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Who Bears the Burden of Real Estate Transfer Taxes? Evidence from the German Housing Market

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Who Bears the Burden of Real Estate Transfer Taxes?

Evidence from the German Housing Market

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Who Bears the Burden of Real Estate Transfer Taxes? Evidence from the German Housing Market*

Abstract

This paper examines the effects of real estate transfer taxes (RETT) on house prices using a rich micro dataset on German properties covering the period from 2005 to 2018. We exploit a 2006 constitutional reform that allowed states to set their own RETT rates, leading to frequent increases in states' tax rates in subsequent years. Our monthly event study estimates indicate a price response that strongly exceeds the change in the tax burden for single transactions. I.e., twelve months after a reform, a one percentage point increase in the tax rate reduces property prices by on average 3.5%. Effects are stronger for apartments and apartment buildings than for single-family houses. We interpret these results in the context of a theoretical model that accounts for the effects of RETT on a property's resale value. If a property is expected to be traded more frequently in the future, the decline in its price can exceed the increase in the tax burden. Moreover, larger price effects can be explained by higher bargaining power of sellers.

JEL code: H22, H71, R32, R38

Keywords: Real estate transfer taxes, property taxes, housing market

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1 Introduction

In many countries, taxes on real estate transfers are an important source of public sector revenue. However, they are often criticized for creating large distortions, reducing the number of transactions in the housing market. At the same time, transfer tax holidays are widely seen as an effective measure to stimulate the economy because there are strong behavioral reactions to these tax cuts, mostly regarding the timing of house purchases.¹

This paper focuses on the effects of *permanent* changes in real estate transfer taxes, which are understudied in the literature. Most existing contributions focus on transitory tax changes or discontinuities in the tax schedule. Effects of permanent increases in transfer taxes are important because growing international mobility of both capital and people may increase pressure to raise more revenue from land and real estate. If that happens, a key question is who bears the tax burden. Is the tax capitalized into house prices so that those who own the house when the reform happens effectively pay the tax? Or do the buyers, who actually remit the tax, bear the burden? To provide answers to these questions, we combine theoretical modeling with empirical analyses. In the first part of the paper, we develop a simple and very stylized overlapping generations model where the price effects of transfer taxes depend (i) on the distribution of bargaining power between sellers and buyers as well as (ii) on the likelihood that the buyers will resell the house later. We use this model to derive hypotheses which we then put to an empirical test. In the second part of the paper, we exploit a reform of the German federal fiscal system in 2006 that gave the German states the right to set the rate of the real estate transfer tax (RETT) to study the price effect of RETT rate changes. Before the reform there was a nationwide uniform tax rate of 3.5%. After the reform, most states increased their tax rates, albeit at different points in time. Today, the highest tax rates are equal to 6.5%. Revenue from the RETT is significant. In 2005, just before the reform, revenue from this tax was just 2.7% of overall state tax revenue in Germany. In 2018, this number was equal to 4.5%. This increase partly reflects rising real estate prices in Germany since the financial crisis. In our empirical analysis, we utilize the variation in RETT rates across German states and over time to investigate the impact of RETT on house prices for different types of properties.

¹For instance, in the crisis of 2008-09, the UK government reduced the stamp duty tax on land to stimulate spending on house renovation. Best and Kleven (2018) find that the boost in spending caused by the temporary tax reduction was as large as the tax cut itself.

To this end, we use a unique dataset covering roughly 18 million properties offered for sale over the period from 2005 to 2018. The data was collected by analyzing real estate advertisements from 140 different sources, including property portals such as ImmobilienScout24.de, as well as regional and trans-regional newspapers. Our dataset includes a large number of property characteristics, such as the asking price, the first and the last day the property was listed, floor size, the construction year, as well as several amenity features.

Our paper contributes to the literature studying the effect of property transfer taxes on house prices (Dachis et al., 2012; Besley et al., 2014; Kopczuk and Munroe, 2015; Slemrod et al., 2017; Best and Kleven, 2018). In contrast to the present paper, a large part of the existing literature focuses on *temporary* tax changes and tax holidays. The estimated price effects of property transfer taxes reported in this literature vary notably, suggesting that the price effects may depend on the institutional setting. Besley et al. (2014), for instance, exploit the UK stamp duty tax holiday 2008-09 and find that roughly sixty percent of the tax relief accrued to buyers. Similarly, bunching results in Slemrod et al. (2017) for a transfer tax in Washington D.C. suggest that the burden of the transfer tax is equally split between buyers and sellers. In contrast, Dachis et al. (2012) estimate that the introduction of a (permanent) transfer tax in Toronto in 2008 led to a price reduction equal to the tax, suggesting that sellers bear the burden of the tax.² Kopczuk and Munroe (2015) and Best and Kleven (2018) study transfer taxes in New York/New Jersey and in the UK, respectively, and provide similar evidence. The authors find that price responses to tax thresholds exceed the size of the tax change. What is more, Kopczuk and Munroe (2015) show that a transfer tax notch even leads to an unraveling of the market in a certain price range.

Recent studies have also assessed the incidence of real estate transfer taxes (RETT) in the German real estate market. However, these studies are mainly based on aggregate data. Using annual data at the state level, Petkova and Weichenrieder (2017) assess the effect of RETT increases on transaction prices and transaction volumes for single-family houses and apartments. For houses and vacant lots, the authors find that the number of transactions declines, while prices are not significantly affected. For apartments, however, the authors observe negative price effects,

²This finding refers to the tax on one transaction. Since the tax increase will also apply to future transactions, the true burden implied by the tax increase is likely to be larger, as we will discuss further below, a point also made by Petkova and Weichenrieder (2017).

but no effect on the number of transactions. In a similar vein, Fritzsche and Vandrei (2019) find negative effects of RETT increases on monthly state-level family home transaction volumes. Their results also indicate substantial anticipation effects of RETT reforms. Focusing on commercial property, Baudisch and Dresselhaus (2018) find both a decline in transactions and a decline in prices following a tax increase. In contrast to previous studies relying on state-level data, we exploit a micro-level data set on real estate prices which allows for more credible identification of price effects.

The literature also discusses the importance of different channels through which transfer taxes may affect house prices and transactions. Best and Kleven (2018) consider a model with downpayment constraints and leverage to rationalize large prices responses. Slemrod et al. (2017) study optimization frictions in a bargaining model. Their model allows both buyers and sellers to bear remittance responsibilities and accounts for the possibility that the seller may make quality adjustments to her house prior to the sale. Other bargaining models can be found in Besley et al. (2014) and Kopczuk and Munroe (2015). In the model proposed in the present paper, the price effects of transfer taxes depend on the bargaining power of the sellers vis-à-vis the buyers as well as the likelihood that the buyers will resell the house. In this framework, given that a tax increase is perceived as permanent, price effects are predicted to be larger for real estates which are traded more often. In general, the model predicts that the price effects are likely to be larger than the tax change for a single transaction. Our empirical results are in line with the predictions of our model. The price effects we find are larger than those reported in earlier studies. On average, a one percentage point increase in the tax rate reduces property prices by 3.5% within a year after the tax reform. One interpretation of this result is that the growing tax burden on future transactions is capitalized into the house prices. An alternative explanation for the large price effect is that buyers are crowded out of the market through downpayment constraints as emphasized by Best and Kleven (2018).

The remainder of the paper is structured as follows: The next section describes the institutional background of the RETT in Germany. In section 3, we present a simple housing market model which motivates our empirical analysis and facilitates the interpretation of our results. Section 4 presents the data. In section 5, we describe our empirical approach and section 6 shows the results. Section 7 concludes.

2 Institutional Background

The RETT is an important source of revenue for the German states. With a revenue of 14.1 billion Euro in 2018, which corresponds to 4.5% of state level tax revenues, its weight as a source of revenue is limited, but its importance is due to fact that it is the only significant tax where the states can set the tax rate.³ The RETT is charged on the purchase price on all kinds of real estate, including residential and commercial properties as well as vacant lots. Before 2006, the tax rate was uniform across all states and equal to 2% prior to 1997 and to 3.5% until 2006. In 2006, a substantial constitutional reform permitted the states to set their own RETT rates. With the exception of Bavaria and Saxony, all states have increased their tax rates since, often multiple times (see table 1). So far, no state has ever reduced its tax rate. As shown by Büttner and Krause (2018), the German fiscal equalization scheme sets strong financial incentives for states to raise their RETT. Moreover, the German public debt ceiling (“debt brake”) requires state governments to achieve structurally balanced budgets from 2020 onwards, which may explain why the need of budget consolidation is the most frequent official justification of RETT increases (Fritzsche and Vandrei, 2019).

3 A Simple Model of a Housing Market with Transfer Taxes

We consider a highly stylized model of an economy with overlapping generations. There are two types of agents, the young (Y) and the old (O). All agents live for two periods, they are young in the first period and old in the second. The number of households in each generation is normalized to unity. There is a stock of two units of housing in the economy. For simplicity we abstract from depreciation of housing capital and construction.

