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Dröes, M.I.; Francke, M.K.

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What causes the Positive Price-Turnover Correlation in European Housing Markets?

Martijn I. Dröes[a,b,c]
Marc K. Francke[a,d]

[a] *Faculty of Economics and Business, University of Amsterdam, the Netherlands;*
[b] *Amsterdam School of Real Estate, the Netherlands;*
[c] *Tinbergen Institute, the Netherlands;*
[d] *Ortec Finance, the Netherlands.*

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What Causes the Positive Price-Turnover Correlation in European Housing Markets?

By MARTIJN I. DRÖES*[a,b,c], MARC K. FRANCKE[a,d]

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SUMMARY — This paper examines what determines the correlation between prices and turnover in European housing markets. Using a panel vector autoregressive model, we find that there is a particularly strong feedback mechanism between prices and turnover. Momentum effects are another important reason why prices and turnover are correlated. Common underlying factors, such as GDP and interest rates, also explain part of the price-turnover correlation. The results in this paper imply that, to understand price and turnover dynamics, it is important to model prices and turnover as two interdependent processes. Ignoring this interdependency results in a considerable bias in the coefficient estimates of both price and turnover models.

JEL–code — E02; R31; O18
Keywords — price-turnover relationship; feedback; momentum effects; credit constraints; nominal loss aversion

I. Introduction

It is a well-established empirical fact that prices and turnover in housing markets are positively correlated. There are several explanations for this correlation ranging from credit constraints (Genesove and Mayer, 1997; Stein, 1995) and nominal loss aversion (Genesove and Mayer, 2001) to hedging incentives (Sinai and Souleles, 2005; Han, 2008, 2010). Most previous literature on this topic has focused on the US (see Clayton et al., 2010). Although there have been several European-based studies on price-turnover dynamics, such as for Sweden (Hort, 2000), the UK (Andrew and Meen, 2003), and the Netherlands (De Wit et al., 2013), there has not yet been a cross-country European study on this topic. This paper aims to fill this gap.

* Corresponding author, e-mail: m.i.droes@uva.nl, tel.: + 31 20 525 5414. We thank Paloma Taltavull, Alex van de Minne, and participants of the international AREUEA 2015 conference for useful comments.
[a] Amsterdam Business School, Faculty of Economics and Business, University of Amsterdam, Plantage Muidergracht 12, 1018 TV Amsterdam, The Netherlands.
[b] Amsterdam School of Real Estate, Jollemanhof 5, 1019 GW Amsterdam, The Netherlands.
[c] Tinbergen Institute, Gustav Mahlerplein 117, 1082 MS Amsterdam, The Netherlands.
[d] Ortec Finance, Naritaweg 51, 1043 BP Amsterdam, The Netherlands.

The importance of the price-turnover relationship lies in its connection with the volatility, riskiness of housing markets. Figure 1 shows the standard deviation of the percentage change in house prices for several European countries versus the correlation between house price changes and changes in the number of transactions (turnover). We normalized the number of transactions by the housing stock in each country. Figure 1 suggests that those markets where prices and turnover are more highly correlated are those markets that have the highest price volatility. The correlation between both measures is 0.44.[1 2] A country such as Germany has a low correlation and low risk. By contrast, the housing market in the US is relatively volatile and is characterized by a high price-turnover correlation. Insight into the price-turnover relationship is therefore of fundamental importance to understand what makes some housing markets riskier than others.

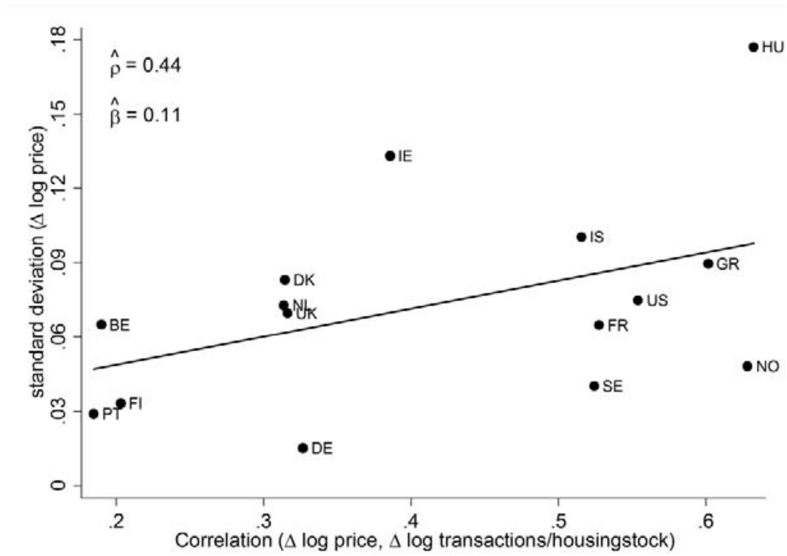

FIGURE 1 — HOUSING MARKET VOLATILITY AND THE PRICE-TURNOVER RELATIONSHIP

Notes: Based on data from 1999-2013. In this figure, Estonia (corr.=0.60, std.=0.24) and Italy (corr.=0.84, std.=0.05) are excluded as outliers.

There are several key reasons why prices and turnover are positively correlated. First, there may be momentum in both prices and turnover. A market that is on the rise has a tendency to keep rising. There is quite some literature on such momentum effects in house

[1] The volatility of the percentage change in house prices (Figure 1, y-axis) is also highly correlated with the volatility of the normalized change in turnover (correlation coefficient of 0.73). A high correlation between prices and turnover is, therefore, associated with volatility in both prices and turnover.

[2] Using real house prices the correlation is 0.41. In our empirical analysis we will show that our findings are very similar, whether we use real or nominal house prices.

prices (see Case and Shiller, 1989, or more recently Lai and Order, 2010; Beracha and Skiba, 2011; Head et al., 2014; Kuang, 2014). A common explanation is that housing market frictions (i.e. search frictions, transaction costs) results in a sluggish adjustment of housing markets (see Díaz and Jerez, 2013; Merlo et al., 2015). Alternatively, there is also quite some literature that focusses on price expectations and speculative behavior (bubbles) in housing markets (e.g. Case and Shiller, 2003; Himmelberg et al., 2005; Glaeser et al., 2008; Han and Strange, 2014; Lin et al., 2015). There is, unfortunately, much less known about momentum in housing market turnover. Some notable exceptions are Piazessi and Schneider (2009), who focus on households beliefs and momentum traders, Krainer (2001), who provides a model of hot and cold housing markets and explains liquidity, amongst others, by the functioning of rental markets, and Anenberg and Bayer (2013) who argue that the cost of simultaneously holding two homes results in a strongly procyclical pattern of residential mobility within the Los Angeles metropolitan area.

A second reason that prices and turnover are correlated is because of a lagged feedback mechanism between prices and turnover. A good example of such a feedback mechanism is given by Ortalo-Magné and Rady (2006) (also see Ortalo-Magné and Rady, 1999). They show in a life-cycle model setup that increases in income (especially of starter households) can result in price increases and subsequent increases in transaction volume. This effect propagates through the housing market, strengthening itself across the property ladder, and resulting in a positive correlation between prices and transaction volume. The positive correlation in this type of model is typically the result of financial constraints. Other models along this line are those of Wheaton (1990), Stein (1995), Goetzmann and Peng (2006), and Bajari et al. (2013). A related strand of literature also adds behavioral considerations, such as nominal loss aversion, to explain the price-turnover relationship (i.e. Genesove and Mayer, 2001; Engelhardt, 2003).

A third reason for the price-turnover correlation is that there are common (macro-economic) factors that determine both prices and turnover. De Wit et al. (2013), for example, find that especially the mortgage rate explains the price-turnover relationship in the Netherlands. Clayton et al., (2010) argue that also labor market conditions and stock markets are important determinants in the US and that their impact depends on the supply elasticity of housing markets. Andrew and Meen (2003) document a change in the price-turnover relationship in the UK in the early 1990s. They argue that this change is, at least in part, the result of a change in the behavior of first-time buyers. Hort (2000) actually finds a negative contemporaneous correlation in Sweden. Buyers respond to demand shocks while the reservation prices of sellers remain the same. As a result, transaction volume declines but the prices of successful transactions increases. Follain and Velz (1995) also find a negative correlation due to a decrease in the importance of downpayment constraints in the US in the 1990s.

