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Coletta Frenzel Baudisch / Carolin Dresselhaus

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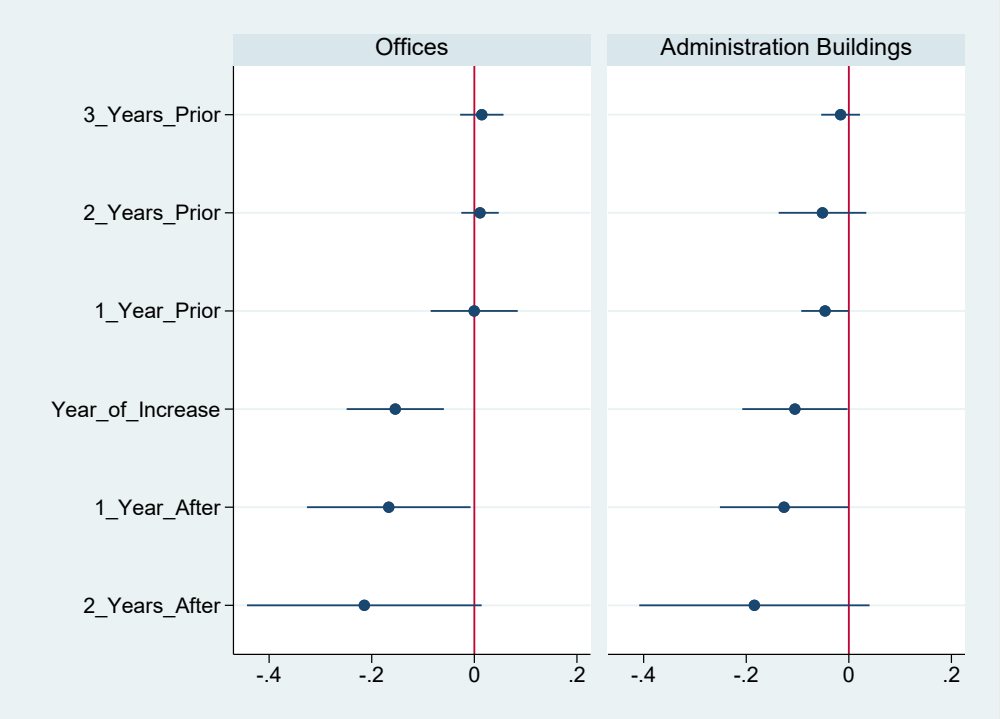
Justus-Liebig-Universität Gießen

Fachbereich Wirtschaftswissenschaften

Figure 1: Coefficient plots of transactions of offices and administration buildings



Impact of the German Real Estate Transfer Tax on the Commercial Real Estate Market

Coletta Frenzel Baudisch[1] Carolin Dresselhaus[1]

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Abstract

The tax burden of real estate transactions in Germany increased considerably since the constitutional reform in 2006. We examine the impact of the real estate transfer tax (RETT) on transactions and (net-of-tax) prices of commercial buildings and vacant commercial lots by means of a fixed-effects panel regression. The empirical analysis shows an association of a rise of the RETT by 1% with a decrease of office transactions by up to 0.41% and reduced prices by up to 0.22%. On the market for other commercial properties, transactions and prices decline by 0.17% and 0.19% respectively following a RETT increase. The negative price effects on the commercial real estate market tentatively indicate tax incidence with the seller. In the case of vacant commercial lots, a RETT increase seems to induce an increase of average prices by 0.36%, denoting tax incidence with the buyer. We find no significant effect on transactions of vacant lots in the data. In addition, we analyze possible neighborhood effects among the states. The empirical evidence for these effects implies that with an average of a 1% RETT increase in the bordering states of one state, the prices for other commercial properties and for vacant lots rise by 0.51% and 0.71% respectively. Hence, the border effect seems to surpass the direct price effect and suggests spatial structural changes in the investment behavior.

Keywords: real estate transfer tax, commercial real estate market, share deal, panel regression.

JEL Codes: H20, H22, H77, R33.

[1]Department of Economics, Justus Liebig University, Giessen
Corresponding author: coletta.frenzel@wirtschaft.uni-giessen.de

1 Introduction

The real estate transfer tax (RETT) is a transaction tax on all kinds of real estate transactions (residential and commercial properties, vacant lots) with the selling price of the property as taxable base. Since the constitutional reform of the German federation in 2006, the German federal states can decide autonomously on the tax rate of the German RETT. While the tax rate was previously set at 3.5% at the federal level, it averages to 5.4% in 2017 over a level range from still 3.5% in two states (Bavaria and Saxony have maintained the initial rate until now) up to a top rate of 6.5% in five states. Over the period 2007 until 2017, 26 increases of the RETT rate have been recorded. Tax revenue more than doubled since the revision of the statute from 6 billion Euro in 2006 to 13 billion Euro in 2017, making the RETT the greatest source of tax revenue at state level. Table A1 in the appendix shows the development of the RETT rate since the reform.

To determine the tax burden, the taxable base which often corresponds to the purchasing price of the property is multiplied with the tax rate. Hence, the RETT increases the transaction costs by driving a wedge between the seller (net) and buyer (gross) price with possible negative repercussions on the efficiency of the real estate market. The ensuing reactions depend on the elasticities of supply and demand. Empirical studies estimate the tax rate elasticity of RETT revenues to range between 0.6 and 0.74 (Büttner 2017, Petkova & Weichenrieder 2017). The literature on financial transaction taxes contains possible reasons for this disproportional rise in tax revenues. Matheson (2012) shows that financial transaction taxes reduce asset values and increase capital costs of investors, hereby diminishing trade volume and liquidity. Transferring these insights to the tax on real estate transactions, we expect variations of net prices (forward and backward shifting), holding periods (temporal adaption), rent (factual adaptation), structure of real estate investments, or a mixture of these effects.

A decline in net-of-tax selling prices may serve as an indication of at least a part of the tax burden to be carried by the seller, whereas a proportional surge in the tax-inclusive

buyer price means that the tax burden may be passed on to the buyer. A disproportional decline then hints at part of the tax burden to be with the buyer because the tax-inclusive buyer price increases even with a decreasing net-of-tax seller price.

Higher transaction costs due to the RETT may result in fewer transactions on the commercial real estate market, also known as lock-in-effect. Therefore, the RETT is assessed as a barrier to transactions in the literature (Hilber & Lyytikäinen 2017). The tax structure of the RETT may exacerbate this effect since the tax is due with every trade of the property without any deduction of previous acquisition costs. Hence, depending on the turnover rate, the property is charged repeatedly. Owners extend the holding-period of the real estate properties, because the relevance of the transaction tax diminishes with time (Slemrod et al. 2013).

There is a discussion in the literature about a possible function of the RETT as a sort of Tobin-tax, which may contain speculation on the real estate market and hereby reduce the risk of price bubbles (Tobin 1978). Price bubbles on the real estate market are among the critical determinants of financial crises (Reinhart & Rogoff 2008). Thus, the RETT might have positive steering effects because the lock-in-effect delays the process of pricing. Hereby, bubbles become less likely. However, there is no empirical confirmation about this theoretical nexus. Fu et al. (2013) empirically find short-term real estate speculation, defined as a resale before final completion of a property, to fall in response to an increase of transaction costs by means of a Tobin-tax on the real estate market in Japan. On the other hand, Crowe et al. (2013) do not detect any distinct relationship between low volatility and high RETT in their cross-national investigation. The authors suspect the low turnover rate of real estate to be the driving force behind this result. Furthermore, the consolidation of budgets usually justifies tax increases and less so macro prudential measures, especially on state-level. Considering the debt brake in the German constitutional law which bans net borrowing for the federal states from 2020 onwards, the states are in need of a higher revenue autonomy. Nevertheless, the fiscal equalization scheme among the federal states bears a conflict of goals

between revenue autonomy and redistribution: while the states should be in the position to adjust their revenues, discrepancies in the financial resources are not accepted and tried to be equalized. The coexistence of revenue autonomy and fiscal equalization scheme incentives excessive taxation, which is also true for the RETT (Buettner & Krause 2018).

However, the tax burden does not necessarily stay with the buyer and seller of a property but may also be partially passed on to the tenant. The rent needs to cover all costs and yield a positive return for real estate to be competitive among capital investments (Poterba 1984). The RETT disadvantages real estate investment over other capital investment, especially financial capital, since no financial transaction tax exists in Germany (Scherf & Dresselhaus 2016).

The structure of the real estate investment enables another substitution effect. Regardless of the kind of investment, whether it is a vacant lot or a lot including a commercial or residential building, the selling price constitutes the taxable base. Therefore, the inclusion of buildings makes investment in the real estate stock more expensive and favors new construction. Rational buyers prefer vacant lots since the construction of a building is free of RETT. Sellers of vacant lots benefit from the demand stimulated by this conception of the RETT. A negative effect on the corresponding transactions is possible, though together with a positive effect on the prices of vacant lots (RWI 2012).

In addition, the RETT triggers a further distortion of the structure of real estate investment concerning commercial properties or properties held as business assets. The RETT counts as ancillary acquisition costs for the buyer of a property, as do the charges for the notary, the real estate agent and the land register entry. These costs can usually not be funded by debts because 100% of the net price represent the limit to the credit amount. The commercial real estate market offers investors a possibility to evade the RETT by acquiring real estate via RETT-free share deals. For that matter, the property is not directly sold, but the shares of the company owning it are transferred. If the buyer holds less than 95% of the company owning the property for a minimum of 5 years, no RETT is due. Anecdotal

evidence backed by statistical correlations (Hentze & Voigtländer 2017) hints at increasing relevance of share deals in the commercial real estate market due to increasing rates of the RETT. A stronger decline in transactions on the commercial than on the residential real estate market in the aftermath of RETT increases could be a pointer in that direction. However, a comparison between transactions on these two markets is only possible to a limited extent because of the different categories (for example apartments on the residential market and offices on the commercial market).

