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The Prices of Residential Land in German Counties

Stefanie Braun
Gabriel S. Lee

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The Prices of Residential Land in German Counties*

Stefanie Braun
University of Regensburg
Universtitaetsstrasse 31
93053 Regensburg, Germany

Gabriel S. Lee
University of Regensburg
Universtitaetsstrasse 31
93053 Regensburg, Germany
And
Institute for Advanced Studies
Josefstaetterstr. 39
1080 Vienna, Austria
Contact Information:
Braun: + 49 941 943 5086; E-mail: stefanie.braun@ur.de
Lee: + 49 941 943 5060; E-mail: gabriel.lee@ur.de

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Abstract

We estimate changes in the value and price of residential land for 379 German counties ("Landkreise") from 2014 to 2017 using a total of 42,685 observations. We use the two-step residual method that decomposes the value of a home into the value of the structure and land value. Despite the short time series, we show that the price of residential land has become relatively more expensive in the majority of German counties. More specifically, we show that the cumulative change in land values varies between 9% and 171% (excluding Berlin with exorbitant high increases of 668% and Saarland with a decrease of 18%) from 2014 to 2017. On average, the home values increased by 30% and 15% for West and East Germany respectively, whereas the land values increased by 108% and 91% for West and East Germany. Our findings imply that cycles in the German land values are more likely to affect the evolution of house prices more in the future than they did in the past. Moreover, our estimated land prices vary significantly to the current land price valuation by one of the German state governments (Hessen).

- *JEL Classification:* R0; R11; R14; R21; R31
- *Keywords:* German Land prices; Land values; German Housing prices; Housing values; Construction costs; Replacement costs

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1 Introduction

Figure 1 shows the housing wealth (including both structures and land) of households and housing prices for Germany from 2003-2017.[1] Three salient facts in Figure 1 are first, housing accounts for 62% of national wealth in Germany at the end of 2017. Second, the housing prices have been sharply increasing in the last ten years. Lastly, the fraction of land in total wealth has been increasing over the last six years, but the fraction of dwellings' value in total wealth has been steadily decreasing. Moreover, boom and bust cycles in the housing sector occurred antecedent to several past great recessions and especially before the most recent financial crisis of 2008-2010. These facts suggest that house price changes may have significant effects on the German macroeconomy. As in Davis and Heathcote (2007) and Davis and Palumbo (2008) for the U.S., we also argue that the movements in the land - and structure values are crucial for understanding the development of German housing markets.

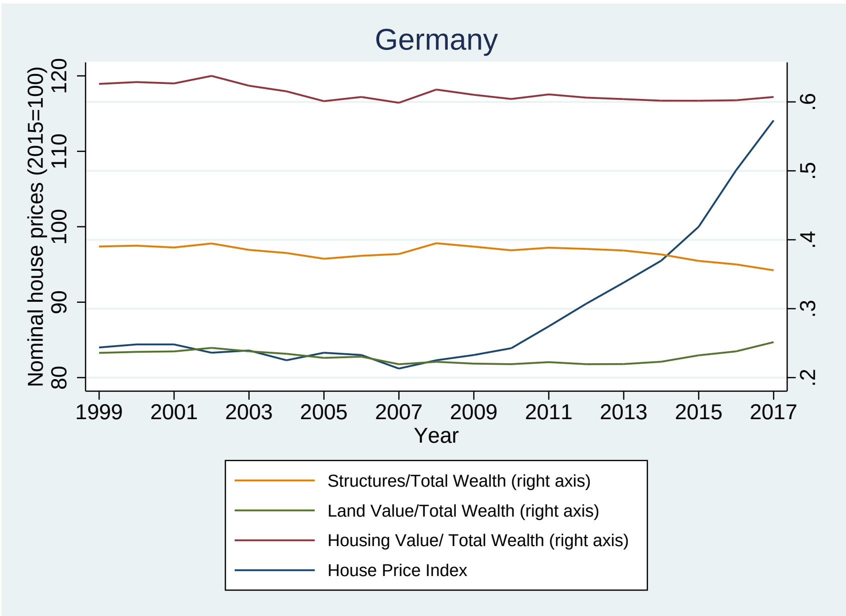

Figure 1: Housing Prices, Housing Wealth for Germany: 1999-2017 Annual

The objective of this paper is to estimate changes in the value and price of residential land for the 402 German counties ("Landkreise")[2] from 2012 to 2017. The framework of our approach is that of Davis and Heathcote (2007), who decompose the value of a home into the value of the structure and land value on the aggregate level for the U.S., and Davis and Palumbo (2008), who estimate the land prices for 46 large U.S. metropolitan areas. Previous works on German land prices such as Kolbe, Schulz, Wersing, and Werwatz (2012, 2015, and 2019) use land value assessment methods using transaction data from local surveyor commissions and focus only on the city of Berlin. Kolbe, Schulz, Wersing, and Werwatz (2012, 2015, 2019) generate highly correlated land value estimates to expert based assessments. However, most of their methods

[1]From the OECD national accounts data set, we construct the total national wealth as the sum of fixed non-financial assets and land, and the net financial wealth. For the housing wealth, we use the total values of dwellings and land.

[2]Official administrative boundaries as of 2014.

require high computational power suggesting that their methods are mostly applicable on a very local level. This paper, however, estimates German land prices on county levels using housing price indices.

Our motivation in estimating the German land prices on county levels using Davis and Palumbo (2008) framework is to provide a systematic method that can address and help the following issues in German housing markets. Germany uses two land value measurements. The first measurement bases on the statistics of purchased values of building land that reports purchase/selling prices and other characteristics of undeveloped land.[3] The second measurement uses the land reference values from the expert committees for land values.[4]

Consequently, existing large-scale measurements of land values in Germany only refer to undeveloped land or are estimated by local surveyor commissions in German counties and county-free cities with some inconsistent standards and time intervals. Hence, these measurements are not comparable for all single-/double family housing units throughout Germany. Subsequently, our residual method provides an unbiased estimate of land prices for single-/double family housing on the county level for the whole of Germany. Moreover, our land price estimates could further provide an alternate view for real estate market participants in evaluating the economic feasibility of their projects, and help policymakers in addressing some of the housing regulation laws. In particular, our estimates help to implement the current German property tax reform that requires a frequent, cost-effective land price valuation methodology.[5]

One of the main results from both Davis and Heathcote (2007) and Davis and Palumbo (2008) is that the prices of both components of the housing bundle evolve quite differently. Consequently, they shed light on the importance of distinguishing between the values of construction costs and residential land when analyzing home prices. Without the decomposition of housing prices, Davis and Palumbo (2008) argue that regression results from housing market-related variables on the fundamentals in determining housing prices can lead to misguiding conclusions. Furthermore, both Davis and Heathcote (2007)) and Davis and Palumbo (2008) show that land prices appear to be three times more volatile at business cycle frequencies than the value of the structural component. Moreover, the average share of a home's value attributed to residential land increased significantly between 1984 and 2004, and while the inflation-adjusted price of land increased by more than 400%, the price of housing structures appreciated by only 33%. Consequently, to estimate and identify land prices in a systematic method is crucial in understanding housing prices.

As with Davis and Palumbo (2008), we also show that despite the short time series, the price

[3]These statistics are available at the regional statistics website from the statistical offices of the German federation and countries under statistic number 61511.

[4]Two critiques on the expert valuation method. First, the method is extremely ad hoc. A second critique is that the valuation occurs irregularly: the vaulations are decided anually or biennially either on December 31st of the previous year or January 1st of the current year. (See Paragraph 196 BauGB).

[5]The calculation of the property tax is based on decades old property values. For West German countries, they are based on land values from 1964, and for East German countries on values of the year 1935. As land values have developed quite differently since these years, the deadline for a new regulation is set at December 31, 2019, in order to eliminate unequal tax treatment. If a new regulation is introduced by the end of 2019, then the old rules can still be applied until end of 2024. Starting 2025 the new legal regulation must then be used. (Source: Federal Ministry of Finance).

of residential land has become relatively more expensive in the majority of German counties. The counties around urban centers such as Munich, Stuttgart, Berlin, Hamburg, Dresden and the cities in the Ruhr area experienced the highest land price increases. But in general, an upward shift in home values, land values, and the share of residential land occured in almost every state. The most significant differences in the changes in land prices are between the new and old federal states of Germany. Although the differences in the average land's share of home value increased between East and West, the absolute differences in home values, the value of residential land, and replacement costs did not decrease. More specifically, the cumulative change in land values from 2014 to 2017 varies between 9% and 171% (excluding Berlin with exorbitant high increases of 668% and Saarland with a decrease of 18%). On average, the home values increased by 30% and 15% for West and East German counties respectively, whereas the land values increased by 108% and 91% for West and East Germany. Our findings imply that cycles in the German land values are likely to influence the evolution of house prices more in the future than they did in the past.

The next section briefly overviews the literature. We then outline the methodology in Section 3 as well as the detailed description of Davis and Heathcote (2007) and Davis and Palumbo (2008) version for Germany. Our empirical results and discussions are in Section 4. Section 5 concludes followed by the Appendix.

2 Literature Review

The literature on the estimation of land prices can broadly be attributed to two strands of literature. First, the residual method by Davis and Heathcote (2007) and Davis and Palumbo (2008) measures the price of land as the difference between housing value and the replacement cost of the structure. The second line of research follows spatial transaction based approaches that use data on sales of vacant land as in, for example, Albouy, Ehrlich, and Shin (2018), Nichols, Oliner, and Mulhall (2013) and Haughwout, Orr, and Bedoll (2008).

Davis and Heathcote (2007) and Davis and Palumbo (2008) decompose the value of a home into the value of the structure and land value, both on the aggregate level for the U.S. as well as for 46 large U.S. metropolitan areas. The two-step procedure calculates estimates of replacement costs of residential structures in a given base year and builds aggregate structure share for a given regional unit in that year. In the second step, the benchmark estimates for structures share and replacement costs are extrapolated, and the growth in land prices over the time series is derived. They show the importance of distinguishing between values of construction costs and residential land rather than using exclusively home prices in addressing macroeconomic and housing market implications.

Recent work by Davis, Oliner, Pinto, and Bokka (2017) extends the two-step residual method by focusing on new homes using proprietary data on zip-code level for the Washington DC metro area. By doing so, Davis et al. (2017) avoid estimating the depreciation of structure costs, and hence reducing the amount of estimation error. Using appraisal data for more than 900 counties, 8,000 ZIP codes and 11,000 census tracts in the United States, Davis, Larson, Oliner, and Shui (2019) further exclude homes with an effective age of more than ten years given the predictions of a calibrated option model of teardowns to ensure that market values are represented by estimated replacement cost. Davis et al. (2019) also account for the size of a lot when estimating land values to standardize land values to a per acre basis. They then apply spatial interpolation methods to estimate land prices also for housing units without appraisal reports.