Finally, there may be fixed institutional differences across countries that can explain the heterogeneity in price-turnover correlations. In the US, for example, down-payment constraints play an important role in the transaction process. By contrast, there are no such formal down-payment constraints in many European countries, although loan-to-value (LTV) ratios can still be interpreted as a measure of informal constraints imposed by banks (see Chiuri and Jappelli, 2003). Other institutional differences across countries include the tax treatment of owner-occupied housing, whether mortgage loans are recourse or non-recourse loans, and the extent to which there are zoning regulations. Although it is out of the scope of this text to provide a full overview of such differences, the fact that we will use cross-country data at least allows us to control for 'fixed' institutional factors that determine prices and turnover.

A specific contribution of our paper is that we examine all of the aforementioned determinants of the price-turnover relationship within a single estimation framework. In particular, we use data on prices and turnover of 16 European countries over the period 1999-2013. The dataset is based on several statistical publications of the European Mortgage Federation and on Eurostat data. The dataset contains information about some key macro-economic and housing market indicators, such as the amount of outstanding mortgage balance to GDP, the interest rates on new mortgage loans, and the housing stock. More importantly, besides data on house prices, the dataset contains information about the number of transactions. Although there have been several OECD/IMF studies examining price dynamics (e.g. Hilbers et al., 2011; André, 2010; Andrews, 2010; Andrews et al., 2011; Sánchez and Johansson, 2011), to the best of our knowledge there is no such study examining the relation between prices and turnover across European countries. A further interesting aspect of the dataset is that it contains data on both the pre-crisis and crisis period. This allows us to examine nominal loss aversion, especially since the timing of the financial crisis, and the extent to which prices declined, has been considerably different across European countries.

We simultaneously model prices and turnover as two interdependent endogenous processes. We use a unrestricted panel VAR approach. Since we have 15 years of data we have to pool the data to estimate the VAR parameters. Since including lagged dependent variables in a panel data setup results in biased coefficient estimates (see Nickell, 1981), we use an instrumental variable approach along the lines of Arellano-Bond (1991). A further complication is that some of the variables, including prices and turnover, appear to be non-stationary. We examine whether there is cointegration between those variables. We discuss what are the key determinants of prices and turnover for the European countries as a whole (on average) and we will highlight some key differences across countries (decomposition of house price dynamics).

The results in this paper show that there is a considerable degree of lagged feedback between prices and turnover. A one percent increase in (real) house prices increases turnover (normalized by the housing stock) by 0.74 percent, while a one percent increase in the turnover rate increases prices by 0.24 percent. There are also strong momentum effects in prices and turnover. Price increases in one year have an effect of 34 percent on house prices the next year. For turnover this autoregressive effect is even 60 percent. Jointly with GDP and (real) interest rates, momentum and lagged feedback are key in explaining the price-turnover relationship. A historical decomposition of house price changes in Europe shows that especially shocks in turnover (contribution of 12.4 percent) and real house prices (contribution of 6.7 percent) explain house price dynamics. Other factors, like the loan-to-GDP ratio, population growth, and inflation, do not seem to play a large role. In addition, we do not find evidence for nominal loss aversion or cointegration.

The key message of this paper is that it is essential to model the interdependency between prices and turnover when examining price or turnover dynamics. Our results indicate that there is considerable bias if this interdependency is not explicitly taken into account. In particular, the autoregressive coefficient on house prices is about 14 percent higher and the autoregressive coefficient on turnover 43 percent lower if the feedback between prices and turnover is not correctly specified. This is an important result because it implies that part of the (house price) momentum that is typically found in housing markets (i.e. Case and Shiller, 1989; Lai and Order, 2010) can be explained by the feedback between prices and turnover.

Further results indicate that the bias in the real GDP coefficient ranges from 21 percent in the price equation to 3 percent in the turnover equation. The effect of real interest rates is severely overestimated in the price equation (although its effect is statistically insignificant) and it is underestimated by 21 percent in the turnover equation. In both equations the year-specific time trends are also underestimated. There is a growing literature suggesting that it is important to account for liquidity when calculating housing returns (Cheng et al., 2013) or property price indices (Fisher et al., 2003; Goetzmann and Peng, 2006). We argue that this line of reasoning should be extended to include regression models that aim to explain house price dynamics.

The remainder of this paper is organized as follows. Section II discusses the data used in this study. Section III covers the empirical methodology. In Section IV, we present the results. Section V concludes.

II. European data on house prices and turnover

Several statistical publications published by the European Mortgage Federation (EMF) have been combined to create a dataset on house prices and turnover for a selected sample of European countries. The data in the EMF reports is based on a variety of sources including National Statistical Offices, the Central Banks of several member states, Eurostat, and the OECD. The dataset contains information on the housing stock, the outstanding mortgage balance as a percentage of GDP, the interest rate on new mortgage loans, and GDP at current market prices. Population, the share of young population (18-30 years old), and inflation (based on the Harmonised Index of Consumer Prices, HICP) is taken from Eurostat.

We use the EMF (2013) report to create our main dataset. It contains information from 2001-2012. Based on two additional report, EMF (2012) and EMF (2011), we extent the data to 1999 and fill in some missing gaps in our main dataset. The EMF (2005) report also contains some information to fill in missing observations and it contains data up until 1995. Unfortunately, as the time period increases the number of cross-sectional units that remain in the analysis drop considerably (from 16 to 10 countries) or the dataset becomes highly unbalanced, which would result in a comparison of different housing market periods across different countries, a situation we want to avoid. As a consequence, we decided to use data as of the year 1999. The EMF (2014) report is used to update the data to include the year 2013. Hence, our main period of analysis is 1999-2013.

TABLE 1 — HOUSE PRICES, TURNOVER, AND OTHER MACRO-ECONOMIC VARIABLES (LEVELS)

Variables	Mean	Std. Dev.	Min.	Max.
House prices (index)	88.8	22.2	28.8	147.3
Real house prices	86.7	17.9	33.7	130.4
Number of transactions	293,408	355,858	3,039	1,785,000
Housing stock (x1000)	10,336	12,615	103	41,217
Turnover rate (trans./housing stock)	0.039	0.024	0.007	0.115
Outstanding mortgage balance to GDP (%)	51.19	29.50	1	159
Interest rate new mortgage loans (%)	5.05	2.18	1.89	16.07
Real interest rate (%)	2.00	2.20	-9.20	10.84
GDP (euros, current prices)	603,111	735,802	5,359	2,714,807
Real GDP	597,811	724,658	6,385	2,396,969
Population (in millions)	22.07	26.18	0.28	82.54
Share of population between 18 and 30 years of age	0.172	0.017	0.137	0.219
HICP (level index)	101.6	13.9	65.8	168.0
Inflation (%, HICP)	2.66	2.06	-1.66	16.26
Sample period		1999-2013 (15 years)		
Number of countries		16		
Number of observations		240		

Notes: The number of observations is a bit different per variable since we do not have a fully balanced panel dataset. The dataset is strongly balanced with the number of observations per variable ranging from 228 to 240.

TABLE 2 — HOUSE PRICES, TURNOVER, AND OTHER MACRO-ECONOMIC VARIABLES (DIFFERENCES)

Variable	Mean	Std. Dev.	Min.	Max.
Δ log house prices (index)	0.048	0.096	-0.446	0.621
Δ log real house prices (index)	0.021	0.094	-0.448	0.526
Δ log number of transactions	-0.023	0.167	-0.925	0.418
Δ log housing stock	0.012	0.011	-0.004	0.088
Δ log turnover rate	-0.035	0.168	-0.949	0.409
Δ outstanding mortgage balance to GDP (%)	2.137	3.897	-13.6	32.8
Δ interest rate new mortgage loans (%)	-0.241	1.045	-4.58	2.53
Δ real interest rate	-0.086	1.029	-5.18	5.51
Δ log GDP	0.036	0.065	-0.372	0.206
Δ log real GDP	0.009	0.068	-0.492	0.192
Δ log population	0.0045	0.0060	-0.0066	0.0309
Δ share of population between 18 and 30 years of age	-0.0013	0.0028	-0.0132	0.0051
Δ log HICP (level index)	0.026	0.020	-0.017	0.151
Δ log inflation	-0.009	0.780	-3.954	2.805
Sample period	1999-2013 (15 years)			
Number of countries	16			
Number of observations	224			

Notes: The number of observations is a bit different per variable since we do not have a fully balanced panel dataset. The dataset is strongly balanced with the number of observations per variable ranging from 211 to 224.

