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Abstract

This paper analyzes the tax effects of the German real estate transfer tax (RETT). While the vast majority of single-family houses in Germany are owner-occupied, apartments are usually held by private and incorporated investors. For this reason, we conducted a regression analysis to determine the effects of increasing RETT on the number and the prices of transactions separately for these two market segments. Our findings suggest that increasing the RETT by 1% is associated with a decline in transactions by 0.23% for single-family houses, but with no significant effect on the prices of traded houses. Conversely, for apartments, we find no significantly negative effects on the transactions, but the price effect of the RETT tends to be negative. Finally, for vacant lots, we find even larger quantity effects than for single-family houses suggesting roughly an elasticity of -1. The results for this specific market segment indicate that the government operates near the top of a Laffer curve.

Keywords: real estate transaction tax, stamp duty, housing market, taxation, financial transaction tax

JEL classification: H24, R21

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1 Introduction

While taxes on the transfers of housing properties are pervasive around the world, until recently, the economic effects of these taxes have received only limited attention from economists (Dachis et al., 2011).[1] However, real estate transfer taxes (RETTs) have obvious negative effects on the efficiency of the housing market such as reducing the number of mutually beneficial transactions. As the tax can be avoided by not selling a presently owned property and buying a different house, the tax is expected to lead to a fall in transactions, a reduction of mobility of homeowners, and may bias homeownership away from frequent movers towards infrequent movers (O'Sullivan et al., 1995). Even for immobile owners, the tax may lock-in owners into dwellings that do not suit their preferences. For example, the tax may prevent older couples and singles, who have a reduced demand for space, from making their houses available to large families.[2]

Moreover, a RETT not only affects transactions concerning owner-occupied housings. In several countries, including Germany, the tax will also fall on changes in ownership of property that is rented out and held as a capital investment. In this case, the tax will not reduce the mobility of the respective dwellers, i.e. the tenants. Indeed, frequent movers may actually self-select into the rental market to avoid transfer taxes. Instead, the transfer tax in this situation may be considered as a specific financial transaction tax that reduces the fungibility of the asset, but not worker mobility. Empirically, the average holding period of apartments, which are usually rented-out, at least in Germany, is shorter than the holding period of houses that are usually owner-occupied.[3] Hence, the asset fungibility problem should therefore be more salient in the case of apartments. As a result, if fungibility is more highly valued in the case of apartments than in

[1] For an overview of land transfer taxes in the EU, see European Commission (2015, chap. 3.2).

[2] According to survey evidence provided by Sánchez and Andrews (2011, p. 15), family and housing related motives are behind most cases of residential mobility in many developed countries.

[3] For the different ratios of transactions and the stock of houses and apartments see, e.g., Deutsche Bundesbank (2015).

the case of houses, then a high transfer tax rate should tend to reduce asset values of apartments more than for single-family houses.[4]

Indeed, a major distinction between single-family houses and apartments is connected to ownership. While some 81% of the families that are living in owner-occupied housing own a single-family house, only 19% live in an apartment.[5] At the same time, single-family houses account for less than a third of all German housing units. This suggests that, unlike single-family houses, the vast majority of apartments are held as a form of capital investment.[6]

From the above discussion, one may expect that an increase in the RETT may lead to a fall in transactions and a reduction in prices, where the latter effect, because of higher turnover rates, may be more pronounced for apartments than for houses. As a further market segment, we consider sales of vacant lots that may either be used for apartments or single-family homes.

In this paper, we will look for such price and quantity effects of the RETT in the German property market. Until 2006, there was a tax rate of 3.5% on the purchase price of German real estate (*Grunderwerbsteuer*) that was uniformly applied in all states (*Bundesländer*), although the revenues accrue to the state in which the transaction takes place. Since 2006, the RETT is no longer set at the federal level. Instead, each of the 16 German states is not only entitled to receive the tax revenue, but may decide on its own individual rate. The current level of the land transfer tax in Germany varies between 3.5% and 6.5%.

Our panel data regressions exploit these state differences in order to examine the tax effects on state-wide indices of property transactions and transaction prices. Our findings can be summarized as follows. For single-family houses, we find that a one percent increase of the tax rate leads to a fall of some 0.23 percent in the

[4] In Germany, single-family houses are defined as property with just one housing unit, i.e., detached houses, semi-detached houses and terraced houses.

[5] Statista (2016); Based on a simulation model, Kaas et al. (2017) recently concluded that the RETT is partly responsible for the low German ratio of self-occupied housing.

[6] It should be noted that a RETT is also triggered by direct or indirect transfers of at least 95% of the interest in a partnership or of shares in a company owning real estate in Germany.[6] The tax can be avoided if only 94.9% are sold to a single buyer or by having the shareholder either keep the remaining 5.1% or sell it to a second one not connected to the other shareholder.

number of transactions. At the same time, there is an insignificant effect on transaction prices. Conversely, for apartments, the effect of a tax increase is insignificant when it comes to the number of transactions, but there tends to be a negative effect when we look at transaction prices. These differences between types of tenure, to the best of our knowledge, have not received attention in the literature. They may reflect that, in contrast to single-family houses, apartments may be viewed as capital investments where an increase in the transaction tax leads to a loss of asset value due to reduced fungibility. What is more, we find the largest tax elasticity of transactions for vacant lots. For this market segment our result of a unit elasticity of sales suggests that the top of the Laffer curve is reached, where a tax increase does not raise additional tax revenues.

The reminder of the paper is organized as follows. Section 2 presents a literature review of recent papers on the economic effects of RETTs. Section 3 provides an introduction to the effect of transaction taxes on asset values. Section 4 contains our empirical results before Section 5 concludes.

2 Literature Review

While for a long time RETTs have been largely neglected, recently several papers examined the empirical effects in various countries.

Some of the studies rely on panel data with different tax changes in different regions of a country. Dachis, Duranton and Turner (2008) analyze the impact of the introduction of a 1.1% land transfer tax in Toronto that did not apply in the surrounding region. They find that the introduction of the tax resulted in a 16% fall in housing sales and a 1.5% reduction in housing values. Davidoff and Leigh (2013) estimate that the Australian stamp tax on house sales lowers house prices with a tax elasticity around 0.26 and reduces housing turnover with an elasticity of 0.3.

There is also a growing literature that uses tax notches, i.e. discontinuities in the tax schedule, for the identification of tax effects.[7]

[7] See Hilber and Lyytikainen (2013), Best and Kleven (2013), Kopczuk and Munroe (2015), Besley et al. (2014), Slemrod et al. (2016).

Most of these studies find significant effects of RETTs on the transaction volume in the market.

Despite the fact that the German tax rates have now been regionally differentiated for ten years, there has been only limited research on the empirical effects of the German RETT. Fritzsche and Vandrei (2016) look at single-family house transactions in six of the sixteen German states. Their estimates suggest that a one-percentage-point increase in the RETT reduces transactions by 6%. By using the average tax rate in their sample (4.17%), this semi-elasticity corresponds to an elasticity of -0.25. This magnitude is confirmed by our own results that are based on the full set of states. In a recent discussion paper, Buettner (2017) looks at the tax rate elasticity of tax revenues and finds that across the German federal states a one percent tax increase leads to significantly less than a one percent increase in revenue, which is interpreted as evidence for behavioral effects and a sizable excess burden.

