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Abstract

This paper employs cross-sectional data on 96 German regions to investigate the interregional variability of homeownership rates. Among the explanatory variables, the analysis includes important regional housing market indicators as well as regional socio-demographic composition, urbanization and labor market performance. An estimation strategy is chosen which accounts for different forms of spatial dependence among the regional units. We find that regional differences in the relative price of owning versus renting, and the affordability of owner-occupied housing play a key role in explaining why homeownership rates vary so substantially across the country. The results indicate significant neighborhood effects for several variables.

JEL-Code: R210, R310, R380.

Keywords: homeownership, regional housing markets, spatial econometrics.

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1 Introduction

The rate of homeownership[1] is traditionally interpreted as a major indicator of economic welfare. Homeownership is associated with a high level of wealth accumulation and economic freedom (Turner and Luea, 2009). Homeowners also tend to be more satisfied with their housing situation than tenants (Elsinga and Hoekstra, 2005). Several studies even report a positive influence of homeownership on social cohesion and stability (Rossi and Weber, 1996; Glaeser and DiPasquale, 1999; Dietz and Haurin, 2003). In contrast, other studies emphasize the potentially harmful effects of high homeownership rates. Since homeowners face significant mobility constraints, some authors conjecture an inverse relationship between the rate of homeownership and the capacity of regions to adjust to negative labor demand shocks (Oswald, 1996; Coulson and Fisher, 2009). The financial crisis has recently highlighted another weakness of social over-reliance on homeownership, as a surge in mortgage defaults and declining house prices exerted substantial negative effects on economic activity in many countries (Shiller, 2007; Muellbauer and Murphy, 2008).

While the question of whether high homeownership regions fare better than others remains unresolved, interregional disparities in homeownership rates are impressive on their own. In most countries, the variation in homeownership rates over space clearly exceeds the corresponding variation over time. A country well-known for its low nationwide homeownership rate[2], Germany is no exception to this rule: while the national homeownership rate stagnated over the past decade, regional homeownership rates vary by as much as fifty percentage points. Pronounced homeownership disparities not only exist between rural and urbanized regions, but also between regions of similar structural characteristics. The homeownership rates of Emsland (Lower Saxony, 63.5%) and Oberland (Bavaria, 44.0%), for instance, differ by almost twenty percentage points, although the demographic composition and urbanization rate of both regions are quite comparable. Thus, the question arises which factors make homeownership so attractive in some regions, while it seems to lack attractiveness in others.

Although there is an extensive body of literature on housing tenure choice, little is known about the origins of regional homeownership disparities. A significant part of existing empirical research focuses either on microeconomic decisions of owning

[1] The rate of homeownership can either be defined as the proportion of households owning their housing unit or as the proportion of dwellings owner-occupied. In this paper, we refer to the first definition.

[2] At 43%, Germany‘s homeownership rate ranks second-lowest for the advanced economies.

versus renting (see, e.g., Clark et al. (1997) using German household data), or on cross-country differences in homeownership rates (Proxenos, 2002; Fisher and Jaffe, 2003; Earley, 2004; Gwin and Ong, 2008). There is, however, a surprising paucity of studies empirically analyzing differences in owner-occupation rates *within* countries. While cross-country homeownership differences can be reasonably explained by national differences in history, institutions, and macroeconomic conditions, these factors hardly explain why homeownership rates are not uniform across regions, given that regions in the same country share very similar historical, institutional and macroeconomic arrangements.[3] Analyzing the regional variability of homeownership rates hence creates the important opportunity to gain more insight about the regional-economic and socio-demographic factors affecting household tenure choice. In particular, it allows to determine the contribution of regional housing market conditions on homeownership outcomes, which has interesting ramifications for regionally oriented housing policies. The use of regional data also enables the explicit modeling of space, a factor with particular relevance for housing markets that is virtually ignored in both household and cross-country analysis.

Among economic factors potentially generating regional homeownership disparities, the housing literature points to two primary variables, namely regional differences in the relative costs of owner-occupied versus rental housing and regional differences in capital requirements for home purchase that affect homeownership affordability (Meen, 2001). Theory suggests that the proportion of owner-occupiers should be high in regions where house prices are low in comparison to rents, and where incomes are sufficiently high and stable to carry the financial burden of servicing long-term debt. The special features of the German housing market create a unique opportunity for studying these economic propositions empirically. First, the German housing market is characterized by a strong sector for rental housing (Hubert, 1998). Private renting is a close substitute for homeownership anywhere in the country, but regional rent levels still vary considerably. Second, the German system of mortgage lending is characterized by substantial down payment requirements, long-term fixed rate loans, and high transaction costs (Voigtlander, 2009). These features may impose significant barriers on homeownership affordability in regions where house values are high in comparison to incomes.

[3] The role of institutions is particularly emphasized when it comes to explaining the low homeownership rate in Germany. A recent study by Voigtlander (2009) lists the price regulation of rental housing, the strong legal protection of tenants, the absence of strong tax incentives for homeowners, and a conservative mortgage lending system among the most influential factors.

We subsequently investigate the extent to which cross-regional variation in homeownership rates can be ascribed to the aforementioned economic fundamentals. For this purpose, we analyze in a novel way owner-occupation rates over 96 functional German regions, using data for 2006. The use of spatially disaggregated data enables us to examine the relationship between regional homeownership rates and the price of owner-occupied housing (both relative to rental housing and household incomes within a region), as well as a regions demography, settlement structure, and labor market performance. In addition to OLS estimates, empirical results are presented for a selection of augmented spatial models, which take spatial dependence between regions into account. All estimations suggest regional homeownership disparities to be indeed strongly associated with our measures of relative regional housing prices and homeownership affordability. Regional differences in household size, age composition, urbanization, and employment levels also explain why homeownership rates differ across space, while a structural homeownership gap is found to exist between west and east German regions. Our analysis represents the first examination of regional homeownership for the German housing market, but the findings are likely to apply to other economies as well. In particular, this holds true for countries with similarly conservative systems of housing finance.

The remainder of this study is structured as follows. Sections 2 and 3 review the economic theory of housing tenure choice and previous empirical research on homeownership at the regional level. Section 4 yields a detailed discussion of our explanatory variables, while Sections 5 and 6 describe data and methodology. The estimation results are presented in Section 7. Section 8 offers conclusions and policy implications.

2 Economic theory of housing tenure choice

In each regional housing market, households must decide on the quantity of demand for housing services and whether to own or to rent their housing unit. The regional rate of homeownership then simply reflects the summation of individual tenure choice decisions by resident households. Microeconomic theory of housing tenure choice accordingly represents an appropriate tool for deriving hypotheses about aggregate regional homeownership rates (Megbolugbe and Linneman, 1993).

Traditional models of tenure choice rely heavily on standard neoclassical theory.[4]

[4] A comprehensive review of the more traditional tenure choice models is provided in surveys by Arnott (1987) and Whitehead (1999).

In these models, the demand for homeownership is part of a households decision on how to optimally allocate income (or wealth) between housing and other goods, with the quantity of housing and the form of tenure chosen simultaneously (Poterba, 1984; Swan, 1984; Goodman, 1988). The usual propositions of multi-period utility maximization subject to a budget constraint and a given set of prices apply: the choice of tenure depends only on (permanent) income, the relative price of owner-occupied versus rental housing, the prices of other consumption goods, and preferences that are directly related to the socio-demographic characteristics of the household under consideration.

The seminal model of Poterba (1984) fully integrates homeownership demand into a neoclassical general competitive equilibrium framework. A specific feature of this model is its emphasis on the dual role of owner-occupied housing, which incorporates both the features of a consumption good and a durable investment good. Recognizing this duality enables the theoretical deduction of a comprehensive measure of the so-called user cost of ownership: while the cost of rental housing is simply rent per time period, the user cost of ownership represents the imputed net cost of housing for homeowners, including possible capital gains. The user cost can be computed as the product of capital invested in the home (equaling its market value) and the homeowner's average cost of capital, which comprises interest, depreciation and maintenance, property tax, and expected capital gains on the house.[5]

A central proposition of the Poterba model is that because households compare the user cost of owning against the cost of rental housing, there must always be a close connection between owner-occupied and rental housing. In competitive equilibrium (i.e., in the absence of market imperfections), the cost of owning will equal the market price of rental housing, and the marginal household is indifferent between owning and renting.[6] In this context, only government policy can distort the relative attractiveness of either form of tenure. Public policy may, for instance, alter the relative cost of owning and renting by tax policy. Since the user cost of owning includes mortgage interest and property taxes, allowing the deduction of these expenses from the income tax base (while not taxing the imputed rent accruing from

[5] If P^H equals house value, i denotes interest, dm depreciation and maintenance, τ effective property tax, and $E(\pi^H)$ expected (nominal) house price appreciation, the user costs of ownership result in the following formula: $UC^{own} = P^H[i + dm + \tau - E(\pi^H)]$. The formula has been adapted to the German tax system, in which imputed rent from owner-occupied housing is not taxed. Interest payments, depreciation and maintenance expenses, and property taxes are not deductable from the income tax base. After a 10-year holding period, capital gains are also not subject to taxation.

[6] Due to market imperfections, prices and rents can however diverge from their long-run equilibrium values for longer periods in practice.

owner-occupation) creates a tax wedge which renders owning more favorable than renting. As this tax wedge increases with income, homeownership becomes relatively more attractive to higher-income households.

In contrast to traditional neoclassical models, more recent models of tenure choice place considerably more emphasis on idiosyncratic imperfections in the housing market.[7] Among the most notable forms of imperfection are uncertainty, transaction and coordination costs, and credit constraints. According to the model of Henderson and Ioannides (1983), homeownership decisions are affected by the degree of a household‘s risk-aversion. Since households are poorly able to diversify away from owner-occupied housing as a risky asset, more risk-averse households tend to rent. Labor income risk is another relevant form of uncertainty in the homeownership context. Since the bulk of household income is labor earnings, the propensity of ownership decreases with higher levels of wage uncertainty, in particular with a higher risk of becoming unemployed (Haurin, 1991; Ortalo-Magne and Rady, 2002). Another group of models points to the importance of transaction costs associated with home selling and purchasing. Since transaction costs delay the financial amortization of the ownership investment, the propensity of homeownership typically decreases with greater levels of expected mobility (Haurin and Gill, 2002).