In addition to the option of a share deal, commercial users may activate the RETT as ancillary acquisition costs regardless of the way of utilization and depreciate it by 3% annually. Thereby, companies have to pay the RETT completely, but crediting it against their income tax liability reduces the tax burden the longer the holding period lasts.

Besides the factual adaptation and the possibility to pass the tax burden on to the tenant, another possible reaction to an increase of the RETT is the relocation into a state with a lower RETT rate which seems more relevant on the commercial than on the residential real estate market. Taking one of the top locations for business in Germany, Frankfurt/ Main as an example, it is situated in Hesse with a current RETT rate of 6%. This rate is considerably lower at 3.5% in the neighboring state Bavaria, with the Bavarian city Aschaffenburg located close to Frankfurt. Considering these potential savings out of RETT payments, spatial effects between the states are possible (Büttner 2017).

So far, empirical studies of effects of the RETT in Germany concentrated on residential real estate (Fritzsche & Vandrei 2016, Petkova & Weichenrieder 2017). The possibility of commercial investors to set the RETT off against their tax liabilities serves as one explanation of this chosen focus, since the estimated effects might be distorted. However, private owners of real estate have this opportunity available, too, if they do not occupy the property themselves. Annual depreciation rates vary from 2% for residential real estate and 3% for commercial real estate according to 7 (4) EStG. Consequently, residential real estate and related utilities are depreciated after 50 years, whereas commercial real estate takes ap-

proximately 33 years to be completely depreciated. Considering the significant effects found in analyses of the German residential market with a renting quota of ca. 50% (Eurostat, 2016), we also expect significant effects on the commercial real estate market. Rented-out residential real estate investment illustrates the resemblance to investments in commercial real estate with the possibilities of tax reductions. Moreover, the taxation principles of the RETT increase the burden of a property together with its turnover ratio.

The current study aims at closing the gap in the economic literature on empirical effects of the RETT on transactions and prices of commercial real estate in Germany. Furthermore, we intend to complement the literature on regional border effects of tax rate modifications, where other studies did not find any significant results so far (Büttner 2017, Slemrod et al. 2013). It is the first time that this data source is applied for an analysis of RETT effects. In this paper, we identify the expected reactions on the real estate market to a tax increase in a theoretical model. Then, we examine the identified quantity- and price-effects of the RETT on the German market for commercial real estate by means of a fixed-effects panel regression. Our panel data regressions make use of the state differences of the RETT rate to analyze these effects. Additionally, neighborhood effects are analyzed.

The reminder of this paper is organized as follows. Section 2 integrates our research question into the relevant literature on transaction taxes. The corresponding theory is presented in section 3. Section 4 provides the data and the empirical approach used in this study. Section 5 has the results of our estimations and section 6 concludes.

2 Literature Overview

Empirical studies analyzed taxpayers reactions to the RETT on the international market as well as for the German market. Dachis et al. (2011) find that the implementation of a RETT with the rate of 1.1% in Toronto led to a decrease in the sales of single family homes by 15%. Davidoff & Leigh (2013) study the price and quantity effects caused by an increase of the

Australian RETT. Similar to the German case, the Australian stamp duty varies between the states. Their dataset shows that a tax increase by 1% leads to a short-term decline in housing turnover by 0.3% in the first year, and expands to a decline by 0.6% over a three-year period. When reducing the sample to transactions near state borders (< 50 km), the impact of the RETT increases, but the results turn insignificant. The authors attribute the imprecise estimation of the border effects to the small sample. Slemrod et al. (2013) show that an increase of the RETT by 1% reduces the real estate turnover by 0.2% in Washington D.C. In addition, they identify the need for further research on the implications of tax rate modifications at geographical borders. The presumable differences between the real estate demand and supply elasticities in a major capital city and in a country with abundant space could explain the diverging results of the studies just mentioned. Deviating from the results quoted so far, Best & Kleven (2017) analyze the tax exemption of real estate transfers in 2008 and 2009 in Great Britain, which increased the activity on the residential market by 20% in the short-term. They conclude that their results show the effectiveness of tax rate modifications to stimulate activity on the residential market.

It is the readjustment of the RETT in the context of the federalism reform II that made regionally diverging tax rates for the transfer of property possible in Germany. From the different tax rates results a database for the empirical analysis of the impact of RETT changes on the German market.

Büttner (2017) shows that increases of the RETT involve excess burden for an economy by means of less than proportionally increased tax revenues. Fritzsche & Vandrei (2016) analyze the impact of the RETT on single-family home trades in six German states. According to their estimations, an increase of the RETT by one percentage point reduces transactions on this market by 6%.[1] In addition, the authors presume regional border effects especially in city-states which compete directly with the surrounding states. However, the dataset used contains only Berlin and Brandenburg as a corresponding example with differing tax rates.

[1]The estimate of a reduction in house transactions of 6% following a RETT increase of one pecentage point found by Fritzsche & Vandrei (2016) resembles the estimate of Davidoff & Leigh (2013) of 8%.

The long-term effects seem to be only slightly reduced when omitting these two states from the sample, hereby confirming their results. Petkova & Weichenrieder (2017) examine the quantity- and price-effects of an increase of the RETT by 1% on the markets for single-family homes, apartments and vacant lots separately. Transactions of single-family homes decrease by 0.23%, whereas no significant effect on their prices results. For apartments, a negative price effect emerges, but their transactions seem to be not affected by RETT modifications. The German dweller structure may serve as an explanation with single-family homes mostly owner-occupied and apartments often rented out by the owners.

Besides these studies on residential real estate, the commercial real estate market starts to receive attention in current research. Devaney et al. (2017) study the determinants of transactions on the Northern-American office market and identify significantly negative coefficients of transfer taxes. These results match those of a study executed by Lieser & Groh (2014) on determinants of commercial real estate investments in 47 countries. They also find high RETT rates to have a negative influence on these investments.

3 Theoretical Approach

Many studies analyzed the impact of transaction taxes on financial markets (Collett, Lizieri und Ward 2003; Matheson 2012; Poterba 2002). Since the design of the RETT resembles that of a financial transaction tax, theoretical approaches to explain the effects of financial transaction taxes suggest themselves as applicable to real estate transactions. Nevertheless, as opposed to real estate, financial capital is a mobile capital investment, raising the assumption of relatively weaker effects on the real estate market. Based on the theory of Matheson (2012), we analyze the impact of a transaction tax with rate T, which has to be paid with every real estate transaction after the holding period N, on the acquisition price V. Hence, the seller obtains $(1-T)V$ and the buyer pays V. We assume continuous discounting with the interest rate i and a constant growth rate g of the commercial revenue M which repre-

sents revenues through renting for example. To simplify the presentation, $R = i - g$ with $R > 0$ combines these two determinants. At time 0, the acquisition price V results from the expected rental income over the holding period and the future resale value $V(N)$. This can be implicitly shown by

$$V(0) = \int_0^N Me^{-Rt}dt + (1-T)e^{-RN}V(N) \tag{1}$$

The expected rental income over the period N until $N + N$ of the subsequent investor determines the future selling price $V(N)$.[2] Under the assumption that the limiting value of the selling price is zero if $N \to \infty$, equation 1 can be shown explicitly by

$$V(0) = \sum_s^\infty (1-T)^s \left\{ \int_{sN}^{sN+N} Me^{-Rt}dt \right\} = M \sum_{s=0}^\infty (1-T)^s \frac{e^{-RsN}}{R}(1-e^{-RN}) \tag{2}$$

and then transformed to

$$V(0) = \frac{M}{R}(1-e^{-RN}) \sum_{s=0}^\infty (1-T)^s e^{-RsN} = \frac{M}{R}(1-e^{-RN}) \sum_{s=0}^\infty [(1-T)e^{-RN}]^s. \tag{3}$$

By means of a geometric series equation (3) becomes

$$V(0) = \frac{M}{R}(1-e^{-RN}) \frac{1}{1-(1-T)e^{-RN}} \tag{4}$$

Equation (4) shows the proportional reduction of the property value when a transaction tax is implemented. However, this study is not involved with the implementation of a transaction tax, but with an increase of already existing transaction taxes and the ensuing variation of the value of commercial real estate. By generating the following difference, this variation

[2] This assumption seems reasonable since the income generating capacity of commercial properties is a major determinant of its value (An et al. 2016).

can be illustrated:

$$\Delta(V) = \frac{M(1-e^{-RN})}{R[1-(1-T)e^{-RN}]} - \frac{M(1-e^{-RN})}{R[1-(1-T')e^{-RN}]} \tag{5}$$

The starting rate of the RETT in Germany was already set at 3.5% which was then successively increased up to 6.5% in five federal states. Therefore, we need to consider the difference between the initial tax rate and the new rate T to model the theoretical implications of these tax rate raises. We choose to set the discount rate not at 0.01 or 0.03 as it is done in the literature (Matheson 2012), but based on effectively calculated values. The mean of the long-term capital market interest rate in the current century is 2.89% (Statista 2018*c*). The average annual rent increase is estimated to be 3.5% (Sachverständigenrat 2016). Hence, the discount rate is set at $R = 0.006$ ($= |0.0289 - 0.035|$). Table 1 shows how tax rate increases are capitalized in the prices of commercial real estate under the assumptions stated.

