DEUTSCHE BUNDESBANK
EUROSYSTEM

Discussion Paper

Deutsche Bundesbank
No 04/2021

Real estate transaction taxes and credit supply

Michael Koetter
(Otto-von-Guericke University Magdeburg,
Halle Institute for Economic Research (IWH) and Deutsche Bundesbank)

Philipp Marek
(Deutsche Bundesbank and Halle Institute for Economic Research (IWH))

Antonios Mavropoulos
(Halle Institute for Economic Research (IWH))

Deutsche Bundesbank, Wilhelm-Epstein-Straße 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-0

Please address all orders in writing to: Deutsche Bundesbank,
Press and Public Relations Division, at the above address or via fax +49 69 9566-3077

Internet http://www.bundesbank.de

ISBN 978–3–95729–812–6 (Internetversion)

Non-technical summary

Research Question

We investigate whether changes in the real estate transfer tax (RETT) have an effect on the development of house prices and on the supply of mortgage loans by regional banks in Germany. Answering this question is important from a financial stability perspective because historical real estate bubbles were often driven by excessive growth in mortgage markets.

Contribution

The analysis comprises three steps. First, we construct quarterly hedonic price indices (HPI) at the level of NUTS-3 in Germany between 2008 and 2017. Second, we investigate how changes in the RETT affect regional house prices. Third, we analyze how house price changes induced by increases in the RETT affect mortgage credit supply by regional banks. To implement these steps, we combine around 33 million real estate online listings, staggered RETT changes across German states, and administrative balance sheet data by all regional banks.

Results

The results show that a 1ppt hike in the RETT leads to a 1.2% decline in house prices, whereas rental markets are hardly affected. This effect is more pronounced in rural areas. Furthermore, the analysis shows that a 1% decline in regional house prices induced by RETT increases leads to a 1.4% drop in mortgage lending by regional banks. This effect is also driven by rural regions, whereas it is largely independent of bank capitalization. Since changes in the RETT as well as an LTV cap both affect access to mortgage lending, we may translate our findings to macroprudential policies. Against the background of heterogeneity in demand elasticities, uniformly applied borrower-based instruments may have different effects across regions.

Nichttechnische Zusammenfassung

Fragestellung
In dieser Arbeit werden die Auswirkungen der Veränderungen der Grunderwerbsteuer auf die Entwicklung von Wohnimmobilienpreisen sowie auf die Kreditvergabe von regoinal tätigen Banken analysiert. Aus Sicht der Finanzstabilität sind Antworten auf diese Frage besonders wichtig, da Immobilienpreisblasen häufig durch exzessive Hypothekenvergabe getrieben wurden.

Beitrag
Um die Fragestellung zu beantworten, werden drei Schritte implementiert. Erstens erstellen wir auf Basis von 33 Milllionen Online-Angeboten für Wohnimmobilien einen Hauspreisindex auf Kreisebene in Deutschland. Diese Daten werden für die Analyse mit Angaben zu Erhöhungen der Grunderwerbsteuer in den Bundesländern sowie mit Aufsichtsdaten über regional tätige Banken verknüpft. Im zweiten Schritt untersuchen wir den Einfluss von Erhöhungen der Grunderwerbsteuer auf regionale Hauspreise. Drittens analysieren wir, inwiefern Hauspreisänderungen, die auf die Erhöhungen der Grunderwerbsteuer zurückzuführen sind, die Hypothekenvergabe regionaler Banken beeinflussen.

Ergebnisse
Die Ergebnisse zeigen, dass infolge einer Erhöhung der Grunderwerbsteuer um einen Prozentpunkt die Preise für Wohnimmobilien um 1,2% sinken. Dieser Effekt ist vor allem im ländlichen Raum ausgeprägt. Die Analyse zeigt zudem, dass ein durch die Erhöhung der Grunderwerbsteuer verursachter Rückgang der Wohnimmobilienpreise um 1% zu einer Reduktion der Hypothekenvergabe regionaler Banken um 1,4% führt. Dieser Effekt ist im ländlichen Raum besonders ausgeprägt. Dagegen hat die Kapitalisierung von Banken keinen Einfluss. Änderungen der Grunderwerbsteuer können einen ähnlichen Einfluss auf den Finanzierungszugang beim Immobilienerwerb haben wie erhöhte Eigenkapitalanforderungen. Daher können die Ergebnisse der Analyse auf die Einführung makroprudenzieller Instrumente übertragen werden. Vor dem Hintergrund heterogener Nachfrageelastizitäten kann die Aktivierung kreditnehmerbezogener Instrumente für die Wohnimmobilienfinanzierung regional unterschiedliche Auswirkungen entfalten.

Deutsche Bundesbank Discussion Paper No 04/2021

Real estate transaction taxes and credit supply*

Michael Koetter † Philipp Marek ‡ Antonios Mavropoulos §

Abstract

We exploit staggered real estate transaction tax (RETT) hikes across German states to identify the effect of house price changes on mortgage credit supply. Based on approximately 33 million real estate online listings, we construct a quarterly hedonic house price index (HPI) between 2008:q1 and 2017:q4, which we instrument with state-specific RETT changes to isolate the effect on mortgage credit supply by all local German banks. First, a RETT hike by one percentage point reduces HPI by 1.2%. This effect is driven by listings in rural regions. Second, a 1% contraction of HPI induced by an increase in the RETT leads to a 1.4% decline in mortgage lending. This transmission of fiscal policy to mortgage credit supply is effective across almost the entire bank capitalization distribution.

Keywords: Fiscal Shocks, Real Estate Markets, Mortgage Lending, Price-to-Rent ratio

JEL classification: H30; R00; R31

*We thank Peter Egger for comments and benefited from feedback received at the Bundesbank Research seminar, the 9th ifo Dresden Workshop on Regional Economics, the Household Finance and Consumption Network (HFCN) meeting at the ECB, the Macro and Money Brown Bag Seminar at Goethe University, and the DPE seminar series at the IWH. The views expressed are those of the authors and do not necessarily represent the views of Deutsche Bundesbank or the Eurosystem. All errors are our own.

†Otto-von-Guericke University Magdeburg, Halle Institute for Economic Research (IWH) and Deutsche Bundesbank, Germany. E-mail: michael.koetter@iwh-halle.de

‡Deutsche Bundesbank and Halle Institute for Economic Research (IWH), Germany. E-mail: philipp.marek@bundesbank.de

§Halle Institute for Economic Research (IWH), Germany. E-mail: antonios.mavropoulos@iwh-halle.de

1 Introduction

We investigate if and how real estate transaction tax (RETT, *"Grunderwerbsteuer"*) hikes slow down mortgage credit supply by banks. Understanding the (in)ability of fiscal policy to curtail mortgage lending is important because many historical financial crises were preceded by housing booms (Reinhart and Rogoff, 2008; Brunnermeier and Schnabel, 2016). Whereas these events triggered the launch of novel macroprudential policy tools to contain excessive (mortgage) borrowing, such as loan-to-value (LTV) caps, their effectiveness remains ambiguous (Grodecka, 2020). We propose a formal relationship between tax changes and LTV caps and provide evidence on how the fiscal policy mechanism can impact mortgage credit as a historically important driver of financial instability.

Many scholars attribute the real estate bubble that preceded the Financial Crisis of 2007 to mortgage lending hikes due to deteriorating lending standards and poor securitization practices in the US (Mian and Sufi, 2009, 2011; Keys, Mukherjee, Seru, and Vig, 2010; Favara and Imbs, 2015; Justiniano, Primiceri, and Tambalotti, 2019). Real estate bubbles may disguise excessive household borrowing against overvalued collateral (Cloyne, Huber, Ilzetzki, and Kleven, 2019), thereby displacing corporate lending (Farhi and Tirole, 2012).[1] The loose monetary policy stance since the GFC fueled again mortgage lending in the US (Rodnyansky and Darmouni, 2017; Mian and Sufi, 2018; Chakraborty, Goldstein, and MacKinlay, 2020), but also in large European economies like Germany (Koetter, 2019), and concomitant house price hikes concern guardians of financial stability once more.[2]

Our approach to answer if fiscal policy can contain mortgage lending by its effect on real estate prices exploits a unique empirical setting that combines spatial heterogeneity of fiscal shocks, granular information on real estate prices, and administrative data about the population of regional mortgage lending. We use the staggered increases in RETT across the 16 federal states of Germany on quality-adjusted regional house price indices (HPI). To isolate mortgage credit supply adjustments due to fiscal policy shocks, we regress instrumented regional HPIs on bank-level mortgage lending by regional banks. This setting of autonomous tax changes paired with granular bank and housing market data overcomes the notorious challenge that real estate prices and credit supply are jointly determined (e.g. Gerlach and Peng, 2005; Hott, 2011). Overcoming this limitation allows us, in turn, to exploit strictly local fiscal shocks and lending responses by the many local banks in this large, open economy (see, e.g. Gerlach and Peng, 2005; Cloyne et al., 2019). Thereby, we isolate the causal effects of fiscal policy on mortgage supply more directly.

The main upshot of our empirical exercises is that fiscal policy hikes can contain mortgage lending. An increase of RETT by 1 percentage point reduces purchase prices by 1.2% over the period of up to six quarters after the tax change. Rental prices, in turn, respond only mildly in the quarter of the RETT hike, exhibiting a fall by 6.8 basis points. An important qualification emerges from the separation of urban and rural regions. Both exhibit eventually declining purchase prices and price-to-rent ratios, but the effect is driven by rural regions. Urban real estate markets exhibit a substantially smaller and later purchase price impact. The effect in rural and urban rental markets oppose another: rents

[1] Either during the build-up of imbalances if banks re-allocate lending (Chakraborty, Goldstein, and MacKinlay, 2018) or after drastic price corrections (Peek and Rosengren, 2000; Gan, 2007) that cause sudden lending stops.

[2] Deutsche Bundesbank (2018) estimates an excess pricing in large German cities of 15-30% since 2017.

decline in the former, but increase in the latter. These responses suggest that potential buyers of real estate are forced to rent due to the RETT, thereby exerting upward pressure on rental prices in urban regions. Using increases in the RETT as a predictor for changes in HPI, results from a instrumental variable regression yield that a 1 percentage point drop in predicted HPI leads to a 1.4% decline in mortgage lending by regional banks in rural areas. Mortgage supply by banks in urban regions, in turn, does not exhibit a statistically significant response. Except for the very tails of the bank capitalization distribution, these effects remain significantly positive. Hence, the effectiveness of fiscal policies to contain mortgage lending depends on the regional real estate market to which a bank caters rather than its capitalization. Given the effectiveness of fiscal policy to dampens housing demand, we may translate our findings to the implementation of borrower-based macroprudential instruments, particularly the introduction of an LTV cap.

The analyses in this paper proceed in three steps. First, we follow Bauer, Feuerschütte, Kiefer, an de Meulen, Micheli, Schmidt, and Wilke (2013) and develop a quality adjusted, quarterly hedonic HPI at a granular regional level (NUTS-3, *"Kreis"*) to overcome the lack of according official statistics. HPI changes are based on approximately 33 million observations on residential properties offered online for sale or rent between January 2007 and October 2017 on the real estate portal *Immobilienscout24* (an de Meulen, Micheli, and Schaffner, 2014).[3] We consider asking prices for residential dwellings (houses and apartments) that are offered for rent or sale between the first quarter of 2008 up to the last quarter of 2017. These granular information allow us to account for the well-documented spatial heterogeneity in house price dynamics between rural and urban regions (see e.g. Mian and Sufi, 2009; Holly, Pesaran, and Yamagata, 2010) and resulting asymmetric reactions to policy interventions (Saiz, 2010).

Second, we gauge the effects of transfer tax hikes on the hedonic HPI by exploiting the staggered introduction of different RETT in 14 out of 16 federal states as shown in Figure 1, ranging from 3.5% in Bavaria and Saxony to 6.5% in four other states in 2018.

Staggered changes of the RETT across states make for an ideal quasi-natural experiment for a number of reasons. Most importantly, the mandate to set the tax was relegated from the federal level to the 16 states in 2006. This change was part of a larger effort to provide states with means to consolidate their public budgets so as to comply with a new fiscal rule—the so-called debt brake ("*Schuldenbremse*")—that prohibited German states from running structural deficits as of 2020 (Heinemann, Janeba, Schröder, and Streif, 2016). Fiscal policy choices set at the state-level to consolidate public finances so as to comply with new budget rules anchored in German Basic Law are arguably orthogonal to mortgage lending choices of regional banks at the county level. At the same time, RETT hikes exert strong direct effects on house prices due to more equity required for obligatory downpayments. These must not be part of the mortgage by German law. Hence, RETT hikes increase purchase prices and reduce demand for real estate directly without affecting mortgage supply in and of itself, which strongly suggest them as a valid instrument of HPI changes to identify mortgage supply responses.

In the third step, we instrument house price growth with RETT changes per region to explain mortgage lending supply by regional savings (*"Sparkassen"*) and cooperative banks (*"Genossenschaftsbanken"*). Regional banks are organized in associations and adhere to

[3]Germany comprises 402 NUTS-3 regions that belong to one of the 16 federal states. *Immobilienscout24* is the largest real estate web platform, and covers 50% of all online residential listings in Germany.

de jure or *de facto* rules to operate only in the NUTS-3 regions where they reside (Koetter and Popov, 2020). This feature of German banking creates an ideal setting to investigate whether regional house price fluctuations affect bank-specific mortgage lending supply.

Our paper speaks to the literature on the effects of fiscal policy on real estate markets. Most studies focus on the number of transactions in response to tax changes and document that tax hikes reduce market depth, depress prices, and reduce trading volumes. For example, Dachis, Duranton, and Turner (2011) find that the introduction of a 1.1% land transfer tax in Toronto resulted in a 16% fall in sale transactions and a 1.5% drop in values. Similarly, Fritzsche and Vandrei (2019) find that a one percentage point higher transfer tax yields approximately 6% fewer transactions over the long run. Petkova and Weichenrieder (2017) also observe fewer transactions after the RETT introduction, but no significant price effects. We take a more granular approach regarding house prices and are the first to identify resulting mortgage lending effects, which is important form a financial stability perspective.

We also relate to studies that investigate how rising house prices affect household and firm choices, such as increasing consumption (Mian and Sufi, 2011), surging leverage because of higher collateral values that alleviate credit constraints Cvijanović (2014), or more self-employment (Adelino, Schoar, and Severino, 2015). We add to this literature how households respond in terms of housing demand to fiscal policy and the commensurate adjustments by banks' mortgage supply stance in response to changing housing demand.

Finally, we complement research on the bi-directional relationship between house prices and mortgage credit that often lack geographically granular data. Overcoming this limitation allows us, in turn, to exploit strictly local fiscal shocks and lending responses by the many local banks in this large, open economy (see, e.g. Gerlach and Peng, 2005; Cloyne et al., 2019). Thereby, we isolate the causal effects of fiscal policy on mortgage supply more directly.

The remainder of this paper is structured as follows. Section 2 illustrates the institutional setting of the RETT and introduces methods and the generation of data to estimate, first, the response of house prices to fiscal policy and, second, changes in mortgage lending supply in response to house price changes. Section 3 discusses subsequently the empirical results for these two relationships and associated robustness checks. Section 4 summarizes the main findings and implications of this paper.

2 Method and data

Section 2.1 provides some institutional background for the RETT that renders it useful for identification. Section 2.2 specifies how to estimate house price responses to RETT changes and describes the construction of the house price index. Section 2.3 discusses how RETT changes can have similar effects to LTV caps on mortgage lending, provides the empirical specification to estimate this relationship, and describes the data employed to do so.

2.1 Institutional setting and identification

The Real Estate Transaction Tax (RETT) is ideal to identify causal effects on mortgage lending via its effect on house price dynamics because state governments changed it

independent of local banks' lending stances and because it is an important fiscal tool.

Until 2006:q3, the tax rate was identically set to 3.5% in all 16 federal states. In the wake of a general reform of the relationship between national and federal legislative responsibilities (*"Föderalismusreform"*), each state received the mandate to levy the RETT independently. Only the states of Bavaria and Saxony did not change the RETT rate after 2006 and therefore serve as control groups.[4] All remaining states increased the RETT between one and four times over the sample period in nodges between 0.5% and 1.5%. In 2018, the levels of the RETT ranged from 3.5% to 6.5%. These staggered tax changes across federal states entail tax rates that are identical within each of the 16 German federal states, but that differ considerably across states (see Figure 1). Changes in the RETT are thus arguably exogenous policy shocks to local banks and their local mortgage lending choices.