A key issue of modern tenure choice models is their emphasis on borrowing constraints in housing finance. Since house values considerably exceed rental payments, households usually depend on external financing in order to become homeowners. In the presence of information asymmetry, lenders however require a down payment in order to mitigate credit risk. This forces equity-constrained households to rent until sufficient equity is accumulated (Artle and Varaiya, 1978; Brueckner, 1986). Borrowing constraints are thus closely related to the concept of financial homeownership affordability (Linneman and Megbolugbe, 1992; Bourassa, 1996; Stone, 2006). Several empirical studies indicate that a lack of mortgage access indeed decreases the propensity of homeownership, and that credit constraints well explain why homeownership rates are low among young and minority households (Ermisch and Di Salvo, 1997; Andrew, 2007).[8]

From a regional perspective, it is important to understand that both the equity requirement needed to qualify for a loan and the interest burden rise with house value. This makes regional house price differentials a primary candidate for gener-

[7]A comprehensive review of these models is provided in a survey by Hubert (2006).

[8]Meen (2001) shows that borrowing constraints can be integrated in Poterbas user cost formula in form of a shadow price.

ating regional homeownership disparities. Engelhardt (1994) points out that in the presence of uncertainty, down payment ratios are positively correlated with average house values, arguing that higher house values imply larger loan volumes. As potential losses rise proportionally to outstanding loans, risk-averse lenders demand higher down payment ratios in order to mitigate additional risk. In regions with high house price levels, the income requirements of obtaining and carrying a mortgage may hence be substantial, rendering the path to homeownership more difficult. Credit constraints are of particular relevance under the German lending system, where homebuyers have to make substantial down payments instead of taking out 100 per cent loans.[9]

The factors discussed above all address the demand for homeownership. However, the origins of regional homeownership disparities are not necessarily limited to the demand side of the housing market. Modern property rights theory suggests that there should be a close relationship between homeownership, building density, and the physical composition of the housing stock, which are in turn closely linked to a region‘s rate of urbanization (Glaeser, 2011). Homeownership is ultimately a form of contract helping to mitigate the coordination problems associated with housing investment decisions (Henderson and Ioannides, 1989). Since the costs of coordinating maintenance and other investment decisions usually scale up with building size, homeownership is less common in multi-family structures, which dominate most urban areas in Germany.[10] Scale economies in renting out multi-family houses and restrictions in land supply are two further arguments why higher population densities should crowd out homeownership (Linneman, 1986; Hansen and Skak, 2005).

3 Previous related research

One of the first attempts at regional homeownership research was provided by Eilbott and Binkowski (1985) for US metropolitan regions. These researchers find the inter-metropolitan variation in homeownership rates to be associated with regional differences in the size and age distribution of households, income and house price levels, and recent population growth. They conclude that the use of regional data yields results that are consistent with studies based on microeconomic data. A subsequent study of Blackley and Follain (1988) extended the analysis of Eilbott and

[9]According to Proxenos (2002), typical loan-to-value ratios average between 60 and 80 per cent.

[10]Unsurprisingly, one- and two-family homes are significantly more likely to be owned than rented. In 2006, 80 per cent of all owner-occupied housing units were located in these types of buildings.

Binkowski (1985) by the use of pooled cross-sectional data and a differentiation between demographic subgroups. Their econometric results confirm the importance of socio-demographic characteristics, household incomes, and housing prices as sources of regional homeownership disparities. The authors also find that the relative contribution of each variable differs across household types.

A study by Coulson (2002) combines micro and aggregate data to estimate the partial effects of various socio-demographic and economic factors on regional (state-level) homeownership rates in the US. In order to replicate regional homeownership rates, average homeownership probabilities derived from regionally stratified household samples are combined with market-level variables reflecting structural differences in regional housing markets. Coulson finds that regional market-level variables such as population density, geographic location and the relative costs of owning and renting have a greater explanatory power for regional variability of homeownership rates than demographic or income differences. He concludes that variables related to the supply side of regional housing markets may play a more prominent role for interregional homeownership variation than assumed in previous studies.

In a recent study, Lauridsen et al. (2009) investigate the geographic heterogeneity of homeownership rates across Danish municipalities. They assess the relative impact of regional house price levels, short and medium term house price changes, public regulation, socio-demographic factors, and various factors related to the supply side of regional housing markets. While considerable temporal as well as geographic variation in the effects are found, their results point to the size and socio-demographic composition of households, the level of urbanization, regional house values, and public regulation as the most important explanatory variables. To our knowledge, their study marks one of the first to use data from a European country to explain regional tenure choice disparities in more depth. These authors are also the first to apply spatial econometric techniques to the problem at hand.

Altogether, the few existing regional studies corroborate most theoretical propositions. However, evidence on the relationship between regional housing prices and homeownership seems not entirely convincing, as some studies do not control for the regional cost of rental housing or fail to find a statistically significant coefficient for that variable. Some earlier studies are likely to suffer from omitted variables and spatial dependency in the data, while the considered regions are highly heterogeneous and seldomly conform to functional areas. Since the majority of studies examines regions in the US, little is also known about the role of regional house prices in the presence of more conservative mortgage lending standards.

4 Selection of explanatory variables

Guided by theoretical considerations and the findings of previous studies, we expect regional differences in homeownership rates (HOR) to be linked to regional differences in the price of owner-occupied housing relative to the price of rental housing (P^{own}/P^{rent}), the regional level of homeownership affordability (measured by the ratio of house prices to disposable household incomes P^{own}/Y^{disp}), the socio-demographic population composition (captured by the vector DC), and some further control variables (included in the vector X):

$$HOR_i = f(\frac{P_i^{own}}{P_i^{rent}}, \frac{P_i^{own}}{Y_i^{disp}}, DC_i, X_i) \tag{1}$$

Regional price-to-rent ratio

The price-to-rent ratio captures differences in the relative prices of owning and renting across regions. The price-to-rent ratio directly compares the regional median value of standard owner-occupied homes with the median annual market rent for standard rental apartments. Theory suggests that the higher the level of homes prices in comparison to rent levels, the less attractive the mode of owner-occupancy and thus the rate of homeownership.

As discussed earlier, average regional house prices are not necessarily perfectly correlated with average regional user costs of owning, which also comprise interest, depreciation and maintenance, property tax and expected house price appreciation. In order to compute an exact measure of the regional user cost of owning, it would be necessary to account for systematic regional differences in each cost component. This task is severely constrained by data limitations and conceptual problems (Garner and Verbrugge, 2009). More importantly for our purposes, interregional differences in homeownership costs should be mainly driven by differences in average house values instead of differences in capital costs. With perfect capital mobility, interest rates are the same for all regions, and it is reasonable to assume that maintenance and depreciation rates also do not vary strongly across regions. Regional variation in property tax rates clearly exists, but should barely affect user costs given the extremely low effective level of the German property tax.[11] A further argument for omitting differences in effective property tax rates and other operating expenses is that these differences should largely be capitalized into differences in property

[11] According to Spahn (2004), the effective property tax rate (the ratio of annual nominal tax burden to the market value of the house) average between 0.1 and 0.2 per cent.

values between jurisdictions (Goodman, 1983). In contrast, expected appreciation in regional house values may affect homeownership rates more decisively. In order to capture these effects, with regional rates of urbanization and recent changes in average regional house values we include two second-order variables that are related to regional user costs.

Regional price-to-income ratio
In addition to the price-to-rent ratio, in the regional price-to-income ratio we employ an aggregate measure of financial homeownership affordability. By relating regional house prices to average disposable incomes, the price-to-income ratio captures the income requirements for purchasing a standard home in a certain region. As higher house prices relative to household incomes increase the severity of capital constraints, regions with high price-to-income ratios are expected to have lower homeownership rates. It is established that the price-to-income ratio provides an adequate indicator of homeownership affordability in regional housing markets, particularly if combined with further variables related to credit constraints (Bogdon and Can, 1997; Green and Malpezzi, 2003). The measure still has to be interpreted carefully, as it does not account for regional differences in housing preferences and in non-housing costs of living (Stone, 2006). Furthermore, its numerator refers to a market with a disproportional share of higher-income households, while its denominator refers to the entire household population (Girouard et al., 2006).

Regional socio-demographic composition
Among this variable group, we include the proportions of minors (persons aged under 18 years), young adults (persons aged 18-25 years), elderly adults (persons aged 50-65 years) and foreigners (persons without German citizenship) in the regional population. We also control for average household size. Higher proportions of minors and elderly adults are expected to be associated positively with homeownership, as is average household size. Larger households, and particularly families with minors, tend to favor owning over renting due the demand for more living space (e.g., gardens) or a higher demand for housing autonomy (Mulder, 2006). Elderly adults tend to own because of wealth effects and lower expected mobility. Cohort effects may also play a role, given that homeownership was basically more affordable when these households became owners in the past. By contrast, we anticipate higher proportions of young adults and foreigners to be negatively associated with homeownership. Both demographic groups are usually characterized by high expected mobility rates (e.g., changing workplaces) as well as restricted access to external finance.

Regional rate of urbanization
Due to building density and congestion effects, the regional rate of urbanization (measured by the proportion of residents living in municipalities with a minimum population density of $150/km^2$) is considered as an important supply-side variable related to the rate of owner-occupation. We also expect this variable to capture regional differences in unobserved user cost components. Urbanized areas are typically characterized by high proportions of multi-family dwellings in the housing stock, increased levels of land scarcity, and high ownership operating expenses, all of which should impede homeownership.

Regional unemployment
The regional rate of unemployment (2002-2006 average) is included as a second-order variable related to the affordability of homeownership in the context of credit constraints. The regional unemployment rate is inversely related to the proportion of households with a job status and salary enabling them to obtain and repay a long-term mortgage. Unemployment furthermore serves as an indicator of regional labor market risk, utilizing that residents in low unemployment regions have better employment opportunities and also earn higher wages.

Recent change in regional house values
The regional demand for owner-occupied housing depends not only on current house price levels, but also on expectations of future price developments. While high house values dampen demand, the expectation of further price increases may trigger additional investment incentives that outweigh increased affordability concerns (Myers et al., 2005). There is plenty of evidence that housing market activity is cyclical and that households tend to engage in speculative behaviour in regions where house prices are increasing, while the opposite holds true in the presence of declining house prices (Muellbauer and Murphy, 1997; Muellbauer, 2008). We test the link between house price change and homeownership demand by including regional house price change rates over 2004-2006. The underlying assumption is that market participants form backward-looking expectations of future property values.

