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On the Turnaround of Vacancy Stocks: The Stock Flow Model for the German Residential Rental Market

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We apply the stock flow model for the German residential rental market using a data set that includes the overwhelming majority of nomenclature of territorial units for statistics (NUTS) 3 regions for the 2004-2007 period. Aside from proving conditional rental price convergence, we have detected a turnaround in vacancy stocks between the short and the long term. While East German counties and West German independent cities currently exhibit the highest and lowest vacancy rates, respectively, the opposite holds true at equilibrium. Leaning on theoretical suggestions, landlords in well-developed areas have incentives to hold onto vacancies in view of future rent increases. Our results support this idea, which demonstrates the significantly positive impact of household income and net birth rate on the natural vacancy rate.

Keywords

Rental Market; Adjustment Process; Natural Vacancy Rate; Regional Analysis; Germany

1. Introduction

The simultaneous analysis of dynamic and equilibrium states for regional housing markets is generally based, in terms of theory, on the stock flow models of Blank and Winnick (1953), Eubank and Sirmans (1971), Rosen and Smith (1983) and the extended model of Wheaton and Torto (1994). This facilitates an abstract, but helpful view on the market proceedings where the relationship between rental prices and the vacancy stock is sufficient for investigation.

For residential rental markets without exceptions, sub samples of large cities in the U.S. market have been examined (Benjamin et al., 1996; Reece, 1988)[1]. Gabriel and Nothaft (1988), and Zhou (2008) have considered the time-varying properties of the natural rate of vacancies. They detect changing rates over time, but do not investigate the determinants that might be responsible for equilibrium vacant stock. Hagen and Hansen (2009) do not specify the natural vacancy rate as endogenous either, but they find a significant decline during the time period following the introduction of the Internet. Until now, only Rosen and Smith (1983), and Gabriel and Nothaft (1988) have attempted to explain the natural rate of vacancies based on its fundamentals. They choose factors that alter both the duration and the incidence of vacancy, which, from a theoretical point of view, determine the natural vacancy rate. Although they use long panels with relatively small numbers of cross-sectional units, they show a significant impact of variables that are related to mobility and market heterogeneity. Household mobility determines the incidence of vacancies, and market heterogeneity increases searching costs and determines vacancy duration as explicitly shown by Gabriel and Nothaft (2001). Moreover, the authors also let the adjustment speed vary across observation units. For some cities, they obtain rental price divergence processes and hence, no individual natural vacancy rate.

We will apply the stock flow model to the German residential rental market and test its application potential in a European environment. This is extremely relevant for Germany because Germany has a relatively high rental occupation rate in comparison with those of other industrial states. Our paper is also the first to include an overwhelming majority of cities and counties in an entire country. As a result, the number of cross-sectional units is significantly larger than that of previous studies, and as a result, equilibrium disparities across space can be captured more appropriately.

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[1] Much more studies are conducted for the office or commercial rental market by De Francesco (2008), Frew and Jud (1988), Glascock et al. (1990), Hendershott et al. (1999), Hendershott, MacGregor and White (2002), Hendershott, MacGregor and Tse (2002), Mourouzi-Sivitanidou (2002), Shilling et al. (1987), Sivitanides (1997), Wheaton (1987) and Wheaton and Torto (1988).

Based on our data sample, we consider the adjustment process for administrative bodies located in East and West Germany to account for regional heterogeneity over time and in a steady state.

To explain variation in the natural vacancy rate, we have included variables that proxy market heterogeneity, household mobility and market expectations. In addition to the mean-based ordinary least squares (OLS) estimation method, quantile regression is used as well. This procedure reveals different impacts of factors in different quartiles of the distribution of the natural vacancy rate. In other words, it offers a comparison of the different parameters in districts with different natural vacancy rates. Moreover, due to the nature of the data and for robustness, we also account for possible spatial correlation by estimating a spatial autoregressive (SAR) lag model.