The following 16 countries are included in the dataset: Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, The Netherlands, Norway, Portugal, Sweden, and the UK. It is evident that most of the Eastern European countries are missing. The main limiting variable is turnover. Consistent data about the number of transactions in, for example, Latvia, Luxembourg, Poland, Romania, Slovenia, Spain, and Ukraine, is simply not available. In addition, if more than 3 years of turnover are missing, we excluded the country from the dataset. The (strongly balanced) dataset on 16 countries for a period of 15 years, however, provides us with sufficient observations to empirically analyze the price-turnover relationship. Table 1 contains the descriptive statistics of the variables in levels and, similarly, Table 2 reports descriptive statistics in (log) differences. The empirical analysis, see section III, will be based on the differenced variables. Note that we also report several variables (house prices, GDP, and interest rates) in real terms. The analysis in this paper, however, starts in nominal terms since it allows us to distinguish between (nominal) price increases and price declines. As a robustness check, we will show that using real values will not change our main results. Finally, Appendix A contains the time series plots of house prices and transaction volume for the 16 countries. Although these time series are sometimes volatile, 'eyeballing' these plots suggest that the time series are reasonably well behaved.[3,4]

TABLE 3 — HOUSE PRICE CHANGES AND THE START OF THE FINANCIAL CRISIS

Country	Annual return 1999-2013	Before crisis Average return	Start crisis	Until 2013 Average return
Belgium	0.066	-	-	-
Denmark	0.034	0.082	2007	-0.031
Estonia	0.094	0.270	2007	-0.053
Finland	0.044	0.047	2009	0.036
France	0.057	0.101	2007	-0.002
Germany	0.012	0.008	2006	0.016
Greece	0.027	0.084	2008	-0.075
Hungary	0.075	0.145	2008	-0.050
Iceland	0.081	0.134	2007	0.009
Ireland	0.019	0.116	2007	-0.110
Italy	0.029	0.056	2008	-0.020
Netherlands	0.024	0.064	2008	-0.048
Norway	0.071	0.091	2007	0.045
Portugal	0.015	0.025	2010	-0.020
Sweden	0.062	0.070	2011	0.011
UK	0.064	0.109	2007	0.003
Sample period		1999-2013 (15 years)		

Notes: The house price changes are based on the differenced log nominal house price index per country.

A. House prices

We use a nominal house price index as our main house price indicator. The year 2006 is the base year (Index = 100). Especially the percentage change in this variable, not the level of the index in itself, is interesting. The average annual return (log-differences) across the European countries in our dataset has been 4.8 percent between 1999-2013. Most of the

[3] There are quite some differences in the underlying methodologies used to construct the price and turnover series. For example, the prices series for Belgium is based on the average prices of existing homes and that of Estonia also includes new dwellings. The transaction volume for Denmark excludes self builds and the data for Ireland is based on mortgage approvals (for a detailed discussion, see EMF, 2013). This implies that, as is often the case with cross-country studies, the data is not perfect and caution should be taken with interpreting the results. We are fully aware of this limitation.

[4] There is also quite some heterogeneity across countries in terms of turnover and prices. There is for example a high min-max spread in the differenced series (see Table 2). For example, Estonia had a very large price decrease from 2008-2009 (-0.446), Iceland a large turnover decrease from 2007-2008 (-0.925), and Hungary a large price/turnover increase from 1999-2000 (0.621/0.418). Also, we noticed a negative real interest rate for Iceland in 2010. Although it is questionable whether these values should be interpreted as outliers, the estimates excluding these values are much in line with the final model estimates presented in the results section of this paper.

price series are hump shaped as a result of the financial crisis. Table 3 contains the average percentage return for each of the 16 countries before and during the financial crisis. The starting point of the financial crisis per country, based on the first year house prices started to decrease, is also reported.

Table 3 shows several important results. First, it is evident that house price changes between 1999-2013 differ considerably across European countries. Iceland has had the highest annual house price appreciation (8.1 percent) and Germany the lowest (1.2 percent). Second, the start of the financial crisis, and to which extent prices declined, is different across European countries. Germany responded relatively fast to the financial crisis, while Portugal and Sweden responded relatively late. Belgium did not have a price decline at all. For most countries, however, the average returns have decreased substantially as a result of the financial crisis. Interestingly, some countries still have positive average house price appreciation suggesting that they already recovered from the price declines. A country such as Germany, has had a very small response to the crisis and its average annual return after 2006 is actually higher than before the crisis. The question we examine in this paper is what can explain these differences in house price dynamics. We will use house prices as one of the main endogenous dependent variables in our empirical analysis.

B. Turnover

Besides house prices, the transaction volume of owner-occupied houses – in this paper denoted as turnover – will be used as a key dependent variable. The average number of transactions (houses sold) per year across the European countries is about 300,000. The highest turnover is in the UK, 1.3 million transactions per year, and the lowest in Iceland with 8,500 transactions per year. The average growth in transactions, however, shows a yearly decrease in the number of transaction of 2.3 percent. The can be explained by the financial crisis.

Instead of the actual transaction volume as dependent variable, we have used the housing stock per country (and year) to normalize turnover.[5] In almost all countries the housing stock has been steadily increasing over the years, with the growth decreasing during the financial crisis. The average increase has been 1.2 percent. Germany and France are the countries with the highest housing stock. The housing stock is about 4.2 million and 3.5 million in 2013, respectively. This suggests that, although the housing stock and

[5] The housing stock is a proxy for the total potential size of the housing market within a country. As such, it includes rental housing. To the extent that owner-occupancy rates do not change over the sample period (i.e. we only have 15 years of data), the differences in owner-occupancy rates are captured by the fixed effects. Unfortunately, there are no consistent owner-occupancy time series available for Europe. More importantly, the housing stock is an inherently endogenous process. Instead of increasing the dimensionality of the system of equations, we decided to use the ratio of turnover and housing stock as dependent variable, which reflects our main research focus.

turnover are highly correlated (correlation coefficient of 0.77), the correspondence between housing stock and turnover is not one-for-one. Especially interesting is the turnover rate: the number of transactions as a fraction of the housing stock. This variable gives a better and more comparable indication of the demand side pressures in each of the European housing markets. Figure 2 shows the average turnover rate for each of the selected European countries. There is considerable heterogeneity in this rate. In countries such as Norway about 8 percent of the total housing stock is sold each year. Instead, in a country such as Greece this is 2 percent. We are particularly interested to examine how these differences (and their changes over time) can explain the different experience in terms of price dynamics in European countries.

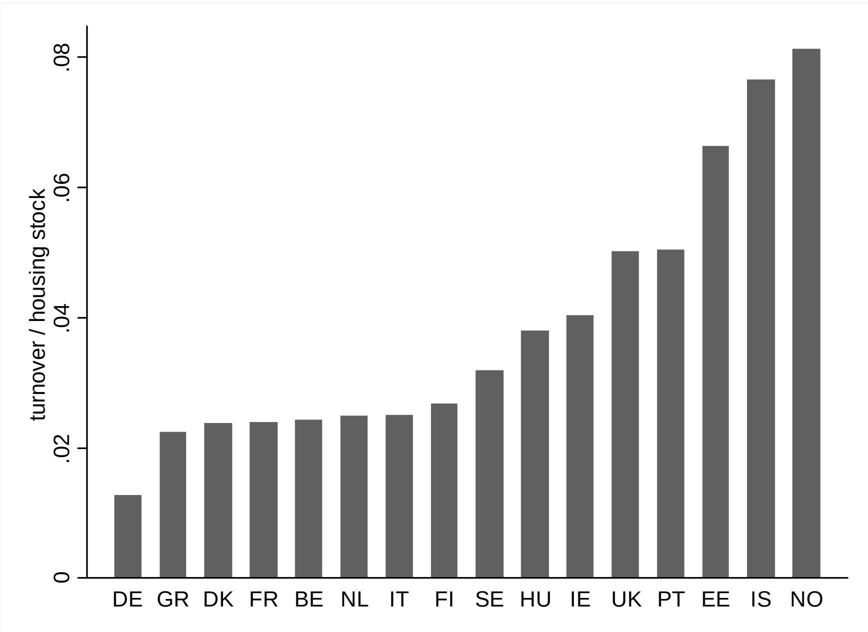

FIGURE 2 — THE TURNOVER RATE IN DIFFERENT EUROPEAN COUNTRIES

Notes: Based on data from 1999-2013. The turnover rate is the number of transactions relative to the total housing stock. This figure reports the average turnover rate (between 1999-2013) per country.