While the present paper is certainly not the first paper that examines the behavioral effects of a RETT, to the best of our knowledge it is the first that distinguishes between prices and transactions for apartments and single-family houses and additionally presents results for sales of vacant lots. Moreover, the paper also uses a new data source that has not previously been employed to study tax effects.

The distinction between apartments and single-family houses is potentially very important, at least for the German housing market. As highlighted above, the rate of self-occupancy is much different for single-family houses and apartments. While transaction taxes, therefore, may reduce labor mobility or increase commuting when applied to single-family homes, the main effect for apartments may be a reduced asset fungibility. Thus, the next section provides a short introduction into the relevant theory of transaction taxes.

3 Transaction Taxes and Asset Values

Transaction taxes are not only prominent when it comes to property sales. They have recently also received large attention in connection to the plans for a EU-wide financial transaction tax. The literature on financial transaction costs argues that such costs may not only reduce the number of trades, but also asset prices.[8] Clearly, transaction taxes are part of the transaction costs. The insight that a transaction tax can be expected to decrease asset values, however, is not restricted to financial assets but extends to real assets that are subject to a transaction tax in the case of an ownership change.[9]

Following Matheson (2011, 2012), assume that an asset produces a real cash flow, say a net rental income, of CF_t at time t, that for simplicity may be assumed to grow at an exogenous rate g and is discounted at an exogenous interest rate $r > g$. Each time the asset changes owner, an ad valorem tax at rate T has to be paid on the transaction. If the holding period of each owner of the asset is constant and denoted by N, then the tax inclusive price at time 0 that a purchaser may pay the incumbent owner can be written as

$$V(0) = \int_0^N CF_t \cdot e^{-(r-g)t} dt + (1-T)e^{-rN} V(N). \qquad (1)$$

In such a simple framework, it can be shown (Matheson, 2011, p. 39-41) that the proportional reduction of the tax inclusive purchase price can be expressed as

$$\Delta(T) = \frac{Te^{-(r-g)N}}{1-(1-T)e^{-(r-g)N}} . \qquad (2)$$

Table 1 illustrates this result for $r - g = 1\%$ and different holding periods N. Clearly, the shorter the holding period, the larger the negative impact of a given tax rate on the transaction price. We will come back to this insight in the empirical section below.

Another observation that may be highlighted is that the price fall described by equation (2) is triggered even with a constant holding period N. This in turn implies that a price decrease may not necessarily require a reduction in transaction volume, which would be reflected in longer holding periods.

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[8] See Amihud and Mendelson (1986).

[9] A distinct issue is that in both markets (housing, financial assets) there is the question whether a transaction tax can reduce market bubbles. We do not embark on this question here.

Table 1. The Interplay of Holding Period and Proportional Reduction of Asset Value

Holding Period (years)	5	10	30	100
Tax rate 3%				
Δ(3%)	36.9%	22.2%	7.9%	1.7%
Tax rate 6%				
Δ(6%)	53.9%	36.3%	14.6%	3.4%

Note: Based on equation (2) and $r - g = 0.01$. For a similar table adapted to holding periods and tax rates of financial securities cf. Matheson (2012).

Several authors have been surprised by their large estimated tax effects, which sometimes suggest that a one euro increase in the land transfer tax leads to a more than a one euro drop in house transaction prices (see, e.g., Davidoff and Leigh, 2013, p. 403; Kopczuk and Munroe 2015; Ihlanfeldt and Shaugnessy, 2004). The tax capitalization effects illustrated in Table 1 are a potential explanation for these findings. As a once and for all tax increase will affect all future transactions, capitalization effects may well exceed the tax due on a single transaction today, in particular, if the average holding period of real estate is short.

4 Empirical Results

In this section, we use the panel variation of RETT rates across German states to evaluate their impact separately on transactions and prices in different segments of the property market. Table 2 illustrates the development after the decentralization of the tax rate decision, following a constitutional change enacted in 2006.[10] Since then, only two states (Bavaria and Saxony) have kept the initial rate of 3.5%. All other states have raised the tax rate at least once. The tax rate is applied on the transaction value as fixed in the contract drawn up before a notary. Formally, the buyer of the property is required to pay the tax and the change of ownership is pending until the tax payment has been received. While the decision on tax rates has been decentralized, all states have to follow the same definition of the tax base.

[10] *Gesetz zur Änderung des Grundgesetzes*, 28 August 2006 (BGBl. I 2006, p. 2034).

Table 2. German RETT Rates in Percent of Purchase Price

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Baden-Wurttemberg	3.5	3.5	3.5	3.5	3.5	3.5	5.0	5.0	5.0	5.0	5.0
Bavaria	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Berlin	3.5	3.5	4.5	4.5	4.5	4.5	4.5	5.0	5.0	6.0	6.0
Brandenburg	3.5	3.5	3.5	3.5	3.5	3.5	5.0	5.0	5.0	5.0	5.0
Bremen	3.5	3.5	3.5	3.5	3.5	3.5	4.5	4.5	4.5	5.0	5.0
Hamburg	3.5	3.5	3.5	3.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Hesse	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	5.0	6.0	6.0
Mecklenburg-Vorpommern	3.5	3.5	3.5	3.5	3.5	3.5	3.5	5.0	5.0	5.0	5.0
Lower Saxony	3.5	3.5	3.5	3.5	3.5	3.5	4.5	4.5	4.5	5.0	5.0
North Rhine-Westphalia	3.5	3.5	3.5	3.5	3.5	3.5	5.0	5.0	5.0	5.0	6.5
Rhineland-Palatinate	3.5	3.5	3.5	3.5	3.5	3.5	3.5	5.0	5.0	5.0	5.0
Saarland	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4.5	5.5	5.5	6.5
Saxony	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Saxony-Anhalt	3.5	3.5	3.5	3.5	3.5	4.5	4.5	5.0	5.0	5.0	5.0
Schleswig-Holstein	3.5	3.5	3.5	3.5	3.5	3.5	3.5	5.0	5.0	6.5	6.5
Thuringia	3.5	3.5	3.5	3.5	3.5	3.5	5.0	5.0	5.0	5.0	5.0
Average Tax Rate	3.5	3.5	3.6	3.6	3.6	3.7	4.2	4.6	4.8	5.0	5.3

Note: Tax rates are shown as applicable in January of the respective year.

4.1 Price and Quantity Effects

In the following, we make use of indices of property transactions and average purchase prices that have been generated at the state level. For single-family houses and apartments, the data on the real estate transactions for the period between 2003 and 2014 for all 16 federal states in Germany is proprietary data that has been provided by GEWOS GmbH, Hamburg. For vacant lots, there is data from the German Statistical Office. Transactions are divided into three groups: single-family homes, apartments, and vacant lots.[11] For the first two groups, the base year, 2003 has an index of 100 in all states. The number of property transactions in the following years has been compared to this base year and adjusted accordingly. In the case of vacant lots, we use data on the area sold. For the estimation of the price effects, we operate with the average purchase prices (given in €1.000) of single-family homes and apartments for the period between 2003 and 2014 as provided by Statista. Data by the German

[11] In German: *Einfamilienhäuser*, *Eigentumswohnungen and Bauland.*

Statistical Office on the average price per square meter (on the state-year level) is taken for vacant lots.

