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Housing market convergence: Evidence from Germany

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No. 44-2022

Umut Unal, Bernd Hayo, and Isil Erol

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Housing Market Convergence: Evidence from Germany

Abstract

This paper provides an analysis of the convergence pattern of German housing prices and rents employing a new dataset that covers all the country's administrative districts. In addition to conventional tests for β -convergence and σ -convergence, we apply Phillips and Sul's (2007) approach so as to allow for the various heterogeneity and transitional dynamics across districts. Our results reveal no evidence of convergence across Germany or within states; rather, we discover widespread evidence of divergence, as well as evidence of inter-state convergence and support for the existence of convergence clubs. At the federal level, we identify club numbers ranging from 11 (for existing flat prices) to 5 (for new flat rents). At the state level, the estimated number of clubs is generally lower, ranging from 0 to 6.

JEL classification: R10; R30; R31

Keywords: Convergence; Germany; Housing prices; district-level data; convergence clubs

1. Introduction

The 2008/09 Global Financial Crisis, which was 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 terms of 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).

To date, only a limited, albeit steadily increasing, amount of literature has been available on the convergence behaviour of regional housing prices. Recently, several researchers have studied whether absolute convergence and divergence exist across regional housing prices for both developed and developing countries and provided support for convergence in multiple sub-groups (or club convergence) in the UK (Montagnoli and Nagayasu, 2015), the US (Montanes and Olmos, 2013; Kim and Rous, 2012), Australia (Churchill et al., 2018), China (Cai et al., 2022) and Turkey (Ganioglu and Seven, 2021).

Despite its importance for policymakers and financial institutions, long-term housing price dynamics have not yet been studied in Germany. Aimed at addressing this gap in the literature, we analyse the existence of convergence in housing prices and rents across 401 administrative districts in Germany from 2004 to 2020. Methodologically, we employ conventional concepts in the form of β - and σ -convergence and Phillips and Sul's (2007) panel convergence test. Spatially, we study convergence between districts at both the federal and state levels.

Section II discusses the data and methodology employed in the study. Section III presents a discussion of the results and Section IV concludes.

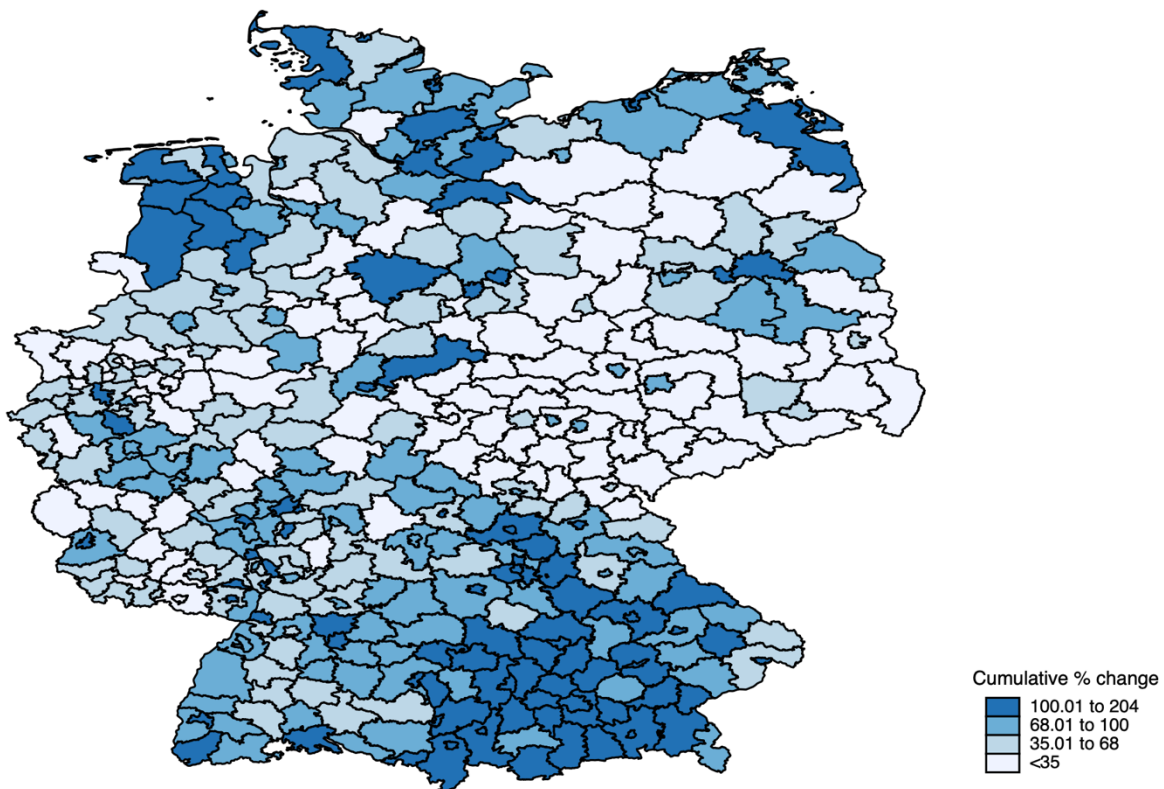
2. Data and methodology

Our sample contains data on all 401 administrative districts in Germany over the period 2004–2020 published by the Regional Real Estate Information System (RIWIS). The market price of houses is measured as an absolute value in euro, whereas flat prices and rents are measured in euro per sqm.

Over the period 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 particularly large increases in price of flats in Bavaria and in parts of Lower Saxony, 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)



The conventional analysis of convergence relies on the β - and σ -convergence concepts; the former indicates that housing prices in the regions that were characterised by lower housing prices at the start of the observation window grew faster than in those regions with high house prices, and the latter refers to reductions in the price dispersion over time. We test for β -convergence by regressing the growth rate of the respective housing price in each district on the natural logarithm of the initial housing price level. σ -convergence is tested by comparing the standard deviation (alternatively: the coefficient of variation) at the starting point of the sample period in 2004 with the value in 2020.

One of the disadvantages 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). 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). However, dividing the standard deviation by the mean of the series, i.e. employing the coefficient of variation for the σ -convergence test, serves to partially rectify this issue.

Phillips and Sul’s (2007) $\log t$ test avoids some of the shortcomings of standard convergence tests; it is based on the following decomposition of the variable of interest:

$$\log y_{it} = \left(\varphi_{it} + \frac{\varepsilon_{it}}{\mu_t}\right)\mu_t = \delta_{it}\mu_t, \quad Eq(1)$$

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.

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

Equation (2) identifies the relative deviation of district i from the common growth path μ_t and measures individual behaviour in relation to other districts. The *logt* test is based on time series regression, 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.

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

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

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) develop a four-step clustering algorithm for identifying so-called ‘convergence clubs’ in the relevant panel of cross-sectional units. Since this algorithm tends to overestimate the number of convergence clubs, Phillips and Sul (2009) propose the merging of the clusters using the same test at a later stage. The drawbacks of the *logt* 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).

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 either across Germany as a whole or within states (Table A1). In the case of standard deviations, our statistical tests for σ -convergence suggest significant divergence across (almost) all regions (Table A2). The use of 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, with respect to 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, i.e. 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/or districts at the state

level. The club clustering algorithm identifies 13 clubs across Germany in terms of 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 5 for new flat rents.² The estimated geographic housing market segmentation is graphically illustrated in Figures 2 to 6. The convergence club members did not necessarily neighbour each other geographically, which suggests that conventional definitions of regions, such as in the form of administrative districts, may not be the best choice in terms of the study of 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-Wuerttemberg	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*

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

Table 1 also shows that although some states (e.g. Bavaria, Baden-Wuerttemberg, 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).

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.

