is a target of an activist campaign in the next fiscal year. In Table 5, we only report the results for activist campaigns launched by all activist types but note that the results using campaigns launched by hedge funds produce similar results.

As in the whole sample of firms, the likelihood of an activist campaign directed at a REIT decreases in relative valuation (market-to-book) and increases in cash-to assets. The likelihood also decreases in profitability (ROA), the abnormal return in the prior year, and seems to be significantly higher for equity REITs as compared to mortgage or hybrid REITs. In contrast to the whole sample of firms, the size, sales growth, and dividend yield seem to have no impact on being targeted by an activist investor. Thus it seems that among REITs, cash rich firms with low profitability and valuation seem to be the most likely targets of an activist campaign. None of the ownership characteristics appear to be significantly related to the likelihood of an activist campaign.

4.2 Short-term and Long-term Market Reaction to the Announcements of Activist Campaigns

As discussed in the introduction, the conventional wisdom today seems to be that REITs are less likely targets of activism, partly because the gains to the activist from an activist campaign are expected to be small. In the previous section we obtain results indicating that the likelihood of an activist campaign does not significantly differ for REITs and non-REITs. In this section we examine whether there are any differences in the short-term and long-term gains realized around the announcement of activist campaigns. We measure the short-term and long-term gains for all firms several ways and over several event windows. First, we measure the gains for all firms as the cumulative abnormal returns (CARs) around the announcement of the activist event with the abnormal returns calculated as the stock return minus the value-weighted CRSP index return. Second, we measure the gains as the buy-and-hold abnormal returns (BHARs) calculated as the buy-and-hold stock return minus the buy-and-hold value-weighted CRSP index return. Third, in measuring the abnormal gains for REITs we replace the value-weighted CRSP index return with the value-weighted CRSP-Ziman REIT index.

We measure and report the abnormal returns for initial activist events only. Initial activist events are defined as the events not preceded by any other activist events in the prior 365 days. Some companies in the sample are subject to more than one activist event, and for some companies, the multiple activist events are relatively close together and related to the initial activist event. Thus it is likely that the initial event contains the most information and so does the market reaction to this event. The sample period in this analysis is reduced to 2006-2013 as we cannot observe (do not have data to calculate) long-term abnormal returns for events announced in 2014.

The results are summarized in Table 6. Panel A reports the short-term market reaction using daily returns over two event windows {-5, +5} and {-20, +20} with day zero being the announcement date of the campaign. Panel B reports the long-term market reaction using monthly returns over one event window {-1, +12} with month zero being the month of the announcement date. As evidenced from the table, the average and median short-term market reaction is positive and statistically significant for REITs and non-REITs in both reported windows when using all but one method for calculating abnormal returns. The returns are not statistically significant for REITs when calculated as BHAR over 41-day event period using the CRSP-Ziman index as the market index. The CARs for REITs are comparable in size to those of non-REITs but the statistical significance is weaker. This is understandable as the sample size of activist events in REITs is much smaller. Nevertheless, the market reaction to the activist campaigns in REITs does not statistically differ from the market reaction launched in non-REITs. Thus we find no evidence that the short-term value gains around the announcement of an activist campaign are smaller for REITs than they are for non-REITs.

In terms of magnitude, the results are generally consistent with prior studies. For example, we report average CAR of 3.76% in an 11-day window for non-REITs and 6.62% for REITs. In the 41-day window, we report average BHAR of 5.55% for non-REITs and 4.23% for REITs. In comparison, Greenwood and Schor (2009) report a CAR of 3.5% in the {-10, +5} window, Clifford (2008) reports 3.4% in a {-2, +2} window, and Brav, et al., report 7.2% in the {-20, +20} window.

Our results for REITs start to differ from the results for non-REITs when examining the long-term market response to activist campaigns. While we continue to observe a positive average CAR and BHAR over the 14-month window for non-REITs, the average market response for REITs is insignificant using all ways of calculating abnormal returns and the averages we report are negative in magnitude. Thus, we conclude that an average activist target that is a REIT does not see significantly positive abnormal return in the longer-term.

4.3 Changes in Accounting Performance and Real Variables in REITs

Given that we find no statistically positive impact on REIT stock prices in the longer-term, one would not expect to find any improvements in performance. Nevertheless, we collect data and calculate various measure of accounting performance one year prior and one year following the activist event, including operating return on assets, net return on assets, funds from operations relative to assets, and all profit variables scaled alternatively by revenue. In unreported results, we do not find any significant changes in these variables. We also do not find any significant changes in payouts, shares outstanding, leverage, or investment measures that are equity REIT specific. Additionally, we do not find any meaningful correlations between the changes and the short-term or long-term abnormal returns reported in Table 6. Thus we turn to examining the hypothesis that the positive short-term returns we observe for REITs reflect an increase in the market expectation of the takeover likelihood of the activist target firm.

4.4 Shareholder Activism, the Likelihood of Takeover, and the Gains to Activism

If improvement in operating performance or changes in real variables do not explain the positive short-term gains around the announcement of activist events in REITs, then these gains may instead be derived from an increased likelihood that the targets of activist campaigns will be taken over and a takeover premium realized. This hypothesis holds under two conditions. First, activist interventions are a signal that there is an increase in takeover likelihood. Second, when the firms are ultimately taken over, positive abnormal long-term gains to the shareholders are realized. When they are not taken over, no positive long-term gain is realized.

To examine whether the first condition holds, we perform a probit analysis measuring the likelihood of a takeover as a function of an activist attack and other control variables potentially related to the takeover likelihood. To perform this analysis, we use the same panel data that we used when examining the likelihood of an activist campaign in Table 5 and report the results in Table 7. The dependent variable in these regressions equals one if the firm delists from CRSP within two years from the end of the fiscal year due to merger or acquisition (i.e., delisting codes that start with the digits 2 or 3). The main independent variable equals one if the firm experiences an activist campaign within two years of the end of the fiscal year. Other control variables include those that we used in Table 5 to explain activist campaigns. All regressions use robust standard errors clustered by firms and include fiscal year indicators.

The results indicate that activist campaigns launched at REITs are, indeed, associated with an increased likelihood that the firm is eventually taken over. Marginal effects indicate that an activist campaign increases this likelihood by 6 to 7.5%. Thus, controlling for other potential determinants of a takeover, activists seem to matter for takeover likelihood. This result is consistent with that of Greenwood and Schor (2009), which suggests that activists have the ability to force target firms into a takeover. In our REIT sample, the other independent variables that seem to matter for takeover likelihood are size, return on assets, whether the firm is an equity REIT and abnormal returns in the prior fiscal year.

To examine whether activist campaigns yield positive gains when the targets are ultimately taken over and no gains when they are not, we perform subsample analyses for the various measures of abnormal returns that we previously report in Table 6. Specifically, we split both REIT and non-REIT samples into subgroups based on whether the target is ultimately taken over within 18 months of the initial activist campaign. The results are reported in Table 8. Among non-REITs, the short term gains are positive and significant for firms that are acquired within 18 months and firms that are not. However, the returns to the firms that are acquired, especially in the longer 41-day window, are decidedly larger than the gains to firms that are not acquired. Examining the long-term returns in non-REITs, we observe that the returns to the firms that are acquired are positive and large, reflecting the takeover premium. The returns to the firms that are not acquired are not significant.

The results for REITs are similar, albeit statistically weaker. As for non-REITs, we observe statistically positive short-term returns for both sub-groups: targets that are acquired with 18 months and those that are not. However, there is no statistical difference between the average returns for these sub-groups. In examining long-term returns, we observe that these returns are significantly positive using the measures of abnormal return based on the CRSP index as the market index, but not significant when using the CRSP-Ziman REIT index as the market index. We also find that BHAR for REITs that are not eventually acquired are significantly negative and that the difference between the BHAR for the acquired firms and not acquired firms is statistically significant. This difference is similar in magnitude when the abnormal returns are measured as CARs but is not statistically significant. Nevertheless, the overall evidence suggests that while long-term gains tend to be positive for REITs that are acquired within 18 months of an activist campaign, the long-term gains are insignificant or negative for REITs that are not acquired.

The results we report in this section for non-REITs are similar in magnitude to those reported in Greenwood and Schor (2009) where the sample includes only hedge fund campaigns in 1993-2006. Thus, it seems that their explanation for abnormal returns to activism holds beyond their sample period and after including other types of activists (i.e., investment advisors, private equity funds, etc.). The evidence in this section also suggests that, similar to non-REITs, the short-term gains to activism in REITs might reflect the expectation of higher acquisition likelihood.

5. Conclusion

In this paper, we examine the incidence and wealth effects of shareholder activist campaigns in REITs and the possible sources of those gains. Conventional wisdom suggests that activist campaigns in REITs are rare events. This conventional wisdom is plausible for two reasons. First, REITs are thought to be well protected from hostile takeovers. Second, it might be relatively difficult to create value in REITs that operate as relatively transparent companies whose values are relatively easy to assess.

Our results indicate that this conventional wisdom does not hold for our sample of activist campaigns in REITs from 2006-2014. Specifically, we find that REITs are as likely to be subjects of activist campaigns as non-REITs and the campaigns directed toward REITs are, in many respects, similar to the campaigns launched against non-REITs. Additionally, the short-term gains around the announcements of activist campaigns for both REIT and non-REIT firms are decidedly positive. Our further analysis shows that these positive short-term gains are unlikely to result from improvements in operational efficiency, performance, investment, capital structure or payout policies as we find no evidence of significant changes in these measures around activist events. Further, for the whole sample of REITs there is no evidence of positive average long-run returns and the changes in the various measures are not correlated with long-run returns.

More importantly, we present two pieces of evidence that suggest that the positive short-run returns most likely reflect the expectation that activist targets may ultimately be taken over and the anticipated takeover premia realized. Specifically, we document that the REIT targets of activist attacks are more likely than other similar REIT firms to be acquired within 18 months of an activist campaign and that the long-term average returns to the target firms that are ultimately acquired are, on average, positive.

Collectively, the evidence in this paper suggests that REITs are as likely to be the focus of shareholder activism as other publicly traded firms and that the activist campaigns launched at REITs are in many respects similar to the activist campaigns launched at non-REITs. The evidence in this paper also suggests that a likely source of the positive announcement returns to shareholders of firms targeted by activists arises from the expectation of a sale of the firm.

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Figure 1 – Activist Campaign Distribution

The distribution of sample activist campaigns by year. The sample contains 3,590 activist campaigns from SharkRepellent that also have data on CRSP and Compustat. The campaigns launched solely by corporations, religious groups or labor unions, or any combination of these types of activists an activist group, are excluded.

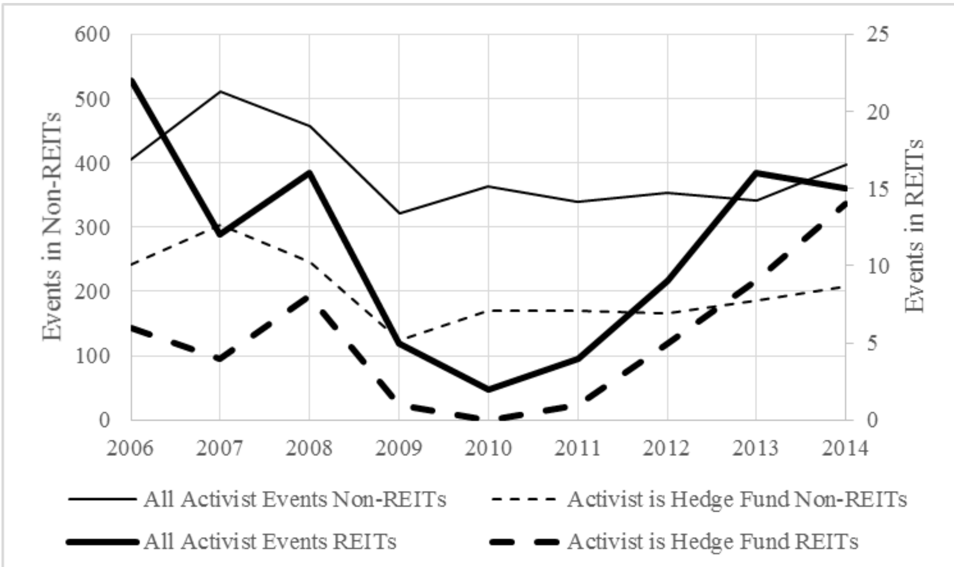

Table 1 – Activist Campaign Distributions

Panel A shows the distribution of sample activist campaigns by year. The sample contains 3,590 activist campaigns from SharkRepellent that also have data on CRSP and Compustat. The campaigns launched solely by corporations, religious groups or labor unions, or any combination of these types of activists in an activist group, are excluded. Panel B shows the distribution of sample activist campaigns by primary type, as identified by SharkRepellent. Panel C shows the distribution of sample activist campaigns that list specific value or governance demands as reported in SharkRepellent. Not all sample campaigns list the demands and some sample campaigns may list more than one value or governance demand.

Panel A

	All Activist Events		Activist Group Includes Hedge Fund	
	REITs	non-REITs	REITs	non-REITs
2006	22	406	6	241
2007	12	511	4	304
2008	16	456	8	245
2009	5	322	1	124
2010	2	363	0	170
2011	4	340	1	170
2012	9	353	5	167
2013	16	341	9	186
2014	15	397	14	208
Total	101	3,489	48	1,815

Table 1 - continued

Panel B

Primary Campaign Type \ Campaigns in:	REITs N	REITs [%]	non-REITs N	non-REITs [%]
Maximize Shareholder Value	33	32.7	1,013	29.0
Vote/Activism Against a Merger	14	13.9	254	7.3
Board Representation	13	12.9	707	20.3
Board Control	12	11.9	196	5.6
Vote For a Stockholder Proposal	8	7.9	304	8.7
13D Filer - No Publicly Disclosed Activism	6	5.9	562	16.1
Hostile/Unsolicited Acquisition	4	4.0	58	1.7
Support Dissident Group in Proxy Fight	4	4.0	70	2.0
Vote For a Management Proposal/Support Management	3	3.0	36	1.0
Remove Director(s), No Dissident Nominee to Fill Vacancy	2	2.0	19	0.5
Vote Against a Management Proposal	2	2.0	122	3.5
Enhance Corporate Governance	-		110	3.2
Public Short Position/Bear Raid	-		26	0.8
Remove Officer(s)	-		12	0.3
Total	101	100.0	3,489	100.0

Table 1 - continued

Panel C:

Campaigns with: \ Campaigns in:	REITs N	REITs [%]	non-REITs N	non-REITs [%]
Value Demand(s)	57	56.4%	1,510	43.3%
Governance Demand(s)	37	36.6%	1,654	47.4%
Value or Governance Demand(s)	80	79.2%	2,526	72.4%
Success In at Least One Value Demand	19	33.3%	662	43.8%
Success In at Least One Governance Demand	12	32.4%	714	43.2%
Success In at Least One Demand	28	35.0%	1,275	50.5%

Value Demand Types and Occurrence	REITs	non-REITs
Seek Sale/Merger/Liquidation	23	584
Review Strategic Alternatives	21	501
Block Merger/Agitate for Higher Price (Target)	11	223
Return Cash via Dividends/Buyback	9	357
Other Capital Structure Related, Increase Leverage, etc.	7	148
Potential Acquisition (Friendly and Unfriendly)	7	133
Breakup Company, Divest Assets/Divisions	5	233
Block Acquisition/Agitate for Lower Price (Acquirer)	3	31
Other	1	192

Governance Demand Types and Occurrence	REITs	non-REITs
Board Seats (activist group)	25	999
Remove Takeover Defenses	6	234
Other Governance Enhancements	5	378
Remove Director(s)	4	112
Add Independent Directors	3	153
Compensation Related Enhancements	1	214
Remove Officer(s)	0	105
Social/Environmental/Political Issues	0	105

Table 2 – Activist Campaign Characteristics

Summary of activist campaign characteristics. The sample contains 3,590 activist campaigns from SharkRepellent that were launched in 2006-2014 and also have data on CRSP and Compustat. The campaigns launched solely by corporations, religious groups or labor unions, or any combination of these types of activists in an activist group, are excluded. All variables are taken from SharkRepellent and are self-explanatory.

Activist Campaigns with non-REIT Targets (n=3,489)

	Average	5th Percentile	Median	95th Percentile
Number of Activists in Activist Group	1.20	1	1	2
Activist Group Includes (Is) Hedge Fund	0.52			
Activist Group Ownership at Announcement [%]	8.77	1.0	6.7	23.2
Activist Campaign Length [days]	161	2	96	536
Activist Initiates Proxy Fight	0.20			
Target Market Cap at Announcement [$ million]	7,928	19	265	26,846
Target Classified Board	0.45			
Target Poisson Pill	0.27			
Target Incorporated Maryland	0.05			
Target Incorporated Delaware	0.61			

Activist Campaigns with REIT Targets (n=101)

	Average	5th Percentile	Median	95th Percentile
Number of Activists in Activist Group	1.16	1	1	2
Activist Group Includes (Is) Hedge Fund	0.48			
Activist Group Ownership at Announcement [%]	7.08**	0.5	5.8	16.8
Activist Campaign Length [days]	171	1	100	480
Activist Initiates Proxy Fight	0.23			
Target Market Cap at Announcement [$ million]	1,783	35	378**	7,536
Target Classified Board	0.36*			
Target Poisson Pill	0.30			
Target Incorporated Maryland	0.74***			
Target Incorporated Delaware	0.09***			

Table 3 – Panel Sample Characteristics

Panel sample characteristics by REITs and non-REITs. REITs are identified using the CRSP Ziman REIT database. The panel contains all US Compustat firm-years from 2005-2013 with data available to calculate market capitalization and total assets. A firm-year observation is classified as subject to any activist event (hedge fund activist event) if the firm experiences at least one activist campaign (campaign launched by a hedge fund) during the next fiscal year. All accounting and market variables are from the fiscal year-end immediately preceding the activist campaign event. Market Value of Equity is the end-of-fiscal year stock price times the number of shares outstanding. Market-to-Book is (book value of assets + market value of equity minus book value of equity and deferred taxes) divided by book value of assets. Sales Growth is the growth in net sales calculated over the last fiscal year. Net Income is the income before extraordinary items. Assets is the book value of assets. Dividend Yield is the dividend paid to common stockholders divided by the market capitalization. Debt is the long-term plus short-term debt. R&D is the maximum of zero or the reported R&D expense. Averages are reported with the medians below in brackets. *, **, *** in column (2) indicates that REIT characteristics are significantly different from non-REIT characteristics at the 10%, 5%, and 1% significance level.

	Non-REITs (1) (55,597 firm-years)	REITs (2) (1,533 firm-years)
Proportion of firm-years subject to		
any activist event	0.0471	0.0483
hedge fund activist event	0.0267	0.0235
Market Value of Equity (MVE)	4,214	2,394***
	[250]	[1,049]***
log(MVE)	5.49	6.72***
	[5.52]	[6.96]***
Market-to-Book Assets (Q)	5.43	1.28***
	[1.39]	[1.19]***
Sales Growth 1 Year	0.195	0.236**
	[0.070]	[0.075]
Net Income/Assets (ROA)	-0.434	0.007***
	[0.011]	[0.012]
Cash/Assets	0.213	0.046***
	[0.110]	[0.022]***
Dividend Yield	0.013	0.061***
	[0.000]	[0.051]***
Debt/Assets	0.370	0.550***
	[0.154]	[0.542]***
R&D/Assets	0.064	0.000***
	[0.000]	[0.000]***

Table 4 – Activist Campaign Likelihood for All Firms (REITs and non-REITs)

Probit model for the likelihood that a firm becomes a target of an activist campaign in any given fiscal year. The panel contains all US Compustat firm-years in 2005-2013 with data available to calculate market capitalization and total assets. The dependent variable in columns (1) and (2) equals 1 if the firm is subject to at least one activist campaign launched by any type of activist during the fiscal year. The dependent variable in columns (3) and (4) equals 1 if the firm is subject to at least one activist campaign launched by a hedge fund during the fiscal year. All accounting and market variables are described in Table 2 and are from the end of the fiscal year immediately preceding the activist campaign event. REIT indicator equals 1 for all firms-years classified as REITs by the CRSP Ziman REIT database and equals zero otherwise. Robust standard errors clustered by firms are in parentheses below coefficient estimates or below marginal effects. Marginal effects reflect the change in the probability of an activist campaign for a one standard deviation change in a continuous variable, or a shift from zero to one for an indicator variable. *, **, *** indicate statistical significance at the 10%, 5%, and 1% significance level.

Table 4 – continued

	All Activist Events		Activist is Hedge Fund	
	(1)	(2)	(3)	(4)
	Coefficients	Marginal Effects	Coefficients	Marginal Effects
log(MVE)	0.178***	0.018***	0.346***	0.022***
	(0.028)	(0.003)	(0.035)	(0.002)
log(MVE) squared	-0.012***	-0.001***	-0.028***	-0.002***
	(0.003)	(0.000)	(0.003)	(0.000)
Market-to-Book (Q)	-0.110***	-0.011***	-0.112***	-0.007***
	(0.013)	(0.001)	(0.018)	(0.001)
Sales Growth 1 Year	-0.095***	-0.010***	-0.089***	-0.006***
	(0.022)	(0.002)	(0.028)	(0.002)
ROA	0.014	0.001	-0.034	-0.002
	(0.040)	(0.004)	(0.037)	(0.002)
Cash/Assets	0.297***	0.030***	0.248***	0.016***
	(0.064)	(0.007)	(0.076)	(0.005)
Dividend Yield	-2.362***	-0.239***	-3.439***	-0.216***
	(0.485)	(0.049)	(0.699)	(0.045)
Debt/Assets	0.074	0.007	0.064	0.004
	(0.046)	(0.005)	(0.052)	(0.003)
R&D/Assets	0.249**	0.025**	0.373***	0.023***
	(0.101)	(0.010)	(0.115)	(0.007)
REIT Indicator	0.002	0.000	-0.020	-0.001
	(0.077)	(0.008)	(0.088)	(0.005)
Year Dummies	Yes	Yes	Yes	Yes
Pseudo R-squared	0.028		0.045	
Observations	51,552	51,552	51,552	51,552

Table 5 – Activist Campaign Likelihood for REITs

Probit model for the likelihood that a REIT firm becomes a target of an activist campaign in any given fiscal year. The panel contains REIT firm-years on Compustat from 2005-2013 with data available to calculate market capitalization and total assets. REITs are identified using the CRSP Ziman REIT database. The dependent variable equals 1 if the firm is subject to at least one activist campaign launched by any type of activist during the fiscal year. The Abnormal Return 1 Year is the buy-and-hold stock return minus the buy-and-hold value-weighted CRSP-Ziman REIT index return during the prior fiscal year. Insider Ownership is the percentage ownership by officers and directors. Institutional Ownership is the percentage ownership of all institutional 13f holders. Institutional Ownership Concentration is the Herfindahl-Hirschman index of institutional holdings. UPREIT, Maryland, and Not-Self-Managed indicators equal one if the SNL Financial reports that the REIT is organized as an UPREIT, is incorporated in Maryland, and is not self-managed; and equals zero otherwise. All other accounting and market variables are described in Table 2 and are from the end of fiscal year immediately preceding the activist campaign event. Equity REIT indicator equals 1 for all firm-years classified as Equity REITs by the CRSP Ziman REIT database and equals zero otherwise. Robust standard errors clustered by firms are in parentheses below coefficient estimates or below marginal effects. Marginal effects reflect the change in the probability of an activist campaign for a one standard deviation change in a continuous variable, or a shift from zero to one for an indicator variable. *, **, *** in indicate statistical significance at the 10%, 5%, and 1% significance level.

