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Umut Unal, Bernd Hayo, and Isil Erol

Housing Market Convergence: Evidence from Germany

Coordination: Bernd Hayo • Philipps-University Marburg
School of Business and Economics • Universitätsstraße 24, D-35032 Marburg
Tel: +49-6421-2823091, Fax: +49-6421-2823088, e-mail: hayo@wiwi.uni-marburg.de

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Umut Unal
Research Institute for Labour and Social Affairs (RILSA)
Dělnická 213/12, 170 00 Prague 7
Czech Republic
Tel.: +420 211 152 711
E-mail: umut.unal@rilsa.cz

Bernd Hayo
Marburg Centre for Institutional Economics (MACIE)
School of Business and Economics (FB 02)
Philipps-Universität Marburg
Universitätsstr. 24
D-35037 Marburg – Germany
Tel.: +49 6421-28-23091
E-mail: hayo@wiwi.uni-marburg.de

Isil Erol
Department of International Finance
Faculty of Business
Özyeğin University 34794 Istanbul - Turkey
E-mail: isil.erol@ozyegin.edu.tr

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Abstract

This paper analyses the convergence pattern of German housing prices and rents, employing a new dataset covering the country's administrative districts. In addition to conventional tests for β-convergence and σ-convergence, we apply Phillips and Sul's (2007) approach to allow for the various heterogeneity and transitional dynamics across districts. Our results reveal no evidence of convergence across Germany or within states; instead, we discover widespread evidence of divergence and inter-state convergence, as well as support for the existence of convergence clubs. At the federal level, we identify club numbers ranging from 11 (for existing flat prices) to five (for new flat rents). At the state level, the estimated number of clubs is generally lower, ranging from zero to six.

JEL classification: R10; R30; R31
Keywords: Convergence; Germany; housing prices; district-level data; convergence clubs

1. Introduction

The 2008/09 Global Financial Crisis, triggered by a collapse in housing prices, highlighted the role of housing markets in the economy (Canarella et al., 2012; Churchill et al., 2018). Given the risk of overinflated housing markets and disparities in housing prices across regions, the dynamic relationship or relatedness of regional housing prices warrants particularly close attention. This will assist in both preventing the creation of housing bubbles (Holmes et al., 2018) and uncovering inequalities across regional housing markets, and will provide the foundation for regionally diversified and locally adapted adjustment policies (Cai et al., 2022).

Housing prices are believed to be determined by the spatial equilibrium process, a fundamental principle in urban economics. A spatial equilibrium across cities implies that households, employers and homebuilders all meet the equilibrium conditions (Glaeser et al., 2006). For households, the location must be optimised to maximise utility, as utility is assumed to be positively correlated with amenities and wages and negatively correlated with housing costs. Employers must optimise the firms' locations and the use of production factors to achieve maximum profits (which are zero in a perfect competition world). In growing markets, the price of housing must equal the cost of producing (equivalent) new residences for homebuilders.

Because theoretically, it is utility that converges, rather than wages, housing prices, or city amenities, there is limited theoretical support for the idea that housing prices should converge (Kim and Rous, 2012; Kemeny and Storperi, 2012). In light of this, it is essential to explore empirically whether housing prices are converging at the national/state/city/region level and understand the convergence's nature and extent. Perfect convergence would imply that all prices of comparable housing in predefined regions, such as cities or districts, converge to the same price in the long run. Such an outcome would imply that aggregate regional income and the aggregate value of amenities will also converge, which we would not expect in heterogeneous or highly segmented housing markets. However, since we tend to observe income convergence over time in regions within one country (Barro and Sala-i-Martin, 1992), it would not be surprising to find a convergence of housing prices between some of these regional entities. Typically, but not necessarily, these 'convergence clubs' would be characterised by similar economic fundamentals and amenities (Kim and Rous, 2012).

The modelling of subnational or regional house prices has received considerable attention since the early 2000s. Using a range of techniques, such as cointegration and spatial econometrics, various researchers have explored the extent to which some areas are convergence leaders and the degree to which convergence is (re)established over time (Meen, 2016). Most early research on the convergence behaviour of regional housing prices focused on the United Kingdom (UK). Cook (2003) examines the convergence of regional house prices and discovers a widespread convergence of house prices in several regions of the UK. Cook (2003 and 2005) suggests that previous studies' failure to detect convergence might originate from the inability to account for varying speeds of adjustment in regional house prices during upswings and downturns. Such a discovery has guided a subsequent analysis undertaken by Cook (2012), where the cyclical dynamics of the UK housing market, with the dynamics of regional house prices over this cycle and its constituent phases, were studied. Specifically, the varying adjustment speed of regions during different phases of the housing cycle suggests that convergence may be cycle related. Cook (2012) concludes that while significant evidence of convergence is present throughout the dataset's entire cycle, the most compelling evidence of convergence occurs during cyclical downturns. To rephrase this conclusion: long-term housing price convergence seems to be driven by recessions in the housing cycle.

Cook and Watson (2016) employ a directional forecasting technique to examine co-movement and cyclical sub-samples in the UK housing market and explore the extent to which changes in regional house prices are influenced by those in London. They show that proximity to London is positively related to the degree of co-movement between house prices in UK regions and the capital. While research into regional housing dynamics has mainly focused on the UK, where small geographic size could explain the prevalence of co-movements, an increasing body of evidence indicates that a lead city or area can also exist on an international scale. Instances of price convergence are observed, for example, in the United States of America (US) (Gupta and Miller, 2010; Holmes et al., 2011; Barros et al., 2012), Malaysia (Lean and Smyth, 2013), and South Africa (Balcilar et al., 2013).