The utility for the young (old) of owning a house while young (old) is given by U^Y (U^O). Ownership of a house may or may not imply that a household actually occupies a house. There is a perfectly competitive rental market which makes sure

³There is more tax autonomy at the local level. Local governments can set the property tax rate and the rate of the local business tax. The rates of the most important revenue sources, the income tax and the value added tax, are set at the federal level. Through the second chamber, the states participate in decisions regarding income and value added tax rates, and they receive a share of the revenue.

Table 1: Tax rate changes

| State | Initial Tax Rate | Date of Increase | New Tax Rate | First Legal Draft |
|-------------------------------|------------------|------------------|--------------|-------------------|
| Baden-Württemberg | 3.5% | 05.11.2011 | 5.0% | 13.09.2011 |
| Bavaria | 3.5% | - | - | - |
| Berlin | 3.5% | 01.01.2007 | 4.5% | 07.11.2006 |
| | | 01.04.2012 | 5.0% | 18.01.2012 |
| | | 01.01.2014 | 6.0% | 10.10.2013 |
| Brandenburg | 3.5% | 01.01.2011 | 5.0% | 13.09.2010 |
| | | 01.07.2015 | 6.5% | 04.03.2015 |
| Bremen | 3.5% | 01.01.2011 | 4.5% | 22.06.2010 |
| | | 01.01.2014 | 5.0% | 09.07.2013 |
| Hamburg | 3.5% | 01.01.2009 | 4.5% | 14.10.2008 |
| Hesse | 3.5% | 01.01.2013 | 5.0% | 25.09.2012 |
| | | 01.08.2014 | 6.0% | 13.05.2014 |
| Mecklenburg-Western Pomerania | 3.5% | 01.07.2012 | 5.0% | 14.02.2012 |
| Lower Saxony | 3.5% | 01.01.2011 | 4.5% | 31.08.2010 |
| | | 01.01.2014 | 5.0% | 17.09.2013 |
| North Rhine-Westphalia | 3.5% | 01.10.2011 | 5.0% | 10.05.2011 |
| | | 01.01.2015 | 6.5% | 28.10.2014 |
| Rhineland-Palatinate | 3.5% | 01.03.2012 | 5.0% | 23.11.2011 |
| Saarland | 3.5% | 01.01.2011 | 4.0% | 19.10.2010 |
| | | 01.01.2012 | 4.5% | 18.10.2011 |
| | | 01.01.2013 | 5.5% | 08.10.2012 |
| | | 01.01.2015 | 6.5% | 07.10.2014 |
| Saxony | 3.5% | - | - | - |
| Saxony-Anhalt | 3.5% | 02.03.2010 | 4.5% | 30.09.2009 |
| | | 01.03.2012 | 5.0% | 28.09.2011 |
| Schleswig-Holstein | 3.5% | 01.01.2012 | 5.0% | 23.08.2010 |
| | | 01.01.2014 | 6.5% | 26.07.2013 |
| Thuringia | 3.5% | 07.04.2011 | 5.0% | 06.01.2011 |
| | | 01.01.2017 | 6.5% | 23.09.2015 |

that all households live somewhere. For the purposes of our analysis we do not need to model this market explicitly. We consider a housing market with frictions. At the beginning of each period, a fraction $0 < q < 1$ of the young enters the housing market.⁴ Only old households consider selling a house. Each young household in the market is matched with an old household.

If no trade takes place, the old agent keeps the house while old and passes it on to the next generation, which generates a utility for the old household denoted by U^O .⁵ The reservation utility of the young households is equal to zero. If a transaction

⁴A standard way of modeling frictions would be to assume that a share of $1-q$ young households is liquidity constrained. A limitation of our model is that we do not endogenize q , which implies that changes in transfer taxes in our model do not influence the number of transactions. We make this assumption because our empirical analysis focuses on effects of tax changes on prices, not on the number of transactions. The main objective of our theoretical analysis is to highlight specific factors which are likely to affect the impact of tax changes on prices.

⁵This may or may not include the utility of the old of passing on a property to the next generation. Note that, in equilibrium, at the beginning of each period, before transactions take place, only the old households own houses, which is why only they can sell houses. After transactions have taken place, the old households still own $2-q$ units of housing. At the end of period two, the old households die and the houses owned by the old are inherited by the next generation of old households.

takes place, the buyer pays a transfer tax equal to T per cent of the house price.

It is straightforward to determine the equilibrium house price. When the young negotiate, they take into account that they will sell the house with probability q when they are old. With probability $1 - q$ they will keep and use the house while old, so that the present value of the surplus from buying the house is given by

$$U^Y + \frac{q}{(1 + \rho)}p_{t+1} + (1 - q)\frac{U^O}{(1 + \rho)} - p_t(1 + T) \quad (1)$$

where t is the period index and ρ is the discount rate. The surplus of the old agent from selling is simply given by $p_t - U^O$.

The equilibrium house price in period t is thus given by maximizing the Nash maximand

$$\beta \ln \left(U^Y + \frac{q}{(1 + \rho)}p_{t+1} + (1 - q)\frac{U^O}{(1 + \rho)} - p_t(1 + T) \right) + (1 - \beta) \ln(p_t - U^O)$$

over p_t , which yields

$$p_t^*(1 + T) = \beta U^O(1 + T) + (1 - \beta) \left(U^Y + \frac{q}{(1 + \rho)}p_{t+1} + (1 - q)\frac{U^O}{(1 + \rho)} \right). \quad (2)$$

Our analysis focuses on the house price effects of changes in the transfer tax T which are perceived as permanent. It is therefore sufficient to consider the tax effect on prices in the steady state, where prices are the same in each period in this stationary model. The steady state house price is given by

$$p^* = \left(1 + T - \frac{(1 - \beta)q}{(1 + \rho)} \right)^{-1} \left[\beta U^O(1 + T) + (1 - \beta) \left(U^Y + (1 - q)\frac{U^O}{(1 + \rho)} \right) \right]. \quad (3)$$

Denote the semi-elasticity of the house price with respect to the tax rate by $\varepsilon \equiv \frac{dp^*}{dT} \frac{1}{p^*}$. Consider first the two polar cases $\beta = 1$ (buyer has all the bargaining power) and $\beta = 0$ (seller has all the bargaining power). If the buyer has all the bargaining power it follows directly from (3) that $\varepsilon = 0$. Since the seller is always reduced to her reservation utility and the house price is the net of tax price, changes in T are always fully borne by the buyer and the house price does not change. In the opposite polar case, where the seller has all the bargaining power ($\beta = 0$), we get

$$\varepsilon = -\frac{1}{1 + T - \frac{q}{(1 + \rho)}}. \quad (4)$$

Equation (4) yields various important insights. First, if q converges to zero, which implies that buyers do not expect further transactions during their lifetime, a one percentage point increase in the transfer tax ($dT = 0.01$) reduces the price by approximately one percent. But if q is positive, the decline in the price will be larger than one percent because the tax increase is also expected to be a burden on future transactions. Unsurprisingly, the impact of future transactions is stronger, the lower the discount rate. Moreover, we should expect the price effects of a permanent increase in transfer taxes to be higher, the more likely it is that the property will be traded more than once over the relevant time horizon. In particular, we may then observe that a one percentage point increase in the real estate transfer tax reduces house prices by more than one percent. Consider finally the general case $0 < \beta < 1$, where:

$$\varepsilon = \left[1 + T - \frac{(1 - \beta)q}{(1 + \rho)} \right]^{-1} \left[\frac{\beta U^O}{p^*} - 1 \right] < 0 \quad (5)$$

As we show in the appendix, equation (5) defines ε as a function of β and q , that is $\varepsilon = \varepsilon(\beta, q)$, with $\frac{\partial \varepsilon}{\partial \beta} > 0$ and $\frac{\partial \varepsilon}{\partial q} < 0$. For our empirical analysis, this implies that we would expect to see (i) a smaller price reduction in response to a tax increase in transactions where buyer bargaining power is higher and (ii) a larger price reduction in cases where the traded property is expected to be traded more frequently in the future.⁶

4 Data and Descriptive Statistics

In our empirical analysis we use a novel and large dataset on the German real estate market provided by F+B, a commercial real estate consultancy firm. The dataset covers roughly 18 million properties that were offered for sale in Germany during the period from January 2005 until December 2018. The dataset was created by analyzing real estate advertisements from 140 different sources, including online property portals, regional and trans-regional newspapers, as well as real estate agencies, using web-scraping techniques. The raw data was thoroughly cleaned to make sure that properties that were listed in more than one source at the same time only appear once in the final dataset. For all properties included in the final dataset, we know

⁶Of course, the expected number of future transactions will itself be a function of the transfer tax. In the simple model considered here, the number of future transactions is exogenous because our empirical analysis focuses on price effects, not the quantity of housing transactions.

the first day the property was listed as well as the last day it was listed. Moreover, the final dataset includes the complete list of sources in which the property was advertised.