Figure 2: Convergence of House Prices across German Districts

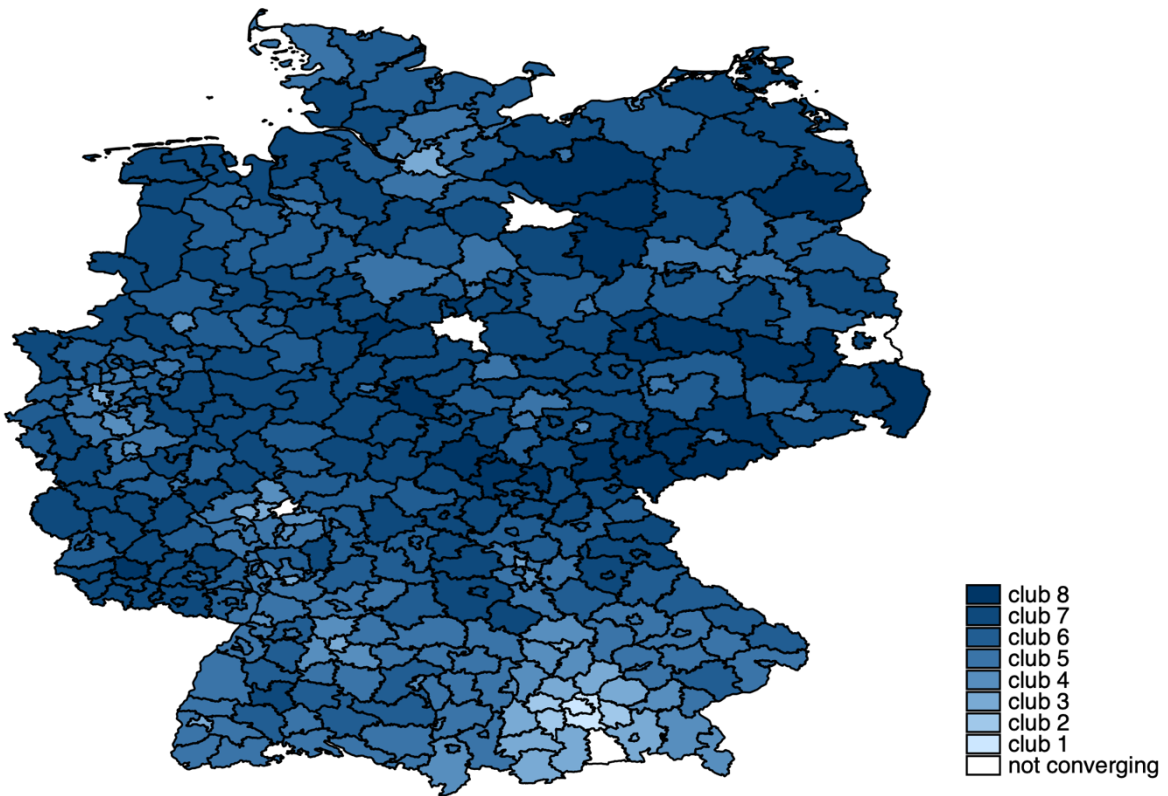


Figure 3: Convergence of Existing Flat Prices across German Districts

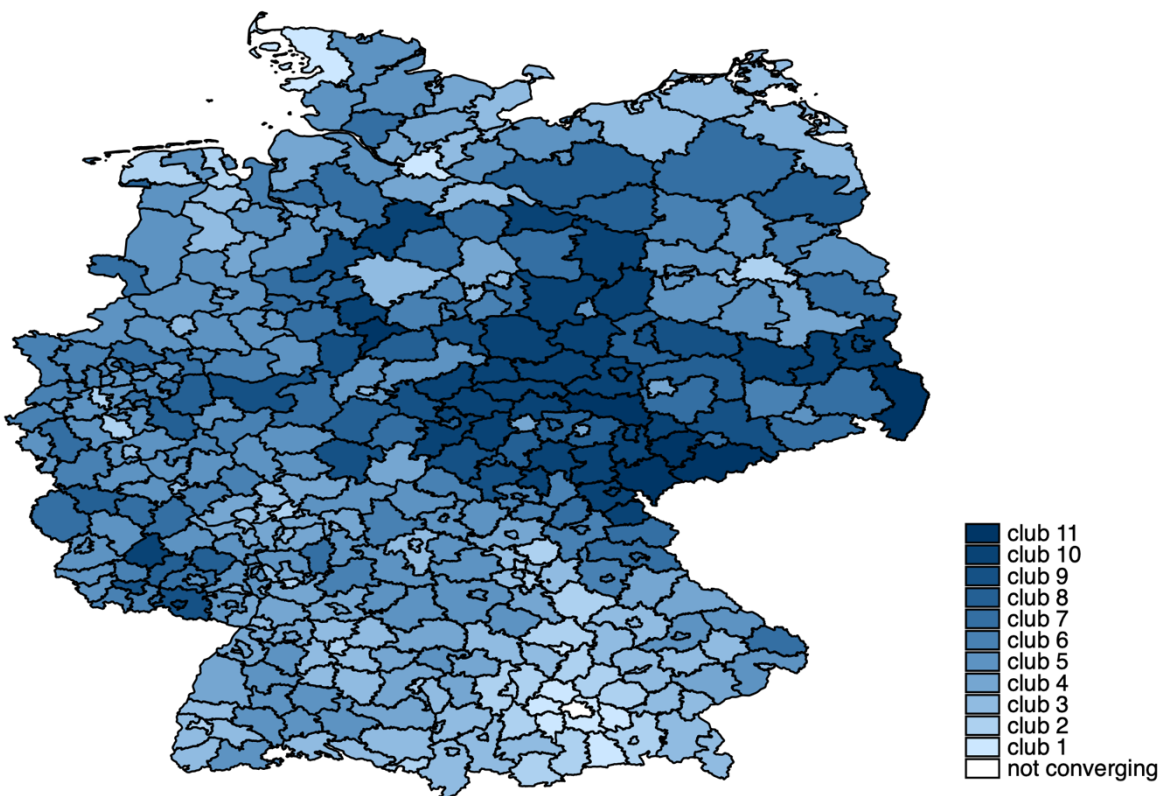


Figure 4: Convergence of New Flat Prices across German Districts

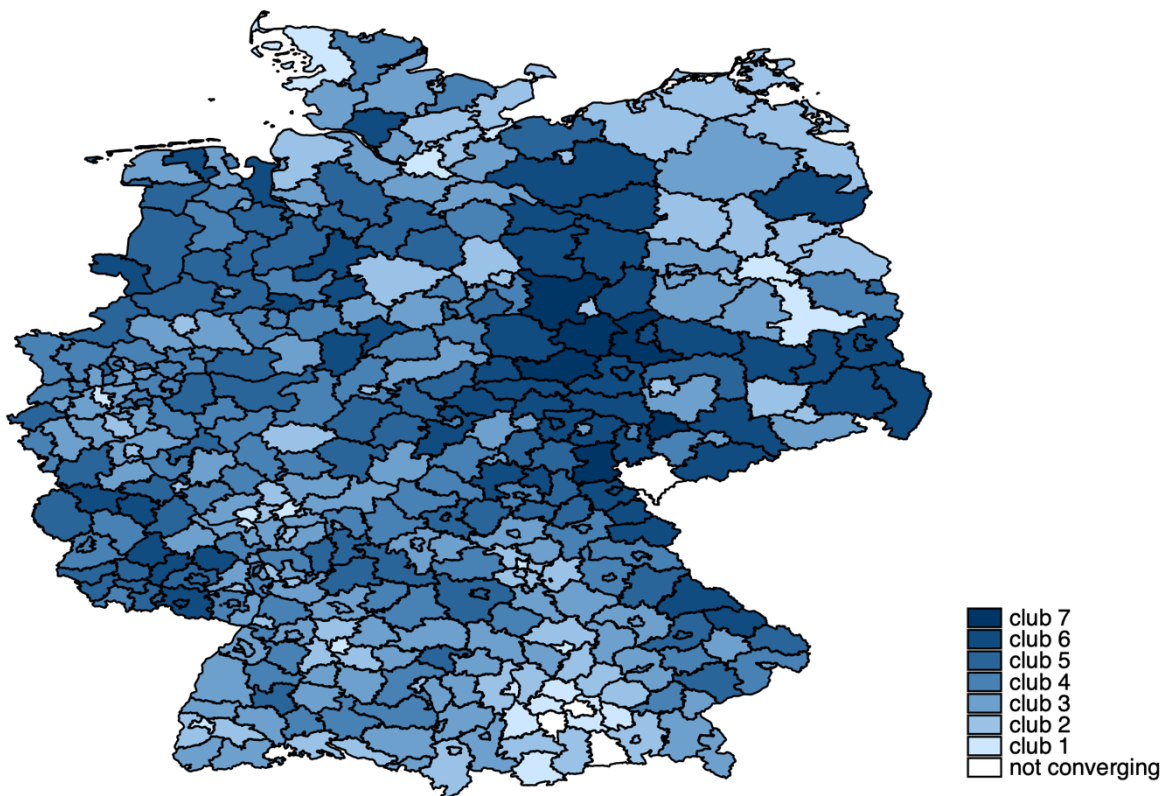


Figure 5: Convergence of Existing Flat Rents across German Districts

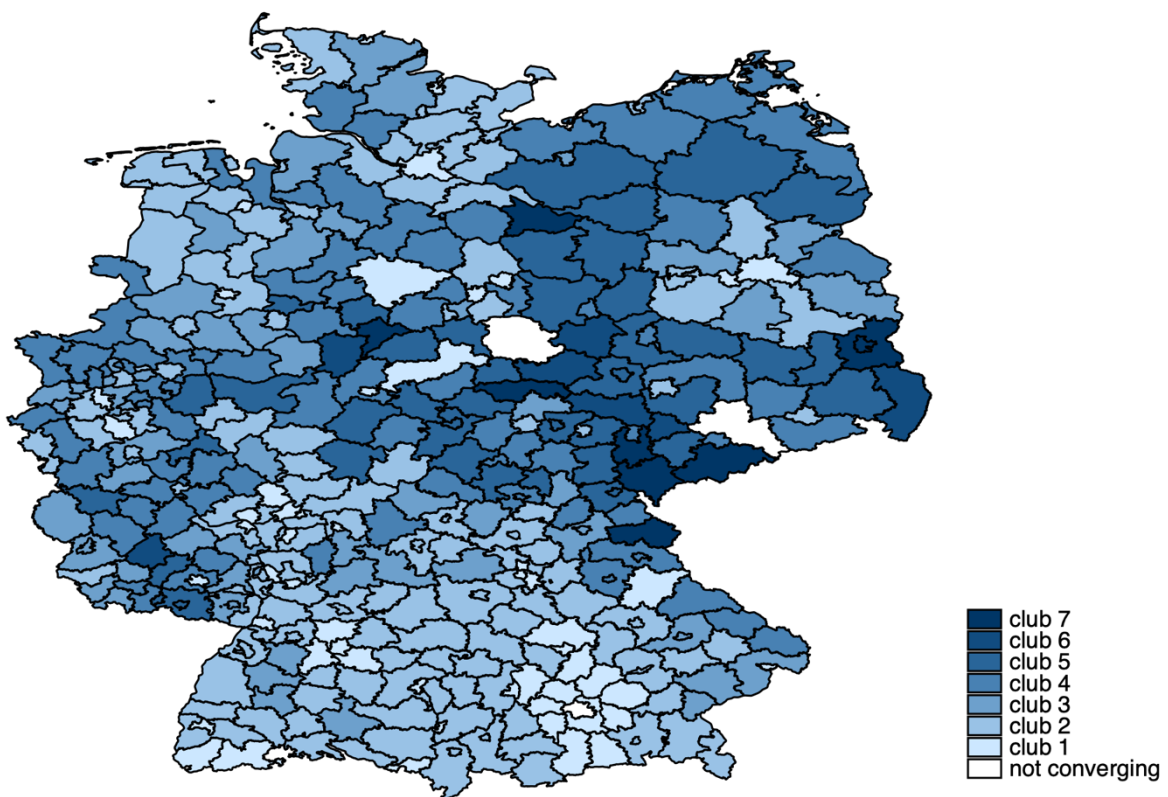
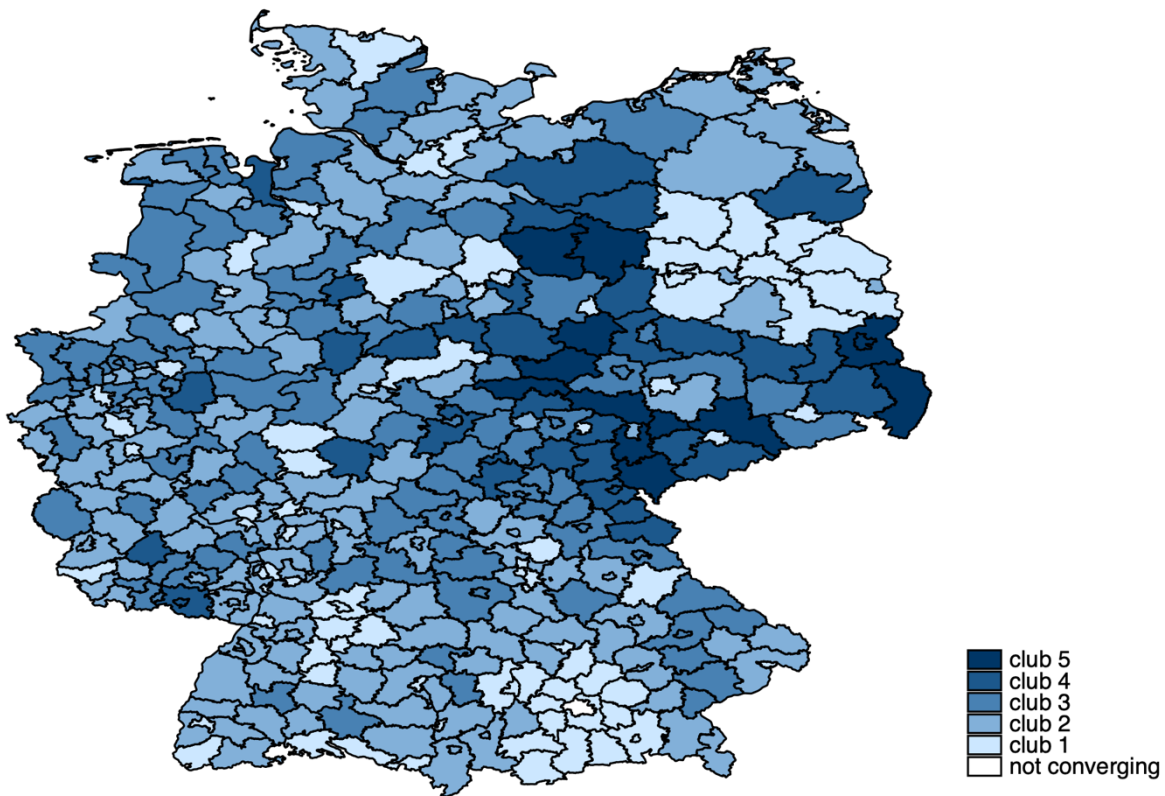