The spatial transaction-based approaches, for example, by the aforementioned authors, use observed market price data on transactions of vacant or almost vacant land (for the U.S. mainly from the CoStar Group Inc.). They estimate land prices for either only one, several, or close to the universe of metropolitan areas in the U.S. Key assumption in these methods is that the closer land is to the city center, the more valuable it is. Typical findings of this literature are that land prices in the United States tend to be more volatile than structure prices, which likely arises from the fact that the supply of structures is much more elastic than the supply of land (e.g., Gyourko & Saiz, 2006). This finding supports the so-called land leverage hypothesis, which implies that home prices are more volatile in areas with a relatively large share of land value in housing value (e.g., Bostic, Longhofer, & Redfearn, 2007).

Kolbe et al. (2012, 2015, 2019) focus on German land prices. In particular, they present different land value assessment methods using transaction data from local surveyor commissions from Berlin, Germany. They use a semiparametric method to construct location values. First, they separate the house value into structure and land components. Second, using different non-parametric regression methods such as the adaptive weight smoothing approach, they separate the first stage residual into the location value and a noise term. In contrast to kernel regressions, for example, adaptive weight smoothing allows the location value surface to be determined entirely by the data. They generate highly correlated estimates with expert-based assessments.

3 Methods and Data

We follow Davis and Heathcote (2007) and Davis and Palumbo (2008) in constructing our land price index. For the expositional purpose, we briefly outline the method below. We then describe and present in detail how we merge different sources of data to compute annual time series estimates for the average value of land in German counties and county-free cities.

We start with the nominal market value of residential land at date t:

$$p_t^l l_t = p_t^h h_t - p_t^s s_t. \tag{1}$$

We denote p_t^l, p_t^h and p_t^s as the quality-adjusted prices per unit of land, houses and structures; and l_t,h_t and s_t represent the quality-adjusted quantities. Hence, $p_t^h h_t$ is the market value of the housing stock and $p_t^s s_t$ the replacement cost of stock of residential structures and "land" refers to everything that increases home value by more than the replacement cost.

Assuming that houses in a set observed over two successive periods do not change (i.e., structures and land are constant), we can express the growth rate in house prices using the decomposition from Equation (1) as

$$\frac{p^h_{t+1}h_t}{p^h_t h_t} = \frac{p^s_{t+1}s_t + p^l_{t+1}l_t}{p^h_t h_t} = \frac{p^s_t s_t(p^s_{t+1}/p^s_t) + p^l_t l_t(p^l_{t+1}/p^l_t)}{p^h_t h_t} = w^s_t \frac{p^s_{t+1}}{p^s_t} + w^l_t \frac{p^l_{t+1}}{p^l_t}, \tag{2}$$

where $w^s_t = \frac{p^s_t s_t}{p^h_t h_t}$ and $w^l_t = \frac{p^l_t l_t}{p^h_t h_t}$ are the shares of home value that are accounted for by replacement cost of structures and market value of land in period t, respectively. As these shares sum to one, we can rearrange Equation (2) to express the percentage changes of (constant-quality) land prices for a certain county i in period t as follows:

$$g^{lp}_{it+1} = \frac{1}{w^l_t}[g^{hp}_{it+1} - (1 - w^l_t)g^{cc}_{it+1}]. \tag{3}$$

where, g^{lp}_{it+1} is the value-weighted average growth rate of residential land containing the existing stock of homes in a county i between period t and $t+1$. It is important to note that the index is simply the growth rate of the price of all attributes (including location and amenities) that make the homes in a county more expensive than the replacement costs of their structures. It is, however, not a "euro-per-square-meter" concept. To estimate changes in residential land prices for German counties, we apply a two-step procedure similar to Davis and Palumbo (2008) to obtain time series for w^l_t and w^s_t. The next section describes in detail the procedure and data for Germany. However, in short, the first step involves estimating structures share at a benchmark date using real estate data for Germany. In the second step, given these estimated structure shares at a benchmark date, growth in construction cost and house prices, we apply the following dynamic equation to construct a time series of structure shares.:

$$w^s_{it} = w^s_{it-1}\left(\frac{g^{cc}_{it}}{g^{hp}_{it}}\right)\left(\frac{h_{it-1}}{h_{it}}\right) + \theta_{it}\frac{\Delta h_{it}}{h_{it}} \tag{4}$$

where, $g^{cc}_{it} = \frac{p^s_{t+1}}{p^s_t}$ is the growth rates in construction cost, $g^{hp}_{it} = \frac{p^h_{t+1}}{p^h_t}$ is the growth rate of house prices, $\frac{h_{it-1}}{h_{it}}$ is a proxy for the growth rate of real housing stock, and θ_t is a value for the structure intensity of nominal net new housing.

Some of the implications of Equation (4) are worthwhile noting. First, when there is no growth in the housing stock ($h_t = h_{t-1}$), then the structures share in period t equals the structures share of period $t-1$ adjusted for growth in construction cost relative to house prices. Second, for growing cities ($h_t > h_{t-1}$), the growth in construction cost relative to house prices is relatively less important in determining structures share of the next period. Instead, the structures share of new housing plays a larger role.

3.1 Benchmark Estimates for the Replacement Cost of Residential Structures: German Case

In this section, we describe our approach in computing the annual time series estimates for the average value of land in German counties and county-free cities. As described in the previous

Section, for each county, we use a two step estimation process following Davis and Palumbo (2008).

For our dataset, we use house price indexes for single- and double-family houses on the county and independent city level for the years 2007-2018 from vdp Research GmbH[6]. For the construction costs at the county level, we use data published by the BKI[7]. First, we use construction cost data per square meter of single- and double-family houses from 2016 (BKI, 2016). Second, we use BKI construction cost regional factors for German counties from 2012 to 2019[8].

In the first step, we combine microdata for key housing variables from the ImmobilienScout24 website with data on construction cost from the Construction Cost Information Centre of German Chambers of Architects GmbH (BKI)[9]. The goal of this first step, for each county, is to generate a benchmark estimate of the replacement cost of single-/double-family, owner-occupied residential structures and a corresponding share of home values that are represented by the value of residential structures. [10]

For our estimation, we use a total of 42,685 observations that met all of our selection criteria. Table 1 shows the summary statistics, where the median number of observations for each county is 106.5, with a minimum sample of 4 and a maximum sample of 1262. We drop the observations of 23 of 402 counties with less than 10 observations per county. Table 5 in Appendix 6.3 lists the raw number of observations by county.

	Number of observations			
number of counties	mean	sd	min	max
402	106.5746	106.193	3	1007

Table 1: Number of observations by county - descriptive statistics

To generate our benchmark estimates for replacement costs for each housing unit in the sample, we impute the cost of rebuilding the structure as if it were brand new as of the year the ad was removed from the ImmobilienScout24 website. And hence, we estimate a cost function for new single-/double-family detached homes using construction cost data published by the BKI (2016). We then apply this cost function to each of the housing units in the sample.

We use the following estimated cost-function that captures the essential variations in costs per square meter across different types:

$$\begin{aligned} New\ cost\ per\ square\ meter,\ German\ average,\ 2016 &= \\ 2801.298 + 200.3204 * \text{basement} - 0.789 * \text{hgsize} - 497.840 * I(\text{floors} &\geq 2) \\ -705.377 * I(\text{quality} &= 1) - 274.561 * I(\text{quality} = 2) \end{aligned} \tag{5}$$

[6]The time series from 2007 onwards are based on evaluations of property databases compiled by the vdp Research.

[7]BKI stands for Baukosteninformationszentrum Deutscher Architektenkammern.

[8]After 2011, the method of calculating the regional construction cost factors was updated. Hence, according to experts from the surveyor commissions, it would not be consistent to use a longer time series.

[9]Baukosteninformationszentrum Deutscher Architektenkammern GmbH

[10]More detailed description of methods and variables that we use is in Appendix 6.1

In Equation (5), $I(\cdot)$ is an indicator function that is 1 if the expression is true and 0 otherwise[11].

Using a depreciation rate for the new building cost for structure, the following $s_{i,t}$ denotes the replacement cost of the structure after accounting for depreciation:

$$s_{i,t} = str\_cost\_new_{i,t} \cdot \left(\frac{1}{1+\delta}\right)^{age_{i,t}} \tag{6}$$

where, $str\_cost\_new_{i,t}$ denote the new building cost for structure of housing unit i in period t (using Equation 5). The variable $age_{i,t}$ is the age (in years) of the structure of housing unit i in period t. δ is the annual depreciation rate, which we set equal to 0.02.[12].

Lastly, we calculate a county-wide benchmark structures share for the year 2012 as it is the first year of our time series and denote it as w_t^s in period $t = 2012$:

$$w_{2012}^s = \sum_i \frac{s_{i,2012}}{value_{i,2012}}, \tag{7}$$

where we calculate $s_{i,2012}$ by

$$s_{i,2012} = s_{i,eyear} * \frac{RF_{2012,j} * CCI_{2012} * CPI_{2012}}{RF_{eyear,j} * CCI_{eyear} * CPI_{eyear}} \tag{8}$$

and $value_{i,2012}$ by

$$value_{i,2012} = value_{i,eyear} * \frac{HPI_{2012,j} * CPI_{2012}}{HPI_{eyear,j} * CPI_{eyear}}. \tag{9}$$

The index i indicates a housing unit and j refers to a specific county. RF denotes the regional construction cost factors and CCI the Germany-wide construction cost index. CPI refers to the consumer price index and HPI is the house price index on county-level from vdpResearch. The summation in both the numerator and denominator in Equation (7) is over all housing units/housholds in a particular county. According to the assumption that a home's value is the sum of the replacement cost of the physical structure and the market value of the land, it follows a benchmark land share for a given county of $w_t^l = 1 - w_t^s$.

3.2 Extrapolating the Benchmark Estimates for Structures Share and Replacement Cost: German Case

To estimate a continuous annual time-series of structure shares, we extrapolate forward the benchmark structures share derived above: This is the second step of the two-step procedure. Recall that the total value of housing in a particular county at date t is defined as:

$$p_t^h h_t = p_t^l l_t + p_t^s s_t, \tag{10}$$

[11] More details on the cost function estimation are in Appendix 6.1.