Table 1: Theoretical price reductions due to transaction tax rate increases

Holding period	**5**	**10**	**20**	**50**
Tax rate 3,5% Δ1% to 4,5%	6,2%	6,0%	4,5%	2,3%
Tax rate 3,5% $\Delta 1,5\%$ to 5%	8,7%	8,6%	6,6%	3,4%
Tax rate 4,5% $\Delta 0,5\%$ to 5%	2,5%	2,6%	2,1%	1,1%
Tax rate 5% $\Delta 0,5\%$ to 5,5%	2,2%	2,4%	2,2%	1,1%
Tax rate 5% Δ1% to 6%	4,2%	4,5%	3,8%	2,1%

It emerges distinctly, that the negative effect of the RETT on the real estate value attenuates with increasing holding period. In addition, the negative effect of a tax increase is stronger if the starting rate is lower. When applied to the German RETT, the impact of tax rate raises should be weaker in states that have increased the tax rate successively in small steps (i.e. Saarland) than in states that chose to increase the RETT rate once (i.e. Baden-Wurttemberg).

A simple present-value model confirms these results. A discount rate, which could also be

realized with an alternative investment, is used to discount cash-inflows and -outflows, that occur at different times, to the date of the investment. To deduce the impact of the RETT on the real estate value, we make assumptions following the reflections of (Matheson 2012). We explore the impact of a RETT with tax rate T, which is due with every real estate sale after the holding period N, on selling price V. Hereby, we assume continuous discounting with interest rate i and a constant growth rate g of the commercial revenue M through usage (e.g. rent) of the property. Hence, the selling price V at initial date 0 results from expected rents over the holding period and from the future resale value $V(N)$. This can be formally shown by

$$V(0) = \sum_{t=0}^{N-1} M \frac{(1+g)^t}{(1+i)^t} + \frac{(1-T) \cdot V(N)}{(1+i)^N} \tag{6}$$

We analyze this scenario for an investment period of ten years with a useful life of the property of 50 years. The assumption about the length of the useful life is based on the depreciation rules of the tax law. Hence, the property is traded five times up to a residual value of zero. In avoidance of distortions attributable to the property‘s value, the growth rate equals the discount rate with $i = g = 0.02$. The annual rent is set to amount to 1,000 currency units.

The raise of the tax rate from 3.5% to 5% represents the influence of the RETT, matching effective RETT changes in federal states. Table 2 shows the corresponding impact on tax-inclusive and net-of-tax prices. The RETT has a negative impact on both and it emerges distinctly, that the negative effect of the RETT on the real estate value attenuates with increasing holding period. Investors postpone the transaction and hold the real estate longer, hereby consolidating the lock-in effect.

Table 2: Present-value model showing price reductions following a RETT increase

n	0	10	20	30	40
Discounted rent	1.000	1.219	1.486	1.811	2.208
Gross price (tax rate 3,5%)	46.731	46.342	43.088	35.615	22.080
Net price	45.151	44.775	41.631	34.410	21.334
Future resale price	36.731	34.152	28.229	17.501	-
Sum of discounted rents	10.000	12.190	14.860	18.114	22.080
Gross price new (tax rate 5%)	45.460	45.386	42.489	35.365	22.080
Net price - new	43.295	43.225	40.466	33.681	21.029
Future resale price - new	35.460	33.196	27.630	17.251	-
Impact on gross price	-2,7%	-2,1%	-1,4%	-0,70%	0,00%
Impact on net price	-4,1%	-3,5%	-2,8%	-2,1%	-1,4%

There are only few investigations about the holding period of commercial real estate. (Gau & Wang 1994) confirm an influence of taxes on the holding period of commercial real estate. Collett et al. (2003) and Cheng et al. (2010) estimate the average holding period of commercial real estate to lie between 8 and 12 years. Considering these results, our sample period of 13 years seems well suited for the purpose of this research. We infer from the models shown the expectation of negative price and quantity effects as a result of RETT raises through an extended holding period on the commercial real estate market. Since the impact of a tax increase on the net-of-tax price is stronger than on the tax-inclusive price, we expect at least a partial incidence of the tax with the seller.

4 Data and Empirical Approach

We use yearly state-level data on the RETT from 2004 until 2016 to analyze the effects of RETT raises on the quantity of transactions of commercial real estate as well as on their prices. Hence, the data set comprises of two years before the reform of the RETT in 2006 and 11 years since. Based on a nationwide consistent tax rate of 3.5% up to and including

the year 2006, the median and the mean of the RETT rate developed to 5% and 5.28% respectively in 2016 over a range from 3.5% to 6.5%. Therefore, the average tax rate has increased by 51% over the course of 10 years. Except for Bavaria and Saxony, all states raised the tax rate at least once in this time span.

The RETT rate is the main explanatory variable in our econometric model. In 10 cases of the 25 tax increases over the period considered, the increase took effect during the relevant year and not first of January.[3] In these cases, the tax rate is a weighted average over the year with the respective share of the year, that the two different tax rates were applicable to, as weighting factors. Several dummy variables on tax increases are used to picture possible anticipation effects. Changes to the RETT have to pass the state parliament. The media cover the corresponding discussions more than the actual increase, hereby raising public awareness of RETT alterations in advance of their implementation (Fritzsche & Vandrei 2016). If the increase happens first of January, the dummy D(Tax increase year before) incorporates the relevant state combined with the year preceding the raise. The year of the raise itself combined with the relevant state is represented by the dummy D(Tax increase). The third dummy D(Tax increase during year) pictures state-year combinations with RETT raises during the year. All dummies are multiplied with the corresponding tax increase. These products are then integrated into the regressions denominated as expressed in brackets above, so that the extent of the tax increase is taken into account.

GEWOS GmbH, Hamburg provided the data on transactions of commercial real estate over the sampling period. The data is divided into three categories: offices, other commercial property as administration and business buildings and vacant commercial lots. We also dispose of information about the relevant space in hectare for the latter category. The estimations incorporate the data on transactions via indices that we built for every state and all three categories with 2004 being the base year. In addition, GEWOS GmbH provided

[3] A RETT increase during the year took effect in the following state-year combinations: Baden-Wurttemberg 2011, Berlin 2012, Brandenburg 2015, Hesse 2014, Mecklenburg-Vorpommern 2012, North Rhine-Westphalia 2011, Rhineland-Palatinate 2012, Saxony-Anhalt 2010 und 2012 and Thuringia 2011.

the turnover value in million Euro per commercial real estate category. To estimate price effects, we built a ratio of the annual turnover per category to the number of associated transactions. In the absence of information on the size of individual transactions, this is the only way to approximate average prices.

The econometric model contains the following macroeconomic control variables: last year's debt level, nominal GDP, population and unemployment rate, all at state-level. The capital market yield is the only cross-sectionally constant variable. All controls are taken from the German federal statistical office. To analyze possible neighborhood effects[4], we expand the model by a variable capturing the average tax rate in bordering states (Buettner 2003):

$$\overline{\tau}_{(j,t)} = \sum_{j} W_t \{i, j\} \tau_{j,t} \tag{7}$$

Here, $\tau_{j,t}$ denotes the RETT rate in the neighboring state j at time t, and $\overline{\tau}_{(j,t)}$ is the so-called spatial lag in state i. For neighboring states, the weights are $W_t\{i, j\} > 0$, whereas they are defined as $W_t\{i, j\} = 0$ for states j with no common border with state i and in the case $j = i$. The weights of the different tax rates are row-standardized, so that $\sum_j W_t\{i, j\} = 1$. Thus, every neighbor receives an equal weight, independent of the length of the common border, the economic potential or the population. Table A2 in the appendix has an explanation of all variables and their sources.

Our econometric approach to analyze quantity and price effects of variations of the RETT on the commercial real estate market by means of a fixed-effects regression follows closely the approach taken by Petkova & Weichenrieder (2017), who examine these effects on the German housing market. However, it differs in several aspects as we account for the cross-sectional dependence in the panel data set and we add the capital market yield to allow for

[4]For example, Bremen and neighboring Lower Saxony increased the RETT simultaneously and by the same percentage points, why no distortions are expected at this border. But Hamburg, neighboring Lower Saxony and Schleswig-Holstein, currently charges a lower RETT rate than its border states, why an impact of the RETT on the location decision seems possible.

the role of commercial real estate as a capital investment in an investor's portfolio.[5] Finally, we estimate border effects to identify possible fiscal externalities.

We use a multivariate model with the following formal specification:

$$\gamma_{it} = \beta_0 + \beta_1 TAX_{it} + \beta_2^{'} X_{it} + \beta_3^{'} Z_{it} + \nu_{it} \tag{8}$$

$$\nu_{it} = \mu_i + \lambda_t + \upsilon_{it}, \quad with \quad i = 1, \ldots, N, \quad t = 1, \ldots, T \tag{9}$$

N denotes the number of the German states which totals to 16. The sampling period T covers 13 years. The dependent variable γ_{it} is either the index of transactions of one real estate category or the corresponding price. TAX_{it} represents the weighted average RETT rate at state level, X_{it} has the dummy variables on tax increases, and Z_{it} is a vector of the macroeconomic control variables. Unobserved, time-invariant (fix) state effects μ_i vary across the states, whereas time-variant but cross-sectionally invariant effects are subsumed under λ_t. The idiosyncratic error term ν_{it} complements υ_{it}. The model is based on a log-log specification to enable an interpretation as elasticities.

A Hausman-test recommends the use of a fixed effects (FE) regression to estimate the model. Since we analyze the impact of a (due to a political decision) changing variable, we are already interested in the effects within the panel groups, facilitated by a within-estimation. We have to reject the null of homoscedasticity in the residuals, why the application of heteroscedasticity-robust standard errors is required. Additionally, we find cross-sectional dependence to be present in the data which is unsurprising with regard to the shared framework within the federal republic of Germany. Nevertheless, correlation across panel groups can generate biased estimation results. Driscoll-Kraay heteroscedasticity-robust standard errors offer a solution by allowing for possible spatial and temporal dependence in the resid-

[5] Alternatively, we also used the rental index as a control variable instead of the capital market yield in the estimations to take account of the yield opportunities on the real estate market. On the office market and on the market for other commercial buildings, a negative but insignificant impact of the rental index on transactions emerges. Investors seem to particularly demand office buildings with expiring leases or even vacancies because new rental contracts facilitate the enforcement of higher rents (JLL, 2018).

uals (Hoechle et al. 2007). The results shown in the subsequent section are based on FE regressions using Driscoll-Kraay standard errors. All estimations allow for time-fixed effects to differ between urban and rural states.[6] Additionally, we insert time-fixed effects for the city-states Berlin, Bremen and Hamburg, to account for specific effects in these metropolitan areas. The results are extended by a FE estimation with cluster-robust standard errors as a further robustness test.