Figure 6: Convergence of New Flat Rents across German Districts



4. Conclusion

The study of all the administrative districts in Germany applying the β -convergence and σ -convergence concepts and Phillips and Sul's (2007) *log t* test reveals 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, 8 clubs for house prices, 7 clubs for existing flat rents, 7 clubs for new flat prices and 5 clubs for new flat rents. At the state level, the estimated number of clubs is generally lower, ranging from 0 to 6. Since the convergence club members do not necessarily neighbour each other geographically, administrative districts may not be the best choice with respect to the study of regional housing market dynamics.

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Appendix

Notes: All statistical tests are conducted at a 5% significance level. ‘City states’ (Hamburg, Bremen, and Berlin) are excluded from the within state analysis.

Table A1: Beta Convergence Test Results

	Germany	Baden- Wuerttemberg	Bayern	Brandenburg	Hessen	Lower Saxony	Mecklenburg- Vorpommern	North Rhine Westphalia	Rhineland- Palatinate	Saarland	Saxony	Saxony Anhalt	Schleswig- Holstein	Thuringen
House Prices														
beta	0.14** (0.02)	0.08 (0.05)	0.26** (0.05)	0.27 (0.16)	0.19** (0.06)	0.06 (0.12)	0.67 (0.74)	0.06 (0.07)	0.14* (0.06)	-0.50 (0.19)	0.23 (0.30)	0.57 (0.28)	-0.19 (0.18)	0.27 (0.29)
Constant	-1.28** (0.27)	-0.51 (0.69)	-2.78** (0.59)	-2.90 (1.93)	-1.90* (0.79)	-0.35 (1.50)	-7.63 (8.94)	-0.42 (0.91)	-1.23 (0.74)	6.40 (2.35)	-2.45 (3.66)	-6.35 (3.37)	2.80 (2.23)	-2.81 (3.52)
Observations	401	44	96	18	26	45	8	53	36	6	13	14	15	23
R-squared	0.09	0.05	0.25	0.15	0.27	0.01	0.12	0.01	0.13	0.63	0.05	0.25	0.08	0.04
Existing Flat Prices														
beta	0.64** (0.05)	0.31* (0.12)	0.39** (0.07)	0.80** (0.29)	0.42* (0.18)	0.32 (0.27)	-0.01 (0.72)	0.53** (0.16)	0.60* (0.24)	0.86 (0.75)	0.75* (0.28)	-0.81 (0.58)	0.16 (0.20)	0.73* (0.31)
Constant	-4.08** (0.38)	-1.65 (0.89)	-2.12** (0.52)	-5.30** (2.04)	-2.56 (1.33)	-1.74 (1.89)	0.60 (5.19)	-3.45** (1.12)	-3.80* (1.70)	-5.85 (5.37)	-5.11* (1.96)	5.65 (3.98)	-0.52 (1.45)	-5.06* (2.17)
Observations	401	44	96	18	26	45	8	53	36	6	13	14	15	23
R-squared	0.26	0.13	0.24	0.32	0.18	0.03	0.00	0.18	0.16	0.25	0.40	0.14	0.05	0.21
New Flat Prices														
beta	0.21** (0.04)	0.27 (0.15)	0.46** (0.08)	0.07 (0.30)	0.20 (0.14)	-0.48*** (0.15)	-0.19 (0.55)	0.34** (0.12)	-0.26 (0.24)	-0.56 (0.37)	0.89 (0.43)	0.41 (0.94)	0.34 (0.43)	0.58 (0.28)
Constant	-0.93** (0.28)	-1.47 (1.13)	-2.90** (0.59)	0.14 (2.21)	-0.85 (1.02)	4.16*** (1.07)	2.17 (4.07)	-1.91* (0.89)	2.56 (1.76)	4.72 (2.76)	-5.86 (3.10)	-2.54 (6.75)	-1.89 (3.24)	-3.63 (2.04)
Observations	401	44	96	18	26	45	8	53	36	6	13	14	15	23
R-squared	0.07	0.07	0.28	0.00	0.08	0.20	0.02	0.14	0.04	0.36	0.28	0.02	0.05	0.17
Existing Flat Rents														
beta	0.16** (0.03)	-0.05 (0.09)	0.02 (0.04)	0.34 (0.22)	0.02 (0.09)	-0.07 (0.14)	0.94* (0.33)	0.15 (0.08)	0.38** (0.11)	-0.62 (0.57)	0.39 (0.33)	-0.09 (0.43)	-0.26 (0.13)	0.35 (0.23)
Constant	0.10* (0.05)	0.54** (0.15)	0.41** (0.07)	-0.25 (0.36)	0.33* (0.16)	0.49** (0.22)	-1.28* (0.54)	0.06 (0.13)	-0.26 (0.17)	1.32 (0.93)	-0.41 (0.51)	0.32 (0.64)	0.82** (0.22)	-0.30 (0.36)
Observations	401	44	96	18	26	45	8	53	36	6	13	14	15	23
R-squared	0.06	0.01	0.00	0.13	0.00	0.01	0.58	0.07	0.28	0.23	0.12	0.00	0.23	0.10
New Flat Rents														
beta	0.08** (0.03)	-0.05 (0.08)	0.07 (0.05)	0.24 (0.29)	-0.11 (0.08)	-0.10 (0.17)	0.01 (0.21)	-0.09 (0.09)	0.04 (0.13)	-0.85 (0.42)	1.67** (0.33)	1.52 (0.88)	-0.24 (0.14)	0.39 (0.27)
Constant	0.29** (0.06)	0.54** (0.15)	0.35** (0.09)	0.09 (0.49)	0.65** (0.16)	0.58* (0.29)	0.46 (0.35)	0.56** (0.17)	0.40 (0.23)	1.92 (0.72)	-2.29** (0.54)	-2.07 (1.38)	0.90** (0.25)	-0.30 (0.44)
Observations	401	44	96	18	26	45	8	53	36	6	13	14	15	23
R-squared	0.02	0.01	0.02	0.04	0.07	0.01	0.00	0.02	0.00	0.51	0.69	0.20	0.20	0.09

Notes: Standard errors in parentheses. **p < 0.01 and *p < 0.05.

Table A2. Sigma Convergence Test Results for Standard Deviation

	House Price			Existing Flat Price			New Flat Price			Existing Flat Rent			New Flat Rent		
	2004	2020		2004	2020		2004	2020		2004	2020		2004	2020	
Federal level															
Germany	91827	198557	+	344	1094	+	409	1158	+	1.04	1.96	+	1.19	2.21	+
States (Lander) level															
Baden-Wuerttemberg	790890	151203	+	241	684	+	270	841	+	0.97	1.66	+	1.10	1.82	+
Bavaria	107220	272171	+	411	1245	+	417	1405	+	1.34	2.23	+	1.35	2.50	-
Brandenburg	45075	109162	+	232	744	+	280	855	+	0.61	1.39	+	0.81	2.00	+
Hesse	113670	222971	+	375	1055	+	404	1230	+	1.40	2.23	+	1.62	2.44	
Lower Saxony	29928	60824	+	200	694	+	252	482	+	0.60	1.07	+	0.63	1.34	+
Mecklenburg-Vorpommern	15222	65561	+	248	782	+	245	795	+	0.41	1.12	+	0.82	1.44	+
North Rhine-Westphalia	65287	122516	+	205	615	+	227	719	+	0.74	1.32	+	0.87	1.48	+
Rhineland-Palatinate	56475	111255	+	194	642	+	205	657	+	0.66	1.45	+	0.70	1.47	+
Saarland	24369	22454		106	302	+	113	179		0.24	0.38		0.35	0.46	
Saxony	32356	78426	+	240	571	+	189	872	+	0.41	0.95	+	0.47	2.13	+
Saxony-Anhalt	13120	42949	+	134	314	+	83	516	+	0.22	0.50	+	0.26	1.62	+
Schleswig-Holstein	51237	83128	+	427	1096	+	220	927	+	0.88	1.10		0.90	1.23	
Thuringia	23737	78877	+	175	503	+	176	670	+	0.43	1.04	+	0.59	1.60	+

Notes: The third column for each variable indicates the standard deviation F-test results (H_0 : same standard deviation in 2004 and 2020; + = significant divergence and - = significant convergence).

Table A3. Sigma Convergence Test Results for Coefficient of Variation

	House Prices			Existing Flat Prices			New Flat Prices			Existing Flat Rents			New Flat Rents		
Federal level															
Germany	0.36	0.49	+	0.26	0.47	+	0.22	0.33	+	0.20	0.25	+	0.20	0.23	+
States (Lander) level															
Baden-Wuerttemberg	0.25	0.30		0.15	0.23	+	0.12	0.21	+	0.16	0.18		0.16	0.17	
Bavaria	0.36	0.51	+	0.27	0.40	+	0.20	0.33	+	0.24	0.26		0.21	0.25	
Brandenburg	0.25	0.39		0.19	0.42	+	0.19	0.29	+	0.12	0.20	+	0.15	0.22	
Hesse	0.38	0.47		0.25	0.41	+	0.21	0.31	+	0.23	0.26		0.24	0.23	
Lower Saxony	0.15	0.20		0.18	0.36	+	0.16	0.17		0.13	0.15		0.11	0.16	+
Mecklenburg-Vorpommern	0.08	0.23	+	0.19	0.32		0.15	0.23		0.08	0.16		0.15	0.16	
North Rhine-Westphalia	0.23	0.31	+	0.15	0.31	+	0.12	0.21	+	0.14	0.18		0.14	0.16	
Rhineland-Palatinate	0.24	0.30		0.16	0.32	+	0.12	0.20	+	0.13	0.20	+	0.12	0.16	
Saarland	0.55	0.08		0.20	0.18		0.17	0.06	-	0.10	0.06		0.13	0.05	
Saxony	0.18	0.29		0.22	0.43	+	0.13	0.32	+	0.09	0.16	+	0.09	0.28	+
Saxony-Anhalt	0.09	0.19	+	0.14	0.29	+	0.06	0.24	+	0.05	0.09	+	0.05	0.24	+
Schleswig-Holstein	0.20	0.20		0.31	0.42		0.12	0.25	+	0.15	0.13		0.14	0.12	
Thuringia	0.15	0.32	+	0.16	0.43	+	0.13	0.29	+	0.09	0.17	+	0.12	0.22	+

Notes: The third column for each variable indicates the coefficient of variation t-test results (H_0 : same coefficient of variation in 2004 and 2020; + = significant divergence and - = significant convergence).