Using the transaction numbers, we exploit a panel data structure. Table 3 in panels A, B, and C presents the results that are separately calculated for single-family homes, apartments and vacant lots. We rely on a log-log specification where the coefficient of the tax rate variable, Ln(Tax rate), can be interpreted as the elasticity of transaction numbers (traded square meters in the case of vacant lots) with respect to a change in the tax rate. Column (1) starts with a parsimonious model for single-family houses that contains state fixed effects, density dependent time fixed effects (as explained below), and the log of the tax rate. For selected years, in which the tax rate was changed within a calendar year, we are using the average rate with the length of the respective rate applicability as the weighting factors. A possible problem that could arise is that tax changes are anticipated and may lead to transactions being pulled forward in time to avoid tax increases. Such effects may blow up the tax base in a year preceding a tax increase and lower it in the year of the increase. For this reason, we designed two variables that are designed to pick up possible time shifts. D(Year before tax increase) is constructed with the help of a dummy that indicates state-years that precede a tax increase in January of the next year. The relevant dummy has been multiplied with the tax increase. Likewise, D(Year of tax increase) marks state-years with a tax increase in January and is also scaled by the tax increase.

Several tax increases did not take place at the start of the year, but at some point during the year. In this case, the average tax rate may exaggerate the effective tax if tax payers shift transactions into the more lowly taxed part of the same year. For this reason, we construct a variable D(Within year increase) that measures the size of the increase in state-years with a tax change between February and November of the calendar year and is zero in other years.[12]

[12] Since empirical evidence with selected micro data (Fritzsche and Vandrei, 2016) suggests that anticipation effects in Germany are short-lived and seem to be restricted to a time window of approximately two months before and after the tax hike, we decided to encode $D_{i,t-1}$(Year before tax increase) = $D_{i,t}$(Year of tax increase) = 0 in the case of a tax increase in the middle of year t.

While all estimations of Table 3 allow for time-fixed effects, there is the possibility that time-trends for the property market are different for urban and more rural states. Therefore, we additionally allow time-fixed effects to differ between two groups of states.[13]

Table 3. Elasticity of Transactions
Panel A. Single-family Houses

	(1) FE, OLS	(2) FE, OLS	(3) FE, OLS	(4) FE, OLS	(5) FE, OLS	(6) FE, Poisson
Ln(Tax rate)	-0.231	-0.211	-0.219	-0.186	-0.26	-0.259
	[0.000]***	[0.003]***	[0.002]***	[0.011]**	[0.000]***	[0.000]***
D(Year before		3.766		3.627	2.088	2.36
tax increase)		[0.036]**		[0.051]*	[0.306]	[0.071]*
D(Year of tax		0.393		-0.066	-0.425	-0.659
increase)		[0.846]		[0.975]	[0.792]	[0.617]
D(Within year		2.39		2.427	2.024	2.04
increase)		[0.200]		[0.187]	[0.212]	[0.078]*
Ln(GDP)			-0.139	-0.073	0.061	0.033
			[0.676]	[0.827]	[0.835]	[0.945]
Ln(l.Debt)			0.013	0.007	0.003	0.003
			[0.532]	[0.738]	[0.886]	[0.858]
Ln(Population)			-0.185	-0.091	0.54	0.478
			[0.684]	[0.842]	[0.203]	[0.455]
Ln(UE)			-0.108	-0.099	0.108	0.096
			[0.357]	[0.400]	[0.341]	[0.522]
Observations	192	192	185	185	185	185
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Density dep. year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
City-state year fixed effects	NO	NO	NO	NO	Yes	Yes
R-squared	0.73	0.739	0.748	0.757	0.814	--
States	16	16	16	16	16	16

[13] Based on a threshold of 70% of space with sparse population according to the German Statistical Office, we classified six states as “rural“ (Bavaria, Brandenburg, Rhineland-Palatinate, Saxony-Anhalt, Schleswig-Holstein and Thuringia).

Panel B. Apartments

	(1) FE, OLS	(2) FE, OLS	(3) FE, OLS	(4) FE, OLS	(5) FE, OLS	(6) FE, Poisson
Ln(Tax rate)	0.064	0.178	0.115	0.271	0.204	0.208
	[0.584]	[0.160]	[0.362]	[0.027]**	[0.104]	[0.079]*
D(Year before		8.958		10.312	10.511	11.041
tax increase)		[0.002]***		[0.001]***	[0.001]***	[0.001]***
D(Year of tax		-2.904		-3.385	-1.542	-1.783
increase)		[0.395]		[0.322]	[0.654]	[0.574]
D(Within year		3.505		3.712	4.886	5.419
increase)		[0.215]		[0.149]	[0.036]**	[0.017]**
Ln(GDP)			0.608	0.776	0.671	0.711
			[0.305]	[0.152]	[0.134]	[0.105]
Ln(l.Debt)			0.015	-0.003	-0.03	-0.022
			[0.805]	[0.959]	[0.482]	[0.452]
Ln(Population)			0.42	0.635	-0.355	-0.541
			[0.606]	[0.428]	[0.677]	[0.550]
Ln(UE)			-0.205	-0.193	-0.432	-0.445
			[0.287]	[0.299]	[0.044]**	[0.033]**
Observations	192	192	185	185	185	185
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Density dep. year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
City-state year fixed effects	NO	NO	NO	NO	Yes	Yes
R-squared	0.809	0.822	0.827	0.844	0.865	--
States	16	16	16	16	16	16

Panel C. Vacant Lots

	(1) FE, OLS	(2) FE, OLS	(3) FE, OLS	(4) FE, OLS	(5) FE, OLS	(6) FE, Poisson
Ln(Tax rate)	-0.955	-1.061	-0.856	-0.931	-1.032	-1.211
	[0.000]***	[0.000]***	[0.004]***	[0.002]***	[0.001]***	[0.064]*
D(Year before		7.935		9.154	3.436	-2.973
tax increase)		[0.302]		[0.235]	[0.647]	[0.836]
D(Year of tax		7.09		6.828	2.637	5.564
increase)		[0.531]		[0.542]	[0.811]	[0.872]
D(Within year		19.184		20.108	18.09	13.531
increase)		[0.031]**		[0.020]**	[0.047]**	[0.926]
Ln(GDP)			-2.233	-2.215	-2.933	-5.552
			[0.156]	[0.155]	[0.086]*	[0.127]
Ln(l.Debt)			-0.091	-0.113	-0.142	-0.157
			[0.218]	[0.123]	[0.069]*	[0.068]*
Ln(Population)			-0.042	0.138	1.241	-1.196
			[0.981]	[0.938]	[0.544]	[0.673]
Ln(UE)			-0.351	-0.325	0.242	0.127
			[0.395]	[0.423]	[0.610]	[0.847]
Observations	184	184	177	177	177	177
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Density dep. year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
City-state year fixed effects	NO	NO	NO	NO	Yes	Yes
R-squared	0.951	0.953	0.953	0.955	0.96	.
States	16	16	16	16	16	16

Note: Endogenous variable: log of index of housing transactions (2003-2014) in Panels A and B, log of traded square meters in Panel C. Robust p-values in brackets. ***, ** and * denote significance at the 1, 5 and 10 percent confidence level. D(Year before tax increase) is the product of a dummy that indicates state-years that precede a tax increase in January of the next year and the size of the tax increase. D(Year of tax increase) marks state-years with a tax increase in January and is also scaled by the tax increase. D(Within year increase) is zero in state year without a tax change between February and November of the calendar year, but reflects the size of the tax increase otherwise. LnGDP, Ln(l.Debt), Ln(Population), and Ln(UE) represent the log of GDP, the log of the lagged debt level, the log of the population and the log of unemployed for the respective state.