Table 5 – continued

	All Activist Events			
	(1)	(2)	(3)	(4)
	Coefficients	Marginal Effects	Coefficients	Marginal Effects
log(MVE)	-0.051	-0.005	-0.268	-0.023
	(0.191)	(0.018)	(0.251)	(0.022)
log(MVE) squared	0.000	0.000	0.016	0.001
	(0.017)	(0.002)	(0.018)	(0.002)
Market-to-Book (Q)	-0.674*	-0.062*	-0.850**	-0.072*
	(0.367)	(0.036)	(0.424)	(0.037)
Sales Growth 1 Year	-0.003	-0.000	-0.003	-0.000
	(0.003)	(0.000)	(0.007)	(0.001)
ROA	-1.691**	-0.156**	-3.381**	-0.288***
	(0.844)	(0.076)	(1.325)	(0.111)
Cash/Assets	2.315**	0.213**	2.482**	0.211**
	(0.937)	(0.087)	(1.185)	(0.101)
Dividend Yield	-0.008	-0.001	-0.883*	-0.075*
	(0.232)	(0.021)	(0.458)	(0.039)
Debt/Assets	0.392	0.036	-0.116	-0.010
	(0.383)	(0.035)	(0.461)	(0.039)
Equity REIT Indicator	0.360*	0.028**	0.597**	0.040**
	(0.197)	(0.014)	(0.258)	(0.016)
Abnormal Return 1 Year			-0.529***	-0.045***
			(0.184)	(0.017)
Insider Ownership			-0.013	-0.001
			(0.013)	(0.001)
Institutional Ownership			-0.321	-0.027
			(0.370)	(0.031)
Inst. Own. Concentration			-1.108	-0.094
			(0.730)	(0.063)
UPREIT Indicator			-0.365	-0.034
			(0.232)	(0.024)
Maryland Indicator			0.140	0.011
			(0.202)	(0.015)
Not-Self-Managed Indicator			0.014	0.001
			(0.241)	(0.021)
Year Dummies	Yes	Yes	Yes	Yes
Pseudo R-squared	0.086		0.117	
Observations	1,436	1,436	1,238	1,238

Table 6 –Abnormal Returns for Initial Activist Campaigns

Daily and monthly abnormal returns around the announcement of activist campaigns. The sample contains 2,275 initial activist campaigns from SharkRepellent launched in 2006-2013 that also have data on CRSP and Compustat. Initial campaigns are defined as the campaigns launched against a target firm that are not preceded by any other campaigns in the same target firm in the past 365 days. 2,219 initial campaigns are launched against non-REIT firms, 56 against REIT firms. The campaigns launched solely by corporations, religious groups or labor unions, or any combination of these types of activists in an activist group, are excluded. CAR is the cumulative abnormal return where the abnormal return is calculated as the stock return minus the value-weighted CRSP index returns. BHAR is the buy-and-hold abnormal return where the abnormal return is calculated as the buy-and-hold stock return minus the buy-and hold value-weighted CRSP index return. CRSP index return is replaced with the value-weighted CRSP-Ziman REIT index in the rows indicated as “w/REIT index.” Averages are reported with the medians below in brackets. [a], [b], and [c] indicate statistical significance at the 1%, 5%, and 10% level for the test that the abnormal returns equal zero. ***, **, * indicate that the abnormal returns for REITs are different from the abnormal returns for non-REITs at the 1%, 5%, and 10% level (no such statistical difference is observed in the sample).

Table 6 – continued

	Initial Activist Events		
	non-REITs	REITs	Difference
	n=2219	n=56	
Panel A: Daily Returns			
CAR {-5, +5}	3.76%[a]	6.62%[b]	2.86%
	[2.13%][a]	[3.94%][b]	[1.81%]
w/REIT index		6.90%[b]	
		[2.37%][b]	
CAR {-20, +20}	5.39%[a]	8.87%[b]	3.31%
	[3.51%][a]	[5.31%][a]	[1.80%]
w/REIT index		7.92%[b]	
		[5.79%][b]	
BHAR {-20, +20}	5.55%[a]	4.23%	-1.32%
	[2.07%][a]	[3.34%][b]	[1.27%]
w/REIT index		3.96%	
		[3.86%]	
Panel B: Monthly Returns			
CAR {-1, +12}	5.71%[a]	-7.09%	-12.80%
	[5.65%][a]	[1.69%]	[-3.96%]
w/REIT index		-9.30%	
		[-0.08%]	
BHAR {-1, +12}	7.24%[a]	-6.33%	-13.57%
	[-0.05%]	[-3.32%]	[-3.37%]
w/REIT index		-4.46%	
		[-5.66%]	

Table 7 –Likelihood of Takeover for Activist Targets

Probit model for the likelihood that a REIT firm is taken over within two years from the end of the fiscal year. The panel contains REIT firm-years on Compustat in 2005-2013 with data available to calculate market capitalization and total assets. REITs are identified using the CRSP Ziman REIT database. The dependent variable equals 1 if the firm is delisted due to merger or acquisition within two years from the end of the fiscal year. The Activist Campaign Indicator equals one if the firm is subject to an activist campaign within the next two fiscal years. All other accounting and market variables are described in Table 2 and Table 5. Robust standard errors clustered by firms are in parentheses below coefficient estimates or below marginal effects. Marginal effects reflect the change in the probability of an activist campaign for a one standard deviation change in a continuous variable, or a shift from zero to one for an indicator variable. *, **, *** in indicate statistical significance at the 10%, 5%, and 1% significance level.

Table 7 – continued

	All Activist Events			
	(1)	(2)	(3)	(4)
	Coefficients	Marginal Effects	Coefficients	Marginal Effects
Activist Campaign Indicator	0.516**	0.060*	0.688**	0.075*
	(0.241)	(0.036)	(0.304)	(0.046)
log(MVE)	0.516*	0.045*	0.272	0.020
	(0.287)	(0.026)	(0.623)	(0.046)
log(MVE) squared	-0.040*	-0.003*	-0.030	-0.002
	(0.023)	(0.002)	(0.045)	(0.003)
Market-to-Book (Q)	-0.317	-0.028	-0.157	-0.012
	(0.266)	(0.024)	(0.379)	(0.028)
Sales Growth 1 Year	-0.007	-0.001	-0.058	-0.004
	(0.061)	(0.005)	(0.098)	(0.007)
ROA	-1.625*	-0.143*	-3.745	-0.277
	(0.943)	(0.083)	(3.341)	(0.241)
Cash/Assets	0.728	0.064	1.018	0.075
	(0.983)	(0.088)	(1.459)	(0.110)
Dividend Yield	0.304	0.027	0.850	0.063
	(0.406)	(0.036)	(0.601)	(0.044)
Debt/Assets	0.186	0.016	-0.707	-0.052
	(0.551)	(0.048)	(0.768)	(0.058)
Equity REIT Indicator	0.582**	0.041**	-0.021	-0.002
	(0.293)	(0.016)	(0.351)	(0.026)
Abnormal Return 1 Year			-0.762*	-0.056*
			(0.427)	(0.034)
Insider Ownership			-0.034	-0.003
			(0.023)	(0.002)
Institutional Ownership			0.328	0.024
			(0.505)	(0.038)
Inst. Own. Concentration			-1.523	-0.112
			(1.732)	(0.127)
UPREIT Indicator			0.333	0.023
			(0.234)	(0.016)
Maryland Indicator			-0.006	-0.000
			(0.271)	(0.020)
Not-Self-Managed Indicator			0.069	0.005
			(0.259)	(0.020)
Year Dummies	Yes	Yes	Yes	Yes
Pseudo R-squared	0.197		0.220	
Observations	1,436	1,436	1,130	1,130

Table 8 –Abnormal Returns by Target Acquisition Outcome

Daily and monthly abnormal returns around the announcement of activist campaigns sorted by whether the activist targets delist from CRSP due to merger or acquisition with 18 months from an initial activist campaign. The sample contains 2,275 initial activist campaigns from SharkRepellent launched in 2006-2013 that also have data on CRSP and Compustat. Initial campaigns are defined as the campaigns launched against a target firm that are not preceded by any other campaigns in the same target firm in the past 365 days. 2,219 initial campaigns are launched against non-REIT firms, 56 against REIT firms. The campaigns launched solely by corporations, religious groups or labor unions, or any combination of these types of activists in an activist group, are excluded. CAR and BHAR are defined in Table 6. The CRSP index return is replaced with the value-weighted CRSP-Ziman REIT index in the rows indicated as "w/REIT index." Averages are reported with the medians below in brackets. [a], [b], and [c] indicate statistical significance at the 1%, 5%, and 10% level for the test that the abnormal returns equal zero. ***, **, * indicate that the abnormal returns for delisted activist targets are different from the abnormal returns for non-delisted activist targets at the 1%, 5%, and 10% level.

	Initial Activist Events					
	non-REITs			REITs		
	Delisted n=532	Other n=1682	Difference	Delisted n=12	Other n=44	Difference
Panel A: Daily Returns						
CAR {-5, +5}	4.74%[a]	3.45%[a]	-1.29%*	5.06%[c]	7.05%[c]	1.99%
	[1.53%][a]	[2.45%][a]	[0.92%]**	[2.24%]	[5.00%][b]	[2.76%]
w/REIT index				4.73%[c]	7.50%[c]	2.77%
				[1.56%]	[3.39%][c]	[1.83%]
CAR {-20, +20}	13.22%[a]	2.89%[a]	-10.34%***	7.44%[b]	9.26%[c]	1.82%
	[7.35%][a]	[2.45%][a]	[-4.90%]***	[6.07%][c]	[4.80%][b]	[-1.27%]
w/REIT index				6.48%[b]	8.32%[c]	1.84%
				[7.74%]	[5.30%][c]	[-2.14%]
BHAR {-20, +20}	13.70%[a]	2.95%[a]	-10.75%***	7.72%[b]	3.28%	-4.44%
	[7.08%][a]	[1.06%][a]	[-6.02%]***	[6.50%][c]	[3.12%]	[-3.38%]
w/REIT index				6.77%[b]	3.19%	-3.58%
				[8.17%]	[3.72%]	[-4.45%]
Panel B: Monthly Returns						
CAR {-1, +12}	26.90%[a]	-0.68%	-27.58%***	12.97%[b]	-12.68%	-25.65%
	[21.02%][a]	[0.46%]	[-20.55%]***	[9.71%][b]	[-7.25%]	[-16.96%]
w/REIT index				9.01%	-14.30%	-23.31%
				[3.85%]	[-4.02%]	[-7.87%]
BHAR {-1, +12}	27.94%[a]	0.99%	-26.94%***	14.70%[b]	-12.20%[c]	-26.91%**
	[18.92%][a]	[-6.94%][a]	[-25.87%]***	[10.31%][b]	[-14.60%][c]	[-24.91%]***
w/REIT index				10.33%	-8.49%	-18.83%*
				[3.67%]	[-11.87%]	[-8.2%]***

The Effect of Dividend Reinvestment and Stock Purchase Plan On REIT Payout Choice

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This study investigates whether implementing Dividend Reinvestment and Stock Purchase Plan (DRSPP) influences REIT choice of cash flow distribution methods. Both agency cost and signaling models indicate that REITs with DRSPP should make relatively conservative payout choice, in order to attract and incentivize current and new shareholders to make long-term investments in stocks. We provide supportive evidence that relative to REITs without DRSPP, REITs with DRSPP are less likely to omit all the payouts, including regular dividends, extra dividends, and share repurchases; and REITs with DRSPP are less likely to pay extra dividends and/or repurchase shares when they pay stable regular dividends. Less volatile stock market as response to dividend announcements of REITs with DRSPP also reflects on the managerial effectiveness on maintaining a discretionary payout policy. In addition, we find strong dividend payment date effect in REITs with DRSPP but not in REITs without DRSPP, suggesting higher temporary price pressure in REITs with DRSPP around the dividend payment date.

Keywords: Divid Reinvestment and Stock Purchase Plan, Divid Payment Date, Payout Choice, Divid Announcement

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VG004, June 10, 2016, 2:15 - 3:45pm

The Effect of Dividend Reinvestment and Stock Purchase Plan

On REIT Payout Choice

Abstract

This study investigates whether implementing Dividend Reinvestment and Stock Purchase Plan (DRSPP) influences REIT choice of cash flow distribution methods. Both agency cost and signaling models indicate that REITs with DRSPP should make relatively conservative payout choice, in order to attract and incentivize current and new shareholders to make long-term investments in stocks. We provide supportive evidence that relative to REITs without DRSPP, REITs with DRSPP are less likely to omit all the payouts, including regular dividends, extra dividends, and share repurchases; and REITs with DRSPP are less likely to pay extra dividends and/or repurchase shares when they pay stable regular dividends. Less volatile stock market as response to dividend announcements of REITs with DRSPP also reflects on the managerial effectiveness on maintaining a discretionary payout policy. In addition, we find strong dividend payment date effect in REITs with DRSPP but not in REITs without DRSPP, suggesting higher temporary price pressure in REITs with DRSPP around the dividend payment date.

Introduction

This study investigates whether a REIT implementing dividend reinvestment and stock purchase plan (DRSPP) affects her payout choice to make changes on regular dividend payments, pay extra dividends, and repurchase shares. DRSPP provides an economical and convenient way for investors to reinvest cash dividends paid on common shares to purchase additional common shares, and in many cases, make optional cash payment to purchase shares directly from the sponsoring companies. Investors who participate in the DRSPP will not be charged brokerage commissions or service charges for purchases made under the plan, and may purchase common shares at a discount of 0% ~ 5% of the market prices of shares with a limitation of the amount of allowable investment each time. Companies select other companies or banks (i.e., Computershare Trust Company, American Stock Transfer & Trust Company LLC, Wells Fargo Banks, and others) as transfer agents to administer the plan, and pay all costs of administration[1]. While companies have responsibility with respect to the preparation or contents of all the prospectus that help communicate with investors, the administrators keep records, send statements of account to each participant, and perform other duties related to the plan, including the safekeeping of the shares purchases for each participant. The administrators also act as the dividend disbursing agent, transfer agent, and registrar for common stocks. Investors can complete and sign an authorization form to participate in the plan. The plan is entirely voluntary, and investors can withdraw at any time.

Companies may use newly issued shares, shares purchased in the open market, shares purchased in privately negotiated transactions, or shares acquired by a combination of such

1. However, investors must pay brokerage commissions and an administrative fee if request the plan administrator to sell their shares held in the plan.

methods to exchange for the cash dividends and additional cash investment. DRSPP allows companies to raise new equity capital with much less flotation costs and to encourage shareholders to make long-term investments in common stocks of the companies. The companies can use the proceeds received from sales of the shares for general corporate purposes, including but not limited to, the repurchase of shares pursuant to their share repurchase plan, working capital, investment in real estate and repayment of debt.

Back to the early 1960s, some U.S. firms started to adopt dividend reinvestment plan, which allows investors to elect to have all or a portion of their cash dividends automatically invested in additional shares at the market price. The plan gradually adds some new features. For instance, it allows interested investors to make optional cash payment to buy shares directly from the company. Today, most enrollment forms allow investors to decide the extent of their participation in the plan. Investors normally indicate which features of the plan they will use, by selecting one or two of the following choices on the form: (1) full reinvestment of dividends, (2) partial reinvestment of dividends, or (3) optional cash investments.

According to a file documented by the SEC, more than 1,000 U.S. firms had some forms of DRSPP by the year of 1994. However, only a handful of studies related to DRSPP have been documented for lack of data. Companies with DRSPP are not required to report sources and amounts of shares that are used for the plan.

Our study focuses on the REITs for several reasons: (1) we only need to focus the equity REIT sample in the recent two decades due to regulation and policy changes in REIT industry. In addition, most REITs started to adopt DRSPP after the SEC simplified the procedures of implementing DRSPP in December of 1994.This suggests that hand-collecting data process in

REITs is relatively feasible and precise. (2) We collect DRSPP related data based on SNL financial, SEC Edgar files, Google Search, and Factiva, rather than COMPUSTAT. (3) DRSPPs facilitate REITs to retain some internally generated cash flows and convert these funds to new equity capital with much less flotation costs. This is important due to high dividend payout requirement in REITs. REITs need to pay out at least 90 percent of their taxable income to shareholders as dividends, in order to qualify for tax-exempt status. (4) DRSPPs help REITs obtain wider ownership of shares. The plan requires participants to possess stock certificates issued in their own names, instead of in the name of their brokers. This is meaningful as well since REITs are also required to be beneficially owned by 100 or more persons and must not be closely held.

Even though REIT dividend payouts are greatly constrained by their internally generated cash flows, REIT managers do not make payout decisions entirely based on the legislation, and still aim to smooth dividend payout over time. For examples, Wang, Erikson, and Gau (1993) first show that REITs can pay dividends more than their net income. Hardin and Hill (2008) find that REIT dividend payments can be decomposed into mandatory payment and excess payment. The mandatory payment is essential for REIT to stay tax-preferred status, and the excess payment – payment above the statutory minimum, is optional. Boudry (2011) proposes a new methodology and decomposes REIT dividends into discretionary and nondiscretionary components. All these studies indicate that REIT managers have concerns about their payout choice and make discretionary dividend payout decisions.

According to SNL Real Estate database, 262 out of 721 active and non-active REITS have DRSPPs. Shareholders holding a particular REIT with DRSPP can make election to participate in the plan. However, to our best of knowledge, none of the existing literature has investigated any REIT topics related to DRSPP, and no extant payout studies in both accounting and finance have examined whether adopting a DRSPP affects firm payout choice. This study tries to fill this gap. We investigate whether a REIT adopting DRSPP influences her use of changes in dividends and share repurchases.

Prior studies have documented many factors (i.e., book-to-market, firm size, and leverage) that affect firm payout choice. Firm managers tend to maintain a relatively stable payout policy and may use special dividends and share repurchases to distribute non-sustainable excess cash. While firm managers use share repurchases to signal undervaluation, they may increase regular dividends only if they expect sustainable higher future earnings. Because increases in regular dividends may be interpreted by the principle - stockholders as the long-term commitment of agent to distribute future cash flows.

On the other hand, implementing DRSPP can align interest of managers and shareholders. Managers are motivated to invest in positive NPV projects and improve performance, in order to attract and incentivize current and new shareholders to make long-term investment in the stocks of the companies. This implies that investors who participate in DRSPP would expect REITs to pay consistently high dividend payout ratio, and REITs adopting DRSPP recognize the importance of this alternative cash preservation strategy for sustainable growth and thus make discretionary payout choices. In addition, Scholes and Wolfson (1989) argue that implementing a DRSPP may avoid a negative signal a new equity offering provides. In that adopting DRSPP to raise equity capital over a long period of time, rather than all at once, can mitigate the adverse selection problem and reduce information asymmetries. Due to the sensitivity of investors to payout policy, REITs with DRSPP should have a less flexible payout policy than REITs without

DRSPP. Therefore, both agency cost and signaling models indicate that REITs with DRSPP should make relatively conservative payout choice.

We examine the effect of DRSPP on REIT payout choice using multinomial logit regression model. The sample includes 271 equity REITs over a period from 1999 to 2014. And 127 out of the 271 REITs have DRSPP. After controlling for factors documented in prior studies that affect firm payout choices, we find that relative to REITs without DRSPP, REITs with DRSPP are less likely to omit all the payouts, including regular dividends, extra dividends, and share repurchases; and REITs with DRSPP are less likely to pay extra dividends and/or repurchase shares when they pay stable regular dividends. These findings indicate that implementing DRSPP in REITs influence REIT managers to make discretionary payout choice.

Furthermore, we apply even study methodology to examine the dividend announcement date effect and dividend payment date effect between REITs with DRSPP and REITs without DRSPP. Less volatile stock market as response to dividend announcements of REITs with DRSPP also reflects on the managerial effectiveness on maintaining a discretionary payout policy. For example, market reactions to dividend increase (decrease) are smaller (no difference) for REITs with DRSPP than (and) for REITs without DRSPP.

We study the dividend payment date effect. The dividend payment date will be the date on which the administrators will invest any dividends for the purchase of common shares, if plan administrators purchase shares directly from the issuing company. Unless the dividend payment date is not a trading day, in which case the dividend reinvestment date will be the next trading day. If the administrators purchase common shares in the open market, the administrators will make such purchases beginning on or after the dividend payment date, in most cases, within 30 days after such date. We find strong dividend payment date effect in REITs with DRSPP but not in REITs without DRSPP, suggesting higher temporary price pressure in REITs with DRSPP around the dividend payment date, consistent with Berkman and Koch (2016).

Our study contributes to the existing literature by providing new evidence that REIT payout choices are sensitive to the implementation of DRSPP. Most REITs use newly issued shares to investors who participate in the DRSPP, converting a portion of internally generated cash flows into new equity without flotation costs. Implementing DRSPP helps REITs access public capital market to raise less costly new equity. As a consequence, REIT managers, after adopting DRSPP, tend to make conservative payout choice. Our finding may help explain why less than 30 REITs choose to distribute elective stock dividends subsequent to the enactment of the new IRS rules during financial crisis and why REIT investors do not seem to favor cash dividend over stock dividends, some facts documented by Devos, Spieler, and Tsang (2014). They attribute their findings to the fact that “under efficient market investors can always convert stock dividends into cash by selling the stock; hence investors are generally not worse off receiving stock dividends”. Alternatively, we interpret the behavior of a few REITs distributing elective stock dividends as a reflection of manager discretionary payout policy. Besides, if a REIT adopting DRSPP attracts many investors to participate in the plan, the REIT can still retain a significant portion of distributed cash flow.

The remainder of this paper proceeds as follows. Section II provides related literature review and develops the research hypotheses. Section III discusses the sample selection procedures and research design. Section IV summarizes the empirical results and section V presents robustness test results. Section VI concludes.

Related Literature and Hypothesis Development

REITs can distribute cash flow back to shareholders in the forms of regular dividends, extra dividends - including irregular dividends and excess dividends, and stock repurchases. In a sample of 8,290 REIT regular dividend announcements, 91 percent (about 7,562) of regular announcements are made on a recurring quarterly basis and less than 10 percent of regular dividend announcements are made on a recurring monthly, annual, or semiannual basis. Special dividends are usually one-time dividend distributions to shareholders, and are considered not to be sustained in the future. Most REITs repurchase stocks using open market stock repurchase program or tender offer. REITs, rather than regular corporations, have much lower overall level of repurchases because of the regulation on dividend payout policy (Boudry, Kallberg, and Liu, 2013). And thus repurchases cannot be the dominant form of REIT payout, which is different from regular corporations that use repurchases to substitute for dividend payout in recent decades (Grullon and Michaely, 2002; and Skinner, 2008).

Existing literature has developed four possible hypotheses to explain firm payout policy: agency cost, signaling effect or information content of dividends, clientele effect, and tax consideration. Our study builds on both agency-cost and signaling literature to develop four main testable hypotheses. Extant studies provide mixed results on the tax and clientele effects on payout choice. While Brav, Graham, Harvey, and Michaely (2005) suggest that taxes play a second-order role in firm payout choice; Hanlon and Hoopes (2014) provide evidence that managers adjust corporate payout choices as response to changed investor-level taxes. But shareholders who participate in the DRSPP have the same federal income tax obligation for dividends reinvested under the plan as for dividends received in cash. The clientele effect concerns about the reaction of institutional investors. Interestingly, DRSPP limits the allowable periodic investment to attractive individual clients but to prevent institutional investors and corporate insiders from exploiting large economies of scale. These findings suggest that estimating the possible link of tax and clientele effects with REIT payout choices is complicated, and thus deserves another independent study. We leave it to the future work.

Agency Cost Theory

The principal-agent problem arises when firm managers do not act in the interest of shareholders. Firm managers should invest positive NPV projects and maximize returns to shareholders in order to attract current and new shareholders to participate in DRSPP. REITs are capital-intensive in nature, and often raise funds from external capital markets. Debt holders often act as a control to monitor firms' activities and make sure that firms can fulfill their debt obligations. Similarly, firms should have less asymmetric information and invest projects that generate positive cash flows to incentivize investors to participate in DRSPP. Agency cost models argue that when faced with high asymmetric information, a firm will pay more of its cash flow in dividends. Consistent with this model's prediction, Ghosh and Sirmans (2006) provide evidence to show that dividend decisions reflect managerial motives and incentives. Good performing managers invest in positive NPV projects to maximize shareholder value and need not pay high dividends, but poorly performing mangers pay generous dividends to appease disgruntled investors. Under agency costs, firms with DRSPP should motivate managers to invest positive NPV projects and improve stock performance, thereby conducting conservative payout policy.