The tax is economically meaningful. In 2019, the German states collected € 15.8 billion in RETT, which compares to a total state-level tax income of € 329.1 billion in 2019. The RETT is thus not only the largest single tax income item for federal states in Germany, it is also the fastest growing component due to both rising tax rates and real estate valuation.[5] It is calculated and collected at the regional level, typically a county or city, by the tax and revenue authority to which the buyer of a property files.

The institutional setting of the tax is as follows. After the buyer and seller agree on a price for a dwelling, a notary drafts a contract between the two parties and certifies the purchase of the property. Besides the two parties, the tax office as well as the land registry receive copies of the contract (Fritzsche and Vandrei, 2019). The tax office calculates the RETT incurred by the buyer based on the total acquisition cost: the purchase price plus any encumbrances on the property, usage rights, abatement costs and broker fees.[6] It is waived for transactions of less than € 2,500, inheritances, and family transfers. Importantly, the taxed amount does not count towards the market value of the property that is considered by banks as collateral or constitutes the basis for subsequently due land taxes (*"Grundsteuer"*). Thus, the RETT has to be financed by the buyer's equity and the borrower must not include it as part of her mortgage.

In sum, the RETT directly affects house prices without being mechanistically correlated with mortgage loan demand.

2.2 House prices and tax hikes

2.2.1 Real estate data and hedonic House Price Indices (HPI)

To estimate the impact of tax hikes on house prices, we first have to create a granular house price index at the regional level. From the Research Data Center Ruhr at the RWI, we obtain data on all dwellings listed on the online platform Immobilienscout24.de, containing the highest amount of real estate listing for sale and for rent among German online real estate portals (an de Meulen et al., 2014).[7] The data comprise granular information on all apartments and houses that were offered for sale or for rent on the website

[4] In fact, we exploit this discontinuity in fiscal policy treatments and compare HPI responses in contiguous counties across these states' borders in Appendix B.5.

[5] See German Statistical Office: www.destatis.de.

[6] The term "property" includes fractional shares of the property, land rights and condominiums.

[7] All variables used are described in Table A.1.

between January 2007 and October 2017. We observe approximately 33 million listings that include detailed geographical information in 98.5% of cases, and many qualitative traits of dwellings. The latter data allow the construction of quality adjusted hedonic regional house price indices (HPI).

Following Bauer et al. (2013), we keep dwellings with a living space ranging from 25m^2 to 500m^2 and with less than 12 rooms to reduce the influence of extreme outliers. With respect to listed houses, we keep objects with a surface area between 50m^2 and 10,000m^2. We sample dwellings for sale with asking prices between €100 and €20,000 per m^2 and rental properties with a monthly rent between €2 and €30 per m^2. Note that we observe asking, but not transaction prices. However, Dinkel and Kurzrock (2012) show for rural areas in Rhineland-Palatine that apart from a slight price markup there are no systematic differences between asking and transaction prices.

If sellers adjust a listing, it is treated as a new observation with the same object identifier. Whenever the same object is listed multiple times within six months, we consider only the latest traits that are closest to the realized transaction in the HPI estimation. Each listing features a start and an end date. Listings are assigned to the month of the starting date because this is when the ask price is set.

The geographical information provided comprise zipcodes, geo-coordinates (1 km^2 grid), and administrative municipality identifiers (*"Allgemeiner Gemeindeschlüssel"*, AGS). These data are crucial to devise hedonic HPIs as the location of real estate explains most of the observed variation in asking prices. Each NUTS-3 region is divided into strata based on the municipalities (*"Gemeinde"*) nested in NUTS-3 regions. Sufficiently large municipalities are further divided into multiple strata based on zipcodes.[8] Dwellings sharing the same zipcode are geographically close and prices should not deviate too much when adjusting for quality. We adjust the data for the very few missing values of geographical information and inconsistencies.[9] A caveat associated with this approach is that the size of municipalities varies across federal states. For example, Schleswig-Holstein consists of 1,116 municipalities with less than 3 million inhabitants, whereas Nordrhein-Westfalen consists of 396 municipalities with about 18 million inhabitants. Therefore, we merge members of a union of municipalities (*"Gemeindeverband"*) into one strata. Among the German NUTS-3 regions the number of strata varies between one (county-free cities such as Straubing or Eisenach with only one zipcode) and 189 in Berlin. Finally, we exclude duplicate observations that exhibit exactly identical traits across different object identifiers.

Hedonic models are ideal for the construction of quality-adjusted house price estimates (Hill and Scholz, 2018). For dwelling i, we adjust for k observable characteristics (e.g. size, year of construction, balcony, etc.), $X_{k,i}$, and the location as gauged by the strata, S_i (Saiz, 2010). We pursue a three-stage approach to estimate regional hedonic price indices for each of the 402 German NUTS-3 regions (Gouriéroux and Laferrère, 2009). First, we estimate a price regression for a reference stock of dwellings in a reference period

[8] Postal code districts are homogeneous in size and cover around 40,000 inhabitants (Mense, Michelsen, and Kholodilin, 2017).

[9] Missing data is rare, namely 1.5% of zipcodes and 3% of AGS-code and geo-coordinates, respectively. Postbox zipcodes are replaced by the dominant zipcode in the reported geo-coordinate.

(2008q1:2009q4):

$$\ln P_{i,y,q} = \alpha_0 + \sum_{k=1}^{K} \alpha_k X_{k,i} + \sum_{s=1}^{S} \beta_s S_{s,i} + \sum_{y=1}^{2} \gamma_y Y_y + \sum_{q=1}^{4} \delta_q Q_q + \epsilon_{i,y,q}, \tag{1}$$

where $P_{i,y,q}$ denotes the asked price or rent per m^2 of dwelling i in year y and quarter q. The model contains an intercept, α_0, a vector of housing characteristics with k elements $-X_{k,i}-$, a vector equal to the number of strata s in the NUTS-3 county $-S_{s,i}-$, annual fixed effects $-Y_y-$ per year y and seasonal fixed effects $-Q_q-$ in quarter q within the reference period. Second, we estimate the price of a reference dwelling $-P_0-$, at mean values of the covariates denoted in Equation (1) during the reference period:

$$\ln \hat{P}_0 = \hat{\alpha}_0 + \sum_{k=1}^{K} \hat{\alpha}_k \bar{X}_{k,0} + \sum_{s=1}^{S} \hat{\beta}_s \bar{S}_{s,0} + \sum_{y=1}^{Y} \hat{\gamma}_y \bar{Y}_{y,0} + \sum_{q=1}^{4} \hat{\delta}_q \bar{Q}_{q,0}. \tag{2}$$

Third, we estimate the price of the reference dwelling in period τ by adjusting the observed price of dwelling i in period τ. Specifically, we account for differences in the characteristics between dwelling i and the reference dwelling given the average traits in the reference period. Whereas we omit year fixed effects, which are only specified within the reference period, quarterly indicators account for seasonality:

$$\ln \hat{P}_{i,\tau} = \ln P_{i,\tau} - \sum_{k=1}^{K} \hat{\alpha}_k (X_{k,i,\tau} - \bar{X}_{k,0}) - \sum_{s=1}^{S} \hat{\beta}_s (S_i - \bar{S}_{s,0}) - \sum_{q=1}^{4} \delta_q (Q_q - \bar{Q}_{q,0}). \tag{3}$$

The hedonic HPI for period τ is derived from the average of adjusted estimated prices:

$$\hat{P}_\tau = \frac{1}{N} \sum_{i=1}^{N} \exp(\hat{P}_{i,\tau}). \tag{4}$$

The price-to-rent ratio index equals the ratio of the hedonic price and rent per m^2 at each period. The hedonic HPI are smoothed by cubic splines and each time series is divided by equidistant knots (see Mense et al., 2017). Between these knots, the time series is fitted by a function with three polynomials, which is estimated after each knot separately. The interval between the knots equals four quarters.

The two top panels in Table 1 underpin the importance to control for observable quality differences of real estate when aiming to assess the effect of tax changes.

We describe the data one year before and after a tax hike in terms of means, standard deviations, and observations. The right-most columns show a t-test whether the means of variables exhibit statistically significant differences before and after an increase in the RETT. Consider the comparison of mean price-to-rent ratios and HPI in both purchase and rental markets between regions with (Treated) and without (Control) changes in the RETT. Mean hedonic HPI are statistically different from another whereas the moments of the raw price and rent data shown in the second panel of Table 1 are not statistically discernible from another. These differences in hedonic HPI bode well for the identification of mortgage lending responses to fiscal policy via the effect on real estate prices.

2.2.2 Empirical specification

Using these data, we estimate the following regression model to gauge the impact of tax hikes on regional house prices as:

$$\Delta HPI_{r,t} = \alpha_r + \alpha_t + \sum_{j=-1}^{6} \beta_j TaxIncrease_{r,t-j} + \sum_{i=1}^{2} \gamma_i \Delta Unemployment_{r,t-i} + e_{r,t}, \quad (5)$$

where r indicates the administrative NUTS-3 county and t is the quarterly calendar date. The dependent variable $HPI_{r,t}$ denotes the quarterly growth rate of regional hedonic house price indices (HPI) that we develop below. The variable of interest captures the intensive margin of the tax increase measured in percentage points, $TaxIncrease_{r,t-j}$. As the impact of the tax change may not only unfold contemporaneously, the variable is decomposed into a lead variable one quarter prior the tax change, the contemporaneous indicator, and lagged variables for each quarter up to 6 quarters after the tax change.[10] To avoid distorting effects of subsequent tax increases, we dismiss observations if a RETT increase was implemented less than 24 months after the previous tax hike, which would preclude the distinction of anticipation and post-activation effects. Hence, we exclude regions located in the federal states of Saarland from 2012 onwards, Berlin for the year 2014 or later, and Hesse for the year 2015 or later (see Figure 1).[11] To account for dynamics in regional demand, we also specify quarterly seasonally adjusted *Unemployment* rates per county provided by the federal employment agency (*"Bundesagentur für Arbeit"*). We also specify region α_r and quarter α_t fixed effects and cluster standard errors at the state-by-quarter level. Thus, our identification exploits within-state variation of house prices while holding constant observable macro conditions at the county level.

2.3 Mortgage lending and house prices

2.3.1 The RETT, macroprudential policy, and mortgage lending

Formally, the increase of the RETT leads to higher transaction costs for the purchase of a real estate. As these costs may not be financed through a mortgage, the tax increase reduces the maximum downpayment of a household requesting mortgage. As outlined by Kelly, McCann, and O'Toole (2018), a household's credit access for a mortgage is determined by the minimum of three credit conditions: loan-to-value (LTV), debt-service-to-income (DSTI), and loan-to-income (LTI). The LTV constraint is the only credit condition affected by the downpayment and the by the transaction costs. DSTI and LTI are mostly driven by the income profile of households. Hence, it is straightforward to focus on the LTV constraint when assessing the impact of changes in the RETT on mortgage credit. In this setting, the price of the dwelling $P_{i,r,t}$ consists of the downpayment, $D_{i,r,t}$ and the loan volume, $Loan_{i,r,t}$.

$$P_{i,r,t} = D_{i,r,t} + Loan_{i,r,t} \quad (6)$$

[10] Figure 2 shows that the effect of RETT changes on house price growth vanishes six quarters after the tax increase.

[11] In Appendix B.2 we also specify an indicator variable of RETT changes instead of the intensive margin and also consider samples including multiple tax hikes. All results remain qualitatively unaffected.

The downpayment of household i is determined by its financial assets $F_{i,r,t}$ minus the transaction costs related to the purchase of the real estate. The latter is the product of the price of the dwelling $P_{i,r,t}$ times a fraction required to cover the costs related to the its purchase, $\theta_{r,t}$. The fraction includes fees for the broker, the notary, and for the entry to the land register, which sum up in Germany to about 5% of the transaction price, as well as the RETT (see e.g. Voigtländer, 2016), $\tau_{r,t}$.

$$D_{i,r,t} = F_{i,r,t} - P_{i,r,t}\theta_{r,t} \tag{7}$$

According to Kelly et al. (2018), the loan volume is determined by the downpayment, $D_{i,r,t}$, and a maximum LTV ratio, $\overline{LTV}$ (see Kelly et al., 2018).

$$Loan_{i,r,t} = \frac{D_{i,r,t}}{1-\overline{LTV}} - D_{i,r,t} = D_{i,r,t}\frac{\overline{LTV}}{1-\overline{LTV}} = (F_{i,r,t} - P_{i,r,t}\theta_{r,t})\frac{\overline{LTV}}{1-\overline{LTV}} \tag{8}$$

By inserting (6) and (7) into (8), we obtain the following equation for the maximum price of a dwelling, a house can afford, depending only on the financial assets $F_{i,r,t}$, the maximum LTV, $\overline{LTV}$, and the transaction costs, $\theta_{r,t}$.[12]

$$P_{i,r,t} = \frac{F_{i,r,t}}{1-\overline{LTV}+\theta_{r,t}} \tag{9}$$

From Equation (8) and (9) we can obtain the maximum mortgage volume for household i if the LTV constraint is binding.

$$Loan_{i,r,t} = F_{i,r,t}\frac{\overline{LTV}}{1-\overline{LTV}+\theta_{r,t}} \tag{10}$$

Given that the LTV constraint is binding (e.g. that income requirements are not binding), Equation (10) clearly shows that effect of an activation of an LTV cap may also be achieved by changes in the RETT. Let's assume that the market based LTV is set at 80% and transaction costs sum up to 10% of the purchase price, implying that the RETT is set to 5%. Before increasing the RETT, the maximum loan volume is 2.667 times the size for a given value of financial assets. An increase in the RETT by 1 ppt to 6%, would lead to a reduction of the factor to 2.581 equaling a decline in mortgage supply by 3.3%. Given Equation (9), the house prices would be affected in the same magnitude. According to Equation (10), a reduction of the maximum LTV from 80% to 79.3% would also lead to 3.3% drop in mortgage lending. This example is illustrates the potential substitution between changes in the RETT an activation of an LTV cap. However, the model is based on several strict assumption, such as the bindingness of the LTV constraint for all household purchasing a dwelling and the lack of substitution to other market segments. Therefore, the effect of this illustration (for the assumed parameters) may be considered as a maximum effect of the RETT increase on mortgage supply.

2.3.2 Empirical specification

To answer the question if fiscal policy can dampen the supply of mortgage credit, we estimate the impact of regional HPI growth on changes in regional mortgage lending

[12] See Appendix A for detailed derivation of equations (9) and (10).

of local banks. To account for endogeneity between both factors, we instrument house price growth with changes in the RETT. Predicted changes in purchase and rent HPI in regional real estate markets constitute the exogenous shock for credit demand to identify how house price changes affect bank-level mortgage credit supply. We apply a two-stage instrumental variable (IV) regression and use a GMM framework.

The first stage of the IV approach resembles Equation (5), where we specify the cumulative effect of RETT hikes up and until six quarters after state-specific tax policy changes (see columns 3-6 in Table 2) and the lead variable of the tax change. Banks located in Bavaria or Saxony are excluded from this analysis, since no tax increase was activated in these federal states throughout the whole sample period. In the second stage of the IV, we specify outstanding mortgage credit of bank b in quarterly date t, $MortgageLending_{b,t}$ as:[13]

$$\Delta MortgageLending_{b,t} = \alpha_b + \alpha_t + \beta_1 \Delta \hat{Price}_{r,t-1} + \gamma BankControls_{b,t-1} + e_{b,t}. \quad (11)$$

The predicted house price growth obtained from the first stage of the IV, $\Delta \hat{Price}$, is the main explanatory variable of interest. We specify also a set of lagged bank-specific control variables, $BankControls_{b,t-1}$: the natural logarithms of total assets, as well as deposit, equity, liquidity, and securities ratios (see also Section 2.3.3). Bank and time fixed effects are included. Standard errors are clustered at the county by quarter level.