According to the results from the parsimonious model presented in Column (1) of Panel A, the number of transactions goes down by 0.23% if the tax rate is increased by 1%. Column (2), (4), (5) and (6), which add variables that may capture anticipation effects, yield comparable magnitudes. Of these additional variables, only D(Year before tax increase), which captures additional transactions in the year preceding a tax increase, is significant in most of our equations in Panel A. Columns (3) to (6) include essential macro variables like the log of GDP, the log of unemployed, and the log of state population that, however, are not statistically significant.

A possible variable that may drive both the tax base of the RETT and the decision to enact a tax increase is the debt level of the state. The debt level may decrease property values and may, as a result, influence purchases through the expectations of future tax increases and the respective tax capitalization. At the same time, it is the case that especially the particularly high indebted states have increased the tax rate, while the two most prudent low-debt states Saxony and Bavaria have been the only states that have kept the initial tax rate of 3.5%. Ignorance of the debt level could potentially lead to an omitted variables bias, as the debt level could both influence the decision to enact tax increases and the attractiveness of the property market. However, the introduction of the log of last year's debt level, Ln(l.Debt), does not yield a significant coefficient. Presumably, the mere state-fixed effects are enough to pick up debt differences across states and reduce the significance of state specific macro variables.

Columns (5) and (6) use the same right-hand variables, but, as a further robustness test, add specific time fixed effects for the three city-states (Berlin, Bremen and Hamburg), as for those, the development of the housing market may differ beyond what the simple density-dependent time effects can pick up.

In the case of the regressions for single-family houses, a Breusch-Pagan/Cook-Weisberg test does usually not reject the null that errors are homoscedastic; however our log-log specification may lead to a bias if errors indeed are heteroscedastic.[14] For this reason, Column (6) presents the results from a fixed-effects Poisson estimator with robust standard errors (Wooldridge 1999). Here, the transaction index has been introduced without taking the log, but the coefficient of the tax rate again can be interpreted as an elasticity. The results confirm the magnitude of the coefficients found in the simple OLS fixed effects estimates and the rounded point estimates of the OLS in Column (5) and the Poisson estimate in (6) are both -0.26 and very close to those in the parsimonious regression.

The results for apartments in Panel B of Table 3 are quite different from those for single-family houses. The elasticity here tends to be positive, but insignificant with the exception of Column (4) and

[14] See Santos Silva and Tenreyro (2006).

Column (6) where the coefficient is significant at the ten percent level. Note that in Columns (3) to (6), the macroeconomic variables, Ln(GDP), Ln(l.Debt), Ln(UE) and Ln(Population), with only two exceptions for Ln(UE), are neither individually nor jointly significant, which indicates no advantage over the more parsimonious models (1) and (2).[15] On the other hand, the rejection of homoscedasticity for Columns (1) to (5) may suggest using (6) as the preferred specification, although the similarity of coefficients for Ln(Tax rate) in columns (5) and (6) is striking and does not indicate a bias of the OLS estimate.

Panel C of Table 3 presents the results of the quantity effects for vacant land. The coefficients for our main variable of interest, Ln(Tax rate), are highly significant in all specifications and close to -1 (ranging from -0.86 to -1.21). Apart from the main tax variable, few other variables are significant. An exception is the variable D(Within year increase), which indicates a larger transaction volume in years in which the rate is changed. When interpreting the coefficient of D(Within year increase), note that the average value of the variable, for years in which a within year change happens, is 0.012. Therefore, a coefficient of 20.1 translates into a moderate elasticity of 0.24. Furthermore, the level of state government debt enters negatively, but is significant only in columns (5) and (6).

Summary statistics for these and following regressions are presented in Table 4. For clarity, some variables that have been used in log form in the regressions are reported without logs in this summary table.

[15] The insignificance of state GDP may be due to its limited quality. See Burret, Feld and Köhler (2017).

Table 4. Summary Statistics

	Obs	Mean	Std.Dev.	Min	Max
Tax rate (weighted)	192	0.0389193	0.0065053	0.035	0.065
GDP (in €1.000)	192	158020.5	159801	24382	624668
l.Debt	186	9648.871	5527.313	1845.8	31298.5
UN	192	226573.6	190366.7	34282	1057649
Population	192	5106126	4685176	652182	18100000
Price houses (in € 1.000)	192	157.7307	71.95047	59.8	420.4
Price apartments (in € 1.000)	192	121.2214	37.87135	55.4	295.5
Transaction index houses	192	96.86458	11.1549	67	142
Transaction index apartments	192	113.7344	28.60358	76	237
Traded vacant lots (m^2)	185	7003.951	6708.829	251	28599
Price vacant lots (per m^2)	190	106.0829	106.6987	17.05	548.31
D(Year before tax increase)	192	0.0008594	0.0030981	0	0.015
D(Year of tax increase)	192	0.0007292	0.0028468	0	0.015
D(Within year increase)	192	0.0005496	0.0026265	0	0.015

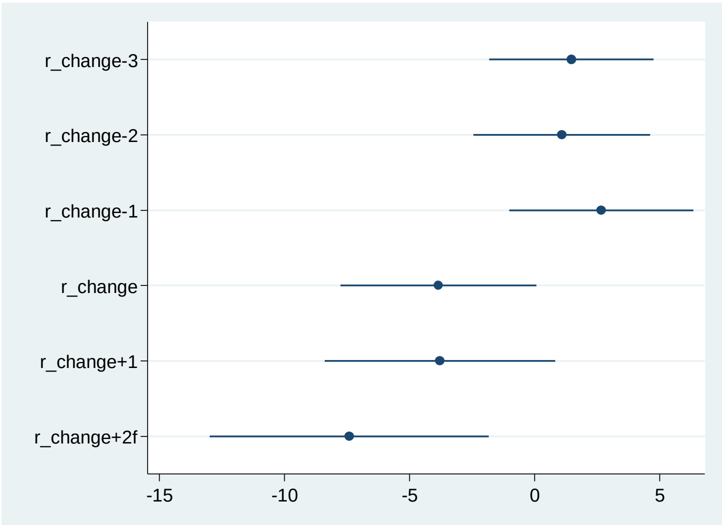
Although our regressions include density dependent year fixed effects, a possible remaining concern may be that the time trend for states that did or did not increase their tax rates may differ systematically. To further investigate the causal effect of tax rate changes on the transactions of houses and vacant lots, we look at whether the reaction of transaction volumes is closely connected to the year of the relevant tax increases.[16] Six new variables are generated for this purpose. r_change-3, r_change-2 and r_change-1 take on the value of any tax rate change that happens three, two and one years later. r_change+1 equals the tax rate change one year after the reform; in all consecutive years the variable r_change+2f is used as the lag variable. Finally, r_change measures the tax increase in the year of the increase itself.