Table 3 presents summary statistics of the variables used in the regressions. For reasons of clarity, all variables enter this overview in their original format, so before their log-transformation.

Table 3: Summary statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Tax rate	208	4.1346	0.8607	3.50	6.50
Index offices	208	131.1108	49.7241	49.36	335.71
Index buildings	208	116.5088	33.0921	61.16	306.67
Index buildings & offices	208	118.3191	33.2561	62.68	300.87
Index vacant lots	208	97.5463	42.9445	15.79	279.50
Revenue per vacant lot	208	0.4124	0.5787	0.03	3.94
Revenue per building	208	1.3463	1.8860	0.11	9.47
Revenue per office	208	2.6402	3.1334	0.17	16.22
D(Tax increase year before)	208	0.0865	0.3104	0.00	1.50
D(Tax increase)	208	0.0793	0.2944	0.00	1.50
D(Tax increase during year)	208	0.0577	0.2719	0.00	1.50
Population (in 1,000)	208	5,102.56	4,686.26	651	18,070
Unemployed	208	214,475.90	186,004.90	34,282	1,057,649
GDP (in € 1,000)	208	165,659	167,677	24,694	669,676
Lagged debt (in € million)	192	34,323.70	35,031.76	2,294	208,257
Spatial lag	208	4.10	0.73	3.50	6.50

5 Results

Quantity Effects

We present the effects of RETT rate changes on the office market in table 4. Columns (1) to (5) have results from FE regressions with Driscoll-Kraay standard errors in order

[6] Following Petkova & Weichenrieder (2017) we categorize states as rural whose sparsely populated area exceeds 70% based on the degree of urbanization (Statista 2018*b*). But opposed to their finding of 6 rural states, we identify 8 out of 16 German states as rural: Schleswig-Holstein, Lower Saxony, Rhineland-Palatinate, Bavaria, Brandenburg, Mecklenburg-Vorpommern, Saxony-Anhalt and Thuringia.

to obtain consistent parameters despite of cross-sectional dependence in the data set. All regressions contain density-dependent time-fixed effects (see footnote 6), and city-state year fixed effects are used from regression (4) onwards. Their relevance becomes evident when comparing the R^2 values between the otherwise identical regressions (3) and (4).

Table 4: Elasticity of office transactions

	(1)	(2)	(3)	(4)	(5)	(6)
dependent variable			Ln(index offices)			
Ln(Tax rate)	-0.008	0.116	-0.317*	-0.414***	-0.297**	-0.414**
	(0.141)	(0.116)	(0.157)	(0.093)	(0.125)	(0.157)
D(Tax increase year before)		0.054*			0.015	
		(0.030)			(0.038)	
D(Tax increase)		-0.076***			-0.075**	
		(0.025)			(0.029)	
D(Tax increase during year)		-0.008			-0.004	
		(0.014)			(0.013)	
Ln(GDP)			0.230	0.545	0.436	0.545
			(1.087)	(1.228)	(1.193)	(0.991)
Ln(l.debt)			0.417***	0.501***	0.464***	0.501***
			(0.098)	(0.061)	(0.073)	(0.124)
Ln(Population)			1.575	2.690**	2.940***	2.690
			(0.879)	(1.152)	(0.945)	-1.649
Ln(Unemployed)			-0.204	-0.269	-0.236	-0.269
			(0.253)	(0.200)	(0.205)	(0.372)
Ln(Capitalrate)			0.019	0.034	0.039	1.857***
			(0.118)	(0.066)	(0.066)	(0.419)
Observations	208	208	192	192	192	192
States	16	16	16	16	16	16
R^2	0.378	0.391	0.407	0.498	0.506	0.498
City-state fixed effects	no	no	no	yes	yes	yes
Standard errors	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	robust

Notes: The symbols ***, ** and * denote statistical significance at the 1, 5 and 10 per cent level respectively. Standard errors in parentheses.

The parsimonious model in column (1) as well as the model extended by dummy variables on the tax increase in column (2) report no significant impact of the RETT on the number of transactions. Starting from column (3), we control for crucial macroeconomic variables like GDP, lagged debt level, population, the unemployment rate and the capital market yield, all in logs. According to the estimation in column (3), the number of transactions on the office market goes down by 0.32% at a significance level of 10% if the RETT rate is raised by 1%. By including city-state time-fixed effects, magnitude and significance of the coefficients

increase such that a raise of the RETT rate by 1% results in a reduction of office transactions by 0.41% at a significance level of 1%. The inclusion of further controls as well as of city-state fixed effects increases the share of the dependent variable's variance explained by the independent variables from 0.38 to 0.51. Regression (6) is identical to regression (4) except for the application of cluster-robust standard errors instead of Driscoll-Kraay standard errors as a robustness check. It confirms the magnitude and significance of the coefficients.[7]

In regressions (2) and (5), a tax increase at the beginning of a year negatively impacts office transactions similarly with coefficients of D(Tax increase) close to -0.08. There is limited evidence of anticipation effects since the corresponding variable D(Tax increase year before) is significantly positive only in regression (2). The states' debt level of the preceding period shows significantly positive coefficients. Petkova & Weichenrieder (2017) argue that the states' debt level influences the taxable base such that real estate and vacant lots deteriorate in value due to less public investment in the local infrastructure.[8] Furthermore, a higher debt level may involve a higher likelihood of future tax increases. Since the enactment of tax rises as well as the attractiveness of the real estate market may be influenced by the debt level, its omission might lead to a bias. However, there is no evidence of the states' debt level to significantly impact on the number of transactions on the residential market (Petkova & Weichenrieder 2017). In the case of office buildings, an increase of the lagged debt level by 1% increases the corresponding transactions by 0.42% to 0.50% at a consistently high significance level of 1%. The different decision approaches for the acquaintance of commercial or private real estate may serve as a possible explanation for the diverging results. A higher population seems also to be associated with more office transactions. The capital market yield only shows a significantly positive effect on office transactions in regression (6) using cluster-robust standard errors. The standard-errors applied in the other regressions account for the cross-sectionally uniform variable, which could be the reason for the variable's in-

[7]The regression in column (5) of this and all subsequent result tables have also been estimated using cluster-robust standard errors as robustness checks. The results were confirmed.

[8]Since we employ the debt level of the previous year as explanatory variable, we assume the real estate value to already be affected.

significance in the first five regressions. Contrary to the other variables, the coefficients of the log of the capital market yield deviate distinctly in magnitude and significance depending on the standard errors applied.

Table 5: Elasticity of administration and business building transactions

	(7)	(8)	(9)	(10)	(11)	(12)
dependent variable			Ln(index buildings)			
Ln(Tax rate)	-0.169*	-0.102	-0.194	-0.205	-0.097	-0.205
	(0.088)	(0.155)	(0.153)	(0.136)	(0.233)	(0.120)
D(Tax increase year before)		0.052			0.039	
		(0.034)			(0.041)	
D(Tax increase)		-0.033			-0.054	
		(0.036)			(0.041)	
D(Tax increase during year)		0.022			0.023	
		(0.016)			(0.018)	
Ln(GDP)			-0.781	-0.490	-0.564	-0.490
			(0.480)	(0.516)	(0.503)	(0.918)
Ln(l.debt)			0.040	0.059	0.018	0.059
			(0.191)	(0.171)	(0.178)	(0.100)
Ln(Population)			2.047**	2.687***	2.902***	2.687*
			(0.729)	(0.836)	(0.744)	(1.318)
Ln(Unemployed)			-0.179	-0.131	-0.093	-0.131
			(0.227)	(0.252)	(0.277)	(0.230)
Ln(Capitalrate)			-0.117	-0.078*	-0.073	1.336**
			(0.079)	(0.037)	(0.048)	(0.462)
Observations	208	208	192	192	192	192
States	16	16	16	16	16	16
R^2	0.406	0.419	0.417	0.501	0.515	0.501
City-state fixed effects	no	no	no	yes	yes	yes
Standard errors	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	robust

Notes: The symbols ***, ** and * denote statistical significance at the 1, 5 and 10 per cent level respectively. Standard errors in parentheses.

Table 5 replicates the pattern of table 4 with the index of transactions of other commercial real estate as administration and business buildings as dependent variable. The parsimonious model in column (7) with only one explanatory variable shows a slightly significant decline in transactions by 0.17% for a RETT rate rise by 1%. Yet, the ensuing model extensions cannot establish a significant impact of the RETT on transactions of commercial building, even though the sign of the corresponding coefficient remains negative. As for office buildings, the size of the population positively affects the dependent variable, as does the capital market yield in column (12).