Table A4: Log-t test results

Germany	Variable	b-coefficient	t-statistic
	House price	-1.142	-381.256**
	Existing flat price	-1.819	-123.889**
	New flat price	-1.204	-257.406**
	Existing Flat Rent	-1.076	-404.518**
	New Flat Rent	-0.868	-53.648**
Baden-Württemberg	House price	-1.053	-81.641**
	Existing flat price	-1.426	-85.419**
	New flat price	-1.540	-595.240**
	Existing Flat Rent	-0.813	-58.701**
	New Flat Rent	-0.637	-22.958**
Bayern	House price	-1.340	-1048.007**
	Existing flat price	-1.497	-673.528**
	New flat price	-1.527	-235.307**
	Existing Flat Rent	-0.715	-31.794**
	New Flat Rent	-0.769	-31.082**
Brandenburg	House price	-1.373	-135.632**
	Existing flat price	-2.098	-49.281**
	New flat price	-1.395	-43.617**
	Existing Flat Rent	-1.471	-508.574**
	New Flat Rent	-1.234	-67.391**
Hessen	House price	-1.069	-93.347**
	Existing flat price	-1.579	-112.142**
	New flat price	-1.202	-236.833**
	Existing Flat Rent	-0.762	-41.167**
	New Flat Rent	-0.562	-18.899**
Lower Saxony	House price	-1.601	-99.486**
	Existing flat price	-2.253	-191.328**
	New flat price	-0.867	-28.631**
	Existing Flat Rent	-1.234	-181.792**
	New Flat Rent	-1.182	-231.757**
Mecklenburg-Vorpommern	House price	-2.473	-95.834**
	Existing flat price	-1.991	-76.770**
	New flat price	-1.518	-112.588**
	Existing Flat Rent	-1.881	-505.035**
	New Flat Rent	-0.648	-34.837**
North Rhein – Westphalia	House price	-0.990	-70.345**
	Existing flat price	-1.768	-185.235**
	New flat price	-1.227	-187.280**
	Existing Flat Rent	-0.955	-54.963**
	New Flat Rent	-0.605	-15.281**
Rhineland-Palatinate	House price	-1.117	-155.560**
	Existing flat price	-1.961	-115.906**
	New flat price	-1.740	-95.559**
	Existing Flat Rent	-1.195	-92.955**
	New Flat Rent	-1.004	-31.915**
Saarland	House price	-0.747	-32.221**
	Existing flat price	-1.594	-36.186**
	New flat price	0.283	3.092
	Existing Flat Rent	-1.380	-26.738**
	New Flat Rent	-1.431	-15.912**
Saxony	House price	-1.761	-53.282**
	Existing flat price	-2.109	-48.624**
	New flat price	-1.779	-776.116**
	Existing Flat Rent	-1.782	-404.466**
	New Flat Rent	-1.837	-114.003**
Saxony-Anhalt	House price	-1.623	-384.122**
	Existing flat price	-3.343	-19.898**
	New flat price	-3.005	-325.983**
	Existing Flat Rent	-2.206	-29.014**
	New Flat Rent	-2.767	-118.926**
Schleswig-Holstein	House price	-0.888	-79.225**

	Existing flat price	-1.231	-194.716**
	New flat price	-1.355	-110.177**
	Existing Flat Rent	-0.657	-74.747**
	New Flat Rent	-0.324	-8.276**
Thuringen	House price	-1.770	-78.286**
	Existing flat price	-2.318	-144.696**
	New flat price	-1.624	-113.980**
	Existing Flat Rent	-1.633	-399.594**
	New Flat Rent	-1.520	-231.050**

Notes: * and ** indicates the rejection of $H_0 = \text{convergence}$ at the 5% and 1% significance level, respectively.

Table A5: Logt test - Initial Convergence Clubs

		House Price		Existing flat price		New flat price		Existing Flat Rent		New Flat Rent	
		b-coefficient	t-statistic	b-coefficient	t-statistic	b-coefficient	t-statistic	b-coefficient	t-statistic	b-coefficient	t-statistic
Germany	Club 1	2.037	7.776	0.219	3.223	0.091	1.296	0.267	4.091	0.145	1.948
	Club 2	0.03	0.307	0.287	4.218	1.119	0.743	0.34	4.51	0.17	2.121
	Club 3	0.648	5.374	0.326	3.155	0.116	1.235	0.266	3.794	0.116	1.578
	Club 4	0.346	2.893	0.082	1.037	0.382	5.71	0.136	2.032	-0.068	-1.209
	Club 5	0.281	3.333	0.158	2.61	0.272	3.535	0.21	2.883	-0.014	-0.589
	Club 6	0.127	1.729	0.361	3.899	0.151	2.166	0.163	1.932	1.315	8.762
	Club 7	0.293	2.754	-0.032	-1.204	0.314	3.269	0.236	2.34	1.487	4.071
	Club 8	0.235	2.676	0.771	5.541	0.329	3.278	0.142	1.622		
	Club 9	0.125	1.633	0.48	3.451	0.224	1.929	0.112	1.466		
	Club 10	0.163	1.594	0.391	8.791	0.435	4.999	0.296	2.603		
	Club 11	0.269	3.649	0.322	4.849	0.457	4.317	0.489	3.737		
	Club 12	0.552	3.954	0.285	5.923	0.084	1.028	0.17	2.275		
	Club 13	1.085	7.403	-0.024	-0.094	0.693	5.57	0.742	3.007		
	Club 14	-1.342	-333.729+	-1.666	-132.968+	-1.566	-488.279+	0.051	0.711		
		Club 15							-1.321+	-759.838+	
Baden-Wuerttemberg	Club 1	0.583	5.834	-0.016	-0.331	0	-0.007	0.06	2.259	-0.065	-1.356
	Club 2	2.78	4.931	0.732	9	-0.021	-0.257	0.503	8.436	0.13	1.809
	Club 3	0.302	2.911	-2.146	-1.381	0.041	0.304	7.405	4.262	0.416	4.108
	Club 4	0.006	0.077	0.856	6.366	0.1	1.566	3.194	9.74	-0.443	-38.248+
	Club 5	0.334	2.901	0.5	6.175	0.352	4.214	1.001	3.576		
	Club 6	0.308	4.087	0.938	1.885	-1.752	-710.064+	2.227	52.947+		
	Club 7	1.724	5.585	1.688	5.649						
	Club 8	-1.246	-156.627+	-1.639	-122.306+						
Bayern	Club 1	2.037	7.776	0.132	2.551	0.194	2.274	0.188	3.328	0.31	6.474
	Club 2	0.03	0.307	0.182	2.571	-0.079	-1.626	0.14	1.938	0.136	1.96
	Club 3	-0.078	-1.116	0.073	0.982	0.451	12.25	0.15	2.05	0.087	1.485
	Club 4	0.068	1.147	0.045	0.923	1.527	9.572	0.213	3.478	0	-0.005
	Club 5	-0.003	-0.048	0.233	1.386	0.245	2.267	0.143	1.624	0.221	3.031
	Club 6	0.146	1.441	-0.071	-1.096	1.068	10.534	0.244	2.604	0.198	8.584
	Club 7	0.201	1.414	0.002	0.038	0.418	4.475			0.987	8.954
	Club 8	0.132	1.296	1.575	5.18	0.798	5.427			-0.925	-14.649+
	Club 9	0.323	2.734	1.117	2.931	0.4	5.305				
	Club 10	-0.073	-1.562	-1.804	-259.708+	-1.953	-379.337+				
	Club 11	0.515	7.026								
	Club 12	0.949	3.958								
Brandenburg	Club 1	0.189	3.924	0.35	2.662	0.003	0.062	1.655	4.382	0.097	1.726

	Club 2	4.631	2.081	0.038	0.314	0.595	10.076	0.974	5.115	0.529	6.407
	Club 3	0.481	4.87	2.266	5.42	-6.554	-5.693+	0.506	8.805	-1.04	-70.59+
	Club 4	1.364	5.558	0.708	6.535			0.112	0.2		
	Club 5	-1.916	-354.284+	-1.905	-118.455+			-1.603	-176.592+		
Hessen	Club 1	1.815	6.201	0.023	0.61	0.822	5.543	0.155	2.287	0.06	1.307
	Club 2	-0.027	-1.181	-4.569	-1.493	0.744	13.803	0.244	3.886	0.354	3.998
	Club 3	0.25	5.733	0.378	4.248	0.476	13.177	0.31	3.601	0.189	4.435
	Club 4	0.094	1.558	0.048	0.811	0.438	3.367	0.375	5.324	-0.789	-26.125
	Club 5	0.183	2.522	4.672	2.902	0.747	5.521				
	Club 6	0.524	3.469	0.15	0.424	-0.665	-13.423+				
	Club 7	-1.164	-62.732+	0.352	5.302						
	Club 8			-1.527	-180.134+						
Lower Saxony	Club 1	0.236	10.188	-0.109	-0.676	1.036	9.901	-0.025	-1.619	0.328	5.261
	Club 2	-0.042	-0.638	-1.325	-0.794	0.245	3.736	0.53	7.595	0.921	7.157
	Club 3	0.05	0.627	-0.391	-1.176	1.672	8.6	1.309	4.391	0.935	4.566
	Club 4	0.879	7.176	3.623	6.799			1.239	2.511	0.144	3.383
	Club 5	0.165	2.904	1.31	0.918			-0.286	-0.137	0.472	7.964
	Club 6	1.412	3.177	0.495	3.201			4.893	3.634	-1.333	-129.951+
	Club 7	-1.234	-28.906+	0.059	1.383			0.939	9.715		
	Club 8			0.206	2.317			-2.283	-64.118+		
	Club 9			-2.047	-138.708+						
Mecklenburg-Vorpommern	Club 1	-0.879	-0.318	2.984	6.481	0.043	1.467	1.197	8.421	0.032	0.388
	Club 2	2.496	8.103	2.57	7.765	0.64	3.354	1.685	1.177	0.23	2.192
	Club 3	-2.911	-72.107+	-4.685	-48.327+	3.111	1.973	-1.9	-733.692+	-1.74	-164.749+
	Club 4										
North Rhein - Westphalia	Club 1	5.422	3.648	1.281	6.606	0.337	2.215	-0.25	-1.112	0.185	2.024
	Club 2	0.9	4.338	0.218	5.517	0.489	3.389	0.26	2.345	0.077	0.83
	Club 3	0.066	0.739	-0.011	-0.221	0.42	3.39	0.202	2.6	0.319	3.462
	Club 4	0.286	3.043	0.587	4.245	0.2	2.509	0.182	1.736	0.297	3.15
	Club 5	0.162	1.782	0.689	3.511	0.121	1.477	0.277	2.807	0.663	1.766
	Club 6	-0.783	-9.017+	0.37	2.342	0.056	1.527	0.106	0.787	-1.166	-22.86+
	Club 7			-1.715	-175.133+	1.087	4.945	0.606	6.336		
	Club 8					-3.265	-0.882	0.205	6.957		
	Club 9					-1.484	-57.611+	0.515	4.298		
	Club 10							-1.505	-40.601+		
Rhineland-Palatinate	Club 1	1.024	7.112	0.002	0.009	0.03	0.537	1.273	11.511	1.342	44.435
	Club 2	0.312	3.739	0.597	10.009	1.025	6.292	0.919	8.887	0.948	1.021
	Club 3	0.81	3.548	1.134	2.707	0.19	4.52	0.196	12.329	0.254	2.139