Only a limited number of studies employ the club convergence and clustering procedure introduced by Phillips and Sul (2007, 2009) to study regional house price dynamics. For instance, Kim and Rous (2012) explore house price convergence in US states and metropolitan areas. They discover a lack of overall convergence yet identify multiple convergence clubs in the US housing market. Given the heterogeneity of the US, this finding is unsurprising. The authors also search for critical determinants of convergence club membership and identify housing supply regulation and climate as particularly important. Montagnoli and Nagayasu (2015) find that the UK housing market is complex and heterogeneous, too, and they group house prices into four regional clusters. They also document the dynamics of house price spillover effects across regions. There appear to be notable spillovers from the core regions, especially London, to the peripheral regions, but regional economic and financial developments are also important for regional house price dynamics. Apergis et al. (2015) investigate the long-run behaviour of house prices across nine provinces in South Africa and discover that they do not form a homogeneous convergence club. However, the authors lack the data to formally analyse the drivers behind convergence club formation.

Blanco et al. (2016) study regional housing prices in Spain. They report that the Spanish housing market is segmented, and regional house prices do not converge to a common trend. Instead, similar to the results in the UK, the housing market is grouped into four separate convergence clubs. The study finds that differences in population growth, rental market size, initial house supply, and geographical situation play significant roles in determining club membership. Holmes et al. (2019) examine the extent of convergence club formation in England and Wales. Their analysis is based on a disaggregated panel dataset comprising multiple housing types across the local authorities. They conclude that prices for flats are more likely to converge, whereas prices for terraced housing are less likely to converge. In the case of terraced housing, relative price divergences could worsen the affordability of housing in certain areas. Regarding the formation of convergence clubs, crime rate and congestion issues are significant factors in bringing about these clusters.

In light of this literature, gaining further insights into how relative regional or even local house prices change over time is of great importance. These factors can affect the economic activity of a region, as well as the affordability of housing, relocation costs, and labour mobility between areas. Although a considerable body of literature explores state- or city-level house price convergence using aggregated region time-series data, little is known about the evolution of intra-regional house prices and the increased disparities within regions. To our knowledge, no previous study has investigated Germany's long-term housing price dynamics. The present study examines district-level housing price convergence across 401 administrative districts in Germany from 2004 to 2020 using the club convergence and clustering procedure developed by Phillips and Sul (2007, 2009). Given that housing affordability is a significant concern in

many countries, including Germany, house price convergence/divergence across different housing tenures (owner-occupied and rental) and dwelling types (existing and new flats, houses) is of potential interest to policymakers. Moreover, gaining an understanding of the dynamics of regional house prices is crucial for obtaining a comprehensive understanding of the housing market in Germany. Therefore, it is valuable to provide empirical evidence of convergence/divergence and its presence across different types of dwellings and tenures.

The remainder of the paper is structured as follows: Section II discusses the data and methodology employed in the study, Section III presents a discussion of the results, and Section IV concludes.

2. Methodology and Data

2.1 Review of Convergence

Examining regional inequality and its evolution over time is a prominent area of investigation in the economics literature. Various methodologies were developed to study how and to what extent regional entities converge. The two most widely-used methods for studying convergence are β-convergence and σ-convergence. In our context, β-convergence indicates that regions with lower housing prices at the beginning of the observation window experienced faster growth in housing prices compared to regions that initially had higher housing prices. However, the conventional β-convergence test can be misleading, particularly when poorer regions experience significantly higher growth rates than their wealthier counterparts, leading to a situation where an even wider income gap exists at the end of the examination period compared to the beginning (Lichtenberg, 1994). Another disadvantage of the β-convergence concept is that it focuses on the overall distribution and not on the dynamics of individual units in a panel. Since it is based on cross-section regression, β-convergence is potentially subject to Galton's fallacy (Quah, 1993).

The other conventional method for examining convergence, σ-convergence, measures the decline in regional dispersion by comparing the standard deviation at the beginning of the sample period with the value at the end (Lau, 2010). However, time-series data are often characterised by increasing variance over time, which renders the application of the σ-convergence concept problematic (Phillips and Sul, 2007). A simple approach to addressing this issue is dividing the standard deviation by the mean of the series, i.e. employing the coefficient of variation for the σ-convergence test. Still, at best, this is only a partial solution to these problems, and at worst, it is entirely ineffective.

Reflecting on these methods, Phillips and Sul (2007) introduce a novel approach to analysing economic transition behaviour that considers different time paths and individual heterogeneity. This methodology is particularly effective in measuring progress towards a long-term growth path or a common steady state. The authors emphasise that failure to detect convergence in a panel does not necessarily imply a lack of convergence in its subgroups. A situation where different groups converge to distinct steady-state levels is called 'club convergence'. Moreover, this data-driven statistical approach to identifying convergence clubs is more accurate than regional convergence research that relies on defining clubs solely based on geographic location (Tian et al. 2016).