C. *Other macro-economic indicators*

There are several other factors that we include in the analysis as exogenous control variables. In particular, we include two mortgage market indicators: the outstanding mortgage loans to GDP and the interest rate on new mortgage loans. The average loan-to-GDP is 52 percent. This ratio has been increasing in most countries over time with a stabilization or decline as a result of the financial crisis. Interestingly, the loan-to-GDP has been decreasing during the sample period for Germany. In 2013, the lowest loan-to-GDP ratios are in Hungary (19 percent) and Italy (23 percent). The highest ratios are in Iceland (159 percent) and the Netherlands (104 percent). The loan-to-GDP ratios an indicator of the amount of credit consumed. It is a proxy for credit constraints in the economy. Instead, the interest rate measures the price of credit and it is therefore an indicator of the availability of credit. In all countries, the interest rate is currently low. The interest rates are highest in Hungary (12.1 percent), which can probably explain why the loan-to-GDP ratio is so low in this country. In Sweden and Finland mortgage credit is cheapest with an interest rate of 3.7 percent.

Further macro-economic factors include GDP, population, inflation, and the share of young population (between the years of 18 and 30) in a country. Countries with a high share of young population are more likely to be affected by house price shocks. In particular, young people usually do not have a considerable degree of accumulated wealth and they are typically starters at the housing market. Older households might, to some extent, recoup losses on their house because buying a new house is typically also cheaper (see Sinai and Souleles, 2005). We are particularly interested whether this variable affects price and turnover dynamics. The share of young population in many countries, such as Belgium, Denmark, Germany, Sweden, The Netherlands, Norway, Iceland, shows a U-shaped time series pattern. On average, the lowest share of young population is in Germany, about 15.4 percent. Finally, average growth in GDP between 1999-2013 has been 3.6 percent and inflation about 2.7 percent. Average GDP Growth has been highest in Estonia, 8.7 percent, and lowest in Iceland, 1.8 percent. Iceland virtually went bankrupt due to the financial crisis which affected its economic growth severely. In conjunction with a high inflation rate of 5.0 percent (only Hungary had higher inflation, 5.8 percent), Iceland's real GDP growth has been -3.7 percent. Instead, Estonia had the highest real GDP growth, 4.6 percent.

D. Stationarity

A well-known fact is that many macro-economic time series are potentially non-stationary. Table 4 contains the Fisher type of test (based on the Dickey-Fuller test) of non-stationarity. The null hypothesis is that all panels are non-stationary versus the alternative that at least one panel is stationary. We only report the inverse chi-squared statistic. The inverse normal, inverse logit, and modified inverse chi-squared statistic gave very similar results.

Table 4 suggest that log normalized turnover, loan-to-gdp, and log (real) GDP are non-stationary. Interestingly, house prices turn out to be stationary (in at least one of the panels). Typically, we would expect house prices to be non-stationary. It might be that the time series are too short for house prices to be non-stationary. On the other hand, the results also hinge on including a trend. Excluding a trend in the Dickey-Fuller test results in an inverse chi-squared statistic of 33.50 (p-value of 0.394). In any case, given the evidence about non-stationarity of several of the variables, and the overwhelming evidence that the variables are stationary in differences, we decided to include all variables in first-differences in the regression analysis.

TABLE 4 — STATIONARITY: PANEL UNIT ROOT TESTS

	Levels		Differences	
Variable	Inverse Chi-sq.	p-val.	Inverse Chi-sq.	p-val.
Log house prices (index)	59.63	0.002	51.39	0.016
Log real house prices	53.25	0.011	48.26	0.033
Log number of transactions	29.44	0.600	57.62	0.004
Log turnover rate (trans./housing stock)	31.32	0.501	64.67	0.001
Outstanding mortgage balance to GDP (%)	33.49	0.395	78.44	0.000
Interest rate new mortgage loans (%)	70.29	0.000	105.29	0.000
Real interest rate (%)	50.04	0.022	202.23	0.000
Log GDP (euros, current prices)	22.02	0.907	60.44	0.002
Log real GDP	24.29	0.834	64.40	0.000
Log population (in millions)	97.00	0.000	46.05	0.005
Share of population between 18 and 30 years of age	63.18	0.001	29.23	0.607
Log HICP (level index)	56.81	0.004	91.59	0.000
Log inflation	49.48	0.025	196.50	0.000
Sample period	1999-2013 (15 years)			
Number of countries	16			
Null hypothesis: All panels unit root	Alter.: At least one panel stationary			

Notes: Fisher type of test based on the Dickey-Fuller test. All the tests on the level variables are based on the demeaned variables to account for cross-sectional dependence and include one lag, to account for serial correlation, and a trend. For the tests on the differenced variables we do not include a trend.

E. Cointegration

Given that several of the variables are non-stationary, it might be that they are cointegrated. Table 5 reports residual-based cointegration tests (again the Fisher test) of several different cointegrating vectors. We estimated those vectors with (ordinary least squares) OLS but also using dynamic OLS (DOLS). In case of panel data, ordinary OLS leads to inconsistent estimates (Kao and Chiang, 2000). Although there are alternative estimation methods, such as fully modified OLS, it turns out that the DOLS estimator outperforms most other alternative estimators (Wagner and Hlouskova, 2009). For the DOLS estimates, however, we need full time series (1999-2013). Unfortunately, we only have such series for 9 of the countries.

TABLE 5 —COINTEGRATION

Cointegrating vector	Inverse Chi-sq.	p-value
OLS		
Log house price, log turnover rate	9.22	1.000
Log house price, log turnover rate, log GDP	81.19	0.000
Log house price, log turnover rate, log GDP, loan to GDP	31.74	0.480
DOLS		
Log house price, log turnover rate	4.62	0.999
Log house price, log turnover rate, log GDP	33.53	0.014
Log house price, log turnover rate, log GDP, loan to GDP	20.58	0.301
Null hypothesis: No cointegration		

Notes: Fisher type of test based on the Dickey-Fuller test. One lag and a time trend are included in the Dickey-Fuller equations. The estimated cointegration equations include fixed effects.

The results in Table 5 indicate that there is mixed evidence for a generally applicable European cointegration mechanism. This does not imply that there is no cointegration in some of the countries but that, on average, we do not find much statistical evidence of such a mechanism. Even if, in some of the cases we tried (e.g. with turnover and GDP), we did find some evidence of cointegration, the (estimated) adjustment parameter on the resulting error correction mechanism in the price or turnover model would be close to zero or, for example, some of the long run equilibrium parameters would be statistically insignificant. Given these consideration, we decided not to use an error correction approach.

III. Methodology

We estimate the following reduced form bivariate panel vector autoregressive, PVAR(1), model with price and the normalized turnover as dependent variables:

$$\begin{bmatrix} \Delta\log p_{it} \\ \Delta\log trate_{it} \end{bmatrix} = \begin{bmatrix} \Delta\tau_{1,t} \\ \Delta\tau_{2,t} \end{bmatrix} + \begin{bmatrix} \gamma_1 & \delta_1 \\ \gamma_2 & \delta_2 \end{bmatrix} \begin{bmatrix} \Delta\log p_{it-1} \\ \Delta\log trate_{it-1} \end{bmatrix} + \begin{bmatrix} \beta_1{}' \\ \beta_2{}' \end{bmatrix} \Delta x_{it} + \begin{bmatrix} \epsilon_{1,it} \\ \epsilon_{2,it} \end{bmatrix} \tag{1}$$

where $\Delta\tau_t$ are time fixed effects (differenced time dummies) and Δx_{it} are the differenced macro-economic variables (loan-to-GDP, interest rate, log GDP, log population, the share of young population, and log HICP), which are assumed to be exogenous.

As mentioned, we estimate the model in first differences because of the non-stationarity of many of the variables. As a result, the constant and the fixed effects are differenced out.

This also implies that, although we control for the fixed effects, we do not separately identify them. More importantly, although we estimate the model in first differences, the interpretation of the coefficients remains in levels. That is, as is customary, we use first differences as estimation method to identify the parameters of the underlying equation in levels.