	Club 4	-0.036	-0.85	3.05	2.146	-2.366	-59.011+	0.855	6.817	1.659	5.186
	Club 5	0.585	3.991	0.227	0.624			0.294	3.825	0.54	4.536
	Club 6	0.562	1.998	5.154	3.952			0.557	4.162	0.725	6.164
	Club 7	-0.824	-35.329+	-2.25	-140.755+			1.808	1.75	-0.277	-0.581
	Club 8							-0.132	-0.319	-1.928	-60.163+
	Club 9							-0.979	-25.064+		
Saarland	Club 1	2.051	1.282	0.267	2.229	0.283	3.092	5.53	2.976	0.542	1.026
	Club 2	1.181	2.756	-2.898	-140.89+			1.244	5.997+	-7.72	-11.354+
	Club 3	-0.593	-9.188+								
Saxony	Club 1	0.563	5.441	1.826	6.018	0.297	2.799	0.139	0.926	3.674	2.258
	Club 2	0.536	3.338	0.699	4.672	-2	-0.708	1.397	7.904	-0.212	-0.079
	Club 3	4.007	0.753	1.579	1.134	0.688	4.074	2.663	4.137	0.434	3.953
	Club 4	0.521	5.877	0.328	2.665	2.545	1.977	0.26	1.445	-3.172	-91.926+
	Club 5					-2.337	-50.976+	-0.024	-0.154		
Saxony-Anhalt	Club 1	6.504	5.532	2.125	16.146	0.369	1.386	0.361	5.372	1.952	0.708
	Club 2	2.013	4.456	0.022	0.03	0.875	5.646	0.475	2.296	0.196	1.717
	Club 3	0.997	3.616	0.69	2.444	4.669	1.62	-3.286	-141.959+	-0.366	-1.193
	Club 4	4.278	4.302	-3.91	-35.671+	0.909	0.392			0.882	0.675
	Club 5	0.737	3.337			-3.342	-63.259+			0.687	5.458
	Club 6									-5.041	-12.583+
Schleswig-Holstein	Club 1	0.137	1.797	0.265	3.492	1.114	4.863	0.598	12.617	0.067	0.705
	Club 2	2.314	21.861	0.337	3.274	0.045	1.313	0.307	3.492	0.285	3.269
	Club 3	0.495	6.863	-1.316	-127.55+	1.5	6.816	0.107	4.975	-0.054	-1.463
	Club 4	-1.292	-167.45+			-1.88	-48.834+	0.547	3.864	0.337	12.118
Thuringen	Club 1	1.841	10.048	0.171	1.176	2.759	5.937	1.881	8.034	0.011	0.064
	Club 2	0.009	0.046	1.819	6.447	0.193	1.605	0.203	3.031	1.014	15.604
	Club 3	-0.099	-1.379	1.932	12.048	0.444	8.507	0.204	1.544	1.201	7.67
	Club 4	-4.342	-83.259+	0.802	0.359	1.757	8.261	1.197	8.809	-2.529	-93.929+
	Club 5			0.565	3.966			0.022	0.143		
	Club 6			1.143	6.888			-1.642	-33.241+		
	Club 7										

Notes: The clubs are obtained by applying the algorithm proposed by Phillips and Sul (2007), which is based on finding groups of districts with similar convergence speeds than the average. t-stat is the convergence test statistic, which is distributed as a one-sided t-test with a critical value of -1.65 at the 5% significance level. “+” indicates non-convergent group rather than a club in the respective row.

Table A6: Logt test - Club Merging

		House Price		Existing flat price		New flat price		Existing Flat Rent		New Flat Rent	
		b-coefficient	t-statistic	b-coefficient	t-statistic	b-coefficient	t-statistic	b-coefficient	t-statistic	b-coefficient	t-statistic
Germany	Club 1	2.037	7.776	0.219	3.223	-0.08	-0.941	0.043	0.915	0.158	2.154
	Club 2	0.03	0.307	0.049	0.737	0.027	0.477	-0.03	-0.573	0.116	1.578
	Club 3	0.129	1.919	0.054	0.968	0.092	1.253	0.163	1.932	-0.068	-1.209
	Club 4	0.281	3.333	0.361	3.899	0.224	1.929	-0.024	-0.352	-0.014	-0.589
	Club 5	-0.075	-1.182	-0.032	-1.204	0.435	4.999	0.133	2.314	-0.014	-0.311
	Club 6	0.235	2.676	0.771	5.541	-0.033	-0.544	0.742	3.007	-1.261	-155.690+
	Club 7	-0.09	-1.542	0.48	3.451	0.693	5.57	0.051	0.711		
	Club 8	-0.076	-1.526	0.391	8.791	-1.566	-488.279+	-1.321	-759.838+		
	Club 9	-1.342	-333.729+	0.322	4.849						
	Club 10			0.285	5.923						
	Club 11			-0.024	-0.094						
	Club 12			-1.666	-132.968+						
Baden-Württemberg	Club 1	0.583	5.834	-0.016	-0.331	No clubs can be merged		0.06	2.259	No clubs can be merged	
	Club 2	2.78	4.931	0.909	7.989			0.448	6.295		
	Club 3	0.235	2.626	0.856	6.366			0.126	2.01		
	Club 4	0.334	2.901	0.5	6.175			2.227	52.947		
	Club 5	-0.047	-0.907	0.31	5.902			-1.096	-67.692+		
	Club 6	-1.246	-156.627+	-1.639	-122.306+						
Bayern	Club 1	2.037	7.776	0.132	2.551	0.194	2.274	0.188	3.328	-0.001	-0.028
	Club 2	0.03	0.307	0.182	2.571	-0.079	-1.626	-0.164	-0.279	0	-0.005
	Club 3	-0.078	-1.116	-0.039	-0.672	-0.017	-0.266	0.213	3.479	0.221	3.031
	Club 4	0.068	1.147	0.233	1.386	0.021	0.263	0.143	1.624	0.198	8.584
	Club 5	-0.017	-0.211	-0.071	-1.096	0.383	4.678	0.244	2.604	0.987	8.954
	Club 6	0.168	1.694	0.002	0.038	0.4	5.305			-0.925	-14.649+
	Club 7	-0.073	-1.562	1.575	5.18	-1.953	-379.337+				
	Club 8	0.515	7.026	1.117	2.931						
	Club 9	0.949	3.958	-1.804	-259.708+						
Brandenburg	Club 1	No clubs can be merged		No clubs can be merged		No clubs can be merged		No clubs can be merged		No clubs can be merged	
	Club 2										
	Club 3										
	Club 4										
	Club 5										
Hessen	Club 1	1.815	6.201	0.168	4.273	0.822	5.543	-0.037	-0.786	No clubs can be merged	
	Club 2	-0.027	-1.181	-0.069	-1.352	0.119	2.475	0.31	3.601		
	Club 3	0.25	5.733	4.672	2.902	0.017	0.269	0.375	5.324		
	Club 4	0.094	1.558	0.15	0.424	-0.665	-13.423+	-1.034	-52.551+		

	Club 5	0.233	2.985	0.352	5.302						
	Club 6	-1.164	-62.732+	-1.527	-180.134+						
Lower Saxony	Club 1	0.236	10.188	-0.109	-0.676	No clubs can be merged	-0.025	-1.619	0.328	5.261	
	Club 2	-0.042	-0.638	-1.325	-0.794		0.217	5.952	0.894	6.617	
	Club 3	-0.05	-1.38	-0.391	-1.176		0.906	6.246	0.144	3.383	
	Club 4	0.165	2.904	1.188	4.712		0.939	9.715	0.472	7.964	
	Club 5	1.412	3.177	0.495	3.201		-2.283	-64.118+	-1.333	-129.951+	
	Club 6	-1.234	-28.906+	0.059	1.383						
	Club 7			0.206	2.317						
	Club 8			-2.047	-138.708+						
Mecklenburg-Vorpommern	Club 1	No clubs can be merged		No clubs can be merged		No clubs can be merged	No clubs can be merged		-0.078	-1.283	
	Club 2								-1.74	-164.749	
	Club 3										
	Club 4										
North Rhein - Westphalia	Club 1	No clubs can be merged		1.281	6.606	0.337	2.215	-0.25	-1.112	-0.028	-0.379
	Club 2			0.218	5.517	-0.051	-0.684	0.26	2.345	-0.062	-1.168
	Club 3			-0.011	-0.221	0.121	1.477	0.162	2.09	-1.166	-22.86+
	Club 4			0.083	1.028	0.254	3.62	0.106	0.787		
	Club 5			0.37	2.342	-3.265	-0.882	0.377	5.873		
	Club 6			-1.715	-175.133+	-1.484	-57.611+	0.515	4.298		
	Club 7							-1.505	-40.601+		
Rhineland-Palatinate	Club 1	No clubs can be merged		No clubs can be merged		No clubs can be merged		1.273	11.511	1.342	44.435
	Club 2							0.919	8.887	0.293	3.198
	Club 3							0.196	12.329	-0.084	-1.205
	Club 4							0.855	6.817	-0.277	-0.581
	Club 5							0.294	3.825	-1.928	-60.163+
	Club 6							0.127	1.101		
	Club 7							-0.132	-0.319		
	Club 8							-0.979	-25.064+		
Saarland	Club 1	No clubs can be merged		No clubs can be merged		No clubs can be merged		No clubs can be merged		No clubs can be merged	
	Club 2										
	Club 3										
Saxony	Club 1	No clubs can be merged		No clubs can be merged		No clubs can be merged		No clubs can be merged		No clubs can be merged	
	Club 2										
	Club 3										
	Club 4										
	Club 5										
Saxony-Anhalt	Club 1	6.504	5.531	No clubs can be merged		No clubs can be merged		-0.018	-0.749	No clubs can be merged	
	Club 2	2.012	4.455					-3.286	-141.958+		

	Club 3	0.250	1.991						
	Club 4	0.737	3.336						
	Club 5								
	Club 6								
Schleswig-Holstein	Club 1	-0.039	-0.613	No clubs can be merged	No clubs can be merged	0.272	7.606	0.06	0.819
	Club 2	0.495	6.863			0.107	4.975	-0.054	-1.463
	Club 3	-1.292	-167.45+			0.547	3.864		
	Club 4					1.287	-61.843+		
Thuringen	Club 1	No clubs can be merged	No clubs can be merged	No clubs can be merged	No clubs can be merged	No clubs can be merged	No clubs can be merged	No clubs can be merged	No clubs can be merged
	Club 2								
	Club 3								
	Club 4								
	Club 5								
	Club 6								

Notes: The clubs are obtained by applying the algorithm proposed by Phillips and Sul (2007), which is based on finding groups of districts with similar convergence speeds than the average. t-stat is the convergence test statistic, which is distributed as a one-sided t-test with a critical value of -1.65 at the 5% significance level. “+” indicates non-convergent group rather than a club in the respective row.