The dataset contains two price variables: the offering price of the property on the day it was first listed and the offering price on the last day the property was listed. In our analysis, we focus on the final offering price. Note that we drop properties from our dataset in case the offering price (i) increased by more than factor two or (ii) decreased by more than 50% during the posting period since we are concerned that offering prices of those properties do not reflect market prices. Moreover, the dataset covers a wide range of property characteristics, such as floor space, the number of rooms, the construction year, as well as binary indicators for equipment and locational features, and the postal code of the property. The data is available for three different property types: apartments, single-family houses, and apartment buildings. In our empirical analysis, we study the price effects of a change in the real estate transfer tax separately for each property type.

Table 2 shows the sample means of important property characteristics separately for (i) the three different property types as well as (ii) three different time periods: 2005-2009, 2010-2014, and 2015-2018. A glance at the price variables suggest that property prices have increased notably over the past years. I.e., between 2015 and 2018, the average price per square meter for an apartment (single-family house) was roughly 650 euros (400 euros) higher than it was between 2010 and 2014. This corresponds to a price increase of about 34% (24%).

Table 2: Descriptive statistics

| | Apartments | | | Single-fam. Houses | | | Apt. Buildings | | |
|--------------------|------------|-----------|-----------|--------------------|-----------|-----------|----------------|-----------|-----------|
| | 2005-2009 | 2010-2014 | 2015-2018 | 2005-2009 | 2010-2014 | 2015-2018 | 2005-2009 | 2010-2014 | 2015-2018 |
| First asking price | 1,785.29 | 1,933.02 | 2,584.02 | 1,599.76 | 1,595.06 | 1,974.54 | 1,004.66 | 1,021.84 | 1,320.34 |
| Last asking price | 1,767.08 | 1,925.08 | 2,578.10 | 1,583.96 | 1,586.74 | 1,968.17 | 990.02 | 1,014.25 | 1,314.39 |
| Floor size | 92.61 | 94.27 | 102.36 | 150.02 | 151.98 | 153.28 | 385.46 | 312.28 | 325.52 |
| Rooms | 3.10 | 3.06 | 3.20 | 4.79 | 5.05 | 5.04 | 7.43 | 8.44 | 8.99 |
| Construction year | 1979 | 1979 | 1982 | 1981 | 1978 | 1980 | 1954 | 1952 | 1954 |
| Kitchen | 0.33 | 0.41 | 0.31 | 0.17 | 0.22 | 0.25 | 0.11 | 0.17 | 0.21 |
| Parking spot | 0.61 | 0.63 | 0.65 | 0.57 | 0.60 | 0.59 | 0.58 | 0.64 | 0.67 |
| Garden | 0.25 | 0.23 | 0.28 | 0.32 | 0.32 | 0.44 | 0.31 | 0.28 | 0.41 |
| Balcony | 0.47 | 0.37 | 0.43 | 0.31 | 0.24 | 0.39 | 0.33 | 0.23 | 0.40 |
| Basement | 0.28 | 0.46 | 0.46 | 0.35 | 0.40 | 0.42 | 0.31 | 0.39 | 0.45 |

Notes: The table shows the average realizations of different property characteristics for different property types and across different time periods. Floor space is measured in square meters. Asking prices refer to the price per square meter.

A closer inspection of our data reveals that by far the largest fraction of the properties included in our dataset (i.e., more than one-third) were advertised on the online property portal ImmobilienScout24.de, which is by far the largest online property portal in Germany. To check whether properties listed on ImmobilienScout24.de differ from those advertised in other outlets, we compare the characteristics of properties listed on ImmobilienScout24.de to the characteristics of properties that were solely listed in other outlets. The results are shown in table 3.

Table 3: Descriptive statistics

| | Apartments | | Single-fam. Houses | | Apt. Buildings | |
|--------------------|------------|--------------|--------------------|--------------|----------------|--------------|
| | IS24 | Other source | IS24 | Other source | IS24 | Other source |
| First asking price | 2,172.86 | 1,999.76 | 1,772.68 | 1,639.41 | 1,197.06 | 1,090.61 |
| Last asking price | 2,160.27 | 1,990.79 | 1,761.13 | 1,629.82 | 1,186.79 | 1,083.64 |
| Floor size | 94.06 | 97.49 | 148.80 | 153.87 | 312.26 | 336.26 |
| Rooms | 3.21 | 3.03 | 5.25 | 4.72 | 10.48 | 7.33 |
| Construction year | 1979 | 1980 | 1983 | 1977 | 1954 | 1953 |
| Kitchen | 0.39 | 0.33 | 0.14 | 0.26 | 0.10 | 0.22 |
| Parking spot | 0.68 | 0.59 | 0.62 | 0.56 | 0.69 | 0.61 |
| Garden | 0.28 | 0.22 | 0.31 | 0.38 | 0.30 | 0.35 |
| Balcony | 0.48 | 0.37 | 0.28 | 0.33 | 0.29 | 0.32 |
| Basement | 0.50 | 0.32 | 0.45 | 0.34 | 0.51 | 0.33 |

Notes: The table shows the average realizations of different property characteristics for different property types separately for properties listed on immobilienScout24.de vs. properties listed in other sources. Floor space is measured in square meters. Asking prices refer to the price per square meter.

The descriptive statistics in Table 3 indicate that properties listed on ImmobilienScout24.de do not appear to be representative of the German property market. On average, properties listed on ImmobilienScout24.de are more expensive than properties solely listed in other outlets. Also, the characteristics of properties advertised on ImmobilienScout24.de differ from the characteristics of properties listed in other sources. For instance, apartments advertised on ImmobilienScout24.de appear to be smaller, but are more likely equipped with a kitchen, a parking spot, a garden, a balcony, and a basement.

5 Empirical Strategy

We employ an event study design to assess the impact of changes in real estate transfer tax rates on residential property prices. For each property type, i.e., apartments,

single-family houses, and apartment buildings, we estimate the following model:

$$\ln(p)_{i,c,t} = \sum_{j=-12}^{23} \beta_j D_{c,t-j} + \nu X_i + \mu_c + \varsigma_{c,t} + \epsilon_{i,c,t}$$

Index i refers to the property, c to the postal code area the property is located in, and t to the month it was offered for sale. The dependent variable is the log of the property price per square meter. $D_{c,t-j}$ are monthly event study indicators for real estate transfer tax rate changes. The event window runs from 12 months prior to the tax change to 24 months after the tax change.⁷ End points are adjusted in line with Schmidheiny and Siegloch (2019). Following Schmidheiny and Siegloch, we mainly focus on the size of the tax rate change $\Delta\tau$ as event study indicator. Additionally, a robustness check employs the change in the log net-of-tax rate as in Fuest et al. (2018). While the first set of indicators assumes a linear relationship between the change in the tax rate and the percentage change in the property price, the latter set of indicators captures the elasticity of property prices with respect to the net-of-tax rate $\eta = (\frac{\Delta p}{p}) / (\frac{\Delta(1-\tau)}{1-\tau})$. We include postal code area fixed effects μ_c to account for time-invariant local characteristics that influence property prices. $\varsigma_{c,t}$ is a time-fixed effect for months and years which we interact with a set of four different dummy variables indicating the degree of urbanization. That way, we account for the fact that property prices have experienced a stronger increase in urban areas over the last years (Baldenius et al., 2019). Binary indicators for the degree of urbanization (*Siedlungsstrukturelle Kreistypen*) are provided by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR). Standard errors are clustered at the postal code level.

Deviating from a standard event study setting, we choose $t - 4$ as the reference period relative to which the change in property prices is measured. We do so for two reasons. Firstly, the price of a property offered for sale shortly before a tax reform might already reflect the upcoming tax rate change. As it may take several months to complete a property transaction, setting an earlier reference period ensures that prices are compared to a time period in which the preceding tax rate still applies. Secondly, the median time between the first legal draft and the reforms' implementation amounts to 3.2 months. The 4-month window hence ensures that the pre-trend is not as much driven by announcement effects.

⁷The event study window runs until month 23 as the month of the tax change is coded as 0.