East Germany dummy variable
For historical reasons, we still expect homeownership rates in east German regions (including Berlin) to differ structurally from western German ones. Homeownership played only a very limited role in the GDR socialist housing system, which restricted private property in housing politically.

5 Data

The computation of regional homeownership rates requires household-level data that identifies both the status of housing tenure and the geographical region in which a household is located. In the German case, housing tenure mode is surveyed in quadrennial intervals in a supplementary survey of the German Microcensus, a random sample covering one per cent of the total German household population (about 380.000 households). All of our estimations rely on regional homeownership rates for 2006, the most recent year for which household tenure status has been reported in the Microcensus.[12] We use a sample of $N = 96$ planning regions *(Raumordnungsregionen)*, the smallest consistent geographical unit for which homeownership rates are reliably estimable based on Microcensus data. Since their delineation is based on commuting patterns, planning regions represent reasonable proxies for functional areas.

The data on regional homeownership rates, price-to-rent ratios and price-to-income ratios were provided by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (*Bundesamt für Bau-, Stadt- und Raumforschung*), BBSR. While homeownership rates refer to the Microcensus, price-to-rent and price-to-income ratios refer to the BBSR regionalized housing monitoring system, a comprehensive database on regionalized housing prices. The BBSR uses internet platform ads for standard owner-occupied homes and rental apartments to calculate regionally representative median house prices and rents (Sigismund, 2005). Through the large number of observations (more than 1.4 million ads per year), high spatial coverage is achieved.[13] True market prices might, however, be overestimated, as offer instead of transaction prices are observed (von der Lippe and Breuer, 2010). The data on the remaining variables were obtained from various official sources.[14]

Table 1 documents selected descriptive statistics for the included variables. For each variable, we report overall means as well as conditional means by type of region, differentiating between western and east German as well as between rural, urban and agglomerated regions.[15] As measures of interregional variation and global spatial au-

[12]Due to an irregularity in the conduction of the Microcensus, new data on tenure choice will not become available before 2012. Homeownership data prior to 2006 cannot be used for our purposes, because data on regional price-to-rent and price-to-income ratios is available only from 2004 onwards.

[13]All observations are corrected for double counts and implausible outliers.

[14]A detailed description of definitions and data sources is given in the Appendix.

[15]Our classification follows the official BBSR definition. Rural regions comprise areas with a population density lower than $100/km^2$ and areas with a population density of $100 - 150/km^2$ which do not contain a city with at least 100,000 inhabitants. Urbanized regions comprise areas with a population density

tocorrelation, we furthermore report variation coefficients[16] and Moran‘s I statistics (Cliff and Ord, 1981).[17]

As shown in Table 1, the 2006 mean regional homeownership rate was 45%. The average homeownership rate of western regions (47.8%) exceeded that of eastern regions (35.6%) by more than ten percentage points. Conditional means for rural regions, urbanized regions and agglomerations show that almost half of all households owned their homes in rural and urban locations, while the average homeownership rate in agglomeration regions was considerably lower (36.5%). The variation coefficient reveals that homeownership rates vary stronger across space than price-to-rent ratios, price-to-income ratios, and most demographic variables. Unemployment and urbanization vary even more, as do recent regional house price changes. Concerning the geographic distributions, Moran‘s I indicates positive spatial autocorrelation (significant at the 1%-level) both for the dependent and the independent variables (with the only exception of regional house price change).[18] The degree of spatial autocorrelation in homeownership rates turns out to be comparatively modest, while high values are found for price-to-rent ratios, unemployment rates, and also some demographic variables. This highlights the need to account appropriately for spatial dependence in the upcoming estimations.

As graphical supplements to Table 1, Figures 1 to 3 illustrate the distribution of homeownership rates, price-to-rent ratios, and price-to-income ratios across space. Most regions characterized by high homeownership rates are shown to be located in the north-western and southern part of the country. Comparatively low levels are found for almost the entire eastern part as well as for important agglomeration regions like Berlin, Hamburg and the Rhein-Ruhr area. In analogy to homeownership, price-to-rent ratios and price-to-income ratios vary substantially across regions and tend to cluster in space, with east German regions yielding comparatively low values. Both relative to rents and incomes, house prices generally increase with higher levels of urbanization. Interregional house price differences are generally not offset

of $150 - 300/km^2$ and areas with a population density of $100 - 150/km^2$ which do contain a city of at least 100,000 inhabitants. Agglomeration regions comprise areas with a minimum population density of $300/km^2$ and areas which contain a city with at least 300,000 inhabitants.

[16]The variation coefficient is defined by $VC = \frac{\sqrt{1/(N-1)\sum_{i=1}^{N} x_i - \overline{x}}}{1/N \sum_{i=1}^{N} x_i}$.

[17]Moran‘s I is defined by $I = \frac{N}{W_0} \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} w_{ij}(x_i - \overline{x})(x_j - \overline{x})}{\sum_{i=1}^{N}(x_i - \overline{x})^2}$ with $W_0 = \sum_{i=1}^{N}\sum_{j \neq 1}^{N} w_{ij}$.

[18]Statistical significances for the Moran‘s I values were calculated using permutation tests.

Variable	Overall	West	East	Rural	Urban	Aggl.	VC	Morans I
Homeownership rate	45.0	47.8	35.6	47.5	48.0	36.5	0.22	0.35
Price-rent ratio	23.40	24.56	19.49	22.31	23.10	25.14	0.20	0.70
Price-income ratio	4.94	5.05	4.56	4.55	4.70	5.81	0.14	0.40
Household size	2.15	2.17	2.06	2.19	2.18	2.04	0.06	0.26
Prop. below 18 years	17.4	18.5	13.7	17.0	17.9	17.0	0.13	0.75
Prop. 18-25 years	8.4	8.1	9.4	8.6	8.4	8.2	0.09	0.53
Prop. 50-65 years	18.4	17.9	20.0	18.7	18.2	18.3	0.06	0.60
Prop. foreign	7.1	8.4	2.9	4.4	6.5	11.4	0.53	0.50
House price change	-1.63	-1.55	-1.90	-1.15	-1.55	-2.28	2.03	0.01
Unemployment rate	12.0	9.6	20.2	13.6	11.2	11.7	0.43	0.84
Urbanization rate	69.3	72.6	57.9	43.7	70.2	95.2	0.30	0.33
Dummy east	0.22	0	1	0.38	0.20	0.13	1.84	0.84
Observations	96	74	22	26	46	24	96	96

Table 1: Descriptive statistics for the included variables

by corresponding differences in incomes, an observation that is consistent with a long-term income elasticity of house prices greater than one (Meen, 2001).

6 Econometric approach

As a starting point for our investigation of regional homeownership disparities, we estimate a standard multiple linear regression model:

$$y = X\beta + u \tag{2}$$

with y denoting a N-dimensional vector of regional homeownership rate observations, X denoting a $N \times K$ matrix including regional observations for all previously defined explanatory variables, β a K-dimensional vector of regression coefficients, and u a N-dimensional vector of stochastic innovations with usual properties.

While this basic OLS model is useful as a reference, it has some methodological drawbacks. First, each unit of observation represents a region located in space. This makes spatial dependence between the observations a likely scenario. As pointed out by Meen (2001), regional dependence in housing markets can arise from both systematic linkages and non-systematic shocks. While systematic linkages take the form of migration, commuting, or spatial arbitrage, non-systematic linkages simply arise from inappropriate geographical delineation.[19] Inappropriate delineation could

[19]The latter case has become known as the modifiable areal unit problem (Openshaw and Taylor, 1983).