Note that the dimensionality of the dependent variable, estimated at the bank-level, and the instrumented variable obtained from the first stage at the level of NUTS-3 regions, are different in the second stage of the IV. This difference can lead to inconsistent estimates of the standard errors. We account for the different dimensions within the IV framework using 1,000 bootstrapped iterations of the sample. Each bootstrapped sample is based on a random sample drawn at the level of NUTS-3 regions with replacement. The empirical results are obtained by deriving the mean and the standard deviation of the corresponding coefficient estimates. The validity of the instrumented variables is assessed through the Kleibergen-Paap and Cragg-Donald F-Statistics. As the distribution of the F-Statistics is not symmetric around the mean, the output provides information on the median value of the corresponding test statistics.

2.3.3 Mortgage lending data

To analyze the relationship between regional housing markets and mortgage lending, we obtain detailed financial data for the population of all banks operating in Germany from microprudential supervisory reports filed with Deutsche Bundesbank (*cf.* Table A.1.) We source balance sheet information from the Monthly Balance Sheet Statistics database (*"Monatliche Bilanzstatistik"*, BISTA Gomolka, Schäfer, and Stahl, 2020), which comprise end-of-month book values of assets and liabilities since 1999. We approximate mortgage lending to households by the amount of outstanding loans to individuals with a maturity of at least five years.

Since we focus on the relationship between regional housing markets and mortgage loan supply, we consider only savings banks and cooperative banks. These banks are organized in pan-regional or national banking associations. They are obliged to operate on

[13] Recall that we approximate mortgage lending by the amount of outstanding loans to private individuals with a maturity of more than 5 years of bank b at time t.

de jure or *de facto* delineated local markets[14]. Therefore, we follow existing literature and assign each bank based on the location of its headquarter to a unique NUTS-3 region (see e.g. Koetter and Popov, 2020). To control for observable bank traits that co-determine bank-lending choices, we account for size of the bank and specify also the natural logarithm of total assets. Additional bank-level covariates are the deposits and equity ratio (Chakraborty et al., 2020) as well as the liquidity and securities ratio (Koetter, 2019).

3 Results

Section 3.1 presents the empirical results and robustness checks pertaining to the relationship between tax hikes and regional house prices. Section 3.2 discusses, in turn, the results about mortgage lending responses to house price changes.

3.1 The effect of RETT hikes on house prices

3.1.1 Headline results

Table 2 shows the results when regressing the percentage point change in RETT rates on the growth rates of quality-adjusted purchase HPI, rent HPI, and price-to-rent ratios for the period 2008 to 2017.

The first three columns report the results obtained for the entire sample of all NUTS-3 regions in Germany. Regarding potential HPI responses to RETT changes, we consider first regional markets to purchase real estate. Column (1) shows that the growth rate of house prices declines by 21 basis points in the quarter of the tax increase. This effect remains constant up and until five quarters after the tax change, accumulating to around 120 basis points.

The over-proportionate price response in real estate markets is remarkable, but may reflect concerns voiced by policy makers about supply lags in selected urban regions that lead to overheated markets (Deutsche Bundesbank, 2018). Given the ample evidence on important regional differences (Himmelberg, Mayer, and Sinai, 2005; Holly et al., 2010), we therefore consider urban and rural regions separately below.

Before, we turn to another concern related to policy measures that aim to mitigate real estate price hikes. A potential (unintended) consequence of requiring more equity in real estate transactions is to force potential buyers into rental markets, thereby exerting upward pressure on rents (Petkova and Weichenrieder, 2017). The according effect of the RETT on rents is shown in column (2) and does not support such concerns. It is statistically significant, but relatively small, summing up to a decline of around 10 basis points.

At the same time, column (3) shows that the price-to-rent ratio declines significantly by 67 basis points over the course of five quarters after the tax shock. To the extent that price-to-rent ratios gauge the returns that real estate investors expect to earn (Himmelberg et al., 2005), RETT changes appear to burden capital owners relatively more than consumers of rental housing.

[14] See Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung (2013) p.232 for further details.

Given that the effect of RETT changes on regional real estate purchase HPI vanishes after six quarters, as illustrated also by Figure 2, we specify in columns (4) to (6) of Table 2 a joint coefficient for this post-RETT change period instead of estimating quarter-specific responses.

This average response per quarter of purchase HPI, rent HPI and price-to-rent ratios exhibits qualitatively very similar results and almost identical goodness of fit measures. Column (4) shows that a one percentage point increase in the RETT induces negative growth rates of house prices on the order of 18 basis points per quarter, accumulating to 125 basis points six quarters after the RETT hike. The response of rents shown in column (5) resembles the relatively weak negative impact estimated in column (2), but is not statistically significant. Hence, the significant decline of price-to-rent ratios in column (6), accumulating to 85 basis point six quarters after a tax increase of one percent, is indeed mainly driven by a contraction of asset values rather than expected yields accruing to capital owners from renting.

This initial assessment whether RETT changes caused a change in house prices hinges crucially on the assumption that such policy changes were not anticipated by market participants. Otherwise, agents adjust their behavior prior to the shock, for instance by preponing transactions or by staying below tax thresholds as shown by Kopczuk and Munroe (2015), which would invalidate our identification strategy. Therefore, we specify a lead indicator equal to the value of the tax hike in the quarter before the actual policy shock in all six specifications. The coefficient of this lead indicator has no significant effect on house price growth, which bodes well for our identification strategy.

3.1.2 Rural versus urban regions

Real estate dynamics differ fundamentally between rural and urban agglomeration areas (Himmelberg et al., 2005; Saiz, 2010). The latter are smaller in size and more densely populated, which implies constrained housing supply due to scarce space, thus exerting price pressure given demand. Excess demand paired with development lags in the supply of new urban housing are often blamed to drive overvaluations on the order or 30% in urban regions according to Deutsche Bundesbank (2018). Therefore, we show estimation results for the cumulative RETT hike responses for sub-samples of urban and rural areas in Table 3.

We define urban areas as cities that are not assigned to a NUTS-3 region, so-called county-free cities (*"Kreisfreie Stadt"*).[15]. Out of the 402 counties that correspond to NUTS-3 regions, around 107 are urban areas according to this definition.

The regional distinction between urban and rural regions reveals important additional insights. House price growth in rural real estate markets is substantially more affected by increases in the RETT than urban ones. Columns (1) and (4) clearly indicate that purchase prices contract in the former by 26 basis points contemporaneously whereas they do not respond significantly in more densely populated agglomeration areas. The dynamic effects are for both types of regional markets statistically significant, but the responses differ quantitatively. Purchase prices in urban regions contract by 93 basis points after six quarters, whereas the value depreciation in rural areas amounts to 15 basis points more. Taken together, these estimates support the notion that more densely populated

[15]The status of county-free city is generally given to large cities with more than 100,000 inhabitants.

agglomeration areas exhibit a substantially lower price elasticity of demand in real estate markets. This feature would render the effectiveness of small scale policies aiming to mitigate the emergence of real estate bubbles more limited compared to rural areas that face less tight demand conditions and fewer supply side frictions in the supply of housing.

Columns (2) and (5) highlight another important difference in the response of real estate markets to RETT hikes. Whereas rents in rural regions confirm the smaller decline in rental HPIs documented in Table 2, column (2) shows that urban rental markets suffer indeed from upward pressure in response to RETT hikes. Hence, requiring higher equity capital due to increased down-payments may have, especially in already tight regional real estate markets, unintended consequences by forcing potential buyers into renting real estate.

Columns (3) and (6) indicate that any crowding-out of potential buyers bears also important implications for different price-to-rent ratio responses to a given RETT hike. While negative in both types of regional real estate markets, the investment required to realize rental income contracts more in urban regions compared to rural areas. The cumulative effect amounts to 135 basis points in cities after six quarters, whereas it is only 72 basis points in less densely populated markets. On the margin, more substantial reductions in price-to-earnings ratios in urban regions may thus attract further investments in already tight regional markets. Clearly, such a re-allocation of real estate investment would depend on the availability of credit, to which we turn below. Before doing so, we discuss a number of scrutiny checks regarding the validity of identifying real estate market responses to fiscal policy changes.

3.1.3 Scrutinizing HPI responses

Appendix B provides a range of tests to scrutinize the measurement of regional house prices, the specification of tax changes, and the identification of house price responses to RETT shocks. First, we test whether and how important it is to develop a regional HPI at quarterly frequency. We replicate the baseline results for all purchase prices, rents, and price-to-rent ratios in the full and for the regionally differentiated samples in Appendix B.1. These results underscore the crucial importance to account for quality differences and unobserved regional macro conditions because simply specifying the moments based on the raw listing data yields virtually no significant relationship with fiscal policy changes.

Second, we consider in Appendix B.2 the sensitivity of our headline results towards the specification of the intensity of tax changes rather than a simple indicator of possible changes of the fiscal stance of state governments towards their real estate market. Whereas the saturation of the specification with regional fixed effects as well as county-level unemployment as a proxy for regional macro conditions greatly enhances the explanatory power of the estimation, the choice of an indicator or continuous RETT change variable makes no qualitative difference for our main findings.

Third, we tackle the notorious challenge to identify causal effects of RETT changes on house prices in three ways. In Appendix B.3, we replicate Table 2 using randomly generated tax treatments. These placebo shocks are all statistically insignificant. In Appendix B.4, we conduct a panel regression at the level of federal states presented to test whether changes in the RETT are orthogonal to regional house prices. The results presented in Table A.5 clearly show that the RETT is not affected by the development of

previous house prices. Both tests corroborate the validity of RETT changes as exogenous fiscal shocks to HPI. A more elaborate test to this end in Appendix B.5 focuses on a subset of Bavarian regions, which did not experience any tax changes, and compare them to bordering regions in Baden-Württemberg that were subject to a RETT hike in November 2011. By ensuring otherwise equal (county) macro conditions, and by focusing on a single tax shock in otherwise identical regions, we can apply standard difference-in-difference techniques (Card and Krueger, 1994; Huang, 2008). Results are both qualitatively and quantitatively strikingly similar.

3.2 Regional real estate responses and mortgage credit

3.2.1 Headline results

Table 4 shows the estimation results to explain mortgage lending as a function of regional real estate price developments. Given the important regional differences in real estate price responses to taxes documented above, we show results for the total sample as well as for urban and rural regions only. The first three columns depict OLS estimates where we specify observed price changes as main explanatory variable. Real estate price hikes correlate positively with mortgage lending growth, although the quantitative effect is rather small and only statistically significant at the 10%-level for the total and the urban regions sample. But against the backdrop of the extensively documented interdependence between house prices and mortgage lending, these estimates may suffer from endogeneity and be inconsistent.

Therefore, columns (4) to (6) of Table 4 provide the estimates obtained from the bootstrapped IV regressions using the predicted HPI growth rate as main explanatory variable. Price effect estimates according to OLS are much smaller compared to the IV regression. At the same time, the results for the validity of instruments strongly support an IV specification over the OLS estimator.[16] Specifically, the Kleibergen-Paap and the Cragg-Donald F-test support the validity of the RETT increase as instruments for house price growth for the total sample and for rural regions. The Kleibergen-Paap F-tests report values of 12.59 for the entire sample and 11.63 for the subsample of rural regions. These values are above the critical value of 10 suggested by Stock and Yogo (2005). Furthermore, the Cragg-Donald tests are above the 5% critical values for both samples. For the sub-sample of urban regions, the Kleibergen-Paap F-Statistic reports a value of 1.2, while the Cragg-Donald test statistics reaches a value of 4.8. Both values are far below the corresponding critical value. Hence, changes in the RETT may be considered as a weak instrument assessing house price growth in urban region. These tests confirm our findings from Section 3.1, which showed that increases in the RETT unfold stronger impact in rural housing markets.

For the entire sample, the instrumental regression results indicate that banks increase their mortgage lending by 1.4% in response to a house price increase of 1 percent in the previous period. Taking the previous result into consideration, that a 1 percentage point increase in the RETT leads to a 1.2% decline in house prices, the elastic reaction of house

[16] In finite samples, the mean squared error of the biased OLS estimator of an endogenous variable can actually be smaller than the mean squared error of a correctly specified IV estimator. This is because of the efficiency loss (as described above) and because of the finite-sample bias of the IV estimator.

price growth on mortgage lending suggests that a 1%-increase in the tax rate reduces mortgage lending by about 1.7%. For rural regions, the estimates suggest an elasticity of 1.2 translating into a decline of 1.6% as a reaction to 1 percentage point increase in the RETT. The coefficient estimate for urban region is similar in the magnitude to the previous estimates, but it is exposed to a variance eight times higher in comparison to the other (sub)samples. Therefore, the estimates of the IV regression suggest that the effect of the changes in the RETT affect prices and quantities in regional housing markets.

In sum, the empirical findings strongly suggest that fiscal policy can be effective to contain mortgage credit supply through a dampening effect on the demand for dwellings to purchase. Importantly, this effect is only statistically significant in rural regions, which face less tight demand conditions and fewer construction lags to provide newly-built housing. To further assess whether and to what extent fiscal policies can serve as an instrument to contain a hallmark driver of financial instability—mortgage credit supply—we shed next more light on lending responses conditional on bank capitalization.

3.2.2 RETT lending responses conditional on bank capitalization

We consider mortgage lending responses conditional on the capitalization profiles because one of the main responses by policy makers after the GFC to enhance the resilience of the financial system was to require higher core capital buffers. Higher equity capital was deemed one if not the most important macroprudential tool because of the insight that insufficiently capitalized banks pose a threat to financial stability in case of systemic and sudden asset price deterioration–such as bursting housing market bubbles in the US in 2007.

Given the ample evidence on substantial spatial heterogeneity of these real estate asset price bubbles and their dissolution (see, e.g. Holly et al., 2010), we investigate banks' mortgage supply responses to this credit demand shock conditional on both their capitalization as well as their geographical location by means of interactions with instrumented house price growth. According to Goldsmith-Pinkham, Sorkin, and Swift (2020), the interaction of the instrument obtained from a single first stage IV regression may suffer from misspecification. Therefore, we use Bartik instruments for each covariate containing the instrumented variable. These covariates are the dependent variables in the first stage of the IV regression, which are estimated in separate regressions. These predicted values are then specified as explanatory variables in the second stage.

Table 5 shows the results from these IV specifications using Bartik instruments. Column (1) features two instrumented covariates obtained from the first stage of the IV regression, namely the predicted purchase HPI growth and the interaction term between the HPI and the dummy for rural regions. The specification in column (2) contains a time-varying dummy, LOW_{t-1}, that indicates whether a bank's capitalization was in the bottom quartile (P25) of the equity ratio distribution across banks in each period t. Column (3) contains both interaction terms.

Column (1) of Table 5 confirms the headline finding that increasing house prices reduce the supply of mortgage credit by banks located in rural regions. We estimate an elasticity between house prices and mortgage lending equal to 0.65 in urban regions and 1.31 in rural ones. The elasticity of 1.37 between house prices and mortgage lending in Column (2) is significant. The interaction term between house price growth and the indicator of

bottom quartile capitalization is insignificant though. This result suggests that location matters more than the capital ratio for a bank's reaction to house price changes, a finding confirmed when specifying indicators of location and poor capitalization in Column (3). For rural regions, the estimates suggest an elasticity of 1.35 for banks with a capitalization better than the bottom quartile and an elasticity of 1.33 for relatively poorly capitalized banks. In urban regions, the elasticity equals 0.79 for banks with a capitalization above the lowest quartile and an elasticity of 0.42 for low-capitalized banks. Except for the latter type of banks in urban regions, the elasticity estimates are significantly different from zero.

The consideration of a continuous capitalization allows a more detailed assessment of the impact of capitalization on mortgage lending. Hence, column (4) builds upon the interaction term of the price indicator and the equity ratio of the bank, whereas column (5) combines terms for the price indicator interacted with the rural dummy and the equity ratio, respectively. At first glance, the estimation results do not seem to provide additional insights. When omitting the spatial component in column (4), the estimates for the predicted price and for the interaction term are positive but insignificant. The same holds for the specification reported in column (5) with a positive impact of the interaction between the price and the rural dummy being the only significant term.

To put these interactions into perspective, we derive marginal effects of price growth changes on mortgage lending growth conditional on the bank capitalization distribution from regression results using the Delta-Method. Figure 3 illustrates these marginal effects of capitalization for the specification in column (4). Medium capitalized banks are more likely to respond to price fluctuations, whereas the effect is insignificant for banks at the top or at the bottom of the capitalization distribution. Figure 4 reflects the estimates from column (5) in Table 5. The effect of house price changes on mortgage lending in rural regions is significantly positive with an elasticity of around 1.3 across the entire capitalization distribution.[17] For urban regions, Figure 4 shows that only medium-capitalized banks significantly react to changes in house prices with an elasticity of about one.