Table 6: Elasticity of aggregated commercial real estate transactions

	(13)	(14)	(15)	(16)	(17)	(18)
dependent variable	Ln(index offices and buildings)					
Ln(Tax rate)	-0.158*	-0.090	-0.209	-0.232*	-0.130	-0.232**
	(0.077)	(0.136)	(0.153)	(0.117)	(0.208)	(0.106)
D(Tax increase year before)		0.049*			0.035	
		(0.027)			(0.033)	
D(Tax increase)		-0.036			-0.054	
		(0.034)			(0.038)	
D(Tax increase during year)		0.026*			0.026	
		(0.013)			(0.016)	
Ln(GDP)			-0.599	-0.289	-0.370	-0.289
			(0.529)	(0.560)	(0.535)	(0.809)
Ln(l.debt)			0.071	0.103	0.064	0.103
			(0.184)	(0.154)	(0.159)	(0.083)
Ln(Population)			2.027**	2.784***	2.991***	2.784**
			(0.668)	(0.829)	(0.698)	(1.016)
Ln(Unemployed)			-0.172	-0.147	-0.110	-0.147
			(0.254)	(0.213)	(0.236)	(0.203)
Ln(Capitalrate)			-0.095	-0.062	-0.058	1.406***
			(0.083)	(0.040)	(0.048)	(0.416)
Observations	208	208	192	192	192	192
States	16	16	16	16	16	16
R^2	0.431	0.444	0.432	0.539	0.554	0.539
City-state fixed effects	no	no	no	yes	yes	yes
Standard errors	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	robust

Notes: The symbols ***, ** and * denote statistical significance at the 1, 5 and 10 per cent level respectively. Standard errors in parentheses.

Eventually, we aggregate the two categories of commercial real estate transactions (offices and other commercial buildings) and index the sum analogously to the individual categories. The logarithmized index serves as dependent variable in the regressions of table 6. Transactions on the commercial real estate market decrease significantly by 0.16% to 0.23% in response to RETT raises in most models without dummy variables on tax increases. Regression (14) shows evidence of anticipation effects of tax raises at the beginning of a new year as well as during a year. The effect is stronger in the former case which also occurs more often.[9] The dummy D(Tax increase during year) does not yield significant results when analyzing the transactions on the office market and on the other commercial real estate market separately. Therefore, it seems to be of minor importance in the complete commercial real

[9] 62% of RETT increases took effect at the beginning of a new year during the sample period.

estate market.[10]

We now turn to the analysis of vacant commercial lots. RETT rate raises do not affect the corresponding transactions significantly as shown in table 7.

Table 7: Elasticity of vacant lot transactions

	(19)	(20)	(21)	(22)	(23)	(24)
dependent variable	Ln(transactions vacancies)					
Ln(Tax rate)	-0.191	-0.205	-0.113	-0.156	-0.141	-0.156
	(0.200)	(0.242)	(0.253)	(0.157)	(0.241)	(0.128)
D(Tax increase year before)		0.028			-0.004	
		(0.045)			(0.064)	
D(Tax increase)		0.006			-0.055	
		(0.028)			(0.044)	
D(Tax increase during year)		0.129***			0.113**	
		(0.041)			(0.046)	
Ln(GDP)			0.514	0.904	0.727	0.904
			(1.249)	(1.455)	(1.476)	(0.901)
Ln(l.debt)			0.011	0.021	0.005	0.021
			(0.178)	(0.063)	(0.075)	(0.113)
Ln(Population)			3.061***	5.738***	5.825***	5.738*
			(0.851)	(1.250)	(1.307)	(3.020)
Ln(Unemployed)			-0.044	0.172	0.217	0.172
			(0.575)	(0.389)	(0.399)	(0.387)
Ln(Capitalrate)			0.061	0.062	0.051	0.344
			(0.189)	(0.098)	(0.101)	(0.689)
Observations	208	208	192	192	192	192
States	16	16	16	16	16	16
R^2	0.330	0.341	0.370	0.543	0.554	0.543
City-state fixed effects	no	no	no	yes	yes	yes
Standard errors	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	robust

Notes: The symbols ***, ** and * denote statistical significance at the 1, 5 and 10 per cent level respectively. Standard errors in parentheses.

A within-year RETT increase seems to cause more transactions presumably in the period before the raise takes effect.[11] Petkova & Weichenrieder (2017) also identify this effect for the residential real estate market, even though they use square meters traded instead of the number of transactions.[12]

[10]RETT increases within a year have an average value of 1.2 percentage points without consideration of years without such an increase. Hence, we find evidence for a small elasticity of 0.03 on the market for commercial real estate.

[11]Under consideration of the average value of 1.2 percentage points for within-year RETT increases, we find an elasticity of 0.13 or 0.16 respectively on the market for vacant commercial lots.

[12]We estimated the regressions with the space turnover as well, in which the variable D(Tax increase during year) turns out to be significantly positive in two out of three cases. The log of the RETT rate is

Population contributes substantially to the rise in transactions of vacant lots. A possible explanation is the progressive urbanization of Germany, which grew from 73,3% to 75,5% (Statista 2018*a*) during the sample period. Commercial real estate investors prefer countries with a high share of urban population (Lieser & Groh 2014).

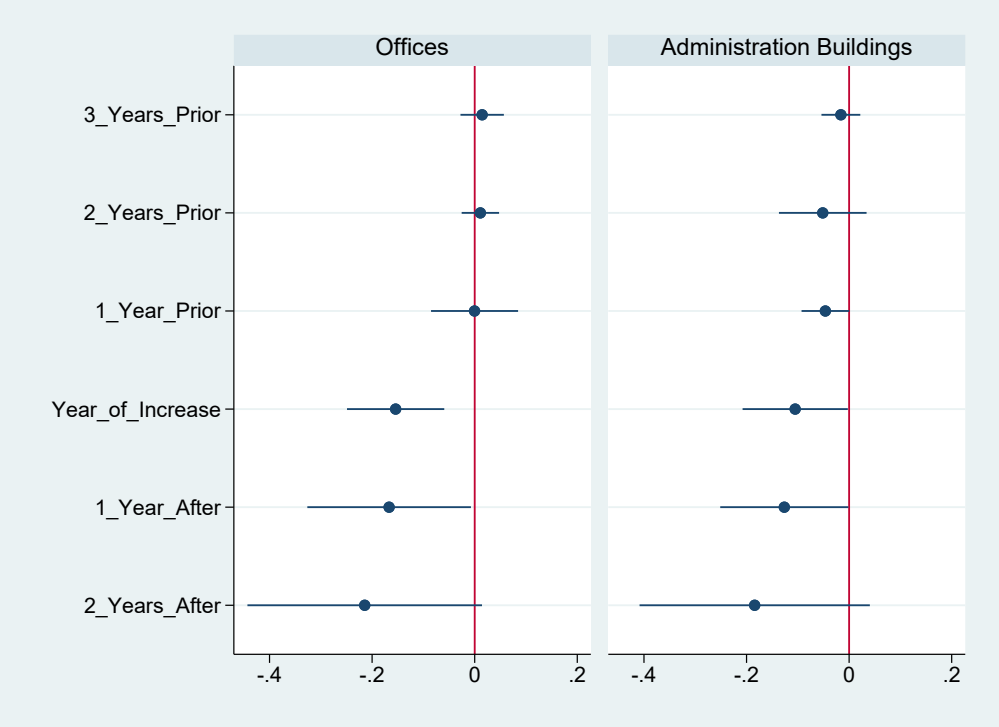
Following other studies on the effects of the German RETT (Fritzsche & Vandrei 2016, Petkova & Weichenrieder 2017), we deepen our analysis of causal effects of the RETT on commercial real estate transactions by an inspection of the connection between the quantity reactions and the year of the relevant tax increase. This seems appropriate with respect to the possibility of a systematic difference between the individual states' time trends causing quantity effects in states that raised the RETT. Even though the empirical evidence of negative transaction effects of the RETT is based on the inclusion of density-dependent time-fixed effects, this concern persists. For this purpose, we augment the regression model with lead and lag variables capturing the value of a tax rate change up to three years before implementation and up to two years after. In the years later than two years after the tax rate change, the second lag variable applies. These lead and lag variables then replace the dummy variables on tax rate increases used in the previous regressions, as well as the log of the average tax rate as main explanatory variable, while the macroeconomic control variables remain included. Figure 1 shows the coefficient plots (Jann 2014) of the lead and lag variables for the transactions on the office market and on the market for administration and business buildings. In case of the first market, the plot seems to back a causal effect of the tax on transactions. While all lead variables have insignificant coefficients, beginning with the year of the increase itself, the coefficients turn significantly negative and remain so in the years after. Their magnitude expands with time, whereas the level of significance decreases. This development can similarly be observed for administration and business buildings with the deviation of the lead variable one year before the tax raise being already significant at the

continuously positive and slightly significant in one case. Nevertheless, R^2 is clearly lower throughout all regressions than in those using the index of transactions as dependent variable. Since we use the number of transactions independent of the size of an individual building as dependent variable for commercial real estate, we assess the use of this indicator in the case of vacant lots as consistent.

10 percent significance level.

With respect to the insignificant results of quantity reactions on the market for vacant lots, we do not present the corresponding coefficient plot.

Figure 1: Coefficient plots of transactions of offices and administration buildings



Notes: The point estimates are shown as dots and the corresponding 95% confidence intervals as horizontal lines. Since the lag and lead variables are based on the tax increase in percentage points and not on logs of the tax rate, no elasticities can be read from the coefficients plotted.

Price Effects

The economic incidence of a tax does not necessarily coincide with its statutory incidence. Even though the RETT is levied on the buyer of a property administratively, the question whether the buyer ends up paying the tax may only be answered via an incidence analysis. Theoretically, inelastic factors bear the tax burden, i.e. with buyers being more price-inelastic than sellers, the incidence is with the former and prices of properties remain stable with increasing RETT rates. In case of more price-inelastic sellers, they bear the tax burden

and the prices of real estate decrease (Davidoff & Leigh 2013).

A RETT raise seems to be reflected in reduced average net selling prices of office buildings whereas this negative effect only turns out to be significant after the inclusion of the dummy variables on anticipation effects in column (2) of table 8.