As a robustness check, we additionally control for property characteristics that may influence prices per square meter. The property characteristics that we consider are the same that as in tables 2 and 3, i.e., floor space, the number of rooms, dummy variables for construction year groups, as well as dummy variables indicating whether the property comes with a kitchen, a parking spot, a garden, a balcony, or a basement. In another robustness check, we also include county-level variables that might be related to regional property market developments. These variables include population figures, per-capita GDP, and the unemployment rate. Note that those variables are only available at an annual frequency. Moreover, per-capita GDP as well as unemployment rates are only available at the county level. The data are provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

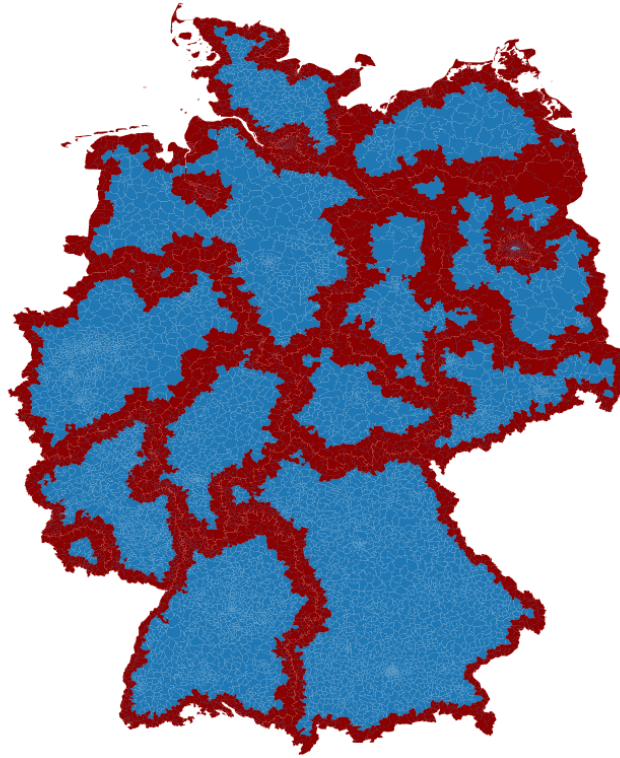
In a final robustness check, we address the concern that effects in border regions may be partially driven by spillover effects. I.e., an increase in a state's tax rate may shift demand to border regions in neighboring states, which might result in higher prices in the control group. This could lead to an overestimation of price effects. We therefore estimate a specification without observations in the vicinity of a border. More precisely, we exclude postal code areas that either directly adjoin a state border, or for which the postal code's centroid is located less than 10 kilometers away from the border. Figure 1 indicates which postal codes areas are excluded in this specification.

Our theoretical model highlights the importance of transaction frequencies as well as the distribution of bargaining power between the seller and the buyer of a property for the price effect of the RETT. Unfortunately, we neither observe the intended holding period of a specific property nor the distribution of bargaining power between buyers and sellers directly. However, we approximate both factors using two different municipality-level indicators. As a proxy for transaction frequencies, we use the fraction of property advertisements relative to the number of residential properties in a municipality. Data on the number of residential properties is taken from the 2011 census. We then compute transaction frequency quartiles within each state and estimate the event study separately for each quartile.

We approximate the bargaining power of sellers using population growth between 2005 and 2017. Arguably, the more people move to a municipality, the higher is the demand for houses, implying more bargaining power for the seller. We again compute quartiles within states and estimate our model separately for each quartile.

Note that when assessing the importance of transaction frequencies and bar-

Figure 1: Postal codes in the vicinity of state borders



Notes: This figure shows all German postal code areas, distinguished by their distance to state borders. Red areas indicate postal codes that either directly adjoin a state border or whose centroid is located at a distance of up to 10 kilometers to a border.

gaining power for the price effects of RETT, we restrict our analysis to single-family houses. The reason is that apartment and apartment buildings are often considered as investments and, consequently, bought by institutional investors, which is why population growth may only represent a poor proxy for bargaining power. Likewise, if a property is bought as an investment, the link between transaction frequency and the fraction of properties offered for sale over the property stock should be less strong. In contrast, the vast majority of single-family houses is owner-occupied, which is why our proxies for transaction frequencies and bargaining power should be better suited. Also note that when constructing the proxy for transaction frequencies, we omit all municipalities that have less than 1,000 buildings.⁸

⁸Without a minimum municipality size, very small municipalities might be assigned to high transaction frequency categories if just few buildings are on offer.

6 Results

6.1 The Effect of RETT on Property Prices

Figure 2 displays the results for the baseline specification in which we employ the change in the RETT rate $\Delta\tau$ as event study indicator.

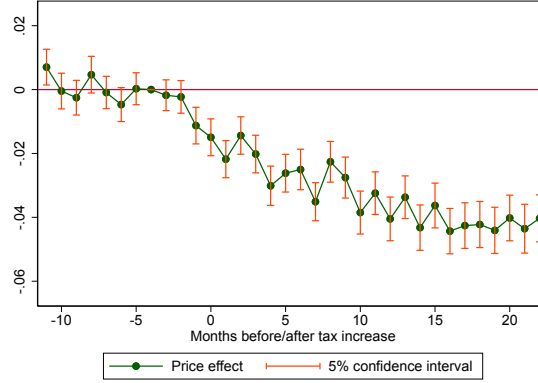
For all three property types considered in our analysis, prices start to drop immediately after the tax hike becomes effective, whereas the magnitude of the response increases (in absolute terms) over time. Apartment prices gradually decline until the price response reaches a minimum at around -0.04 after one year. This indicates that an increase in the tax rate by one percentage point reduces the price of apartments by up to 4%. For single-family houses and apartment buildings, the price response is somewhat smaller, i.e., -0.015 and -0.03 , respectively, and reaches its minimum more quickly. Nevertheless, for all three property types, the price decrease exceeds the increase in the tax burden. Note that this finding is well in line with our theoretical model. The larger price effect for apartments compared to single-family houses and apartment buildings may be due to a shorter average holding period: While houses are mainly bought by families who plan to live in the property for many years (and may even have a bequest motive), apartments are more frequently bought by investors who may intend to resell the property at some point in time (Petkova and Weichenrieder, 2017; Deutsche Bundesbank, 2018).

Note that we observe a small pre-trend for houses, although the post-reform effect rapidly stabilizes at a rather constant level. Also, price effects fluctuate prior to the reform. This could partly be driven by anticipation effects: Depending on the state and the reform, a tax increase may have been announced just two months or an entire year prior to the reform. This could have induced anticipatory responses at different points in time preceding the respective reforms.

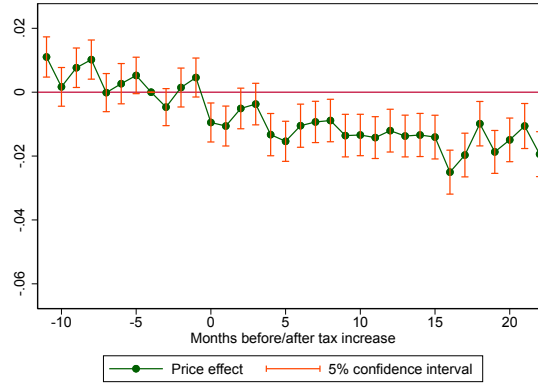
Over the last decades, we have seen a very heterogeneous development of property prices in Germany. Some large German cities, such as Munich or Berlin, as well as some more rural areas in their vicinity, have experienced a rapid increase in property prices over the last decades, considerably driven by a substantial growth in population size. At the same time, there are some predominately rural areas in Germany that suffer from a population drain, leading to declining property prices. Although we account for heterogeneous time trends across regions characterized by different degrees of urbanization in our baseline specification, we are still concerned

Figure 2: Baseline: Effects of changes in the RETT rate $\Delta\tau$

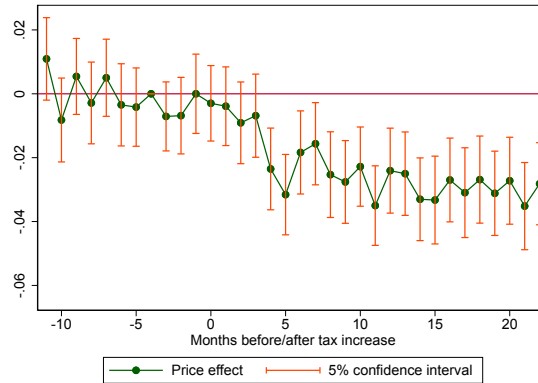
(a) Apartments



(b) Houses



(c) Apartment buildings



Notes: The figure plots monthly event study estimates and corresponding 95% confidence bands for the baseline event study specification. The dependent variable is a property's log price per square meter, and event study indicators correspond to the change in the tax rate $\Delta\tau$. Specifications include postal code and month-year \times urbanization level fixed effects. Standard errors are clustered at the postal code level.

that our results might be affected by some outliers that have experienced extreme migration patterns during our sample period. In order to address this concern, we winsorize our sample according to municipal population growth between 2005 and 2017.⁹ I.e., we drop all municipalities with a population growth rate that is smaller than the population-weighted 5% quantile or larger than the population-weighted 95% quantile of the population growth rate.¹⁰

The results are depicted in figure 3. While the coefficients are very similar to those illustrated in figure 2, no significant pre-trend remains once municipalities are dropped that exhibit extreme population growth rates. The decline in prices starts in the three months prior to the reform. This is in line with our expectations and reflects the importance of anticipation effects. If a property is offered for sale shortly before the RETT rate change becomes effective, it is unlikely that the transaction will be completed before the implementation date, implying that the higher RETT rate will apply. Therefore, we already observe a decrease in property prices before the implementation of the reform.

Figure 4 estimates the event study on a combined sample of apartments, houses, and apartment buildings. As before, the pre-trend disappears once municipalities with particularly strong growth or decline in population size are excluded. With a coefficient of roughly 3 to 3.5 after one year, the aggregate effect lies, as expected, between the effects of the individual specifications.