Figure A1: Convergence Maps for Baden-Wurttemberg

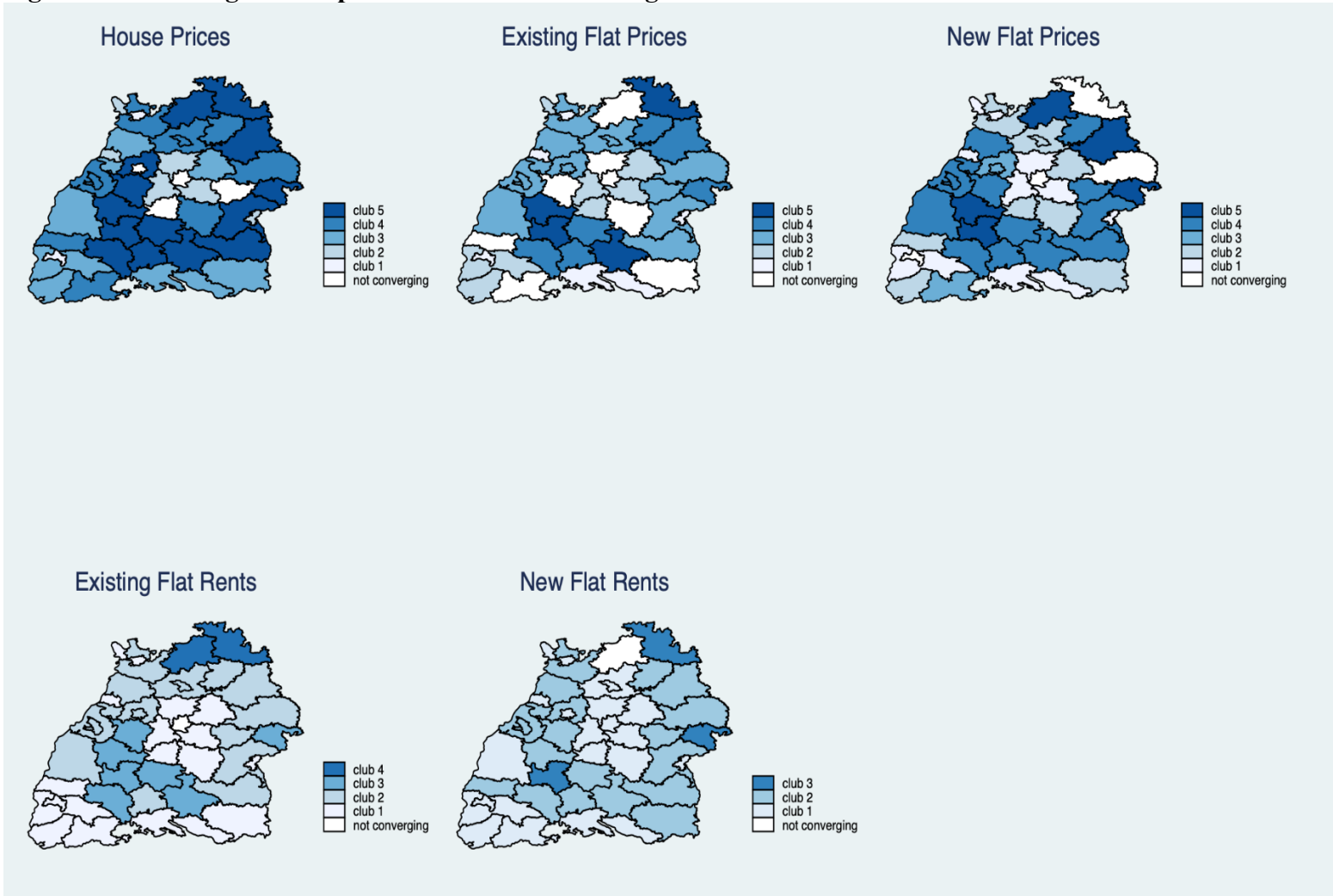


Figure A2: Convergence Maps for Bayern



Figure A3: Convergence Maps for Brandenburg

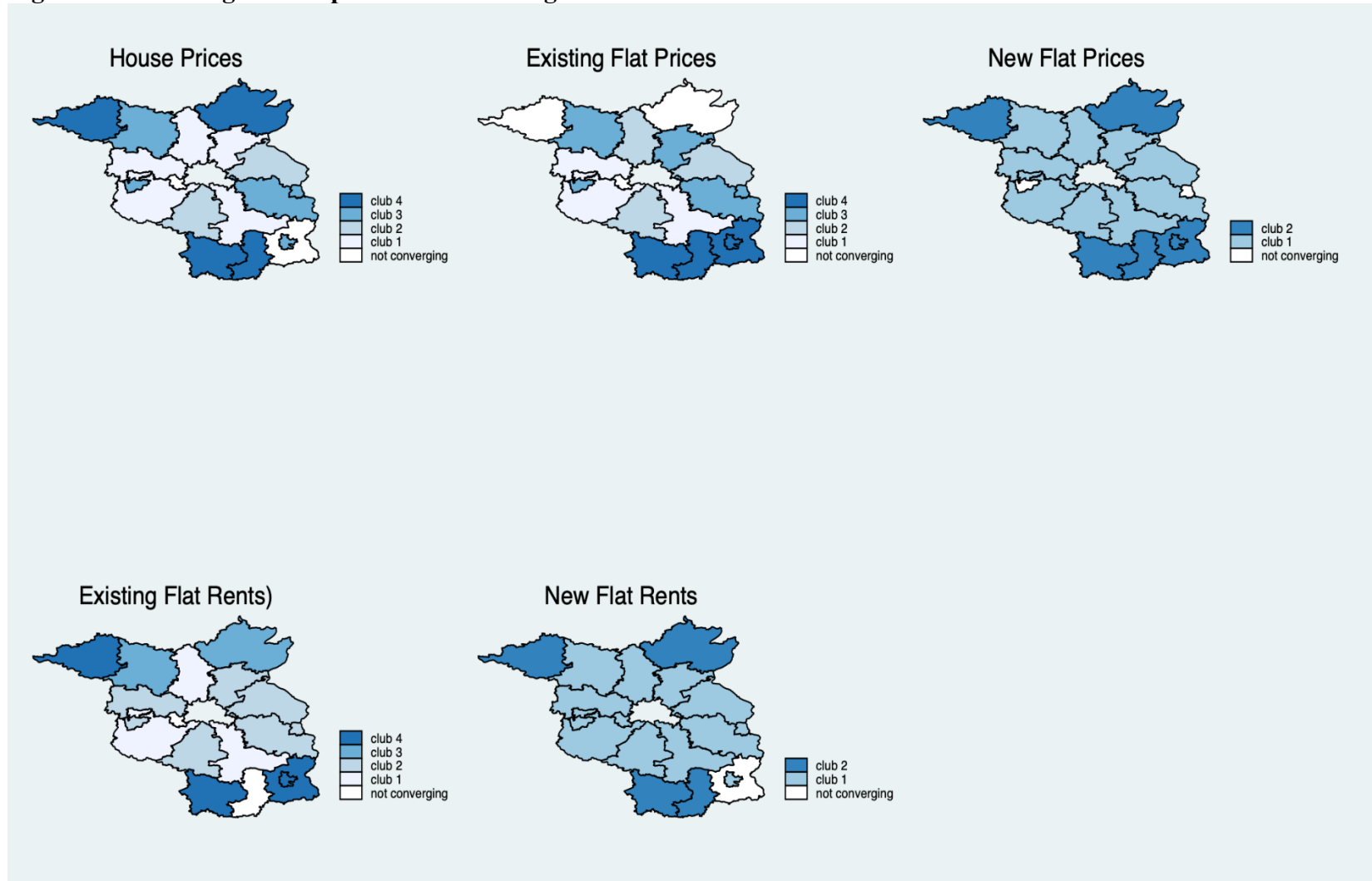


Figure A4: Convergence Maps for Hessen

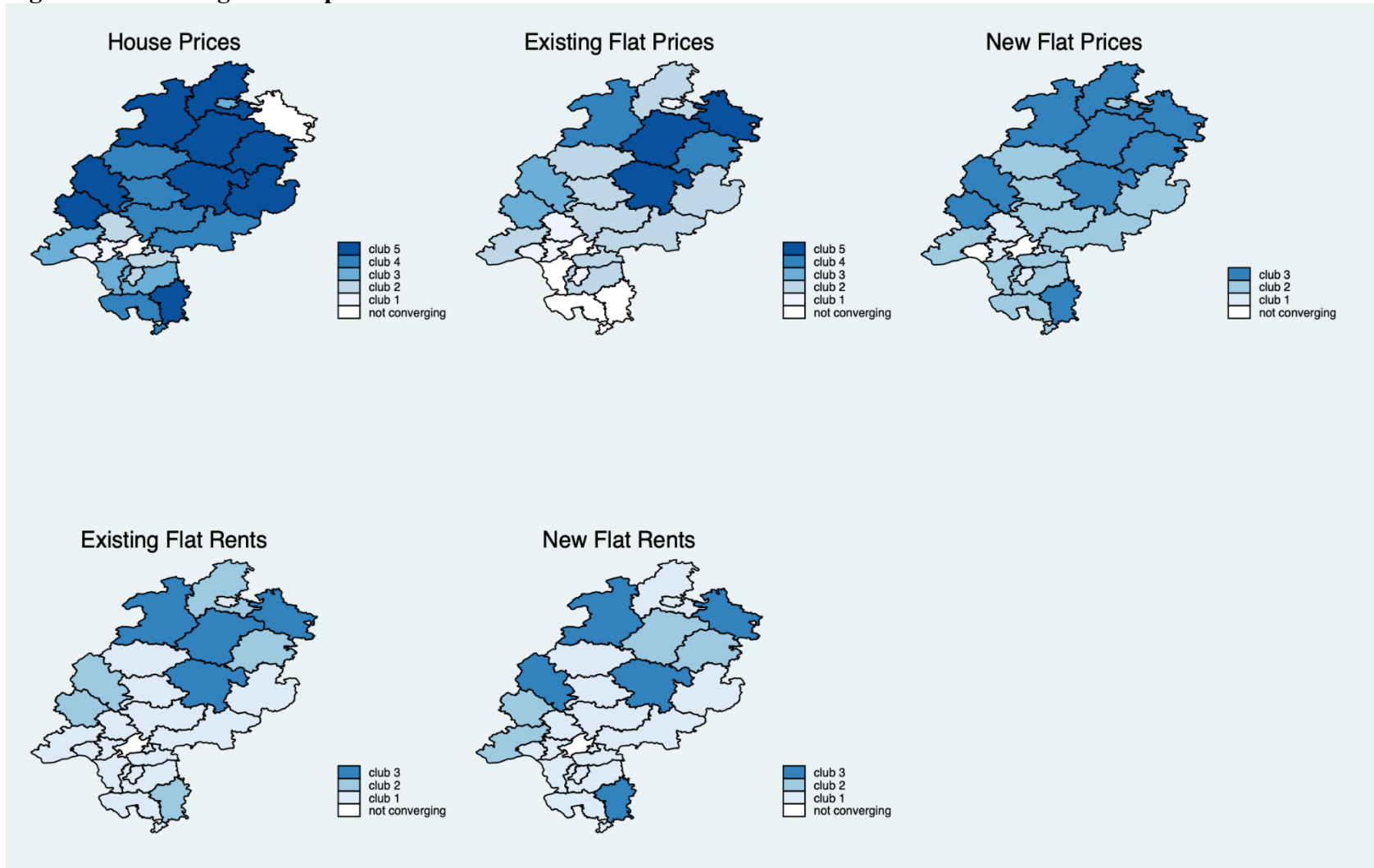