[17] Column (5) of Table 5 implies a negligibly small elasticity of mortgage lending of 2 basis point w.r.t. an additional percent in the capital ratio.

4 Conclusion

In this paper, we exploit a unique combination of high-frequency, quality-adjusted house price index (HPI) responses to staggered real estate transaction tax (RETT) hikes to show that fiscal policy shocks can contain mortgage lending supply of regional banks. This insight is crucial in light of soaring real estate prices and the historically pivotal role played by credit-driven real estate bubbles in times of loose monetary policy that jeopardized financial resilience in many economies.

Tax changes at the state level are arguably exogenous to mortgage credit supply of regional banks, which allows us to isolate causal effects of RETT hikes via real estate price effects on housing demand on credit supply. A one percentage point increase in the RETT dampens house price growth in rural regions by more than 1%. As rents remain unaffected, changes in house prices also translate into changes in the price-to-rent ratio. Urban regions, which face tighter real estate markets, exhibit a slight increase in rental growth, which may indicate a an unintended crowding out of potential buyers towards renting markets. These results are robust to alternative empirical measurement methods of both house price indices and the tax shock, a randomized policy treatments, and when focusing only on contiguous regions in two states with very similar macro and banking market conditions.

To isolate the effect of fiscal policy changes on mortgage lending by regional banks, we specify RETT changes as an instrument in an IV setting to explain HPI growth. The results show that mortgage lending supply growth is elastic with respect to changes in HPI growth in rural regions, but not in urban ones. This result corroborates the subordinate importance of the RETT for real estate investment decisions in urban housing markets. We do not find any differentiating evidence across different bank capitalization profiles. Our analysis clearly shows that location matters more than the capital position of banks for its reaction to house price changes.

The irrelevance of the bank's capitalization on the transmission of house price changes to mortgage lending has potentially important implications for the conduct of financial stability policies aiming to contain mortgage lending supply. Whereas higher capital requirements to generally strengthen banks' loss-absorbing capacities, we find little indication that it influences its stance on supplying mortgage credit. The effectiveness of fiscal policy that dampens housing demand, in turn, bodes well for borrower-based macroprudential instruments pertaining to ensuring stable mortgage lending practices, such as the loan-to-value (LTV) ratio. We show formally that fiscal policy shocks resemble LTV caps since both tools directly alter down-payment requirements. To that extent, our result thus indicate that increased equity requirements due to LTV caps as a macroprudential instrument can mitigate housing demand and thereby mortgage issuance, mostly in rural regions. Regionally differentiated policies between urban and rural regions that account for the differences in demand elasticities documented in this paper may therefore be warranted.

References

Adelino, M., A. Schoar, and F. Severino (2015). House prices, collateral, and self-employment. *Journal of Financial Economics 117*(2), 288–306.

an de Meulen, P., M. Micheli, and S. Schaffner (2014). Documentation of German Real Estate Market Data - Sample of Real Estate Advertisements on the Internet Platform ImmobilienScout24. *RWI Materialien 80*.

Bauer, T. K., S. Feuerschütte, M. Kiefer, P. an de Meulen, M. Micheli, T. Schmidt, and L.-H. Wilke (2013). Ein hedonischer Immobilienpreisindex auf Basis von Internetdaten: 2007–2011. *AStA Wirtschafts-und Sozialstatistisches Archiv 7*(1-2), 5–30.

Boelmann, B. and S. Schaffner (2019). FDZ Data description: Real-Estate Data for Germany (RWI-GEO-REDv1) - Advertisements on the Internet Platform ImmobilienScout24. RWI Projektberichte.

Brunnermeier, M. and I. Schnabel (2016). Bubbles and central banks: Historical perspectives. In M. D. Bordo, Ø. Eitrheim, M. Flandreau, and J. F. Qvigstad (Eds.), *Central banks at a crossroads: What can we learn from history?*, Chapter 12, pp. 493–563. Cambridge, UK: Cambridge University Press.

Card, D. and A. Krueger (1994). Minimum wages and employment: A case study of the fastfood industry in New Jersey and Pennsylvania. *American Economic Review 84*, 772–793.

Chakraborty, I., I. Goldstein, and A. MacKinlay (2018). Housing price booms and crowding-out effects in bank lending. *Review of Financial Studies 31*(7), 2806–2853.

Chakraborty, I., I. Goldstein, and A. MacKinlay (2020). Monetary stimulus and bank lending. *Journal of Financial Economics 136*, 189–218.

Cloyne, J., K. Huber, E. Ilzetzki, and H. Kleven (2019). The effect of house prices on household borrowing: A new approach. *American Economic Review 109*(6), 2104–2136.

Cvijanović, D. (2014). Real estate prices and firm capital structure. *Review of Financial Studies 27*(9), 2690–2735.

Dachis, B., G. Duranton, and M. A. Turner (2011). The effects of land transfer taxes on real estate markets: Evidence from a natural experiment in Toronto. *Journal of Economic Geography 12*(2), 327–354.

Deutsche Bundesbank (2018). *Financial Stability Review 2018*. Frankfurt a.M., Germany.

Dinkel, M. and B. Kurzrock (2012). Asking prices and sale prices of owner-occupied houses in rural regions of Germany. *Journal of Interdisciplinary Property Research 13*(1), 5–25.

Farhi, E. and J. Tirole (2012). Bubbly liquidity. *Review of Economic Studies 79*(2), 678–706.

Favara, G. and J. Imbs (2015). Credit supply and the price of housing. *American Economic Review 105*(3), 958–92.

Fritzsche, C. and L. Vandrei (2019). The German real estate transfer tax: Evidence for single-family home transactions. *Regional Science and Urban Economics 74*, 131–143.

Gan, J. (2007). The real effects of asset market bubbles: Loan-and firm-level evidence of a lending channel. *Review of Financial Studies 20*(6), 1941–1973.

Gebhardt, H. (2008). *Geographie Baden-Württembergs: Raum, Entwicklung, Regionen*, Volume 36. W. Kohlhammer Verlag.

Gerlach, S. and W. Peng (2005). Bank lending and property prices in Hong Kong. *Journal of Banking & Finance 29*(2), 461–481.

Goldsmith-Pinkham, P., I. Sorkin, and H. Swift (2020). Bartik instruments: What, when, why, and how. *American Economic Review 110*(8), 2586–2624.

Gomolka, M., M. Schäfer, and H. Stahl (2020). Monthly Balance Sheet Statistics (BISTA) - Data Report 2020-04 - Metadata Version BISTA-Doc-v2-0. *Deutsche Bundesbank, Research Data and Service Centre (RDSC).*

Gouriéroux, C. and A. Laferrère (2009). Managing hedonic housing price indexes: The French experience. *Journal of Housing Economics 18*(3), 206–213.

Grodecka, A. (2020). On the effectiveness of Loan-to-Value regulation in a multiconstraint framework. *Journal of Money, Credit and Banking 52*(5), 1231–1270.

Hainmueller, J. (2012). Entropy balancing for causal effects: A multivariate reweighting method to produce balanced samples in observational studies. *Political Analysis 20*(1), 25–46.

Heinemann, F., E. Janeba, C. Schröder, and F. Streif (2016). Fiscal rules and compliance expectations: Evidence for the German debt brake. *Journal of Public Economics 142*, 11–23.

Hill, R. J. and M. Scholz (2018). Can geospatial data improve house price indexes? A hedonic imputation approach with splines. *Review of Income and Wealth 64*(4), 737–756.

Himmelberg, C., C. Mayer, and T. Sinai (2005). Assessing high house prices: Bubbles, fundamentals and misperceptions. *Journal of Economic Perspectives 19*(4), 67–92.

Holly, S., M. H. Pesaran, and T. Yamagata (2010). A spatio-temporal model of house prices in the USA. *Journal of Econometrics 158*(1), 160–173.

Hott, C. (2011). Lending behavior and real estate prices. *Journal of Banking & Finance 35*(9), 2429–2442.

Huang, R. (2008). The real effect of bank branching deregulation: Comparing contiguous counties across US state borders. *Journal of Financial Economics 87*, 678–705.

Justiniano, A., G. E. Primiceri, and A. Tambalotti (2019, June). Credit supply and the housing boom. *Journal of Political Economy 127*(3), 1317 – 1350.

Kelly, R., F. McCann, and C. O'Toole (2018). Credit conditions, macroprudential policy and house prices. *Journal of Housing Economics 41*, 153–167.

Keys, B. J., T. Mukherjee, A. Seru, and V. Vig (2010). Did securitization lead to lax screening? Evidence from subprime loans. *Quarterly Journal of Economics 125*(1), 307–362.

Koetter, M. (2019). Lending effects of the ECB's asset purchases. *Journal of Monetary Economics*, forthcoming.

Koetter, M. and A. Popov (2020). Political cycles in bank lending to the government. *Review of Financial Studies*, forthcoming.

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.

Mense, A., C. Michelsen, and K. Kholodilin (2017). Empirics on the causal effects of rent control in Germany. *FAU Discussion Papers in Economics* (24/2017).

Mian, A. and A. Sufi (2009). The consequences of mortgage credit expansion: Evidence from the US mortgage default crisis. *Quarterly Journal of Economics 124*(4), 1449–1496.

Mian, A. and A. Sufi (2011). House prices, home equity-based borrowing, and the US household leverage crisis. *American Economic Review 101*(5), 2132–56.

Mian, A. and A. Sufi (2018). Finance and business cycles: The credit-driven household demand channel. *Journal of Economic Perspectives 32*(3), 1–30.

Peek, J. and E. S. Rosengren (2000). Collateral damage: Effects of the Japanese bank crisis on real activity in the United States. *American Economic Review 90*(1), 30–45.

Petkova, K. and A. J. Weichenrieder (2017). Price and quantity effects of the German real estate transfer tax. *WU International Taxation Research Paper* (2017-07).

Reinhart, C. M. and K. S. Rogoff (2008). Is the 2007 US sub-prime financial crisis so different? An international historical comparison. *American Economic Review 98*(2), 339–344.

Rodnyansky, A. and O. M. Darmouni (2017). The effects of quantitative easing on bank lending behavior. *Review of Financial Studies 30*(11), 3858–3887.

Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung (2013). Gegen eine rückwärtsgewandte Wirtschaftspolitik - Jahresgutachten 2013/14. Wiesbaden.

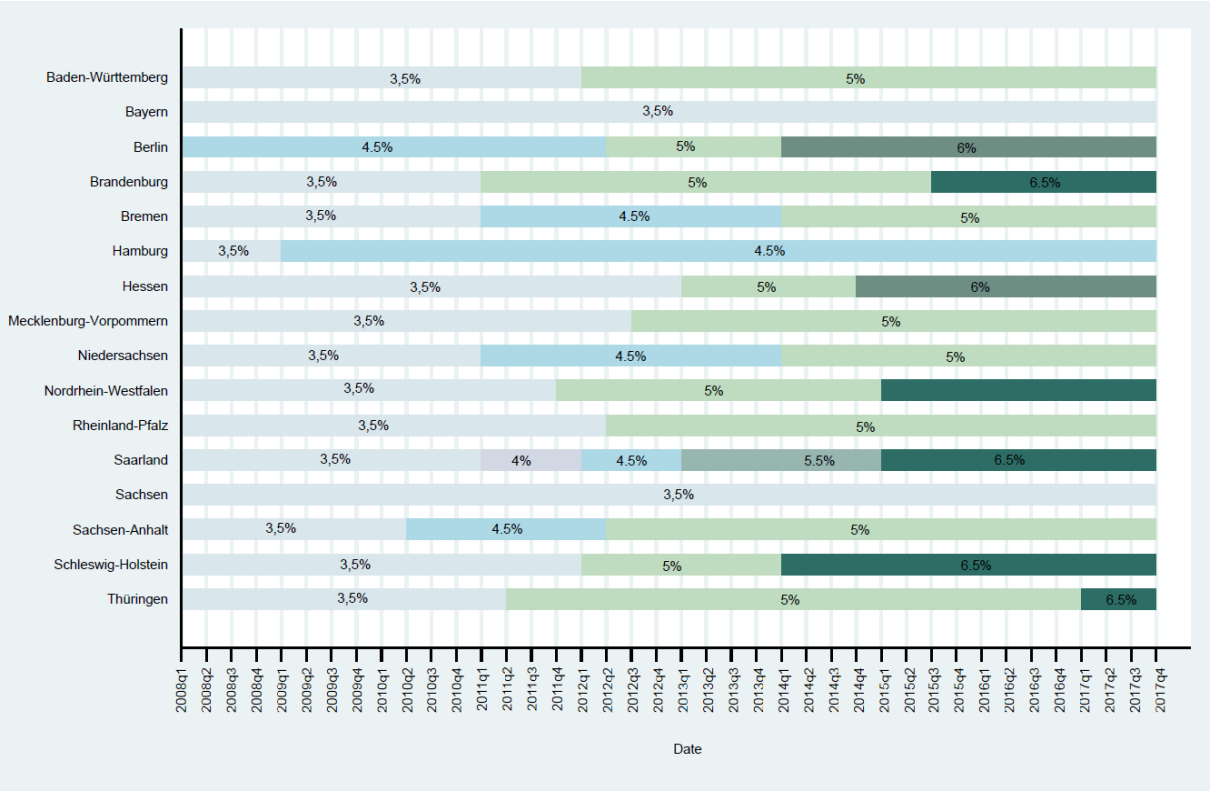
Saiz, A. (2010). The geographic determinants of housing supply. *Quarterly Journal of Economics 125*(3), 1253–1296.

Stock, J. and M. Yogo (2005). Asymptotic distributions of instrumental variables statistics with many instruments. In D. W. K. Andrews (Ed.), *Identification and Inference for Econometric Models*, Chapter 6, pp. 109–120. Cambridge University Press.

Voigtländer, M. (2016). Transaction costs: A high financial burden for German home buyers. *IW-Kurzbericht 72.2016*.