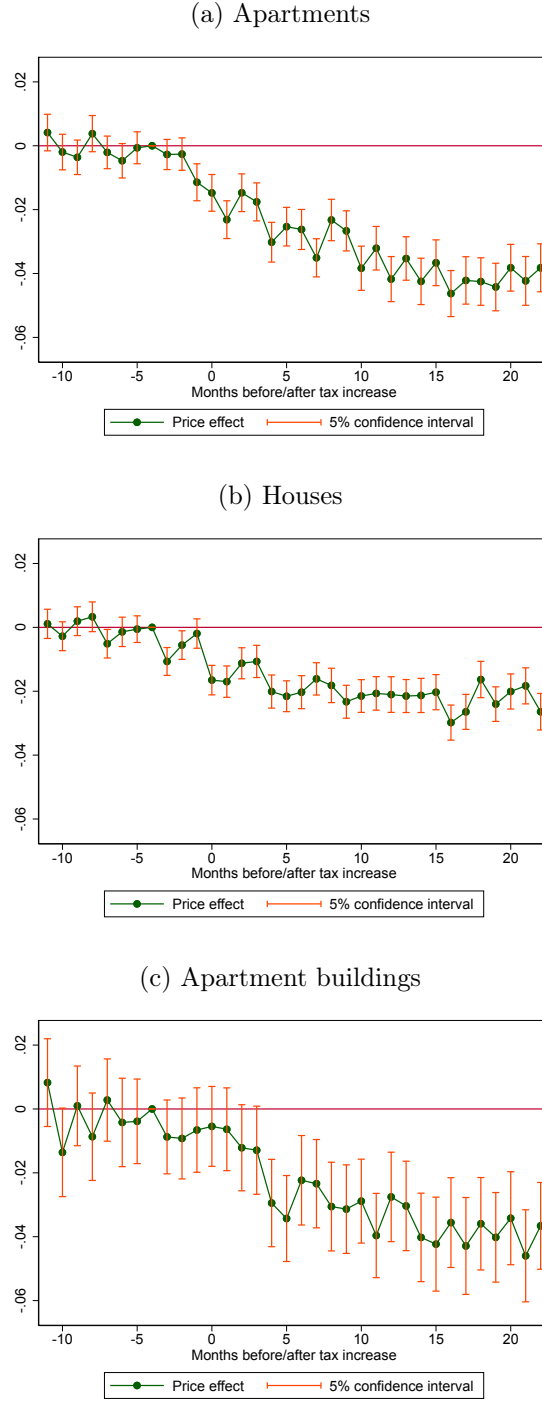
To check the robustness of our results, we modify our empirical specification in several additional ways. Note that all further robustness checks are based on the winsorized sample. As a first robustness check, we replace the change in the RETT rate by the log net-of-tax rate. A glance at figure 5 reveals that our results remain qualitatively unchanged. For apartments and apartment buildings, the estimated price elasticity with respect to the log net-of-tax rate reaches a maximum of 4, while the estimated elasticity for houses is somewhat smaller.

Second, we add property-specific control variables to equation 5. Specifically, we control for the floor space in square meters, the number of rooms, construction year categories, as well as various amenities. Controlling for property characteristics

⁹Administrative data on municipal population size was only available until 2017 at the time of writing the paper.

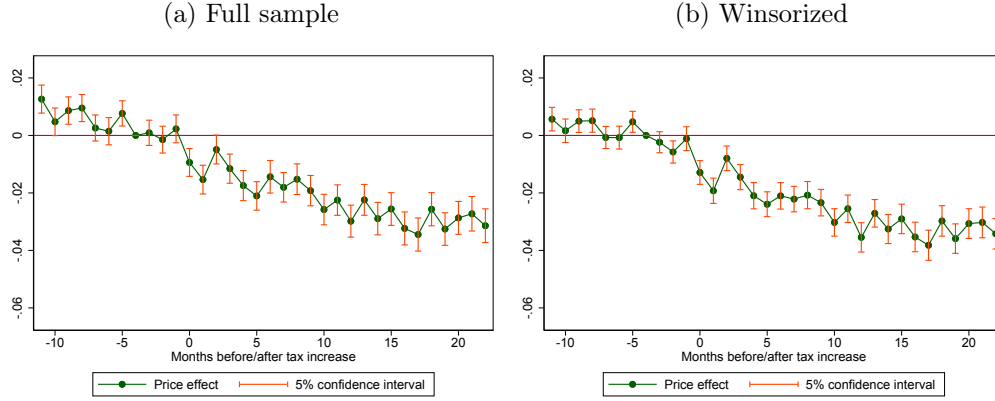
¹⁰Dropping properties offered for sale in areas that experienced particularly large increases and declines, respectively, in population growth, rather than directly winsorizing based on property prices, ensures that the selection of our sample is not endogenous, that is, related to price changes induced by a decrease in RETT rates.

Figure 3: Winsorizing municipal population growth rates



Notes: The figure plots monthly event study estimates and corresponding 95% confidence bands. The dependent variable is a property's log price per square meter, and event study indicators correspond to the change in the tax rate $\Delta\tau$. Specifications include postal code and month-year x urbanization level fixed effects. Standard errors are clustered at the postal code level. This specification excludes the population-weighted top and bottom 5% of municipalities according to municipal population growth between 2005 and 2017.

Figure 4: Joint estimation for apartments, houses and apartment buildings



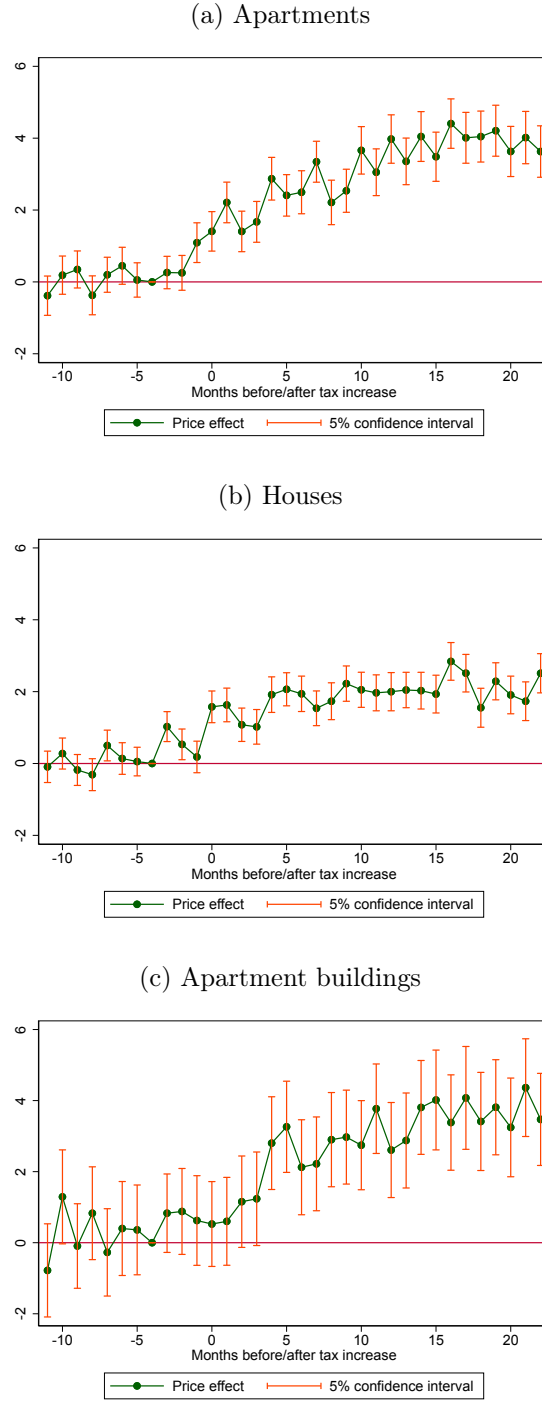
Notes: The figure plots monthly event study estimates and corresponding 95% confidence bands for a joint sample including apartments, houses and apartment buildings. The dependent variable is a property's log price per square meter, and event study indicators correspond to the change in the tax rate $\Delta\tau$. Specifications include postal code and month-year \times urbanization level fixed effects. Standard errors are clustered at the postal code level. The first specification considers the full sample. The second specification excludes the population-weighted top and bottom 5% of municipalities according to municipal population growth between 2005 and 2017.

ensures that our findings are indeed due to changes in offering prices and not driven by composition effects. This concern would be relevant if a change in RETT has an effect on the pool of properties that are offered for sale. The results are displayed in figure 6. While the figure closely resembles figure 3, the coefficients' magnitude slightly decreases. However, with the confidence bands becoming more narrow, the significance of the coefficients remains unaffected.

In a third robustness check, we add several variables to our empirical model that cover regional housing market conditions. We control for county-level GDP, population size, and the unemployment rate. The results are illustrated in figure 7. Again, we find that our results remain qualitatively unchanged.