The rest of the paper is organized as follows. Section 2 provides an overview of the German rental market, current economic situation and underlying data set. Section 3 is divided into three parts. In the first part, theoretical applications are presented, while empirical results with regards to rental dynamics and the natural vacancy rate are shown in subsections two and three. Section 4 offers the conclusion.

2. Insights in Germany's Economy

2.1 Review of Real Estate Market Developments

Before 1990, two entirely different socio-economic environments existed side by side in Germany. While in West-Germany housing transactions had been guided by firms and households in a decentralized fashion, in East-Germany, attempts had been made by the German Democratic Republic (GDR) to centrally plan such actions years in advance.

Thus, the majority of the housing stock in cities in the GDR consisted of large industrialized apartment blocks. The goal was to provide living space as affordably and efficiently as possible which was close to people's workplaces, most notably in the industrial areas of various cities. Re-investments in the existing housing stock were not made; instead, new areas were steadily developed for new construction (Kommission 2000).

Nevertheless, attempts were also made to guide housing demand. Inner German population movements were bounded by the imposition of significant bureaucratic expenses. From the population‘s point of view, regulation led to an increase in transportation costs and thus to a decrease in incentives to move.

After reunification in 1990, East-German households in particular had an unexpectedly high level of demand for new single-family houses in suburban regions. The existing stock could not satisfy that demand, so the new all-

German administration responded with high subsidies for owner-occupied housing (Dohse et al. 2002). At least two market effects were induced by that policy which predominantly affected East German cities.

On the one hand, a boom in construction began that lasted until 1999, and construction rates only started to decline after that time as a result of a step-wise reduction in subsidies. On the other hand, inherent in the construction boom was an expansion in migration to suburban regions, which led to rising vacancy rates in cities. In addition to the already relatively high re-investment costs associated with the vacated housing, the industrialized apartment blocks, together with the shrinking demand for rental housing, held down rental prices in general.

At the end of the 1990s, the vacant stock in East-Germany corresponded to approximately one million apartments, in which about 30% were located in inner city old buildings (Kommission 2000).

Between 2002 and 2004, the political administration took steps against the circulation of development by implementing inner-city housing programs entitled “Stadtumbau Ost“ (Urban Restructuring in West Germany) and “Stadtumbau West“ (Urban Restructuring in East Germany). The most essential aims of the programs were to revitalize the housing environment in cities, increase in investments in the existing housing stock, and demolish uninhabitable apartments (Federal Ministry of Transport 2008a, 2008b).

Aside from disparities in the housing market, there have also been discrepancies in the labor market between administrative bodies in East and West Germany. The level of employment and productivity is still much lower in most counties in the East than in the West (Fuchs-Schündeln and Izem 2007, Sinn 2002), even though income convergence has been proven (Juessen 2009, Kosfeld et al. 2006).

The better socio-economic conditions in West Germany attract new households, primarily those composed of young and well-educated individuals in East Germany, thereby intensifying the recent intra German disequilibrium (Fuchs-Schündeln and Schündeln 2009)[2].

However, the negative demographic trend in Germany affects both regions in the same way. Among the European states, Germany exhibits the highest percentage of childless adults and the lowest birth rate (Dorberitz 2008). These implied life preferences affect housing demand by altering household

[2] For asymmetrical housing price effects due to population changes, see Dust and Maennig (2008).

formation. Small sized rental units for "single-households" are therefore in greater demand than larger ones.

Closely linked to this and equally important is the rental occupation rate, which is higher in Germany than in any other industrial state except for Switzerland. In Germany, the rate amounts to roughly 58%, while in the rest of Europe, the rate varies from 16% to 46% (ECB 2005), and in the U.S., it is 34% (U.S. Census Bureau 2008). Moreover, the distribution of the landlord's market share indicates a relatively high level of competition. The market share for public renters corresponds to 12%, housing associations make up just 10%, and private landlords enjoy the overwhelming majority of the share (GdW 2005).