2.2 Log t test

To analyse the transitional behaviour of housing prices across German districts between 2004−2020, we apply the log *t* test developed by Phillips and Sul (2007):

$$logy_{it} = (\varphi_{it} + \frac{\varepsilon_{it}}{\mu_t})\mu_t = \delta_{it}\mu_t, \qquad Eq(1)$$

where φ_{it} is the district *(i)* characteristic component, δ_{it} the time-varying idiosyncratic element that captures the deviation of district *i* from the common growth path μ_t, and ε_{it} the error term, which is weakly dependent over *t*, but *iid*(0,1) across *i*. The test focuses on the evolution of individual transition paths compared to the common growth component. Removing the common growth path in the form of the cross-sectional average from the original variable yields h_{it}, the relative transition coefficient:

$$h_{it} = \frac{\log y_{it}}{(1/N)\sum_{i=1}^{N} logy_{it}} = \frac{\delta_{it}}{(1/N)\sum_{i=1}^{N} \delta_{it}} \qquad Eq(2)$$

Equation (2) identifies the relative deviation of district *i* from the common growth path μ_t and measures individual behaviour concerning other districts. The log *t* test is based on time series regressions, where the transformation of the cross-section variance of $h_{it}(\sigma_{it}^2)$ is regressed on log(*t*). Coefficient *b* is then employed to test for convergence:

$$\text{Log}\left(\frac{\sigma_{h1}^2}{\sigma_{ht}^2}\right) - 2\log[L(t)] = c + b\ log(t) + u_t \qquad Eq(3)$$

$$\text{for } t = [rT], [rT]+1, \dots, T$$

where $r \in (0,1)$ and $L(t)$ are slowly varying functions. For $T \leq 50$, Phillips and Sul (2007) suggest using $L(t) = \log(t)$ and $r = 0.3$. In the case of convergence, $h_{it} \rightarrow 1$ for all *i* as $t \rightarrow \infty$. Applying a one-sided test, the null hypothesis of convergence ($b \geq 0$) is tested against the alternative $b < 0$. The null hypothesis of convergence is rejected at the 5% significance level if $t_{\hat{b}} <$ -1.65.

Phillips and Sul (2007) developed a four-step clustering algorithm for identifying so-called 'convergence clubs' in the relevant panel of cross-sectional units. In the first step, the units are sorted in descending order based on the last period in the time series dimension of the panel. Second, convergence clubs are identified using the log *t* test. This is done by adding regions one by one to a group consisting of the two highest housing price regions at the beginning and running the log *t* test until the convergence test statistic for this group is greater than |-1.65| (adopting a 5% significance level). The next step is to repeat the log *t* test for this group and all the units remaining in the sample, one by one, to check whether they converge. If they do not converge, the first three steps are applied to the remaining units. If no clubs are found, it can be concluded that the geographical units diverge over time.

Since this algorithm tends to overestimate the number of convergence clubs, Phillips and Sul (2009) propose merging the groups formed according to the clusters using the same test at a later stage. In this context, the algorithm commences by taking the first and second groups and running the log *t* test. We do not reject the null hypothesis as long as the *t*-statistic is smaller

than |-1.65|, concluding that both groups form a club. We repeat the test after adding the next group and continue until the log *t* test indicates a rejection of the convergence hypothesis. From this, it can be concluded that all groups except the last one converge. Finally, we repeat the test with the group for which the convergence hypothesis was rejected.

Some drawbacks of the log *t* test include the loss of observations due to the computation of the long-term component using the Hodrick-Prescott filter and the specification of the null hypothesis as 'convergence', which implies that the inferential support for convergence, as well as convergence clubs, is, at best, weak (the non-rejection of H_0).