Payout as Signaling Mechanism

Theoretical models suggest that firm managers use payout to signal changes in their expectations about future prospects of the firm (e.g., Leland and Pyle, 1977; Bhattacharya, 1979; Aharony and Swary, 1980; Miller and Rock, 1985; John and Williams, 1985). Thus, payouts as signaling device, in the form of regular dividend, special dividend, or share repurchase, require managers to pay due diligence on conveying information about future prospects. Bradley, Capozza, and Seguin (1998) find that REIT managers make discretionary payout choice to mitigate the negative effect of dividend reduction on stock market. Brau and Holmes (2006) provide evidence that the managerial signaling hypothesis explains for the abnormal returns observed around share repurchase announcements. The strict regulation on payout policy disenables REITs to finance their growth via internally generated cash flows. Consequently, the access to equity market to finance positive NPV projects is crucial for long-term REIT growth. REIT managers are aware that the maintenance of dividend payments is a requirement for greater access to capital markets. As a return, the capital market rewards REIT managers for considering investor demand for dividends.

By adopting DRSPP, REITs not only promote long-term investment from existing shareholders but also encourage wider ownership of shares. In addition, DRSPPs allow REITs not to pay much less flotation costs on newly issued equity, and thus raise equity capital cheaper than seasoned equity offerings. Therefore, we make hypothesis that REITs with DRSPP should have a conservative payout policy under signaling models, due to high costs for decreasing dividends.

In sum, both the reduction of the agency problem and the signaling effects of payout suggest that implementing DRSPP affects REIT payout decision. In our sample of 2,269 firm-year observations, REIT payout choices can be classified into 7 categories: (1) paying stable regular dividends only; (2) paying regular dividends, and meanwhile distributing extra dividends, repurchasing shares, or both; (3) increasing regular dividends only; (4) increasing regular dividends, and meanwhile distributing extra dividends, repurchasing shares, or both; (5) decreasing and/or suspending regular dividends, with a possibility of distributing extra dividends, repurchasing shares, or both; (6) distributing extra dividends, repurchasing shares, or both (without regular dividend payment); (7) omitting all the payout. First, we consider one extra payout policy- the payout choice (7). Li and Lie (2006) argue that payout omissions signal firm financial stress and uncertainty on future performance. We then make the first testable hypothesis:

Hypothesis 1 After adopting DRSPP, REITs have lower tendency to omit all the payouts during each of the sample years, as opposed to making other payout choices.

Second, we consider the payout choice (2) - REITs paying stable regular dividends. Since the dividend policy is sticky and the financial need for REITs with DRSPP to invest their positive NPV projects, REITs with DRSPP would prefer not paying additional payouts such as extra dividends and/or stock repurchase while maintaining stable regular dividends. But for the other five payout choices, we cannot easily infer different preferences of these five payout choices for REITs with or without DRSPP. Thus, we only state a second hypothesis as follows:

Hypothesis 2 Relative to REITs without DRSPP**,** REITs with DRSPP should be less likely to pay stable regular dividends with additional payouts, as opposed to making other payout choices.

Payouts convey managerial confidence about future cash flows and thus help alleviate uncertainty faced by outside investors (Brav, Graham, Harvey, and Michaely, 2005). After adopting DRSPP, firm managers make discretionary payout policy to cater to investor demand for a stable dividend policy, and as a return, such behavior is rewarded with less shock to their stock market valuations in dividend announcement events. Thus, we expect that

Hypothesis 3 Dividend announcement date effects should be weaker in REITs with DRSPP than in REITs without DRSPP.

In addition, since investors who participate in DRSPP will receive the new shares converted from cash dividends at each dividend payment date, increased demand for shares at that date leads to temporary price pressure. Berkman and Koch (2012) use a sample of regular firms from 2008 to 2012, and show that the payment date effect is concentrated in firms with DRIP, but not in firms without DRIP. In a similar vein, we state a fourth hypothesis as follow.

Hypothesis 4 The dividend payment date effects are more pronounced in REITs with DRSPP than REITs without DRSPP.

Data and Research Design

Sample

We first select all the U.S. REITs, about 725 REITs, from SNL's Real Estate database. With the field search for "dividend reinvestment plan" in Data Wizard, we find whether REITs have DRIP in the most recent year, say, 2014 in our sample. We also identify the REITs with DRIP showed in the annual lists of DRIP firms since 1996 from the American Association of Individual Investors (AAII). These two sources only roughly tell us whether active or non-active REITs have DRIP. We then match these 725 REITs with REITs in CRSP/Ziman Real Estate Data by ticker and/or company name and only select overlapped REITs showed in both database.

Companies with DRIPs communicate with investors through filings with Securities and Exchange Commission - for example, letters to shareholders, prospectuses, prospectus supplements (forms 424 B3, B4, or B5), securities registration forms (forms S-3, S-3D, or 3-11), and/or quarterly/annual forms (10-Q/10-K).To identify the initial offering date and suspension periods of DRIP for each REIT, we search the key terms "reinvest" and/or "dividend" in the above mentioned SEC filings, and read through the designated firm report. When we are not sure whether a REIT has DRIP, we further search REIT name with key terms "reinvest" and "dividend" in Google and Factiva. We find another eight firms that release public news regarding to the initial offering date of DRIP, which is earlier than the date filed in SEC reports. We also notice that many REITs have DRIPs but their names are not showed in the annual lists of DRIPs provided by AAII. More interestingly, we find that most REITs that have DRIP in the early 1990s now change to DRSPP, and most REITs that adopted the DRIP in recent years name the plan as DRSPP.

Our sample period covers the period from 1999 to 2014. Since accounting data for REITs might be limited before the year of 1999(Hardin III and Hill, 2008). We require the sample to have positive total asset, positive market equity, and non-missing institutional ownership data. The final sample includes 2,269 firm-year observations of 271 REITs. And 127 out of the 271 REITs have DRSPP. The data set is an unbalanced panel. The sample REITs have year-observations between 1 year and 16 years.

Table 1 presents the distribution of REITs with DRSPP and REITs without DRSPP by year. Columns (1) and (3) show that the number of sample REITs with DRSPP ranges from 71 to 81, with an average of 75; and the number of sample REITs without DRSPP ranges from 48 to 89, with an average of 66. Columns (2) and (4) indicate a slightly higher percentage of REITs that have DRSPPs than those that do not have DRSPPs on average.

[Put Table 1 about Here]

We collect dividend distribution information from SNL Real Estate's database. This database provides the dividend announcement date, ex-dividend date, dividend payment date, and the amount of distributed dividends. It also shows that whether the dividends are distributed as a regular, special, irregular, or suspended dividend payment; and whether regular dividends are paid on a recurring quarterly, monthly, annual, or semiannual basis. In this study, we define the special and irregular dividends as extra dividends for the sake of simplicity.

Following Boudry, Kallberg, and Liu (2013), we collect the number of shares repurchases and the average price of repurchased shares from SNL Real Estate's database. The database has these two items available starting in the year of 2006. Note that the SEC Exchange Act rule 10b-18 requires public firms to disclose the two items in their financial statements (i.e., forms 10-K and 10-Q) beginning at March 15th, 2004 (Dittmar and Field, 2015). The dollar value of share repurchases is the product of these two variables. For share repurchase data before 2006, we obtain the line item common shares repurchases from the cash flow statement.

We define a REIT with increasing (decreasing) regular dividends in a given fiscal year as the REIT with greater (less) regular dividends in the current year than those in the prior fiscal year. A REIT is defined to have stable regular dividends, if it distributes the same amount of regular dividends in both current and prior fiscal years. A REIT is defined to pay extra dividends in a given fiscal year if it pays any extra dividend during the year. A REIT is defined to have suspended dividends in a given fiscal year if it makes dividend suspension announcement during the year. A REIT is defined to repurchase shares if it buys back shares in a given fiscal year.

In our sample of 2,269 firm-year observations, REIT payout choices can be summarized into 7 categories: (1) paying stable regular dividends only; (2) paying regular dividends, and meanwhile distributing extra dividends, repurchasing shares, or both; (3) increasing regular dividends only; (4) increasing regular dividends, and meanwhile distributing extra dividends, repurchasing shares, or both; (5) decreasing and/or suspending regular dividends, with a possibility of distributing extra dividends, repurchasing shares, or both; (6) distributing extra dividends, repurchasing shares, or both (without regular dividend payment); (7) omitting all the payout. Table 2 reports fractions of REIT payout choice during each of the years from 1999 to 2014. In Table 2, columns (1) and (2) show that an average of 12 percent of REITs only pay regular dividends each year, and an average of 6 percent of REITs pay regular dividends, and meanwhile distribute extra dividends, repurchase shares, or both; columns (3) and (4) show that about half of REITs increase regular dividends; columns (5) - (7) present that an average of 15 percent of REITs decrease and /or suspend regular dividends, with a possibility of distributing extra dividends, repurchasing shares, or both; around 7 percent of REITs distribute extra dividends, repurchases shares, or both, but they do not pay regular dividends during the year; and about 11 percent of firms omit all the payout.

[Put Table 2 about Here]

Research Methodology

We examine the effect of implementing DRSPP on REIT dividend payout choices using multinomial logit regression model. The payout choices have j = 7 alternatives. We try to explain the probability that REIT i chooses alternative j,

$$P_{ij} = \beta_0 + \beta_1 \text{ DRSPP}_i + \Sigma\beta_m \text{ CONTROLS}_i + \beta_n \text{ Fixed Effects}_i + \varepsilon \quad (1)$$

The dependent variable P_{ij} stands for seven possible payout choices of REITs and is an indicator variable, which (1) takes a value of one if a REIT only pays stable regular dividends during the year; (2) takes a value of two if a REIT pays regular dividends, and meanwhile distributes extra dividends, repurchases shares, or both; (3) takes a value of three if a REIT only increases regular dividends; (4) takes a value of four if a REIT increases regular dividends, and in the same year, distributes special dividends, repurchases shares, or both; (5) takes a value of five if a REIT decreases and/or suspends regular dividends, with a possibility of distributing extra dividends, repurchasing shares, or both; (6) takes a value of six if a REIT pays special dividends and/or repurchases shares, but does not pay regular dividends; (7)takes a value of seven if a REIT omits all the payout. Note that the alternatives j = 1, 2, 3… 7 are assigned arbitrarily and have no meaning, because the alternatives have no particular ordering.

The main variable of interest is DRSPP, which takes the value of 1 for REITs with DRSPP and 0 otherwise. We follow Bradley, Capozza, and Seguin (1998), Lie (2005), Hardin and Hill (2008), and Case, Hardin, and Wu (2012) to select control variables that affect REIT payout choices. The control variables include MTB, BLEV, SIZE, IO, ΔDRAWN, ROA, FFO, BETA_{-1}, ΔBETA, PAYOUT RATIO, DIVIDEND YIELD, and CREDIT/AT. MTB is the market value of equity plus the book value of debt in year t scaled by book value of total assets in year (t - 1). BLEV is measured as the book value of total debt in year t over book value of total assets in year (*t* - 1). SIZE is the log of market capitalization of a firm in year (*t* - 1). The market capitalizations are deflated to 2014 dollars using the consumer price index. IO is the percentage of the total shares owned by institutional investors according to 13F filings in the event year *t*. ΔDRAWN is the difference of the ratio of credit line drawn to total credit line between year (*t* - 1) and year *t*. ROA is measured as net income available to common shareholders in year *t* divided by total assets in year (*t* - 1). FFO is funds from operations, defined as net income excluding gains or losses from sales of real estate, plus depreciation and amortization in year *t*, divided by total assets in year (*t* - 1). $BETA_{-1}$ is the equity estimated using daily returns from CRSP during the year (*t* - 1). ΔBETA is the difference between the equity beta estimated using daily returns during the year (*t* + 1) and $BETA_{-1}$. PAYOUT RATIO is the total dividends in year *t* scaled by net income available to common shareholders in year (*t* - 1). If the dividends exceed the net income, the payout ratio is set to 1. DIVIDEND YIELD is the split-adjusted regular dividends per share during the year (*t* - 1) scaled by the price at the end of the year (*t* - 1). CREDIT/AT is the ratio of credit line available in year *t* over total assets in year (*t* - 1). All the variables are also defined in detail in Appendix A. We also include year fixed effect and property-type fixed effect to control for time-invariant unobserved correlated variables. We follow Hardin and Hill (2008) and use seven property types: multifamily, retail, office, industrial, self-storage, hotel, and other.

We use standard event study methodology to investigate differences of dividend announcement date effects and dividend payment date effects between REITs with DRSPP and REITs without DRSPP. A standard market model is used with the value-weighted Ziman REIT index being the market return index, and the estimation period spans from 250 to 10 days prior the dividend announcement date. Similar to Case, Hardin, and Wu (2012), we calculate the cumulative abnormal returns around dividend announcement date T_1 based on three different event windows: (T_1 - 30, T_1 -1), (T_1 + 0, T_1 + 1), and (T_1 + 2, T_1 + 30). Following Berkman and Koch (2016), we calculate the cumulative abnormal returns around dividend payment date T_2 based on three different event windows: (T_2 - 10, T_2 -1), (T_2 + 0, T_2 + 1), and (T_2 + 2, T_2 + 10). The estimation period is from (T_2 - 250) to (T_2 -10).

Empirical Results

Descriptive Statistics

In Table 3, Panel A reports descriptive statistics for the full sample. The average REIT has a market-to-book ratio of 1.46. The sample means of BLEV, SIZE, IO, and ROA are, respectively, 0.63, 20.51, 0.56, and 0.02. Although the REITs have small payout ratio with mean 0.000, the dividend yield is 5.633. Since the variable SIZE has mean much greater than the other variables, we standardize all of the selected variables to make our model better behave.

Panel B presents descriptive statistics for two subsamples: REITs with DRSPP and those without DRSPP. When comparing firm fundamentals between the two subsamples, we make the null hypothesis that means (medians) of variables between the two subsamples are equal. The last two columns of Panel B indicate that REITs with DRSPP and REITs without DRSPP have very different firm characteristics. For example, relative to REITs without DRSPP, REITs with DRSPP tend to have higher MTB, larger size, higher percentage of shares owned by institutional investors. REITs with DRSPP also report higher ROA and FFO, resulting in higher payout ratio and dividend yield. Interestingly, REITs with DRSPP appear to have significantly larger beta in year (t - 1). Panel C reports the Pearson correlation coefficients. ΔDRAWN is not significantly correlated with other selected firm characteristics.

[Put Table 3 about Here]

Multinomial Logistic Regression Results

We present the main empirical results of the multinomial logistic regression analyses for specification (1) in Tables 4 & 5. All the independent variables except DRSPP are standardized. Thus, we can interpret each estimated coefficient as the effect of a one-standard-deviation increase in the independent variable on the percentage change in the possibility of a specific payout choice, with the other variables in the model held constant. Odds ratios can be interpreted as the effect of a one-standard-deviation increase in the independent variable on the predicted odds ratio of making a specific payout choice, with the other variables in the model held constant. Year and property-type fixed effects are also included in all regressions.

Wald Tests of Individual Effects

Table 4 reports Type 3 Analysis of Effects, based on the Wald test. Each chi-square is to test the null hypothesis that the explanatory variable has no effect on the payout choice. The significant level on DRSPP is beyond the 0.01 level. Therefore, we cannot reject the null hypothesis that DRSPP has no effect on the payout choice. Other control variables also significantly impact REIT payout choice, except ΔDRWAN.

[Put Table 4 about Here]

REIT Payout Choices

In Table 5, Panel A presents results with REIT payout choice (7), in which REITs omit all the payout, as the reference category. The statistically significant positive estimated coefficients on DRSPP in columns (1) and (3)-(5) indicate that implementing DRSPP decreases the likelihood of REITs omitting all the payout during each of sample years. In other words, having DRSPP increases the possibility of REITs to pay regular dividends, increase regular dividends, increase regular dividends and meanwhile distribute special dividends, repurchase shares, or both, and decrease regular dividends with a possibility of distributing extra dividends, repurchasing shares, or both. The corresponding odds ratios, respectively, show that having DRSPP results in a 2.2-fold increase in the odds of REITS paying stable regular dividends; a 2.1-fold increase in the odds of REITs increasing regular dividends; a 2.4-fold increase in the odds of REITs increasing regular dividends and meanwhile distributing special dividends, repurchasing shares, or both; and a 1.9-fold increase in the odds of REITs decreasing and/or suspending regular dividends. But columns (2) and (6) indicate that neither the odds of REITs paying regular dividends with additional payout, nor the odds of REITS distributing extra dividends, repurchasing shares, or both, without regular dividends, are significant different from the odds of REITs omitting all the payout.

Column 1 of Panel A, in Table 5, indicates that a one standard deviation increase in MTB produces, on average , a 1.400 decrease in the log odds of getting REIT payout choice (1) – paying stable regular dividends only. That is, higher MTB induces greater possibility of REITs omitting all the payment. The same conclusion can be drawn from the significant negative coefficients on MTB in columns (2) and (4) - (6). In addition, REITs are more likely to omit all the payout, when they have higher BLEV, smaller firm size, lower FFO, greater market beta in the year prior to the event year, lower dividend yield, or lower CREDIT/AT.

Panel B of Table 5 displays results with REIT payout choice (2), in which REITs pay regular dividends, and meanwhile distribute extra dividends, repurchase shares, or both, as the reference category. The positive and significant estimated coefficients and odds ratio in Columns (1)-(4) indicate that REITs with DRSPP are less likely to make payout choice (2), relative to the other payout choices –such as paying stable regular dividends only, increasing regular dividends, and decreasing dividends. In column (1), the odds ratios for DRSPP is 2.2, implying that the odds that REITs with DRSPP paying regular dividends, rather than regular dividends with other additional payouts, are about 2.2 times the odds for REITs without DRSPP. The odds ratio for DRSPP is 2.1 in column (2), suggesting that the odds that REITs with DRSPP will increase regular dividends rather than regular dividends with other payout are about 2.1 times the odds for REITs without DRSPP. Similarly, the odds that REITs with DRSPP will increase regular dividends, as shown in columns (3)-(4), rather than regular dividends with other payout are about twice the odds for REITs without DRSPP. The coefficient of DRSPP in columns (6) has positive sign but is not statistically significant, indicating that the possibility that REITs with DRSPP will only pay extra dividends and/or share repurchases instead of regular dividends with other payout is not different from the possibility for REITs without DRSPP.

Column 2 of Panel B, in Table 5, indicates that a one standard deviation increase in MTB produces, on average , a 2.056 increase in the log odds of getting REIT payout choice (3) - increasing regular dividends only. That is, lower MTB induces greater possibility of REITs paying regular dividends and making other additional payment, instead of paying regular dividends merely. But the significant negative coefficient on MTB in column (4) of Panel B indicate that higher MTB is associated with greater possibility of REITs paying regular dividends and other additional payout, instead of deceasing regular dividends. REITs with Lower BLEV, larger firm size, or lower percentage of institutional ownership (IO) are more likely to make payout choice (2).

Panel C of Table 5 shows results based on comparisons of any other two possible payout choices. The coefficients on DRSPP are all insignificant, suggesting no significant difference of making any two of payout choices (1) and (3) - (6) between REITs with DRSPP and REITs without DRSPP.

[Put Table 5 about Here]

Dividend Announcement Date Effect

In this section, we study how market responds to different dividend announcements. Stable regular dividend announcements are defined as quarterly regular dividends paid at date T_1 are the same as the most recent quarterly regular dividends. Regular dividend increase (decrease) announcements are defined as regular dividends paid at date T_1 are greater (less) than the most recent regular dividends. Extra dividend announcements include the announcements of special dividends and irregular dividends. Increased (decreased) extra dividend announcements are defined as extra dividends paid at date T_1 are greater (less) than the most recent regular dividends. Included in the analyses are 5,650 quarterly stable regular dividend announcements, 1,361 regular dividend increase announcements, 168 regular dividend decrease announcements, 79 dividend suspension announcements, and 217 extra dividend announcements. The extra dividend announcements consist of 111 increased extra dividend announcements and 106 decreased extra dividend announcements. We find that relative to REITs without DRSPP, REITs with DRSPP are more likely to pay stable regular dividends, increase regular dividends, and decrease regular dividends; and they are less likely to suspend regular dividends and pay extra dividends. Announcement period returns are the abnormal stock returns measured from the date T_1 a REIT makes dividend announcement through the day after the announcement ($T_1 + 1$) using market model, where the value-weighted Ziman REIT index is used to proxy overall market returns and the estimation period spans from 250 days to 10 days prior to the announcement date.

The results in Table 6 indicate that the market response to regular dividend increase announcements or extra dividend announcements is stronger than the response to either stable regular dividend announcements or regular dividend decrease announcements. Importantly, we find that REITs with DRSPP, rather than REITs without DRSPP, have much weaker market reaction for each type of dividend announcements, a reflection of possible managerial effect to stabilize market reaction. For example, Panel B shows that CARs from date T_1 to date (T_1 + 1), or (0, +1) are 0.30 percent (t-stat = 4.80) for REITs with DRSPP and 0.73(t-stat = 6.97) for REITs without DRSPP, respectively. The difference of CARs (0, +1) between REITs with DRSPP and REITs without DRSPP is 0.43 percent (t-stat = 2.75). The positive CARs (0, +1) in Panel E are most likely to be driven by the strong market response to increased extra dividend announcements. Panel F shows that CARs (0, +1) in increased extra dividend announcements are 0.36 percent (t-stat = 2.59) for REITs with DRSPP and 3.10 percent (t-stat = 2.17) for REITs without DRSPP, respectively, with a difference of 2.30 percent (t-stat= 2.17) CARs. CARs from (T_1 - 30) to (T_1 + 30) in regular dividend decrease announcements in Panel C are, respectively, 2.88 percent (t-stat = 0.11) for REITs with DRSPP and - 5.90 percent (t-stat = -3.28) for REITs without DRSPP. In the case of dividend suspension announcements, there is no statistically difference of CARs around the announcement dates regardless of REITs having DRSPP. We also notice that there is lower percentage of positive daily returns in REITs with DRSPP than in REITs without DRSPP, in the day and one day after stable regular dividend announcements, regular dividend increase announcements, or extra dividend announcements, respectively; while there is higher percentage of positive daily returns in REITs with DRSPP than in REITs without DRSPP.

[Put Table 6 about Here]

Dividend Payment Date Effect

In this section, we follow Berkman and Koch (2016) to investigate the dividend payment date effect. They find that the dividend payment date effect is concentrated among firms with DRIPs. In that the new shares are purchased at each dividend payment date. Therefore, we make hypothesis that REITs with DRSPP should have stronger dividend payment date effect than REITs without DRSPP. As in the last section, we classify all the dividend announcements into six different types, such as stable regular dividend announcements, regular dividend increase announcements, regular dividend decrease announcements, extra dividends announcements (increased or decreased), and dividend suspension announcements. Each dividend announcement, excluding the suspension one, has the corresponding dividend payment date. We have slightly different observations of dividend payment date due to the availability of daily stock return data. Shown in Table 7 are 5,469 quarterly stable regular dividend announcements, 1,312 regular dividend increase announcements, 165 regular dividend decrease announcements, and 217 extra dividend announcements. The extra dividend announcements consist of 112 increased extra dividend announcements and 105 decreased extra dividend announcements.

Table 7 reports cumulative abnormal returns (CAR) around dividend payment date T_2. CARs are separately estimated from three event windows: (T_2 - 10, T_2 - 1), (T_2, T_2 + 1), and (T_2 + 2, T_2 + 10). A standard market model is used with the value-weighted Ziman REIT index being the market return index, and the estimation period spans from 250 to 10 days prior the dividend payment date.