[12] We follow the linear depreciation schedule for tax return, where the starting point for calculating depreciation on buildings is the acquisition or construction cost of the building. The proportionate land costs are not included in the basis of assessment. See, https://www.steuertipps.de/lexikon/a/abschreibung-gebaeude

where the market value of land is denoted as $p_t^l l_t$ and the overall replacement cost in that county in a given period as $p_s^s s_t$. Furthermore, Davis and Palumbo (2008) define the total nominal value of structures in a particular county at period $t+1$ as the sum of the total nominal value in the previous period t, revalued for changes in construction costs ($\frac{p_{t+1}^s}{p_t^s}$) and the nominal net new structures ($p_{t+1}^s \Delta s_{t+1}$), i.e. new structures less depreciation:

$$p_{t+1}^s s_{t+1} = p_t^s s_t \left(\frac{p_{t+1}^s}{p_t^s} \right) + p_{t+1}^s \Delta s_{t+1} \tag{11}$$

Moreover, we assume that the nominal value of net new structures in a particular county is equal to some proportion (θ_t) of the nominal value of net new housing in a particular county ($p_{t+1}^h \Delta h_{t+1}$):

$$p_{t+1}^s \Delta s_{t+1} = \theta_t p_{t+1}^h \Delta h_{t+1} \tag{12}$$

Inserting (12) in (11) and dividing by the nominal value of housing at $t+1$, $p_{t+1}^h h_{t+1}$, we have the share of structure as

$$\frac{p_{t+1}^s s_{t+1}}{p_{t+1}^h h_{t+1}} = \frac{p_t^s s_t}{p_t^h h_t} \frac{\frac{p_{t+1}^s}{p_t^s}}{\frac{p_{t+1}^h}{p_t^h}} \left(\frac{h_t}{h_{t+1}} \right) + \theta_t \frac{\Delta h_{t+1}}{h_{t+1}}, \tag{13}$$

where the identity $p_{t+1}^h h_{t+1} = p_t^h h_t \frac{p_{t+1}^h}{p_t^h} \frac{h_{t+1}}{h_t}$ is used. When we let the total structures share of aggregate house value in a county in period t be defined as $w_t^s = \frac{p_t^s s_t}{p_t^h h_t}$ and inserting into equation (3), we obtain Equation (4) or

$$w_{t+1}^s = w_t^s \left(\frac{\frac{p_{t+1}^s}{p_t^s}}{\frac{p_{t+1}^h}{p_t^h}} \right) \left(\frac{h_t}{h_{t+1}} \right) + \theta_t \frac{\Delta h_{t+1}}{h_{t+1}}. \tag{14}$$

Given structures share in period t, w_t^s, the growth rates in construction cost and house prices, $\frac{p_{t+1}^s}{p_t^s}$ and $\frac{p_{t+1}^h}{p_t^h}$, a value for the structure intensity of nominal net new housing, θ_t, and a proxy for the growth rate of real housing stock, $\frac{h_t}{h_{t+1}}$, we can now calculate the structures share in period $t+1$, w_{t+1}^s using Equation (14).

To implement this dynamic equation we use the benchmark structures share for each county in 2012 derived in the previous section. For growth in construction cost by county, we multiply county specific time-series of regional construction cost factors from the BKI with the Germany wide construction cost index for new residential buildings from the German Federal Statistical Office. Both indices are annual time-series.[13] For growth in house prices, we use constant-quality county-specific house prices for single-/double family houses from vdpResearch, based on property transaction database carried out by vdpResearch.

[13]We use the "Baupreisindex" series of the German Federal Statistical office, which is a constant quality-index and should include builder's margins. We could alternatively use the "Baukostenindex" which excludes changes in productivty and builder's margins. Doing so, those changes however would be attributed to the value of land instead. https://www.destatis.de/DE/Themen/Wirtschaft/Preise/Baupreise-Immobilienpreisindex/Publikationen/Downloads-Bau-und-Immobilienpreisindex/bauwirtschaft-preise-2170400193224.pdf?__blob=publicationFile

We approximate the growth in the real housing stock ($\frac{h_{t+1}}{h_t}$) by the growth in the number of households of a county. We assume that both growth rates are proportional. The number of households by county in each period is computed by dividing the population in a particular county by the average household size of Germany in that period[14]. We use population data by county and the number of households of a certain size in Germany from the federal statistical office, where the latter is used to construct the average household size in Germany in a given period. Both datasets are reported at an annual frequency.

Lastly, we assume that the fraction of new home value accounted for by new structures is

$$\theta_t = \frac{exp(1.98w_t^s)}{1 + exp(1.98w_t^s)}. \tag{15}$$

The parameter, θ, allows for varying land intensity of new housing with the average land intensity in a county. We choose the scale parameter to be 1.98 to have a structure's share of new housing of around 0.77 when the average structures share in a county is 0.6.

We do not have an estimate for the share of the nominal value of structures in percent of the nominal value of new housing as Davis and Palumbo (2008). However, we assume a value of around 80%, arguing that land prices increased more than construction costs. Suggesting an increased land intensity of new housing (Figure 2).[15] Moreover, we still choose a relatively high value as construction style is quite more expensive in Germany compared to the US. [16]

4 Results

Figure 3 shows the total number of observations on home values that we construct for 379 of 402 German counties and county-free cities using the annual dataset from 2014 and 2017.[17]

[14]There is no continuous data on average household size by county. Although we are aware that household size varies across counties, we use this assumption as the estimation method only requires percentage changes in the average household size by the county to be correct.

[15]Note that the housing price index was slightly decreasing from 2000 to 2008, although both the land price index and construction costs have been increasing. We think this counter-intuitive fact is partially due to that the land prices represent only for the "ready to build" land. Consequently, the prices for the non-useable construction land could have been decreasing in those periods: These land prices are not publicly available.

[16]https://www.nwb-experten-blog.de/kaufpreisaufteilung-fuer-ein-bebautes-grundstueck-darf-es-ein-bisschen-mehr-gebaeude-sein/

[17]We drop counties where we have less than 10 observations from the ImmobilienScout24 dataset (Indicated by a yellow outline in Figure 2).

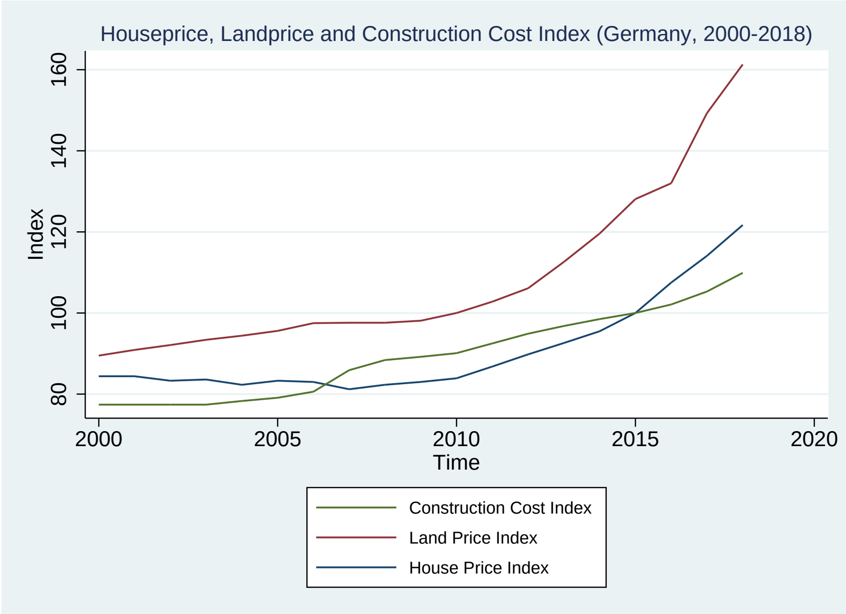

Figure 2: German Housing Market Development; Source: Destatis, German Federal Statistical Office

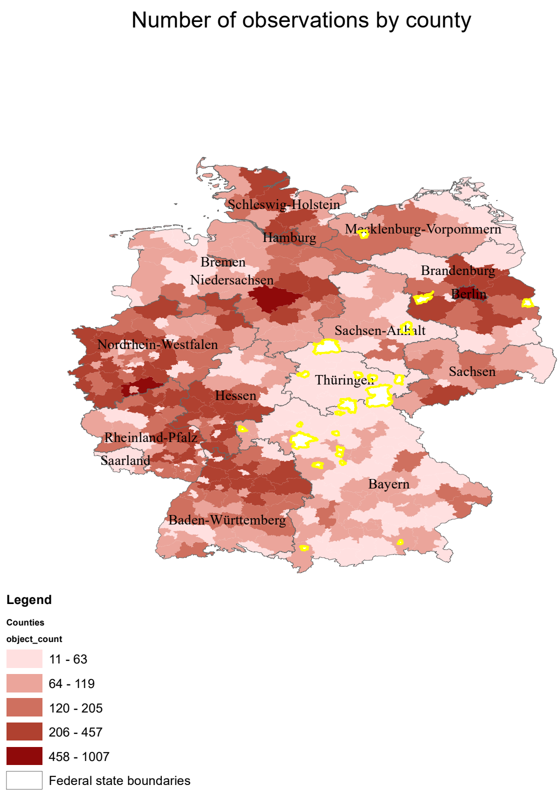

Figure 3: Number of observations by county

Figure 4 shows the components of home value by county in 2014. We construct price indices for residential land and estimate average values for the stock of single-/double-family owner-occupied housing. We also estimate their structure and land components by estimating land's share of home value. We present a detailed description in Figure 4 below by the state level, differentiating between the new federal states[18] and the old federal states of Germany. We then describe the basic differences among the German states and counties and highlight some of the trends over time.

4.1 Components of Home Value in 2014

Table 2 shows the home, land and structure values in 1000s € as well as the land's share of home value and the land value per square meter for German federal states, divided into East and West. On average, homes are more expensive in West German states compared to East German states in 2014. The city-states of Hamburg and Berlin, followed by the southern German states of Bavaria and Baden-Württemberg, have the by far highest home values in 2014. This pattern also becomes evident in Figure 4. Home values and land values are significantly higher in the south of Germany (especially in Bavaria around Munich and in Baden-Württemberg around Stuttgart). But also the large agglomeration of urban centers in the Ruhr area (Nordrhein-Westfalen) and Hamburg show high home and land values.

Although there are quite significant differences in the value of residential land, the states and corresponding counties differ relatively little in terms of the average replacement cost of structures. Two features that highlight the difference between the West and East German states are first that the land's share is significantly higher in the West than East (51% versus 38%). Second, Table 2 also shows that the land value is significantly higher than the structure in the West (184 versus 158), whereas, in the East, the structure value is higher than the value of land (82 versus 132). At the end of 2014, residential land accounted for between 27 and 48 percent in states of former East Germany and between 36 and 70 percent of home value in Western German states, where Hamburg has the highest share of land in home value, with 70 percent.

[18] Also known as "East Germany" and before 1990 part of the German Democratic Republic(DDR).