2.2 Data and Stylized Facts

Despite the availability of vast amounts of economic datasets, information on rental housing and especially vacancies are very scarce. Therefore, research up to this time has been mainly done in the context of the American Housing Survey (AHS) or composed of several individual sources.

In our paper, we make use of a representative and geographically comprehensive data set for independent cities and counties in Germany for the period of 2004-2007. As Figure 1 shows, we have covered the majority of the districts, including ca. 92% or 404 sample units; the district boundaries were created on December 31, 2006.

Vacancy data are provided from the empirica institute in cooperation with Techem AG. Since 2001, for almost all districts and independent cities, vacancy rates for roughly five million multi-family houses with at least three units are levied each year. Only apartments equipped with central-heating and/or central hot water supply systems are included. The average vacancy rates are therefore lower than the ones published in the Mikrozensus, because they are calculated as flow variables for the whole year and not as stock variables for a reference day[3].

Data for residential rentals are taken from the Federal Office for Building and Regional Planning (BBR). The BBR records basic, freely-financed supply rentals from daily newspapers and popular internet platforms assigned to counties and independent cities based on local boundaries from December 31, 2006.[4]

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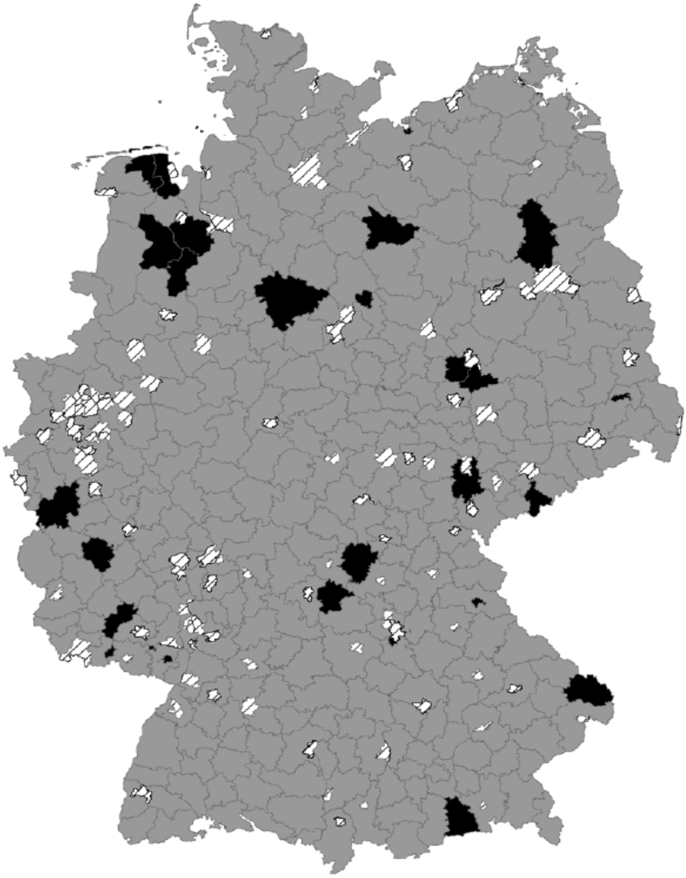
[3] See http://www.empirica-institut.de.
[4] See http://www.bbr.bund.de. Here, we assume no significant influence of single-family and terraced houses on the entire rental stock. Thus, rental prices and vacancy data predominantly reflect dwellings in multi- family houses.

Figure 1 Sample Units



Notes: The district boundaries are current as of December 31, 2006. The graph shows the dataset used for the dynamic analysis. Grey districts correspond to counties, shaded districts to independent cities, and black districts to regions that were not included. For the equilibrium analysis in Table 4, the following districts are neglected due to missing income data: Osterholz, Stade, Straubing-Bogen, Mecklenburg-Strelitz, Niederschlesischer Oberlausitzkreis, Riesa-Großenhain, Görlitz, Bernburg, Eichsfeld and Saalfeld-Rudolfstadt. The BBR has made a further district-based differentation for the Federal State of Brandenburg. It differentiates between more and less closely integrated areas. We have chosen data on districts, which are less closely integrated.