In Table 7, Panel A shows that CARs from date (T_2 + 0) to date (T_2 + 1) are, respectively, 0.18 percent (t-stat = 4.21) for REITs with DRSPP and 0.09 percent (t-stat = 1.50) for REITs without

DRSPP. But the difference of CARs between these two groups is not significant. Panel B shows that CARs from date (T_2 + 0) to date (T_2 + 1) are, respectively, 0.23 percent (t-stat = 3.65) for REITs with DRSPP and 0.02 percent (t-stat = 0.26) for REITs without DRSPP, with a difference of -0.21 percent CARs (t-stat = -2.13). We find a similar pattern of dividend payment date effect in extra dividend announcements and increased extra dividend announcements. Overall, we show the strong dividend payment date effect in REITs with DRSPP. In addition, we find higher percentage of daily returns in date (T_2 + 0) and date (T_2 + 1) in REITs with DRSPP than REITs without DRSPP. CARs from date (T_2 - 10) and date (T_2 + 10) are not significantly different between these two groups of REITs. All these findings are consistent with the results in Berkman and Koch (2016).

[Put Table 7 about Here]

Robustness Check

We also use a logistic regression model to model the probability of REITs that pay stable regular dividends (decrease regular dividends, increase regular dividends, pay extra dividends, or repurchase shares) taking on a value of 1, rather than the probability of REITs that do not pay stable regular dividends (do not decrease regular dividends, do not increase regular dividends, do not pay extra dividends, or do not repurchase shares) taking on a value of 0. When not considering alternative payout choice during the year, we show that REITs with DRSPP are more likely to decrease regular dividends (see Column (2) of Table 8) and to increase regular dividends (see Column (3)). This result might mislead us to interpret as more flexible payout choice in REITs with DRSPP. Thus, it is important to take all the payout choice into account when we study the effect of adopting DRSPP on REIT payout choice.

[Put Table 8 about Here]

We also use alternative definition of payout choice to re-examine the dividend announcement date effect and dividend payment date effect. Stable regular dividend announcements are defined as regular dividends paid at quarter *Q* are the same as the regular dividends paid at the same quarter of last year, or quarter (*Q* - 4). Regular dividend increase (decrease) announcements are defined as regular dividends paid at quarter *Q* are greater (less) than the regular dividends paid at the same quarter of last year. According to the new definition of payout choice, we show that dividend announcement date effect is weaker in REITs with DRSPP than in REITs without DRSPP, and dividend payment date effect is stills stronger in REITs with DRSPP than in REITs without DRSPP.

Conclusion

To stay federal tax-preferred status, REITS are required to make distributions, other than capital gain dividends, to their shareholders each year in an amount at least equal to the sum of 90 percent of their income. This greatly limits REIT managers to use internally generated cash flows and requires them to access capital market frequently to raise capital. Therefore, it is important for REIT managers to retain some internal generated cash flows through DRSPP to alleviate the need for external financing. Although REIT payout policy has received a great deal of attention in the literature, none of the existing studies on REITs has looked into the effect of adopting DRSPP on payout decisions.

This study examines whether implementing DRSPP affects REIT payout choice. Consistent with the prediction from agency cost and signaling models, we show managers in REITs with DRSPP employ a relatively conservative dividend payout policy. We find relative to REITs without DRSPP, REITs with DRSPP are less likely to omit dividend payments; and DRIP REITs are less likely to increase dividends and/or repurchase shares while maintaining a stable payout policy. Besides, less volatile stock market as response to dividend announcements of REITs with DRSPP also reflects on the managerial effectiveness on maintaining a discretionary payout policy.

In addition, we find strong dividend payment date effect in REITs with DRSPP but not in REITs without DRSPP, suggesting higher temporary price pressure in REITs with DRSPP around the dividend payment date. Future work will be of great interest if: (1) we can trace how and to what extent, firms raise new issues through the DRSPPs; (2) we can figure out why some firms adopt this plan while others not; and (3) we can compare the risk and returns of those firms that adopted the plan.

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Appendix A

Variable Definition

Seven REIT payout choices during a year:

(1)REITs only pay stable regular dividends during the year;

(2) REITs pay regular dividends, and meanwhile distribute extra dividends, repurchase shares, or both;

(3) REITs only increase regular dividends;

(4) REITs increase regular dividends, and in the same year, distribute special dividends, repurchase shares, or both;

(5) REITs decrease and/or suspend regular dividends, with a possibility of distributing extra dividends, repurchasing shares, or both;

(6) REITs pay special dividends and/or repurchase shares, but do not pay regular dividends;

(7) REITs omit all the payout.

Main Variable of Interest

DRSPP takes the value of 1 for REITs with DRSPP during a year, and 0 otherwise.

Controls Variables

MTB is the market value of equity plus the book value of debt in year *t* scaled by book value of total assets in year (*t* - 1).

BLEV is measured as the book value of total debt in year *t* over book value of total assets in year (*t* - 1).

SIZE is the log of market capitalization of a firm in year (*t* - 1). The market capitalizations are deflated to 2014 dollars using the consumer price index.

IO is the percentage of the total shares owned by institutional investors according to 13F filings in the event year *t*.

Δ*DRAWN* is the difference of the ratio of credit line drawn to total credit line between year (*t* - 1) and year *t*.

ROA is measured as net income available to common shareholders in year *t* divided by total assets in year (*t* - 1).

FFO is funds from operations, defined as net income excluding gains or losses from sales of real estate, plus depreciation and amortization in year *t*, divided by total assets in year (*t* - 1).

$\boldsymbol{BETA_{-1}}$ is the equity estimated using daily returns from CRSP during the year (*t* - 1).

Δ*BETA* is the difference between the equity beta estimated using daily returns during the year (*t* + 1) and $BETA_{-1}$.

PAYOUT RATIO is the total dividends in year *t* scaled by net income available to common shareholders in year (*t* - 1). If the dividends exceed the net income, the payout ratio is set to 1.

DIVIDEND YIELD is the split-adjusted regular dividends per share during the year (*t* - 1) scaled by the price at the end of the year (*t* - 1).

CREDIT/AT is the ratio of credit line available in year *t* over total assets in year (*t* - 1).

Table 1
Distribution of REITs With DRSPP and REITs Without DRSPP
By Year

This table reports number and percentage of REITs each year that have DRSPP and do not have DRSPP, respectively. The sample includes 271 REITs and covers the period from 1999 to 2014. And 127 out of the 271 REITs have DRSPP.

Year	REITs With DRSPP		REITs Without DRSPP	
	(1)	(2)	(3)	(4)
	No. of REITs	% of REITs	No. of REITs	% of REITs
1999	76	0.46	89	0.54
2000	72	0.46	83	0.54
2001	78	0.52	73	0.48
2002	79	0.55	65	0.45
2003	77	0.53	67	0.47
2004	81	0.53	73	0.47
2005	80	0.52	73	0.48
2006	73	0.55	60	0.45
2007	71	0.58	51	0.42
2008	71	0.60	48	0.40
2009	71	0.59	50	0.41
2010	74	0.57	56	0.43
2011	74	0.55	60	0.45
2012	76	0.56	60	0.44
2013	76	0.51	73	0.49
2014	77	0.48	82	0.52
Average	75	0.54	66	0.46

Table 2
REIT Payout Choice by Year

This table reports fractions of sample REITs with available data that (1) pay stable regular dividends only;(2) pay regular dividends, and meanwhile distribute extra dividends, repurchase shares, or both;(3) increase regular dividends only;(4) increase regular dividends, and meanwhile distribute extra dividends, repurchase shares, or both;(5) decrease and/or suspend regular dividends, with a possibility of distributing extra dividends, repurchasing shares, or both; (6) distribute extra dividends, repurchase shares, or both (without regular dividends); and (7) omit all the payout, during each of the years from 1999 to 2014. The sample has 2,269 firm-year observations.

Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1999	0.145	0.055	0.309	0.297	0.097	0.018	0.079
2000	0.090	0.065	0.297	0.303	0.187	0.013	0.045
2001	0.079	0.046	0.291	0.285	0.152	0.046	0.099
2002	0.125	0.049	0.326	0.215	0.139	0.028	0.118
2003	0.125	0.104	0.326	0.104	0.153	0.049	0.139
2004	0.188	0.065	0.325	0.084	0.091	0.091	0.156
2005	0.131	0.059	0.386	0.144	0.065	0.078	0.137
2006	0.098	0.053	0.421	0.211	0.068	0.053	0.098
2007	0.115	0.090	0.262	0.279	0.098	0.082	0.074
2008	0.084	0.042	0.277	0.176	0.286	0.076	0.059
2009	0.083	0.050	0.107	0.066	0.521	0.066	0.107
2010	0.138	0.023	0.238	0.062	0.277	0.092	0.169
2011	0.179	0.067	0.328	0.112	0.067	0.119	0.127
2012	0.162	0.096	0.346	0.118	0.088	0.081	0.110
2013	0.141	0.047	0.356	0.195	0.060	0.081	0.121
2014	0.107	0.063	0.346	0.245	0.069	0.069	0.101
Average	0.124	0.061	0.309	0.181	0.151	0.065	0.109

Table 3
Summary Statistics

This table presents summary statistics for the sample of 271 equity REITs and 2,269 firm-year observations from 1999 to 2014. MTB is the market value of equity plus the book value of debt in the event year t scaled by book value of total assets in year (*t* - 1). BLEV is measured as the book value of total debt in year t over book value of total assets in year (*t* - 1). SIZE is the log of market capitalization of a firm in year (*t* - 1). The market capitalizations are deflated to 2014 dollars using the consumer price index. IO is the percentage of the total shares owned by institutional investors according to 13F filings in year *t*. ΔDRAWN is the difference of the ratio of credit line drawn to total credit line between year (*t* - 1) and year *t*. ROA is measured as net income available to common shareholders in year *t* divided by total assets in year (*t* - 1). FFO is funds from operations, defined as net income excluding gains or losses from sales of real estate, plus depreciation and amortization in year *t*, divided by total assets in year (*t* - 1). $BETA_{-1}$ is the equity estimated using daily returns from CRSP in year (*t* - 1). ΔBETA is the difference between the equity beta estimated using daily returns during the year (*t* + 1) and $BETA_{-1}$. PAYOUT RATIO is the total dividends in year *t* scaled by net income available to common shareholders in year (*t* - 1). If the dividends exceed the net income, the payout ratio is set to 1. DIVIDEND YIELD is the split-adjusted regular dividends per share in year (*t* - 1) scaled by the price at the end of the same year. CREDIT/AT is the ratio of credit line available in year t over total assets in year (*t* - 1). Panel A is the descriptive statistics for full sample. Panel B is the descriptive statistics for REITs with DRSPP and REITs without DRSPP, respectively. In last two columns of Panel B, the null hypothesis is that means (medians) of variables in REITs with DRSPP and those of variables in REITs without DRSPP are equal. P-value is the p-value of the nonparametric Wilcoxon two-sample test. Panel C is the correlation matrix. The upper triangular matrix shows the Pearson correlations. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Descriptive Statistics for the Full Sample

Variable	N	Mean	Median	Std Dev	25%	75%
MTB	1,997	1.455	1.252	2.931	0.962	1.570
BLEV	1,997	0.630	0.563	2.447	0.455	0.687
SIZE	1,997	20.505	20.754	1.733	19.526	21.613
IO	2,269	0.564	0.632	0.313	0.308	0.821
ΔDRAWN	1,997	-1.245	0.000	29.384	-14.365	13.265
ROA	1,997	0.023	0.021	0.086	0.003	0.042
FFO	1,994	0.056	0.059	0.112	0.042	0.077
$BETA_{-1}$	2,172	0.807	0.889	0.437	0.562	1.064
ΔBETA	2,010	0.025	0.025	0.386	-0.137	0.201
PAYOUT RATIO	1,995	0.000	0.000	0.011	0.000	0.000
DIVIDEND YIELD	2,269	5.633	5.445	4.218	3.229	7.398
CREDIT/AT	1,997	0.160	0.139	0.219	0.071	0.209

Panel B. Descriptive Statistics for REITs With DRSPP and REITs Without DRSPP

	REITs With DRSPP			REITs Without DRSPP				
Variable	N	Mean	Median	N	Mean	Median	ΔMean	ΔMedian
MTB	1,110	1.340	1.261	887	1.599	1.225	0.259**	-0.035***
BLEV	1,110	0.586	0.568	887	0.686	0.553	0.099	-0.015***
SIZE	1,110	20.822	20.967	887	20.109	20.547	-0.713***	-0.420***
IO	1,206	0.593	0.663	1,063	0.530	0.595	-0.063***	-0.068***
ΔDRAWN	1,110	-1.551	0.000	887	-0.863	0.000	0.687	0.000
ROA	1,110	0.026	0.024	887	0.019	0.018	-0.007**	-0.006***
FFO	1,110	0.061	0.060	884	0.048	0.058	-0.013***	-0.002***
$BETA_{-1}$	1,191	0.860	0.931	981	0.743	0.804	-0.116***	-0.128***
ΔBETA	1,114	0.036	0.027	896	0.011	0.024	-0.025	-0.003
PAYOUT RATIO	1,110	0.000	0.000	885	-0.001	0.000	-0.001	0.000***
DIVIDEND YIELD	1,206	6.310	5.968	1,063	4.865	4.501	-1.445***	-1.467***
CREDIT/AT	1,110	0.167	0.149	887	0.152	0.116	-0.014	-0.033***

Panel C. Correlations

	BLEV	SIZE	IO	ΔDRAWN	ROA	FFO	$BETA_{-1}$	ΔBETA	PAYOUT RATIO	DIVIDEND YIELD	CREDIT /AT
MTB	0.85***	0.01	-0.04	0.02	-0.25***	-0.57***	-0.07***	0.00	-0.22***	-0.06***	0.68***
BLEV	1	-0.06***	-0.04	0.02	-0.47***	-0.79***	-0.03	-0.01	0.004	-0.001	0.78***
SIZE		1	0.71***	0.02	0.15***	0.20***	0.59***	-0.004	-0.02	-0.03	0.01
IO			1	0.02	-0.01	0.09***	0.55***	0.007	0.016	-0.16***	0.03
ΔDRAWN				1	-0.03	-0.02	-0.06***	0.04*	-0.01	0.04*	0.04**
ROA					1	0.84***	-0.04*	0.05**	-0.39***	0.05**	-0.35***
FFO						1	0.05**	0.04*	-0.30***	0.05**	-0.58***
$BETA_{-1}$							1	-0.41***	0.04	-0.04*	0.02
ΔBETA								1	0.01	0.08***	0.01
PAYOUT RATIO									1	0.05**	0.03
DIVIDEND YIELD										1	0.10***

Table 4
Type 3 Analysis of Effects

This table reports type 3 analyses of effects from estimation of a multinomial logistic model. The dependent variable is an indicator variable showing seven possible payout choices of sample REITs. DRSPP takes the value of 1 for REITs with DRSPP and 0 otherwise. Other explanatory variables are defined in detail in Table 1 and Appendix A. Each chi-square is a test of the null hypothesis that the explanatory variable has no effect on the REIT payout choice. The model also controls for year-fixed effects and property-type fixed effects. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Effect	**Wald Chi-Square**
DRSPP	20.293***
MTB	40.161***
BLEV	22.829***
SIZE	58.087***
IO	25.484***
ΔDRAWN	0.789
ROA	21.983***
FFO	51.469***
$BETA_{-1}$	34.187***
ΔBETA	14.613**
PAYOUT RATIO	23.002***
DIVIDEND YIELD	158.926***
CREDIT/AT	31.472***
Year-Fixed-Effect	Yes
Property-Type-Fixed-Effect	Yes
Observations	1,828
Pseudo R^2	0.59

Table 5
Multinomial Logistic Regression of REIT Payout Choice

This table reports estimation from multinomial logistic regression of REIT payout choice. Seven REIT payout choices include: (1) REITs that pay stable regular dividends only; (2) REITs that pay regular dividends, and meanwhile distribute extra dividends, repurchase shares, or both; (3) REITs that only increase regular dividends; (4) REITs that increase regular dividends, and meanwhile distribute special dividends, repurchase shares, or both; (5) REITs that decrease and/or suspend regular dividends, with a possibility of distributing extra dividends, repurchasing shares, or both; (6) REITs that distribute extra dividends, repurchase shares, or both (without regular dividends); and (7) REITs that omit all the payments during each of the years. Independent variables are defined in detail in Appendix A. All the independent variables except DRSPP are standardized. The corresponding odds ratios (O.R.) are reported. Panels A and B report estimations using payout choice (7) and (2), respectively, as the reference categories. Panel C reports estimations using the other payout choices as the reference categories. The total number of observations for this analysis is 1,828. Year and property-type fixed effects are also included in each specification. In bracket is the P-value. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Using payout choice (7) REITs that omit all the payment during the year as the reference category

Variable	(1) 1 vs. 7		(2) 2 vs.7		(3) 3 vs.7		(4) 4 vs. 7		(5) 5 vs.7		(6) 6 vs.7	
	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.
DRSPP	0.773***	2.167	-0.026	0.975	0.728***	2.071	0.867***	2.380	0.626**	1.871	0.503	1.654
	(0.01)		(0.94)		(0.01)		(0.00)		(0.03)		(0.17)	
MTB	-1.400*	0.247	-2.046**	0.129	0.010	1.010	-1.748**	0.174	-4.628***	0.010	-3.002***	0.050
	(0.09)		(0.04)		(0.96)		(0.02)		(0.00)		(0.00)	
BLEV	-3.079**	0.046	-7.081***	<0.001	-3.377***	0.034	-3.690***	0.025	-2.035	0.131	-0.816	0.442
	(0.02)		(0.00)		(0.00)		(0.01)		(0.12)		(0.60)	
SIZE	0.110	1.116	1.049***	2.854	0.874***	2.396	1.226***	3.409	0.386*	1.470	0.795***	2.213
	(0.63)		(0.00)		(0.00)		(0.00)		(0.06)		(0.00)	
IO	0.171	1.187	-0.428*	0.652	0.206	1.229	0.260	1.296	-0.235	0.791	0.529**	1.697
	(0.44)		(0.08)		(0.31)		(0.23)		(0.26)		(0.05)	
ΔDRAWN	-0.018	0.983	-0.002	0.998	0.037	1.038	-0.017	0.983	0.004	1.004	-0.014	0.986
	(0.89)		(0.99)		(0.75)		(0.89)		(0.97)		(0.93)	
ROA	-0.240	0.787	0.141	1.151	-0.158	0.854	-0.315	0.730	0.769***	2.158	0.493	1.637
	(0.51)		(0.61)		(0.55)		(0.39)		(0.00)		(0.18)	
FFO	1.273**	3.572	0.674	1.962	1.497***	4.466	2.370***	10.693	-0.717**	0.488	0.174	1.189
	(0.02)		(0.15)		(0.00)		(0.00)		(0.05)		(0.75)	
$BETA_{-1}$	-0.495***	0.610	-0.654***	0.520	-0.461***	0.631	-0.671***	0.511	-0.073	0.930	-1.113***	0.329
	(0.01)		(0.01)		(0.01)		(0.00)		(0.63)		(0.00)	
ΔBETA	-0.372***	0.689	-0.237	0.789	-0.151	0.860	-0.290**	0.748	-0.019	0.981	-0.485***	0.616
	(0.01)		(0.16)		(0.27)		(0.05)		(0.87)		(0.01)	
PAYOUT RATIO	0.695***	2.004	0.640*	1.897	0.665***	1.944	0.659***	1.933	0.762***	2.142	-0.189	0.827
	(0.00)		(0.06)		(0.00)		(0.00)		(0.00)		(0.37)	
DIVIDEND YIELD	2.252***	9.510	1.931***	6.894	2.028	7.596	1.8892***	6.614	1.630***	5.104	-0.852***	0.427
	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.01)	
CREDIT/AT	1.245***	3.473	0.833**	2.299	1.454***	4.279	1.223***	3.397	1.306***	3.690	0.123	1.131
	(0.00)		(0.03)		(0.00)		(0.00)		(0.00)		(0.81)	

Panel B. Using payout choice (2) REITs that pay regular dividends, and meanwhile distribute extra dividends, repurchase shares, or both as the reference category

	(1)		(2)		(3)		(4)		(5)	
	1 vs. 2		3 vs. 2		4 vs. 2		5 vs.2		6 vs. 2	
	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.
DRSPP	0.799***	2.223	0.754***	2.125	0.893***	2.441	0.652***	1.919	0.529	1.697
	(0.00)		(0.00)		(0.00)		(0.01)		(0.18)	
MTB	0.646	1.908	2.056**	7.813	0.298	1.347	-2.582**	0.076	-0.956	0.384
	(0.57)		(0.03)		(0.78)		(0.02)		(0.43)	
BLEV	4.002***	54.707	3.704***	40.598	3.391**	29.692	5.046***	155.429	6.266***	526.130
	(0.01)		(0.01)		(0.04)		(0.00)		(0.00)	
SIZE	-0.939***	0.391	-0.175	0.840	0.178	1.195	-0.663***	0.515	-0.254	0.776
	(0.00)		(0.40)		(0.43)		(0.00)		(0.40)	
IO	0.599***	1.821	0.635***	1.886	0.688***	1.989	0.194	1.214	0.957***	2.603
	(0.00)		(0.00)		(0.00)		(0.33)		(0.00)	
ΔDRAWN	-0.016	0.985	0.039	1.040	-0.015	0.985	0.006	1.006	-0.012	0.988
	(0.90)		(0.72)		(0.90)		(0.96)		(0.94)	
ROA	-0.380	0.684	-0.299	0.742	-0.456	0.634	0.629**	1.875	0.352	1.422
	(0.30)		(0.30)		(0.23)		(0.02)		(0.37)	
FFO	0.599	1.821	0.823*	2.277	1.696***	5.451	-1.391***	0.249	-0.500	0.606
	(0.29)		(0.08)		(0.00)		(0.00)		(0.42)	
$BETA_{-1}$	0.159	1.172	0.193	1.212	-0.018	0.982	0.581***	1.787	-0.460	0.632
	(0.49)		(0.36)		(0.94)		(0.01)		(0.11)	
ΔBETA	-0.135	0.874	0.086	1.090	-0.053	0.948	0.218	1.244	-0.248	0.781
	(0.41)		(0.57)		(0.74)		(0.15)		(0.21)	
PAYOUT RATIO	0.055	1.057	0.025	1.025	0.019	1.019	0.122	1.129	-0.830**	0.436
	(0.86)		(0.94)		(0.96)		(0.73)		(0.02)	
DIVIDEND YIELD	0.322*	1.379	0.097	1.102	-0.042	0.959	-0.301*	0.740	-2.783***	0.062
	(0.06)		(0.56)		(0.81)		(0.07)		(0.00)	
CREDIT/AT	0.413*	1.511	0.621***	1.861	0.3905	1.478	0.473*	1.605	-0.7091	0.492
	(0.10)		(0.01)		(0.13)		(0.06)		(0.16)	

Panel C. Using payout choice (6)REITs that distribute extra dividends, repurchase shares, or both (without regular dividends), as the reference category in columns (1)-(4); using payout choice (5) REITs that decrease and/or suspend regular dividends, with a possibility of distributing extra dividends, repurchasing shares, or both, as the reference category in columns(5)-(7); using payout choice (4) REITs that increase regular dividends, and meanwhile distribute special dividends, repurchase shares, or both, as the reference category in columns (8)-(9);and using payout choice (3) REITs that only increase regular dividends; as the reference category in columns (10), respectively.