Table 8: Elasticity of office prices

	(1)	(2)	(3)	(4)	(5)	(6)
dependent variable	ln(revenue per office)					
Ln(Tax rate)	-0.119	-0.209*	0.119	-0.118	-0.216	-0.118
	(0.079)	(0.114)	(0.167)	(0.259)	(0.307)	(0.254)
D(Tax increase year before)		-0.000			0.045	
		(0.088)			(0.096)	
D(Tax increase)		0.067			0.089	
		(0.074)			(0.091)	
D(Tax increase during year)		0.073			0.097	
		(0.075)			(0.074)	
Ln(GDP)			0.657	0.227	0.340	0.227
			(0.698)	(0.742)	(0.854)	(1.809)
Ln(l.debt)			-0.319**	-0.199	-0.186	-0.199
			(0.109)	(0.145)	(0.121)	(0.212)
Ln(Population)			0.358	-0.184	-0.421	-0.184
			(1.536)	(1.605)	(1.623)	(3.447)
Ln(Unemployed)			0.361	0.099	0.100	0.099
			(0.587)	(0.639)	(0.638)	(0.621)
Ln(Capitalrate)			-0.208	-0.007	-0.012	6.336***
			(0.171)	(0.084)	(0.089)	(1.198)
Observations	208	208	192	192	192	192
States	16	16	16	16	16	16
R^2	0.597	0.600	0.609	0.647	0.653	0.647
City-state fixed effects	no	no	no	yes	yes	yes
Standard errors	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	robust

Notes: The symbols ***, ** and * denote statistical significance at the 1, 5 and 10 per cent level respectively. Standard errors in parentheses.

The results suggest that the selling price reduces by 0.21% at a significance level of 10% in response to a RETT increase by 1%. This indicates a capitalization of the tax in the property price. There is evidence for a dampening price effect of the public debt level.

The impact of the RETT on the average selling price of other commercial properties resembles the impact on office prices. Tax incidence is with the seller since we observe a price reduction by 0.19% at a significance level of 5% in column (8) of table 9 as long as the anticipation-dummies are the only explanatory variables besides the RETT rate. The

Table 9: Elasticity of administration and business building prices

	(7)	(8)	(9)	(10)	(11)	(12)
dependent variable	ln(revenue per building)					
Ln(Tax rate)	-0.112	-0.191**	0.025	-0.065	-0.162	-0.065
	(0.083)	(0.077)	(0.102)	(0.122)	(0.138)	(0.193)
D(Tax increase year before)		-0.029			0.003	
		(0.056)			(0.069)	
D(Tax increase)		0.035			0.063	
		(0.046)			(0.063)	
D(Tax increase during year)		0.047			0.047	
		(0.049)			(0.050)	
Ln(GDP)			0.438	0.031	0.103	0.031
			(0.474)	(0.593)	(0.624)	(0.966)
Ln(l.debt)			-0.061	-0.000	0.024	-0.000
			(0.077)	(0.086)	(0.110)	(0.156)
Ln(Population)			2.789***	2.507***	2.298**	2.507
			(0.674)	(0.701)	(0.773)	(1.805)
Ln(Unemployed)			-0.149	-0.367	-0.380	-0.367
			(0.362)	(0.365)	(0.369)	(0.363)
Ln(Capitalrate)			-0.073	0.082**	0.076***	5.608***
			(0.053)	(0.026)	(0.022)	(1.040)
Observations	208	208	192	192	192	192
States	16	16	16	16	16	16
R^2	0.749	0.751	0.761	0.788	0.791	0.788
City-state fixed effects	no	no	no	yes	yes	yes
Standard errors	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	robust

Notes: The symbols ***, ** and * denote statistical significance at the 1, 5 and 10 per cent level respectively. Standard errors in parentheses.

positive effect of the size of the population is significant in most regressions. Capital market yield affects the price significantly positive throughout all estimations using city-state fixed effects. We find strong deviations in the size of the corresponding parameters depending on standard errors applied. High R^2 - values illustrate that the model explains well fluctuations in prices. Merging the turnover value of offices and of other commercial properties in table 10 verifies the price effects identified.

Table 10: Elasticity of aggregated commercial real estate prices

	(13)	(14)	(15)	(16)	(17)	(18)
dependent variable	ln(revenue per buildings and offices)					
Ln(Tax rate)	-0.092	-0.159**	0.032	-0.107	-0.206	-0.107
	(0.080)	(0.068)	(0.096)	(0.124)	(0.127)	(0.181)
D(Tax increase year before)		-0.017			0.012	
		(0.061)			(0.070)	
D(Tax increase)		0.041			0.071	
		(0.049)			(0.067)	
D(Tax increase during year)		0.045			0.053	
		(0.055)			(0.055)	
Ln(GDP)			0.485	0.049	0.137	0.049
			(0.350)	(0.440)	(0.489)	(1.021)
Ln(l.debt)			-0.060	0.021	0.044	0.021
			(0.069)	(0.078)	(0.091)	(0.154)
Ln(Population)			2.407**	2.089**	1.870*	2.089
			(0.847)	(0.863)	(0.911)	(2.008)
Ln(Unemployed)			-0.055	-0.297	-0.310	-0.297
			(0.402)	(0.410)	(0.411)	(0.377)
Ln(Capitalrate)			-0.093	0.074**	0.068**	6.007***
			(0.070)	(0.030)	(0.025)	(1.085)
Observations	208	208	192	192	192	192
States	16	16	16	16	16	16
R^2	0.745	0.747	0.753	0.786	0.790	0.786
City-state fixed effects	no	no	no	yes	yes	yes
Standard errors	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	robust

Notes: The symbols ***, ** and * denote statistical significance at the 1, 5 and 10 per cent level respectively. Standard errors in parentheses.

The average selling price per transaction of vacant commercial lots seems to be increased by RETT rate rises as shown in table 11.[13] The positive tax rate coefficients of 0.30 and 0.36

[13] Apart from the average selling price per transactions of vacant commercial lots we also used the average selling price per hectare as dependent variable. Then, the elasticity of the RETT is negative throughout and significant in two cases. Hence, incidence lies with the seller. But R^2 values are even lower than in table 11, indicating no ideal fit.

Table 11: Elasticity of vacant lot prices

	(19)	(20)	(21)	(22)	(23)	(24)
dependent variable	ln(revenue per vacant lot)					
Ln(Tax rate)	0.303**	0.363***	0.152	0.116	0.178	0.116
	(0.120)	(0.116)	(0.120)	(0.114)	(0.160)	(0.292)
D(Tax increase year before)		-0.024			-0.012	
		(0.045)			(0.037)	
D(Tax increase)		-0.065			-0.057	
		(0.051)			(0.068)	
D(Tax increase during year)		-0.019			-0.014	
		(0.017)			(0.026)	
Ln(GDP)			1.101	1.289	1.195	1.289
			(0.912)	(0.963)	(0.963)	(1.377)
Ln(l.debt)			0.005	0.003	-0.013	0.003
			(0.160)	(0.152)	(0.164)	(0.133)
Ln(Population)			-5.599***	-7.367***	-7.215***	-7.367**
			(1.599)	(2.058)	(1.991)	(2.647)
Ln(Unemployed)			0.588	0.612	0.627	0.612
			(0.544)	(0.566)	(0.584)	(0.446)
Ln(Capitalrate)			-0.054	-0.023	-0.022	2.127
			(0.113)	(0.054)	(0.058)	(2.733)
Observations	208	208	192	192	192	192
States	16	16	16	16	16	16
R^2	0.326	0.330	0.313	0.393	0.396	0.393
City-state fixed effects	no	no	no	yes	yes	yes
Standard errors	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	robust

Notes: The symbols ***, ** and * denote statistical significance at the 1, 5 and 10 per cent level respectively. Standard errors in parentheses.

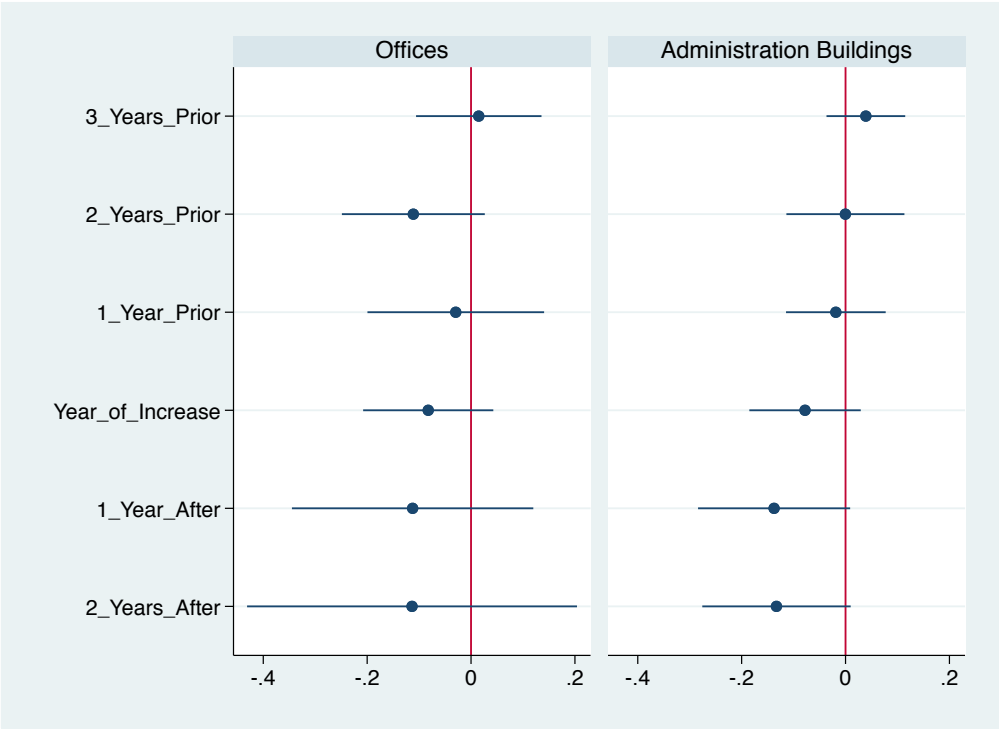
are significant at the 5% and 1% confidence level respectively in the parsimonious model without control variables and in the model with the dummy variables of a tax increase. This may be an indication of tax incidence with the buyers of vacant lots. In view of the possible savings by acquiring vacant lots instead of existing buildings due to the taxable base of the RETT, a positive relationship between the tax rate and prices of vacant lots meets our expectation. However, the interpretation of the results in table 11 has to take the low R^2 values of the regressions into account.