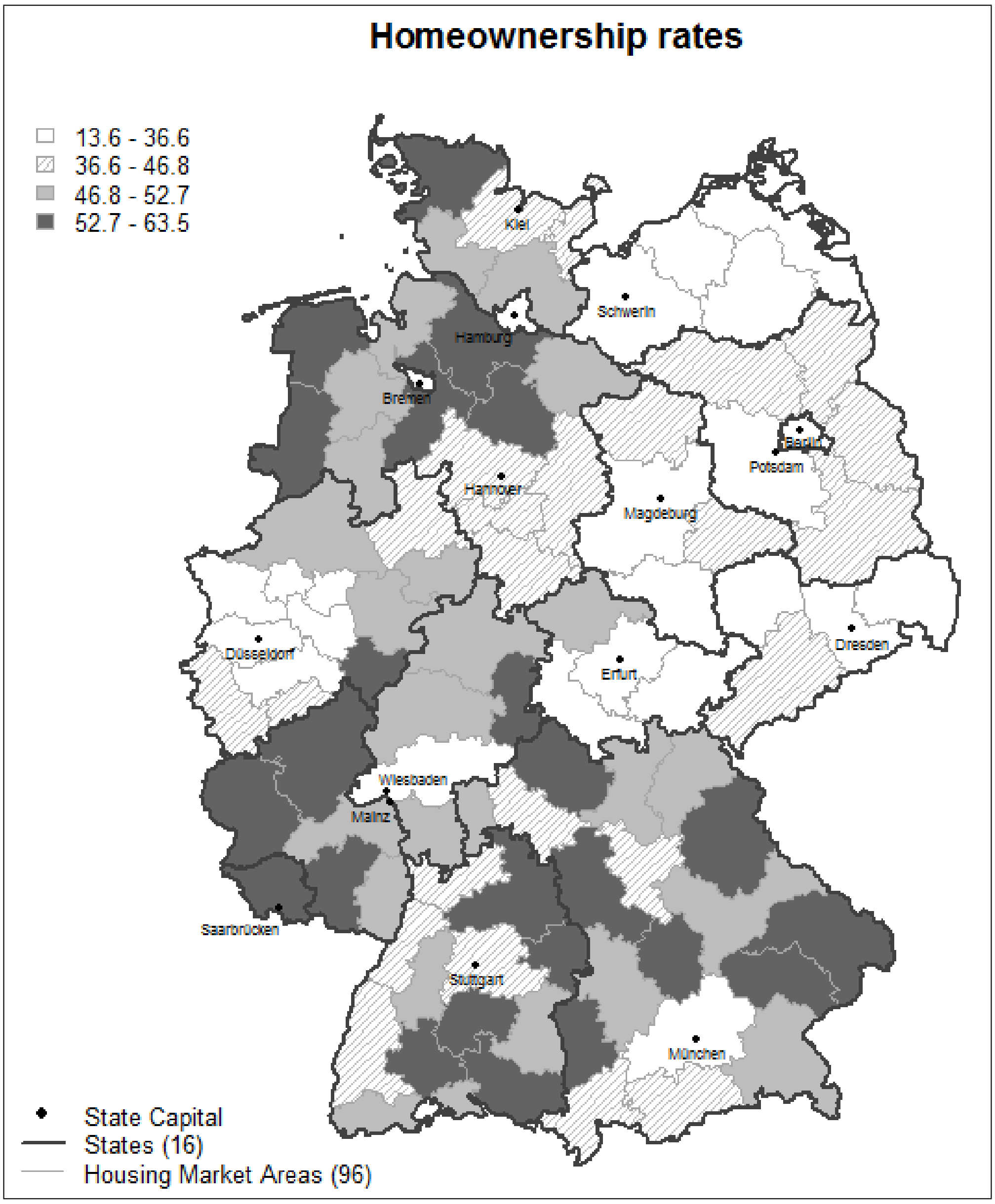

Figure 1: Spatial distribution of homeownership rates, 2006

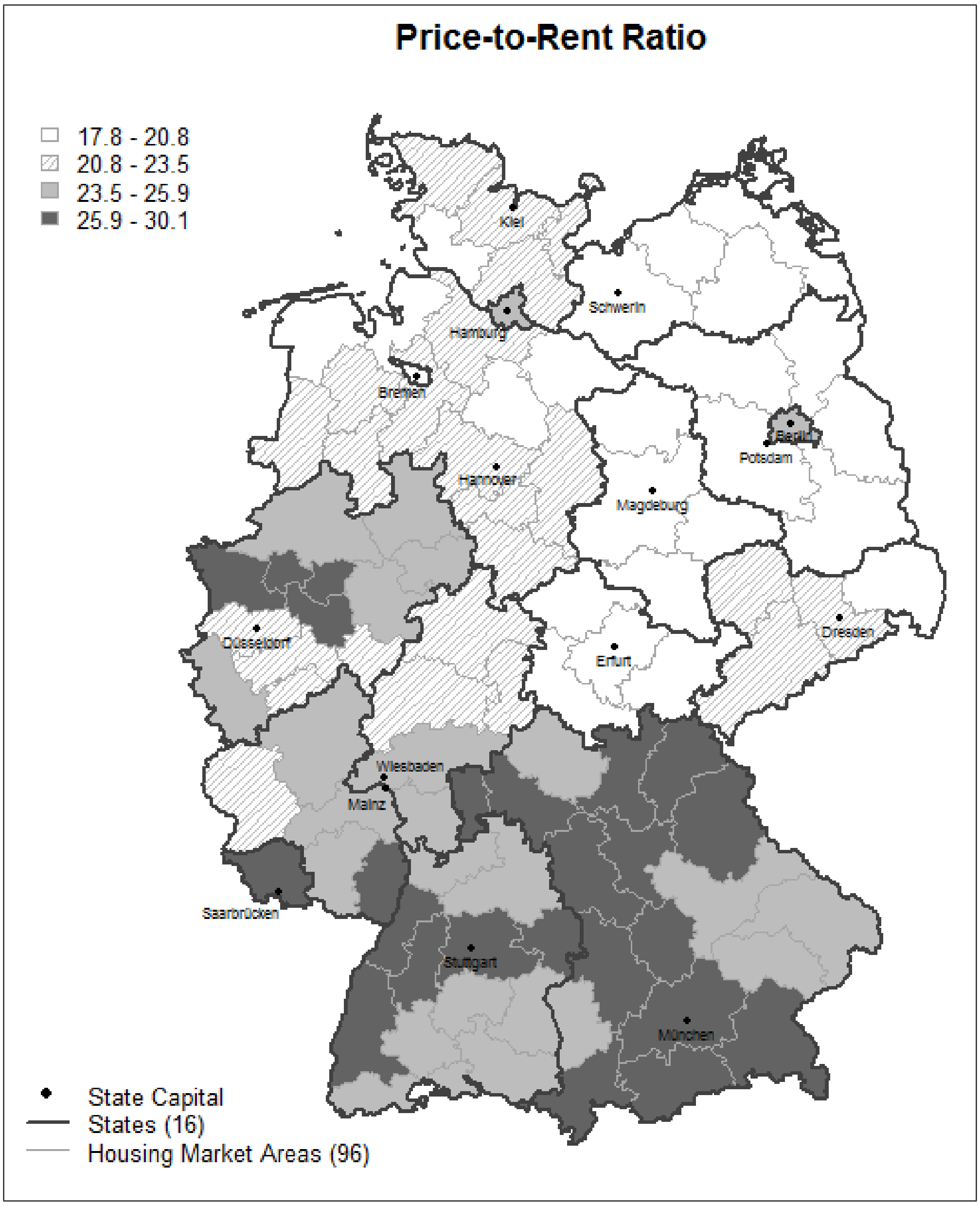

Figure 2: Spatial distribution of price-to-rent ratios, 2006

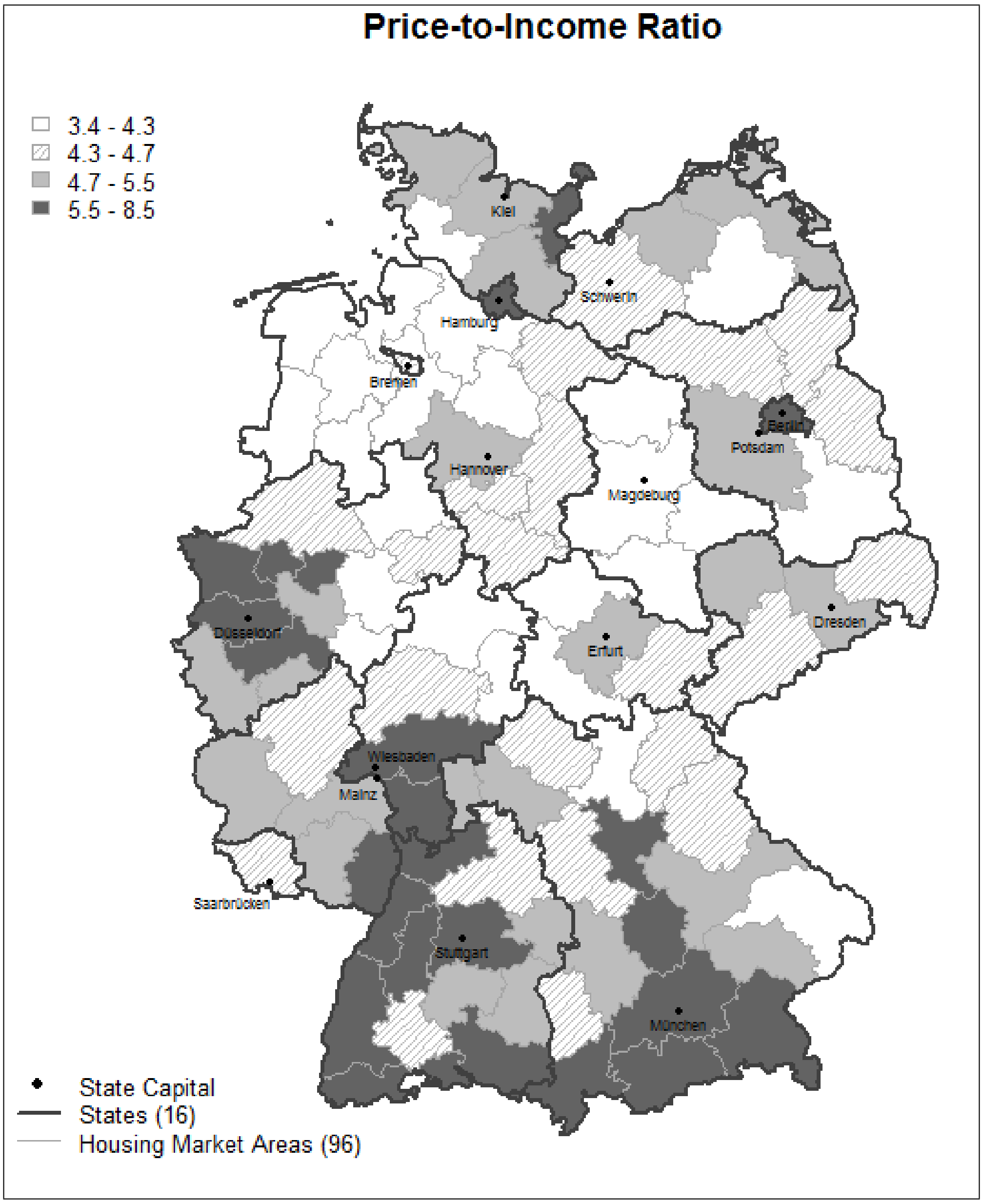

Figure 3: Spatial distribution of price-to-income ratios, 2006

indeed be present in our case, given that even functional areas virtually never coincide with 'true' regional housing markets. In the presence of spatial dependence, the OLS estimator is known to be no longer the best linear unbiased estimator; while spatial dependence in the dependent variable causes bias in OLS estimates, spatial dependence in the error terms leads to asymptotically unbiased but inefficient estimates (Anselin, 1988; Anselin et al., 2004). Hence, the cost of ignoring spatial dependence in the homeownership rate would be high, relative to ignoring spatial dependence in the residuals.

A second potential source of bias is the existence of unobserved regional characteristics that exert an influence on regional homeownership rates. For instance, the share of owner-occupiers in a given area may be affected by unobserved preferences for homeownership, e.g. regional traditions. If any of the omitted factors correlate with the explanatory variables, their influence may wrongly be attributed to the included covariates. Using cross-sectional OLS - i.e., in the absence of a panel - it is not possible to control directly for unobserved regional characteristics. However, it is well-established in spatial econometrics that the inclusion of spatial lags in the dependent and the explanatory variables allows to capture unobserved regional characteristics indirectly (LeSage and Pace, 2009). Put differently, modeling spatial dependence can act as a substitute for regional fixed effects.[20] The intuitive reason is that neighboring regions are likely to have unobserved regional characteristics in common and hence exhibit spatial dependence on their own.

The simultaneous presence of spatial dependence and omitted variables provides a very strong motivation to use spatial models in our empirical investigation. As Pace and LeSage (2010) point out, spatial dependence amplifies conventional omitted variable bias when there is non-zero correlation between the included explanatory variables and any omitted regional characteristics. The magnitude of bias amplification depends on the relative strength of spatial dependence in the dependent variable, the independent variables, and the disturbances. We believe that independence of included and unobserved variables is unlikely in our case, given that any latent regional characteristics should exhibit very similar patterns of spatial dependence as the included variables.