For all other explanatory variables, we have benefited from the large and comprehensive regional online-data portal continuously updated by the statistical offices of the German government and the federal states.[5] To ensure

[5] See http://www.regionalstatistik.de and http://www.vgrdl.de.

comparability, we have deflated the prices and income into real terms by using the consumer price–index of the Deutsche Bundesbank (2009). The data overview is given in Table 1.

Table 1 Descriptive Statistics

Variables	Description	Mean	Std.Dev.	Min	Max
Rent Growth	Differences in log real rental prices	-0.015	0.018	-0.135	0.131
SpZo	Area space (in 1000 km)	0.074	0.166	0.005	3.05
Rent	Real rental price (in €/m²)	5.431	1.067	3.66	10.85
Vac	Vacancy rate	0.041	0.035	0.001	0.217
Abs	Change in vacancy rates	0.001	0.010	-0.050	0.059
NetNatCh	Change in net-birth rates divided by previous population size	-0.002	0.002	-0.008	0.003
NetInflow	Change in net-migration divided by previous population size	-0.000	0.009	-0.026	0.127
Foreigners	Percent foreigners	0.073	0.047	0.006	0.258
Income	Real income per household member (in 1000€)	17.21	2.28	12.70	26.94
Room_3	Percent of apartments with three rooms	0.196	0.058	0.091	0.364
Room_4	Percent of apartments with four rooms	0.286	0.059	0.166	0.481
Room_5	Percent of apartments with five rooms	0.204	0.029	0.124	0.278
Room_6	Percent of apartments with six rooms	0.120	0.043	0.033	0.224
Room_7	Percent of apartments with seven or more rooms	0.121	0.069	0.009	0.311
Pop65	Percent 65+	0.196	0.020	0.138	0.252
Fam_house	Percent of single- and double-family houses	0.820	0.119	0.464	0.967

Notes: Rents are deflated by the consumer price-index of the German central bank, see Section 2.2.

As Figures 2 and 3 for the year 2007 show, there exists an obvious negative relationship between the average nominal rent for officially offered apartments and the vacancy rate for Germany. That inverse relationship becomes obvious when the eastern regions are set in contrast to the south western areas.

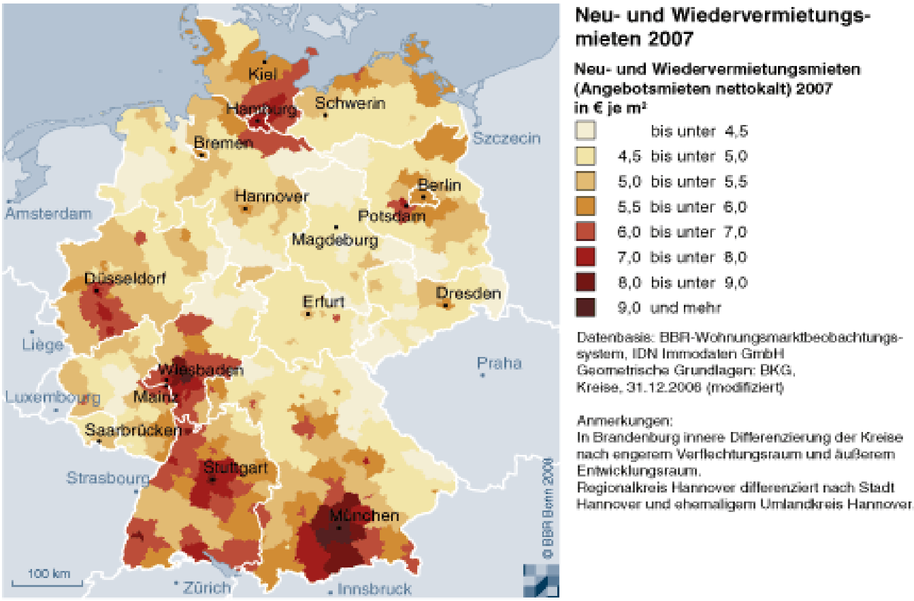
Figure 2 Vacancy Rates 2007

Source: Empirica (2009), Techem-empirica-Leerstandsindex (Regional segmentation is based on district boundaries), See http://www.empirica-institut.de/empi2007/tel.html, retrieved on September 24, 2008.