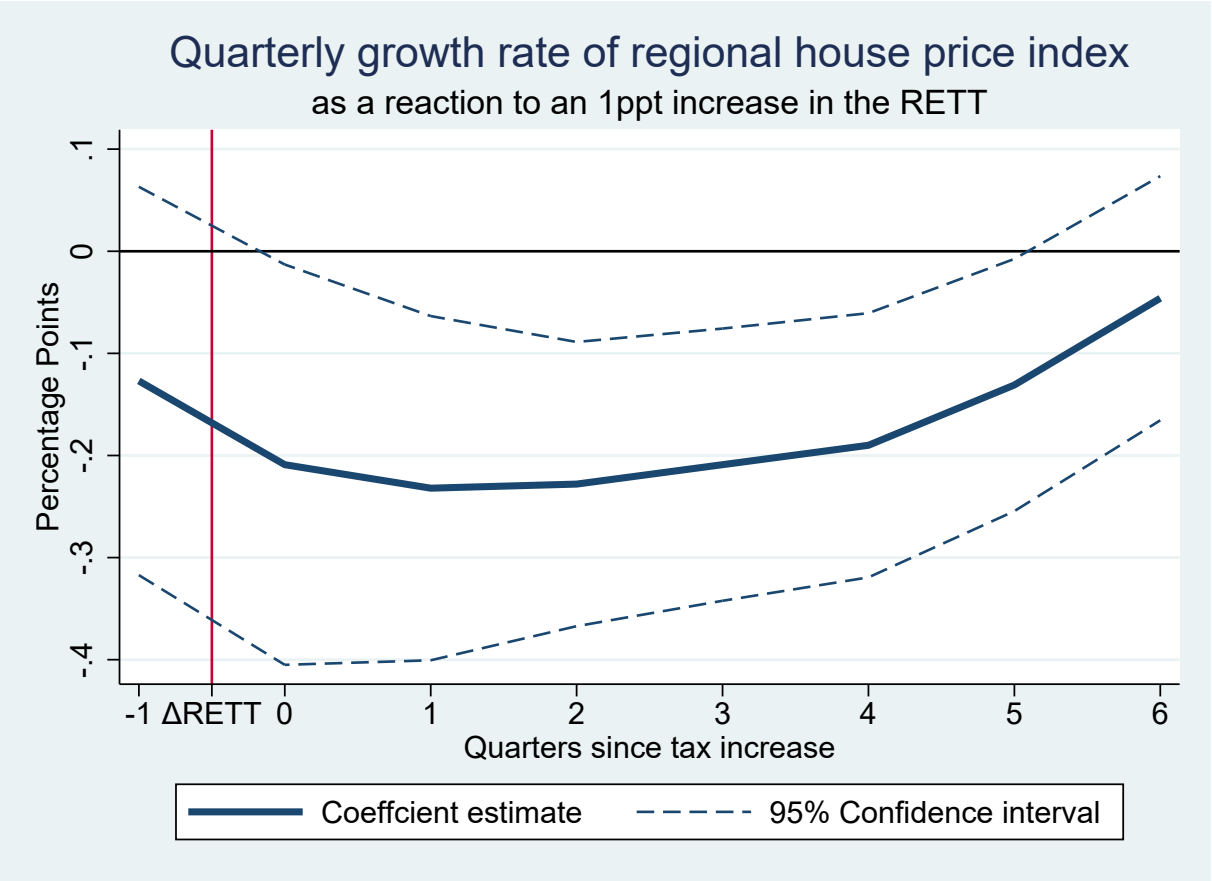
5 Figures

Figure 1: Real Estate Transfer Tax in German States from 2008 to 2017



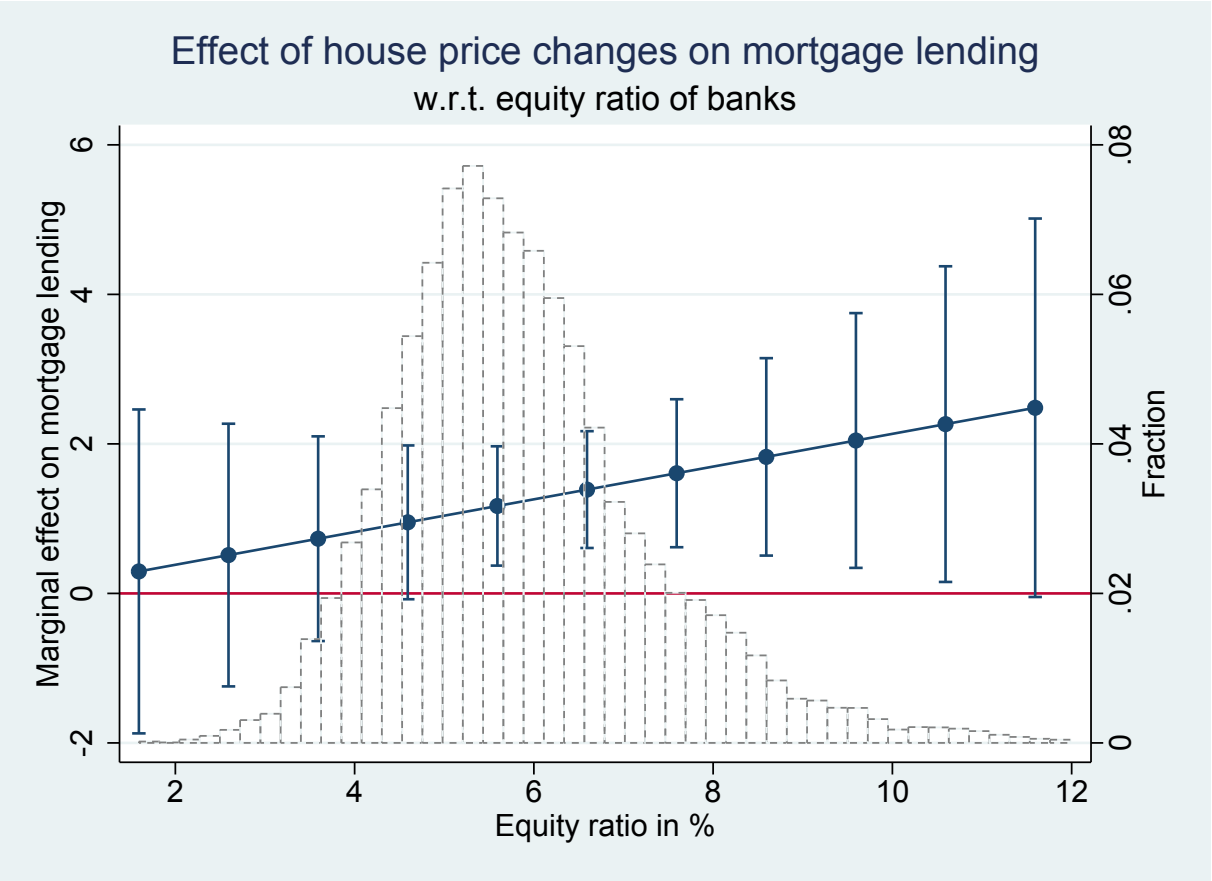
Notes: The figure represents the levels of the real estate transfer tax (RETT) in the German federal states from the first quarter of 2018 until the end of 2017. The figure does not report the first state change (Berlin, 2006:q3) since our house price data begin in 2008. Source: Official announcements of German state governments.

Figure 2: Tax increase and the regional house price index



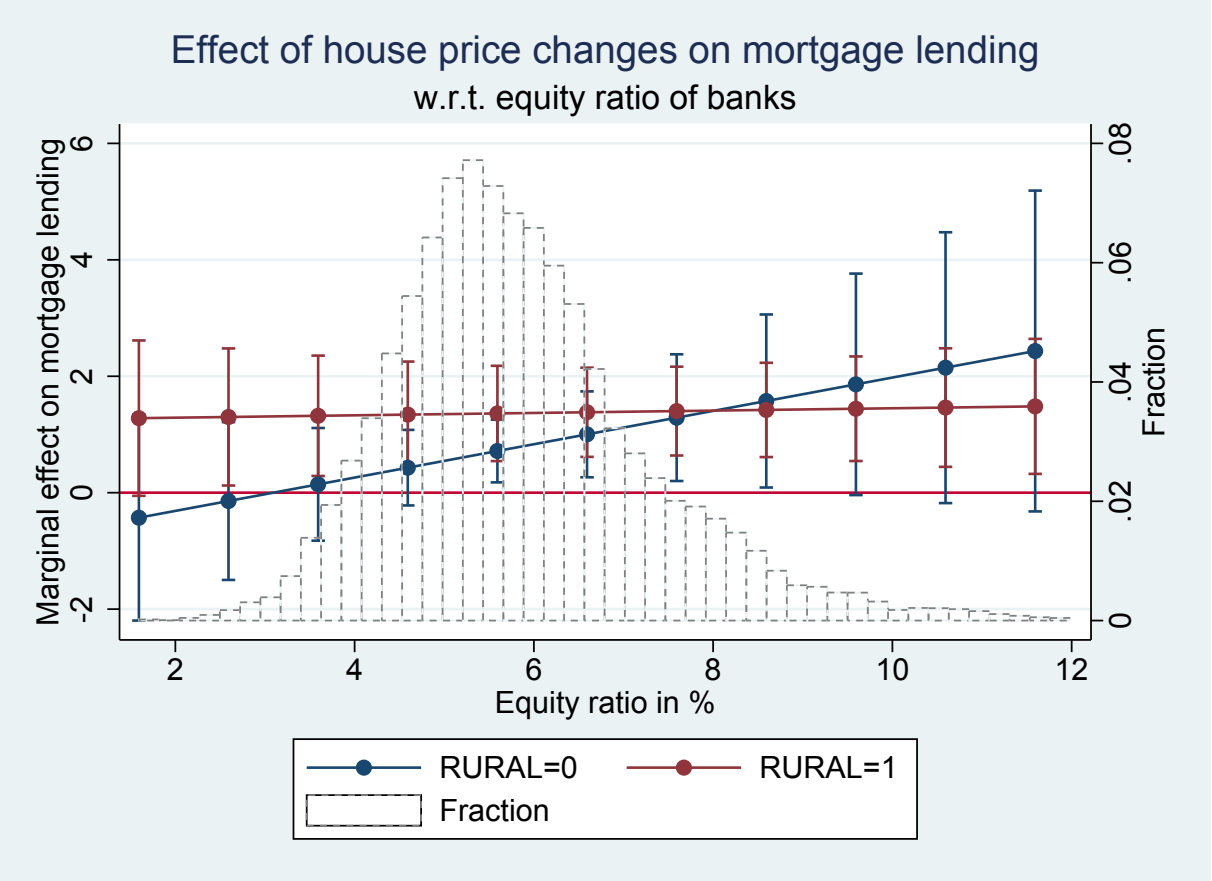
Notes: This figure illustrates the effect of a 1ppt RETT increase on the regional house price index for the sample of all 402-NUTS-3 regions in Germany. The graph is based on an event study presented in Table 2 in Column (1). The coefficient estimates are represented by the solid line, the corresponding 95%-confidence interval by the dashed lines. Source: Immscout24.de, own calculations.

Figure 3: Marginal effects of house price increases conditional on bank capitalization



Notes: This figures illustrates the effect of house price growth induced by a change in the RETT on mortgage lending conditional on the capitalization of regionally operating banks. The graph is based on the 2^{nd}-stage of the IV-regression presented in Table 5 in Column (4). The estimated effect is presented by the blue line with dots. The intercept (for banks with an equity ration of 0) is determined by the coefficient estimates for $\Delta \hat{Price}_{t-1}$, namely -0.055, whereas the slope is determined by the interaction term of $\Delta \hat{Price}_{t-1}$ and $Equity\ Ratio_{t-1}$ taking a value of 0.219. The joint standard errors are obtained by means of the Delta-Method. For each dot on the blue line, the vertical line represents the corresponding 95%-confidence interval. The distribution of the equity ratio of the banks' in the sample is illustrated by the dashed bars in the background of the figure. Source: Immoscout24.de, Monthly Balance Sheet Statistics, own calculations.

Figure 4: Marginal effects of house price increases conditional on bank capitalization and geographic location.



Notes: This figures illustrates the effect of house price growth induced by a change in the RETT on mortgage lending conditional on the capitalization of regionally operating banks and their geographic location. The latter refers to a distinction between banks located in urban regions (defined as county-free cities), and rural regions (counties with at least 2 municipalities). The graph is based on the 2^{nd}-stage of the IV-regression presented in Table 5 in Column (5). The estimated effect for banks operating in urban regions is presented by the blue line with dots, while the red line represents the effect for banks located in rural regions. For banks located in urban regions, the intercept (for banks with an equity ration of 0) is determined by the coefficient estimate for $\Delta\hat{Price}_{t-1}$, namely -0.885, whereas the corresponding slope is determined by the interaction term of $\Delta\hat{Price}_{t-1}$ and $Equity\ Ratio_{t-1}$ taking a value of 0.286. For banks operating in rural regions, the intercept is determined by the sum of the coefficient estimates for $\Delta\hat{Price}_{t-1}$ and $Rural * \Delta\hat{Price}_{t-1}$, equal to 1.249. The corresponding slope is determined by sum of two interaction terms, $Equity\ Ratio_{t-1}$+$\Delta\hat{Price}_{t-1}$ and $Rural$*$Equity\ Ratio_{t-1}$+$\Delta\hat{Price}_{t-1}$ taking a value of 0.020. The joint standard errors are obtained by means of the Delta-Method. For each dot on both lines, the vertical line represents the corresponding 95%-confidence interval. The effect of zero is marked by a red line. In the case that the vertical line capturing the 95% confidence interval does not intersect with the zero line, the effect may be considered as significant conditional on a bank's equity ratio. The distribution of the equity ratio of the banks' in the sample is illustrated by the dashed bars in the background of the figure. Source: Immoscout24.de, Monthly Balance Sheet Statistics, own calculations.

6 Tables

Table 1: Regional and Bank level Summary Statitics

	Total Sample						Treated Regions			Control Regions			T-test	
			Percentile				One year after tax increase							
	Mean	Std.Dev.	25th	50th	75th	N	Mean	Std.Dev.	N	Mean	Std.Dev.	N	Delta	p-value
Hedonic Price Index														
Price to Rent ratio	0.3	2.0	-0.5	0.3	1.1	15276	0.3	1.6	1713	0.5	1.6	7049	0.24***	(0.00)
Price per sqm.	0.9	2.0	0.0	0.9	1.8	15276	0.9	1.5	1713	1.3	1.6	7049	0.45***	(0.00)
Rent per sqm.	0.6	0.8	0.2	0.6	1.0	15276	0.5	0.6	1713	0.8	0.8	7049	0.21***	(0.00)
Statistical House Price Averages														
Price to Rent ratio	0.4	11.5	-5.3	0.4	6.0	15270	0.1	11.0	1713	0.4	11.8	7049	0.34	(0.27)
Price per sqm.	1.1	10.5	-4.0	1.1	6.2	15270	0.7	10.4	1713	1.2	10.6	7049	0.49	(0.08)
Rent per sqm.	0.7	5.0	-1.6	0.6	2.9	15276	0.7	4.5	1713	0.8	5.4	7049	0.15	(0.28)
Regional Data														
Unemployment rate change (y-o-y)	-0.2	0.6	-0.5	-0.2	0.1	14070	-0.3	0.5	1713	-0.4	0.5	7049	-0.03*	(0.04)
Bank Level Data														
Mortgage Lending	-0.0	1.2	-0.2	-0.1	0.1	35434	0.1	1.4	5799	-0.1	1.0	17760	-0.15***	(0.00)
Log size	18.8	1.4	17.9	18.8	19.8	53715	18.8	1.4	6227	18.8	1.4	22941	-0.00	(0.98)
Deposits ratio	72.4	8.9	67.7	73.5	78.4	53715	71.0	8.6	6227	73.9	8.6	22941	2.90***	(0.00)
Liquidity ratio	0.8	0.4	0.6	0.7	1.0	53715	0.8	0.3	6227	0.8	0.4	22941	0.01*	(0.03)
Securities ratio	27.0	11.9	18.5	25.8	34.0	53715	25.7	11.8	6227	29.1	12.0	22941	3.38***	(0.00)

Notes: This Table shows descriptive statistics for the quarterly growth rates of the variables used in the analysis. We show total sample statistics and distinguish between treated and non-treated regions for year following a tax increase. In the last two columns we perform a t-test of the mean differences between the two sub-samples and report the first difference and its statistical significance. Variables are defined in Table A.1. All values are percentages(i.e. $0,3 = 0,3\%$). *Standard errors* in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: RETT increases and the impact on the hedonic price indices

	Event Analysis			Pre-Post Dummy Analysis		
	Price(%) (1)	Rent(%) (2)	Price-to-Rent(%) (3)	Price(%) (4)	Rent(%) (5)	Price-to-Rent(%) (6)
Tax Increase$_{t+1}$	−0.127	−0.047	−0.082	−0.117	−0.040	−0.078
	(0.097)	(0.029)	(0.104)	(0.098)	(0.030)	(0.104)
Tax Increase$_{t}$	−0.208*	−0.141	−0.044	−0.203**	−0.068*	−0.137
	(0.100)	(0.037)	(0.100)	(0.101)	(0.037)	(0.100)
Tax Increase$_{t-(1-6)}$				−0.175***	−0.037	−0.140***
				(0.042)	(0.030)	(0.044)
Tax Increase$_{t-1}$	−0.232***	−0.093*	−0.142*			
	(0.086)	(0.055)	(0.082)			
Tax Increase$_{t-2}$	−0.228***	−0.115	−0.118			
	(0.071)	(0.089)	(0.095)			
Tax Increase$_{t-3}$	−0.209***	−0.013	−0.198**			
	(0.068)	(0.038)	(0.081)			
Tax Increase$_{t-4}$	−0.190***	0.003	−0.195**			
	(0.066)	(0.035)	(0.077)			
Tax Increase$_{t-5}$	−0.131**	0.005	−0.138**			
	(0.063)	(0.029)	(0.070)			
Tax Increase$_{t-6}$	−0.046	0.001	−0.047			
	(0.061)	(0.024)	(0.059)			
Regional Controls						
Unemployment Change$_{t-1}$	−0.135**	0.024	−0.159***	−0.139**	0.020	−0.159***
	(0.054)	(0.026)	(0.060)	(0.055)	(0.026)	(0.060)
Unemployment Change$_{t-2}$	0.062	−0.075***	0.138**	0.067	−0.069***	0.137**
	(0.051)	(0.025)	(0.057)	(0.051)	(0.025)	(0.057)
Observations	12,801	12,801	12,801	12,801	12,801	12,801
R-squared	0.223	0.231	0.117	0.222	0.230	0.117
TimeFE	Yes	Yes	Yes	Yes	Yes	Yes
RegionFE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster S.E. (State*Quarter)	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This Table illustrates the regression results assessing the impact of increases in the RETT on house price growth. The dependent variables are the quarterly growth rates of the quality adjusted prices per square meter, rents per square meter as well as the price-to-rent ratio. The variable of interest –Tax Increase– is an intensity measure capturing the level of changes in the RETT. We illustrate two different specifications. First, the event analysis in Columns (1) to (3) captures changes in the RETT by a lead variable, a contemporaneous indicator, and lagged variables for each quarter up to 6 quarters after the tax change. Columns (4) to (6) show the results of pre-post dummy specification assuming a constant effect for six quarters following a change in the RETT, Tax Increase$_{t-(1-6)}$. We also include year-on-year changes in the unemployment rate to account for the general macroeconomic trend at the regional level. Regional fixed effects at the county level and time fixed effects are included. Standard errors are clustered on the Federal State times quarter level. *Standard errors* in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: RETT increases. geographic location and the impact on hedonic price indices