We hence choose to estimate a selection of models accounting for combinations of spatial dependence in the dependent variable, the explanatory variables, and the disturbances.[21] In order to address the uncertainty regarding presence of spatial

[20] We thank an anonymous referee for pointing out this important fact.

[21] In regional science, spatial dependence is often dealt with by first estimating models with a spatial lag

dependence in the dependent variable versus the disturbances, we first estimate a model that includes both a spatial lag in the dependent variable and a spatial autoregressive process for the disturbances:

$$y = \rho W y + X\beta + \epsilon, \quad \epsilon = \lambda W \epsilon + u \tag{3}$$

The above model has been labeled spatial simultaneous autoregressive model (SAC) by LeSage and Pace (2009) and spatial autoregressive model with autoregressive disturbances (SARAR) by Kelejian and Prucha (1998). In (3), y, X, β and u are the same as in (2), W denotes an $N \times N$ row-stochastic spatial weight matrix representing the structure of spatial connectivity between the included regions, ρ and λ are scalar parameters, and ϵ is a disturbance term governed by a spatial autoregressive process. Since this model nests both the spatial lag model (SL) and the spatial error model (SE), it allows for both possible forms of spatial dependence simultaneously. In the case of $\rho = 0$, the model reduces to the SE model, while in the case of $\lambda = 0$, it reduces to a SL model.

While it is useful for distinguishing systematic from unsystematic dependence, a shortcoming of the SAC model is that it does not allow for spatial lags in the explanatory variables. Including such lags might however be useful in the presence of unobserved, spatially dependent regional characteristics. In these situations, the literature advises the use of spatial Durbin models, a class of models including spatial lags of the explanatory variables together with either a spatial lag in the dependent variable or a spatially autoregressive error term. The use of spatial Durbin models for applied practice has been particularly advocated by Pace and LeSage (2010) and Elhorst (2010), who argue that spatial dependence in the explanatory variables can influence the performance of spatial models in relation to OLS models substantially. Only in the special case that the dependent variable does not exhibit spatial dependence, and there are no spatially dependent omitted variables correlated with the included covariates, OLS and spatial Durbin models should yield similar parameter estimates.

Building on the SAC model results, we estimate a model that features both a vector of spatially lagged explanatory variables and a spatially autocorrelated error

in the dependent variable (spatial lag model) and models with a spatially autoregressive error term (spatial error model) separately, and then choosing the appropriate model via a Lagrange multiplier test. This approach has been criticized in the literature on various grounds (LeSage and Pace, 2009). In comparison to testing models with just one spatial dependence parameter separately, estimating combinations of spatial effects provides richer information on spatial patterns (Elhorst, 2010).

term, labeled spatial Durbin error model (SDEM) by LeSage and Pace (2009):

$$y = X\beta + WX\gamma + \epsilon, \quad \epsilon = \lambda W\epsilon + u \tag{4}$$

In (4), y, X, β, λ, W and u are equal to (3), while γ denotes a K-dimensional vector that indicates the spatial dependency in the explanatory variables.[22]

The specific form of W is probably the strongest assumption of the spatial analysis, since it must be defined a-priori. The spatial weights included in this matrix are usually interpreted as functions of economic or geographic proximity between spatial units. Yet, economic theory provides little guidance to specifying these weights. In order to examine the robustness of the results with respect to the form of W, we employ three different weight matrices. Our reference matrix is a row-stochastic first-order queen-contiguity matrix with $w_{ij} = \frac{1}{n_i}$ if regions i, j $(i \neq j)$ share common borders and 0 otherwise, with n_i denoting the number of neighbors of region i. In addition to the first-order contiguity matrix, all calculations were performed for a four-nearest-neighbor inverse distance matrix (using Euclidean distances between the regions centroids) and for a 90 km-threshold-distance matrix. The results turned out to be largely insensitive to the alternative weight matrices.[23]

7 Estimation results

Table 2 reports estimation results for the OLS model and the two augmented spatial models SAC and SDEM. The spatial models were estimated using Maximum likelihood with Monte Carlo approximate log-determinants as proposed by Pace and LeSage (2004) and computationally implemented in R by Bivand et al. (2011). All presented results draw upon the reference first-order contiguity matrix. In order to compare the alternative models, we provide some summarizing measures. For each model, we report R-square values, error variances and Akaike and Schwarz criteria. For the spatial models, we additionally document log-likelihoods as well as the likelihood ratio and Wald statistics for testing on joint significance of the spatial parameters. To infer the presence of spatial autocorrelation, we furthermore report Lagrange multiplier tests for error dependence and the Moran‘s I statistic for the estimated residuals.

[22] We also estimated an spatial Durbin model (SDM) in which the spatial autoregressive process in the disturbances was substituted by a spatial lag in the dependent variable: $y = \rho Wy + X\beta + WX\gamma + \epsilon$. The results came very close to those of the SDEM model and are not reported here.

[23] Results for different weight matrices are documented in Table 4 in the Appendix.

	OLS		SAC		SDEM	
Explanatory variable	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Price-rent ratio	-0.47** (0.23)	0.04	-0.42** (0.21)	0.04	-0.48** (0.20)	0.02
Price-income ratio	-1.91** (0.81)	0.02	-1.32* (0.79)	0.09	-1.73** (0.72)	0.02
Household size	23.28*** (7.17)	0.00	30.68*** (6.90)	0.00	18.95*** (6.56)	0.00
Prop. under 18	1.95** (0.77)	0.01	1.71** (0.74)	0.02	1.62** (0.72)	0.02
Prop. 18-25	0.94 (1.31)	0.48	0.78 (1.21)	0.52	1.42 (1.15)	0.21
Prop. 50-65	3.66*** (1.19)	0.00	3.83*** (1.04)	0.00	3.03*** (1.06)	0.00
Prop. foreign	-0.15 (0.27)	0.59	-0.37 (0.25)	0.15	-0.18 (0.25)	0.46
House price change	0.09 (0.13)	0.49	0.02 (0.11)	0.87	0.07 (0.11)	0.51
Unemployment rate	-1.06*** (0.22)	0.00	-0.58** (0.23)	0.01	-0.65*** (0.21)	0.00
Urbanization rate	-0.07** (0.03)	0.03	-0.05 (0.03)	0.12	-0.08** (0.03)	0.01
Dummy east	-3.04 (3.77)	0.42	-8.51** (3.64)	0.02	-6.59* (3.44)	0.06
Lag. Price-rent r.					-0.16 (0.44)	0.71
Lag. Price-income r.					-3.56** (1.70)	0.04
Lag. Household size					-55.92*** (15.73)	0.00
Lag. Prop. under 18					1.47 (1.55)	0.34
Lag. Prop. 18-25					2.75 (2.74)	0.32
Lag. Prop. 50-65					-2.24 (2.39)	0.35
Lag. Prop. foreign					1.11* (0.56)	0.05
Lag. House price ch.					0.20 (0.34)	0.55
Lag. Unemployment r.					-1.88*** (0.43)	0.00
Lag. Urbanization r.					-0.13** (0.06)	0.04
Lag. Dummy east					21.27** (7.89)	0.01
ρ (*"Spatial lag"*)			0.06 (0.13)	0.64		
λ (*"Spatial error"*)			0.54*** (0.14)	0.00	0.46** (0.15)	0.01
R^2	0.86		0.89		0.91	
Error variance (σ^2)	14.69		10.07		7.76	
AIC	543.6		532.4		524.4	
BIC	576.9		570.9		588.5	
Log-likelihood			-251.2		-237.2	
LR-test			15.14***	0.00	7.59***	0.01
Wald-test			14.81***	0.00	9.53***	0.00
LM_{err}-test	12.45***	0.00	0.01	0.93	0.14	0.71
Resid. Morans I	0.23***	0.00	0.01	0.39	0.02	0.29

Table 2: Estimation results (standard errors in parentheses)

All models explain a remarkably high share of the spatial variation in homeownership rates across the considered regions. With the only exception of the proportion of young adults (which is however insignificant), the estimated signs generally meet the theoretical expectations. Yet, the magnitudes of the coefficients differ slightly from model to model. Most explanatory variables are statistically significant throughout. The lack of significance of the remaining variables (proportion of young adults, proportion of foreigners, recent house price change) might be partially explained by multicollinearity as some demographic variables, the rate of urbanization, and the east Germany dummy exhibit considerable correlation among one another. The insignificance of the eastern dummy in the OLS model might also be explained by the inability of this model to account for the presence of spatial dependence in the data. Given a Moran‘s I value of +0.23, the null hypothesis of spatially uncorrelated error terms has to be rejected at any common significance level, a result that is confirmed by the LM test for error dependence.

The need to take spatial dependence into account is supported by the likelihood ratio and Wald tests. In contrast to the OLS model, the SAC and SDEM models are shown to fully capture spatial dependence, as indicated by the LM tests for error dependence and Moran‘s I for the residuals. The SAC model reveals the spatial lag in the dependent variable (ρ) to be insignificant, while a statistically significant spatial error parameter (λ) is estimated. Hence, this model reduces factually to a spatial error (SE) model and will be called SAC/SE model below. The finding of an insignificant spatial lag in homeownership rates and a significant spatial error process may reasonably be explained by the use of planning regions as proxies for functional housing market areas. The use of functional regions implies that spatial dependence processes should arise on statistical, rather than on theoretical grounds. Precisely, the fact that our regional units represent imperfect reflections of true housing markets, and the likely existence of relevant but unobserved factors that are spatially correlated, render non-systematic shocks more likely than systematic linkages.

The spatial dependence-robust SAC/SE model was subsequently augmented with spatial lags in the explanatory variables, resulting in the spatial Durbin error model (SDEM). As indicated, this form of expansion seemed reasonable given the methodological appeal of spatial Durbin models in the presence of spatially dependent omitted regional effects. The SDEM parameters for the spatially lagged covariates are presented in the right column of Table 2 below the ordinary coefficients. In terms of omitted variables and spatial dependence problems, we argue that the estimates of the SDEM model should be considered our most reliable ones, which provides a good justification for basing the coefficient interpretation on this model. Most of the reported summarizing measures also indicate the best fit to be achieved by this model. This impression is confirmed by Figure 4, which illustrates the standardized residuals by region. Only six of 96 standardized residuals lie beyond a reasonable range of +/-1.96, while no remaining spatial autocorrelation is apparent.