	(1)		(2)		(3)		(4)		(5)	
Variable	1 vs. 6		3 vs. 6		4 vs. 6		5 vs. 6		1 vs.5	
	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.
DRSPP	0.270	1.310	0.225	1.252	0.364	1.439	0.123	1.131	-0.147	1.158
	(0.45)		(0.51)		(0.31)		(0.73)		(0.48)	
Other Controls*	Yes		Yes		Yes		Yes		Yes	
Year-Fixed-Effect	Yes		Yes		Yes		Yes		Yes	
Property-Type-Effect	Yes		Yes		Yes		Yes		Yes	

	(6)		(7)		(8)		(9)		(10)	
Variable	3 vs. 5		4 vs. 5		1 vs.4		3 vs. 4		1 vs.3	
	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.
DRSPP	0.102	1.107	0.241	1.272	-0.094	0.911	-0.134	0.870	0.045	1.046
	(0.58)		(0.24)		(0.64)		(0.78)		(0.80)	
Other Controls*	Yes		Yes		Yes		Yes		Yes	
Year-Fixed-Effect	Yes		Yes		Yes		Yes		Yes	
Property-Type-Effect	Yes		Yes		Yes		Yes		Yes	

* Other Controls include MTB, BLEV, SIZE, IO, ΔDRAWN, ROA, FFO, $BETA_{-1}$, ΔBETA,PAYOUT RAITIO, DIVIDEND YIELD, CREDIT/AT

Table 6
Cumulative Abnormal Returns around Dividend Announcement Date

This table reports cumulative abnormal returns (CAR) around dividend announcement date T_1. CARs are separately estimated from three event windows: (T_1 - 30, T_1 - 1), (T_1, T_1 + 1), and (T_1 + 2, T_1 + 30). A standard market model is used with the value-weighted Ziman REIT index being the market return index, and the estimation period spans from 250 to 10 days prior the announcement. Columns (1) and (4) reports the numbers of dividend announcements. Columns (2) and (5) reports CARs. Columns (3) and (6) report percentage of positive daily returns during each event window. Column (7) reports the difference of CARs between REITs with DRSPP and REITs without DRSPP. Columns 1-3 (4-7) report results based on REITs with (without) DRSPP. Stable regular dividend announcements in Panel A are defined as regular dividends paid at date t are the same as the most recent regular dividends. Regular dividend increase (decrease) announcements in Panel B (Panel C) are defined as regular dividends paid at date t are greater (less) than the most recent regular dividends. Extra dividend announcements in Panel E include the announcements of special dividends and irregular dividends. Increased (decreased) extra dividend announcements in Panel F (Panel G) are defined as extra dividends paid at date t are greater (less) than the most recent regular dividends. In bracket is t-stat based on standardized cross-sectional test.

Variable	REITs With DRSPP			REITs Without DRSPP			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	N	CAR_1	% of Returns > 0	N	CAR_2	% of Returns > 0	$CAR_2 – CAR_1$
Panel A. Stable Regular Dividend Announcements							
0 to +1	3,321	0.07	52%	2,329	0.10	53%	0.03
		(1.81)			(1.78)		(0.36)
-30 to -2		**-0.30**	48%		**-0.46**	45%	-0.16
		(-2.56)			**(-3.66)**		(-1.70)
2 to 30		-0.12	49%		0.37	52%	**0.49**
		(-1.19)			(1.63)		**(2.40)**
-30 to 30		**-0.37**	49%		-0.02	49%	0.35
		(-2.24)			(-0.79)		(0.61)
Panel B. Regular Dividend Increase Announcements							
0 to +1	837	**0.30**	59%	524	**0.73**	61%	**0.43**
		(4.80)			**(6.97)**		**(2.75)**
-30 to -2		-0.21	47%		**-0.53**	46%	-0.32
		(-1.29)			**(-2.81)**		(-0.58)
2 to 30		0.38	52%		-0.06	49%	-0.44
		(1.96)			(-0.40)		(-1.81)
-30 to 30		0.39	55%		0.12	48%	-0.27
		(1.54)			(-0.19)		(-1.55)
Panel C. Regular Dividend Decrease Announcements							
0 to +1	97	-0.48	45%	71	-1.12	42%	-0.64
		(-1.15)			(-0.87)		(-0.99)
-30 to -2		0.90	44%		**-4.09**	38%	-4.99
		(-0.49)			**(-2.41)**		(-1.46)
2 to 30		2.60	59%		-0.40	45%	-3.00
		(1.34)			(-0.43)		(-1.57)
-30 to 30		2.88	54%		**-5.90**	35%	**-8.78**
		(0.11)			**(-3.28)**		**(-2.48)**

Table 6 (Cont'd)

Variable	(1) N	(2) CAR_1	(3) % of Returns > 0	(4) N	(5) Ab. Returns	(6) CAR_2	(7) CAR_2-CAR_1
Panel D. Dividend Suspension Announcements							
0 to +1	20	-4.00	35%	59	-2.65	27%	1.35
		(-0.70)			(-1.95)		(0.87)
-30 to -2		-11.00	20%		**-6.75**	42%	4.25
		(-1.84)			**(-2.68)**		(0.50)
2 to 30		2.08	20%		8.16	39%	6.08
		(0.38)			(0.76)		(0.03)
-30 to 30		-12.33	25%		-1.48	39%	10.85
		(-1.71)			(-1.83)		(0.67)
Panel E. Extra Dividend Announcements							
0 to +1	101	**0.36**	62%	116	**2.57**	67%	**2.21**
		(2.37)			**(5.30)**		**(2.61)**
-30 to -2		0.90	53%		0.24	54%	-0.66
		(0.84)			(0.41)		(-0.10)
2 to 30		1.51	59%		1.00	53%	-0.51
		(1.31)			(1.13)		(-0.67)
-30 to 30		**2.85**	63%		**3.60**	59%	0.75
		(2.34)			**(2.86)**		(0.75)
Panel F. Increased Extra Dividend Announcements							
0 to +1	45	**0.80**	69%	66	**3.10**	71%	**2.30**
		(2.59)			**(5.27)**		**(2.17)**
-30 to -2		1.80	51%		2.69	59%	0.89
		(0.10)			(1.73)		(0.84)
2 to 30		1.22	62%		1.73	58%	0.51
		(1.47)			(1.21)		(0.34)
-30 to 30		**3.67**	69%		**7.32**	70%	**3.65**
		(2.20)			**(3.85)**		**(1.61)**
Panel G. Decreased Extra Dividend Announcements							
0 to +1	56	0.00	57%	50	**1.86**	62%	1.86
		(0.52)			**(2.08)**		(1.08)
-30 to -2		0.17	55%		-2.99	48%	-3.16
		(1.04)			(-1.50)		(-1.34)
2 to 30		1.74	57%		0.05	48%	-1.69
		(0.56)			(0.26)		(-0.73)
-30 to 30		2.19	59%		-1.31	44%	-3.50
		(1.23)			(-0.19)		(-1.08)

Table 7
Cumulative Abnormal Returns around Dividend Payment Date

This table reports cumulative abnormal returns (CAR) around dividend payment date T_2. CARs are separately estimated from three event windows: (T_2 - 10, T_2 - 1), (T_2, T_2 + 1), and (T_2 + 2, T_2 + 10). A standard market model is used with the value-weighted Ziman REIT index being the market return index, and the estimation period spans from 250 to 10 days prior the dividend payment date. Columns (1) and (4) reports the numbers of dividend announcements. Columns (2) and (5) reports CARs. Columns (3) and (6) report percentage of positive daily returns during each event window. Column (7) reports the difference of CARs between REITs with DRSPP and REITs without DRSPP. Columns 1-3 (4-7) report results based on REITs with (without) DRSPP. Stable regular dividend announcements in Panel A are defined as current regular dividends are the same as the most recent regular dividends. Regular dividend increase (decrease) announcements in Panel B (Panel C) are defined as current regular dividends paid are greater (less) than the most recent regular dividends. Extra dividend announcements in Panel D include the announcements of special dividends and irregular dividends. Increased (decreased) extra dividend announcements in Panel E (Panel F) are defined as current extra dividends paid are greater (less) than the most recent regular dividends. In bracket is t-stat based on standardized cross-sectional test.

Variable	REITs With DRSPP			REITs Without DRSPP			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	N	CAR_1	% of Returns > 0	N	CAR_2	% of Returns > 0	CAR_2 - CAR_1
Panel A .Stable Regular Dividend Announcements							
0 to +1	3,217	**0.18**	53%	2,252	0.09	50%	-0.09
		(4.21)			(1.50)		(-1.36)
-10 to -1		**-0.15**	48%		-0.10	48%	0.05
		(-2.60)			(-1.12)		(0.67)
2 to 10		**-0.24**	45%		**-0.46**	45%	-0.22
		(-3.37)			**(-4.59)**		(-1.77)
-10 to 10		**-0.21**	48%		-0.46	46%	-0.25
		(-2.60)			(-3.41)		(-1.38)
Panel B. Regular Dividend Increase Announcements							
0 to +1	806	**0.23**	54%	506	0.02	49%	**-0.21**
		(3.65)			(0.26)		**(-2.13)**
-10 to -1		-0.17	48%		**-0.34**	44%	-0.17
		(-1.10)			**(-2.10)**		(-0.91)
2 to 10		-0.28	47%		**-0.78**	40%	-0.50
		(-1.77)			**(-4.13)**		(-1.77)
-10 to 10		-0.22	48%		**-1.10**	40%	**-0.88**
		(-0.97)			**(-4.39)**		**(-2.61)**
Panel C. Regular Dividend Decrease Announcements							
0 to +1	95	0.10	52%	70	0.62	53%	0.52
		(-0.29)			(1.05)		(0.85)
-10 to -1		1.52	51%		0.01	50%	-1.51
		(0.83)			(0.06)		(-1.29)
2 to 10		-0.16	45%		-0.87	47%	-0.71
		(0.29)			(-0.88)		(-0.62)
-10 to 10		1.46	53%		-0.24	49%	-1.70
		(0.68)			(-0.22)		(-0.93)

Table 7 (Cont'd)

Variable	(1) N	(2) CAR_1	(3) % of Returns > 0	(4) N	(5) CAR_2	(6) % of Returns > 0	(7) CAR_2 - CAR_1
Panel D. Extra Dividend Announcements							
0 to +1	95	**0.76**	58%	122	0.55	54%	-0.21
		(3.34)			(1.53)		(-0.46)
-10 to -1		0.37	50%		-0.76	49%	-1.13
		(0.18)			(-0.81)		(-1.24)
2 to 10		**-0.47**	31%		-1.04	36%	-0.57
		(-2.58)			(-1.63)		(-0.58)
-10 to 10		0.63	46%		-1.25	48%	-1.88
		(-0.68)			(-1.20)		(-1.19)
Panel E. Increased Extra Dividend Announcements							
0 to +1	43	**1.25**	67%	69	0.51	51%	-0.74
		(3.34)			(0.44)		(-1.33)
-10 to -1		-0.52	41%		-0.76	52%	-0.24
		(-0.40)			(-0.43)		(-0.18)
2 to 10		**-1.67**	27%		-0.46	38%	1.21
		(-2.08)			(-0.70)		(1.04)
-10 to 10		-0.96	45%		-0.72	49%	0.24
		(-0.49)			(-0.70)		(0.15)
Panel F. Decreased Extra Dividend Announcements							
0 to +1	52	0.34	50%	53	0.61	58%	0.27
		(1.30)			(1.78)		(0.40)
-10 to -1		1.09	57%		-0.76	45%	-1.85
		(0.57)			(-0.76)		(-1.48)
2 to 10		0.51	33%		-1.80	34%	-2.31
		(-1.59)			(-1.80)		(-1.43)
-10 to 10		1.93	46%		-1.94	47%	-3.87
		(-0.47)			(-1.01)		(-1.39)

Table 8
Logistic Regression of REIT Payout Choice

This table reports estimation from logistic regression of REIT payout choice. We model the logit of the probability of REITs that pay stable regular dividends in column (1), REITs that decrease regular dividends in column (2), REITs that increase regular dividends in column (3), REITs that pay extra dividends in column (4), and REITs that repurchase shares in column (5) during each of the years, respectively. We predict the probability of REITs that pay stable regular dividends (decrease regular dividends, increase regular dividends, pay extra dividends, or repurchase shares) taking on a value of 1, rather than the probability of REITs that do not pay stable regular dividends (do not decrease regular dividends, do not increase regular dividends, do not pay extra dividends, or do not repurchase shares) taking on a value of 0.Independent variables are defined in detail in Appendix A. All the independent variables except DRSPP are standardized. The corresponding odds ratios (O.R.) are reported. The total number of observations for this analysis is 1,828. Year-fixed effects and property-type fixed effects are also included. In bracket is the P-value. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)		(2)		(3)		(4)		(5)	
	Stable Reg. Div.		Reg. Div. Decrease		Reg. Div. Increase		Extra Div.		Share Repurchase	
	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.	Coef.	O.R.
DRSPP	-0.072	0.931	0.322**	1.380	0.382***	1.464	-0.128	0.880	-0.134	0.875
	(0.60)		(0.05)		(0.00)		(0.54)		(0.27)	
MTB	-0.242	0.785	-2.516***	0.081	0.082	1.086	-0.464	0.629	-2.005***	0.135
	(0.54)		(0.00)		(0.52)		(0.36)		(0.00)	
BLEV	-1.593**	0.203	-0.044	0.957	-0.009	0.991	-3.242***	0.039	-0.531	0.588
	(0.03)		(0.97)		(0.99)		(0.00)		(0.48)	
SIZE	-0.281**	0.755	-0.224*	0.800	0.669***	1.951	0.442***	1.555	0.603***	1.827
	(0.02)		(0.10)		(0.00)		(0.01)		(0.00)	
IO	0.016	1.016	-0.121	0.886	0.355***	1.426	-0.267*	0.766	-0.017	0.984
	(0.88)		(0.33)		(0.00)		(0.09)		(0.86)	
∆DRAWN	-0.024	0.977	0.000	1.000	0.020	1.020	-0.122	0.885	0.006	1.006
	(0.71)		(1.00)		(0.71)		(0.20)		(0.92)	
ROA	-0.229	0.795	0.621***	1.860	-0.449**	0.638	1.496***	4.462	-0.197	0.821
	(0.27)		(0.00)		(0.04)		(0.00)		(0.35)	
FFO	0.486*	1.626	-1.054***	0.349	1.623***	5.070	-1.433***	0.239	0.078	1.081
	(0.10)		(0.00)		(0.00)		(0.00)		(0.78)	
$BETA_{-1}$	-0.138	0.871	0.308***	1.360	-0.177*	0.838	-0.015	0.985	-0.347***	0.707
	(0.22)		(0.01)		(0.08)		(0.93)		(0.00)	
∆BETA	-0.152*	0.859	0.141*	1.152	-0.032	0.968	-0.205*	0.815	-0.146**	0.864
	(0.08)		(0.08)		(0.67)		(0.10)		(0.03)	
PAYOUT RATIO	0.092	1.096	0.135	1.145	0.503***	1.654	0.145	1.156	-0.006	0.994
	(0.39)		(0.46)		(0.00)		(0.27)		(0.97)	
DIVIDEND YIELD	0.586***	1.797	0.102	1.107	0.279***	1.322	-0.256*	0.774	-0.191***	0.826
	(0.00)		(0.16)		(0.00)		(0.07)		(0.01)	
CREDIT/AT	-0.077	0.926	0.110	1.116	0.530***	1.699	0.056	1.058	0.067	1.070
	(0.51)		(0.42)		(0.00)		(0.75)		(0.52)	
Year-Fixed-Effect	Yes		Yes		Yes		Yes		Yes	
Property-Type-Effect	Yes		Yes		Yes		Yes		Yes	
Obs.	1,828		1,828		1,828		1,828		1,828	
R^2	0.09		0.13		0.26		0.07		0.10	

Table 9

Cumulative Abnormal Returns around Dividend Announcement Date - Alternative Definition of Payout Choice

This table is similar to Table 6 and reports cumulative abnormal returns (CAR) around dividend announcement date t; but uses alternative definition of payout choice. Stable regular dividend announcements in Panel A are defined as regular dividends paid at quarter *Q* are the same as the regular dividends paid at the same quarter of last year, or quarter (*Q* - 4). Regular dividend increase (decrease) announcements in Panel B (Panel C) are defined as regular dividends paid at quarter *Q* are greater (less) than the regular dividends paid at the same quarter of last year. CARs are separately estimated from three event windows: (*t* - 30, *t* - 1), (*t*, *t* + 1), and (*t* + 2, *t* + 30). A standard market model is used with the value-weighted Ziman REIT index being the market return index, and the estimation period spans from 250 to 10 days prior the announcement. Columns (1) and (4) reports the numbers of dividend announcements. Columns (2) and (5) reports CARs. Columns (3) and (6) report percentage of positive daily returns during each event window. Column (7) reports the difference of CARs between REITs with DRSPP and REITs without DRSPP. Columns 1-3 (4-7) report results based on REITs with (without) DRSPP. In bracket is t-stat based on standardized cross-sectional test.

Variable	REITs With DRSPP			REITs Without DRSPP			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	N	CAR_1	% of Returns > 0	N	CAR_2	% of Returns > 0	CAR_2- CAR_1
Panel A. Stable Regular Dividend Announcements							
0 to +1	1,333	0.10	52%	1,024	**0.19**	56%	0.09
		(1.83)			**(2.44)**		(1.08)
-30 to -2		-0.34	49%		**-0.64**	43%	**-0.30**
		(-1.87)			**(-3.23)**		**(-2.09)**
2 to 30		-0.25	48%		0.37	53%	**0.62**
		(-1.57)			(1.52)		**(2.13)**
-30 to 30		-0.50	48%		-0.09	49%	0.41
		(-1.98)			(-0.33)		(0.66)
Panel B. Regular Dividend Increase Announcements							
0 to +1	2,361	**0.13**	54%	1,366	**0.26**	56%	0.13
		(3.09)			**(4.46)**		(1.86)
-30 to -2		**-0.32**	47%		**-0.56**	46%	-0.24
		(-2.42)			**(-3.88)**		(-1.33)
2 to 30		0.05	50%		-0.08	50%	-0.13
		(0.36)			(-0.29)		(-0.20)
-30 to 30		-0.18	51%		-0.42	48%	-0.24
		(-0.72)			(-1.79)		(-1.13)
Panel C. Regular Dividend Decrease Announcements							
0 to +1	319	-0.05	49%	181	-0.29	46%	-0.24
		(-0.91)			(-0.55)		(-1.33)
-30 to -2		1.56	53%		-1.00	48%	-2.56
		(1.78)			(-1.36)		(-1.69)
2 to 30		1.20	58%		2.00	52%	0.80
		(1.25)			(1.63)		(0.17)
-30 to 30		2.62	58%		0.92	49%	-1.7
		(1.74)			(-0.17)		(-1.49)

Table 10
Cumulative Abnormal Returns around Dividend Payment Date
- Alternative Definition of Payout Choice

This table is similar to Table 7 and reports cumulative abnormal returns (CAR) around dividend payment date *T*, but uses alternative definition of payout choice. Stable regular dividend announcements in Panel A are defined as regular dividends paid at quarter *Q* are the same as the regular dividends paid at the same quarter of last year, or quarter (*Q* - 4). Regular dividend increase (decrease) announcements in Panel B (Panel C) are defined as regular dividends paid at quarter *Q* are greater (less) than the regular dividends paid at the same quarter of last year. CARs are separately estimated from three event windows: (*T* - 10, *T* - 1), (*T*, *T* + 1), and (*T* + 2, *T* + 10). A standard market model is used with the value-weighted Ziman REIT index being the market return index, and the estimation period spans from 250 to 10 days prior the announcement. Columns (1) and (4) reports the numbers of dividend announcements. Columns (2) and (5) reports CARs. Columns (3) and (6) report percentage of positive daily returns during each event window. Column (7) reports the difference of CARs between REITs with DRSPP and REITs without DRSPP. Columns 1-3 (4-7) report results based on REITs with (without) DRSPP. In bracket is t-stat based on standardized cross-sectional test.

Variable	REITs With DRIP			REITs Without DRIP			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	N	CAR_1	% of Returns > 0	N	CAR_2	% of Returns > 0	CAR_2 - CAR_1
Panel A. Stable Regular Dividend Announcements							
0 to +1	1,401	**0.26**	54%	1,054	0.09	51%	-0.17
		(3.83)			(0.81)		(-1.54)
-10 to -1		-0.16	49%		-0.01	50%	0.15
		(-1.44)			(-0.18)		(0.88)
2 to 10		-0.17	46%		-0.47	45%	-0.30
		(-2.38)			(-2.59)		(-1.63)
-10 to 10		-0.07	48%		-0.38	47%	-0.31
		(-1.24)			(-1.63)		(-1.12)
Panel B. Regular Dividend Increase Announcements							
0 to +1	2,401	**0.17**	54%	1,402	0.07	49%	-0.10
		(4.26)			(1.31)		(-1.63)
-10 to -1		-0.13	48%		-0.26	47%	-0.13
		(-2.71)			(-2.42)		(-1.01)
2 to 10		-0.19	46%		-0.61	42%	-0.42
		(-2.31)			(-5.04)		(-2.96)
-10 to 10		-0.15	48%		-0.78	45%	-0.63
		(-2.09)			(-4.75)		(-3.24)
Panel C. Regular Dividend Decrease Announcements							
0 to +1	326	-0.01	48%	190	0.33	53%	0.34
		(-1.13)			(1.64)		(0.94)
-10 to -1		0.64	53%		0.87	49%	0.23
		(0.62)			(1.47)		(0.32)
2 to 10		-0.74	45%		0.26	48%	1.00
		(-0.72)			(0.11)		(1.41)
-10 to 10		-0.10	50%		1.46	52%	1.56
		(-0.37)			(1.69)		(1.58)

Barometer for Municipal Community Real Estate

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The purpose of this study is to show how local authorities (municipalities) deal with their community real estate. The study is an annually recurring research: every year since 2008 (except for 2013), Dutch municipalities have been asked to complete a questionnaire about how they manage their real estate. With these results it is possible to perform quantitative analyses on both trends and the current situation. The questionnaire responses have led to the following conclusions: (1) Half of the municipalities has a policy but takes few risk measures, (2) Withdrawing local government, (3) Management and operations most outsourced tasks, (4) Obstacles remain unchanged, (5) Cost reduction most relevant policy theme since 2009, (6) Relevance of some policy themes depends on municipality size, (7) More real estate is offered, smaller percentage is sold, 8) More FTEs for real estate management, especially executive tasks and (9) Conscious focus on quality. Dutch municipalities tune their new developments of the municipal real estate policy to the results of the Barometer for Municipal Community Real Estate. This leads to a further development of professionalism of the municipal real estate portfolios. The contribution to science is showing patterns of community real estate management at Dutch municipalities. A longitudinal study of this size on this subject is unique in The Netherlands.

Keywords: Community Real Estate, Dutch Municipalities, Local Government, Real Estate Management

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Barometer for Municipal Community Real Estate

Developments from 2008 until 2015

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Abstract

The purpose of this study is to show how local authorities (municipalities) deal with their community real estate. The study is an annually recurring research: every year since 2008 (except for 2013), Dutch municipalities have been asked to complete a questionnaire about how they manage their real estate. With these results it is possible to perform quantitative analyses on both trends and the current situation.

The questionnaire responses have led to the following conclusions: (1) Half of the municipalities has a policy but takes few risk measures, (2) Withdrawing local government, (3) Management and operations most outsourced tasks, (4) Obstacles remain unchanged, (5) Cost reduction most relevant policy theme since 2009, (6) Relevance of some policy themes depends on municipality size, (7) More real estate is offered, smaller percentage is sold, 8) More FTEs for real estate management, especially executive tasks and (9) Conscious focus on quality.

Dutch municipalities tune their new developments of the municipal real estate policy to the results of the Barometer for Municipal Community Real Estate. This leads to a further development of professionalism of the municipal real estate portfolios.

The contribution to science is showing patterns of community real estate management at Dutch municipalities. A longitudinal study of this size on this subject is unique in The Netherlands.

Introduction

This article lists the results of the *Barometer for Municipal Community Real Estate 2015* study. The study was carried out by the Professorship Public Real Estate of the NoorderRuimte Centre of Research and Innovation for Built Environment, Hanze University of Applied Sciences. For the seventh time Dutch municipalities have completed the Barometer for Municipal Community Real Estate questionnaire. 227 respondents *(51%)* opened the questionnaire and 173 municipalities *(39%)* then completed the list in whole or in part. As a result, the response rate may differ per question. The specific number of respondents is indicated at each question.