Since both the price equation and turnover equation include a lagged dependent variable we use the standard Arellano-Bond (1991) approach and instrument the differenced lagged dependent variables with its second and third lag in levels. The γ_1 and δ_2 coefficients capture the autoregressive components (momentum) in prices and turnover, respectively. We would expect these coefficient to be positive. The coefficients δ_1 and γ_2 allow for (lagged) feedback between prices and turnover. If the turnover rate is regarded as predominately a demand side factor it should have a positive effect in the price equation (δ_1) and, conversely, an increase in house prices should decrease turnover (negative γ_2).

We estimate several versions of equation (1). First, we report a full model that includes all of the macro-economic variables (see above). We estimate equation (1) in a simple equation-by-equation fashion. In essence, this implies that we do not allow the error terms to be correlated across equations. Second, we estimate a more parsimonious model that only includes the interest rate and log GDP as macro-economic variables. Third, we decompose the lagged differenced log price in a positive and negative price change variables. This allows us to examine the effect of prices on turnover in a rising versus a declining market. Fourth, we reestimate equation (1) based on real prices, real interest rates, and real GDP. Finally, we show a joint estimate of the deflated model based on GMM. It turns out that, regardless of the choice of model and estimation procedure, the results are fairly robust.

IV. Results

A. Full model: The role of loan-to-GDP, population, and inflation

Table 6 reports the main regression results based on equation (1). Column 1 contains the results when a full set of macro-economic indicators are included in the regression equations. It turns out that changes in the outstanding mortgage balance to GDP, population, the share of young population between 18 and 30, and the HICP are not key determinants of the average price and turnover dynamics across European countries. In part, this can be explained by the fact that we estimate the effect of changes in the variables over time. That is, there may be substantial cross-sectional differences in, for example, loan-to-GDP and the share of young population, which could explain differences in price-turnover dynamics, but the changes over time are relatively small and do not contribute to explaining prices and turnover. Moreover, the fact that loan-to-GDP, as our measure of credit constraints, does not

TABLE 6 — THE PRICE-TURNOVER RELATIONSHIP IN EUROPEAN HOUSING MARKETS: PANEL VAR ESTIMATES
(Dependent variables: The logarithm of house prices and the logarithm of the turnover rate)

	(1)		(2)		(3)		(4)		(5)	
	Full model		Parsimonious model		Asymmetric model		Real house price model		Joint estimation	
	Δlog price	Δlog turn.	Δlog price	Δlog turn.	Δlog price	Δlog turn.	Δlog price	Δlog turn.	Δlog price	Δlog turn.
Δ log house prices [t-1]	0.520***	-0.307	0.503***	-0.446***	0.503***					
	(0.112)	(0.248)	(0.089)	(0.165)	(0.089)					
Δ log house prices + [t-1]						-0.345**				
						(0.150)				
Δ log house prices - [t-1]						-0.780**				
						(0.350)				
Δ log real house prices [t-1]							0.350***	-0.675***	0.341***	-0.737***
							(0.079)	(0.144)	(0.088)	(0.129)
Δ log turnover rate [t-1]	0.340**	0.414*	0.307*	0.578**	0.307*	0.588**	0.314**	0.750***	0.240*	0.595*
	(0.150)	(0.223)	(0.165)	(0.295)	(0.165)	(0.284)	(0.156)	(0.186)	(0.136)	(0.151)
Δ interest rate new mortgage loans [t]	-0.008**	-0.065***	-0.006	-0.069***	-0.006	0.070***				
	(0.004)	(0.010)	(0.004)	(0.014)	(0.004)	(0.014)				
Δ real interest rate [t]							-0.007	-0.045***	-0.006	-0.044***
							(0.006)	(0.011)	(0.004)	(0.009)
Δ log GDP [t]	0.215*	1.177***	0.219**	1.182***	0.219**	1.204***				
	(0.130)	(0.373)	(0.104)	(0.438)	(0.104)	(0.436)				
Δ log real GDP [t]							0.319***	1.119***	0.379***	1.135***
							(0.097)	(0.285)	(0.092)	(0.255)
Δ outstanding mortgage balance to GDP [t]	-0.001	-0.002								
	(0.009)	(0.003)								
Δ share of population between 18 and 30 years of age [t]	-1.817	1.946								
	(1.378)	(3.745)								
Δ log population [t]	1.113*	-1.910								
	(0.634)	(1.215)								
Δ log HICP [t]	0.188	-0.938								
	(0.449)	(1.103)								
Δ Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	177	172	177	172	177	172	165	160	160	160
Centered R^2	0.546	0.524	0.581	0.458	0.581	0.455	0.629	0.410	-	-

Notes: Based on data from 1999-2013 for 16 European countries. Clustered (country) standard errors are in parentheses. *, **, ***, 10%, 5%, 1% significance, respectively.

affect house prices and turnover is maybe not that surprising given that the estimated effect is conditional on interest rates and GDP: The key determinants of mortgage credit. Interestingly, the coefficient on the share of young population has a negative sign in the price equation and a positive one in the turnover equation. This might reflect that young households buy cheaper housing and are more mobile in the housing market.

Further results indicate that the consumer price index does not affect house prices and turnover. We would at least have expected that inflation affects house prices. Although the effect is positive, it is not statistically significant. This might be the result of the type of consumer price index we have used. The HICP is based on a basket of goods excluding housing. As such, the HICP measures general inflationary pressures on the economy. This is, at least to some extent, already captured by the time fixed effects. Instead, population increases does seem to affect house prices, although the evidence in favor of such an effect is relatively weak. A one percent increase in population increases house prices by one percent. Even though we estimated the equation using first-differences, note that the interpretation of the coefficients is in levels. The effect of an increase in demand due to more population may already been captured by the (normalized) number of transaction we included in the regression model.

It seems that, of all the macro-economic variables, especially interest rates and GDP are key determinants in explaining changes in house prices and turnover. An increase in interest rates of one percentage point increases prices by 0.8 percent. This is not a very large effect. Instead, it seems that the effect of interest rates mainly goes through turnover. A one percentage point higher mortgage interest rate decreases the turnover rate by about 6.5 percent. The same applies to GDP a one percent increase in GDP increases house prices by 0.22 percent while it increases the turnover rate by 1.1 percent. Lower interest rates and higher income makes it easier to obtain a sizeable mortgage, which is a prerequisite to buy a house. Measuring the effect of interest rates and GDP on house prices while ignoring their primary effect on turnover may lead to incorrect (biased) estimates. It would result in a misspecified model. It is, therefore, important to include turnover when examining price dynamics.

The most interesting part of the estimates reported in column 1 are the coefficient estimates on the lagged prices and turnover variables. In particular, there seem quite some persistence (momentum) in house prices and turnover. An increase in house prices of one percent in year t still has an effect of 0.5 percent in year $t+1$. Equivalently, there is a 40 percent intertemporal spillover of turnover between two consecutive years (autoregressive coefficient estimate of 0.414). Given market frictions, such as search and transaction costs, these finding were to be expected. The magnitude of these effects are, however, intriguing. Furthermore, the results indicate that turnover also has a lagged effect on house prices. An increase in turnover of one percent increases house prices by 0.34 percent the year after. Vice versa, prices have an effect of 0.31 percent on the turnover rate. These results are important because they imply that turnover dynamics are key in understanding price dynamics, a fact that is typically forgotten in studies about house price dynamics. We will go into more detail about the dynamics between prices and turnover (i.e. impulse response functions) in Section E. where we discuss the results of the joint estimation of the price-turnover equations. Finally, the estimates suggest that about 50 percent of the variation in prices and turnover are explained by the model.

B. A parsimonious model

Given that many of the macro-economic variables were not statistically significant, we also estimated a parsimonious model that is only based on interest rates and GDP, the two standard determinants in explaining house price dynamics. The estimation results are reported in column 2. It turns out that the regressions estimates are very similar. This validates our claim that loan-to-GDP, population, and inflation are not the key drivers of price and turnover dynamics. Prices, however, now have a statically significant effect on turnover – a one percent increase in prices decreases turnover by 0.45 percent. Also the lagged feedback between turnover is higher. The autoregressive feedback is now 58 percent instead of 41 percent. Finally, interest rates are no longer significant in the price equation of the panel VAR model.