Figure 1 presents coefficient plots of these variables for the case of the transactions of single-family homes and vacant lots. Panels A and B of Figure 1 support a causal tax effect on transactions. In both cases, the coefficients of the lead variables are insignificant and only

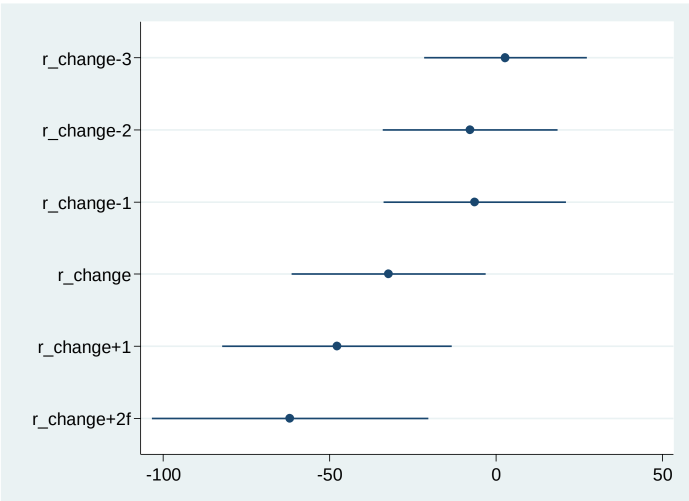
[16] For a similar approach see Autor (2003).

become (at least weakly) significant in the year of the tax increase and thereafter.[17]

Figure 1. Coefficient Plots
Panel A. Single-family Houses



Panel B. Vacant Lots



Note: The coefficient plots show the point estimates and 95% confidence intervals. In Panel A the plot results from a regression of the log of the index of single-family home transactions on the lead and lag variables shown, plus simple year fixed effects, state fixed effects, LnGDP, Ln(l.Debt), Ln(Population), and Ln(UE). In Panel B the right hand side variables are the same, but the left hand variable is the log of the transactions of square meters of vacant lots. Note that the lead and lag variables are not constructed by using the log of the tax rate, but by taking the simple size of the rate changes. Therefore the plotted coefficients, unlike in Table 3, cannot be interpreted as elasticities.

The results in Table 3 (backed up by Figure 1, Panel A) suggest that the RETT increases in German states have reduced transactions

[17] We omit the presentation of a coefficient plot for apartments as for this market segment the regressions showed an insignificant result.

of single-family homes, but not of apartments. Keeping in mind that most houses are owner-occupied, while apartments are not, the difference in the result has an interesting implication. It means that the RETT has an effect on German housing transactions in that market segment, where the mobility of dwellers may indeed be reduced, i.e., in the segment of owner-occupied family houses. Conversely, for apartments, where labor mobility for the huge majority of tenants would not be reduced by a reduction of ownership transactions, we find no negative impact of the tax on ownership changes.

In a next step, we consider the price component of transactions for houses, apartments and vacant lots. This information is provided at the state-year level online by the German Statistical Office (www.destatis.de). Table 5 collects the relevant results. Again, in each of the three panels, Column (1) starts with a parsimonious OLS model containing state fixed effects, density dependent time fixed effects, and the log of the tax rate.[18] The following three model specifications capture anticipation effects and the local macroeconomic conditions.

In the case of single-family houses, no impact of the RETT can be observed. The insignificance of the tax rate prevails if city-state time effects are added in Column (5) and when the estimation is done via a fixed effects Poisson model in Column (6).

As there is no evidence for a significant price effect, this suggests that in the case of single-family houses, the incidence of the tax is with purchasers. Conversely, the RETT tends to have a uniformly negative effect on the prices of apartments that is significant at the five percent level according to the first four models in Panel B. This is compatible with the expectation of a capitalization of the tax in the price of the property, as discussed in Section 3. Indeed, we get a negative price effect of the tax in all models (1) to (6), although the coefficient is not significantly negative once we add city-state time effects as done in (5) and (6). However, note that inclusion of density dependent time effects and city-state time effects tends to make it more difficult to identify tax effects, as this inclusion of dummies

[18] Note that using seemingly unrelated regressions (SUR) to estimate transactions and prices would not improve the efficiency of our estimations, as all regressions are using the same set of regressors.

(although jointly significant) reduces the effective control group for tax increasing states.

The point estimates of the elasticity of the (net-of-tax) price of apartments with respect to the tax rate (ε) in Table 5 lie between -0.079 and -0.166. If taken seriously, what would these estimates imply for the incidence of the tax? Note that a one percent increase of the tax rate ceteris paribus increases the tax inclusive price depending on the tax rate: at a constant net-of-tax price, increasing the tax rate from 3.9% (the sample average) by 1% increases the price by 0.039% ($= 3.9\% \cdot 1\%$). However, based on our point estimates for apartments, ε, the reduction of the pre-tax price overcompensated this price increase. This suggests that more than 100% of the incidence is with the sellers. As the discussion in Section 3 has indicated, such a result is not only suggested by our point estimates. It has also been derived in studies for house markets in other countries and may be related to the character of the tax as a financial transaction tax. As the discussion in Section 3 has also indicated, a tax induced price decrease is even possible if the average holding period and the level of transactions are unchanged. For apartments, the latter is suggested by the insignificant results in Table 3.

Turning to Panel C, we find that the tax coefficient of interest in the case of vacant lots is insignificant, indicating no tax capitalization effect for this segment of the property market. Conversely, as in the cases of houses and apartments, there is consistent evidence of a price dampening effect of state public debt.

Table 5. Price Reactions
Panel A. Single-family Houses

	(1) FE, OLS	(2) FE, OLS	(3) FE, OLS	(4) FE, OLS	(5) FE, OLS	(6) FE, Poisson
Ln(Tax rate)	-0.038	-0.047	0.004	0.008	0.018	0.035
	[0.413]	[0.386]	[0.938]	[0.888]	[0.739]	[0.579]
D(Year before		-1.608		-0.279	0.618	-0.05
tax increase)		[0.198]		[0.828]	[0.550]	[0.971]
D(Year of tax		-0.093		-0.288	0.638	-0.021
increase)		[0.960]		[0.859]	[0.677]	[0.986]
D(Within year		-1.36		-0.966	-0.233	-1.069
increase)		[0.451]		[0.584]	[0.903]	[0.378]
Ln(GDP)			0.408	0.403	0.285	0.177
			[0.091]*	[0.115]	[0.145]	[0.555]
Ln(l.Debt)			-0.043	-0.042	-0.055	-0.049
			[0.148]	[0.160]	[0.003]***	[0.045]**
Ln(Population)			1.074	1.062	0.314	0.412
			[0.002]***	[0.003]***	[0.289]	[0.413]
Ln(UE)			0.198	0.195	-0.007	-0.038
			[0.030]**	[0.033]**	[0.937]	[0.680]
Observations	192	192	185	185	185	185
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Density dep. year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
City-state year fixed effects	NO	NO	NO	NO	Yes	Yes
R-squared	0.99	0.99	0.991	0.991	0.993	.
States	16	16	16	16	16	16