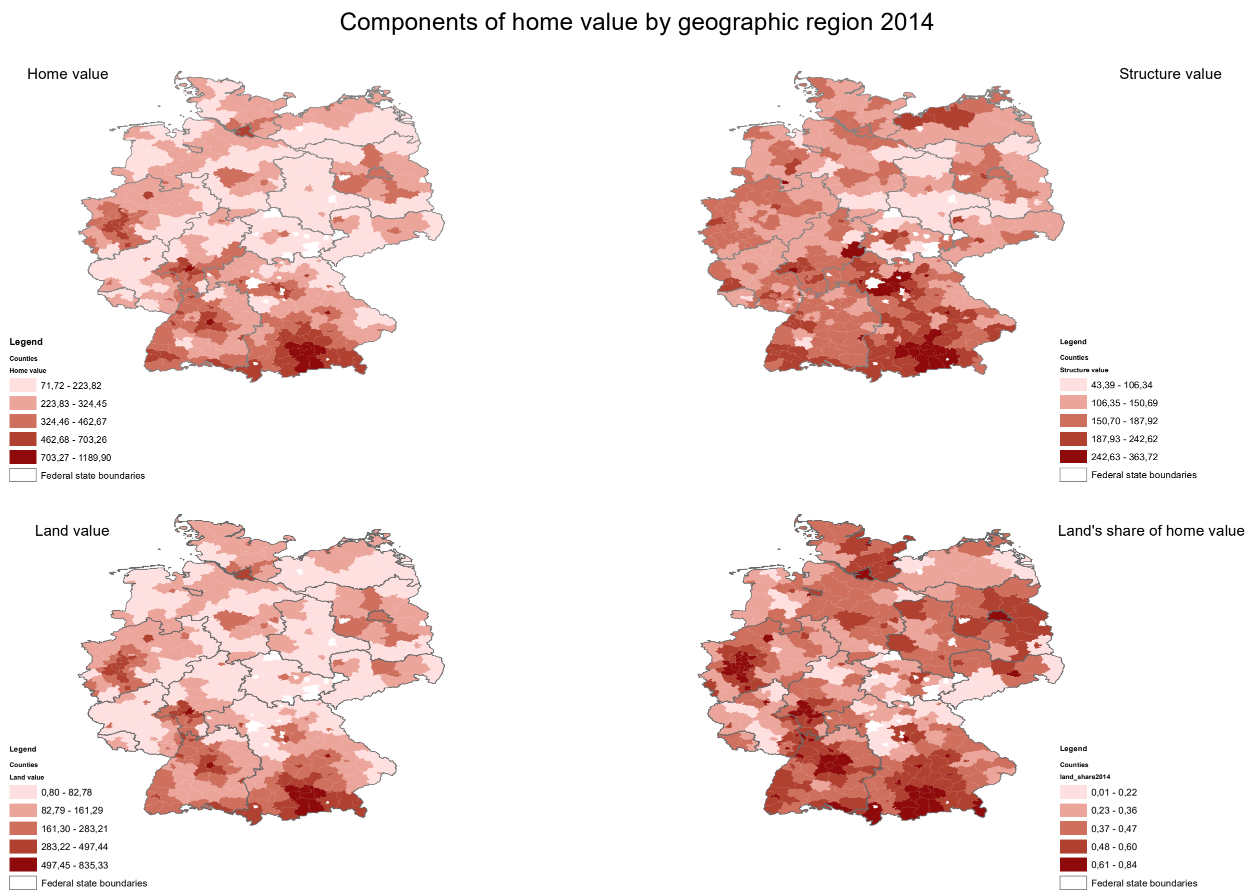

Figure 4: Components of home value by county in 2014

Region/State	Home value (1000s Euros)	Land value (1000s Euros)	Structure value (1000s Euros)	Land's share of home value (pct)	Land value per square meter
West	342	184	158	51	253
Schleswig-Holstein	278	135	144	48	159
Hamburg	600	420	180	70	546
Niedersachsen	227	87	140	38	103
Bremen	242	101	141	42	135
Nordrhein-Westfalen	335	181	154	54	242
Hessen	357	183	174	51	286
Rheinland-Pfalz	262	112	150	43	177
Baden-Württemberg	406	231	175	57	349
Bayern	425	223	203	52	307
Saarland	200	73	127	36	95
Berlin	434	280	154	64	387
East	214	82	132	38	92
Brandenburg	248	118	130	48	131
Mecklenburg-Vorpommern	239	79	160	33	86
Sachsen	239	89	151	37	98
Sachsen-Anhalt	175	77	98	44	87
Thüringen	167	45	122	27	57

Table 2: Components of home value in 2014 by state

4.2 Changes in Home Value: 2014 - 2017

In Table 3 and Figure 5, we present cumulative changes in the components of home value and land's share of home value between 2014-2017 in real terms, i.e., converted to 2015 Euros using the Consumer Price Index from the German federal statistical office, by state and county, respectively. The changes, on average, in the land value for both West and East Germany are much more significant than the changes in the home values: 30% versus 108% in the West, and 15% versus 91% for the East. On the other hand, the structure value increased only marginally, 7% and 12%, for the West and East, respectively. The cummulative change in land values varies between 9% and 171% (excluding Berlin with exorbitant high increases of 668% [19] and Saarland with a decrease of 18%). However, replacement costs only vary between -5% and 26% (again excluding Berlin with an increase of 41%).

[19] We emphasize that our goal is to estimate land prices, and hence, we are silent about the reasons for the land price changes in our work. But such an increase in Berlin's land values needs a bit of attention. A recent work by Möbert (2020) indicates that, among other factors, Berlin's population growth contributes to a significant increase in demand for housing and land. Berlin has experienced both inward migration (at an average of 40 000 new inhabitants annually) and non-Germans migration (at an average increase of 8.3% foreign nationals in Berlin annually) since 2011. One other factor that could contribute to Berlin's extraordinary land value increase in the last few years is the inflow of foreign investments. According to Schaer (2018), up to 68 percent of Berlin apartments were sold to foreigners in 2015.

Region/State	Cumulative change in Home value (pct)	Land value (pct)	Structure value (pct)	Land's share of home value (pctg pts)	Land value per square meter
West	30%	108%	7%	9	125%
Schleswig-Holstein	9%	29%	4%	4	28%
Hamburg	46%	82%	-4%	3	93%
Niedersachsen	6%	26%	5%	17	29%
Bremen	20%	80%	18%	8	66%
Nordrhein-Westfalen	7%	27%	2%	8	28%
Hessen	11%	37%	5%	8	48%
Rheinland-Pfalz	9%	140%	5%	29	163%
Baden-Württemberg	16%	62%	5%	7	86%
Bayern	15%	55%	5%	5	65%
Saarland	-12%	-18%	-5%	4	-20%
Berlin	207%	668%	41%	9	790%
East	15%	91%	12%	1	104%
Brandenburg	21%	43%	17%	4	65%
Mecklenburg-Vorpommern	16%	28%	12%	1	39%
Sachsen	10%	202%	2%	3	222%
Sachsen-Anhalt	2%	9%	2%	0	10%
Thüringen	24%	171%	26%	-5	186%

Table 3: Change in components of home value by state - 2014 through 2017

While values in Table 2 tend to vary quite significantly between East and West German states, the cumulative changes in Table 3 appear to be evenly distributed accross both Eastern and Western German states. However, land's share of home value increases more in the Western parts of Germany compared to the new federal states (East). Moreover, one of the most notable features in Figure 5[20] is that the home values for urban centers such as Hamburg, Berlin, and Munich increased quite substantially more than the surrounding counties. The result reinforces the monocentric Bid-Rent theory that the home and land prices (rents) are inversely related to the distance away from the central business district (CBD).

Moreover, the results in Table 3 indicate that the land component is the main driver for the housing price increase between 2014 and 2017 in Germany.[21] Most regions experienced a significant increase in home value and the share of the market value of residential land in home value. At the same time, the change in the replacement cost of structures was comparatively small.

[20] Note: Classifications of the breaks vary from map to map in Figure 5.
[21] Our estimation results for the components of home value for 2017 is in Appendix 6.2.

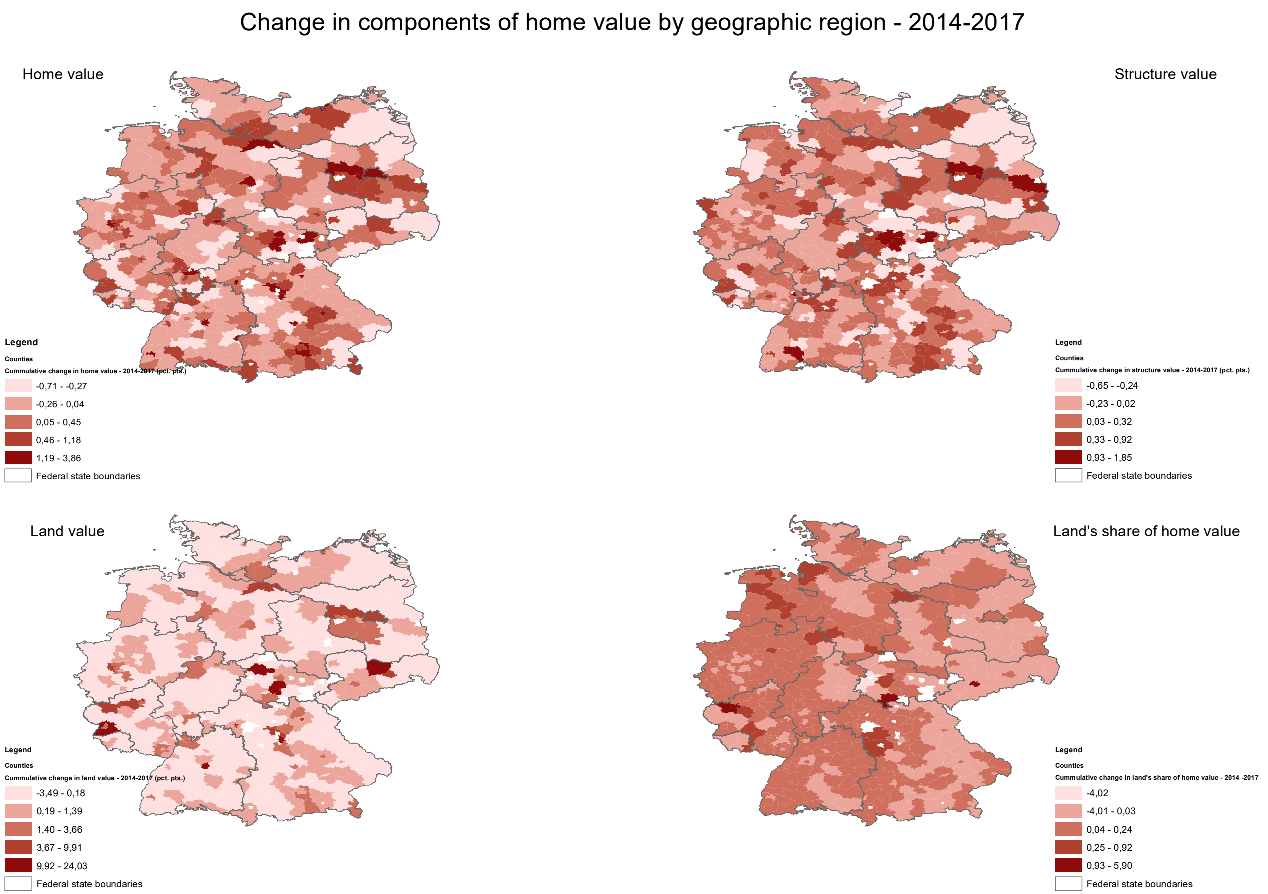

Figure 5: Change in components of home value by county - 2014-2017

4.3 Changes in the Distribution of Land's Share of Home Value and Residential Land Values; 2014-2017

Figure 6 presents the cumulative distribution function of land's share of home value across the 379 German counties and county-free cities in our sample as of 2014 and 2017. Figure 6 shows a relatively even rightward shift of around 4 percent for the second to the ninth percentile of the distribution. The lowest and highest 5 percent of the distribution changed if at all only very slightly. This change suggests that the counties at the top and bottom only shuffled their order, whereas counties in the middle of the distribution experienced an overall rightward shift in the land's share of home value. The range from lowest (around 7 percent) to highest (around 85 percent) land's share of home value stays quite the same between the years. Consistent patterns are shown for the cumulative distribution function of the value of residential land, which is displayed in Figure 7 across the 379 German counties in our sample as of 2014 and 2017.