Coincidently, they also depict prospering agglomeration districts in West-Germany to which people are immigrating from East Germany. So most notably, in urban agglomeration areas near capital cities, such as Munich, Hamburg, Wiesbaden or Düsseldorf, residential rents are much higher than Berlin or Schwerin.

In Table 2, short-term patterns of the development of real rental prices and vacancy rates are presented. Two features emerge that have interesting implications for the following analysis. First, there is a gap of a factor of three in vacancies between the newly- formed and the old federal states, but the convergence tendency is recognizable. Second, rental prices adjust with the same proportions across all subdivided administration bodies. Relative to the current housing environment, the German rental market might tend to the steady state with the same intensity.

Figure 3 Nominal Residential Rents 2007



Source: Rental Prices of newly-rented and re-rented apartments in 2007: Federal Office for Building and Regional Planning: Rental Prices and Real Estate Prices, Bonn 2008, http://www.bbr.bund.de/cln_015/nn_23744/BBSR/DE/Raumbeobachtung/GlossarIndikatoren/indikatoren__dyncatalog,lv2=104776,lv3=290854.html, retrieved on October 10, 2009.

Table 2 Sample Means

			2004	**2005**	**2006**	**2007**	**Obs**
Real Rents (€/m²)	East	Cities	5.32	5.26	5.24	5.11	24
		Counties	4.77	4.72	4.66	4.55	76
	West	Cities	6.02	5.97	5.86	5.75	86
		Counties	5.56	5.50	5.41	5.32	218
Rental Vacancy Rate	East	Cities	0.081	0.075	0.071	-	24
		Counties	0.089	0.084	0.085	-	76
	West	Cities	0.025	0.027	0.028	-	86
		Counties	0.026	0.028	0.030	-	218

Notes: Sample units correspond to those in Figure 1.

3. Modeling and Results

3.1 Theoretical Background

The foundation for our study is the rental stock-flow model of Rosen and Smith (1983). The essential model precondition is an assumed fixed stock of rental housing in the short run that becomes sufficiently flexible in the long run. Thus, temporary disequilibrium can occur, but the coincidence of demand and supply in a steady state is ensured as well.

Economic intention is based on describing unexpected imbalances of demand and supply via the deviation of the vacancy rate $v_{i,t-1}$ from the natural rate v^*_i, which causes rental price reactions $\Delta R_{i,t}$.Whenever demand for dwelling units does not conform to the housing supply in district i in period $t-1$, the limited vacant stock falls below its inflation-stable natural rate and exerts price pressure on t:

$$\Delta R_{i,t} = f(v_i^* - v_{i,t-1}) \, . \tag{1}$$

In equilibrium business cycles are absent, and despite the profit maximization calculus of landlords, there exists a positive vacancy rate.

Following Grenadier (1995), the existence of an equilibrium stock of vacancies can be explained in three ways. First, landlords or developers are willing to keep apartments vacant when they have positive expectations about future increasing returns (Feldstein and Auerbach 1976, Shilling et al. 1987, Voith and Crane 1988, Wang and Zhou 2000). Second, imperfect information among market agents and stock heterogeneity raise search costs for suitable living space and thus increase vacancy duration (Arnott 1989, Gan and Zhang 2006, Read 1993, Wheaton 1990). Third, greater tenant mobility leads to shorter contract length, which raises the incidence of vacancies (Deng et al. 2003, Gabriel and Nothaft 2001, Una-Álvarez et al. 2009).