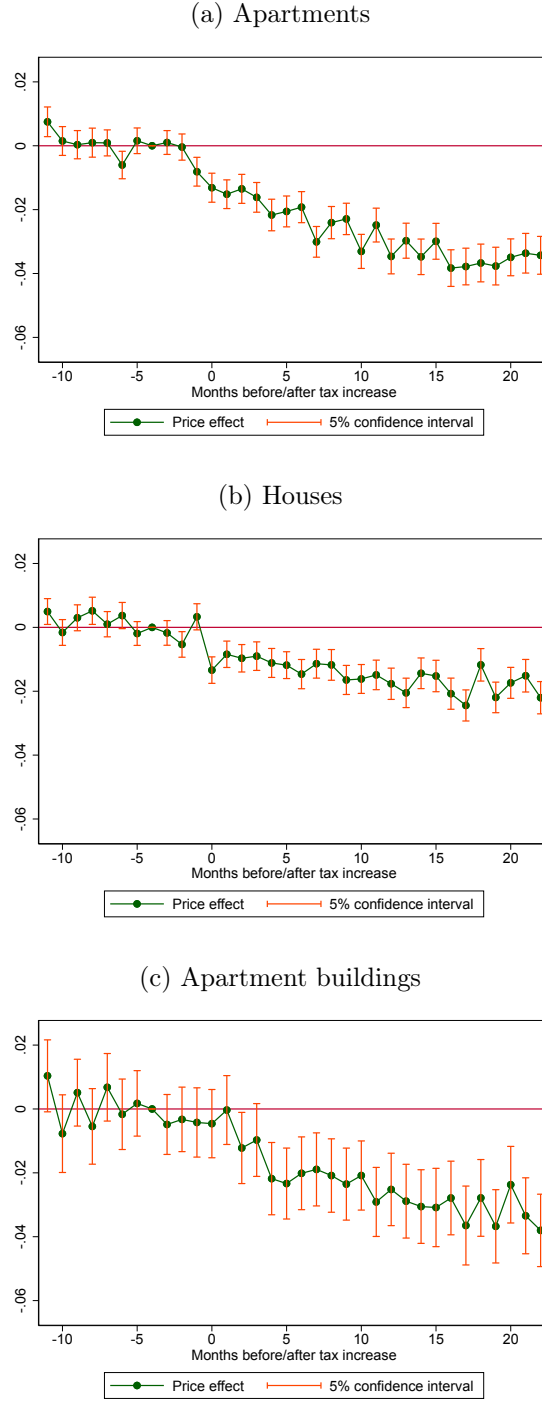
In a final robustness check, we exclude properties located in postal codes in the vicinity of a state border. The reason is that there may be spillover effects of RETT changes into regions that are located close to the border of a state that has implemented the RETT change. I.e., suppose there is a region located in state A and bordering state B. If state B increases the RETT, but state A does not, we may observe an increase in the demand for properties located in that region because of its proximity to state B. Figure 8 shows the results. While the estimated price effects for single-family houses and apartment buildings virtually identical to the ones obtained

Figure 5: Robustness check: Effects of changes in the log net-of-tax rate



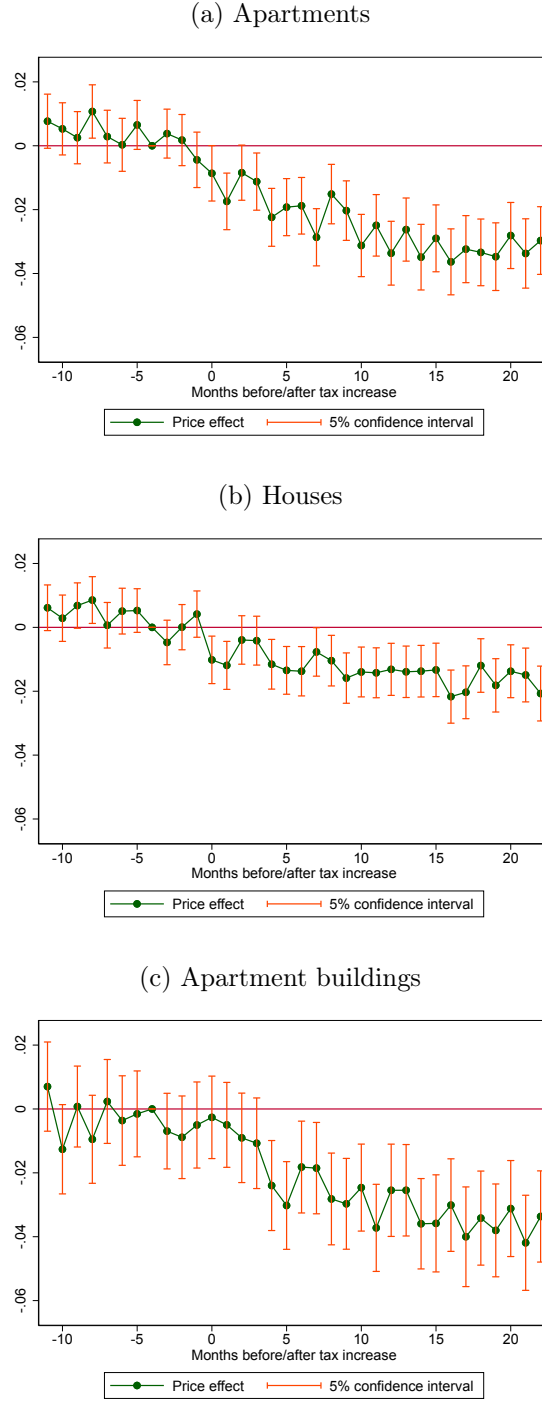
Notes: The figure plots monthly event study estimates and corresponding 95% confidence bands. The dependent variable is a property's log price per square meter, and event study indicators correspond to the change in the log net-of-tax rate. Specifications include postal code and month-year x urbanization level fixed effects. Standard errors are clustered at the postal code level.

Figure 6: Robustness check: Property-specific control variables



Notes: The figure plots monthly event study estimates and corresponding 95% confidence bands. The dependent variable is a property's log price per square meter, and event study indicators correspond to the change in the tax rate $\Delta\tau$. Specifications include postal code and month-year x urbanization level fixed effects. Standard errors are clustered at the postal code level. Specifications control for area in square meter, the number of rooms, the construction year, as well as whether the property has a basement, a parking spot, a garden, and a kitchen, and exclude the population-weighted top and bottom 5% of municipalities according to municipal population growth between 2005 and 2017.

Figure 7: Robustness check: Regional control variables



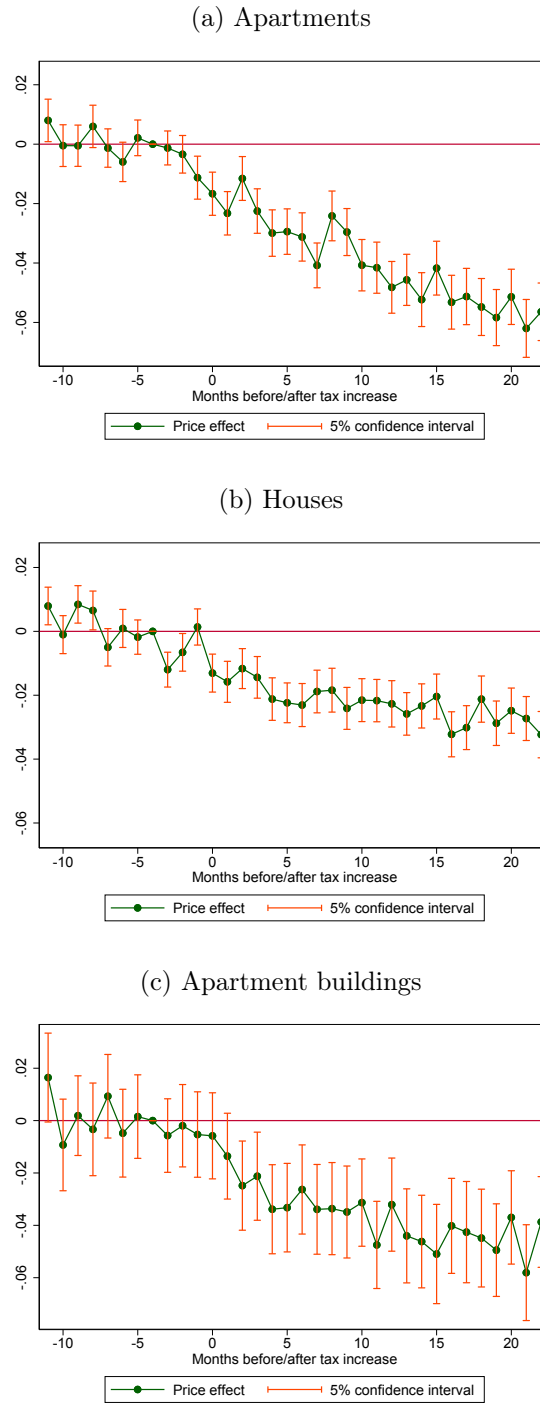
Notes: The figure plots monthly event study estimates and corresponding 95% confidence bands. The dependent variable is a property's log price per square meter, and event study indicators correspond to the change in the tax rate $\Delta\tau$. Specifications include postal code and month-year x urbanization level fixed effects. Standard errors are clustered at the postal code level. Specifications control for annual county-level population, GDP, and the unemployment rate, and exclude the population-weighted top and bottom 5% of municipalities according to municipal population growth between 2005 and 2017.

based on our baseline estimation, the magnitude of coefficient estimates slightly increases for apartments. This alleviates the concern that the rather large effect measured in the baseline specification is attributable to spillover effects into border regions of tax-increasing states. Instead, coefficients are slightly more negative than in the baseline. This could also be due to the specific municipalities that are excluded here: amongst others, not considering border regions almost fully excludes the three city states from the sample.