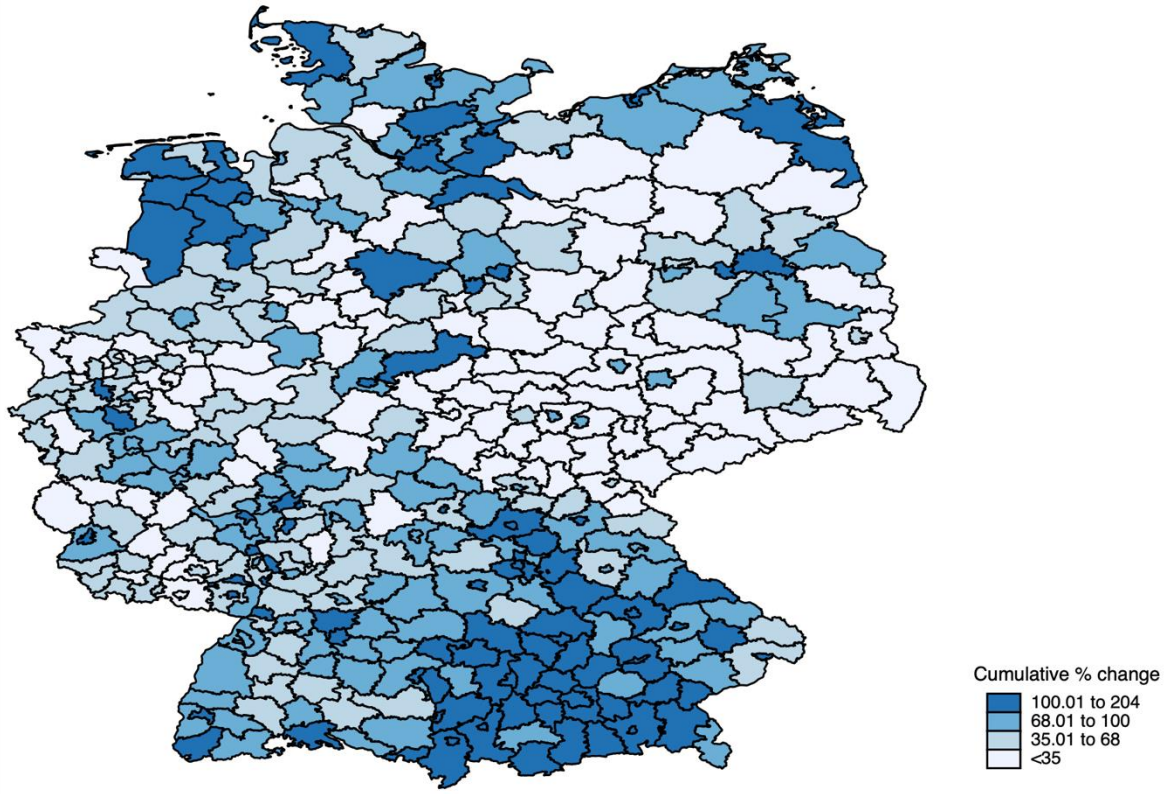
2.3 Data

Our sample contains annual data on all 401 administrative districts in Germany from 2004−2020 published by the Regional Real Estate Information System (RIWIS). The market price of houses is measured as an absolute value in euros, whereas flat prices and rents are measured in euros per sqm. To achieve a broad overview of the degree of convergence in the markets for different types of housing in Germany, we employ various housing prices and rent in our study. Such an approach can facilitate the identification of housing markets for which prices exhibit diverging trends, which may signify potential imbalances. For instance, when house prices increase considerably faster than rents, this may imply an overheated market and foreshadow an impending correction. Conversely, when rents rise swiftly while house prices remain relatively stable, this may denote a shortage of rental properties relative to demand, thereby offering an opportunity for real estate investors. In sum, incorporating various types of measures in a convergence study can furnish a more comprehensive outlook of the overall housing market, which, in turn, may equip policymakers, investors, and analysts with greater insight to make informed decisions.

From 2004 to 2020, housing prices and rents across Germany exhibited heterogeneous dynamics. Specifically, the median price of a single-family house increased by 54%, the rate of increase per sqm for flats was 69%, and the median rent per sqm increased by 46%. These aggregate developments in housing prices were accompanied by substantial variations across the country's districts. For example, Figure 1 shows substantial increases in the price of flats in Bavaria and parts of Lower Saxony and Mecklenburg. The highest increases in the prices of flats occurred in Munich, Rostock and Ingolstadt.[1]

[1] House prices and flat rents follow a similar pattern (Unal et. al., 2020).

Figure 1: Cumulative Changes in Flat Prices/sqm by Administrative Districts in Germany (2004−2020)



3. Empirical Results

Applying a 5%-significance level, our results reveal no evidence of β-convergence employing district-level data for housing prices and rents across Germany or within states (Table A1). Regarding standard deviations, our statistical tests for σ-convergence suggest significant divergence across almost all regions (Table A2). Using coefficients of variation instead of standard deviations reveals significant evidence of σ-divergence at the federal level for all housing prices (Table A3). At the state level, the occurrence of significant σ-divergence varies depending on the type of housing price. For instance, concerning new flat prices (new flat rents), 11 (4) out of 13 states evince significant σ-divergence. We observe significant evidence of σ-convergence in only one case, new flat prices in Saarland.

The log *t* test results for districts at the country and within-state levels are presented in Table A4. The results indicate the rejection of the null hypothesis of full panel convergence at the 5% level of significance, with the exception of new flat prices in Saarland. Given the rejection of convergence, we consider it interesting to study the potential existence of multiple housing price steady states in the form of convergence clubs between states and districts at the state level. The club clustering algorithm identifies 13 clubs across Germany regarding housing prices (house prices, existing flat prices, and new flat prices) and 14 and seven clubs for existing and new flat rents, respectively (Table 1, Panel A and Table A6).

While it was possible to merge small clubs into larger clubs in the club-merging analysis, the results shown in Table 1 (Panel B) and Table A6 indicate that the merging of clubs is only

supported in a small number of cases. The club merging algorithm reduces the number of identified clubs to 11 for existing flat prices, eight for house prices, seven for existing flat rents and new flat prices, and five for new flat rents.[2] These numbers are higher than those reported for other European countries, such as the UK (Montagnoli and Nagayasu, 2015) and Spain (Blanco et al., 2016). The estimated geographic housing market segmentation is graphically illustrated in Figures 2 through 6. The convergence club members did not necessarily neighbour each other geographically, suggesting that conventional definitions of regions, such as administrative districts, may not be the best choice for studying regional housing market dynamics.

Table 1. Number of Clubs Based on the Initial Convergence and Testing for Club Merging

	A: Initial Convergence Club Specification					B: After Club Merging				
	House Price	Existing Flat Price	New Flat Price	Existing Flat Rent	New Flat Rent	House Price	Existing Flat Price	New Flat Price	Existing Flat Rent	New Flat Rent
Federal level										
Germany	13	13	13	14	7	8	11	7	7	5
States (Lander) level										
Baden-Wurttemberg	7	7	5	5	3	5	5	5*	4	3*
Bavaria	12	9	9	6	7	9	8	6	5	5
Brandenburg	4	4	2	4	2	4*	4*	2*	4*	2*
Hesse	6	7	5	4	3	5	5	3	3	3*
Lower Saxony	6	8	3	7	5	5	7	3*	4	4
Mecklenburg-Vorpommern	2	2	3	2	2	2*	2*	3*	2*	1
North Rhine-Westphalia	5	6	8	9	5	5*	5	5	6	2
Rhineland-Palatinate	6	6	3	8	7	6*	6*	3*	7	4
Saarland	2	1	1	1	1	2*	1*	1*	1*	1*
Saxony	4	4	4	5	3	4*	4*	4*	5*	3*
Saxony-Anhalt	5	3	4	2	5	4	3*	4*	1	5*
Schleswig-Holstein	3	2	3	4	4	2	2*	3*	3	2
Thuringia	3	6	4	5	3	3*	6*	4*	5*	3*

Notes: *indicates that no clubs can be merged. 'City states' (Hamburg, Bremen, and Berlin) are excluded from the within-state analysis.