	Urban Regions			Rural Regions		
	Price(%) (1)	Rent(%) (2)	Price-to-Rent(%) (3)	Price(%) (4)	Rent(%) (5)	Price-to-Rent(%) (6)
Tax Increase$_{t+1}$	0.069	−0.005	0.074	−0.184	−0.046	−0.140
	(0.069)	(0.030)	(0.061)	(0.131)	(0.037)	(0.143)
Tax Increase$_{t}$	−0.044	0.020	−0.065	−0.258**	−0.090**	−0.170
	(0.076)	(0.039)	(0.071)	(0.125)	(0.043)	(0.128)
Tax Increase$_{t-(1-6)}$	−0.155***	0.069**	−0.225***	−0.180***	−0.063*	−0.120**
	(0.060)	(0.031)	(0.060)	(0.049)	(0.034)	(0.057)
Regional Controls						
Unemployment Change$_{t-1}$	−0.187**	0.016	−0.204**	−0.100	0.034	−0.133
	(0.077)	(0.036)	(0.089)	(0.079)	(0.030)	(0.083)
Unemployment Change$_{t-2}$	0.078	−0.086**	0.164*	0.049	−0.058**	0.108
	(0.081)	(0.039)	(0.094)	(0.069)	(0.029)	(0.074)
Observations	3,555	3,555	3,555	9,246	9,246	9,246
R-squared	0.227	0.260	0.131	0.227	0.237	0.122
TimeFE	Yes	Yes	Yes	Yes	Yes	Yes
RegionFE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster S.E. (State*Quarter)	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This Table illustrates the regression results assessing the impact of increases in the RETT on house price growth respective to regional typology. The dependent variables are the quarterly growth rates of the quality adjusted prices per square meter, rents per square meter as well as the price-to-rent ratio. The variable of interest –Tax Increase– is an intensity measure capturing the level of changes in the RETT by a lead variable, a contemporaneous indicator, and lag variable measuring the effect of a change in the RETT for six quarters following the tax change. In Columns (1) to (3), we illustrate the effects of RETT increases in urban (county-free cities) housing markets. Columns (4) to (6) show the effects in rural housing markets. We also include year-on-year changes in the unemployment rate to account for the general macroeconomic trend at the regional level. Regional fixed effects at the county level and time fixed effects are included. Standard errors are clustered on the Federal State times quarter level. *Standard errors* in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: IV-Regressions: The effect of house price growth on mortgage lending growth

	OLS			IV		
	Total	Urban	Rural	Total	Urban	Rural
$\Delta \hat{Price}_{t-1}$	0.043*	0.126*	0.019	1.365**	1.534	1.193*
	(0.025)	(0.068)	(0.068)	(0.626)	(5.038)	(0.661)
Bank Controls						
Log Total assets$_{t-1}$	−12.07***	−10.96***	−12.40***	−11.97***	−10.92***	−12.27***
	(1.501)	(1.640)	(1.629)	(1.211)	(3.186)	(1.319)
Equity Ratio$_{t-1}$	−0.617***	−0.603***	−0.580***	−0.618***	−0.536**	−0.606***
	(0.096)	(0.177)	(0.129)	(0.106)	(0.259)	(0.141)
Securities Ratio$_{t-1}$	0.013	0.044**	0.006	0.007	0.033	0.002
	(0.009)	(0.019)	(0.010)	(0.012)	(0.048)	(0.012)
Liquidity Ratio$_{t-1}$	−0.005***	−0.003	−0.006***	−0.005***	−0.005	−0.006***
	(0.002)	(0.004)	(0.002)	(0.002)	(0.010)	(0.002)
Deposits Ratio$_{t-1}$	−0.089***	−0.058**	−0.097***	−0.091***	−0.067	−0.096***
	(0.017)	(0.039)	(0.019)	(0.018)	(0.044)	(0.021)
Observations	48,865	9,176	39,689	48,865	9,176	39,689
R-Squared	0.096	0.103	0.092			
Kleibergen Paap F-stat				12.59	1.216	11.63
Cragg- Donald F-stat				81.54	4.753	78.33
TimeFE	Yes	Yes	Yes	Yes	Yes	Yes
RegionFE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster S.E. (County*Quarter)	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the regression results estimating the effect of changes in house price growth on mortgage lending growth. Column (1) to (3) contain the results from OLS regressions with the lag of the hedonic house price index in the region, where bank b is located, serving as the key variable of interest. To circumvent the endogeneity problem between mortgage lending and house prices, we conduct IV-regressions reported in Columns (4) to (6) using changes in the RETT as a predictor for the growth rate of the hedonic house price index, $\Delta \hat{Price}_{t-1}$. The results presented in Columns (4) to (6) contain the 2^{nd}-stage estimations explainig the growth rate of mortgage lending. Bank-specific control variables, bank fixed-effects as well as time fixed-effects are included. Since the RETT remained unchanged in Bavaria and Saxoy, the analysis does not contain observations of banks located in these federal states. Due to the difference in sample dimensions between the first and second stage of the IV regression, we bootstrap our results using 1,000 iterations. The reported estimates are dervived by the mean coefficient, whereas the standard errors are determined by the variance of the cofficient estimates across the 1,000 iterations. Given the skewness of the Kleibergen-Paap and Cragg-Donald F-stat for the 1^{st}-stage results, we report the median value of the corresponding statistics among the 1,000 iterations. *Standard errors* in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: IV-Regressions: The effect of house price growth on mortgage lending growth conditional on bank capitalization and geographic location

	Mortage Lending Growth				
	(1)	(2)	(3)	(4)	(5)
$\Delta \hat{Price}_{t-1}$	0.648**	1.371***	0.787***	-0.055	-0.885
	(0.270)	(0.384)	(0.309)	(1.449)	(1.246)
$\text{Rural}_b * \Delta \hat{Price}_{t-1}$	0.662***		0.568*		2.134**
	(0.237)		(0.291)		(1.073)
$\text{Low}_{t-1} * \Delta \hat{Price}_{t-1}$		-0.299	-0.362		
		(0.303)	(0.302)		
$\text{Rural}_b * \text{Low}_{t-1} * \Delta \hat{Price}_{t-1}$			0.333		
			(0.598)		
$\text{Equity Ratio}_{t-1} * \Delta \hat{Price}_{t-1}$				0.219	0.286
				(0.227)	(0.224)
$Rural * \text{Equity Ratio}_{t-1} * \Delta \hat{Price}_{t-1}$					-0.266
					(0.192)
Low_{t-1}		0.271	0.191		
		(0.333)	(0.536)		
$Rural * \text{Low}_{t-1}$			-0.106		
			(0.737)		
$\text{Log Total assets}_{t-1}$	-11.99***	-12.06***	-12.02***	-12.20***	-12.03***
	(1.501)	(1.519)	(1.531)	(1.534)	(1.509)
$\text{Equity Ratio}_{t-1}$	-0.616***	-0.640***	-0.622***	-0.831***	-0.703***
	(0.097)	(0.104)	(0.107)	(0.248)	(0.161)
$\text{Securities Ratio}_{t-1}$	0.006	0.007	0.006	0.004	0.006
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
$\text{Liquidity Ratio}_{t-1}$	-0.006***	-0.006***	-0.005***	-0.006***	-0.005***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$\text{Deposits Ratio}_{t-1}$	-0.084***	-0.089***	-0.083***	-0.082***	-0.083***
	(0.017)	(0.017)	(0.017)	(0.019)	(0.017)
Observations	48,865	48,865	48,865	48,865	48,865
Time FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
Clustered S.E. (County*Quarter)	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the regression results estimating the effect of changes in house price growth on mortgage lending growth conditional on bank capitalization and their geographic location. To circumvent the endogeneity problem between mortgage lending and house prices, we conduct IV-regressions using changes in the RETT as a predictor for the growth rate of the hedonic house price index, $\Delta \hat{Price}_{t-1}$, conditional on bank capitalization and their geographic location. The geographic location is captured by a dummy variable, *Rural*, equal to 1 when the bank is located in a rural region (non county-free city). Bank capitalization is measured in two ways. The variable Low_{t-1} is a time-varying dummy variable indicating a bank below the bottom (P25) capitalization quartile. The variable $Equity\ Ratio_{t-1}$ is a continuous measure of bank capitalization. To avoid misspecifications in the 2^{nd}-stage, each variable containing the house price index needs to be estimated in a separate 1^{st}-stage regression. The corresponding predicted values enter the 2^{nd}-stage as Bartik instruments. Bank characteristics as well as fixed effects at the bank and time level are included as control variables. The results presented contain the 2^{nd}-stage estimations explaining the growth rate of mortgage lending. Since the RETT remained unchanged in Bavaria and Saxony, the analysis does not contain observations of banks located in these federal states. Due to the difference in sample dimensions between the first and second stage of the IV regression, we bootstrap our results using 1,000 iterations. The reported estimates are derived by the mean coefficient, whereas the standard errors are determined by the variance of the coefficient estimates across the 1,000 iterations. Given the skewness of the Kleibergen-Paap and Cragg-Donald F-stat estimated for the 1^{st}-stage results, we report the median value of the corresponding statistics among the 1,000 iterations. *Standard errors* in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

A Online Appendix: The RETT, macroprudential policy, and mortgage lending

As outlined by Kelly et al. (2018), a household's credit access, CA, for a mortgage is determined by the minimum of three credit conditions: loan-to-value (LTV), debt-service-to-income (DSTI), and loan-to-income (LTI).

$$CA = Min(Loan_{DSTI}, Loan_{LTI}, Loan_{LTV}) \tag{12}$$

As we investigate the impact of changes in the RETT on mortgage credit, it is straightforward to focus on the only credit constraint affected by transaction costs, namely the LTV constraint which we set equal to the loan volume $Loan_{i,r,t}$. Hence, the maximum loan for household i depends on its down-payment, $D_{i,r,t}$, and a maximum LTV ratio, $\overline{LTV}$,

$$Loan_{i,r,t} = \frac{D_{i,r,t}}{1-\overline{LTV}} - D_{i,r,t} = D_{i,r,t} * \frac{\overline{LTV}}{1-\overline{LTV}}. \tag{13}$$

The maximum loan, $Loan_{i,r,t}$, and the down-payment, $D_{i,r,t}$, are used to pay the price of a dwelling $P_{i,r,t}$.

$$P_{i,r,t} = D_{i,r,t} + Loan_{i,r,t} \tag{14}$$

The down-payment of household i is determined by its financial assets $F_{i,r,t}$ minus the transaction costs related to the purchase of the real estate. The latter is the product of the price of the dwelling $P_{i,r,t}$ times a fraction required to cover the costs related to the its purchase, $\theta_{r,t}$. The fraction includes fees for the broker (about 3.5% of the transaction price), the notary (about 1%), and for the entry to the land register (about 0.5%), which sum up in Germany to about 5% of the transaction price, as well as the RETT, $\tau_{r,t}$ (see e.g. Voigtländer, 2016).

$$D_{i,r,t} = F_{i,r,t} - P_{i,r,t} * \theta_{r,t} \tag{15}$$

First, we insert (15) into (14) leading to:

$$P_{i,r,t} = F_{i,r,t} - P_{i,r,t} * \theta_{r,t} + Loan_{i,r,t} \Rightarrow Loan_{i,r,t} = P_{i,r,t}(1+\theta_{r,t}) - F_{i,r,t}. \tag{16}$$

Then, (15) and (16) are inserted into (13).

$$\begin{aligned}
P_{i,r,t}(1+\theta_{r,t}) - F_{i,r,t} &= (F_{i,r,t} - P_{i,r,t}) * \theta_{r,t} * \frac{\overline{LTV}}{1-\overline{LTV}} \\
P_{i,r,t}(1+\theta_{r,t}) + P_{i,r,t}\theta_{r,t}\frac{\overline{LTV}}{1-\overline{LTV}} &= F_{i,r,t} + F_{i,r,t} * \frac{\overline{LTV}}{1-\overline{LTV}} \\
\frac{P_{i,r,t}(1+\theta_{r,t})(1-\overline{LTV}) + P_{i,r,t}\theta_{r,t}\overline{LTV}}{1-\overline{LTV}} &= \frac{F_{i,r,t}(1-\overline{LTV}) + F_{i,r,t}\overline{LTV}}{1-\overline{LTV}} \\
P_{i,r,t}(1-\overline{LTV}+\theta_{r,t}) &= F_{i,r,t} \\
P_{i,r,t} &= \frac{F_{i,r,t}}{1-\overline{LTV}+\theta_{r,t}}
\end{aligned} \tag{17}$$

In order to derive the maximum loan volume,$Loan_{i,r,t}$, we insert (15) and (17) into (13).

$$\begin{aligned} Loan_{i,r,t} &= (F_{i,r,t} - P_{i,r,t}\theta_{r,t})\frac{\overline{LTV}}{1-\overline{LTV}} \\ &= (F_{i,r,t} - \frac{F_{i,r,t}\theta_{r,t}}{1-\overline{LTV}+\theta_{r,t}})\frac{\overline{LTV}}{1-\overline{LTV}} \\ &= F_{i,r,t}\frac{1-\overline{LTV}}{1-\overline{LTV}+\theta_{r,t}}\frac{\overline{LTV}}{1-\overline{LTV}} \\ &= F_{i,r,t}\frac{\overline{LTV}}{1-\overline{LTV}+\theta_{r,t}} \end{aligned} \tag{18}$$

B Online Appendix: Robustness

B.1 Hedonic House Price Index vs Statistical Averages

Instead of using a quality adjusted house price index, we specify here observed statistical averages at the NUTS-3 level based on the raw listing data instead of the hedonic price indices developed in Section 2.2.1. Table A.2 show the regression outcomes of Equation (5) using the observed averages for prices, rents and the price-to-rent ratio. These estimates indicate no statistically significant effect of the tax regime on house prices. The specification of a RETT change indicator variable instead of the intensity of tax changes does not affect the results qualitatively and is available upon request.

We conclude that a rigorous (fiscal) policy evaluation thus necessitates the development of more sophisticated house price indices that gauge sample size changes, quality adjustments, time, and stratification effects.

B.2 Gauging RETT changes with an indicator

The variable $TaxIncrease$ is an intensive measure of the level of the tax change. This metric gauges more information than a dummy variable, since we have increases ranging from 0.5% to 1.5%. It also eases the interpretation of economic significance because we can associate a tax increase of 1% to a quantifiable change in house prices. At the same time, the more important effect on regional real estate markets maybe the signal sent by state government that the fiscal policy stance changed. In that case, the mere existence of a change conditional on other (un)observable state-specific traits may be decisive for the effectiveness of RETT changes.

Therefore, Table A.3 illustrates the sensitivity of our headline results towards choosing an indicator versus a continuous tax change variable, the specification of regional fixed effects, and the inclusion of observable county-level macro conditions gauged by changes in the unemployment rate.

The empirical results are shown here for the full sample and the price-to-rent ratio specified as the dependent variable. They are qualitatively very similar to those reported in Table 3. This also holds for the subsamples and the other outcome variables, which are available upon request.

B.3 Fiscal placebo shocks

To scrutinize the findings of Table 2, we run placebo regressions with random treatments at random time stamps and treatment groups. Table A.4 shows the regression outcomes of 1000 bootstrap "random treatment" estimations.