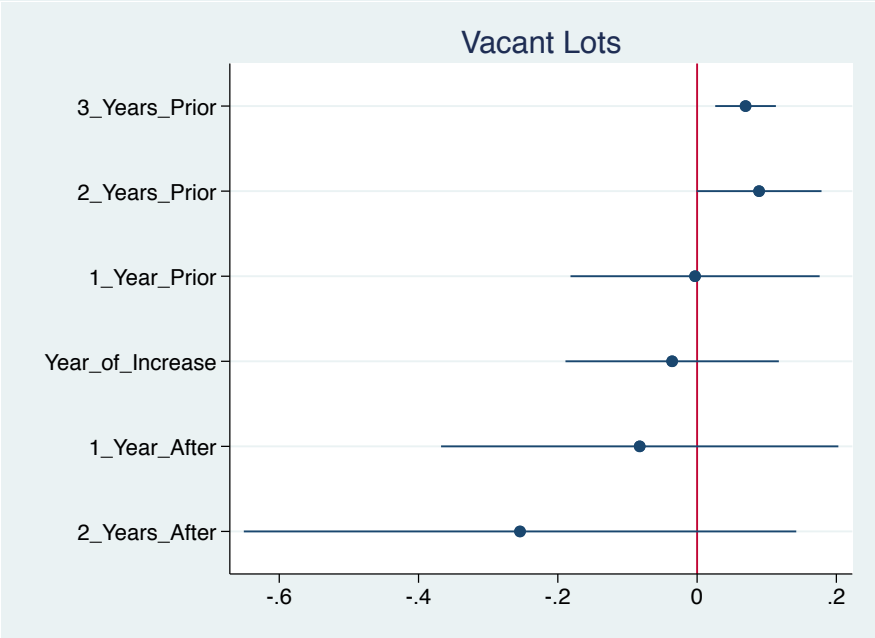
In summary, significant price effects emerge for all commercial real estate categories in the model containing dummy variables on tax increases (second column of each table). However, the results are not robust to variations in the model, as we cannot assert significant price reactions to RETT rate alterations when including macroeconomic control variables.

However, most coefficients in the estimations of built properties do confirm the negative sign of the RETT rate and tend to support the incidence with the seller. A possible transposition into real effects starts with the point estimate of the tax-elasticity of the net price of all commercial buildings at -0.16 in table 10. Ceteribus paribus, the tax-inclusive price increases at a constant net price depending on the tax rate. Based on the sample average tax rate of 4.14%, a tax rise by 1% leads to a surge of the tax-inclusive price by 0.04%. Though, our estimates suggest a reduction of the net-of-tax price of all properties by 0.16% through this policy measure. Hence, this would imply more than 100% of the tax incidence with the seller because the net-of-tax price decreases by more than justified by the tax increase itself. These effects resemble those identified by Petkova & Weichenrieder (2017) for residential apartments: a tax rise by 0.039% based on their sample average tax rate implies a reduction of the prices for apartments by up to 0.17%. The opposite is true for vacant lots: the positive point estimates of up to 0.36% in table 11 translate into an excess surge of the net-of-tax price of vacant lots over the surge by 0.04% attributable to the tax increase. This insinuates more than 100% tax incidence with the buyer.

A closer exploration of the causal effects by means of lead and lag variables in figure 2 as done so for transactions in figure 1 confirms the need for a precautious interpretation of the price effects. Significant negative coefficients emerge for the years following a tax increase in the case of administration and business buildings, with a continuous decrease in prices preceding. This may tentatively confirm negative price effects of RETT raises. In the case of the office market, the only significantly negative price effect occurs two years before the tax increase. Considering that media coverage of RETT increases is high in the year before and even if commercial investors might dispose of information ahead of the media, this time span still seems too distant from the actual rise to justify a causal relationship. Policy makers are not likely to stretch the political process leading to a RETT increase since it may cause disturbances. The positive price effect of vacant lots appears to be triggered by significantly positive effects three and two years before the RETT raise. Analogous to

Figure 2: Coefficient plots of prices of offices, administration buildings and vacant lots





Notes: The point estimates are shown as dots and the corresponding 95% confidence intervals as horizontal lines. Since the lag and lead variables are based on the tax increase in percentage points and not on logs of the tax rate, no elasticities can be read from the coefficients plotted.

the previous category, we cannot affirm a causal relationship.

Neighborhood effects

Table 12 has the model with macroeconomic controls for the transaction index of the different categories as dependent variable. We account for neighborhood effects by adding spatial lags of the tax rate in logs. The variable remains insignificant throughout the regressions. Hence, we fail to reject the hypothesis of absent fiscal externalities for transactions on the commercial real estate market.

Table 12: Neighborhood effects on commercial real estate transactions

	(1)	(2)	(3)	(4)
Transactions	ln(buildings)	ln(offices)	ln(buildings and offices)	ln(vacant lots)
Ln(Tax rate)	-0.220	-0.401***	-0.243*	-0.146
	(0.133)	(0.095)	(0.114)	(0.146)
Ln(Spatial lag)	-0.415	0.347	-0.306	0.258
	(0.235)	(0.223)	(0.218)	(0.296)
Ln(GDP)	-0.475	0.533	-0.278	0.895
	(0.488)	(1.161)	(0.568)	(1.513)
Ln(l.dept)	0.029	0.526***	0.081	0.040
	(0.170)	(0.063)	(0.156)	(0.082)
Ln(Population)	2.534**	2.818**	2.671***	5.833***
	(0.873)	(1.087)	(0.859)	(1.375)
Ln(Unemployed)	0.012	-0.388*	-0.042	0.083
	(0.243)	(0.186)	(0.215)	(0.427)
Ln(Capitalrate)	-0.129**	0.076	-0.100*	0.093
	(0.048)	(0.068)	(0.047)	(0.091)
Observations	192	192	192	192
States	16	16	16	16
r^2	0.515	0.503	0.547	0.544
City-state fixed effects	yes	yes	yes	yes

Notes: The symbols ***, ** and * denote statistical significance at the 1, 5 and 10 per cent level respectively. Standard errors in parentheses.

Table 13 shows the same overview as the previous table with the prices of the different categories on the commercial real estate market as dependent variable. Spatial lags affect the prices of other commercial buildings and vacant lots significantly positively. In response to an increase of the average RETT rate in the neighboring states by 1%, commercial build-

ings become more expensive by 0.51% and vacant lots by 0.71%. Considering the growing attractiveness of vacant lots with increasing tax rates, a rise in prices is plausible at relatively lower tax increases in one state.

Table 13: Neighborhood effects on commercial real estate prices

	(1)	(2)	(3)	(4)
Prices	ln(buildings)	ln(offices)	ln(buildings and offices)	ln(vacant lots)
Ln(Tax rate)	-0.046	-0.135	-0.095	0.142
	(0.112)	(0.268)	(0.123)	(0.114)
Ln(Spatial lag)	0.511*	-0.453	0.343	0.709***
	(0.242)	(0.396)	(0.266)	(0.134)
Ln(GDP)	0.013	0.243	0.037	1.264
	(0.524)	(0.685)	(0.394)	(1.068)
Ln(l.dept)	0.036	-0.232*	0.046	0.054
	(0.084)	(0.119)	(0.078)	(0.149)
Ln(Population)	2.695***	-0.352	2.216**	-7.105***
	(0.693)	(1.484)	(0.856)	(1.996)
Ln(Unemployed)	-0.543	0.255	-0.415	0.368
	(0.377)	(0.602)	(0.417)	(0.498)
Lm(Capitalrate)	0.144**	-0.063	0.116*	0.064
	(0.048)	(0.086)	(0.053)	(0.067)
Observations	192	192	192	192
States	16	16	16	16
R^2	0.793	0.649	0.788	0.404
City-state fixed effects	yes	yes	yes	yes

Notes: The symbols ***, ** and * denote statistical significance at the 1, 5 and 10 per cent level respectively. Standard errors in parentheses.

Revenue effects

To estimate the tax rate elasticity of RETT revenues we employ the total tax revenue from the RETT at state-level as dependent variable in table 14. The tax revenue is only available as an aggregate at state level, rendering a separate examination of the RETT revenue realized by commercial real estate transactions impossible.