Table 1 shows that although some states (e.g. Bavaria, Baden-Wurttemberg, Lower Saxony and Hesse) feature at least six convergence clubs for housing prices, most of the states have a lower number of convergence clubs (e.g. Brandenburg and Mecklenburg-Vorpommern), or even evince convergence across all districts (Saarland). Hence, the heterogeneity of district housing markets within German states is smaller than that across Germany. This suggests that state-level differences in economic development or housing laws matter for housing dynamics.

Overall, our results indicate that prices in Germany's various types of housing markets do not converge towards a single uniform price. Instead, we find evidence of subgroups of districts at the national and state levels for which housing prices tend to evolve towards a common price. In this context, a higher number of clusters could indicate a higher degree of heterogeneity within the respective submarket, with different regions experiencing different economic conditions and housing market dynamics. Correspondingly, fewer clusters may suggest higher housing market homogeneity within the respective submarket.

[2] The log *t* test results for the convergence clubs within each state are provided in Table A5. Maps showing within-state convergence are presented in Figures A1-A13.

Reflecting on these considerations, there are at least three reasons why we expect a large dispersion of housing prices at the district level in Germany. First, research has shown that regional economic performance is a key determinant of house price movements. Regions with strong economic growth and employment opportunities tend to have higher house prices than regions with weaker economic performance. This is because housing demand is driven by income and population growth (Mallick and Mahalik, 2015). In Germany, there are notable regional disparities in economic performance, with some regions experiencing strong growth and others facing economic challenges (OECD, 2018).

Second, differences in supply and demand are another reason for house price dispersion. The housing market is inherently local, with differences in housing supply and demand across regions and districts (Cheshire et al., 2015). In Germany, there are noteworthy regional differences in population growth and migration patterns, which can affect the demand for housing (Unal et al., 2022). At the same time, the housing supply is also affected by local factors, such as land availability, zoning regulations, and construction costs (Cheshire et al., 2015). These differences in supply and demand are likely to lead to housing market dispersion.

A third reason for house price divergence is differences in housing market regulations. Housing market regulations, such as rent controls and restrictions on new construction, can affect the supply and demand for housing and thus impact house prices (Cheshire et al., 2015). In Germany, there are significant regional differences in housing market regulations, with some states imposing stricter regulations than others (Dathe et al., 2021). Each German state has a different building law, with further variations at the district level. There are numerous differences between German states regarding the sale of public plots for building houses. For instance, in North Rhine-Westphalia, it is possible to sell public land without a proper tendering procedure (§15(3) HHG, Budget Law). Moreover, real estate taxes can vary substantially across states and districts. There are also ‘rent breaks’ operating in various regions based on §556d(1) of Germany’s civil law (Bürgerliches Gesetzbuch, BGB). Following §556d(2) BGB, most German states, except Saxony, Saxony-Anhalt, and Saarland, regulate rents according to average rents or housing experts and review these rules every five years (Wissenschaftliche Dienste des Deutschen Bundestages 2021). These regulatory differences are likely to lead to house price divergence across regions and cities.