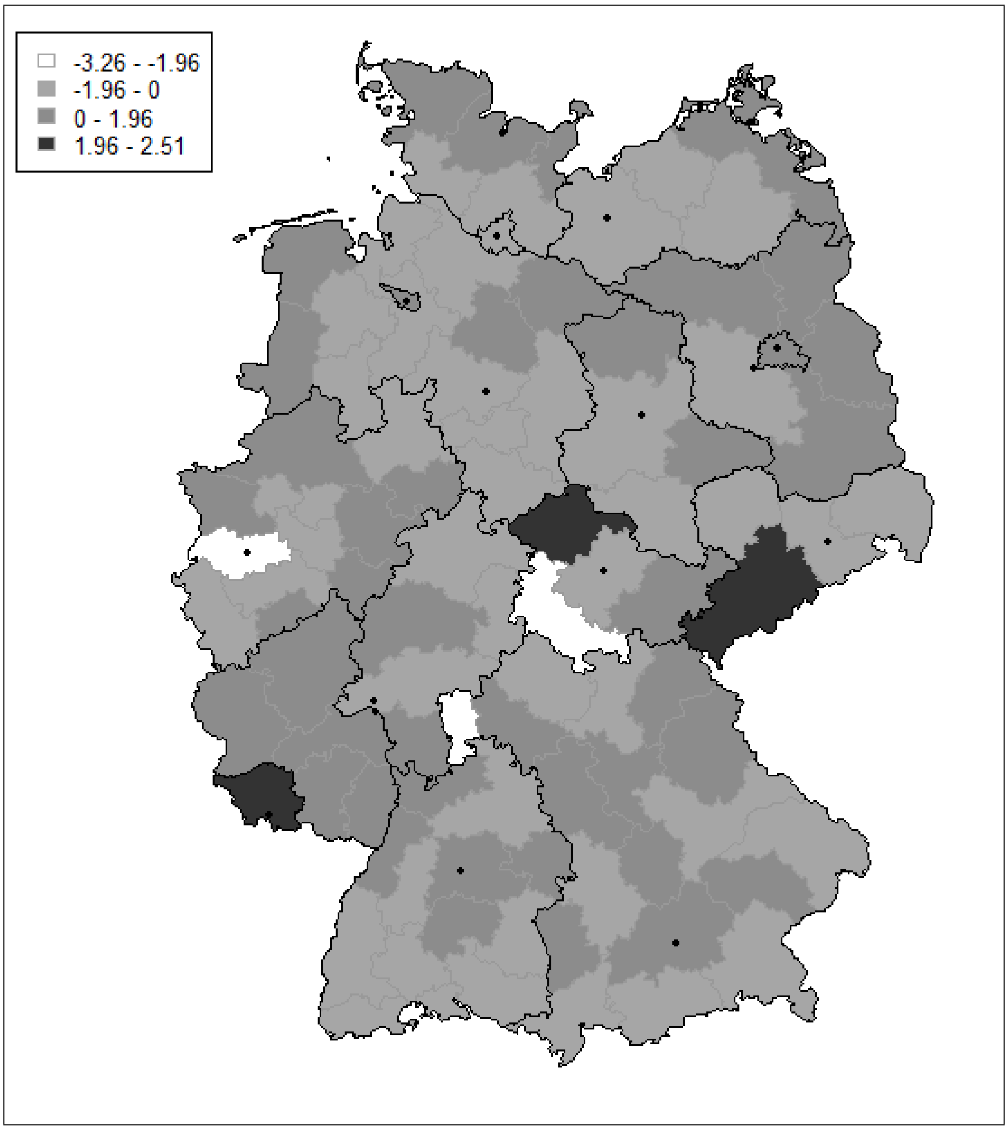

Figure 4: SDEM model standardized residuals by region

Before the parameters can be compared and interpreted, some caveats have to be mentioned. For the OLS model, the parameter estimates have the usual partial derivative interpretation; they indicate the average response of the regional home-ownership rate to variation in the explanatory variables across the regional sample, holding all other factors constant. For the SAC/SE model, the very same interpretation is valid, given that there is no evidence of a significant spatial lag in the dependent variable. Nonetheless, both the OLS and SAC/SE model may suffer from omitting unobserved regional characteristics. This source of bias is indirectly accounted for in the SDEM model, which uses spatial lags in the explanatory variables to resolve this problem. The inclusion of spatial lags however usually comes at a cost, given that parameter interpretation is more cumbersome relative to non-spatial models. An obvious implication of models that include spatial lags is that dependent variables are not solely affected by the regions own characteristics (a direct effect), but also by the characteristics of neighboring regions (an indirect effect).

In comparison to models including a spatial lag in the dependent variable (e.g., the ordinary spatial Durbin model), a beneficial feature of the SDEM model is that it considerably simplifies coefficient interpretation. LeSage and Pace (2009) demonstrate that the β-parameters of SDEM models correspond to direct partial effects, while the γ-parameters estimated on the spatially lagged explanatory variables represent the (cumulative) indirect effects.[24] The SDEM estimates for the partial contribution of each explanatory variable are thus readily comparable to the estimates of the OLS and SAC/SE models. The SDEM also enables to draw the usual inferences on the significance of the spatially lagged explanatory variables (the indirect effects). A quick glance at the lagged explanatory variables reveals that the magnitudes of the indirect effects usually exceed those of the direct effects. While this might seem counterintuitive, it becomes clearer when considering that the parameters denote the cumulative indirect effect of a change in a certain explanatory variable, summarizing the indirect effects over all other regions within the sample. The individual indirect effect falling on a particular neighboring region will always be considerably smaller than the average direct effect falling on the region itself.

Detailed parameter interpretation

Turning first to direct effects, both the regional price-to-rent ratio and regional

[24]For the SDEM, the partial effect of a change in an explanatory variable x_r on y can be obtained by $\frac{\delta y}{\delta x_k} = I_n\beta_k + W_n\gamma_k$ for all k, where $I_n\beta_k$ measures the direct effect and $W_n\gamma_k$ measures the indirect effect. $I_n\beta_k$ results in an $N \times N$ matrix that includes the respective β-coefficient on the diagonal, which can be interpreted as in the common OLS regressions. $W_n\gamma_k$ is the product of the spatial weight matrix with the considered spatial lag parameter γ_k. $W_n\gamma_r$ results in an $N \times N$ matrix that includes the SDEM-typical local multipliers. The average row sum corresponds to the average cumulative indirect effect (denoted by the γ_r).

price-to-income ratio obtain highly significant negative coefficients that are economically large. As anticipated, the finding of a significantly negative price-to-rent ratio supports the view that there is a high degree of arbitrage between the regional submarkets for owner-occupied and rental housing, and that low regional rent levels dampen the demand for homeownership. All else equal, in regions where house prices are high relative to rents, a higher proportion of households choose to rent. This result is consistent with the findings of Coulson (2002), who finds an inverse relationship between homeownership rates and price-to-rent ratios for states in the US. The SDEM estimate of -0.48 indicates that each increase in the regional price-to-rent ratio by two units (i.e., two additional annual rents) is associated with a decrease in homeownership rates of one percentage point on average.

As expected, the regional price-to-income ratio has independent explanative power for homeownership disparities. Holding regional price-to-rent ratios and other factors constant, the higher are regional house values relative to regional household incomes, the lower are regional homeownership rates. This is consistent with the view that higher average equity requirements and interest burdens render it more difficult for households of a given income to access homeownership in high-price regions. The SDEM estimate of -1.73 suggests that regional price-to-income ratios that are one additional income higher are associated with roughly two percentage points lower regional rates of homeownership. It seems worth noting that this finding does not reflect the fact that average house values are positively related to the size and population density of a region, since we included the rate of urbanization as a control variable. Thus, the coefficient of the price-to-income variable should barely be affected by housing supply effects, such as regional housing stock compositions.

The signs for the socio-demographic control variables are mostly in line with theory and the results of previous studies. The positive and highly significant association between homeownership and average regional household size supports the conjecture that larger households are more likely to own. Although there is some variation in the coefficient from model to model, the coefficients magnitude is substantial. The SDEM estimate of 18.95 indicates each increase in average regional household size by 0.1 persons to be associated with a roughly two percentage point higher rate of homeownership, indicating a considerable influence of household size on ownership. The positive and significant coefficients for the proportion of minors and elderly adults in the regional population support the hypothesis that the age composition of regions as well has a distinct effect on its homeownership rate. The proportion of foreigners carries the correct sign, but is not found to be significantly linked to regional homeownership rates. Somewhat surprisingly, the proportion of young adults throughout obtains a positive sign, but is also found to be insignificant.

Concerning the direct effects of the remaining control variables, regional homeownership rates are inversely related to both higher regional rates of urbanization and unemployment, and there is a significant unexplained homeownership gap between east German regions and their western counterparts. We meanwhile find no evidence that recent house price developments add to the explanation of cross-regional homeownership variation. The negatively signed urbanization variable indicates that, independent of higher house prices and other factors, higher levels of urbanization and congestion are associated with lower shares of homeowners, although the magnitude of the effect is somewhat small: a ten percentage point higher rate of urbanization is associated with a one percentage point lower rate of homeownership on regional average. The finding of a significantly negative unemployment variable supports the conjecture that regional unemployment exacerbates borrowing constraints, restricting household financial capacity and thereby lowering regional demand for homeownership. The distinctive geographical distribution of the unemployment variable may also contribute to this finding, as unemployment is highly concentrated in east Germany where homeownership rates are still lower for historical reasons.[25]

After discussing the direct effects, we now turn to the indirect spatial effects revealed by the SDEM model. Several lagged explanatory variables turn out to be significant, including lagged price-to-income ratios, lagged household sizes, lagged unemployment and urbanization rates, and the lagged east Germany dummy. Although the primary motivation for including the lags was capturing unobserved effects, the estimates reveal some interesting insights on the indirect spatial relationships between the explanatory variables and a regions homeownership rate. For instance, a regions homeownership rate is not solely affected by the price-to-income ratio in the region itself, but also by the homeownership affordability in neighboring regions. Put differently, high house prices relative to incomes in one particular region also have adverse impacts on homeownership in neighboring regions. According to the estimated parameters, a regional rise in the price-to-income ratio by one annual income is associated with a 1.7 percentage point lower homeownership rate in that particular region, and a cumulative 3.6 percentage point lower homeownership rate

[25] Due to potential simultaneity between the unemployment and homeownership rate, some care must also be taken in interpreting the established link causally. If homeowners are less inclined to move when losing their jobs, regional unemployment may be affected by the regional share of homeowners (Oswald, 1996).

in all other regions (accruing largely to the first-order neighbors). Thus, the increase has a total effect of minus 5.3 percentage points.[26] It seems plausible that this result mirrors unobserved effects that are correlated to affordability and affect neighboring regions similarly. Comparable propositions can be made for regional rates of unemployment and urbanization.