Methodology

Every year since 2008 (except for 2013), municipalities have been asked to complete a questionnaire about how they manage their real estate. With these results it is possible to perform quantitative analyses on both trends and the current situation. The questionnaire was sent by email to all municipalities. On April 15th (2015) the invitations to complete the questionnaire were sent, on May 11th (2015) a reminder was sent and starting on 18 May municipalities were contacted by phone. The questionnaire was available to participants for a total of 7 weeks.

	All Dutch municipalities (n=393)	**Response** (n=81)
Small municipalities (<20.000 citizens)	32%	25%
Medium sized municipalities (20.000 – 50.000 citizens)	49%	48%
Large municipalities (50.000 ≤ citizens)	19%	27%

Table 1: Dutch municipalities and response rate

Definition of community real estate

This year again, the questionnaire saw the change and addition of several questions. One of the new questions concerned the definition of respondents of community real estate. The 52 open answers to this question paint the following picture. A large part of the municipalities *(85%)* indicated in their description of community real estate that it revolves around the function and/or use of real estate, or they named examples of this to establish a description. More than half of the respondents mentioned ‘community’ in their description of community real estate. However, the combination ‘community real estate’ was obviously not counted. ‘Community’ was mainly combined with (community) function, (community) goal and (community) activities. Policy and goals were used by a quarter of the municipalities to describe community real estate, and in half of those cases these terms were mentioned together (i.e. ‘policy goals’). A small number of municipalities *(13%)* indicated that community real estate is real estate that is the property of municipalities, and only one municipality mentioned (community) return in its description.

Vision and policy

More than half of the municipalities has a maintenance policy *(76%)*, municipal real estate policy *(63%)* accommodation policy *(62%)* and/or lease policy *(54%)*. A surprisingly low percentage can be seen for the number of municipalities that has a risk management real estate policy: this has only been established in 25% of the municipalities. However, 29% are currently working on drawing up such a policy. Also see figure 1.

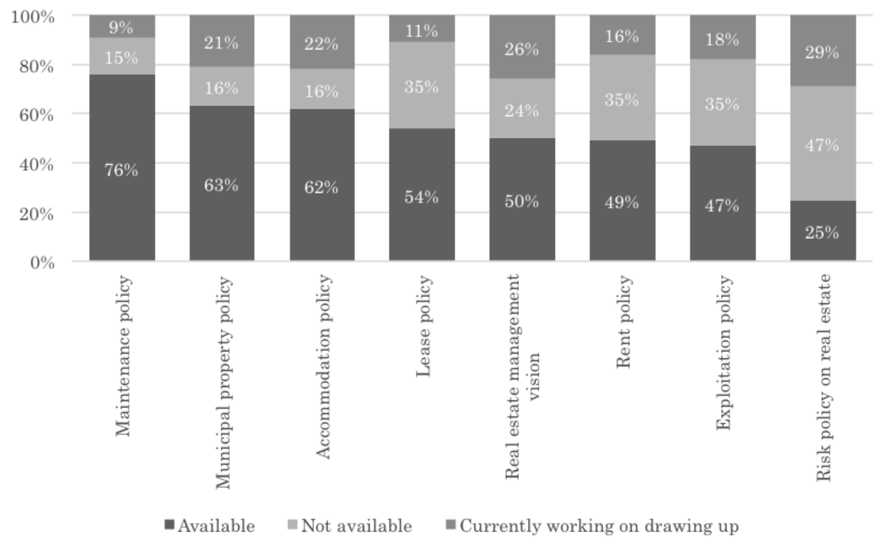

Figure 1: Vision and policy (n=76)

Generally it is mainly the medium sized municipalities *(46%)* that have a policy. A maintenance policy is the policy that is most present among small *(80%)*, medium sized *(77%)* and large municipalities *(96%)*. What is especially striking are the high percentages among large municipalities: (more than) half of these municipalities has one or more of the policies or visions mentioned (see table 2).

	Small municipalities	**Medium sized municipalities**	**Large municipalities**
Maintenance policy	80%	77%	96%
Municipal real estate policy	40%	74%	86%
Accommodation policy	33%	74%	86%
Lease policy	53%	45%	82%
Real estate management vision	27%	45%	86%
Rent policy	40%	52%	68%
Exploitation policy	20%	45%	77%
Risk management real estate policy	20%	13%	50%

Table 2: Policies according to municipality size

Risk management

Last year 18 municipalities *(44%)* indicated that they had taken measures concerning financial risks of community real estate. This year the questionnaire included items asking more specific information on these measures. Currently 36% of the municipalities *(n=39)* has not established any measures, and 10% is currently drawing up measures. Almost a quarter *(23%)* has included a risk section in their real estate policy, while the rest *(41%)* assumes a following position through financial monitoring such as quarterly and monthly reports. Furthermore, 10% indicated that they have taken other measures concerning financial risks.

Core tasks

Figure 2 shows which tasks are regarded as core tasks concerning community real estate *(n=52)* within municipalities. *Management and operations* and *Development planning* were most commonly mentioned as core tasks.

Figure 2: Tasks regarded as core tasks (n=52)

Tasks that have come to be regarded more as core tasks compared to last year are initiating projects *(+8%)* and development planning *(+3%)*. With these changes, the top 3 looks a little different this year: only management and operations has maintained its place. The tasks that dropped most substantially are at the bottom of the list and are appointing locations *(-22%)* and project and process management *(-16%)*.

From 2008 all tasks mentioned have been regarded less and less as core tasks within municipalities concerning community real estate. The figure below (3, with a trend line) visualises this trend.

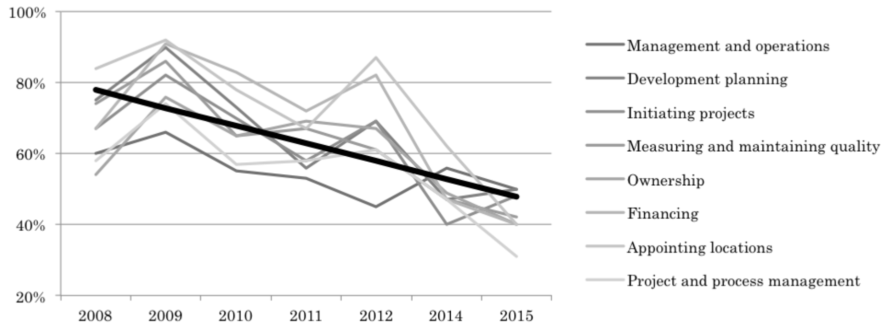

Figure 3: Trends in vision on municipal core tasks

All tasks are seen as core tasks for community real estate most by large municipalities (see table 3). It is true for five core tasks that the larger the municipality, the more it is seen as a core task: development planning, initiating projects, measuring and maintaining quality, financing and appointing locations. Among small municipalities the percentages are generally lower this year than last year. In 2012 they were lower than in 2014 as well. Save for some exceptions, this seems to be fairly consistent for medium sized municipalities, while among large municipalities an increase can be observed between 2012 and 2015.

	Small municipalities			**Medium sized municipalities**			**Large municipalities**		
	2012	*2014*	*2015*	*2012*	*2014*	*2015*	*2012*	*2014*	*2015*
Management and operations	32%	56%	53%	42%	57%	35%	26%	56%	65%
Development planning	23%	63%	40%	55%	40%	45%	23%	44%	65%
Initiating projects	26%	38%	40%	47%	43%	45%	26%	33%	59%
Measuring and maintaining quality	23%	38%	20%	55%	43%	45%	23%	78%	59%
Ownership	23%	50%	33%	50%	47%	30%	27%	56%	59%
Financing	30%	56%	27%	44%	43%	45%	26%	44%	47%
Appointing locations	30%	56%	20%	44%	63%	35%	26%	67%	65%
Project and process management	27%	44%	20%	47%	50%	20%	27%	44%	53%

Table 3: Tasks regarded as core tasks – according to municipality size and years

71% of the municipalities *(n=46)* indicated that they do not outsource any tasks and are not planning to do so. Plans to outsource tasks mainly focus on the fields of management and operations *(33%)*, development planning *(23%)*, ownership *(22%)* and project and process management *(22%)*. Management and operations is also the core task that is currently being outsourced most, at 24%.

Municipalities indicated that outsourcing is currently not opportune, but that they would not exclude it when it is more useful or wise and that they are investigating whether ownership, management and operations of several clusters can be outsourced. Some municipalities cannot answer this question straightforwardly, because in certain locations outsourcing is applied for, for example, operating or management while in other locations it has not (yet) been applied because they are currently working on establishing a policy. Furthermore, the municipalities concretely mention property, (technical) management, operating, (direction of) multiple-year maintenance and sustainability.

If municipalities are considering outsourcing real estate tasks, they mainly *(43%, n=44)* consider privatization (company, foundation, corporation). Last year, municipalities mainly considered cooperation with other municipalities *(71%)*, which has almost halved this year to 36%. Other organisational forms mentioned by municipalities *(23%)* are cooperation with citizens (initiatives), transfer to community initiators and operating by foundations or associations. In addition, municipalities indicated that they are currently undergoing reorganisation, are establishing a real estate company (/ internal privatization / independent real estate company), and are busy making an inventory of this process (including much hiving off). Finally they also mention that the organisational form for outsourcing will depend on the specific situation: a different partner per situation might be desirable.

Obstacles

The lack of a rent price that covers the costs was mentioned most often *(20%)* as an obstacle when carrying out community real estate tasks, followed by low occupancy rates *(18%)* and fragmentation of tasks *(17%)*. Compared to last year, few (major) differences can be observed (figure 4).

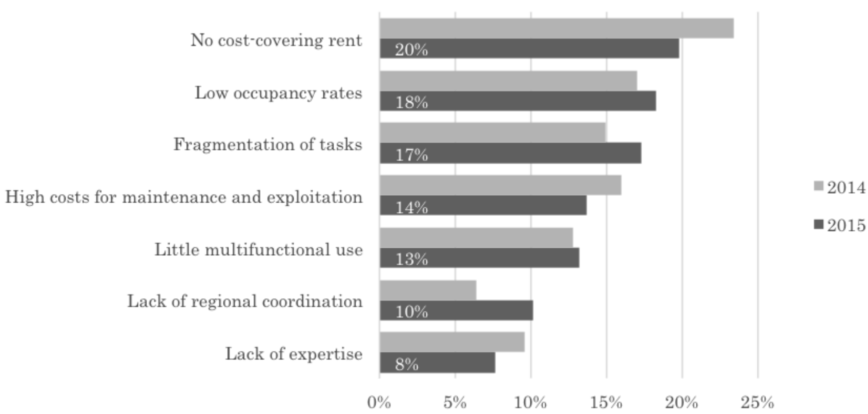

Figure 4: Obstacles when carrying out community real estate tasks (n=52)

About half of the municipalities that indicated that they experience the lack of a rent price that covers the costs *(n=39)* as an obstacle.

Other obstacles mentioned by the respondents are the decreasing demand leading to oversupply of community real estate, the traditional separation between the various policy fields and legislation (such as the Education Act), the historic growth in diversity of property relations, prices and subsidising agreements (no clear line), the vagueness of terminology, the conservation of facilities in depopulating areas, the threat of corporate tax for renter activities (for community use) and the fragmentation of expertise.

Relevant policy themes

The most relevant real estate related policy theme this year is again cost reduction *(89%)*. Since 2009 this theme has occupied the number one spot. Last year it was followed closely by the separation of subsidy for housing and operating expenses with 92%, which is also in second place this year. However, its relevance has dropped a little compared to last year *(61%)* and it shares the second place now with increase of returns *(61%)*.

Another striking fact when comparing the results of this year to those of 2014 is that all policy themes mentioned have become less relevant (also see figure 5). The following themes have seen the largest decrease:

- Protection of the facility level in small centres *(-48%)*
- Improvement of quality and management *(-35%)*
- Development of integral accommodation policies *(-33%)*
- Protection of the facility level in neighbourhoods and districts *(-32%)*
- Separation of subsidy for housing and operating expenses *(-31%)*

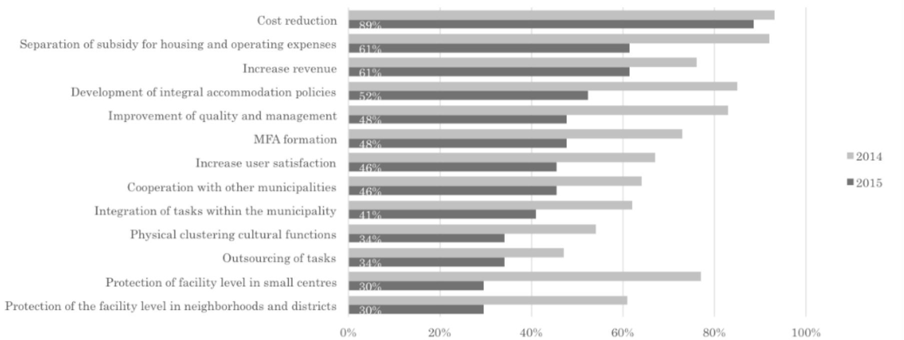

Figure 5: Relevancy of policy themes (n=44)

Other policy themes that are (also) relevant for municipalities *(14%)* are portfolio management, measurement of community performance / social return on investment, sustainability and the introduction of rent prices that cover expenses combined with the reduction of the number of objects in the portfolio while at the same time using objects to realise policy goals.

When ordering the relevance of the policy themes according to municipality size, we see that cost reduction is on top for all three municipality sizes (table 4). For the improvement of policy quality, the integration of tasks in the municipality and the physical clustering of cultural functions, the trend is that the larger the municipality is, the more relevant these themes are. The reverse applies to MFA formation: this is more relevant to small municipalities *(73%)* than to medium sized *(50%)* or large *(27%)* municipalities. For development of an integral accommodation policy, practically no difference can be observed between small, medium sized and large municipalities.

	Small municipalities (n=11)	**Medium sized municipalities (n=18)**	**Large municipalities (n=15)**
Cost reduction	91%	83%	93%
Separation of subsidy for housing and operating expenses	46%	78%	53%
Increase revenue	55%	56%	73%
Development of integral accommodation policies	55%	50%	53%
Improvement of quality and management	27%	44%	67%
MFA formation	73%	50%	27%
Increase user satisfaction	36%	39%	60%
Cooperation with other municipalities	46%	56%	33%
Integration of tasks within the municipality	18%	39%	60%
Physical clustering cultural functions	0%	39%	53%
Outsourcing of tasks	18%	39%	40%
Protection of facility level in small centres	46%	44%	0%
Protection of the facility level in neighborhoods and districts	18%	39%	27%

Table 4: Relevancy of policy themes according to municipality size

Selling community real estate

The policy theme section already shows that cost reduction is the most relevant theme for most municipalities. 74% *(n=39)* indicated that for them, selling community real estate is a means to control expenses. This is almost equal to last year: in 2014 76% of the municipalities confirmed that this was the case for them. The number of community real estate objects on offer varied between 0 and 60 in 2014 with an average of 7.2. The number of objects that was actually sold varied between 0 and 11 with an average of 1.5. Compared to the year before that, the number of transactions had increased slightly (1.2 in 2013). The number of objects on offer was more than two and a half times higher (on average 2.7 in 2013). This means that the percentage of objects sold compared to the number of objects on offer halved from 44% to 21%.

Municipal organisation

This year an average of 14.9 FTEs (full-time equivalents) were allocated to real estate management activities. This is almost 3.5 times as much as last year: that was the first year we asked for this statistic and the average then was 4.4 FTE. Table 5 distinguishes FTEs according to municipality size. It shows that large municipalities employ the most FTEs for real estate management, followed by small municipalities. Medium sized municipalities have the least FTEs, on average, for real estate management activities.

	n	Average	Min	Max
Small municipalities	*20*	15	1	62
Medium-sized municipalities	*39*	8	0	25
Large municipalities	*21*	24	0	80

Tabel 5: FTEs allocated to real estate management activities (n-40)

Municipalities were also asked to indicate in percentages how the number of FTEs are divided within their organisation. On average, 56% is dedicated to executive tasks. 23% of the employees are policy-makers, 13% is operating on management level and the other 10% to 'other' tasks. This shows that municipalities work mostly on an executive level. Per FTE for policy and management, municipalities employ an average of 1.5 FTE for executive tasks.

Community real estate tasks are commonly organised and carried out centrally within municipalities *(55%)*. Over the past years it can be seen that this form of organisation and execution has been the most commonly applied form (see figure 6) and that centralised organisation and decentralised execution decreased from 24% in 2012 to 14% in 2015. The variant in which all tasks are decentralised doubled between 2012 and 2014 for a number of applications, but decreased slightly in 2015.

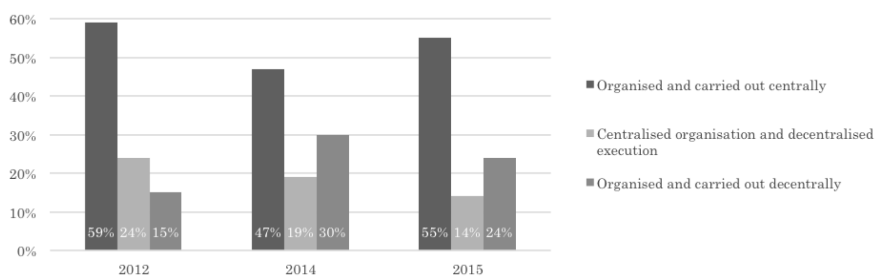

Figure 6: Organisation and execution of the community real estate (n=42)

For some municipalities tasks are still fragmented, or it is unclear after a reorganisation what the organisation and execution of tasks looks like. There is also one municipality that has a system in which a number of tasks have a centralised organisation and execution, while a number of other tasks have a decentralised organisation and centralised execution.

If we look at the organisation and execution of community real estate tasks according to municipality size (see table 6), we see that regardless of size centralised organisation and execution is employed most commonly. Centralised organisation and decentralised execution is carried out mainly among medium sized municipalities (25%), and it is predominantly the small and the large municipalities that employ a decentralised organisation and execution system *(27% and 31%, respectively)*. This is about the same as last year.

	Small municipalities *(n=11)*	**Medium-sized municipalities** *(n=16)*	**Large municipalities** *(n=14)*
Organized and carried out centrally	64%	38%	71%
Centralised organisation and decentralised execution	9%	25%	0%
Organized and carried out decentrally	27%	31%	14%
Otherwise organised	0%	6%	14%

Table 6: Organisation and execution of community real estate tasks according to municipality size

More than half of the municipalities *(61%)* have plans to organise real estate tasks differently in the future than they currently do *(n=41)*. 27% of the municipalities that have this intention chose for centralised organisation and execution. This is only half of last year, when 56% chose for this system. More than half *(54%)* chose for another form from the aforementioned three: integrating more internally, designing real estate companies, organising teams for real estate, and ensuring less fragmentation. A small number of municipalities indicated that (partly) outsourcing is a possibility, but most do not yet know how tasks will be organised in the future. Most municipalities *(68%)* want to introduce the changes in the short term (1 to 2 years). About half *(n=41)* of the municipalities expect that the number of FTEs allocated to real estate management activities will change during the next year, while the other half do not expect any change.

Quality measurements

Like in all previous years, municipalities were asked how often they measured technical quality, user satisfaction and the contribution of community real estate to policy goals. The results can be found in figure 7.

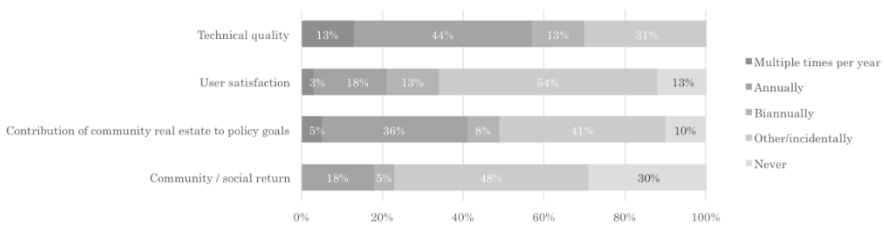

Figure 7: Quality measurements at municipalities in 2015 (n=40)

Table 7 and figure 8 provide an overview of the number of municipalities (in %) that have measured technical quality, user satisfaction and the contribution of community real estate to policy goals in previous years. These overviews combine the answers ‘multiple times per year’, ‘annually’, ‘biannually’ and ‘other/incidentally’ because they only indicate that the elements mentioned are being measured. This year was the first time that the municipalities were asked how often they measure community / social return: 70% of the municipalities indicate that they measure this.

	2008	2009	2010	2011	2012	2014	2015
Technical quality	86%	90%	88%	73%	86%	98%	100%
User satisfaction	70%	70%	60%	83%	47%	61%	87%
Contribution of community real estate to policy goals	71%	60%	30%	79%	33%	56%	90%
Community / social return	-	-	-	-	-	-	70%

Table 7: Quality measurements at municipalities over the years

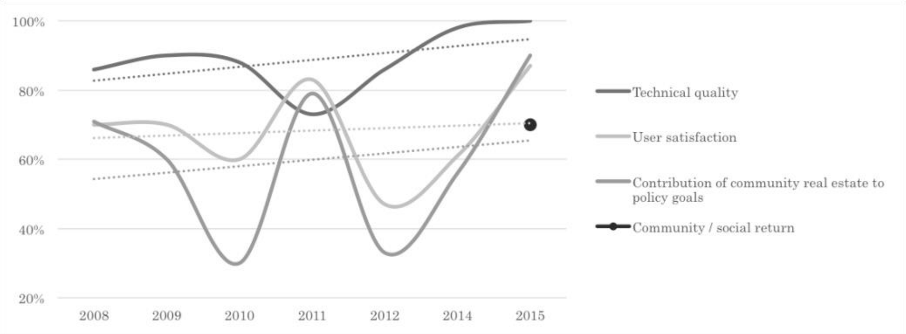

Figure 8: Quality measurements at municipalities

Compared to last year, all three elements have been measured more: the number of municipalities that measure technical quality is currently 100%. The number of municipalities that measure user satisfaction increased by 26%, while the largest increase can be observed with the number of municipalities that measure the contribution of community real estate to policy goals: compared to last year 34% more municipalities indicated that they measure this. The measurement of community return cannot be compared to last year, because this is the first year that the municipalities were asked for this statistic.

Conclusions

In 2015 the Barometer for Community Real Estate was carried out for the seventh time among municipalities in the Netherlands. This year 51% of the 393 municipalities opened the questionnaire and 173 municipalities *(39%)* completed the questionnaire in whole or in part. The ratio for small, medium sized and large municipalities in the response group is fairly representative for all municipalities in the Netherlands. The questionnaire responses have led to the following conclusions.

Half of the municipalities has a policy but takes few risk measures

About half of all municipalities have a maintenance policy, municipal real estate policy, accommodation policy, rental policy, vision of real estate management, a rent price policy and/or an operating policy. An exception is risk management: only a limited number of municipalities have established proactive measures concerning financial risks of community real estate. A larger number of municipalities takes measures through financial monitoring, while almost half of the municipalities has no measures concerning community real estate.

Withdrawing local government

Various tasks have been regarded less and less by municipalities as municipal core tasks concerning community real estate. In 2008 80% of the municipalities regarded the tasks as municipal core tasks, which has dropped to 50% in 2015. This leads to the conclusion that municipalities in the Netherlands may be withdrawing.

Management and operations most outsourced tasks

Almost three quarters of the municipalities do not want to outsource tasks and are not planning to do so. Management and operations is the core task that is currently being outsourced the most and of which the intentions to outsource it are strongest. For municipalities, outsourcing in this case mainly means privatization.

Obstacles remain unchanged

Half of the municipalities face obstacles when carrying out community real estate tasks. Compared to last year, few (large) differences can be observed. The three most common obstacles are the lack of a rent price that covers expenses, low utilisation rates and the fragmentation of tasks. About half of the municipalities that experience the lack of a rent price that covers expenses as an obstacle have a municipal real estate policy and/or a rental policy.

Other obstacles mentioned by respondents are the decreasing demand leading to oversupply of community real estate, the traditional separation between the various policy fields and legislation (such as the Education Act), the historic growth in diversity of property relations, prices and subsidising agreements (no clear line), the vagueness of terminology, the conservation of facilities in depopulating areas, the threat of corporate tax for renter activities (for community use) and the fragmentation of expertise.