Figure 2: Convergence of House Prices across German Districts

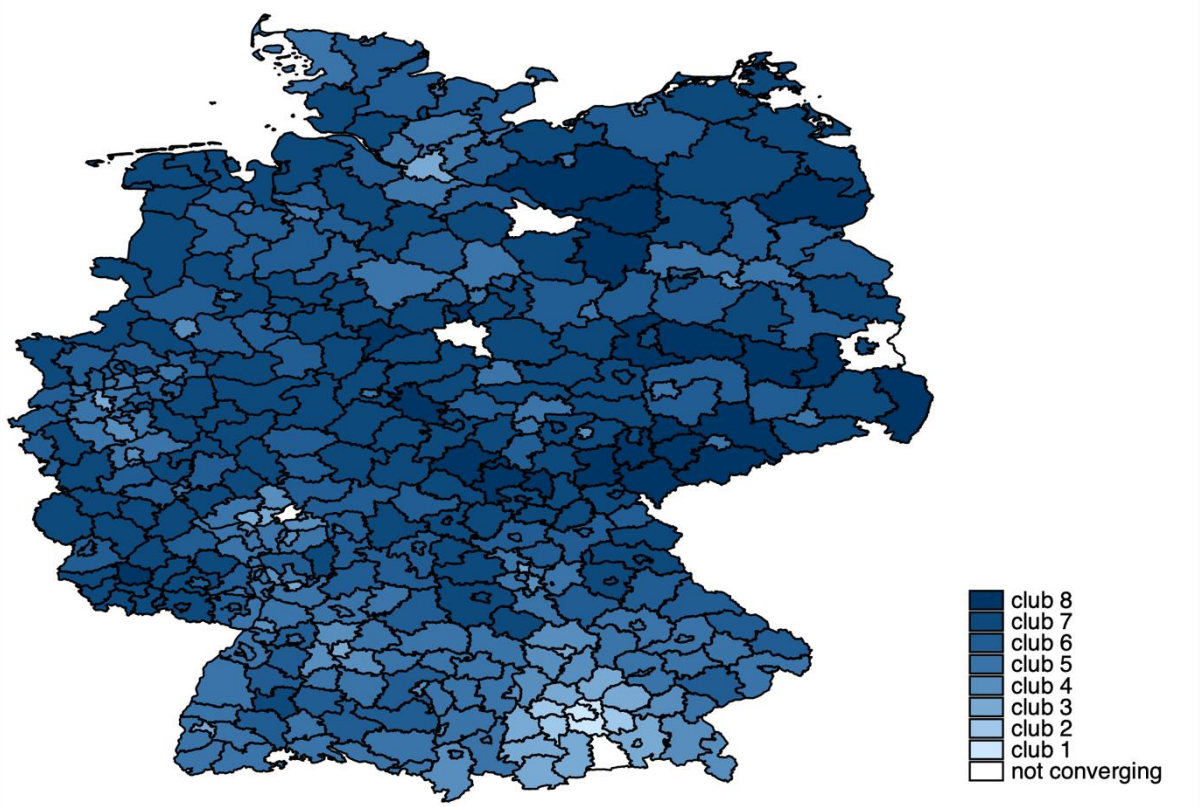


Figure 3: Convergence of Existing Flat Prices across German Districts

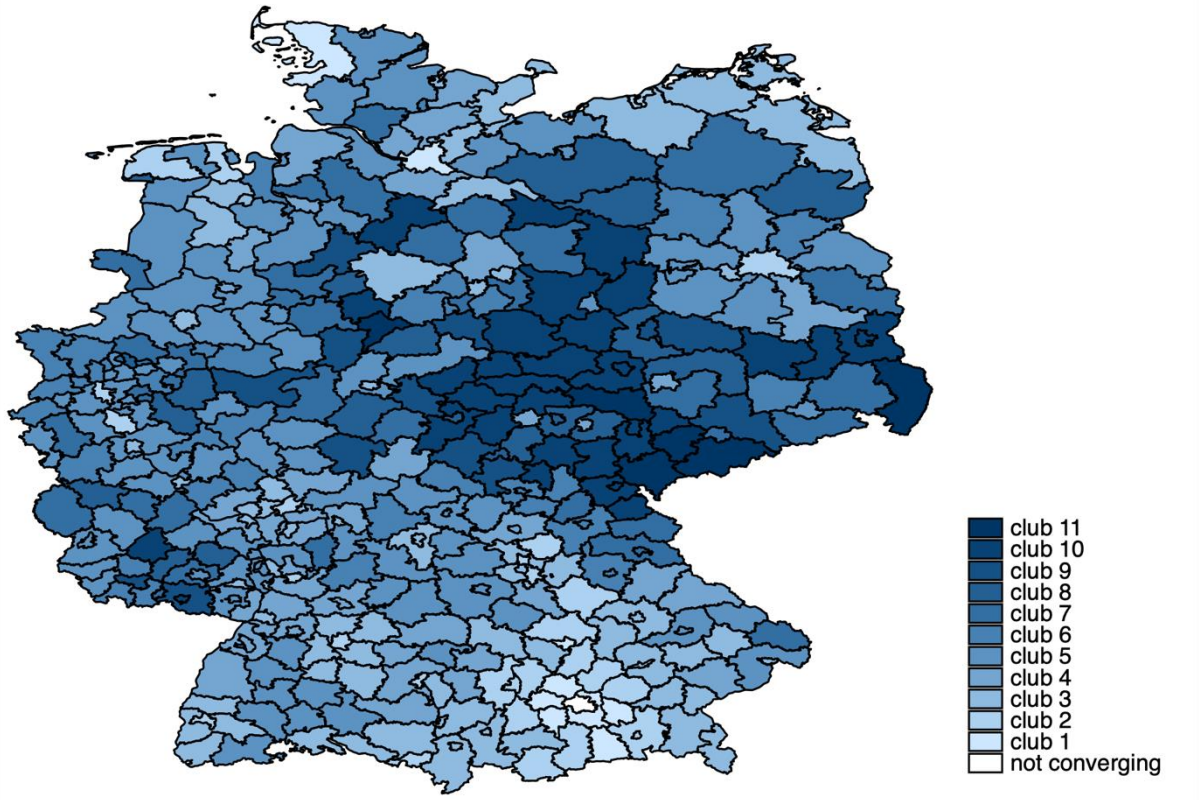