The significant lag parameters for average regional household size, the proportion of foreigners and the east Germany dummy indicate that unobserved effects play a role in these variables as well. However, unlike the other variables, here the direct and indirect spatial effects obtain opposing signs. This implies that changes in these explanatory variables in a particular region are associated with changes in the homeownership rates in neighboring regions that are headed in the opposite direction to that of the region itself. The average household size provides an example: if a regions mean household size is above average, it has, conditional on all other variables, a higher homeownership rate, which represents the direct effect. However, there also is an indirect effect. As the spatial lag of the household size variable indicates, regions that are surrounded by regions with above-average household sizes have lower homeownership rates on average, independent of their own average household size. Put differently, a higher household size in a certain region turns out to be related inversely to the homeownership rate of neighboring regions, with the cumulative magnitude of this effect denoted by the lagged household size coefficient. Comparable propositions can also be made for the east Germany dummy and the proportion of foreigners.[27] Regarding interpretation, it has to be remembered that these results might reflect the impact of unobserved variables exerting a similar form of spatial autocorrelation as the included explanatory variables.

To complete the discussion, it is instructive to return to the example of Emsland and Oberland given in the introduction. According to our findings, the striking homeownership gap between the two rather similar regions is mainly attributed to substantial differences in financial homeownership affordability and average house-

[26] As an alternative interpretation, one could consider a global rise in the price-to-income ratio by one annual income across all 96 regions. On average, this would decrease each regions homeownership rate by 5.3 percentage points. These 5.3 percentage points collapse to a direct effect of 1.7 percentage points which is due to the rise in the particular region, and to an indirect effect of 3.6 percentage points which is due to the rise in all other regions. LeSage and Pace (2009) show that the two views (impact from/impact to an observation) always have to be numerically equal.

[27] The significant spatial lag in the eastern dummy may best be understood as modeling the transition in space from west to east, with zeros for western German regions without eastern neighbors, lower values for more western and higher values for more eastern neighboring regions, and values of one for east German regions with only east German neighbors.

hold size. The average house price-to-income ratio in Oberland (8.1) almost doubles that of Emsland (4.2), implying capital constraints to be considerably less severe in the latter region. Average household size is 2.5 in Emsland versus 2.1 in Oberland, indicating the presence of many households (particularly families) strongly inclined to homeownership. Together, these two variables explain almost two thirds of the total homeownership gap of twenty percentage points. Indirectly, the Emsland region also seems to benefit from comparably low price-to-income ratios in neighboring regions, a finding which may reflect unobserved regional effects correlated with affordability that correspond to north-western Germany as a whole.

8 Conclusions

This paper has explored the spatial variability in homeownership rates among 96 functional regions in Germany, using cross-sectional data for 2006. The use of augmented spatial models has enabled us to identify spatial dependence among regions and to derive estimations of the direct and indirect effects of changes in the explanatory variables. While existing knowledge of the importance of socio-demographics, urbanization, employment and the relative price of self-owned versus rental housing for regional homeownership is confirmed, our findings support the notion that the capital requirements needed to afford owner-occupied housing in a region play an important and independent role in understanding why homeownership rates vary so strongly across regions. Holding both the relative price of owning and renting as well as other regional factors constant, our results suggest that increases in the average price-to-income ratio of one additional income in a certain region are associated with a drop in the homeownership rate of 1.7 percentage points in that particular region, and also a cumulative 3.6 percentage point drop in neighboring regions. This is, in the presence of mortgage borrowing constraints, interregional differences in property values thus represent an economically important explanation of spatial tenure choice patterns. This result is likely to apply to other European housing markets as well, especially those with more rigid standards of mortgage lending.

Considering the policy implications of this paper, the finding of an economically significant role of regional price-to-income ratios adds an interesting insight to the recent debate about homeownership in Germany. In 2009, the new German government defined the promotion of homeownership a major goal of its housing policy, without defining measures for achieving this objective. In contrast to countries in which mortgage market deregulation has led to significant decreases in down payment requirements and borrowing costs for housing, mortgages have become hardly more accessible to prospective homebuyers in Germany. Although our results corroborate the view that high price-to-income ratios and thereby equity requirements indeed restrict homeownership, it remains questionable whether homeownership affordability should be meliorated by relaxing lending standards. As housing crises in various countries have recently demonstrated, substantial increases in average loan-to-value ratios might severely endanger the stability of housing markets and lending systems in the long term. With the easing of credit requirements seeming unlikely, an alternative way of improving the long-term affordability of homeownership could be the elimination of housing supply bottlenecks, in particular in high-priced regions. Malpezzi (1999) and Glaeser and Gyourko (2002) have demonstrated that high regional price-to-income ratios are at least partially generated by constraints in the supply of building sites, a factor which is regulated by local public authorities. In fact, regional policies oriented towards improving the supply of land for new housing could yield results superior to those of long-practiced demand-oriented measures, given that the latter tend to increase house values in high-priced markets even more.

Finally, the results of this study must be considered in the context of a rather high level of spatial aggregation. The extent to which the results are sensitive to the spatial reference level remains open, although we are confident that the explicit modeling of space somewhat mitigates this problem. Nonetheless, it is obvious that differences across submarkets within the geographic units used here may be concealed by our results. Further analysis on the origins of spatial differences in homeownership rates in Germany would surely benefit from data at a more sophisticated level of disaggregation, a task that can be tackled once appropriate data becomes available.

References

M. Andrew. The changing route to owner occupation: household formation and the impact of borrowing constraints on young adult homeownership in britain. *The University of Reading Working Paper*, 2007.

L. Anselin. *Spatial econometrics: methods and models.* Springer, 1988.

L. Anselin, R.J.G.M. Florax, and S.J. Rey. *Advances in spatial econometrics: methodology, tools and applications.* Springer, 2004.

R. Arnott. Economic theory and housing. *Handbook of regional and urban economics: Urban economics*, 2:959, 1987.

R. Artle and P. Varaiya. Life cycle consumption and homeownership. *Journal of Economic Theory*, 18(1):38–58, 1978.

R. Bivand, L. Anselin, O. Berke, A. Bernat, M. Carvalho, Y. Chun, CF Dormann, S. Dray, R. Halbersma, N. Lewin-Koh, et al. spdep: Spatial dependence: weighting schemes, statistics and models. *R package version 0.5-31, URL http://CRAN. R-project. org/package= spdep*, 2011.

D.M. Blackley and J.R. Follain. Variations in metropolitan homeownership rates. *Housing Finance Review*, 7:109–131, 1988.

A.S. Bogdon and A. Can. Indicators of local housing affordability: Comparative and spatial approaches. *Real Estate Economics*, 25(1):43–80, 1997.

S.C. Bourassa. Measuring the affordability of home-ownership. *Urban Studies*, 33 (10):1867, 1996.

J.K. Brueckner. The downpayment constraint and housing tenure choice:: A simplified exposition. *Regional Science and Urban Economics*, 16(4):519–525, 1986.

WAV Clark, MC Deurloo, and FM Dieleman. Entry to home-ownership in germany: some comparisons with the united states. *Urban Studies*, 34(1):7–19, 1997.

A.D. Cliff and J.K. Ord. *Spatial processes: models & applications.* Pion Ltd, 1981.

N.E. Coulson. Regional and state variation in homeownership rates; or if californias home prices were as low as pennsylvanias would its ownership rate be as high? *The Journal of Real Estate Finance and Economics*, 24(3):261–276, 2002.

N.E. Coulson and L.M. Fisher. Housing tenure and labor market impacts: The search goes on. *Journal of Urban Economics*, 65(3):252–264, 2009.

R.D. Dietz and D.R. Haurin. The social and private micro-level consequences of homeownership. *Journal of Urban Economics*, 54(3):401–450, 2003.

F. Earley. What explains the differences in homeownership rates in europe. *Housing Finance International*, 19:25–30, 2004. ISSN 0269-8978.

P. Eilbott and E.S. Binkowski. The determinants of smsa homeownership rates. *Journal of Urban Economics*, 17(3):293–304, 1985.

J.P. Elhorst. Applied spatial econometrics: raising the bar. *Spatial Economic Analysis*, 5(1):9–28, 2010. ISSN 1742-1772.

M. Elsinga and J. Hoekstra. Homeownership and housing satisfaction. *Journal of Housing and the Built Environment*, 20(4):401–424, 2005.

G. Engelhardt. House prices and the decision to save for down payments. *Journal of Urban Economics*, 36(2):209–237, 1994.

J. Ermisch and P. Di Salvo. The economic determinants of young people's household formation. *Economica*, 64(256):627–644, 1997.

L.M. Fisher and A.J. Jaffe. Determinants of international home ownership rates. *Housing finance international*, 18(1):34–37, 2003.

T.I. Garner and R. Verbrugge. The puzzling divergence of us rents and user costs, 1980-2004: Summary and extensions. *Price and Productivity Measurement, Vol. 1: Housing*, pages 125–146, 2009.

N. Girouard, M. Kennedy, P. van den Noord, and C. Andre. Recent house price developments: The role of fundamentals. *OECD Economics Department Working Papers*, (475), 2006.

E. Glaeser. Rethinking the federal bias toward homeownership. *Cityscape: A Journal of Policy Development and Research*, 13(2):5–37, 2011.

E.L. Glaeser and D. DiPasquale. Incentives and social capital: are homeowners better citizens? *Journal of Urban Economics*, 45(2):354–384, 1999.

E.L. Glaeser and J. Gyourko. The impact of zoning on housing affordability. *NBER Working Paper*, 2002.

A.C. Goodman. Capitalization of property tax differentials within and among municipalities. *Land Economics*, 59(2):211–219, 1983.