C. Nominal loss aversion

In line with Genesove and Mayer (2001), we would expect that price declines have a different impact on the price-turnover relationship than price increases. As such, we decomposed the price change variables in the *turnover* equation in two parts: A positive price change (zero otherwise) and negative price change part. Basically, for simplicity, we assume that loss aversion has a direct effect on turnover (the decision to sell) and a subsequent (indirect) effect on prices.[6] The results are reported in Table 6, column 3. If prices decrease we would expect a larger negative effect than the positive effect of an equivalent price increase. Instead, the regression estimates indicate that a price decrease has a larger *positive* effect on turnover. A decrease in prices of one percent increases the turnover rate by 0.78 percent. A one percent increase in prices decreases turnover by 0.35 percent. Apparently, cheaper housing (ceteris paribus) increases housing demand (housing affordability) especially if prices are declining. This is against the classical loss aversion story and it suggests that there are maybe other factors, such as a in loss income, that explain why in case of an economic/financial crisis turnover and prices decrease simultaneously. Of course, our measure of loss aversion (price declines) is at best a very imperfect proxy and more likely measures general differences in price-dynamics during boom-bust periods. However, note that the price decrease and price increase coefficient, although quite different, are not statistically different from each other (Chi-squared of 1.62). This suggests that, with regard to turnover, we do not find much evidence of an asymmetric effect.

D. Real versus nominal house prices

If inflation is indeed not a key factor in explaining house prices and turnover, we would expect that using real house prices would not change our results. As a consequence, we reestimated equation (1) using real house prices, real GDP, and real interest rates. To create real interest rates, we substracted the expected inflation rate from the nominal interest

[6] There are not enough observations to run separate regressions for price increases and price declines. We did experiment with including a boom-bust interaction effect with the autoregressive component in the price equation. This interaction effect turned out to be statistically insignificant.

rates. To measure expected inflation we used a quite standard moving average filter with three lags of inflation and a decreasing weighting scheme (0.70; 0.20; 0.10). The result are reported in Table 6, column 4.

The regression estimates show a very similar pattern as before. The feedback between prices becomes a bit less (coefficient of 0.35) in comparison with the nominal price model. The effect of lagged prices and turnover on the turnover rate becomes a bit higher (coefficient of -0.68 and 0.75, respectively). The effect of a one percent increase in the real interest rate on turnover is 4.5 percent versus 6.9 percent in the nominal case. Especially the linear fit of the model in case of house prices is relatively good, 63 percent of the variation in house prices can be explained by the independent variables.

E. Joint estimation of the price-turnover equations

Finally, we used the parsimonious model and real values of prices, GDP, and interest rates, and estimated the price and turnover equations jointly using GMM, which is basically our most elaborate and preferred way of modeling the price-turnover dynamics. In essence, this approach allows cross-correlation between the error terms of the two equations, which basically implies that we take into account that there are potential common factors in house price and turnover shocks. This also implies that we have to use orthogonalized impulse reponse functions to examine the dynamic behavior of the system of equations. The estimation results of the GMM model are reported in Table 6, column 5.

Joint estimation of the price and turnover equation does not change the results by much. This is as expected. In principle, allowing for cross-correlation of the two symmetric equations should not impact the consistency but only the standard errors of our estimates. The result in column 5 indicate that turnover has a bit less, but still statistically significant, effect on (real) house prices. Real interest rates do still have a small and insignificant effect on house prices and the coefficient on GDP increases from 0.32 to 0.38. Also, the effect of real prices on turnover increases (coefficient of -0.74) in comparison with the equation-by-equation estimate. A one percent increase in the turnover rate has a 0.60 percent effect on real house prices, while an increase in the real interest rate of one percentage point decreases turnover by 4.4 percent. Finally, a one percent increase in real GDP increases prices by 0.38 percent and turnover by 1.1 percent.

F. Ignoring the feedback between prices and turnover leads to biased estimates

An important question is whether it is actually necessary to model both prices and turnover as two interdependent processes. Table 7, panel A, contains the results of the Granger causality test between real prices and turnover based on the jointly estimated model, reported in Table 6, column 5. The results indicate that prices Granger cause the turnover rate and, vice versa, turnover granger causes prices. This implies that it is essential to allow for interaction between prices and turnover. Not doing so may lead to dynamic misspecification. To get an indication of the bias as a result of such a misspecification, we reestimated the model without allowing for interaction (lagged feedback and error term correlation) between real prices and turnover. Table 7, panel B, contains the percentage bias based on the difference between the estimated coefficients. This is based on the assumption that the dynamic model is correctly specified and captures the true data generating process.

TABLE 7 — GRANGER CAUSALITY AND BIAS AS A RESULT OF DYNAMIC MISSPECIFICATION

Panel A: Granger causality prices and turnover

X granger causes Y	Chi-sq.	p-value
X → Y		
Log turnover rate ➔ log real prices	3.22	0.073
Log real prices ➔ log turnover rate	6.309	0.012

Panel B: Bias (%) as a result of dynamic misspecification

	Δlog real price	Δlog turnover rate
Δ log real house prices [t-1]	14.4 %	-
Δ log turnover rate [t-1]	-	-42.7 %
Δ real interest rate [t]	155.4 %	-21.1 %
Δ log real GDP [t]	21.4 %	3.2 %
Δ Year fixed effects (average bias)	-203.4%	-61.8%

Notes: Panel A reports the Wald test of granger causality. Panel B contains the percentage difference between the jointly estimated price-turnover model and the equation-by-equation estimate of the model without allowing for the (lagged) feedback between the price and turnover equation.

The results in Table 7, panel B, indicate that the bias as a result of dynamic misspecification is considerable. Relative to the dynamic model the misspecified model overestimates the AR(1) coefficient on prices by 14.4 percent. Part of the typical evidence about momentum in house price returns (see Case and Shiller, 1989; Lai and Order, 2010) can, thus, be attributed to the interaction between prices and turnover. The AR(1) coefficient on turnover is even underestimated by about 40 percent. Moreover, the coefficient on log real GDP is about 21.4 percent higher in the price equation and 3.2 percent higher in the turnover equation. The effect of interest rates is underestimated by 21.1 percent in the turnover equation. Given the small (and insignificant) effect of real interest rates on house prices it is not surprising to find a high relative bias of 155 percent in the price equation. This particular bias estimate is, therefore, not very meaningful. Finally, the estimated price trends in both the price and turnover equation are severely underestimated. This implies that, for example, price indices that are based on a model that does not take into account the number of underlying transactions, or equivalently the related concept of time on market, should be interpreted with caution. It, again, underlines that a liquidity adjustment, such as for example suggested by Fisher et al. (2003) or Goetzmann and Peng (2006), is essential to correctly measure time trends.

G. Impulse response functions

Figure 3 depicts the eigen values (two endogenous variables) based on the jointly estimated VAR model (γ, δ matrix). If these values are within the unit circle, shocks to the system are eventually absorbed such that the VAR process itself is stationary. Since we are talking about (growth in) prices and turnover, from a long run perspective we would expect a stable process. If this would not be the case it would be a potential indication of misspecification, for example as a result of not including the correct number of lags in the VAR model. Alternatively, we might not have appropriately taken into account a potential error correction mechanism. As such, the results in Figure 3 – the eigen values are inside the unit circle – suggest that the modelled VAR process is stable and correctly specified.

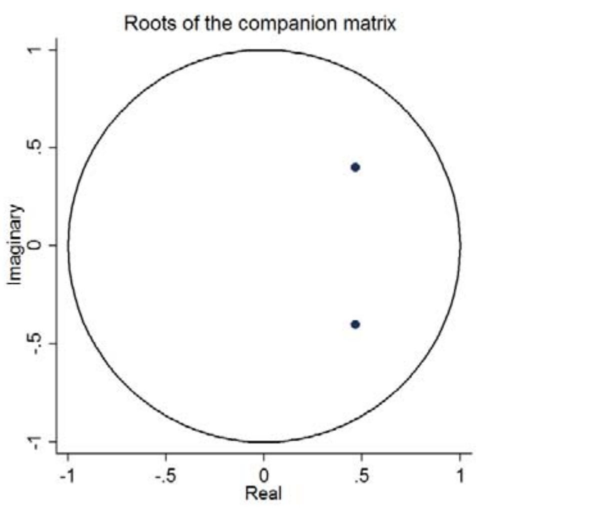

FIGURE 3 — STABILITY OF THE VAR MODEL

Notes: Based on the jointly estimated real price-turnover panel VAR model (data from 1999-2013). This figure reports the eigen values based on the price-turnover coefficient matrix.