Figure 4: Convergence of New Flat Prices across German Districts

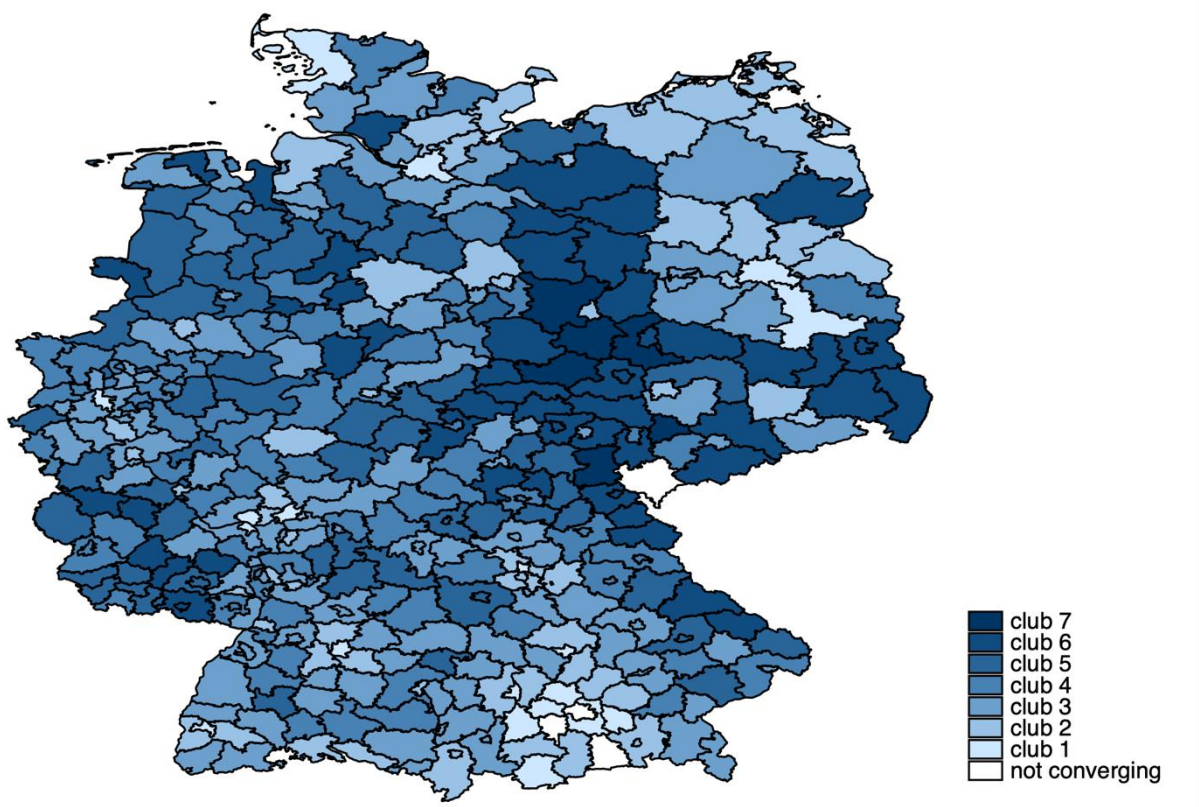


Figure 5: Convergence of Existing Flat Rents across German Districts

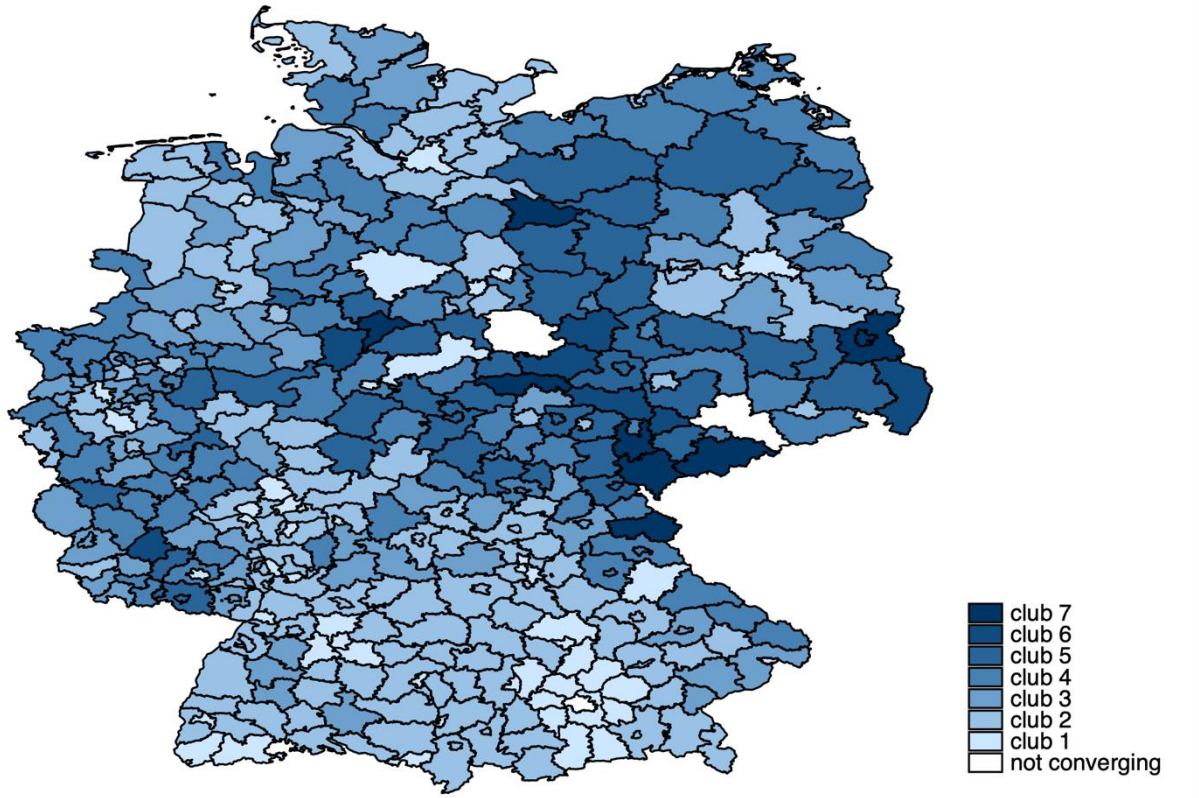
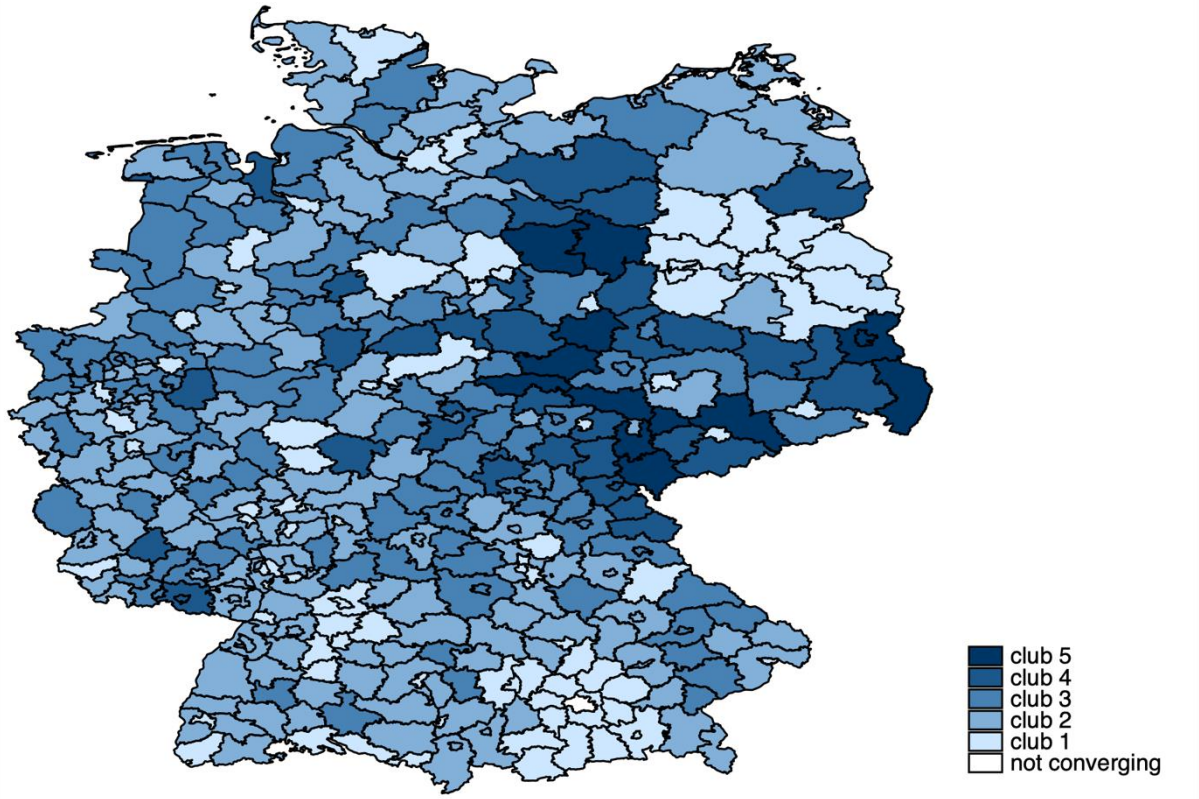