-Table A.4 around here-

We choose to run 1000 arbitrary simulations to approximate the coefficient estimates of 16^{26} (16 Federal states, 27 times the tax was increased) possible treatment combinations. The bootstrap simulations illustrate that coefficients converge after approximately 40-60 iterations. In each simulation, random federal states implement a tax increase of 0.5%–1.5% at random periods. The actually treated regions serve as not-treated control groups. This outcome corroborates our headline results in Table 2. The insignificant estimates strongly suggest that the dampening effect of RETT hikes on hedonic HPI is not a statistical artifact.

B.4 Determinants of RETT changes

In a next step, we test the exogeneity of changes in the RETT from the development of previous house prices. As the level of the RETT is determined at the federal state level, we conduct a panel regression at the level of federal states explaining the level of the RETT. The fixed-effect regression can be expressed as follows:

$$TaxRate_{f,y} = \alpha_f + \alpha_y + \beta_1 \ln HousePrice_{f,y-1} + \beta_2 \ln Debt\ p.c._{f,y-1} + \beta_3\ last\ election + e_{y,t} \tag{19}$$

with $TaxRate_{f,y}$ capturing the level of the RETT in percentage points in federal state f in year y. The key variable of interest, $\ln HousePrice_{f,y-1}$, measures the lagged logartihm of the population-weighted average value of the hedonic house price indices of the NUTS-3 regions located in the corresponding federal state. The relegation of the RETT to the federal state level was part of a larger effort to provide states with means to consolidate their public budgets. Hence, we include the federal states' debt per capita ratio as a control variable, which is provided by the German Federal Ministry of Finance at an annual frequency. The panel regression is implemented at an annual level. The model further contains dummy variables with respect to the number of years since the last election in the corresponding federal state with the election year serving as the benchmark. We also specify fixed effects at the level of federal states α_f, year dummies α_y and standard-errors clustered at the level of federal states.

-Table A.5 around here-

The results of the panel regression are reported in Table A.5. The key variable of interest, $\ln HousePrice_{f,y-1}$, as well as the fixed effects are included in each specification. The estimates clearly show that the level of the RETT is not affected by the previous development of the housing market. The debt per capita indicator is included in column (2) and (4) with estimates suggesting that an increase in the federal states' debt may induce a rise in the RETT. The estimates with respect to the time since last election provide a small indication that governments do not increase the RETT in years of election.

B.5 Comparing contiguous counties

The staggered scheme of increases in the RETT prevents a classical differences-in-differences setup for a sample of all German regions for three reasons. First, the tax was increased in 14 out of 16 federal states leading to a relatively small control group. Second, across federal states the RETT was increased at different points in time. Third, several federal states raised the RETT multiple times. Therefore, the main analysis of RETT hike effects on regional housing markets presented in section 3.1 is based on an event analysis. Yet, the comparison between a subset of very similar regions may sharpen our attempt to identify causal effects of RETT changes. We therefore sacrifice some external validity and focus in this appendix on regional real estate markets located in the federal states of Baden-Württemberg and Bavaria.

In Bavaria, the RETT remained at 3.5% whereas it was increased from 3.5% to 5% in Baden-Württemberg in November 2011. It was the only increase of the RETT in one of the two federal states, which are both relatively large. Baden-Württemberg has slightly more than 11 million inhabitants living in 44 NUTS-3 regions, whereas Bavaria consists of 96 NUTS-3 regions with nearly 13 million inhabitants.[18] Both states are located in the south of Germany and share a common border of 829 km (Gebhardt, 2008, see p.45) with 10 NUTS-3 regions in Baden-Württemberg and 13 regions in Bavaria. Beyond common geographic characteristics, the economic figures are very similar between both federal states. In 2018, the unemployment rates in both federal states were the lowest in Germany with 2.2% in Bavaria and 2.5% in Baden-Württemberg, whereas the national unemployment rate was at 3.8%.[19] Except for the three German city-states, GDP per capita reaches the highest figures in Bavaria (EUR 46,100) and Baden-Württemberg (EUR 45,200). Hence, this setting lends itself to a classical diff-in-diff set up with sufficiently many observations, in which real estate located in Baden-Württemberg is treated and Bavarian ones are the control group.

To test whether the dependent variable (house prices) is exposed to a common trend in both groups before the RETT hike in Baden-Württemberg in November 2011, consider Graphs A.1 and A.2 as well as Table A.6. The latter shows that house price growth in all Bavarian regions was significantly higher prior the tax increase, which is also illustrated in Graph A.2. Hence, a classical diff-in-diff analysis might lead to biased estimates. In contrast, for the subsample of NUTS-3 regions located at the border between both federal states the common trend of house price growth seems to hold. Until 2011 house price growth between the treated regions in Baden-Württemberg did not differ significantly from the growth rates in the control regions in Bavaria. In the first two years after the tax increase, house price growth in Bavaria was significantly above the average growth rate in Baden-Württemberg. This observation would be in-line with the economic expectation that a tax increase leads to lower house prices in the treated regions.

Differences between the sub-sample of contiguous regions and the subsample of all regions located in the two federal states may reflect heterogeneity in the regional housing markets within states. This heterogeneity is especially pronounced in Bavaria. According to the hedonic price index described in section 2.2.1, the seven most expensive NUTS-3 regions are located in the area of Munich with each exceeding a square-meter-price of EUR

[18] See 2018 figures provided by eurostat regional database, *demo_r_d2jan*.
[19] See 2018 figures provided by eurostat regional database, *lfst_r_lfur2gac*.

5,000 in 2017. In these regions house prices nearly doubled in comparison to the prices in 2010. At the same time, northern regions in Bavaria located at the former inner-German border exhibit among the lowest real estate prices in Germany. In 2017, average house prices per m^2 remained below the value of EUR 1,000 and had hardly experienced any increase with respect to the house price values in 2010. Given this important intra-state price dispersion, we focus on contiguous regions, which also reduces the vulnerability to regional shocks. We implement the diff-in-diff analysis for all and contiguous counties in the two states as follows:

$$\ln P_{r,t} = \alpha_r + \alpha_t + \beta Treatment_{r,t} + \sum_{i=1}^{2} \gamma_i \Delta Unemployment_{r,t-i} + e_{r,t}. \tag{20}$$

The log of regional house prices $P_{r,t}$ is the dependent variable. $Treatment_{r,t}$ denotes the main variable of interest, namely the magnitude of the tax increase in percentage points of 1.5 so as to interpret β as an elasticity. We also specify two lags of regional unemployment rate changes as well as time and regional fixed effects. For each subsample, the regression is implemented three times: (i) an unweighted scheme, (ii) using the regions' population figures of the year 2010 as weights, (iii) weights obtained from a weighting procedure coping with the potential violation of the common trend assumption, which is more relevant for the subsample of all 140 regions located in both federal states. To ensure sufficiently similar house price growth before the policy shock between both groups of dwellings, we assign weights to the control group by means of entropy balancing (see Hainmueller, 2012). These weights may take only non-negative values for the control group, leading to similar values of the variable of interest; in our case the average growth rate of house prices. The weights obtained for the pre-treatment year 2010 are used for the analysis with the period of investigation from 2008 until 2017. The average growth rate of house prices in Bavaria is 0.54 for the sub-sample of contiguous regions and 0.569 for the subsample using all 140 regions (see Table A.6).

Estimation results are shown in Table A.7. Without weights, the estimates for contiguous regions suggest that a one percentage point RETT increase reduces regional house prices by about 1.2%. For all 140 regions, the coefficient estimate is twice as large with a value of 2.5%, which may be biased though given the violation of the common trend assumption. This bias is supported by the more pronounced elasticity when accounting for the population size. This weighting scheme assigns higher weights to larger cities, such as Munich, which experienced very strong real estate price appreciation. When controlling for the violation of the common trend by means of entropy balancing, the elasticity shrinks to a value of about 2. This value is still above the estimates based on the sub-sample of contiguous regions. Accounting for the population size, a one percentage point increase in the RETT induces a decline of house prices by 0.5%, while the specification based on balancing weights suggests a drop of 1.6%.

Overall, a one percentage point increase in the real estate transfer tax induces a decline of regional house prices of slightly more than 1%. Hence, this conservative identification strategy yields strikingly similar results compared to the event analysis in Section 3.1.

C Online Appendix Tables

Table A.1: Variable definition

Variable name	Source	Unit Frequency	Level	Description
Primary dependent variables: House Prices				
Price to Rent ratio	Immobilienscout	Levels Quarterly(2008-2017)	County(Kreis)	Own calculations; Detailed Information in Section 2.2.1
Alternative dependent variables: Household lending				
Total Household Lending	BISTA	Levels Monthly(1999-2017)	Bank	Balance sheet information on collateralized household lending
Mortgage Lending	BISTA	Levels Monthly(1999-2017)	Bank	Balance sheet information on collateralized household lending
Unsecured Lending	BISTA	Levels Monthly (1999-2017)	Bank	Balance sheet information on non-collateralized household lending
Bank Controls lagged by one quarter				
Bank Size	BISTA	Levels Monthly(1999-2017)	Bank	Total assets minus total loans
Deposits Ratio	BISTA	Ratio Monthly(1999-2017)	Bank	Total deposits over total assets
Equity Ratio	BISTA	Ratio Monthly(1999-2017)	Bank	Total capital over total assets
Liquidity Ratio	BISTA	Ratio Monthly(1999-2017)	Bank	Cash on Hand over total assets
Securities Ratio	BISTA	Ratio Monthly(1999-2017)	Bank	Total securities over total assets
Regional Macro-Aggregates				
Rate of the RETT	Official Announcement of Federal State governments	Levels Monthly	Federal States	Real estate transfer tax
Unemployment	Federal Employment Agency	Levels Quarterly(2009-2017)	County(Kreis)	Regional Unemployment Rate
Debt per capita	German Federal Ministry of Finance	Ratio Annual	Federal States	Federal state's public debt per capita

This Table shows definitions and sources of the variables. Acronym for BISTA stands for Monatliche Bilanzstatistik; provided by the Deutsche Bundesbank.

Table A.2: RETT increases, geographic location and the impact on observed house prices

	Total Sample			Urban Regions			Rural Regions		
	Price to Rent(%)	Price(%)	Rent(%)	Price to Rent(%)	Price(%)	Rent(%)	Price to Rent(%)	Price(%)	Rent(%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Tax Increase$_t$	0.000	−0.003	−0.003*	−0.006	−0.007	−0.001	0.004	−0.000	−0.004*
	(0.004)	(0.004)	(0.002)	(0.006)	(0.005)	(0.003)	(0.005)	(0.004)	(0.002)
Tax Increase$_{t-1}$	0.001	−0.001	−0.003	0.007	0.005	−0.003	−0.001	−0.003	−0.002
	(0.006)	(0.005)	(0.002)	(0.008)	(0.006)	(0.003)	(0.008)	(0.008)	(0.002)
Tax Increase$_{t-2}$	−0.000	−0.000	−0.000	−0.004	−0.003	0.001	0.002	0.002	−0.001
	(0.005)	(0.005)	(0.002)	(0.007)	(0.006)	(0.003)	(0.007)	(0.007)	(0.002)
Tax Increase$_{t-3}$	−0.008	−0.007	0.001	−0.008	−0.004	0.004*	−0.008	−0.008	−0.000
	(0.006)	(0.006)	(0.002)	(0.009)	(0.010)	(0.002)	(0.007)	(0.007)	(0.002)
Tax Increase$_{t-4}$	−0.002	−0.004	−0.003	−0.007	−0.010	−0.003	0.000	−0.002	−0.002
	(0.006)	(0.006)	(0.002)	(0.009)	(0.007)	(0.004)	(0.008)	(0.008)	(0.003)
Tax Increase$_{t-5}$	−0.002	−0.001	0.002	−0.001	0.004	0.006**	−0.002	−0.002	0.000
	(0.008)	(0.008)	(0.002)	(0.011)	(0.011)	(0.002)	(0.010)	(0.010)	(0.002)
Tax Increase$_{t-6}$	−0.003	−0.005	−0.002	−0.005	−0.007	−0.002	−0.002	−0.004	−0.002
	(0.006)	(0.006)	(0.002)	(0.010)	(0.011)	(0.003)	(0.007)	(0.007)	(0.002)
Regional Controls									
Unemployment Change$_{t-1}$	0.005	0.004	−0.001	0.006	0.005	−0.001	0.004	0.003	−0.000
	(0.004)	(0.004)	(0.001)	(0.006)	(0.006)	(0.002)	(0.006)	(0.005)	(0.002)
Unemployment Change$_{t-2}$	−0.002	−0.002	−0.001	−0.004	−0.004	−0.000	−0.001	−0.002	−0.000
	(0.004)	(0.004)	(0.001)	(0.006)	(0.006)	(0.002)	(0.006)	(0.005)	(0.002)
Observations	12801	12801	12801	3555	3555	3555	9246	9246	9246
R-Squared	0.024	0.032	0.019	0.030	0.031	0.055	0.030	0.040	0.016
TimeFE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
RegionFE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Cluster S.E. (State*Quarter)	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Notes: This Table illustrates the regression results of an event analysis assessing the impact of increases in the RETT on the growth on house price growth respective to regional typology. The dependent variables are the quarterly growth rates of the observed prices per square meter, rents per square meter as well as the price-to-rent ratio. The variable of interest –Tax Increase– is an intensity measure capturing the level of changes in the RETT by a a contemporaneous indicator and lagged variables for each quarter up to 6 quarters after the tax change. In Columns (1) to (3), we illustrate the effects of RETT increases in urban (county-free cities) housing markets. Columns (4) to (6) show the effects in rural housing markets. We also include year-on-year changes in the unemployment rate to account for the general macroeconomic trend at the regional level. Regional fixed effects at the county level and time fixed effects are included. Standard errors are clustered on the Federal State times quarter level. *Standard errors* in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.3: RETT increases and the impact on the Price-to-Rent Ratio (Dummy vs Intensity Measure)

	Dummy Specification			Intensity Specification		
	(1)	(2)	(3)	(4)	(5)	(6)
Tax Increase$_{t+1}$	−0.129	−0.085	−0.086	−0.096	−0.080	−0.082
	(0.130)	(0.127)	(0.127)	(0.108)	(0.104)	(0.104)
Tax Increase$_{t}$	−0.211	−0.175	−0.174	−0.159	−0.143	−0.141
	(0.132)	(0.127)	(0.127)	(0.105)	(0.100)	(0.100)
Tax Increase$_{t-1}$	−0.213*	−0.175	−0.169	−0.165*	−0.147*	−0.142*
	(0.114)	(0.107)	(0.108)	(0.089)	(0.082)	(0.082)
Tax Increase$_{t-2}$	−0.183	−0.146	−0.140	−0.142	−0.124	−0.118
	(0.125)	(0.122)	(0.121)	(0.100)	(0.096)	(0.095)
Tax Increase$_{t-3}$	−0.270**	−0.233**	−0.235**	−0.216***	−0.198**	−0.187**
	(0.104)	(0.106)	(0.106)	(0.081)	(0.081)	(0.081)
Tax Increase$_{t-4}$	−0.266***	−0.242**	−0.246**	−0.209**	−0.195**	−0.187**
	(0.093)	(0.101)	(0.101)	(0.092)	(0.077)	(0.077)
Tax Increase$_{t-5}$	−0.199**	−0.176*	−0.179*	−0.151**	−0.138**	−0.132*
	(0.078)	(0.092)	(0.053)	(0.060)	(0.070)	(0.069)
Tax Increase$_{t-6}$	−0.090	−0.070	−0.072	−0.059	−0.047	−0.047
	(0.072)	(0.083)	(0.082)	(0.053)	(0.060)	(0.059)
Regional Controls						
Unemployment Change$_{t-1}$			−0.163***			−0.159***
			(0.060)			(0.060)
Unemployment Change$_{t-2}$			0.144*			0.138**
			(0.056)			(0.057)
Observations	12801	12801	12801	12801	12801	12801
R-Squared	0.062	0.116	0.117	0.062	0.116	0.117
TimeFE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
RegionFE	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*
Cluster S.E. (State*Quarter)	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Notes: This Table shows the regression results of increases in the RETT on the price-to-rent ratio. The dependent variable is the regional price-to-rent ratio. Columns (1) to (3) report the result using dummy indicatior for changes in the RETT, while Columns (4) to (6) capture the intensity of the tax increase in percentag points. Year-on-year changes in the unemployment rate are included in the specifications reported in Columns (3) and (6). Regional fixed effects at the county level are included in the specifications reported in Columns (2), (3), (5), and (6). Time fixed effects are included in each specification. Standard errors are clustered on the Federal State times quarter level. *Standard errors* in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.4: RETT Increase effects on the Hedonic Price Indices for Prices, Rents and the Price-to-Rent ratio - Random Treatment