Figure 4 contains the cumulative impulse response functions between real prices and the turnover rate based on the jointly estimated price-turnover model (see Table 6, column 5). In essence, these impulse response functions allow us to examine the dynamic impact of shocks in prices and turnover as they propagate through the system of equations. Since we allow for cross-correlations across shocks (error terms) the impulse response functions are not unique and depend on the ordering of the variables. In Figure 4, we chose the ordering in such a way that turnover is allowed to have an immediate impact on prices. Appendix B reports the results in case of a reverse ordering. The results turn out to be similar in terms of both the order of magnitude and pattern. Only the effect of prices on turnover turns out to be substantially less.

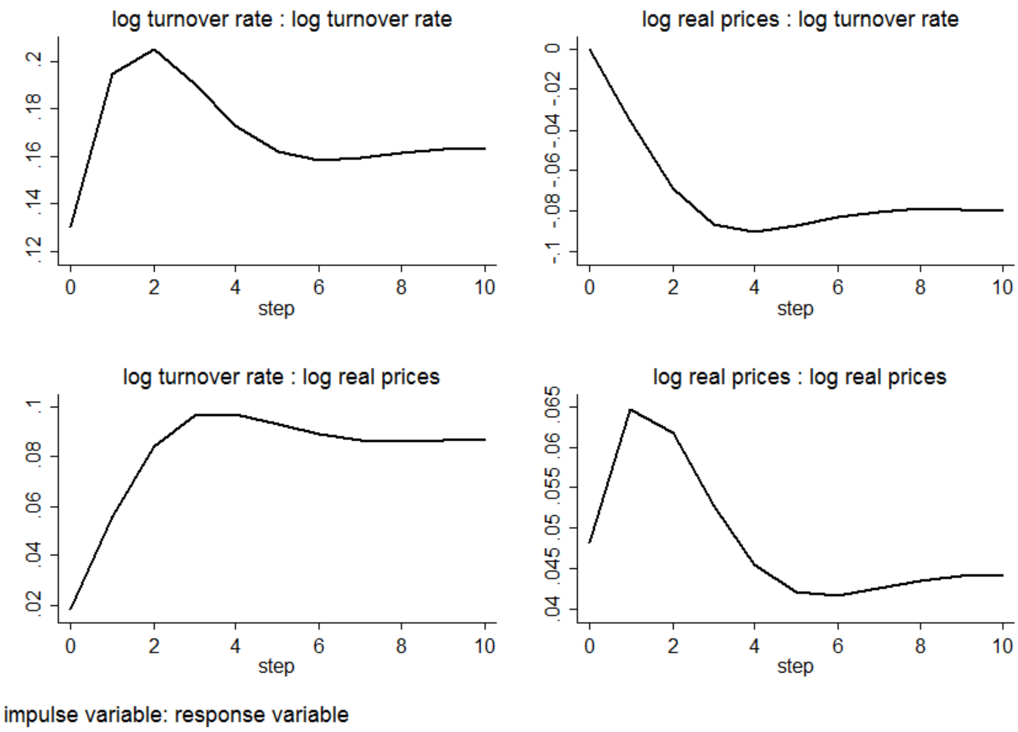

FIGURE 4 — CUMULATIVE IMPULSE RESPONSE FUNCTIONS HOUSE PRICES AND TURNOVER

Notes: Based on data from 1999-2013. The turnover rate is the number of transactions relative to the total housing stock. This figure reports the orthogalized impulse response functions (Cholesky ordering: turnover, prices).

The impulse response functions in Figure 4 show several important results. A unit shock, a one percent change, in turnover has a persistent effect on turnover and prices of 0.16 and 0.08 percent, respectively. Vice versa, the long-run elasticity as a result of a unit shock in (log) real prices is -0.08 percent with respect to turnover and 0.04 percent with respect to prices. Except for the persistency in turnover, the other long run (10 years) effects are very close to zero. This suggest that the price-turnover correlation is most likely the result of repeated shocks to the housing market that result in both a short-run autoregressive effect in prices and turnover and lagged feedback between the two. The autoregressive effect in prices and turnover seems to peak after one to two years after which its effect dissipates over time. The effect of turnover on prices peaks after 4 years and is exactly opposite to the effect of prices on turnover. As such, price increases in themselves, ceteris paribus, seem to weaken the positive correlation between prices and turnover (i.e. negative impact coefficient). The autoregressive, momentum, effects and the impact of turnover on prices, however, seem to outweigh this negative effect. Finally, it is important to note that the exogenous shocks in prices and turnover can also be interpreted in terms of shocks in interest rates and GDP. A one unit shock in log prices is equivalent to a 2.6 percent increase in GDP (1/0.379, see Table 6, column 5). Alternatively, a one unit shock in turnover is equivalent to a 0.88 percent increase in GDP and a 0.23 percentage point increase in real interest rates.

H. Decomposition of house price dynamics in the UK, Germany, and France

It is quite standard to show a forecast error variance decomposition based on the estimated VAR model. The purpose of this paper, however, is not to forecast house price dynamics. Instead, Table 8 reports a historical decomposition – a very much related concept – of house price dynamics based on the jointly estimated VAR model.

TABLE 8 — DECOMPOSITION OF HOUSE PRICE DYNAMICS

	UK	France	Germany	EU
Δ log real house prices	6.5 %	6.8 %	4.0 %	6.7 %
Δ log turnover rate	13.4 %	7.5 %	25.3 %	12.4 %
Δ real interest rate	0.4 %	0.5 %	1.5 %	0.4 %
Δ log real GDP	3.6 %	0.6 %	2.4 %	1.2 %
Unexplained shocks	76.1 %	84.7 %	66.8 %	79.2 %
Total	100 %	100 %	100 %	100 %

Notes: This table reports a historical decomposition of real house price dynamics based on the jointly estimated price-turnover model. The results are based on data from 1999-2013 for 16 European countries. The average contribution of each factor is reported.

In essence, we calculate the changes (shocks) in house prices, turnover, GDP, and real interest rates between 1999-2013 and use the IRF's to calculate the (accumulated) predicted responses to house prices. The difference with actual price changes remains unexplained variation. This includes general economic trends, EU-wide shock, but also (time-varying) country-specific shocks. Relative to the actual year-to-year price changes we can calculate the percentage contribution of each factor. Table 8 reports the average contribution for the EU (average shocks), UK, Germany, and France. We took the average value of the negative contributions and normalized the resulting decomposition such that it adds up to 100 percent. As mentioned, we imposed the restriction that the marginal effects are the same (we basically measure the average effect) across countries. Nevertheless, the total (decomposed) effect for each country can differ. This allows us to examine which factors are the most important in explaining house price dynamics and how this varies across countries.

The results in Table 8 indicate that, besides the unexplained shocks in house prices, the turnover rate is key in understanding house price dynamics. Based on EU (16 countries) average changes in the variables, changes in the turnover rate explain about 12.4 percent of real house price changes. The contribution of house price shocks on subsequent prices changes is the next important factor with a contribution of 6.7 percent. Real GDP and real interest rates have a contribution of 1.2 and 0.4 percent, respectively. These results imply that, from a dynamic point of view, it is especially the feedback between prices and turnover and the momentum in prices, and not so much the shocks in the underlying fundamentals, which explains house price dynamics.

There is also quite some variation in these contributions across countries. In particular, we have used the VAR model to decompose price dynamics in the UK, France, and Germany. In Germany, the turnover rate explains about 25.3 percent of house price dynamics. Prices in Germany are relatively stable (actually during the sample period real house prices have been declining by -0.5 per year). In part, our results suggest that this is due to a more steady rate of sale relative to the housing stock (1.2 percent per year) relative to other countries. Instead, in France, changes in the turnover rate play a less important role in house price dynamics (contribution of 7.5 percent). The intertemporal spillovers in real house prices themselves are more important (contribution of 6.8 percent), relative to Germany, in explaining the quite high house price increases in France (3.9 percent on average per year). Apparently, country-specific shocks, which could be anything from changes in policy to economy wide trends, are far more important in France than in other countries.