Panel B. Apartments

	(1) FE, OLS	(2) FE, OLS	(3) FE, OLS	(4) FE, OLS	(5) FE, OLS	(6) FE, Poisson
Ln(Tax rate)	-0.15	-0.166	-0.131	-0.139	-0.094	-0.079
	[0.020]**	[0.020]**	[0.027]**	[0.026]**	[0.153]	[0.173]
D(Year before		-3.174		-2.117	-1.831	-1.649
tax increase)		[0.031]**		[0.136]	[0.152]	[0.091]*
D(Year of tax		-0.478		-0.6	-1.104	-1.169
increase)		[0.839]		[0.773]	[0.618]	[0.580]
D(Within year		-1.631		-1.146	-0.87	-0.959
increase)		[0.415]		[0.490]	[0.623]	[0.395]
Ln(GDP)			0.556	0.511	0.534	0.38
			[0.014]**	[0.028]**	[0.024]**	[0.188]
Ln(l.Debt)			-0.055	-0.053	-0.078	-0.073
			[0.045]**	[0.063]*	[0.000]***	[0.000]***
Ln(Population)			0.874	0.809	0.576	0.42
			[0.039]**	[0.058]*	[0.177]	[0.325]
Ln(UE)			0.409	0.401	0.377	0.332
			[0.000]***	[0.000]***	[0.000]***	[0.000]***
Observations	192	192	185	185	185	185
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Density dep. year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
City-state year fixed effects	NO	NO	NO	NO	Yes	Yes
R-squared	0.96	0.961	0.967	0.967	0.971	--
States	16	16	16	16	16	16

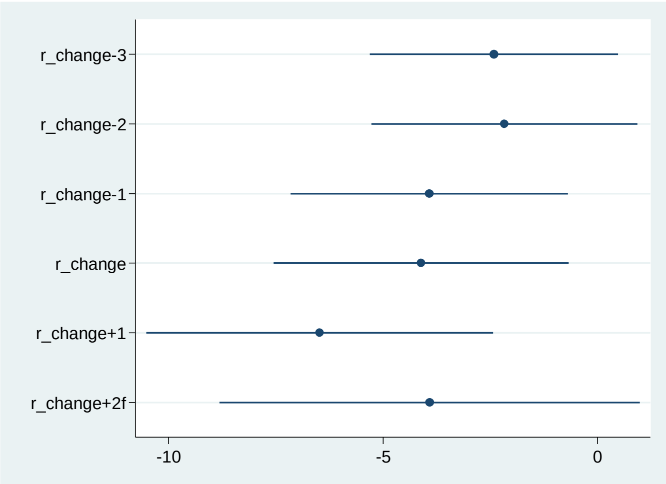
Panel C. Vacant Lots

	(1) FE, OLS	(2) FE, OLS	(3) FE, OLS	(4) FE, OLS	(5) FE, OLS	(6) FE, Poisson
Ln(Tax rate)	-0.177	-0.119	-0.136	-0.072	0.002	0.125
	[0.153]	[0.378]	[0.306]	[0.636]	[0.989]	[0.235]
D(Year before		-4.39		-4.03	-2.726	0.869
tax increase)		[0.240]		[0.303]	[0.418]	[0.772]
D(Year of tax		-4.803		-5.272	-5.922	-1.824
increase)		[0.185]		[0.154]	[0.131]	[0.644]
D(Within year		-5.538		-4.943	-4.753	-0.092
increase)		[0.272]		[0.327]	[0.391]	[0.976]
Ln(GDP)			-0.425	-0.438	-0.457	-0.667
			[0.493]	[0.480]	[0.470]	[0.358]
Ln(l.Debt)			-0.1	-0.096	-0.102	-0.143
			[0.067]*	[0.093]*	[0.118]	[0.028]**
Ln(Population)			-0.165	-0.27	-0.279	0.909
			[0.885]	[0.816]	[0.815]	[0.568]
Ln(UE)			0.283	0.27	0.217	0.373
			[0.304]	[0.328]	[0.455]	[0.189]
Observations	184	184	177	177	177	177
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Density dep. year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
City-state year fixed effects	NO	NO	NO	NO	Yes	Yes
R-squared	0.975	0.976	0.976	0.977	0.979	.
States	16	16	16	16	16	16

Note: Endogenous variable: log of average housing prices in Panel A, log of average apartment prices in Panel B, log of average price per square meter in Panel C (2003-2014). Robust p-values in brackets. ***, ** and * denote significance at the 1, 5 and 10 percent confidence level. D(Year before tax increase) is the product of a dummy that indicates state-years that precede a tax increase in January of the next year and the size of the tax increase. D(Year of tax increase) marks state-years with a tax increase in January and is also scaled by the tax increase. D(Within year increase) is zero in state year without a tax change between February and November of the calendar year, but reflects the size of the tax increase otherwise. LnGDP, Ln(l.Debt), Ln(Population), and Ln(UE) represent the log of GDP, the log of the lagged debt level, the log of the population and the log of unemployed for the respective state.

While the results from Table 5 indicate no price effects of the RETT for vacant land and single-family homes, we receive consistently negative results (although not always highly significant) for apartments. To follow up on the effect for apartments, Figure 2 provides a coefficient plot analogous to the approach behind Figure 1, which dealt with quantity changes. We find that the coefficients are significantly decreased already from the year before the tax rate change, but not in the two previous years. This may indicate anticipation effects that would be consistent with the negative signs of D(Year before tax increase) in Panel B (although these are not significant in all models). Therefore, the coefficient plot may be still seen as a tentative confirmation that the price reductions indeed are triggered by the tax rate changes. The alternative hypothesis that tax rate increases are triggered by a fall in the price for apartments seems to lack plausibility.

Figure 2: Coefficient Plots: Apartments



Note: The coefficient plot with 95% confidence intervals results from a regression of the log of the average prices of apartments on the lead and lag variables shown, plus simple year fixed effects, state fixed effects, LnGDP, Ln(l.Debt), Ln(Population), and Ln(UE). Note that the lead and lag variables are not constructed by using the log of the tax rate. Therefore the plotted coefficients, unlike in Table 5, cannot be interpreted as elasticities.