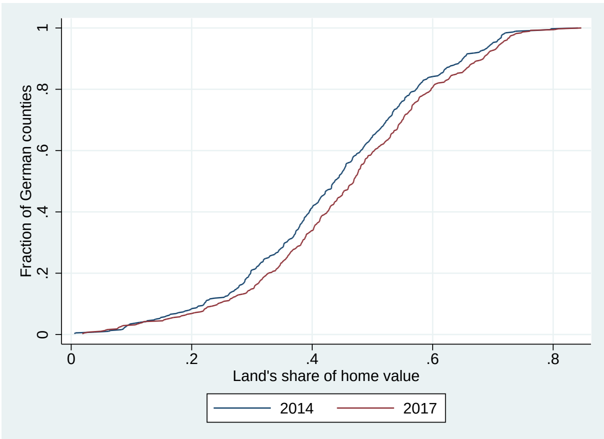

Figure 6: Cumulative distribution of land's share of home value across our sample of 379 German counties

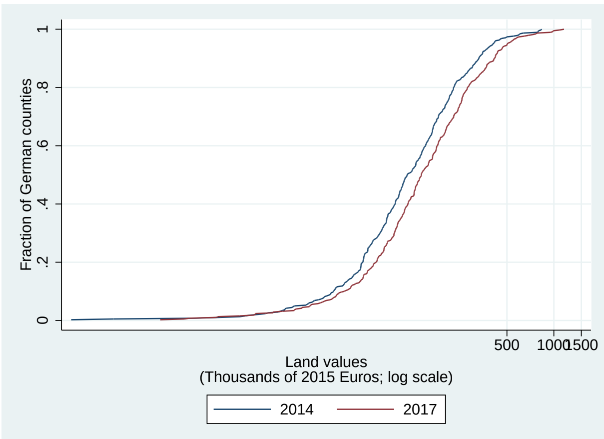

Figure 7: Cumulative distribution of land values across our sample of 379 German counties

4.4 Changes in the Distribution of Land value and Comparison of our Land Value Estimates

Figure 8 maps land values per square meter of lot size for German counties in 2014 and 2017.[22] As expected, the estimated land values per square meter of lot size are highest in counties in and around large agglomerations and decrease the further away from those one gets. Figure 9 shows our - and the expert-based - land value estimates for Hessen's counties in 2014.[23] We choose the state of Hessen for our comparison because the state provides the most available dataset. While expert-based values suggest lower land values in the county-free city of Kassel and higher values in the county of Kassel, our estimates suggest that land values are higher in the city and lower in the county around the city of Kassel. Moreover, our estimates suggest that the land values for Wiesbaden are inversely related to the distance from Frankfurt. In contrast, the expert-based land values are significantly higher also for the county Darmstadt-Dieburg. Figure 9 clearly shows that the differences between our and the experts estimates are not trivial and could have large consequences in the land price valuation.

[22] The cut of levels between classes for the year 2017 are adjusted to those of 2014.

[23] We adjust the cut off levels between classes for the expert-based values to those of our estimates.

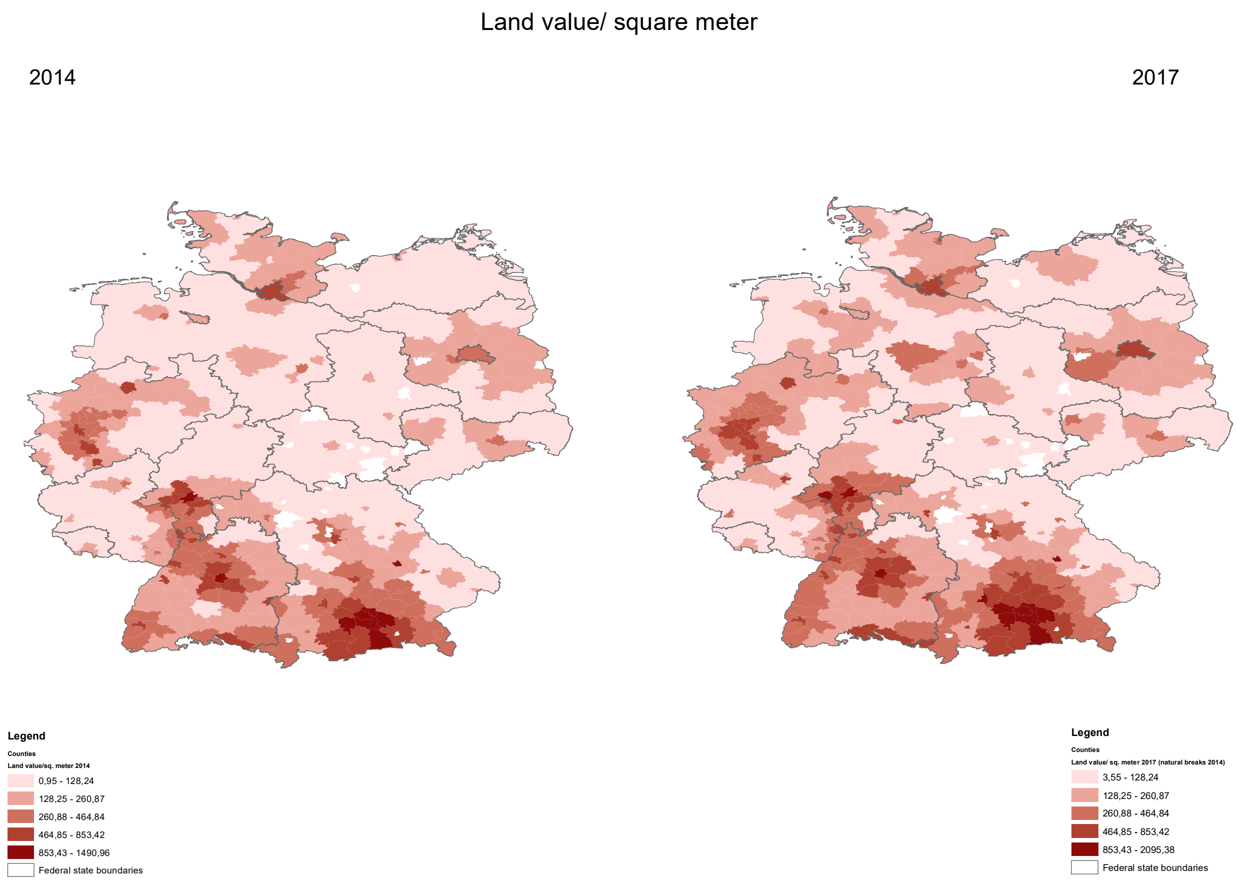

Figure 8: Estimated Land values per square meter of lotsize by county in 2014 and 2017

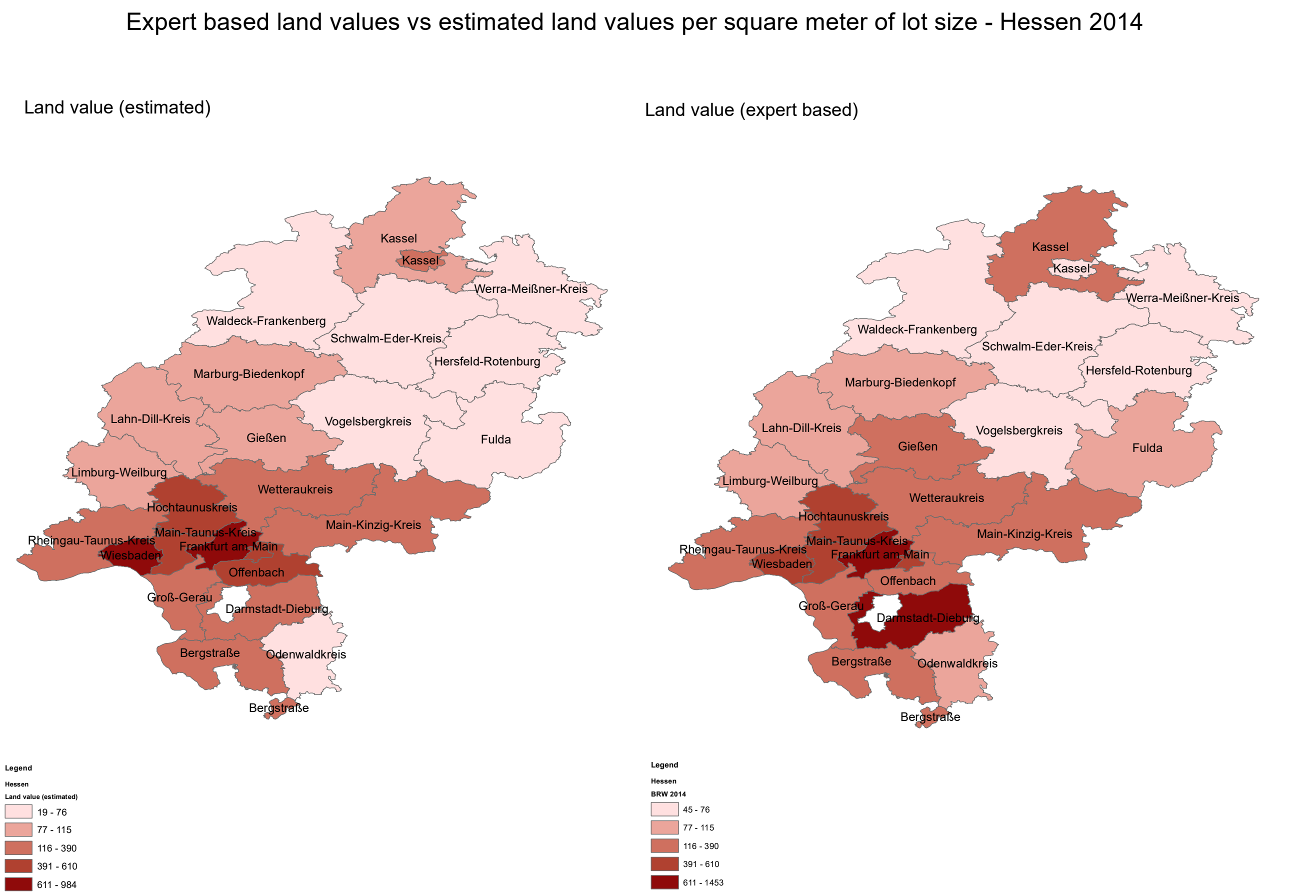

Figure 9: Estimated Land values vs Expert based land values per square meter of lotsize in Hessen 2014

5 Discussion/Conclusion

We estimate land prices and construct a new database for the values of residential land across 379 of 402 German counties and county-free cities over time. Using a total of 42,685 observations from 2014 to 2017, we show that the price of residential land has become relatively more expensive in the majority of German counties. As the urban theory predicts, the highest home and land price increases are in counties around urban centers Munich, Stuttgart, Berlin, Hamburg, Dresden, and the cities in the Ruhr area. But, in general, almost all the counties show an upward shift in home -, land values, the share of residential land in home values. The most significant differences are and seem to remain between the new and old federal states of Germany. The Eastern states are in par with the West (excluding Berlin) in terms of cumulative percentage changes in the value of the components of the housing bundle. However, there was a significant difference in the average land's share of home value increased between East and West. Moreover, the absolute differences in home values, the value of residential land, and replacement costs did not decrease between the two parts of Germany.