	Event Analysis			Pre-Post Dummy Analysis		
	Price(%) (1)	Rent(%) (2)	Price-to-Rent(%) (3)	Price(%) (4)	Rent(%) (5)	Price-to-Rent(%) (6)
Tax Increase$_{t+1}$	0.000	0.001	0.000	−0.000	0.000	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tax Increase$_{t}$	0.001	0.001	0.000	0.001	0.001	0.000
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Tax Increase$_{t-(1-6)}$				0.004	0.002	−0.002
				(0.001)	(0.000)	(0.000)
Tax Increase$_{t-1}$	0.003	0.002	−0.001			
	(0.001)	(0.001)	(0.000)			
Tax Increase$_{t-3}$	0.003	0.002	−0.001			
	(0.001)	(0.001)	(0.000)			
Tax Increase$_{t-4}$	0.003	0.001	−0.001			
	(0.001)	(0.001)	(0.000)			
Tax Increase$_{t-4}$	0.003	0.001	−0.002			
	(0.001)	(0.001)	(0.000)			
Tax Increase$_{t-5}$	0.004	0.001	−0.001			
	(0.001)	(0.001)	(0.000)			
Tax Increase$_{t-6}$	0.003	0.001	−0.001			
	(0.000)	(0.001)	(0.000)			
Regional Controls						
Unemployment Change$_{t-1}$	−0.092***	−0.085***	0.006	−0.091***	−0.077***	0.013
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Unemployment Change$_{t-2}$	0.056***	−0.000	−0.057***	0.089***	0.027*	−0.061***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: This Table illustrates the regression results assessing the impact of placebo increases in the RETT on house price growth. The results obtained from bootstrap regressions with 1000 simulations with *random treatments*. In each simulation, we include 27 tax increases with a magnitude of 0.5, 1.0, or 1.5 percentage points in random federal states at random periods. The coefficient estimate is calculated by the mean value across 1,000 estimates, the corresponding standard error is derived by the variance of the coefficient estimates. The dependent variables are the quarterly growth rates of the quality adjusted prices per square meter, rents per square meter as well as the price-to-rent ratio. The variable of interest –Tax Increase– is an intensity measure capturing the level of changes in the RETT. We illustrate two different specifications. First, the event analysis in Columns (1) to (3) captures changes in the RETT by a lead variable, a contemporaneous indicator, and lagged variables for each quarter up to 6 quarters after the tax change. Columns (4) to (6) show the results of pre-post dummy specification assuming a constant effect for six quarters following a change in the RETT, Tax Increase$_{t-(1-6)}$. We also include year-on-year changes in the unemployment rate to account for the general macroeconomic trend at the regional level. Regional fixed effects at the county level and time fixed effects are included. Standard errors are clustered on the Federal State times quarter level. *Standard errors* in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.5: Fixed-effect regression on the impact of house prices on RETT

Dep. Var. RETT in percentage points	(1)	(2)	(3)	(4)
ln $HousePrice_{f,t-1}$	-2.895	-2.367	-2.888	-2.344
	(1.922)	(1.757)	(1.966)	(1.805)
ln $Debt\ p.c._{f,t-1}$		1.239***		1.276***
		(0.183)		(0.180)
Time since last election. Year of election serving as baseline.				
one year since last election			0.142*	0.148*
			(0.073)	(0.073)
two years since last election			0.126	0.137
			(0.109)	(0.101)
three years since last election			0.194	0.245*
			(0.135)	(0.121)
four years since last election			0.124	0.142*
			(0.085)	(0.074)
Federal State FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Federal States	16	16	16	16
Observations	144	144	144	144
R-squared	0.752	0.792	0.757	0.798
Clustered S.E.- Federal State	yes	yes	yes	yes

Notes: This Table shows the regression results assessing the impact of regional house prices on the level of the RETT at the level of federal states. The dependent variable is the level of the RETT in percentage points. The key dependent variable, logarithm of the lagged average house price in federal state f, as well as regional fixed effects at the federal state level and year fixed effects are included in each specification. The house price in federal state f is determined by the population weighted annual average house price indices in the NUTS-3 regions located in the federal state of consideration. In Columns (2) and (4), we include the federal states debt per capita, whereas Columns (3) and (4) contain dummy variables capturing the time since last election. Standard errors are clustered at the federal state level. Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.6: Development of regional house prices in Baden-Württemberg and Bavaria

	Average quarterly house price growth in %					
	Contiguous regions (23)			All regions (140)		
	1	2	3	4	5	6
	BW	BY	diff.	BW	BY	diff.
2008	0.507	0.205	0.302	-0.511	-0.457	0.053
	(0.176)	(0.290)	(0.365)	(0.140)	(0.105)	(0.084)
2009	-0.118	-0.176	0.058	0.044	0.233	0.189**
	(0.118)	(0.134)	(0.185)	(0.059)	(0.055)	(0.091)
2010	0.540	0.356	0.185	0.569	0.901	0.332***
	(0.153)	(0.146)	(0.213)	(0.059)	(0.051)	(0.085)
2011	0.870	0.820	0.050	0.755	1.433	0.677***
	(0.133)	(0.121)	(0.180)	(0.057)	(0.059)	(0.095)
RETT was increased in Baden-Württemberg in November 2011						
2012	1.106	1.750	0.645***	1.222	1.542	0.320***
	(0.134)	(0.152)	(0.210)	(0.068)	(0.064)	(0.105)
2013	0.933	1.411	0.479**	1.250	1.197	0.052
	(0.114)	(0.144)	(0.193)	(0.059)	(0.066)	(0.106)
2014	1.123	0.720	0.403*	1.239	1.201	0.037
	(0.128)	(0.172)	(0.226)	(0.063)	(0.070)	(0.111)
2015	2.297	1.678	0.619**	2.068	2.086	0.018
	(0.127)	(0.230)	(0.286)	(0.069)	(0.072)	(0.117)
2016	1.536	1.708	0.172	2.231	2.065	0.167
	(0.188)	(0.290)	(0.370)	(0.085)	(0.095)	(0.152)
2017	1.408	1.899	0.491	1.678	2.164	0.486*
	(0.366)	(0.470)	(0.626)	(0.165)	(0.184)	(0.294)
Regions	10	13		44	96	

Notes: This Table illustrates the differences in the house price index growth between Baden-Württemberg(BW) and Bavaria(BY) before and after a tax increase in BW in 2011. Columns (3) and (6) illustrate the t-test of mean difference between the two federal states. The tests are implemented for two subsamples. Columns (1) to (3) contain contiguous regions located at the border between Baden-Württemberg and Bavaria. Columns (4) to (6) contain all NUTS-3 regions located in Baden-Württemberg and Bavaria . *Standard errors* in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

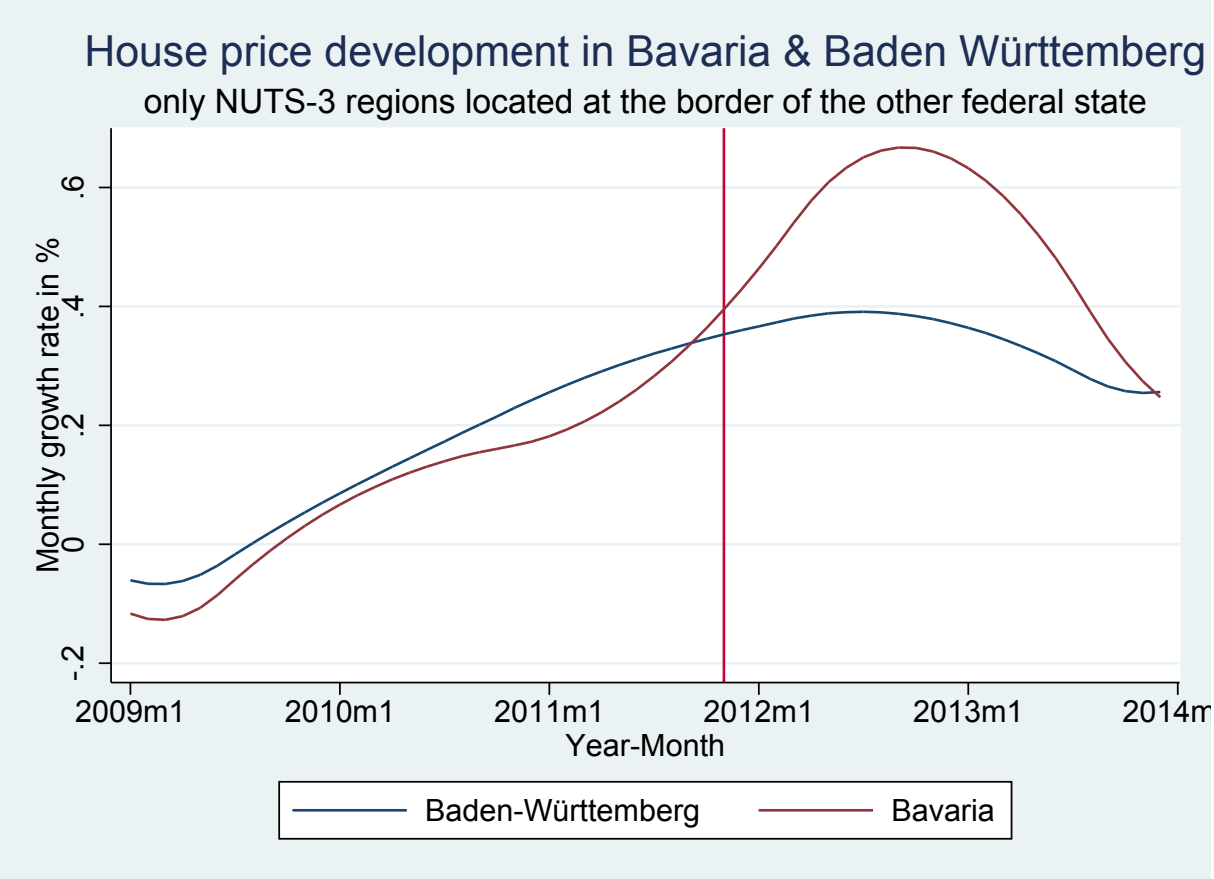
Table A.7: Differences-in-Differences regression on the effects of a RETT increase regional house price index levels between Baden-Württemberg and Bavaria

	Log levels of regional house price index					
	Contiguous regions			All regions		
,	(1)	(2)	(3)	(4)	(5)	(6)
Post-Tax Increase in BW in %	−1.168 * **	−0.459*	−1.662 * **	−2.532 * **	−4.126 * **	−2.006 * **
	(0.170)	(0.231)	(0.162)	(0.210)	(0.257)	(0.122)
Unemployment Change$_{t-1}$	−1.353	−0.532	−1.171	−0.696	−1.081	−0.766
	(1.554)	(1.519)	(1.459)	(0.667)	(0.848)	(0.559)
Unemployment Change$_{t-2}$	−0.404	−0.453	−0.554	0.323	−0.112	0.413
	(1.388)	(1.393)	(1.319)	(0.623)	(0.811)	(0.543)
Observations	759	759	759	4,620	4,620	4,620
R-squared	0.956	0.956	0.959	0.973	0.979	0.975
NUTS-3 Regions	23	23	23	140	140	140
Weights	*No*	*Pop*	*Ebal*	*No*	*Pop*	*Ebal*
Region FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Time FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Clustered S.E. (State*Quarter)	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Notes: This Table shows the regression results from differences-in-differences regressions on house prices in the federal states of Baden-Württemberg and Bavaria. The dependent variable is in levels of the quality adjusted house price index. The treatment variable is defined as the tax increase in Baden-Württemberg from 3.5% to 5% in November 2011. Hence, the variable takes the value of 1.5 in the post-treatment period. The analysis is implemented for two subsamples. Columns (1)to (3) contain only contiguous regions located at the border between both Baden-Württemberg and Bavaria. All NUTS-3 regions located in both Federal States are included in the regressions reported in Columns (4) to (6). The results for both subsamples are based on three regressions using different weighting schemes: unweighted, population weights(Pop) based on number of inhabitants in 2010, and weighting factors obtained from entropy balancing(Ebal) accounting for the growth rate of house prices in 2010. We also include quarterly unemployment changes from year to year. Regional fixed effects at the county level and time fixed effects are included. Standard errors are clustered on the Federal State times quarter level. *Standard errors* in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

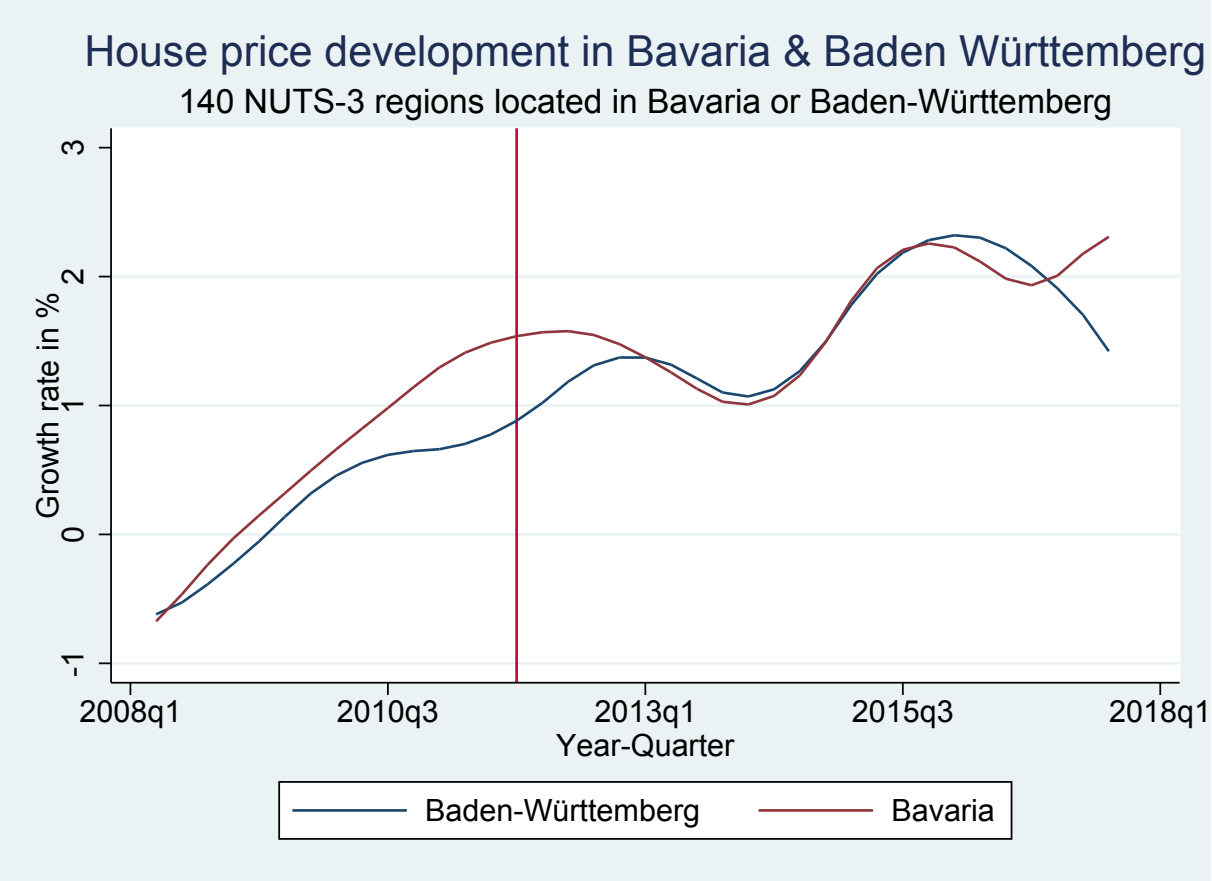
D Online Appendix Figures

Figure A.1: Quarterly HPI growth rate in contiguous regions in Baden Württemberg and Bavaria



Source: Immobilienscout24.de, own calculations

Figure A.2: Quarterly HPI growth rate of all regions in Baden Württemberg and Bavaria



Source: Immobilienscout24.de, own calculations