Finally, the UK seems to be in between these two cases.[7] Turnover shocks explain about 13.4 percent of price changes. When the financial crisis hit the UK in 2008 and real prices decreased with 4.5 percent in 2008 and 10.2 percent in 2009, the turnover rate dropped substantially as well, by 60 percent in 2008 and an additional 5.5 percent in 2009. A decrease in real GDP of 27 percent in 2008 also had a detrimental effect. In the UK, shocks in GDP have had about three times the percentage impact on house price changes in comparison with the EU in total. In sum, the results in this section imply that price dynamics in many of the European housing markets are driven by similar key factors even though the actual price dynamics has been substantially different across countries.

[7] For a discussion on the price dynamics in the UK versus Germany in the 1970s, 1980s, and 1990s, see Muellbauer (1992).

V. Conclusion and discussion

Prices and turnover in housing markets are positively correlated. Those markets with the strongest correlation between prices and turnover are also those markets which are the most volatile. This paper has investigated the price-turnover relationship across 16 European countries. The panel VAR estimates indicate that there is strong feedback between house prices and turnover. A one percent increase in (lagged) real prices decreases turnover by 0.74 percent. Vice versa, a one percent increase in the turnover rate increases real prices by 0.24 percent. There is also quite some momentum in prices and turnover which can in part explain why they are so highly correlated. The autoregressive coefficient on house prices is 0.34 and in the turnover equation it is 0.60. Key other determinants of prices and turnover are GDP and the interest rate on (new) mortgage loans. The effect of GDP and interest rates on house prices mainly goes through turnover. Interestingly, the outstanding mortgage balance to GDP, population increases, the share of young population, and inflation are not found to be key in explaining price and turnover dynamics. We do not find evidence of nominal loss aversion. Instead, price declines seem to increase turnover, ceteris paribus, which is in line with improved housing affordability if prices decrease. A historical decomposition of real house price dynamics shows that, besides unexplained shocks, turnover and lagged house price changes explain most of the changes in house prices, with a EU-wide (16 countries) contribution of 12.4 percent and 6.7 percent, respectively. There is considerable variation in these contributions across countries.

The results in this paper imply that, to understand house price dynamics, it is essential to model both house prices and turnover simultaneously. Especially the feedback between prices and turnover is essential to explain house price dynamics. Our results show that ignoring this feedback leads to considerable bias in the price and turnover regression coefficients. For example, the autoregressive coefficient in the house price model is overestimated by 14 percent if turnover is not explicitly taken into account. The overestimation of the autoregressive coefficient also suggests that part of the momentum in house prices, a typical finding in the housing market literature, can be explained by the feedback between prices and turnover.

There is an increasing interest in the impact of the liquidity of real estate on housing market returns. This paper contributes to the existing literature by explicitly highlighting the important role of turnover in house price models. As more data on house prices and turnover will come available in the coming years it will be possible to better differentiate between the differences in house price dynamics, and the determinants of such differences, across European countries. Moreover, it would allow us to examine the short- versus long-run dynamics in house prices in more detail. House prices and turnover are two endogenous processes that are interrelated. A natural extension would be to also allow construction (the housing stock) to be endogenous.

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Appendix

A. Time series plots house prices and transaction volume

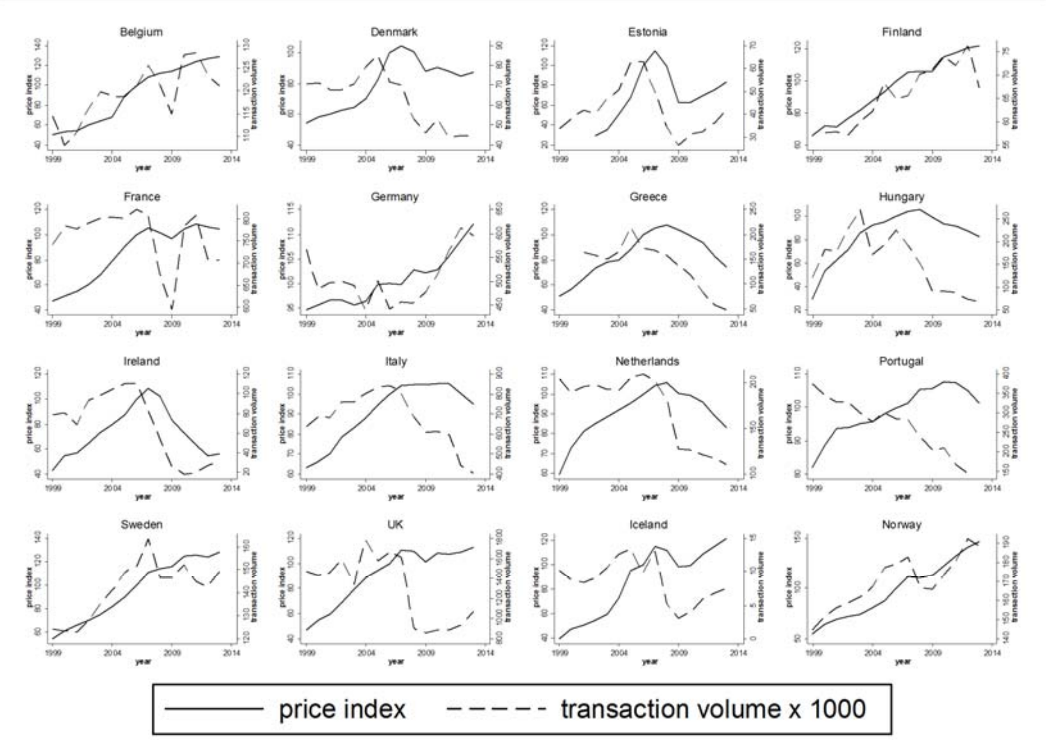

FIGURE A1 — HOUSE PRICES AND TRANSACTION VOLUME

Notes: Time series plots of house price indices and transaction volume for 16 European countries. Based on data from 1999-2013.

B. Impulse response functions, alternative ordering

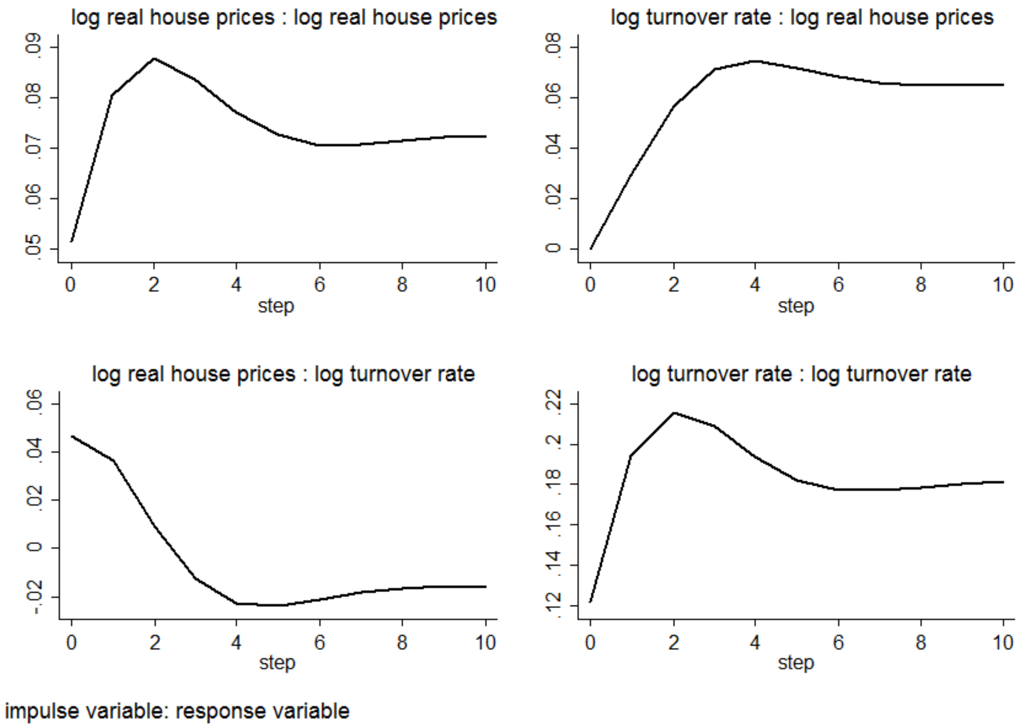

FIGURE B1 — IRF, HOUSE PRICES AND TURNOVER, ALTERNATIVE ORDERING

Notes: Based on data from 1999-2013. The turnover rate is the number of transactions relative to the total housing stock. This figure reports the orthogalized impulse response function (ordering: prices, turnover).