Our results show that a more significant share of land in home value could lead to faster home price appreciation in the future. Consequently, one of the implications of our results is that real land prices drive the movements in home prices and the cycles in the value of land are likely to influence the evolution of house prices more in the future than they did in the past. This implication would affect urban areas with a larger inelasticity of supply in housing. Moreover, this result could lead to more significant swings in house prices due to changes in demand.

In our work, we are silent on some of the shortcomings of the residual method. First, we could use the simple option model as in Davis et al. (2019) to address the assumption that the value of a home is equal to the sum of the replacement cost of its structure and the value of the land. Excluding houses that have an "effective age" of more than 20 years. Second, we could use a more extensive transaction data set to entirely avoid depreciation of replacement costs by using only new homes to estimate the share of land in home value (e.g., Davis et al., 2017).

6 Appendix

6.1 Details on the Benchmark Estimates for the Replacement Cost of Residential structures: German Case

In this section, we provide further detailed description of our approach in computing the annual time series estimates for the average value of land in German counties and county-free cities.

In the first step, we use the house price listings from the internet platform ImmobilienScout24[24] with the RWI - Leibniz Institute for Economic Research as well as the 2016 average construction cost data per square meter of single- and double-family houses. We use the following set of variables from the dataset that characterizes "house": *built* (the year of construction),

[24]See Boelmann and Schaffner (2019) for data documentation.

basement (whether the housing unit has a basement), *garage* (the availability of parking lots)[25], *hgsize* (the living size of the dwelling in square meters), *lotsize* (the lot size corresponding to the dwelling in square meters), *floors*(counts the number of floors), *rooms* (counts the number of rooms), *value* (denotes the posted selling price of the advertisement of the housing unit), and *quality* (records the quality of a building's facilities). We categorize the reported qualities into "simple", "normal" and "high", where the latter is combined of the two highest categories in the variable *facilities*.

We use all the listed single-/double-family houses for sale using the variables "house_category" and "real estate type". We, however, exclude semi-attached single-family buildings ("Doppelhaushälften") from our dataset as we cannot identify whether construction costs refer the one or both parts of the duplex ("Doppelhaus").[26] We also exclude all the observations that are listed as "unfinished buildings", i.e., we exclude objects that are still under construction but are listed and the observations that refer to as "holiday homes".

Although energy-efficient construction is prevalent and subsidized by the German federal government,[27] contrary to our expectations we find energy-efficiency standards not to have a significant impact when estimating our construction cost function. Hence, we do not include a variable *energy* that depicts the energy-efficiency standards of the houses. To eliminate duplicates, we use the variable *dupid_gen* generated by the RWI that classifies object identifiers used more than once. We remove those observations with a duplicate ID of 1, indicating that they are identical in essential variables and were posted several times around the same date. Also, we drop objects with duplicate identifier 2, i.e., close to identical objects as above; however, we keep objects that differ in essential variables and those with object identifiers used only once.

To eliminate possible scam postings and very luxury objects, we eliminate extreme outliers and unrealistic values in the variables we use. First, we remove houses with more than 600 or less than 50 square meters living size, more than 15 rooms and more than 2500 square meters of lot size that are possible for agricultural use. Second, we drop observations with values of less than 10,000 or more than 5,000,000 Euros.[28]

For our cost function estimation, we use the BKI (2016) that publishes how much it would cost per square meter of living space to build a new single-/double-family home on average in Germany in 2016, given several characteristics of the structure. The characteristics published by the BKI include total square meter of living space, the number of stories[29], the veneer/siding, the quality of the building's facilities, the energy-efficiency standard, and whether it has a basement or not. We draw our analysis upon square-foot building costs of single-/double-family homes in the BKI data. Using the sample houses from the BKI database, we have 106 observations for

[25]Unfortunately, no variable explicitely states the kind of parking lot. However, we think it is reasonable to assume that a substantial fraction of single-/double-family dwellings in Germany is equipped with a garage.

[26]Effenberger (2015) reports that semi-attached single-family buildings ("Doppelhaushälften") make up around 33.5% of the stock of single family homes in Germany in 2012. But given the construction cost issue, we exclude these stocks.

[27]See https://www.bmi.bund.de and https://www.kfw.de

[28]We follow the restrictions set by the Immobilienscout24-House-Price-Index.

[29]As there is a picture attached to each housing unit, we can infer these information.

estimating our cost function.[30]

To obtain total construction cost for each housing unit reported in our sample, we multiply the construction cost per square meter using our cost function by the reported unit size in square meters and add 10,000 for units having a garage.[31] As this current measure of total construction cost is the German average for the year 2016q1[32], we multiply the cost by the following ratio to normalize the construction cost to reflect for the "end of advertisement"-year and a given county.

$$\frac{\text{BKI Regional factor of the county * Construction Cost Index, "end of advertisement"-year}}{\text{German average of BKI Regional factors* Construction Cost Index, 2016}} \tag{16}$$

After the cost adjustment by Equation (16), we depreciate the structure cost based on its age to better estimate the actual replacement cost of the structure, i.e., if the land had no value. Following Davis and Palumbo (2008), one may think about depreciation as the expense that it would cost to renovate the existing structure to "like-new" standards. Consequently, our replacement cost of the structure after accounting for depreciation is

$$s_{i,t} = str\_cost\_new_{i,t} \cdot \left(\frac{1}{1+\delta}\right)^{age_{i,t}}$$

6.2 Components of Home Value in 2017

Table 4 and Figure 10 display values of the components of the housing bundle in 1,000s € as well as the land's share of home value in percent and the land value per square meter of lot size for German federal states and counties, respectively. Comparing Figure 4 and Figure 10 we see that differences between counties stayed almost the same. However, Figure 11 [33] and Table 4 indicate that especially home and land values became more expensive compared to 2014. Especially the counties around the prosperous urban centers in the Southern states of Germany and Nordrhein-Westfalen became more expensive in terms of home values and land values, but also values around the city states Berlin and Hamburg (Figure 10). The most affordable home values and land values remain to be in the central parts of Germany and in some regions in the East of Germany. Average home values vary between 177,000€ in Thüringen (located quite in the middle of Germany (Figure 3)) and 732,000€ in Hamburg. With average home values of around 500,000€ Berlin, Bavaria and Baden-Württemberg follow the leader in terms of expensive home values. The same picture results for land's share of home values. The average lot was worth between 26 percent of a home's value in Thüringen and 71 and 73 percent in Berlin and

[30] The variables are defined as varying in home size (from about 90 - 350 square meters of living space), quality (low, normal/average, high), veneer/siding (wood, brick, man-made siding), basement (yes and no), and two-height dimensions (more or less than two stories).

[31] We base our number 10,000€ from the website that reports the standard sizes for single-/double-garages (https://www.garagen-welt.de/blog/garagengroesse-garagenbreite.html). We then multiply the standard size of a single- and double-garage in m^3 with average building costs for a middle-sized single-floor garage in €/m^3. See the following document that outlines the garage costs. https://docplayer.org/51789280-Richtwerte-fuer-die-ermittlung-der-verschiedenen-baukosten-als-grundlage-der-festsetzung-von-baugenehmigungsgebuehren.html.

[32] Inclusive of 16% value-added tax.

[33] In Figure 11 we adjusted the cut-off values in the legend to the corresponding values of 2014.

Hamburg, respectively. While, the counties in the new federal states of Germany do not lag behind in terms of cummulative changes in home value and the value of residential land, the cross regional differences remain.

Region/State	Home value (1000s Euros)	Land value (1000s Euros)	Structure value (1000s Euros)	Land's share of home value (pct)	Land value per square meter
West	409	235	173	54	324
Schleswig-Holstein	321	159	161	50	189
Hamburg	732	533	199	73	692
Niedersachsen	262	113	149	43	133
Bremen	276	125	151	45	168
Nordrhein-Westfalen	387	222	164	57	296
Hessen	419	232	187	55	363
Rheinland-Pfalz	299	139	160	46	220
Baden-Württemberg	477	284	193	60	431
Bayern	503	276	227	55	381
Saarland	220	79	141	36	103
Berlin	601	426	175	71	588
East	235	92	143	38	104
Brandenburg	281	138	143	49	154
Mecklenburg-Vorpommern	266	94	173	35	103
Sachsen	262	97	165	37	108
Sachsen-Anhalt	188	83	105	44	95
Thüringen	177	47	130	26	60