Cost reduction most relevant policy theme since 2009

The most relevant real estate related policy theme is again cost reduction. Since 2009 this theme has occupied the number one spot, followed this year by the separation of subsidy for housing and operating expenses. What is striking when comparing the results of this year to those of 2014 is that all policy themes mentioned have become less relevant. The strongest decrease of relevance can be seen with protection of the facility level in small centres, improvement of policy quality, development of integral accommodation policies, protection of the facility level in neighbourhoods and districts, and the separation of subsidy for housing and operating expenses.

Relevance of some policy themes depends on municipality size

Cost reduction is the most relevant topic for small, medium sized and large municipalities. For the improvement of policy quality, the integration of tasks in the municipality and the physical clustering of cultural functions, the trend is that the larger the municipality is, the more relevant these themes are. The reverse applies to MFA formation: this is more relevant to small municipalities than to medium sized or large municipalities. For development of an integral accommodation policy, practically no difference can be observed between small, medium sized and large municipalities.

More real estate is offered, smaller percentage is sold

Three quarters of the municipalities regard selling community real estate as a means to control expenses. In that light they offered 7.2 objects on average on 2014, of which 1.5 on average were sold (21%). The year before that these figures were 2.7 and 1.2 (44%), respectively.

More FTEs for real estate management, especially executive tasks

This year was the second time the questionnaire included questions on the number of FTEs (full-time equivalents) with the municipalities for real estate management. This is almost 3.5 times as much as last year: The average then was 4.4 FTE while this year it is 14.9 FTE. The additional question on the division of the FTEs for real estate management reveals that municipalities work mostly on an executive level. Per FTE for policy and management, municipalities employ an average of 1.5 FTE for executive tasks. Large municipalities employ the most FTEs for real estate management, followed by small municipalities. Medium municipalities have the least FTEs, on average, for real estate management activities. Most municipalities organise the organisation and execution of community real estate tasks centrally and more than half of the municipalities is planning to organise this differently in the future. About half of the municipalities expect that the number of FTEs will change next year: most expect the number to decrease.

Consciously control quality

The number of municipalities that measure quality has increased. Measurement of technical quality, user satisfaction, contribution to policy goals, and community return takes place multiple times per year, annually, biannually, incidentally or with another frequency. It is striking that 70% of the municipalities indicated that they measure community return, while a clear definition is lacking and it is often unclear how community return can be measured.

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Biographical Details

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Jan Veuger: The common thread in the curriculum vitae of Jan Veuger (1966) is strategic management of (social) property in the business and social housing. Jan completed his studies Master of Real Estate (MRE) in 2006 on a study on governance of social housing and consistency of quality instruments. He is thereby distinguished as best student MRE in 2006. Jan is the owner / director of CORPORATE © Real Estate Management, professor Public Real Estate at Hanze University of Applied Sciences Groningen, member of Committee or quality certificates in Quality Centre Housing Associations Rented Sector (KWH), supervisor at four various civil society organizations (130 to 2,000 employees) in the field of secondary education, youth and elderly. Furthermore he is foundation president at Quality Improvement Development Service organizations Netherlands (KOVON), Fellow of the Royal Institution of Chartered Surveyors (RICS), author of 13 (part of) books and 97 scientific- and professional publications, 4 syllabi, 63 research reports and 90 lectured .

Debt Capital Markets as a Funding Source for Listed Property Funds in South Africa

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Property finance in South Africa has traditionally been a market dominated by bank lending. However in the context of the Basel III Accord creating cost and other regulatory implications for bank lending, as well a maturing listed property market adopting international best practise in the form of REIT legislation, debt capital markets funding is becoming a significant component of REITs' capital structure. The study seeks to determine the merits of this nascent funding source are for REITs in South Africa. With Debt Capital Markets funding now a material contributor to listed property fund capital structures, it is important to assess the impact this funding source has on REITs. Following a review of applicable literature, interviews with senior management of ten listed property funds and other debt capital markets stakeholders were undertaken. Certain advantages and disadvantages of debt capital markets funding, in comparison to other lending sources, were presented as hypotheses to the interviewees. The responses show support from a significant majority of the interviewees for four particular advantages and two disadvantages. The study also finds support for these advantages and disadvantages as being transient and it is advisable for REITs to periodically reassess the respective advantages and disadvantages of this funding source for their business.

Keywords: REIT, Basel III, debt funding, South Africa, debt capital structure

Session: Real Estate Management
VG002, June 10, 2016, 2:15 - 3:45pm

DEBT CAPITAL MARKETS AS A FUNDING SOURCE FOR LISTED PROPERTY FUNDS IN SOUTH AFRICA

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Abstract

Property finance in South Africa has traditionally been a market dominated by bank lending. However in the context of the Basel III Accord creating cost and other regulatory implications for bank lending, as well a maturing listed property market adopting international best practise in the form of REIT legislation, debt capital markets funding is becoming a significant component of REITs' capital structure. The study seeks to determine the merits of this nascent funding source for REITs in South Africa. With Debt Capital Markets funding now a material contributor to listed property fund capital structures, it is important to assess the impact this funding source has on REITs. Following a review of applicable literature, interviews with senior management of ten listed property funds and other debt capital markets stakeholders were undertaken. Certain advantages and disadvantages of debt capital markets funding, in comparison to other lending sources, were presented as hypotheses to the interviewees. The responses show support from a significant majority of the interviewees for four particular advantages and two disadvantages. The study also found support for these advantages and disadvantages to be transient. It is therefore advisable for REITs to periodically reassess the respective advantages and disadvantages of this funding source for their business.

Keywords: *REIT, debt funding, Basel III, debt capital markets, capital structure*

INTRODUCTION

The property finance market in South Africa ("SA") has historically been the preserve of the SA banks, with property finance loans, secured by mortgage bonds over the subject properties, being the principal product offered. The following table sets out the lending landscape (participants and market share) for property finance amongst commercial banks:

Table 1: BA900 Market Share 2010 – 2014

BA900 Market Share										
Bank	**Dec-10**		**Dec-11**		**Dec-12**		**Dec-13**		**Dec-14**	
	R'000	%	R'000	%	R'000	%	R'000	%	R'000	%

ABSA	51	22%	46	19%	42	17%	39	15%	37	13%
FirstRand	11	5%	12	5%	14	6%	13	5%	19	6%
Investec	42	18%	46	19%	50	20%	49	19%	54	18%
Nedbank	88	38%	92	38%	97	38%	103	40%	121	41%
Standard	36	16%	44	18%	45	18%	49	19%	57	19%
Other	3	1%	4	2%	5	2%	6	2%	7	2%
Total per BA 900	231		244		253		259		295	

Source: data per South African Reserve Bank, 2015 and SBG Securities, 2015

In recent years, notably from 2010 onwards, a number of new facets to the property finance market emerged. Undoubtedly the impact of the Basel III regulations, implemented post the 2008 global financial crisis, have led to a change in the manner in which banks are capitalised and the manner in which they source the required liquidity to provide loans to the borrower.

The primary drivers of the Basel III Accord ("B III") are:

- Net Stable Funding Ratio ("NSFR") – Intended to promote a more stable funding structure for banks (reduce dependency on short term wholesale funding). Stable funding is defined as contractually long-term funding (>12 months remaining maturity). Measured as: *Available amount of stable funding/Required amount of stable funding* (BCBS, 2014:2). There is a marked shortage of these high quality liquid assets in certain countries, including SA, (Bech & Keister, 2014:3) and, as such, the supply and demand dynamics are driving up the cost of borrowing.
- Liquidity Coverage Ratio ("LCR") – Intended to ensure banks have enough high quality liquid assets ("HQLA") to protect against a short term liquidity shock. Measured as: *Stock of high quality liquid assets/Net cash outflows over a 30 day period* (BCBS, 2013:4)

With the above structural changes in bank funding parameters, new aspects to the property finance market have been observed. This includes the emergence of Non-Bank Financial Institutions ("NBFI's") – such as life assurance companies and asset managers that seek to hold fixed income investments (including corporate debt) as well as the Debt Capital Markets ("DCM") that has shown itself to be a well-supported platform offering an efficient means of funding for both corporates and state-owned enterprises. Total annual credit issuance has grown from annual levels of below R30 million per annum in 2004 to above R100 million per annum from 2012 onwards (Standard Bank Research, 2015a:13).

Listed property companies have focussed on the DCM to introduce a new funding source to their capital structure. The following table illustrates the growth in DCM activity by listed property entities (outstanding balances as at 31 Dec 2014):

Table 2: Outstanding Property DCM Issuance

Year	Bond Issuance	Commercial paper	Total	% growth

2010	500,000,000	835,000,000	1,335,000,000	
2011	3,485,000,000	2,175,000,000	5,660,000,000	324%
2012	8,764,000,000	5,102,000,000	13,866,000,000	145%
2013	13,595,000,000	5,905,000,000	19,500,000,000	41%
2014	18,427,000,000	5,982,000,000	24,409,000,000	25%

Source: data per Standard Bank Research, 2015b

The following table illustrates the composition of debt funding for all listed property funds that have a DCM programme in place as at December 2014:

Table 3: Listed Property Funds – Lending composition

DCM Proportion - Listed Property Funds with DCM programmes

	Dec-14					
Listed Property Fund	**Bond**	**CP**	**Total DCM**	**Total Debt**	**% DCM**	**Market Cap**
Accelerate Property Fund Limited	701 000 000		701 000 000	2 394 303 000	29,3%	4 681 660 000
Capital Property Fund Limited	1 612 000 000	250 000 000	1 862 000 000	6 943 556 000	26,8%	23 387 070 000
Delta Property Fund Limited	487 000 000	260 000 000	747 000 000	3 677 000 000	20,3%	3 988 170 000
Emira Property Fund	1 270 000 000	700 000 000	1 970 000 000	4 660 355 000	42,3%	8 842 730 000
Fortress Income Fund Limited	991 000 000	866 000 000	1 857 000 000	3 439 484 000	54,0%	15 745 300 000
Growthpoint Properties Limited	3 909 000 000	393 000 000	4 302 000 000	26 020 000 000	16,5%	64 077 040 000
Hospitality Property Fund Limited	870 000 000		870 000 000	1 789 163 000	48,6%	2 298 470 000
Hyprop Investments Limited	1 600 000 000	690 000 000	2 290 000 000	7 061 302 000	32,4%	23 717 470 000
Investec Property Fund Limited	1 070 000 000	200 000 000	1 270 000 000	1 563 757 000	81,2%	6 356 860 000
Premium Properties Ltd	250 000 000	670 000 000	920 000 000	4 332 278 000	21,2%	5 555 480 000
Redefine Properties Limited	2 239 000 000	1 303 000 000	3 542 000 000	19 756 529 000	17,9%	40 280 610 000
Resilient Property Income Fund Ltd	2 108 000 000	350 000 000	2 458 000 000	8 400 785 000	29,3%	28 742 150 000
Vukile Property Fund Limited	1 320 000 000	300 000 000	1 620 000 000	2 829 486 000	57,3%	10 850 040 000
Grand Total	**18 427 000 000**	**5 982 000 000**	**24 409 000 000**	**92 867 998 000**	**26,3%**	**238 523 050 000**

Source: data per Standard Bank Research (2015b), REIT annual financial statements (2014a - m) and Catalyst Fund Managers (2015)

The above funds represent 75% of total market capitalisation (as adjusted below) of the listed property sector on the JSE. This derivation is illustrated below:

Table 4: Proportion of Listed Property Sector with DCM programmes

Listed Property Sector Market Cap – Dec 2014	365 117 547 446
Less: International Funds (with Offshore debt)	
NEPI	31 707 760 000
Redefine International	13 001 100 000
Investec Australia Property Fund	2 934 317 446
Adjusted Sector Market Cap	317 474 370 000

Market Cap - Funds with DCM programmes (Table 2)	238 523 050 000
Proportion of Sector with DCM programmes	75.1%

Source: data per Catalyst Fund Managers, 2015

With 75% of listed property funds, by market capitalisation (as adjusted), having a DCM programme and this DCM issuance representing 26% of their total funding, it appears that DCM funding has become a material contributor to listed property funds' capital structure. Accordingly an analysis of the advantages and disadvantages of the DCM as a funding source for listed property funds is necessary.

The question to be examined is thus "*What are the advantages and disadvantages of the DCM as a funding source for listed property funds in South Africa?*"

To answer the above research question, the following hypotheses were tested:

- H1: The following are advantages of DCM as a funding source (relative to other sources of debt):
  - H1.1 Cheap – lowering the fund's average cost of debt
  - H1.2 Simpler documentation
  - H1.3 Longer debt maturities
- H2: The following are disadvantages of DCM as a funding source (relative to other sources of debt):
  - H2.1 Inflexible as regards variations to terms
  - H2.2 Volatility of the investor base – and thus uncertainty of availability of the funding source

By drawing from the findings of this study, listed property funds in SA will have information pertaining to some significant positive and negative attributes that a new and growing source of funding has for them. In so doing, listed property funds can better position themselves to respond to these advantages and disadvantages. In addition, investors in these instruments can benefit from the study by critically assessing their own investment criteria against the advantages and disadvantages identified in the study and place themselves in a position to improve their standing as a reliable and robust source of funding for the listed property sector. Consequently, benefit to the above parties may be found in improved dialogue that could shape a better outcome for both parties in a nascent funding source for the listed property sector.

The remainder of the article is structured as follows: Firstly it reviews the literature pertaining to the REIT legislation in SA, the Basel III developments that can affect reit funding decisions and lastly the DCM context and how REIT funding decisions and capital structure are shaped. Subsequently the research methodology is introduced and discussed. The findings of the research study are then presented. The paper concludes with a discussion of the findings, implications and aspects for further research.

LITERATURE REVIEW

The literature review commences by providing a sense of the impact of the development of the various Basel Accords, mostly notably B III, on the lending landscape as it relates to bank funding costs. The literature review continues with an outline of the DCM in SA as well positioning the findings of various authors that have studied the decision making drivers for listed property funds and their capital structures. This section of the literature review identifies research undertaken that studies the reasons why listed property funds make the decisions they do in terms of which types of debt are introduced into their capital structure. That is, what advantages and disadvantages are listed property funds attributing to their various funding sources.

Implications of Basel III Accord

A number of studies have been conducted to assess and quantify the impact of higher capital requirements as well as the introduction of the global liquidity standard under B III. The findings of these studies and the extent to which they may inform the SA lending context are examined below. In particular the intention is to understand the bank lending framework confronting listed property funds.

When the Basel III literature is considered in the SA listed property fund context, where gross lending margins for listed property funds are reported to be between 155bps and 175bps for a 5 year bullet tenor (REIT annual financial statements, 2014a – m)), it becomes clear that increased lending spreads of 25bps to 40bps (determined by applying the percentages of 15% to 23% per King (2010), in conjunction with the various actual basis point ranges cited by Cohen and Scatigna (2014:3)) for a one percentage point increase in capital ratios, would have a material impact on the cost of funding. This is a critical factor in a sector that is assessed on its ability to provide investors with an escalating income stream.

A point of interest for the SA context is that King (2010:28) emphasises the offering of shorter dated debt by banks as a means of reducing the cost impact of the NSFR. It is noted that this would not likely hold appeal for listed property funds who seek liquidity for growth in the form of medium term bullet profile debt. In addition the associated refinance risk of too much short tenor debt is not preferred by listed property fund stakeholders (Moody's Investors Service, 2002:4).

The key points to draw from the literature review as regards the banking environment and B III are that:

- Banks in developed markets appear to require a lower increase in lending spreads to recoup the costs of meeting the B III capital adequacy ratios than those in emerging markets (of which SA is one) (Chun, Kim & Ko (2012:22), Di Biase (2012:1276), Schanz, Aikman, Collazos, Farag, Gregory & Kapadia (2011:74));
- Real estate lending is shown to be on the lower end of the lending spread increases required as a result of meeting the capital requirements under B III (Chun et al., 2012:3);
- SA is one of the markets identified as having a shortage of HQLA necessary to meet the LCR (South African Reserve Bank, 2013:4 and Bech & Keister, 2014:3). The South African Reserve Bank provision of a CLF highlights the constraints SA banks face to secure adequate sources of funding to meet the global liquidity standard, suggesting that the cost implications for borrowers are more likely to be material increases of a nature that banks will not absorb; and
- The cost impact of the global liquidity standard on lending spreads appears to be greater than that of the heightened capital requirements. The primary cost driver under the global liquidity standard is the NSFR, with forecast lending spread

increases of 20 to 24bps required to offset the cost of higher levels of longer maturity funding sources (King, 2010:28), Chun et al. (2012:25).

Thus the take away for debt funding for price sensitive listed property funds in an emerging market, is one of a high likelihood of increased lending spreads. In particular the preference to reduce refinance risk with longer dated funding could prove problematic where a market was limited to bank lending as a sole debt source.

Debt Capital Markets and REIT capital structure decisions

SA has a well-established DCM, with participation across a number of categories including municipalities, SOE's, financial institutions (including banks) and corporates (including listed property funds). The local DCM has outstanding issuance of approximately R 1,9 trillion (Nedbank Capital Research, 2014:3). Leading categories are SA Government bonds at 62.6% of total issuance, followed by the financial sector with 15.3% and the SOE sector with 12.8%.

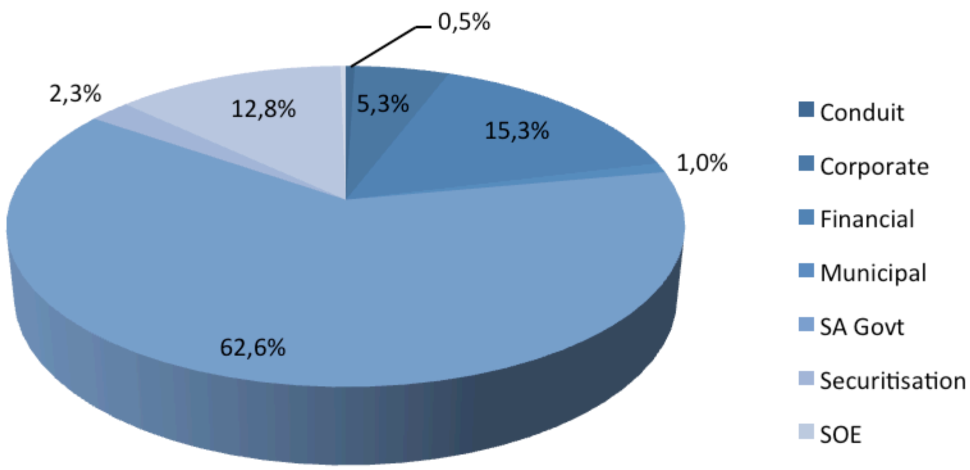
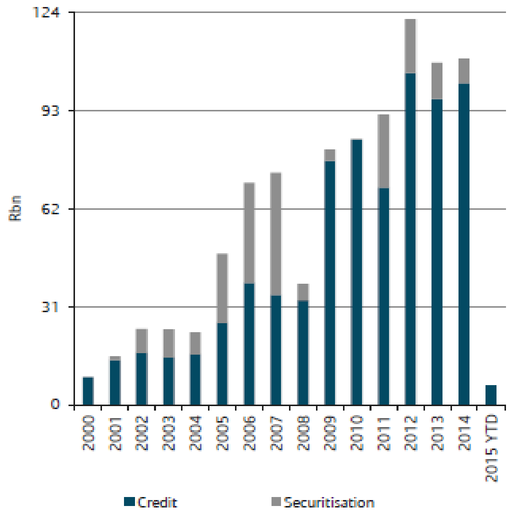


Figure 1: DCM – Outstanding balance per category (Source: Nedbank Capital Research, 2014)

The DCM has seen consistent growth in annual issuance since 2000, with 2008 being the only exception. The issuance levels over the past three years (2012, 2013 and 2014) have been the highest in the 15 years since 2000 per graph below (Standard Bank Research, 2015a:13).



R'bn	2012 issuance	2013 issuance	2014 issuance	2015 Forecast
SOE	14.62	28.49	28.08	30.00
Municipalities	0.80	2.94	2.24	2.00
Corporates	29.08	25.92	22.49	28.00
Financials	60.27	39.29	48.75	50.00
Securitisation	16.90	11.43	7.80	5.50
Total issuance	121.67	108.07	109.36	115.50

Figure 2: DCM – annual issuance and forecast (Source: Standard Bank Research, 2015a)

The property sector constitutes the largest and most active contributor within the corporate DCM issuer universe (Nedbank Capital Research, 2014:6) with its issuance as of December 2014 of R24bn (Standard Bank Research, 2015b) comprising approximately 25% of the total of R101.5bn in outstanding bonds and CP (Nedbank Capital Research, 2014:5).

Property funds show growing evidence of drawing on the DCM as a funding source, with particular emphasis on short-term funding in the CP market, a segment in which property issuers account for approximately half of the total corporate CP issuance outstanding. Listed property funds comprise 10 out of the 17 corporate issuers with outstanding issuances as at October 2014 (Nedbank Capital Research, 2014:9).

Drivers of REIT capital structure and their associated effects

The key points to draw from the literature review as regards REIT participation in the DCM and the impact on REIT capital structure are that:

- Most listed property funds in SA have established a DCM programme and this funding source constitutes a material component of total debt funding (Standard Bank Research, 2015b)
- DCM participation is a function of REIT maturity (Hardin III & Wu, 2010:281)
- An investment grade credit rating is key for DCM participation (Brown & Riddiough, 2003:315)
- Secured versus unsecured debt plays a meaningful role in REIT funding decisions (Moody's Investors Service, 2002:1)
- Unsecured DCM issuance is seen to allow the issuer to remain flexible and manage its asset decisions with limited, if any, third party intervention (Moody's Investors Service, 2002:3-4)
- REIT funding decisions are a function of market timing and a trade-off between the relative costs of debt and equity funding at the point at which the funding decision is made (Boudry, Kalberg & Liu, 2010:118 and Feng, Ghosh & Sirmans, 2007:82)
- Banking relationships can be seen as a facilitator to DCM entry due to the perceived validation and monitoring benefit of this funding source (Hardin III & Wu, 2010:260)

In summary the following can be gained from the literature review:

- SA has a well-established and growing listed property sector with a track record spanning many years
- SA is adopting international best practise with REIT legislation introduced in May 2013. A number of property funds have completed, or are underway, with their REIT conversion
- SA listed property funds show good credit quality as evidenced by their stable external credit ratings
- The introduction of B III (as well as the previous accords) has led to an increase in the cost of capital and liquidity for banks, such that a passing on of costs to borrowers appears unavoidable
- REITs are evaluating and incorporating both secured and unsecured lending in their capital structure. These two forms of debt have discernible pros and cons
- A number of studies show differing quantification of this cost, but it is clear that a cost increase will result
- The DCM in SA is a growing source of funding across borrower types, with evidence of strong growth and material representation as a funding source
- It is indicated that listed property funds see the DCM as a lasting, or permanent feature of their capital structure
- It can be shown that the DCM is not a perfect source of funding and that it is susceptible to volatile investor appetite and is meaningfully influenced by externalities. Clearly these attributes of the DCM must have an impact on listed property funds.

Based on the above, there appears to be the following gaps in the available literature:

- A mapping of the advantages and disadvantages of the DCM as a funding source for listed property funds
- The conducting of the above research in the SA context
- An identification of steps (a possible subject for further research) that listed property funds can take to better position themselves to respond to the identified advantages and disadvantages of DCM funding.

METHODOLOGY

The aim of the research is to determine whether the hypotheses regarding the advantages and disadvantages of DCM as a funding source for listed property funds have any support and can, or cannot, thus be rejected.

To test these hypotheses constitutes an in-depth study that will focused on the findings elicited from the senior management of SA listed property funds as well as industry experts involved in supporting listed property funds to establish and operate their DCM programmes.

In order to achieve adequate sampling of sufficient participants in the listed property sector, with DCM programmes, the following four considerations were assessed:

1) A form of ranking by market capitalisation (as at 31 December 2014) – as a means of assessing the proportion of the sector responding in a certain way – this approach also tends to speak to the maturity of the funds in the sector, with the larger funds typically having the longer track records in the sector relative to those

funds with smaller market capitalisations, which tend to be more recent entrants to the listed property market.