Figure A5: Convergence Maps for Lower Saxony

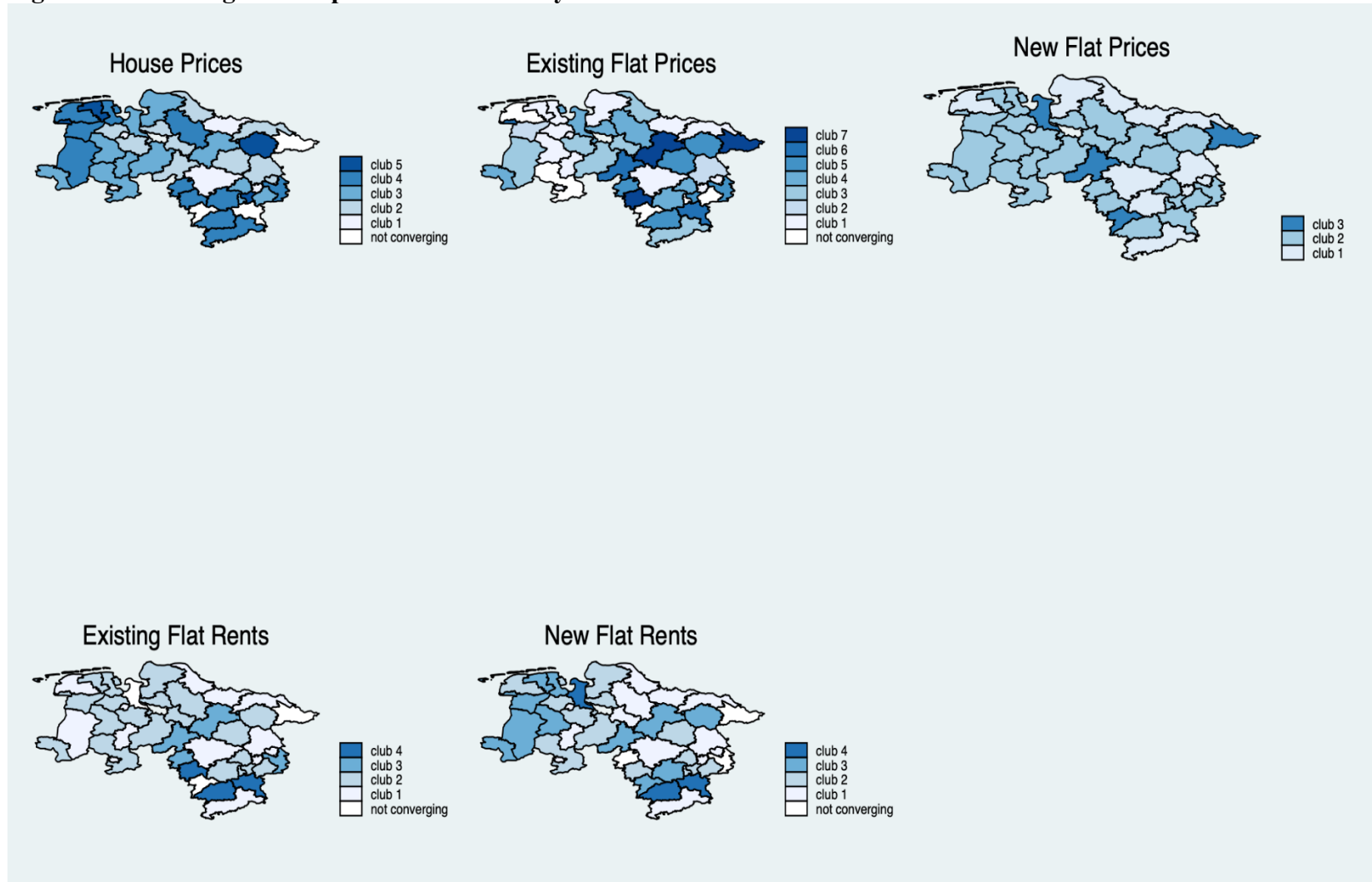


Figure A6: Convergence Maps for Mecklenburg-Vorpommern



Figure A7: Convergence Maps for North Rhein-Westphalia

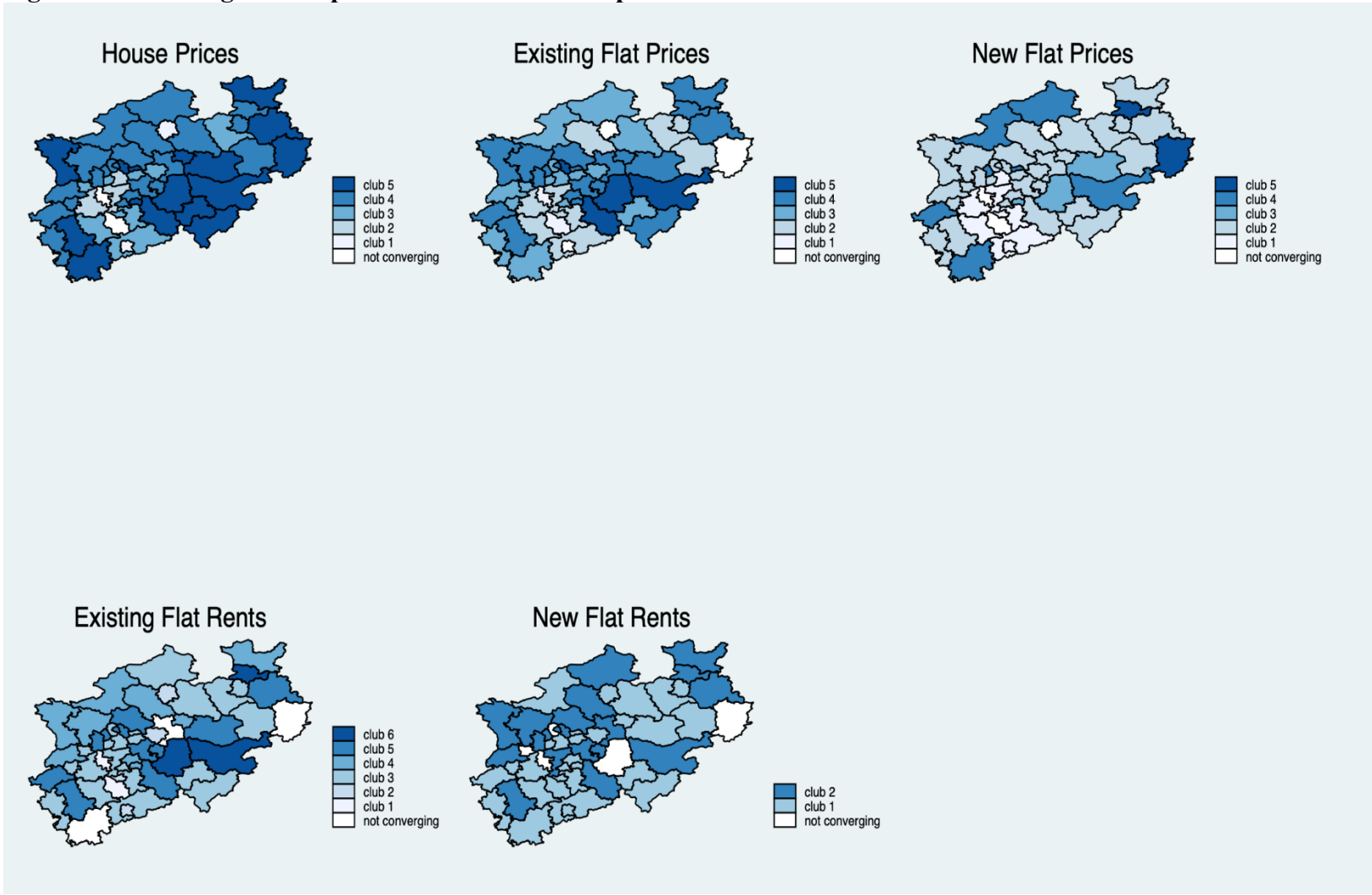


Figure A8: Convergence Maps for Rhineland-Palatinate



Figure A9: Convergence Maps for Saarland