Table 4: Components of home value in 2017 by state

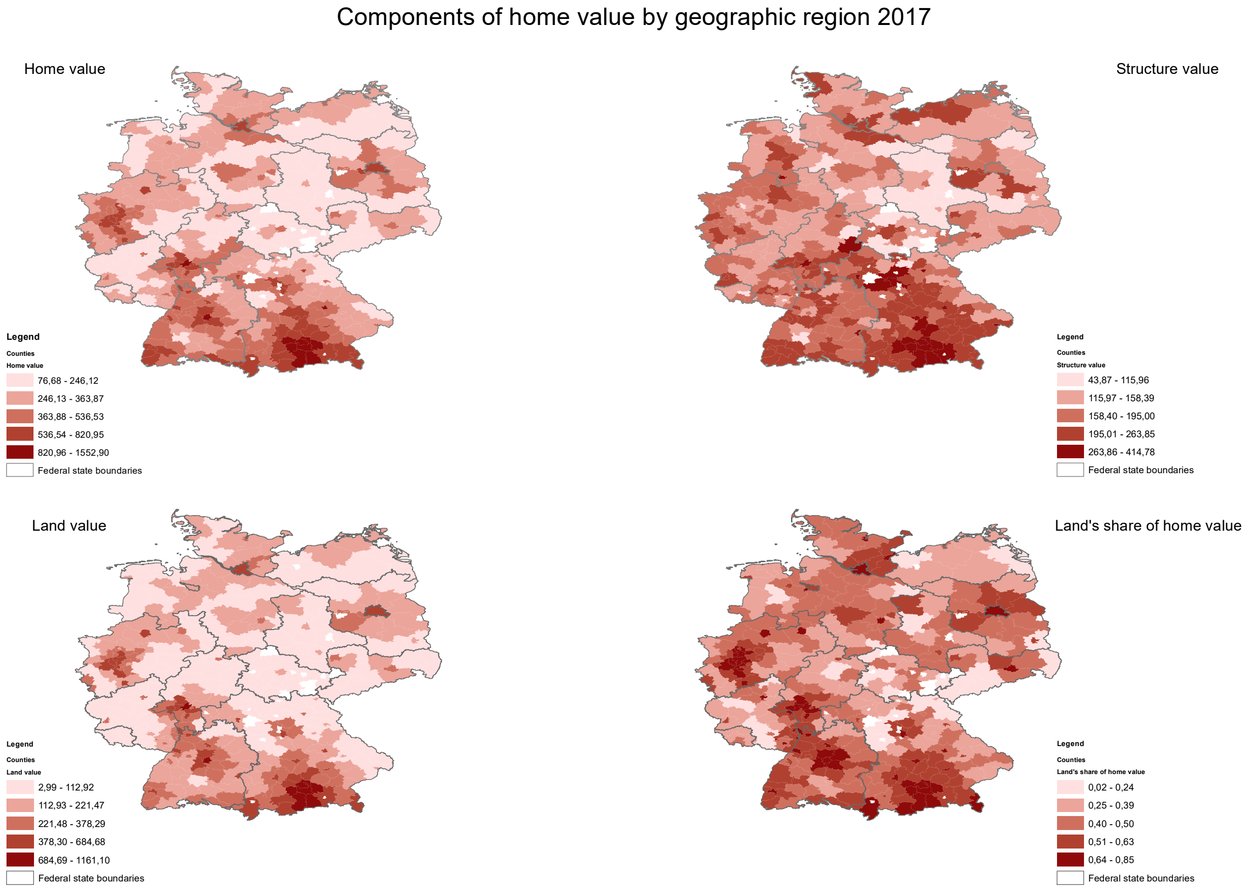

Figure 10: Components of home value by county in 2017

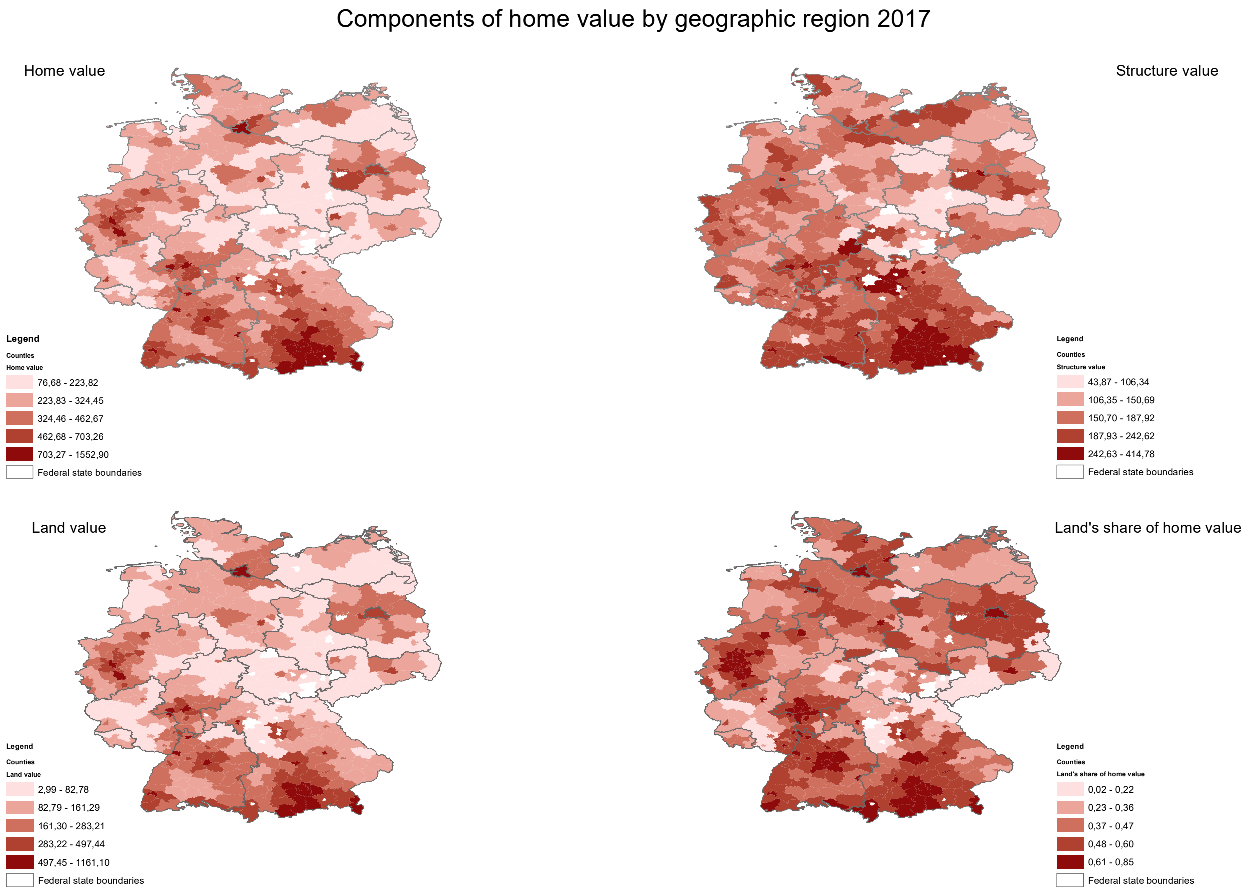

Figure 11: Components of home value by county in 2017 - legend adjusted to 2014

6.3 Table

Table 5: Observations used to calculate benchmark structures share

Region	State	County	Number of observations
West	Schleswig-Holstein	SK Flensburg	37
		SK Kiel	49
		SK Lübeck	47
		SK Neumünster	34
		LK Dithmarschen	152
		LK Herzogtum Lauenburg	121
		LK Nordfriesland	86
		LK Ostholstein	116
		LK Pinneberg	214
		LK Plön	100
		LK Rendsburg-Eckernförde	358
		LK Schleswig-Flensburg	257
		LK Segeberg	217
		LK Steinburg	107
		LK Stormarn	128
	Hamburg	SK Hamburg	223
	Niedersachsen	SK Braunschweig	99
		SK Salzgitter	111
		SK Wolfsburg	158
		LK Gifhorn	457
		LK Göttingen	85
		LK Goslar	109
		LK Helmstedt	178
		LK Northeim	88
		LK Osterode am Harz	101
		LK Peine	163
		LK Wolfenbüttel	183
		LK Region Hannover	917
		LK Diepholz	72
		LK Hameln-Pyrmont	204
		LK Hildesheim	214
		LK Holzminden	65
		LK Nienburg (Weser)	64
		LK Schaumburg	172
		LK Celle	214
		LK Cuxhaven	118
		LK Harburg	161
		LK Lüchow-Dannenberg	126
		LK Lüneburg	134
		LK Osterholz	76
		LK Rotenburg (Wümme)	104
		LK Soltau-Fallingbostel	121
		LK Stade	109
		LK Uelzen	116

	LK Verden	63
	SK Delmenhorst	45
	SK Emden	14
	SK Oldenburg	81
	SK Osnabrück	68
	SK Wilhelmshaven	17
	LK Ammerland	74
	LK Aurich	94
	LK Cloppenburg	63
	LK Emsland	87
	LK Friesland	50
	LK Grafschaft Bentheim	51
	LK Leer	64
	LK Oldenburg	59
	LK Osnabrück	153
	LK Vechta	27
	LK Wesermarsch	26
	LK Wittmund	46
Bremen	SK Bremen	141
	SK Bremerhaven	18
Nordrhein-Westfalen	SK Düsseldorf	91
	SK Duisburg	98
	SK Essen	85
	SK Krefeld	71
	SK Mönchengladbach	104
	SK Mülheim an der Ruhr	59
	SK Oberhausen	41
	SK Remscheid	55
	SK Solingen	60
	SK Wuppertal	115
	LK Kleve	256
	LK Mettmann	186
	LK Rhein-Kreis Neuss	314
	LK Viersen	280
	LK Wesel	334
	SK Bonn	88
	SK Köln	163
	SK Leverkusen	50
	SK Städteregion Aachen	227
	LK Düren	191
	LK Rhein-Erft-Kreis	256
	LK Euskirchen	247
	LK Heinsberg	259
	LK Oberbergischer Kreis	296
	LK Rheinisch-Bergischer Kreis	236
	LK Rhein-Sieg-Kreis	581
	SK Bottrop	29
	SK Gelsenkirchen	20
	SK Münster	59

	LK Borken	205
	LK Coesfeld	155
	LK Recklinghausen	233
	LK Steinfurt	229
	LK Warendorf	101
	SK Bielefeld	113
	LK Gütersloh	78
	LK Herford	152
	LK Höxter	103
	LK Lippe	385
	LK Minden-Lübbecke	253
	LK Paderborn	136
	SK Bochum	32
	SK Dortmund	124
	SK Hagen	55
	SK Hamm	31
	SK Herne	11
	LK Ennepe-Ruhr-Kreis	153
	LK Hochsauerlandkreis	123
	LK Märkischer Kreis	235
	LK Olpe	54
	LK Siegen-Wittgenstein	203
	LK Soest	139
	LK Unna	224
Hessen	SK Darmstadt	33
	SK Frankfurt am Main	112
	SK Offenbach am Main	24
	SK Wiesbaden	97
	LK Bergstraße	248
	LK Darmstadt-Dieburg	231
	LK Groß-Gerau	189
	LK Hochtaunuskreis	357
	LK Main-Kinzig-Kreis	366
	LK Main-Taunus-Kreis	165
	LK Odenwaldkreis	164
	LK Offenbach	228
	LK Rheingau-Taunus-Kreis	252
	LK Wetteraukreis	391
	LK Gießen	215
	LK Lahn-Dill-Kreis	274
	LK Limburg-Weilburg	292
	LK Marburg-Biedenkopf	100
	LK Vogelsbergkreis	132
	SK Kassel	36
	LK Fulda	57
	LK Hersfeld-Rotenburg	108
	LK Kassel	104
	LK Schwalm-Eder-Kreis	49
	LK Waldeck-Frankenberg	49
	LK Werra-Meißner-Kreis	80