To sum up, our findings indicate that property prices decline by more than the magnitude of the tax increase. A one percentage point change in the RETT reduces apartment prices by roughly 3-4%, house prices by 1.5-2% and prices of apartment buildings by 2-4%. While prices start responding immediately to the reform, the response increases in magnitude over the course of the first year after a reform. Responses seem to be more immediate for house prices than for apartment prices.

While in contrast to previous findings for Germany, the observed overshifting is consistent with Best and Kleven (2018), Kopczuk and Munroe (2015) and Davidoff and Leigh (2013), who likewise find a reduction in real estate prices which by far exceeds the increase in the tax rate. Several factors may contribute to this overshifting. First, the capitalization of RETT in a property's future resale value might lower property prices, as described in section 3. This might also help explain why effects are substantially larger for apartments than for single-family houses. While single-family houses are frequently bought by individuals who intend to live in their house for many decades, and hence do not pay as much attention to the future resale value, apartments serve more often as an investment property. Second, downpayment constraints might play an important role here (Best and Kleven, 2018). While it is possible to debt-finance a large share of the property price, taxes need to be paid upfront and are usually not mortgageable. For credit-constrained buyers, an increase in the tax burden thus has a much larger impact on the affordability of a property than a property price change of the same magnitude. For downpayment-constrained households, one can thus expect a price response that exceeds the change in the tax burden.

Figure 8: Robustness check: Without postal codes within 10 km of the border



Notes: The figure plots monthly event study estimates and corresponding 95% confidence bands. The dependent variable is a property's log price per square meter, and event study indicators correspond to the change in the tax rate $\Delta\tau$. Specifications include postal code and month-year \times urbanization level fixed effects. Standard errors are clustered at the postal code level. Specifications exclude the population-weighted top and bottom 5% of municipalities according to municipal population growth between 2005 and 2017, as well as postal codes that either directly adjoin a border or whose centroid is located at a distance of up to 10 kilometers to the border.

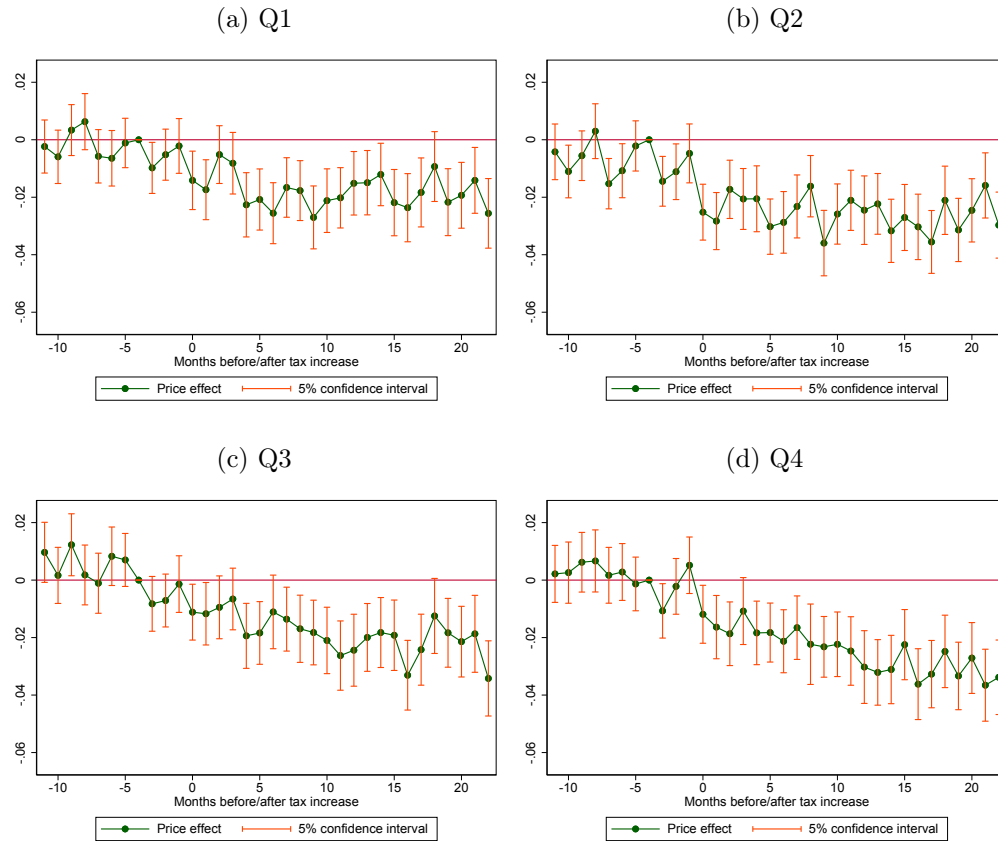
6.2 Price Effects by Transaction Frequency and by Bargaining Power

Our theoretical model suggests that the price effect of a RETT change is larger when (i) the bargaining power of buyers is lower and (ii) when a property is expected to be traded more frequently in the future (see section 3). We provide preliminary evidence for the accuracy of both predictions by approximating properties' transaction frequencies and buyers' and sellers' bargaining power using two different indicators that vary at the municipal level.

To analyze whether property prices respond more strongly to a RETT increase when transaction frequencies are higher, we compute a proxy for transaction frequencies at the municipal level. In a first step, we divide the aggregate number of houses offered for sale in a municipality by the total number of houses in the municipality. Then, we calculate the state-specific quartiles of this variable and assign each municipality to one of the four quartiles. Finally, we re-estimate 5 separately for each quartile. Figure 9 shows the results, with transaction frequencies increasing from Q1 to Q4. In line with the theoretical prediction of our model, price responses seem to be slightly stronger in case housing transaction occur more frequently (even though the differences between the quartiles are of a rather modest size).

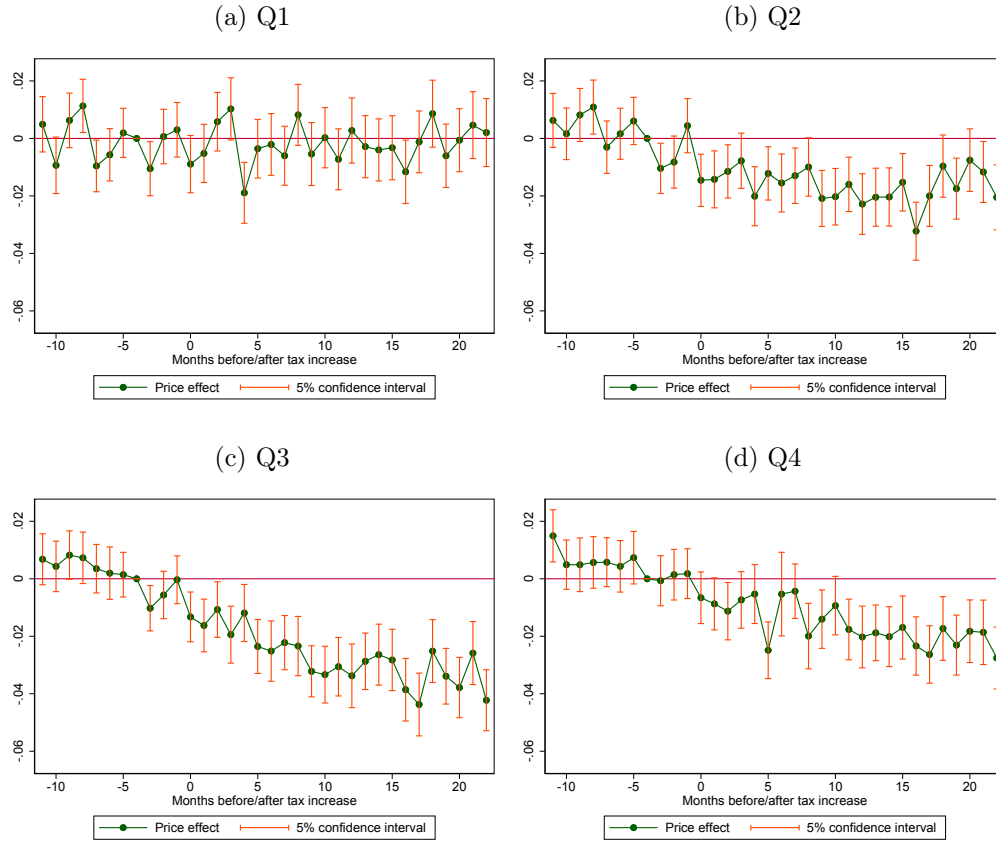
In a similar vein, we proxy bargaining power of sellers and buyers using municipal population growth rates. The idea is that the larger a municipality's population growth, the higher is the demand for properties and, consequently, the better a seller's bargaining position. As before, we compute state-specific population growth quartiles, determine the quartile each municipality belongs to, and re-estimate equation 5 separately for each quartile. Figure 10 displays results. The price effects in the lowest quartile, that is, Q1, are not significantly different from zero. In those municipalities, sellers have little bargaining power. In line with the predictions derived from our model, the house price is close to the net-of-tax price, and no significant price response occurs. In turn, price responses are pronounced when population growth is (relatively) large and, hence, sellers (buyers) have high (low) bargaining power. Yet again, the evidence that we find supports the conclusions that can be drawn based on our theoretical model.