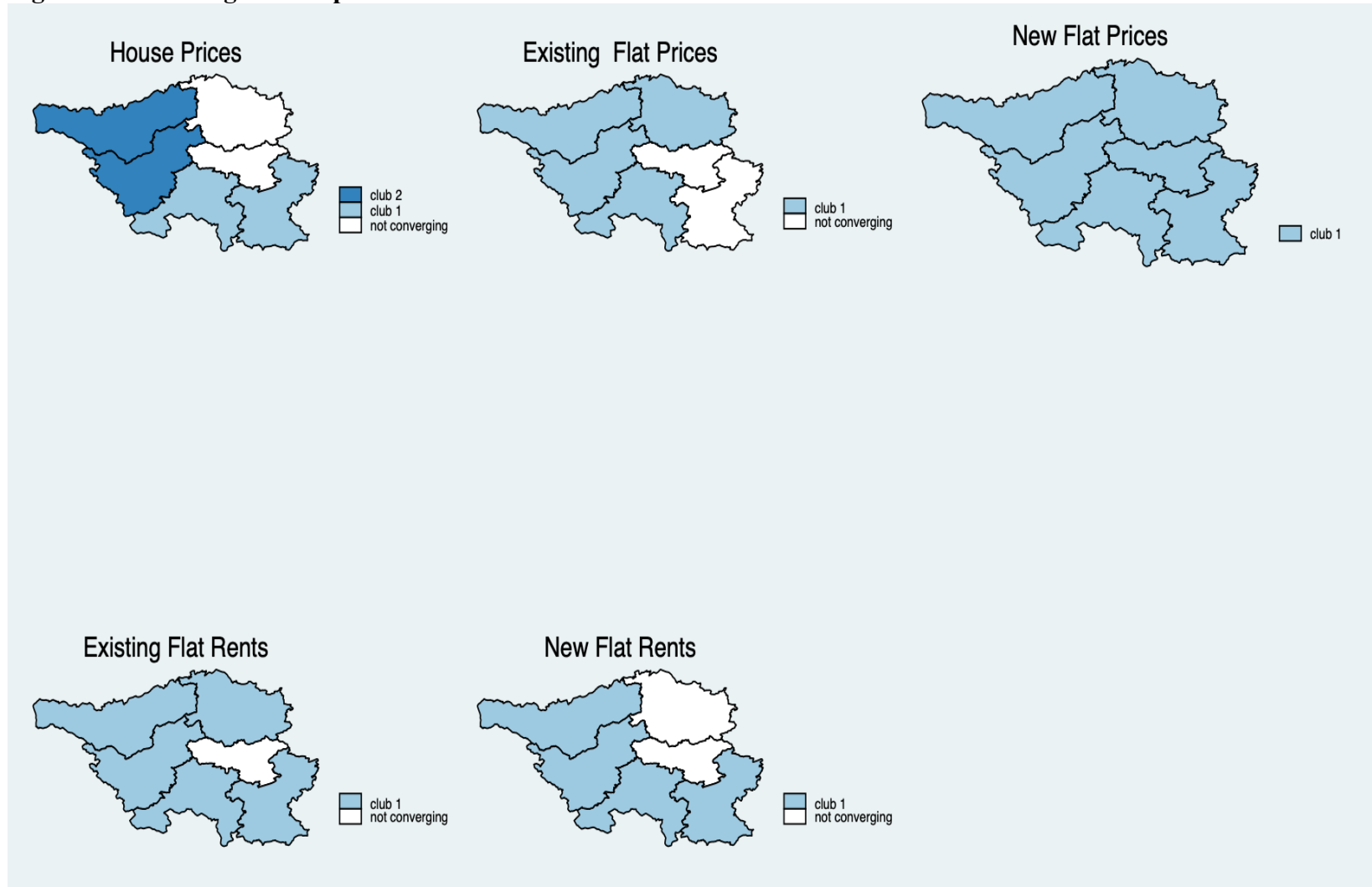


Figure A10: Convergence Maps for Saxony



Figure A11: Convergence Maps for Saxony-Anhalt

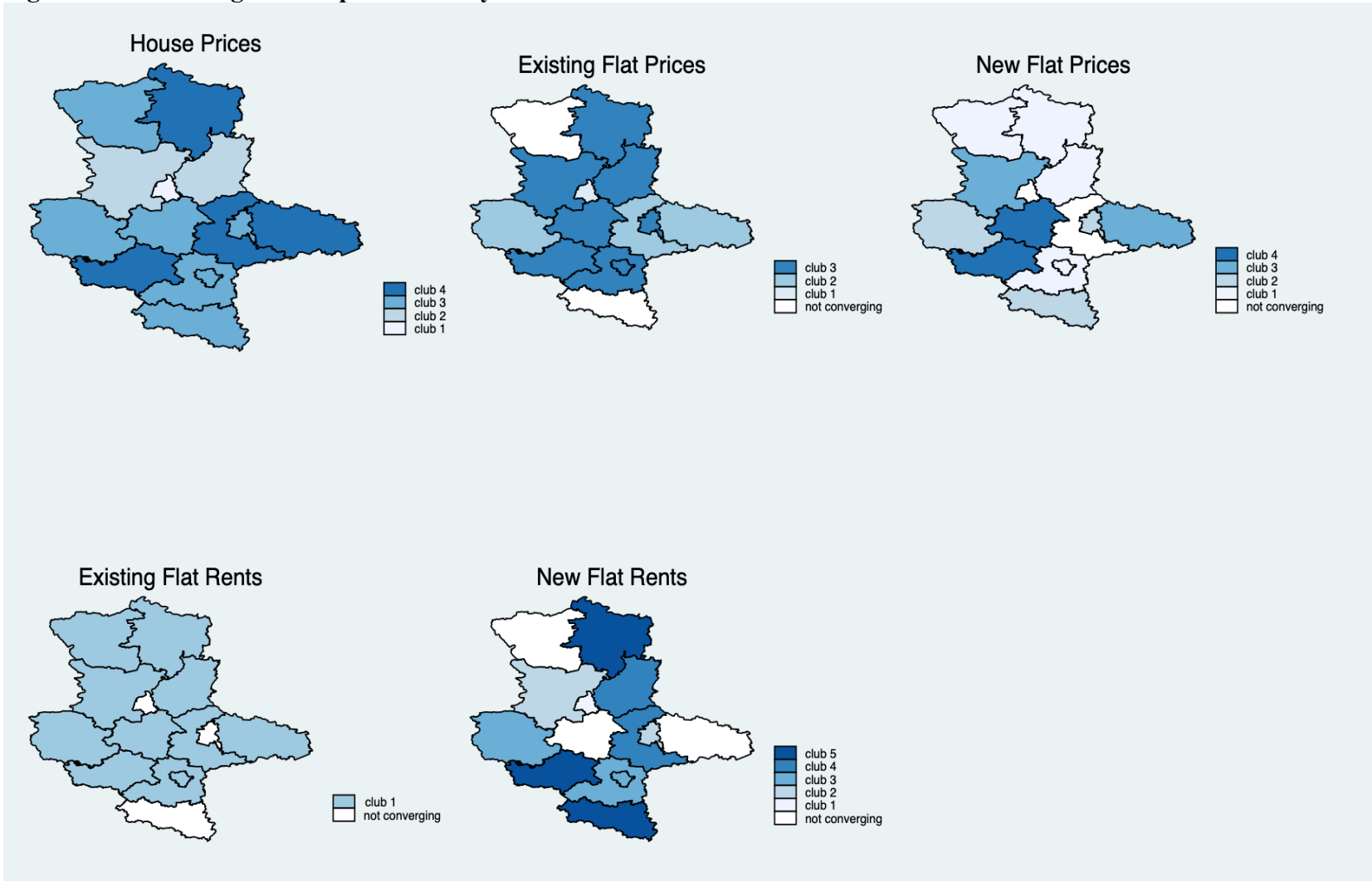


Figure A12: Convergence Maps for Schleswig-Holstein

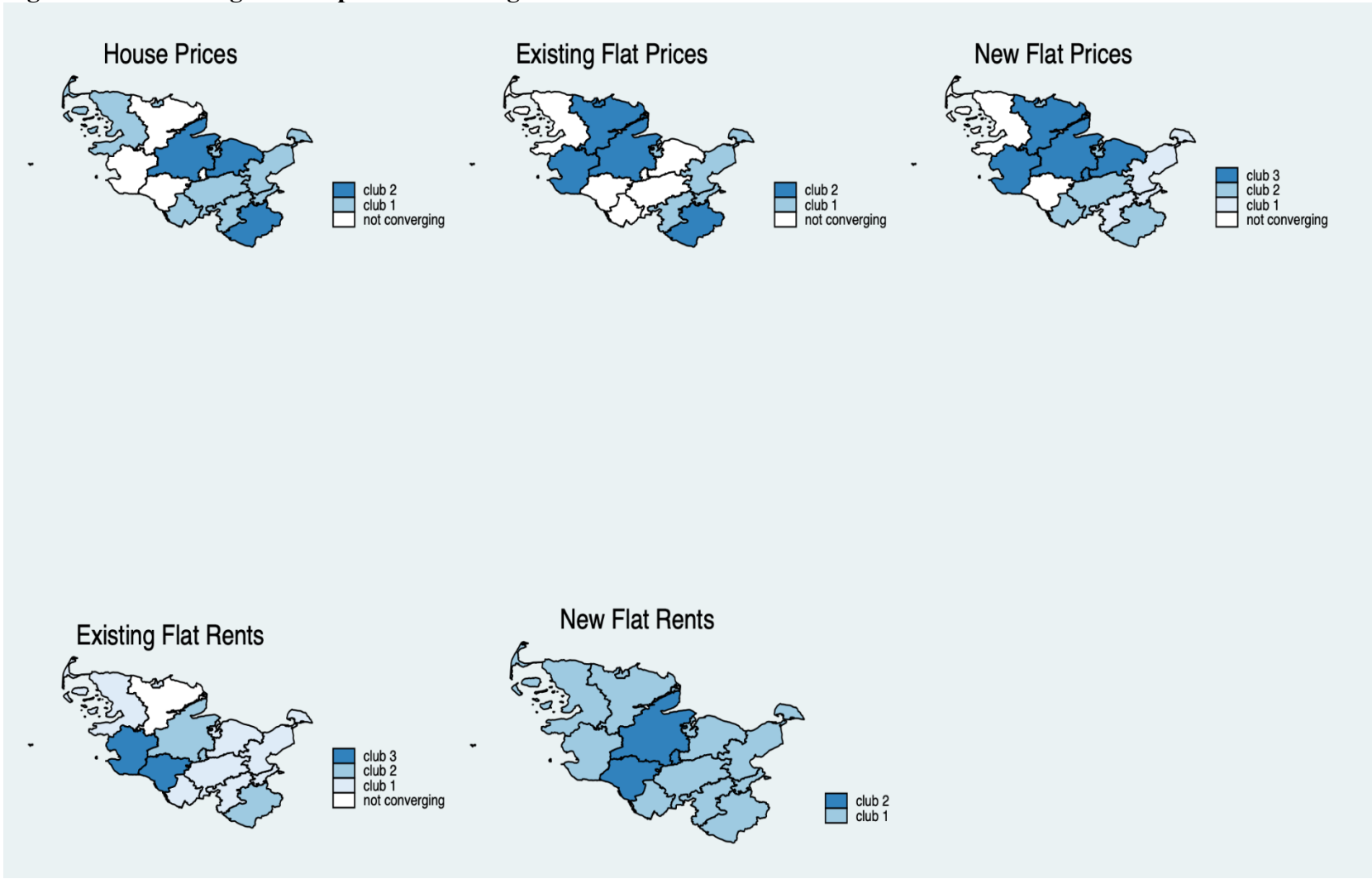


Figure A13: Convergence Maps for Thuringen