Table 6. Adding up Elasticity Estimates

	Single-family Houses				Apartments				Vacant Lots			
	(1) FE, OLS	(2) FE, OLS	(3) FE, OLS	(4) FE, OLS	(1) FE, OLS	(2) FE, OLS	(3) FE, OLS	(4) FE, OLS	(1) FE, OLS	(2) FE, OLS	(3) FE, OLS	(4) FE, OLS
I: Sales	-0.269	-0.265	-0.18	-0.244	-0.062	0.04	0.163	0.133	-1.132	-1.18	-1.003	-1.03
	[0.000]***	[0.003]***	[0.020]**	[0.003]***	[0.613]	[0.783]	[0.224]	[0.348]	[0.000]***	[0.000]***	[0.000]***	[0.001]***
II: Transactions	-0.231	-0.211	-0.186	-0.26	0.064	0.178	0.271	0.204	-0.955	-1.061	-0.931	-1.032
	[0.000]***	[0.003]***	[0.011]**	[0.000]***	[0.584]	[0.160]	[0.027]**	[0.104]	[0.000]***	[0.000]***	[0.002]***	3.436
III: Prices	-0.038	-0.047	0.008	0.018	-0.15	-0.166	-0.139	-0.094	-0.177	-0.119	-0.072	0.002
	[0.413]	[0.386]	[0.888]	[0.739]	[0.020]**	[0.020]**	[0.026]**	[0.153]	[0.153]	[0.378]	[0.636]	[0.989]
I - II – III	0.000	-0.007	-0.002	0.004	0.024	0.028	0.031	0.023	0.000	0.000	0	0

Note: The table collects the tax rate coefficients from Tables 3, 5, and A1. The last line checks whether the estimated coefficients of the transaction and price regressions add up to the coefficient of the sales regression.

To check the consistency of the transaction and price estimations, we also use the index of total sales on the state-year level as (confidentially) provided to us by GEWOS GmbH. The results, using the same set of models and covariates as in Tables (3) and (5), are found in the Appendix. The results are compatible with what can be expected from the previous regressions. On the one hand, for overall sales values of single-family houses, the tax rate coefficient is significantly negative and in the range of -0.2. On the other hand, the coefficient is insignificant (and positive) for apartments. Table 6 reports the tax rate coefficient for the sales regression in line (I), together with the coefficients in the transaction and price regressions. It shows that the tax rate coefficients from the three sets of regressions are consistent, as the coefficients from the price and transaction regressions add up fairly well to the coefficients that derive from the regression of sales volumes on the tax rate. For vacant land, the elasticity of sales values with respect to the tax rate implies that we are at the top of the Laffer curve for this segment of the real estate market.

4.2 The Tax Rate Elasticity of Revenues

In a next step, we compare the above estimates of the quantity and price elasticities with estimates of the elasticity of the overall tax revenues from RETT. Unfortunately, while the tax revenue data is available at the state-year level, there is no separate accounting for the tax revenues from the different market segments. Again, we rely on log-log specification, as the tax revenues derive as a multiplicative interaction of tax base and tax rate.

A possible expectation may be that the overall tax revenue elasticity should be a weighted average of the sales elasticity for apartments, single-family houses and vacant lots. There are several reasons why this may be too simplistic. First, the tax revenue elasticity may be different because of the existence of taxable nonresidential property sales.[19] Another potential reason for such a departure is that, according to discussions with property market

[19] Based on figures of nonresidential property sales, provided by Jones Long LaSalle Germany, and total sales volumes, as reported by IVD Bundesverband, we find that nonresidential property sales should account for some 14% of total sales in 2014.

experts, there may be time lags between transactions and tax revenues.[20] Finally, there could be cases in which some of the tax revenue is evaded, although strong safeguards are in place. Indeed, there is currently a vivid political debate on RETT avoidance in Germany.[21]

Having these issues in mind, we turn to the empirical model, by using panel data on tax revenue,[22] and tax rates to evaluate the tax rate elasticity of revenues. For this exercise, we utilize tax revenues at the state-year level, and use the respective tax rate at the state-year level. For selected years, in which the tax rate was changed within a calendar year, again we use the average rate with the length of the respective rate applicability as the weight.

The results are in line with some of our previous results that indicate behavioral effects of the RETT increases. Depending on the exact specification, we receive a revenue elasticity between 0.58 and 0.72 that is significantly smaller than one.[23] In the case of a constant tax base, a one percent increase in the tax revenue would produce a one percent increase in revenues. Hence, our estimates indicate that tax increases trigger a reduction in the tax base that must come from price reductions, lower transaction values, more tax evasion, or a mixture of these effects.

[20] For example, the case of a property sale to a developer who intends to resell after partitioning the property may lead to a deferred tax payment as, in this case, the tax payment may be deferred until the resale.
[21] Hessisches Finanzministerium (2016).
[22] Tax revenue data have been taken from Statistisches Bundesamt, Finanzen und Steuern, Fachserie 14, Reihe 4, various issues.
[23] Buettner (2017) estimates an elasticity of 0.6 in a related framework.

Table 7. Revenue Elasticity of the German RETT

	(1) FE, OLS	(2) FE, OLS	(3) FE, OLS	(4) FE, OLS	(5) FE, OLS	(6) FE, Poisson
Ln(Tax rate)	0.68	0.658	0.644	0.612	0.692	0.742
	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
D(Year before		-0.25		0.108	-0.509	0.321
tax increase)		[0.913]		[0.967]	[0.857]	[0.848]
D(Year of tax		1.508		2.083	1.457	-1.068
increase)		[0.635]		[0.507]	[0.653]	[0.658]
D(Within year		-1.516		-1.273	-1.523	1.465
increase)		[0.523]		[0.611]	[0.555]	[0.481]
Ln(GDP)			0.686	0.711	0.796	0.857
			[0.228]	[0.221]	[0.103]	[0.001]***
Ln(l.Debt)			0.049	0.051	-0.008	-0.033
			[0.318]	[0.310]	[0.869]	[0.347]
Ln(Population)			1.249	1.283	0.587	0.332
			[0.093]*	[0.085]*	[0.412]	[0.631]
Ln(UE)			0.194	0.202	0.12	-0.055
			[0.296]	[0.279]	[0.547]	[0.771]
Observations	192	192	185	185	185	185
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Density dep. year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
City-state year fixed effects	NO	NO	NO	NO	Yes	Yes
H0: Ln(Tax rate) ≥ 1	0.00***	0.00***	0.00***	0.00***	0.01**	.--
R-squared	0.99	0.99	0.991	0.992	0.994	--
States	16	16	16	16	16	16

Note: Endogenous variable: log of yearly state RETT revenues (2003-2014). Robust p-values in brackets. ***, ** and * denote significance at the 1, 5 and 10 percent confidence level. D(Year before tax increase) is a variable that multiplies a dummy, which equals one in state-years that precede a tax increase in January of the next year, with the size of the tax rate increase. Likewise, D(Year of tax increase) is constructed for state-years with a tax increase in January; D(Within year increase) is positive for state-years with a tax change between February and November of the calendar year. Again, the dummy is scaled by the tax increase. Ln(GDP), l.n(l.Debt) and Ln(Population) represent the log of GDP, the log of the lagged debt level and the log of the population for the respective state. H0: Ln(Tax rate) ≥ 1 reports the confidence level at which the null can be rejected that the coefficient for Ln(Tax rate) is equal or larger than one. Ln(UE) is the log of the state's officially unemployed. City state dependent year fixed effects in column (5) and (6) allow that more densely populated states have different time-fixed effects.

The results in columns (2), and in columns (4) to (6) show insignificant coefficients for all three anticipation dummies and the comparison between (1) and (2) shows hardly any change in the estimated coefficient for the baseline tax effect.