Figure 6: Convergence of New Flat Rents across German Districts



4. Conclusion

When applied to Germany's administrative districts, the log *t* test (Phillips and Sul, 2007), together with the β- and σ-convergence methods, reveal no evidence of housing price convergence (except for new flat prices in Saarland). Conversely, we discover widespread divergence at the federal and state levels, as well as housing market segmentation within states in the form of convergence clubs. At the federal level, we identify the following club numbers: 11 clubs for existing flat prices, eight clubs for house prices, seven clubs for existing flat rents, seven clubs for new flat prices, and five clubs for new flat rents. At the state level, the estimated number of clubs is generally lower, ranging from zero to six. Thus, regarding price convergence, we conclude that the German housing market appears relatively heterogeneous compared to other European countries, such as Spain (Blanco et al., 2016) or the UK (Montagnoli and Nagayasu, 2015). Moreover, since the convergence club members do not necessarily neighbour each other geographically, we argue that administrative districts may not be the best choice for studying regional housing market dynamics.

Further research may fruitfully investigate the characteristics of convergent and divergent sub-groups and possible factors driving the convergence clubs. Existing studies scrutinising housing price dynamics are frequently conceptualised in relation to changes in housing demand and supply (Glaeser et al., 2006; Malpezzi, 1996; and Saks, 2008). Regarding demand, factors that influence housing prices can be grouped into economic, demographic, and social categories. Notable economic factors include household income and the relative costs of renting versus owning. Demographic and social factors may also encompass immigration, population growth, and population composition. Regarding supply, key factors commonly considered include construction costs, existing housing stock, and various territorial

characteristics such as land availability and climate, both relevant at the regional level (Blanco et al., 2016).

However, at this time, it is not easy to obtain suitable data on German districts accounting for all of the above factors. Moreover, it should be noted that attempting to model club membership as a function of these factors is not straightforward and may prove challenging, as spatial equilibrium models provide a theoretical justification for the endogeneity of income, population growth, and housing prices (Glaeser et al., 2006). Specifically, as Kim and Rous (2012) point out, when the housing supply is relatively inelastic, labour supply will also tend to be inelastic since a hike in regional labour demand will result in higher housing prices, requiring wages to rise in order to compensate workers for the increased housing costs. These considerations suggest that in areas with inelastic housing supply, a labour demand shock will lead to modest changes in population, but notable growth in wages and housing prices. Conversely, in areas with a more elastic housing supply, a positive labour demand shock will result in relatively stable wages and housing prices, but also a higher rate of population growth.

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