Figure 9: Transaction frequencies: Effects for houses by transaction frequency quartiles



Notes: The figure plots monthly event study estimates and corresponding 95% confidence bands for each of four transaction frequency quartiles. Quartiles are formed within states and based on overall postings across all years relative to the housing stock. The dependent variable is a property's log price per square meter, and event study indicators correspond to the change in the tax rate $\Delta\tau$. Specifications include postal code and month-year \times urbanization level fixed effects. Standard errors are clustered at the postal code level. This specification excludes the population-weighted top and bottom 5% of municipalities according to municipal population growth between 2005 and 2017.

Figure 10: Bargaining power: Effects for houses by population growth quartiles



Notes: The figure plots monthly event study estimates and corresponding 95% confidence bands for each of the four population growth quartiles. Quartiles are formed within states and based on municipal population growth between 2005 and 2017, also including municipalities with very high and very low population growth. The dependent variable is a property's log price per square meter, and event study indicators correspond to the change in the tax rate $\Delta\tau$. Specifications include postal code and month-year \times urbanization level fixed effects. Standard errors are clustered at the postal code level.

7 Conclusion

This paper exploits a constitutional reform that was passed in Germany in 2006 to study the effect of changes in the real estate transfer tax (RETT) on property prices. The reform granted the German states the right to set the rate of the RETT. Over the following years, 14 out of the 16 states executed this right and increased the RETT rate, often multiple times. Up to date, there have been 27 tax hikes. Before the reform, there was a uniform RETT rate of 3.5% that applied to all German states. Today, the highest RETT rate is 6.5%.

We combine the information on RETT rate changes at the state level with a large micro dataset covering roughly 18 million properties that were offered for sale during the period from January 2005 until December 2018. The dataset was created by collecting information from property advertisements using web-scraping techniques. These information were collected from 140 different sources, including online property portals, regional and trans-regional newspapers, as well as property brokers. The list of variables includes the offering price as well as a large set of property characteristics. Importantly, our dataset contains the exact day the property was listed as well as the postal code of the property. Based on this dataset, we analyze the effect an increase in the RETT rate has on property prices using an event study design. We conduct our analysis separately for apartments, single-family houses, and apartment buildings.

Before turning to the empirical analysis, we set up a stylized theoretical model of the housing market to derive empirically testable predictions. One of the main insights is that in the Nash equilibrium, an increase in the RETT rate may result in a decline in property prices that exceeds the tax increase. Our model predicts that the semi-elasticity of the house price with respect to the RETT may be larger than one if the bargaining power of the seller is high and if a property is expected to be traded more frequently in the future.

Our empirical findings lend support to our theoretical model. We find that a one percentage point increase in the RETT reduces apartment prices by roughly 3-4%, house prices by 1.5-2%, and prices of apartment buildings by 2-4% in the twelve months after the reform. These results are robust to several modifications to our empirical specifications. What is more, we indeed find evidence that the magnitude of the price effect in response to a RETT rate change is positively related to the bargaining power of sellers in the housing market as well as the transaction frequency

of the property.

The findings that we provide bear great importance for economic policy-makers. In light of the increasing international mobility of capital and labor, taxes on property are often regarded as a particularly attractive source of public revenue. However, only little is known so far about the distribution of the tax burden for a permanent increase in real estate transfer taxes. Our results suggest that the biggest share of the tax burden is borne by the seller, not the buyer of a property.

References

- Baldenius, T., S. Kohl, and M. Schularick (2019). Die neue Wohnungsfrage: Gewinner und Verlierer des deutschen Immobilienbooms. *Mimeo*.
- Baudisch, C. F. and C. Dresselhaus (2018). Impact of the German Real Estate Transfer Tax on the Commercial Real Estate Market. *Finanzwissenschaftliche Arbeitspapiere Nr. 100 – 2018, Justus-Liebig-Universität Gießen*.
- Besley, T., N. Meads, and P. Surico (2014). The Incidence of Transaction Taxes: Evidence from a Stamp Duty Holiday. *Journal of Public Economics* 119, 61–70.
- Best, M. C. and H. J. Kleven (2018). Housing Market Responses to Transaction Taxes: Evidence from Notches and Stimulus in the UK. *The Review of Economic Studies* 85(1), 157–193.
- Büttner, T. and M. Krause (2018). Föderalismus im Wunderland: Zur Steuerautonomie bei der Grunderwerbsteuer. *Perspektiven der Wirtschaftspolitik* 19(1), 32–41.
- Dachis, B., G. Duranton, and M. A. Turner (2012). The Effect of Land Transfer Taxes on Real Estate Markets: Evidence from a Natural Experiment in Toronto. *Journal of Economic Geography* 12(2), 327–354.
- Davidoff, I. and A. Leigh (2013). How Do Stamp Duties Affect the Housing Market? *Economic Record* 89(286), 396–410.
- Deutsche Bundesbank (2018). Methodenbericht zu den Wohnimmobilienpreisinizes. *Frankfurt am Main, 29. August 2018*.
- Fritzsche, C. and L. Vandreï (2019). The German Real Estate Transfer Tax: Evidence for Single-Family Home Transactions. *Regional Science and Urban Economics* 74, 131–143.
- Fuest, C., A. Peichl, and S. Siegloch (2018). Do Higher Corporate Taxes Reduce Wages? Micro Evidence from Germany. *American Economic Review* 108(2), 393–418.
- Kopczuk, W. and D. Munroe (2015). Mansion Tax: The Effect of Transfer Taxes on the Residential Real Estate Market. *American Economic Journal: Economic Policy* 7(2), 214–57.

- Petkova, K. and A. J. Weichenrieder (2017). Price and Quantity Effects of the German Real Estate Transfer Tax. *CESifo Working Paper No. 6538*.
- Schmidheiny, K. and S. Siegloch (2019). On Event Study Designs and Distributed-Lag Models: Equivalence, Generalization and Practical Implications. *CEPR Discussion Paper No. DP13477*.
- Slemrod, J., C. Weber, and H. Shan (2017). The Behavioral Response to Housing Transfer Taxes: Evidence from a Notched Change in DC Policy. *Journal of Urban Economics* 100, 137–153.

Appendix

In this appendix we show that $\frac{\delta \varepsilon}{\delta \beta} > 0$ and $\frac{\delta \varepsilon}{\delta q} < 0$, as claimed in the main text. From equation (5) we can derive

$$\begin{aligned} \frac{\delta \varepsilon}{\delta \beta} = & - \left[1 + T - \frac{(1 - \beta)q}{(1 + \rho)} \right]^{-2} \frac{q}{(1 + \rho)} \left[\frac{\beta U^O}{p^*} - 1 \right] \\ & + \left[1 + T - \frac{(1 - \beta)q}{(1 + \rho)} \right]^{-1} \frac{U^O}{p^{*2}} \left[p^* - \beta \frac{\delta p^*}{\delta \beta} \right] \end{aligned} \quad (A1)$$

Note that the first term on the right hand side of (A1) is positive because $\frac{\beta U^O}{p^*} - 1 < 0$. The second term on the right hand side of (A1) is also positive because the price declines with increasing bargaining power of the buyers, i.e.

$$\frac{\delta p^*}{\delta \beta} = - \left[1 + T - \frac{(1 - \beta)q}{(1 + \rho)} \right]^{-1} \left[\frac{p^* q}{(1 + \rho)} - U^O(1 + T) + U^Y + (1 - q) \frac{U^O}{(1 + \rho)} \right] < 0$$

From equation (5) we can also derive

$$\begin{aligned} \frac{\delta \varepsilon}{\delta q} = & \left[1 + T - \frac{(1 - \beta)q}{(1 + \rho)} \right]^{-2} \frac{(1 - \beta)}{(1 + \rho)} \left[\frac{\beta U^O}{p^*} - 1 \right] \\ & - \left[1 + T - \frac{(1 - \beta)q}{(1 + \rho)} \right]^{-1} \frac{\beta U^O}{p^{*2}} \frac{\delta p^*}{\delta q} \end{aligned} \quad (A2)$$

The first term on the right hand side of (A2) is negative because $\frac{\beta U^O}{p^*} - 1 < 0$. The second term is also negative because $\frac{\delta p^*}{\delta q} = \left[1 + T - \frac{(1 - \beta)q}{(1 + \rho)} \right]^{-1} \frac{(1 - \beta)}{(1 + \rho)} (p^* - U^O) > 0$. q.e.d.