The elasticity rises from 0.68 in the parsimonious model in column (1) to 0.85 in column (5). Hereby, it surpasses the elasticities estimated in related studies of 0.74 (Petkova & Weichenrieder 2017) and 0.57 (Büttner 2017). The 95% confidence intervals contain 1 for the two greatest coefficients (0.51 to 1.14 for 0.83; 0.52 to 1.19 for 0.85). Therefore, an

elasticity of 1 cannot be ruled out. Based on the estimated parameter values, an increase of the RETT rate is accompanied by additional costs because tax revenue does not increase to the same extent. There seems to be an alteration in the taxable base induced by transactions and/ or prices in consequence of a tax increase. Our estimates suggest a combination of both effects, since we assert negative quantity and price effects for commercial properties. Due to the minor role vacant lots play in the sales revenue of commercial real estate, the positive price effects of vacant lots can be neglected for total tax revenues.[14] Each Euro raised additionally by means of a higher RETT comes at a cost of around EUR 1.25 for the tax payers. Hence, the deadweight loss associated is 25% of an additional Euro.[15]

Table 14: Real estate transfer tax revenue

	(1)	(2)	(3)	(4)	(5)	(6)
dependent variable	ln(Tax revenue)					
Ln(Tax rate)	0.683***	0.695***	0.746***	0.828***	0.852***	0.828***
	(0.047)	(0.049)	(0.115)	(0.143)	(0.151)	(0.124)
D(Tax increase year before)		-0.023			-0.008	
		(0.024)			(0.024)	
D(Tax increase)		-0.025			0.022	
		(0.037)			(0.032)	
D(Tax increase during year)		-0.002			-0.012	
		(0.020)			(0.018)	
Ln(GDP)			0.656	0.788	0.754	0.788*
			(0.447)	(0.562)	(0.544)	(0.402)
Ln(l.debt)			-0.046	-0.074	0.079	-0.074
			(0.069)	(0.089)	(0.091)	(0.075)
Ln(Population)			1.372**	1.650***	1.709***	1.650**
			(0.564)	(0.511)	(0.445)	(0.686)
Ln(Unemployed)			0.120	0.166	0.169	0.166
			(0.199)	(0.268)	(0.260)	(0.146)
Ln(Capitalrate)			-0.153**	-0.032	-0.032	2.017***
			(0.050)	(0.027)	(0.028)	(0.499)
Observations	208	208	192	192	192	192
States	16	16	16	16	16	16
r^2	0.922	0.922	0.926	0.937	0.937	0.937
City-state fixed effects	no	no	no	yes	yes	yes
Standard errors	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	Driscoll-Kraay	robust

Notes: The symbols ***, ** and * denote statistical significance at the 1, 5 and 10 per cent level respectively. Standard errors in parentheses.

[14]The average turnover value by sales of vacant lots is 7.5% of the total turnover value on the commercial real estate market over the sample period.

[15]The calculation is based on the procedure suggested by Saez et al. (2012). An increase of the tax revenue by EUR 1 leads to a utility loss of 1/[1-(1-0,8)], which corresponds to an excess burden of EUR 0.25 or 25%.

6 Conclusion

The examination of the RETT's impact on transactions and prices of commercial real estate in German states is at the center of this paper. A microeconomic incidence analysis led to the expectation of reduced prices and transactions in consequence of tax increases, as well as of regional and factual structure shifts. Return-oriented commercial investors may exploit the variation in the tax rate across the German federal states, leading to a trend of rising demand and increasing prices in states with a relatively low rate of the RETT. The lower taxable base of vacant commercial lots renders them more attractive than lots including built properties, reflected by higher prices of the former. An ensuing theoretical analysis shows a decreasing capitalization of a RETT rise with an increasing initial tax rate and a longer holding period.

The empirical results of our fixed-effects panel regression across the 16 German states over the time span from 2004 until 2016 mostly correspond to the theoretical expectations. Our findings suggest that transactions on the office market decrease by up to 0.41% in response to an increase of the tax rate by 1%. This reaction is weaker for other commercial properties with a decline by 0.17%. Combining offices and other commercial premises shows a reduction of transactions of built commercial properties by 0.23%. An analysis of the effects depending on their temporal relationship with the tax increase supports a causal interpretation. The economic relevance of these effects becomes even clearer when translated into percentage point increases of the RETT. The RETT rate averages to 4.14% in our sample and the average of all RETT rate raises currently lies at 1.15 percentage points. Hence, our estimates suggest that a rise of the mean tax rate by the mean tax rate increase reduces office transactions by almost 12% and transactions of other commercial buildings by almost 5%.

Petkova & Weichenrieder (2017) find a decline in single-family house transactions by 0.23% on the German housing market, which is almost half the size of the reaction we find on the office market. Nevertheless, the authors do empirically not find any quantity effects

on the market for residential apartments. Considering the dwelling structure in Germany, with single-family houses generally occupied by the owner and apartments often rented-out, the investment decision of commercial investors resembles more private investors of apartments. One reason may lie in the deductibility of the RETT from the tax burden for private investors who do not occupy but rent out the property as well as for commercial investors. With regard to the possibility of tax evasion for commercial investors by means of the share deal, the empirical evidence in this paper, especially in comparison to quantity reactions on comparatively similar categories on the residential real estate market, may be a hint at its relevance. Furthermore, the decrease in transactions implies reduced mobility of companies and hereby no optimal allocation of commercial properties in response to an increase of the transaction tax.

Our estimations reveal no significant effects of a RETT increase on transactions of vacant commercial lots. However, a rise of the tax rate by 1% is associated with an increase of prices of vacant commercial lots by 0.36%. The design of the RETT with its cumulative taxation impact leads to the distortion of investment decisions in favor of vacant lots at the expense of sellers of built properties. A possible solution is the reform approach of an integration of the RETT into the value added tax (Scherf & Dresselhaus 2016). With the input tax being deductible, the value added tax avoids the cumulative impact and tends to level the investment decision. Considering that we find negative price effects on the office market as well as on the commercial real estate market for other properties, a price decline by 0.16% on the aggregated commercial market is unsurprising. The effects differ only marginally between offices and other commercial buildings. Nevertheless, the results for built properties remain fragile and the attempt of a causal interpretation demands caution. When converted into the effect of the average RETT rise of 1.15 percentage points, the prices of vacant lots would surge by an economically meaningful 10% and the prices of commercial properties would fall by 5%. Additionally, our estimates imply significantly positive price effects for other commercial properties and vacant lots in response to a rise of the average tax rate in

neighboring states.

The negative price reaction on the market for all commercial buildings to a tax increase resembles the impact on the market for residential apartments (Petkova & Weichenrieder 2017) in direction and magnitude. In both cases, the incidence is with the seller. Again, the possible alternative for commercial investors of acquisitions via share deals may explain the more price-elastic demand for transactions that are subject to real estate transfer taxation.

Additionally, our analysis reveals a decreasing trend in the welfare costs of the RETT. While Büttner (2017) and Petkova & Weichenrieder (2017) find additional costs of a tax increase of 67% and 42% using samples covering the years 2002-2015 and 2003-2014 respectively, we find the cost share of an additional Euro to be around 25% in a sample ranging from 2004-2016. An explanation of this weaker reaction of the taxable base to a tax increase may be the recently strong rise in real estate prices which weighs more in a sample ranging in the more recent past.

Even though our results indirectly confirm the relevance of share deals, the limited comparability of commercial and residential categories cannot be neglected. Therefore, data covering local transactions and prices per transaction, as well as data on the actual prevalence of transactions via share deals may enable further research on the impact of the RETT on transactions, prices and tax planning activities of commercial investors.

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Appendix

Table A1: Development of the RETT in German federal states since 2006.

States/year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Bavaria	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3,5	3,5
Saxony	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Hamburg	3.5	3.5	3.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Baden-Wurttemberg	3.5	3.5	3.5	3.5	3.5	3.5	5	5	5	5	5	5
Bremen	3.5	3.5	3.5	3.5	3.5	4.5	4.5	4.5	5	5	5	5
Lower Saxony	3.5	3.5	3.5	3.5	3.5	4.5	4.5	4.5	5	5	5	5
Mecklenburg-Vorpommern	3.5	3.5	3.5	3.5	3.5	3.5	5	5	5	5	5	5
Rhineland-Palatinate	3.5	3.5	3.5	3.5	3.5	3.5	5	5	5	5	5	5
Saxony-Anhalt	3.5	3.5	3.5	3.5	4.5	4.5	5	5	5	5	5	5
Berlin	3.5	4.5	4.5	4.5	4.5	4.5	5	5	6	6	6	6
Hesse	3.5	3.5	3.5	3.5	3.5	3.5	3.5	5	6	6	6	6
Thuringia	3.5	3.5	3.5	3.5	3.5	5	5	5	5	5	5	6.5
Brandenburg	3.5	3.5	3.5	3.5	3.5	5	5	5	5	6.5	6.5	6.5
North Rhine-Westphalia	3.5	3.5	3.5	3.5	3.5	3.5	5	5	5	6.5	6.5	6.5
Saarland	3.5	3.5	3.5	3.5	3.5	4	4	5.5	5.5	6.5	6.5	6.5
Schleswig-Holstein	3.5	3.5	3.5	3.5	3.5	3.5	5	5	6.5	6.5	6.5	6.5
Average Tax Rate	3.5	3.56	3.56	3.63	3.69	4.03	4.56	4.75	5.03	5.28	5.28	5.38

Note: Tax increases during the year are shown at the beginning of each year.

Table A2: Overview variables

Variable	Description	Reference
Tax rate	Weighted average of the real estate transfer tax rate	Authors calculation
D(Tax increase year before)	State - year combinations with tax increases in January of the subsequent year, scaled by tax raise.	Authors calculation
D(Tax increase)	State year combinations with tax increases in January,scaled by tax raise.	Authors calculation
D(Tax increase during year)	State year combinations with tax increases within this year, scaled by tax raise.	Authors calculation
GDP	Nominal GDP in million Euro.	German Statistical Office
l.debt	Debt level of the previous year.	German Statistical Office
Population	Population in millions.	German Statistical Office
Unemployed	Number of registered unemployed.	German Statistical Office
Capitalrate	Capital market yield of 10 year government bonds.	German Statistical Office
Transactions	Transactions of commercial real estate.	GEWOS GmbH
Revenues	Revenue of commercial real estate sales.	GEWOS GmbH
Tax revenue	Revenue of the real estate transfer tax in thousand Euro.	German Statistical Office
Spatial lag	Average real estate transfer tax rate of bordering states.	Authors calculation