2) The alternative was to focus on the DCM experience of the funds in the form of aggregating the number of years for which their DCM programme has been active and weighting responses on this basis. In the case of years of DCM, each part of a year for which DCM was in issuance, was included as a full year. The basis being that although an issuance may have been, say, in Dec 2010, the lead time, ratings agency interaction and investor road shows would have covered a number of months of the year, such that the experience was being built up in the lead up to the issuance. This is all the more relevant in the instance of the maiden issuance of each fund. The period covered by the study was 2010 to 2014.
3) The third method considered weighting responses based on the interviewee's proportion of outstanding DCM issuance to the total outstanding REIT sector DCM issuance as at 31 December 2014.
4) The fourth method applied was to weight the responses as a proportion of the total number of interviewees.

The table below sets out the proportion of the universe of 13 listed property funds with DCM programmes and issuance as at 31 Dec 2014 that the achieved sample covers across the four weighting approaches.

Table 5: Determination of sampling coverage

	Market capitalisation	**Years of DCM Issuance**	**Proportion of DCM Issuance Outstanding**	**No. of interviewees**
Participants	R225.9bn	35	R21,522bn	10
Universe	R238.5bn	41	R24,409bn	13
%	94.7%	85.4%	88.2%	76.9%

Source: data from Standard Bank Research, 2015b and Catalyst Fund Managers, 2015

The interviews followed a semi-structured format using the same questions as a basis for each interview and allowed for further opinion and insight to be expressed by the interviewee. This dialogue served to further unlock the reasoning and rationale for the answers provided by the interviewees.

In total twelve interviewees participated in the research. These interviewees included ten REIT executives (the "insiders"), with eight being the CFO or an executive with finance responsibilities, and two being CEOs. The "outsiders" comprised the head of a local SA bank's DCM advisory team and an analyst in the SA office of an international ratings agency.

The following questions were posed to all interviewees:

1) Do you think that including DCM funding could lower the average cost of debt funding for a listed property fund?
2) Do you view the DCM documentation as simpler compared to that of private lending sources (bank and NBFI's)?

3) Do you believe that longer term debt could be sourced from the DCM as opposed to the private lending sources?
4) Do you consider the DCM to be less flexible as opposed to private lending sources in terms of variations to the lending terms and conditions?
5) Do you believe the availability of DCM funding to be less stable as opposed to private lending sources?

In order to enhance the validity of the research project, corroboration or convergence between the views of the "insiders" and "outsiders" was assessed as a means of adding a layer of robustness to the research.

FINDINGS

As a point of departure, the literature review has highlighted certain findings that create some context for the environment in which listed property funds are evaluating their debt funding sources and serve to frame the research question and associated hypotheses. These findings include:

- A developing listed property market in SA that is adopting international best practice in the form of REIT legislation and that is incorporating DCM funding into its debt sources at a growing rate
- BIII regulations, in particular the introduction of the NSFR, which are expected to increase the lending spreads charged to borrowers in the years ahead. Thus diversification of funding sources is necessary to ensure that long dated, low cost, reliable funding is available for a listed property sector that needs to distribute a growing income stream.
- The differing impact of secured and unsecured debt on a REIT's credit rating as well as the necessity of a strong credit rating to optimise access to various debt sources
- The introduction of listed debt serving to reduce the proportion of secured debt owing and/or extending the maturity profile of the issuer, in that bank debt of sub five year tenor is typically replaced with DCM issuances of between five and ten year tenor. Empirically, this extension of the maturity profile does not definitively seem to be the case for listed property funds in SA yet
- The indication that DCM is susceptible to volatile investor appetite and is meaningfully influenced by externalities (such as the ABIL failure)

Testing of hypotheses – summation of interview responses

In summary, the responses received on each of the interview questions leads to the following conclusions regarding the hypotheses H1.1 to H2.2 (Refer Tables 6, 7 and 8 for calculations):

H.1.1 – All interviewees confirmed that DCM funding can lower the average cost of debt funding for a listed property fund, particularly when including CP in the debt funding structure. The extent to which the average cost of debt funding can be lowered is market dependent. A caveat highlighted was the need for standby facilities to provide a liquidity back-stop for short dated CP issuances. A further point noted was that the DCM programme requires some scale in the issuance levels to absorb the initial set up costs of the programme. Furthermore, despite the negative impact of the ABIL event on DCM pricing and appetite, the hypothesis that DCM funding can lower the average cost of debt funding was still supported in a post-ABIL environment, suggesting this advantage to be quite robust, especially with CP in the funding mix.

H.1.2 – In excess of 89% of interviewees (with an average of 90%), across all measurement weightings supported the hypothesis that DCM documentation was simpler than that of the private lending sources. The opinions on whether this simplicity was a material advantage of DCM funding reduced to no less than 50% across the measurements weightings (57% on average) being in support of the hypothesis. A common theme emanating from the interviews was the complexity of the initial DCM programme establishment, but the subsequent ease of issuance thereafter. It was also noted that the private lending market was levelling the playing field through the use of a common terms agreement format for loan documentation, also leading to a simplified documentation process for providing further loan facilities to the borrower.

H.1.3 – No more than 40% of interviewees (with an average of 35%), across all measurement weightings, supported the hypothesis that obtaining longer term debt was an advantage of the DCM. A consistent view expressed was that longer term debt should theoretically be possible, as the construct of the DCM caters for this with its long dated parastatal and government issuers as well as the institutional DCM investor base (asset managers and life assurance companies) that should be targeting longer dated assets to match their liabilities. It was noted by certain interviewees that the cost of longer dated debt, may be a reason why yield focussed listed property funds are not actively pursuing the potential tenor benefit available through the DCM. A number of interviewees allude to the private placement route as opposed to the Dutch auction route, being the route to use to explore an issuance of a longer tenor.

H.2.1 – In excess of 70% of interviewees (with an average of 76%), across all measurement weightings, supported the hypothesis that the inflexibility of DCM to variations was a disadvantage. Mention was made that a defined point of contact and a strong relationship with the lender was key to ensuring a simple and reliable means of negotiating variation of terms as regards private lending sources. It was noted that although securing a favourable decision for a variation under an existing DCM issuance was possible, both the cumbersome process involved and the potential negative market reaction to such variation were likely to deter issuers.

H.2.2 - All interviewees, irrespective of measurement weighting, were in support of the hypothesis that the DCM is a less stable source of funding relative to private lending sources. Some interviewees challenged the view that DCM availability could be achieved “at a price” in that negative market events had shown that DCM investors could withdraw from the market entirely. In contrast, the relationship with lenders and the nature of their business as real estate financiers, made bank and NBFI lending more stable, although at a price. A further contributor to the instability of DCM funding was the inability to secure an early refinance of an issuance and thus the issuer was vulnerable to the vagaries of the market on the given date of refinance or new issuance.

Further advantages revealed

In the process of the interviews that formed the basis of the study, certain other advantages and disadvantages outside of those encapsulated in the hypotheses were raised by the interviewees. In particular, two further advantages were supported by sufficient interviewees such that had they been hypothesis to start with, the study would not have shown any basis on which to reject them.

The further advantages are:

Additional advantage 1 – Diversification of funding sources. In what is considered to be a relatively small market for real estate debt sources in SA, having a further alternative to choose from is an advantage. Comments raised included that this additional source of funding benefited the listed property funds by simply being a further option, regardless of price, as well as driving some price tension and competition amongst the REIT's debt funding sources.

Additional advantage 2 – Operational flexibility. This advantage covers both the ease of use of the DCM (short time to bring an issuance to market off an existing DCM programme) and the unfettered manner in which it allows the listed property fund to manage its asset base, particularly in the case of unsecured DCM issuances, where no lender consent is required if properties are being disposed of or altered. This advantage is not to be confused with the disadvantage of inflexibility of a DCM note as regards variation of agreed upon terms post issuance, referred to in H2.1.

In considering the five hypotheses as well as the two additional advantages presented, the views of the "outsiders" are supportive of the views expressed by the "insiders", i.e. the ten senior management interviewees. A number of similar themes were raised by the "outsiders" such that there is a good indication of convergence of opinions between the "insiders" and outsiders" which further serves to support the outcome of the testing of the hypotheses.

Table 6: Interview responses – By Market Capitalisation and By Proportion of DCM Issuance

					By Market Capitalisation									
Listed Property Fund	**Q1**		**Q2**		**Q3**		**Q4**		**Q5**		**Add 1**		**Add 2**	
Interviewee 1	Yes	4 681 660 000	N/A	-	No	-	Yes	4 681 660 000	Yes	4 681 660 000	Yes	4 681 660 000		-
Interviewee 2	Yes	10 850 040 000	N/A	-	Yes	10 850 040 000	N/A	-	Yes	10 850 040 000		-	Yes	10 850 040 000
Interviewee 3	Yes	40 280 610 000	Yes	40 280 610 000	No	-	Yes	40 280 610 000	Yes	40 280 610 000	Yes	40 280 610 000		-
Interviewee 4	Yes	64 077 040 000	Yes	64 077 040 000	No	-	Yes	64 077 040 000	Yes	64 077 040 000	Yes	64 077 040 000	Yes	64 077 040 000
Interviewee 5	Yes	8 842 730 000	Yes	8 842 730 000	Yes	8 842 730 000	Yes	8 842 730 000	Yes	8 842 730 000	Yes	8 842 730 000		-
Interviewee 6	Yes	28 742 150 000	N/A	-	No	-	Yes	28 742 150 000	Yes	28 742 150 000		-	Yes	28 742 150 000
Interviewee 7	Yes	23 387 070 000	No	-	No	-	Yes	23 387 070 000	Yes	23 387 070 000	Yes	23 387 070 000		-
Interviewee 8	Yes	15 745 300 000	N/A	-	Yes	15 745 300 000	Yes	15 745 300 000	Yes	15 745 300 000		-	Yes	15 745 300 000
Interviewee 9	Yes	5 555 480 000	Yes	5 555 480 000	No	-	No	-	Yes	5 555 480 000	Yes	5 555 480 000	Yes	5 555 480 000
Interviewee 10	Yes	23 717 470 000	Yes	23 717 470 000	Yes	23 717 470 000	N/A	-	Yes	23 717 470 000	Yes	23 717 470 000	Yes	23 717 470 000
Grand Total														
Market Cap - Yes		225 879 550 000		142 473 330 000		59 155 540 000		185 756 560 000		225 879 550 000		170 542 060 000		148 687 480 000
Market Cap - All Interviewees		225 879 550 000		225 879 550 000		225 879 550 000		225 879 550 000		225 879 550 000		225 879 550 000		225 879 550 000
Percentage supporting hypothesis		100%		63%		26%		82%		100%		76%		66%
Market Cap - Yes & N/A				202 492 480 000										
Percentage supporting advantage				90%										
					By Proportion of DCM Issuance									
Listed Property Fund	**Q1**		**Q2**		**Q3**		**Q4**		**Q5**		**Add 1**		**Add 2**	
Interviewee 1	Yes	701 000 000	N/A	-	No	-	Yes	701 000 000	Yes	701 000 000	Yes	701 000 000		-
Interviewee 2	Yes	1 620 000 000	N/A	-	Yes	1 620 000 000	N/A	-	Yes	1 620 000 000		-	Yes	1 620 000 000
Interviewee 3	Yes	3 542 000 000	Yes	3 542 000 000	No	-	Yes	3 542 000 000	Yes	3 542 000 000	Yes	3 542 000 000		-
Interviewee 4	Yes	4 302 000 000	Yes	4 302 000 000	No	-	Yes	4 302 000 000	Yes	4 302 000 000	Yes	4 302 000 000	Yes	4 302 000 000
Interviewee 5	Yes	1 970 000 000	Yes	1 970 000 000	Yes	1 970 000 000	Yes	1 970 000 000	Yes	1 970 000 000	Yes	1 970 000 000		-
Interviewee 6	Yes	2 458 000 000	N/A	-	No	-	Yes	2 458 000 000	Yes	2 458 000 000		-	Yes	2 458 000 000
Interviewee 7	Yes	1 862 000 000	No	-	No	-	Yes	1 862 000 000	Yes	1 862 000 000	Yes	1 862 000 000		-
Interviewee 8	Yes	1 857 000 000	N/A	-	Yes	1 857 000 000	Yes	1 857 000 000	Yes	1 857 000 000		-	Yes	1 857 000 000
Interviewee 9	Yes	920 000 000	Yes	920 000 000	No	-	No	-	Yes	920 000 000	Yes	920 000 000	Yes	920 000 000
Interviewee 10	Yes	2 290 000 000	Yes	2 290 000 000	Yes	2 290 000 000	N/A	-	Yes	2 290 000 000	Yes	2 290 000 000	Yes	2 290 000 000
Grand Total														
DCM Issuance - Yes		21 522 000 000		13 024 000 000		7 737 000 000		16 692 000 000		21 522 000 000		15 587 000 000		13 447 000 000
DCM Issuance - All Interviewees		21 522 000 000		21 522 000 000		21 522 000 000		21 522 000 000		21 522 000 000		21 522 000 000		21 522 000 000
Percentage supporting hypothesis		100%		61%		36%		78%		100%		72%		62%
DCM Issuance - Yes & N/A				19 660 000 000										
Percentage supporting advantage				91%										

Source: data from Standard Bank Research, 2015b and Catalyst Fund Managers, 2015

Table 7: Interview responses – By Years of DCM Issuance and By Number of Interviewees

			By Years of DCM Issuance											
Listed Property Fund	**Q1**		**Q2**		**Q3**		**Q4**		**Q5**		**Add 1**		**Add 2**	
Interviewee 1	Yes	1	N/A	-	No	-	Yes	1	Yes	1	Yes	1		-
Interviewee 2	Yes	3	N/A	-	Yes	3	N/A	-	Yes	3		-	Yes	3
Interviewee 3	Yes	4	Yes	4	No	-	Yes	4	Yes	4	Yes	4		-
Interviewee 4	Yes	5	Yes	5	No	-	Yes	5	Yes	5	Yes	5	Yes	5
Interviewee 5	Yes	4	Yes	4	Yes	4	Yes	4	Yes	4	Yes	4		-
Interviewee 6	Yes	5	N/A	-	No	-	Yes	5	Yes	5		-	Yes	5
Interviewee 7	Yes	4	No	-	No	-	Yes	4	Yes	4	Yes	4		-
Interviewee 8	Yes	3	N/A	-	Yes	3	Yes	3	Yes	3		-	Yes	3
Interviewee 9	Yes	3	Yes	3	No	-	No	-	Yes	3	Yes	3	Yes	3
Interviewee 10	Yes	3	Yes	3	yes	3	N/A	-	Yes	3	Yes	3	Yes	3
Grand Total														
Years of DCM - Yes		35		19		13		26		35		24		22
Year of DCM - All Interviewees		35		35		35		35		35		35		35
Percentage supporting hypothesis		100%		54%		37%		74%		100%		69%		63%
Years of DCM - Yes & N/A				31										
Percentage supporting advantage				89%										
			By Number of Interviewees											
Listed Property Fund	**Q1**		**Q2**		**Q3**		**Q4**		**Q5**		**Add 1**		**Add 2**	
Interviewee 1	Yes	1	N/A	-	No	-	Yes	1	Yes	1	Yes	1		-
Interviewee 2	Yes	1	N/A	-	Yes	1	N/A	-	Yes	1		-	Yes	1
Interviewee 3	Yes	1	Yes	1	No	-	Yes	1	Yes	1	Yes	1		-
Interviewee 4	Yes	1	Yes	1	No	-	Yes	1	Yes	1	Yes	1	Yes	1
Interviewee 5	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1		-
Interviewee 6	Yes	1	N/A	-	No	-	Yes	1	Yes	1		-	Yes	1
Interviewee 7	Yes	1	No	-	No	-	Yes	1	Yes	1	Yes	1		-
Interviewee 8	Yes	1	N/A	-	Yes	1	Yes	1	Yes	1		-	Yes	1
Interviewee 9	Yes	1	Yes	1	No	-	No	-	Yes	1	Yes	1	Yes	1
Interviewee 10	Yes	1	Yes	1	Yes	1	N/A	-	Yes	1	Yes	1	Yes	1
Grand Total														
No. of Interviewees - Yes		10		5		4		7		10		7		6
No. of Interviewees - All Interviewees		10		10		10		10		10		10		10
Percentage supporting hypothesis		100%		50%		40%		70%		100%		70%		60%
No. of Interviewees - Yes & N/A				9										
Percentage supporting advantage				90%										

Source: data from Standard Bank Research, 2015b and Catalyst Fund Managers, 2015

Table 8: Interview responses – range and average and corroborative "outsiders" responses

			Q1	Q2	Q3	Q4	Q5	Add 1	Add 2
Maximum percentage supporting hypothesis			100%	63%	40%	82%	100%	76%	66%
Percentage supporting hypothesis - Average			**100%**	**57%**	**35%**	**76%**	**100%**	**72%**	**63%**
Minimum percentage supporting hypothesis			100%	50%	26%	70%	100%	69%	60%
EXTERNAL 1	E1	Yes	Yes	Yes	Yes	Yes		Yes	
EXTERNAL 2	E2		Yes		Yes		Yes		

Note - Responses market N/A are to be intepreted as: Not Applicable as an advantage or disadvantage of DCM funding. This indicates that while the repsondents may agree with the hypotheses, the aspect covered is not materialenough to warrant a specific advantage or disadvantage of DCM funding

Source: data from Standard Bank Research, 2015b and Catalyst Fund Managers, 2015

DISCUSSION

The study was intended to answer the following research question: "What are the advantages and disadvantages of the DCM as a funding source for listed property funds in South Africa?"

Research proposition or hypotheses

To answer the above research question, the following hypotheses were tested:

- H1: The following are advantages of DCM as a funding source (relative to other sources of debt):
  - H1.1 Cheap – lowering the fund's average cost of debt
  - H1.2 Simpler documentation
  - H1.3 Longer debt maturities
- H2: The following are disadvantages of DCM as a funding source (relative to other sources of debt):
  - H2.1 Inflexible as regards variations to terms
  - H2.2 Volatility of the investor base – and thus uncertainty of availability of the funding source

The above research question and hypotheses were answered and tested through the analysis of the responses to a set of questions put to the interviewees.

The results of the study indicate that hypotheses H1.1, H1.2, H2.1 and H2.2 have strong support and cannot be rejected, while hypothesis H1.3 has little support and could be rejected.

This suggests that DCM as a funding source:

- Can be a cheap source of funding that can lower a REIT's average cost debt;
- Does offer simpler documentation that that of private lending sources;
- Is inflexible as regards variation to its terms relative to private lending sources;
- Is volatile and lacks the stability of the private lending sources;
- However, does not necessarily result in securing debt of a longer tenor that that achievable from private lending sources.

The literature review uncovered a number of factors affecting the landscape for debt funding to listed property funds. The study finds that these factors, set out below, do permeate the thinking of listed sector senior management when considering the advantages and disadvantages of DCM as a funding source for listed property funds:

- The REIT sector in SA is catching up to its international peer group and can thus start to adopt similar practices of incorporating listed debt as an additional debt source and further diversifier of their capital structure
- The introduction of listed debt, such as DCM issuance, as a funding source is a feature of a maturing REIT market
- Cognisance amongst REIT management of the implications of BIII increasing lending spreads for bank debt
- SA property funds see DCM as a permanent feature of their capital structure
- The SA DCM is vulnerable to negative externalities, as demonstrated by the ABIL event, and accordingly price and appetite respond to this information

Limitations and assumptions of the study

The study was limited to SA domiciled listed property funds and to those listed property funds that, at 31 December 2014, had established DCM programmes. It was assumed that the listed fund interviewees were sufficiently unbiased to assess the advantages and disadvantages of their DCM funding activity and that the advantages or disadvantages of the DCM are separately identifiable and not interdependent.

Certain limitations were inherent in the interviewees. A notable differentiator, although difficult to quantify is the differing real estate, finance and in particular, DCM experience of the respective "insiders" and "outsiders". A further intrinsic limitation of the study is that DCM as a REIT funding source is a fairly recent event, with a track record of approximately 5 years since 2010. Notwithstanding, the respective context of a robust DCM over a number of years coupled with the recent and very market-negative event in the failure of ABIL, does create an environment in which the actions and repercussions of the DCM are very topical for REIT senior management.

Aspects for further research

During the course of the interviews conducted for this research study, certain aspects of the DCM were identified that could be researched in greater detail. Theses aspects are presented below:

1) A study examining secured versus unsecured DCM issuance for listed property funds. Areas to investigate could include the interactions when secured and unsecured DCM issuances are undertaken by the same issuer, as well as what the advantages and disadvantages of each type of issuance are for the issuing property fund. What can also be considered is the rating differential achieved between the secured and unsecured issuance of the same issuer and the impact that the rating of the secured issuance may have on the unsecured rating of the issuer and vice versa.
2) A study examining the merits of a listed property fund following a private placement strategy versus a public auction route when issuing DCM. At a cursory level it appears that the private placement route is the more robust means of achieving issuance objectives for an issuer.
3) A case study covering the impact of the ABIL event on the DCM activity of listed property funds in SA. Consideration could be given to facets such as attempting to quantify the movement in pricing and/or issuance size in a pre- and post-ABIL environment.
4) It may be worth revisiting the topic of this research study in future, given that it was the view of a number of the interviewees that the advantages and disadvantages of the DCM as a funding source for listed property funds may change over time.

Conclusion and recommendation

Use of the DCM by listed property funds in South Africa is well established, with approximately a quarter of the debt funding of REITs representing 75% of the listed property sector by market capitalisation (as adjusted, at the end of December 2014), being in the form of DCM issuance.

The results of the research study show that DCM is an established and viable form of funding that has a role to play in the debt composition of listed property funds in SA. It is clearly revealed that it is imperative that listed property funds understand both the advantages and disadvantages of the inclusion of DCM funding in their capital structure. Furthermore the study highlights that listed property funds need to remain cognisant that the particular advantages and disadvantages applicable to DCM funding for listed property funds are, in some respects, a function of the prevailing circumstances facing both the property sector and the DCM at a point in time. Listed property fund management needs to be alert to continually reassessing the advantages and disadvantages of DCM funding as it pertains to listed property funds in South Africa.

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a. ACCELERATE PROPERTY FUND LIMITED (2014) Unaudited interim financial results for the six-month period ended 30 September 2014, p. 3.
b. CAPITAL PROPERTY FUND LIMITED (2015) Preliminary summarised audited consolidated financial statements for the year ended 31 December 2014.
c. DELTA PROPERTY FUND LIMITED (2014) Interim results for the period ended 31 August 2014, p. 12.
d. EMIRA PROPERTY FUND LIMITED (2015) Unaudited interim financial results for six months to 31 December 2014 and income distribution declaration, p. 2.

e. FORTRESS INCOME FUND LIMITED (2015) Condensed unaudited consolidated interim financial statements for the six months ended 31 December 2014
f. GROWTHPOINT PROPERTIES LIMITED (2015) Condensed unaudited results for the six months ended 31 December 2014, p. 1.
g. HOSPITALITY PROPERTY FUND LIMITED (2015) Unaudited Interim Results for the six months ended 31 December 2014 and interest payment declaration, p. 2. [Online]
h. HYPROP INVESTMENTS LIMITED (2015) Summarised unaudited consolidated interim results for the six months ended 31 December 2014, p. 3.
i. INVESTEC PROPERTY FUND LIMITED (2014) Reviewed interim condensed consolidated financial results for the six months ended 30 September 2014, p. 4.
j. OCTODEC INVESTMENTS LIMITED (2014) Financial results for the twelve months ended 31 August 2014, p. 10.
k. REDEFINE PROPERTIES LIMITED (2014) Summarised audited financial statements for the year ended 31 August 2014, p. 2.
l. RESILIENT PROPERTY INCOME FUND LIMITED (2015) Condensed reviewed consolidated interim financial statements for the six months ended 31 December 2014.
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