A.C. Goodman. An econometric model of housing price, permanent income, tenure choice, and housing demand. *Journal of Urban Economics*, 23(3):327–353, 1988.

R.K. Green and S. Malpezzi. *A primer on US housing markets and housing policy.* Urban Inst Pr, 2003.

C.R. Gwin and S.E. Ong. Do we really understand homeownership rates? an international study. *International Journal of Housing Markets and Analysis*, 1(1): 52–67, 2008.

J.D. Hansen and M. Skak. Economics of housing tenure choice. *Odense, University of Southern Denmark, Department of Business and Economics*, 2005.

D.R. Haurin. Income variability, homeownership, and housing demand. *Journal of Housing Economics*, 1(1):60–74, 1991.

D.R. Haurin and H.L. Gill. The impact of transaction costs and the expected length of stay on homeownership. *Journal of Urban Economics*, 51(3):563–584, 2002.

J.V. Henderson and Y.M. Ioannides. A model of housing tenure choice. *The American Economic Review*, 73(1):98–113, 1983.

J.V. Henderson and Y.M. Ioannides. Dynamic aspects of consumer decisions in housing markets. *Journal of Urban Economics*, 26(2):212–230, 1989.

F. Hubert. Private rented housing in germany. *Journal of Housing and the Built Environment*, 13(3):205–232, 1998.

F. Hubert. The economic theory of housing tenure choice. *A Companion to Urban Economics, Boston: Blackwell Publishing*, pages 145–158, 2006.

H.H. Kelejian and I.R. Prucha. A generalized spatial two-stage least squares procedure for estimating a spatial autoregressive model with autoregressive disturbances. *The Journal of Real Estate Finance and Economics*, 17(1):99–121, 1998. ISSN 0895-5638.

J. Lauridsen, N. Nannerup, and M. Skak. Geographic and dynamic heterogeneity of home ownership. *Journal of Housing and the Built Environment*, 24(1):1–17, 2009.

J.P. LeSage and R.K. Pace. *Introduction to spatial econometrics*, volume 196. Chapman & Hall/CRC, 2009.

P. Linneman. A new look at the homeownership decision. *Housing Finance Review*, 5(2), 1986.

P.D. Linneman and I.F. Megbolugbe. Housing affordability: Myth or reality? *Urban Studies*, 29(3-4):369, 1992.

S. Malpezzi. A simple error correction model of house prices. *Journal of Housing Economics*, 8:27–62, 1999.

G.P. Meen. *Modelling spatial housing markets: theory, analysis, and policy*, volume 2. Springer, 2001.

I.F. Megbolugbe and P.D. Linneman. Home ownership. *Urban Studies*, 30(4-5):659, 1993.

J. Muellbauer. *Housing, credit and consumer expenditure.* Centre for Economic Policy Research, 2008.

J. Muellbauer and A. Murphy. Booms and busts in the uk housing market. *The Economic Journal*, pages 1701–1727, 1997.

J. Muellbauer and A. Murphy. Housing markets and the economy: the assessment. *Oxford Review of Economic Policy*, 24(1):1, 2008.

C.H. Mulder. Home-ownership and family formation. *Journal of Housing and the Built Environment*, 21(3):281–298, 2006. ISSN 1566-4910.

D. Myers, G. Painter, Z. Yu, S.H. Ryu, and L. Wei. Regional disparities in homeownership trajectories: impacts of affordability, new construction, and immigration. *Housing Policy Debate*, 16(1):53–83, 2005.

S. Openshaw and P.J. Taylor. *The modifiable areal unit problem.* Geo Books Norwich, 1983. ISBN 0860941345.

F. Ortalo-Magne and S. Rady. Tenure choice and the riskiness of non-housing consumption. *Journal of Housing Economics*, 11(3):266–279, 2002.

A. Oswald. A conjecture on the explanation for high unemployment in the industrialised nations: Part 1. *Warwick Economic Research Papers*, 1996.

R.K. Pace and J.P. LeSage. Chebyshev approximation of log-determinants of spatial weight matrices. *Computational statistics and data analysis*, 45(2):179–196, 2004.

R.K. Pace and J.P. LeSage. Omitted variable biases of ols and spatial lag models. *Progress in Spatial Analysis*, pages 17–28, 2010.

J.M. Poterba. Tax subsidies to owner-occupied housing: an asset-market approach. *The Quarterly Journal of Economics*, 99(4):729–752, 1984.

S. Proxenos. Homeownership rates: a global perspective. *Housing finance international*, 17(2):3–7, 2002.

P.H. Rossi and E. Weber. The social benefits of homeownership: Empirical evidence from national surveys. *Housing Policy Debate*, 7(1):1–35, 1996.

R.J. Shiller. Understanding recent trends in house prices and home ownership. *NBER Working Paper*, 2007.

M. Sigismund. New nationwide and regionalized rent and home price indices (neue bundesweite und regionalisierte mieten-und preisindizes). *Immobilien und Finanzierung*, pages 333–335, 2005.

P.B. Spahn. Land taxation in germany. *Bird, R.M. and Slack, N.E. (Eds.): International handbook of land and property taxation*, pages 98–106, 2004.

M.E. Stone. What is housing affordability? the case for the residual income approach. *Housing Policy Debate*, 17(1):151–184, 2006.

C. Swan. A model of rental and owner-occupied housing. *Journal of Urban Economics*, 16(3):297–316, 1984.

T.M. Turner and H. Luea. Homeownership, wealth accumulation and income status. *Journal of Housing Economics*, 18(2):104–114, 2009.

M. Voigtlander. Why is the german homeownership rate so low? *Housing Studies*, 24(3):355–372, 2009.

P. von der Lippe and C.C. Breuer. Data acquisition for periodical and regional price comparisons – the problem of rents and real estate prices (datengewinnung im periodischen regionalen preisvergleich–die problematik der mieten und immobilienpreise). *Jahrbuch fuer Regionalwissenschaft*, 30:1–32, 2010.

C.M.E. Whitehead. Urban housing markets: theory and policy. *Handbook of regional and urban economics*, 3:1559–1594, 1999.

Appendix

Variable	Definition	Data source
Homeownership rate	Proportion of households living in owner-occupied dwelling as a percentage of total household population in region i	BBSR Wohnungsmarktbeobachtung, Mikrozensus
House price-to-rent ratio	Ratio of median house price (Euro/m^2) to median net rent (Euro/m^2) in region i	BBSR Wohnungsmarktbeobachtung, IDN ImmoDaten
House price-to-income ratio	Ratio of median house price (Euro) to average net disposable household income in region i	BBSR Wohnungsmarktbeobachtung, IDN ImmoDaten, Federal Income Acc.
Household size	Average household size in region i	Population statistics of the Bund and the Laender
Prop. 0-18	Proportion of population aged 0 to 18 years as a percentage of total population in region i	Population statistics of the Bund and the Laender
Prop. 18-25	Proportion of population aged 18 to 25 years as a percentage of total population in region i	Population statistics of the Bund and the Laender
Prop. 50-65 year	Proportion of population aged 50 to 65 years as a percentage of total population in region i	Population statistics of the Bund and the Laender
Prop. foreign	Proportion of population with foreign nationality in per cent of total population in region i	Population statistics of the Bund and the Laender
Urbanization rate	Proportion of residents living in municipalities with a population density of $\geq 150/km^2$ as a percentage of total population in region i	Federal Bureau of Statistics
Unemployment rate	Average proportion of unemployed labor force as a percentage of total labor force in region i, 2002-06	Federal Employment Agency
House price change	Nominal percentage change of house prices in region i during 2004-2006	BBSR Wohnungsmarktbeobachtung, IDN ImmoDaten

Table 3: Detailed data description and sources.

Figure 5: Spatial distribution of remaining explanatory variables

	SAC W=thresh.		SAC W=inv. dist.		SDEM W=thresh.		SDEM W=inv. dist.	
Explanatory Vars.	Coeff.	p-value	Coeff.	p-value	Coeff.	p-values	Coeff.	p-value
Price-rent ratio	-0.42**	0.04	-0.40**	0.05	-0.59***	0.00	-0.48**	0.02
Price-income ratio	-1.32*	0.09	-2.01***	0.01	-2.12***	0.00	-2.59***	0.00
Household size	30.68***	0.00	25.48***	0.00	15.76***	0.01	15.91***	0.02
Prop. pop under 18	1.71**	0.02	1.98***	0.01	2.59***	0.00	2.14***	0.00
Prop. pop 18-25	0.78	0.52	1.91	0.13	2.08*	0.05	2.31*	0.05
Prop. pop 50-65	3.83***	0.00	4.15***	0.00	3.80***	0.00	3.79***	0.00
Prop. foreign pop	-0.37	0.15	-0.15	0.56	-0.11	0.63	0.04	0.89
House price change	0.02	0.87	0.03	0.73	0.06	0.57	0.15	0.18
Unemployment rate	-0.58***	0.01	-0.61***	0.01	-0.73***	0.00	-0.74***	0.00
Urbanization rate	-0.05	0.12	-0.06**	0.05	-0.06**	0.02	-0.08***	0.01
Dummy east	-8.51**	0.02	-11.72***	0.00	-8.02**	0.02	-8.37**	0.02
Lag. Price-income r.					-2.91*	0.10	-1.35	0.33
Lag. Price-rent r.					0.40	0.43	0.04	0.91
Lag. Household size					-55.88***	0.00	-34.00***	0.01
Lag. Prop. under 18					0.99	0.48	0.22	0.87
Lag. Prop. 18-25					3.22	0.21	-0.45	0.85
Lag. Prop. 50-65					-0.85	0.72	-0.57	0.22
Lag. Prop. foreign					0.53	0.34	0.65	0.14
Lag. House price ch.					0.04	0.89	0.48*	0.08
Lag. Unemployment r.					-1.94***	0.00	-1.43***	0.00
Lag. Urbanization r.					-0.09	0.18	-0.08	0.15
Lag. Dummy east					20.96***	0.00	21.64***	0.00
ρ *(spatial lag)*	0.06	0.64	-0.16	0.12				
λ *(spatial error)*	0.54***	0.00	0.66***	0.00	0.48***	0.00	0.26*	0.09
R^2	0.87		0.87		0.90		0.90	
Error variance (σ^2)	10.07		9.05		7.41		8.15	
AIC	532.4		527.9		520.5		526.0	
Log-likelihood	-251.1		-248.9		-235.2		-238.0	

Table 4: Estimation results with different weight matrices