While all estimations of Table 7 allow for time-fixed effects and time fixed effects that are different for rural states (see Footnote 3), there is the possibility that time trends for the property market are even more specific for city states. Therefore, the estimations in Column (5) and (6) introduce those time effects along with the previous time fixed effects. Our main coefficient of interest, Ln(Tax rate), is robust to this variation.

Columns (3) to (6) add macro variables that all turn out insignificant except the log of GDP in the Poisson fixed effects estimate. All estimates report a higher reaction of the tax base than suggested by the sales elasticities of apartments and single-family houses reported in Table 6, but a lower elasticity than the sales elasticity of vacant lots.

5 Conclusion

The paper has empirically analyzed the tax effects of the German RETT. Our analysis has started from the observation that the German markets for single-family houses and apartments differ in their ownership patterns. While the vast majority of single-family houses are owner-occupied, the ownership of apartments is with private and incorporated investors. Conversely, owner-occupied apartments represent a small minority. For this reason, our empirical regressions have dealt with the number of transactions and the prices of transactions separately for these two market segments. In addition to this, we also take into account vacant lots as third market segment.

Our findings suggest that, for single-family houses, the RETT leads to an elasticity of transactions around -0.23, but has no significant effect on prices of the traded houses. Conversely, for apartments, we could not find significant effects on transactions, but the price effect of the RETT tends to be negative. A stronger price effect of apartments may be explained by acknowledging that, for investors, the RETT acts like a financial transaction tax. As apartments are traded more frequently than single-family houses, such a financial transaction tax may have a larger effect for apartments.

The fact that for apartments we find price effects but no quantity effects may seem surprising. However, as highlighted in Section 3, a price capitalization effect is theoretically possible even when holding periods (and therefore transactions) are constant. In the case of vacant lots, which may be used for either owner-occupied, investor owned or business structures, we find no significant price effects, but severe negative quantity effects. For this market segment, a tax increase may not yield revenue increases, as we are now at the top of the relevant Laffer curve.

Our results for single-family houses are able to confirm previous results for single-family houses by O'Sullivan et al. (1995), Besley et al. (2014) and Fritzsche and Vandrei (2016), who have abstracted from the possible differences between owner-occupied housing and rented apartments. As in these studies, we find significant and non-negligible tax effects on the number of transactions. This suggests that the German RETT may imply a possible reduction of labor mobility. As the RETT could lead to an inefficient use of the housing stock and prevent the optimal allocation of residences over households by hampering efficient up-sizing and down-sizing of property, i.e. making some large households live in too small houses and some small households live in too large houses, there may also be unnecessary mismatches between housing needs and housing characteristics (Sánchez and Andrews, 2011).

Unlike evidence provided for other countries (e.g., Davidoff and Leigh, 2013; Kopczuk and Munroe, 2015; Ihlanfeldt and Shaugnessy, 2004), there seems to be no price effect of the tax on single-family houses. Depending on the exact specification, negative price effects are significant in several estimations for apartments. Indeed, the relevant point estimates suggest that the full tax incidence is on the seller side.

For single-family houses and apartments, our estimates imply that the elasticity of total sales with respect to the tax rate is smaller than the overall tax revenue elasticities. Indeed, for apartments we fail to identify any negative tax rate elasticity of sales. This discrepancy in the development of the tax revenues and the development of housing sales may be due to non-residential property, which is also taxed in Germany and may have a higher elasticity. Partly, it can also be explained by the high quantity effects for vacant lots, although this market segment seems to be relatively small compared to houses and apartments.[24] Another possibility may be tax avoidance effects that recently have received considerable attention in the political discussion and which may represent another margin not covered in this paper. The identification of these and other issues should benefit from availability of German micro-data on housing transactions that, so far, has not been made available to researchers in a comprehensive way.

[24] Based on information provided by IVD (a property agent union) and Jones Long LasSalle (a property service company), we calculate that the 2014 sales of vacant lots accounts for some 7.5% of non-industrial property sales.

Table A1. Elasticity of Sales Volumes

	Single-family houses				Apartments				Vacant lots			
	(1) FE, OLS	(2) FE, OLS	(3) FE, OLS	(4) FE, OLS	(5) FE, OLS	(6) FE, OLS	(7) FE, OLS	(8) FE, OLS	(9) FE, OLS	(10) FE, OLS	(11) FE, OLS	(12) FE, OLS
Ln(Tax rate)	-0.269	-0.265	-0.18	-0.244	-0.062	0.04	0.163	0.133	-1.132	-1.18	-1.003	-1.03
	[0.000]***	[0.003]***	[0.020]**	[0.003]***	[0.613]	[0.783]	[0.224]	[0.348]	[0.000]***	[0.000]***	[0.000]***	[0.001]***
D(Year before tax increase)		2.29	3.522	2.927		4.817	7.558	8.139		3.538	5.116	0.702
		[0.293]	[0.100]	[0.238]		[0.119]	[0.024]**	[0.024]**		[0.621]	[0.468]	[0.922]
D(Year of tax increase)		0.614	-0.116	0.482		-4.053	-4.54	-3.103		2.284	1.552	-3.288
		[0.784]	[0.953]	[0.792]		[0.278]	[0.157]	[0.341]		[0.836]	[0.886]	[0.759]
D(Within year increase)		2.349	2.83	3.212		1.629	2.364	3.848		13.647	15.166	13.335
		[0.437]	[0.322]	[0.264]		[0.680]	[0.480]	[0.240]		[0.126]	[0.086]*	[0.163]
Ln(GDP)			0.219	0.24			1.557	1.436			-2.654	-3.39
			[0.545]	[0.475]			[0.010]***	[0.004]***			[0.082]*	[0.046]**
Ln(l.Debt)			-0.038	-0.055			-0.061	-0.112			-0.209	-0.243
			[0.434]	[0.122]			[0.409]	[0.012]**			[0.002]***	[0.000]***
Ln(Population)			1.178	1.09			1.57	0.299			-0.133	0.962
			[0.015]**	[0.022]**			[0.083]*	[0.702]			[0.927]	[0.553]
Ln(UE)			0.116	0.127			0.25	-0.026			-0.056	0.459
			[0.346]	[0.370]			[0.219]	[0.897]			[0.869]	[0.223]
Observations	192	192	185	185	192	192	185	185	184	184	177	177
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Density dep. year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City-state year fixed effects	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
R-squared	0.85	0.852	0.879	0.893	0.849	0.852	0.877	0.896	0.966	0.966	0.969	0.972
States	16	16	16	16	16	16	16	16	16	16	16	16

Note: Endogenous variable: log of sales (index), 2003-2014. Robust p-values in brackets. ***, ** and * denote significance at the 1, 5 and 10 percent confidence level. D(Year before tax increase) is the product of a dummy that indicates state-years that precede a tax increase in January of the next year and the size of the tax increase. D(Year of tax increase) marks state-years with a tax increase in January and is also scaled by the tax increase. D(Within year increase) is zero in state year without a tax change between February and November of the calendar year, but reflects the size of the tax increase otherwise. LnGDP, Ln(l.Debt), Ln(Population), and Ln(UE) represent the log of GDP, the log of the lagged debt level, the log of the population and the log of unemployed for the respective state. State-density dependent year fixed effects are jointly significant in all columns

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