Rheinland-Pfalz	SK Koblenz	42
	LK Ahrweiler	140
	LK Altenkirchen	145
	LK Bad Kreuznach	294
	LK Birkenfeld	54
	LK Cochem-Zell	37
	LK Mayen-Koblenz	275
	LK Neuwied	229
	LK Rhein-Hunsrück-Kreis	160
	LK Rhein-Lahn-Kreis	152
	LK Westerwaldkreis	335
	SK Trier	24
	LK Bernkastel-Wittlich	67
	LK Eifelkreis Bitburg-Prüm	83
	LK Vulkaneifel	40
	LK Trier-Saarburg	132
	SK Frankenthal (Pfalz)	22
	SK Kaiserslautern	78
	SK Landau in der Pfalz	31
	SK Ludwigshafen am Rhein	48
	SK Mainz	60
	SK Neustadt an der Weinstraße	41
	SK Pirmasens	36
	SK Speyer	25
	SK Worms	45
	SK Zweibrücken	24
	LK Alzey-Worms	213
	LK Bad Dürkheim	228
	LK Donnersbergkreis	185
	LK Germersheim	124
	LK Kaiserslautern	232
	LK Kusel	88
	LK Südliche Weinstraße	168
	LK Rhein-Pfalz-Kreis	153
	LK Mainz-Bingen	289
	LK Südwestpfalz	141
Baden-Württemberg	SK Stuttgart	89
	LK Böblingen	178
	LK Esslingen	220
	LK Göppingen	158
	LK Ludwigsburg	212
	LK Rems-Murr-Kreis	252
	SK Heilbronn	50
	LK Heilbronn	302
	LK Hohenlohekreis	123
	LK Schwäbisch Hall	219
	LK Main-Tauber-Kreis	54
	LK Heidenheim	141
	LK Ostalbkreis	285

	SK Baden-Baden	44
	SK Karlsruhe	36
	LK Karlsruhe	266
	LK Rastatt	137
	SK Heidelberg	23
	SK Mannheim	50
	LK Neckar-Odenwald-Kreis	130
	LK Rhein-Neckar-Kreis	299
	SK Pforzheim	70
	LK Calw	158
	LK Enzkreis	253
	LK Freudenstadt	95
	SK Freiburg im Breisgau	13
	LK Breisgau-Hochschwarzwald	83
	LK Emmendingen	38
	LK Ortenaukreis	135
	LK Rottweil	130
	LK Schwarzwald-Baar-Kreis	61
	LK Tuttlingen	91
	LK Konstanz	73
	LK Lörrach	68
	LK Waldshut	126
	LK Reutlingen	177
	LK Tübingen	112
	LK Zollernalbkreis	139
	SK Ulm	28
	LK Alb-Donau-Kreis	148
	LK Biberach	137
	LK Bodenseekreis	59
	LK Ravensburg	87
	LK Sigmaringen	69
Bayern	SK Ingolstadt	100
	SK München	81
	SK Rosenheim	4
	LK Altötting	60
	LK Berchtesgadener Land	20
	LK Bad Tölz-Wolfratshausen	21
	LK Dachau	51
	LK Ebersberg	52
	LK Eichstätt	119
	LK Erding	37
	LK Freising	53
	LK Fürstenfeldbruck	79
	LK Garmisch-Partenkirchen	32
	LK Landsberg am Lech	64
	LK Miesbach	36
	LK Mühldorf a.Inn	52
	LK München	106
	LK Neuburg-Schrobenhausen	84

LK Pfaffenhofen a.d.Ilm	86
LK Rosenheim	94
LK Starnberg	70
LK Traunstein	72
LK Weilheim-Schongau	47
SK Landshut	29
SK Passau	26
SK Straubing	13
LK Deggendorf	147
LK Freyung-Grafenau	115
LK Kelheim	69
LK Landshut	105
LK Passau	189
LK Regen	34
LK Rottal-Inn	55
LK Straubing-Bogen	59
LK Dingolfing-Landau	107
SK Amberg	17
SK Regensburg	30
SK Weiden i.d.OPf.	13
LK Amberg-Sulzbach	60
LK Cham	55
LK Neumarkt i.d.OPf.	57
LK Neustadt a.d.Waldnaab	31
LK Regensburg	96
LK Schwandorf	131
LK Tirschenreuth	19
SK Bamberg	4
SK Bayreuth	16
SK Coburg	8
SK Hof	19
LK Bamberg	43
LK Bayreuth	64
LK Coburg	34
LK Forchheim	35
LK Hof	43
LK Kronach	27
LK Kulmbach	38
LK Lichtenfels	11
LK Wunsiedel i.Fichtelgebirge	16
SK Ansbach	3
SK Erlangen	8
SK Fürth	5
SK Nürnberg	77
SK Schwabach	9
LK Ansbach	106
LK Erlangen-Höchstadt	65
LK Fürth	41
LK Nürnberger Land	71

		LK Neustadt/Aisch-B.Windsh.	53
		LK Roth	49
		LK Weißenburg-Gunzenhausen	32
		SK Aschaffenburg	9
		SK Schweinfurt	3
		SK Würzburg	11
		LK Aschaffenburg	67
		LK Bad Kissingen	28
		LK Rhön-Grabfeld	15
		LK Haßberge	35
		LK Kitzingen	8
		LK Miltenberg	66
		LK Main-Spessart	27
		LK Schweinfurt	46
		LK Würzburg	69
		SK Augsburg	111
		SK Kaufbeuren	37
		SK Kempten (Allgäu)	8
		SK Memmingen	21
		LK Aichach-Friedberg	98
		LK Augsburg	199
		LK Dillingen a.d.Donau	68
		LK Günzburg	62
		LK Neu-Ulm	80
		LK Lindau (Bodensee)	28
		LK Ostallgäu	55
		LK Unterallgäu	67
		LK Donau-Ries	50
		LK Oberallgäu	83
	Saarland	LK Regionalverband Saarbrücken	52
		LK Merzig-Wadern	51
		LK Neunkirchen	59
		LK Saarlouis	39
		LK Saarpfalz-Kreis	82
		LK St. Wendel	36
	Berlin	SK Berlin	1007
East	Brandenburg	SK Brandenburg an der Havel	8
		SK Cottbus	34
		SK Frankfurt (Oder)	7
		SK Potsdam	45
		LK Barnim	265
		LK Dahme-Spreewald	276
		LK Elbe-Elster	60
		LK Havelland	185
		LK Märkisch-Oderland	250
		LK Oberhavel	240

	LK Oberspreewald-Lausitz	64
	LK Oder-Spree	168
	LK Ostprignitz-Ruppin	39
	LK Potsdam-Mittelmark	246
	LK Prignitz	16
	LK Spree-Neiße	51
	LK Teltow-Fläming	125
	LK Uckermark	33
Mecklenburg-Vorpommern	SK Rostock	41
	SK Schwerin	9
	LK Mecklenburgische Seenplatte	115
	LK Rostock	136
	LK Vorpommern-Rügen	49
	LK Nordwestmecklenburg	73
	LK Vorpommern-Greifswald	42
	LK Ludwigslust-Pachim	123
Sachsen	SK Chemnitz	44
	LK Erzgebirgskreis	209
	LK Mittelsachsen	118
	LK Vogtlandkreis	118
	LK Zwickau	127
	SK Dresden	125
	LK Bautzen	106
	LK Görlitz	29
	LK Meißen	144
	LK Sächsische Schweiz-Osterzgebirge	132
	SK Leipzig	111
	LK Leipzig	177
	LK Nordsachsen	83
Sachsen-Anhalt	SK Dessau-Roßlau	4
	SK Halle (Saale)	43
	SK Magdeburg	45
	LK Altmarkkreis Salzwedel	34
	LK Anhalt-Bitterfeld	31
	LK Börde	99
	LK Burgenlandkreis	56
	LK Harz	76
	LK Jerichower Land	30
	LK Mansfeld-Südharz	57
	LK Saalekreis	135
	LK Salzlandkreis	78
	LK Stendal	84
	LK Wittenberg	21
Thüringen	SK Erfurt	22
	SK Gera	8
	SK Jena	7
	SK Suhl	16
	SK Weimar	7

SK Eisenach	4
LK Eichsfeld	13
LK Nordhausen	9
LK Wartburgkreis	38
LK Unstrut-Hainich-Kreis	13
LK Kyffhäuserkreis	13
LK Schmalkalden-Meiningen	32
LK Gotha	30
LK Sömmerda	26
LK Hildburghausen	24
LK Ilm-Kreis	28
LK Weimarer Land	23
LK Sonneberg	9
LK Saalfeld-Rudolstadt	22
LK Saale-Holzland-Kreis	14
LK Saale-Orla-Kreis	5
LK Greiz	27
LK Altenburger Land	11

References

Albouy, D., Ehrlich, G., & Shin, M. (2018). Metropolitan land values. *Review of Economics and Statistics*, *100*(3), 454–466.

BKI. (2016). *BKI Baukosten 2016 Neubau - Teil 1. Statistische Kostenkennwerte für Gebäude.* Stuttgart: BKI Baukosteninformationszentrum Deutscher Architektenkammern GmbH.

Boelmann, B., & Schaffner, S. (2019). Fdz data description: Real-estate data for germany (rwi-geo-red) - advertisements on the internet platform immobilienscout24). *RWI Projektberichte*.

Bostic, R. W., Longhofer, S. D., & Redfearn, C. L. (2007). Land leverage: decomposing home price dynamics. *Real Estate Economics*, *35*(2), 183–208.

Davis, M. A., & Heathcote, J. (2007). The price and quantity of residential land in the United States. *Journal of Monetary Economics*, *54*(8), 2595–2620. doi: 10.1016/j.jmoneco.2007.06.023

Davis, M. A., Larson, W. D., Oliner, S. D., & Shui, J. (2019). The price of residential land for counties, zip codes, and census tracts in the united states. *Federal Housing Finance Agency Working Paper*, 19–01.

Davis, M. A., Oliner, S. D., Pinto, E. J., & Bokka, S. (2017). Residential land values in the washington, dc metro area: New insights from big data. *Regional Science and Urban Economics*, *66*, 224–246.

Davis, M. A., & Palumbo, M. G. (2008). The price of residential land in large US cities. *Journal of Urban Economics*, *63*(1), 352–384. doi: 10.1016/j.jue.2007.02.003

Effenberger, K.-H. (2015). Projektbericht Entwicklungsdynamik EFH Arbeitsbaustein 4: Differenzierung der EFH-Bestände. *Leibniz-Institut für ökologische Raumentwicklung*.

Gyourko, J., & Saiz, A. (2006). Construction costs and the supply of housing structure. *Journal of regional Science*, *46*(4), 661–680.

Haughwout, A., Orr, J., & Bedoll, D. (2008). The price of land in the new york metropolitan area. *Current Issues in Economics and Finance*, *14*(3).

Kolbe, J., Schulz, R., Wersing, M., & Werwatz, A. (2012). *Location, location, location: Extracting location value from house prices* (Tech. Rep.). SFB 649 Discussion Paper.

Kolbe, J., Schulz, R., Wersing, M., & Werwatz, A. (2015). Identifying berlin's land value map using adaptive weights smoothing. *Computational Statistics*, *30*(3), 767-790.

Kolbe, J., Schulz, R., Wersing, M., & Werwatz, A. (2019). Land value appraisal using statistical methods.

Möbert, J. (2020). Berlin housing market rent cap may decouple real estate cycle from economic supercycle for a number of years. *Deutsche Bank Research - Germany Monitor*.

Nichols, J. B., Oliner, S. D., & Mulhall, M. R. (2013). Swings in commercial and residential land prices in the united states. *Journal of Urban Economics*, *73*(1), 57–76.

Schaer, C. (2018, August 27). Mayor suggests locking out foreign investors from berlin real estate. *Handelsblatt*.