It might be surprising at first glance that the long-term impact of the natural vacancy rate on the equilibrium rental price is positive, while the short-term impact of recent vacancies on rent is negative. However, it should eventually become obvious that the states and their frameworks completely change in the long-term. At first, greater vacant stock reduces rental prices because the negotiating power of landlords is lower due to the relatively lower search costs of (potential) tenants[6]. In the long run, agents make rational decisions,

[6] Belsky and Goodman Jr. (1996) even find evidence for a positive relationship between recent vacancy rates and rent changes for the U.S. rental market primarily in the 1980s, which they explain, among others, by time-variation in the natural rate of vacancy, and changes in the search process.

and there exists an optimal total housing stock[7]. Then, a sudden shortage of (optimal) rentable stock given the strategies of agents as expressed by a higher natural vacancy rate leads to increases in rents.

Wheaton and Torto (1994) extend the baseline model in two ways. First, they replace the dynamic relationship in Equation (1) with a geometric lag model. Thus, they account for persistency effects of shocks and ensure a gradual adjustment back to the original equilibrium prices $R^*_{i,t}$:

$$\Delta R_{i,t} = f(R^*_{i,t} - R_{i,t-1})\,. \tag{2}$$

Second, they introduce a proxy for prospective market outcomes. Assuming backward-looking expectations on the part of market agents, the change in rental-occupied stock in a previous period, called rental absorption $A_{i,\,t-1}$, is intended to reveal information about the searching processes of tenants and the average lease duration for a unit. It is used as a proxy for market expectations with regards to ongoing development.

$$R^*_{i,t} = f(v^*_i; v_{i,t-1}; A_{i,t-1})\,. \tag{3}$$

The augmented empirical methodology predominantly rests upon on Koyck (1954)'s lag approach with a one-period delay. The model offers a closed estimation framework when calculating the adjustment pace μ.

In contrast to Gabriel and Nothaft (2001), we are not able to control for individual speed, but we account for specific regional properties when splitting the adjustment process between cities and counties located in East and West Germany via dummy-interactions.

Thus, when we proceed on the assumption of an exponential relationship, the model approach becomes:

$$R_{i,t} = R_{i,t-1} e^{\mu_{l,j,e,w}\left(R^*_{i,t} - R_{i,t-1}\right)} \quad , \quad \mu_{l,j,e,w} \in \mu = [0,1]\ , \tag{4}$$

where $R_{i,t-1}$ denotes the real rent level of district i as an independent city l or a county j located in East e or in West Germany w in period t. The time-invariant inertia rate μ is allowed to differ for these four classes.

3.2 Rental Dynamics

Assuming the linear-additive relationship of (3), which is inserted into (4), and taking the logarithm of the latter, the final equation which includes the respective coefficients α, μ and β becomes:

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[7] Wheaton(1990)suggests that changes in living preferences can emerge in equilibrium as well.

$$\Delta log(Rent_{i,t}) = \alpha_0 + \beta_1 v_{i,t-1} + \beta_2 A_{i,t-1} + \sum_{l=0}^{1}\sum_{j=0}^{1} \mu_{3+j+l} Rent_{i,t-1} * City_{i,t-1}^{l} * County_{i,t-1}^{1-l} * West_{i,t-1}^{j} * East_{i,t-1}^{1-j} + \varepsilon_{i,t}$$

$$\varepsilon_{i,t} = \theta_i + \theta_t + \eta_{i,t} \ , \ \forall i = 1,...,N \ ; \ t = 1,...,T \ . \tag{5}$$

The composite error $\varepsilon_{i,t}$ depends on the time-invariant unobserved heterogeneity θ_i, time-dummy θ_t and idiosyncratic error $\eta_{i,t}$.

The panel results are shown in Table 3.

We test for the appropriate model heterogeneity specification via Hausman and Wald tests. They both clearly identify fixed-effects modeling as the most suitable approach. As we seek to choose the most efficient setting, information criteria such as the adjusted R^2 and the Schwarz criteria cause our preference for Model (3). Hence, the extended version of Wheaton and Torto (1994), without taking into consideration the temporary deviations of vacancies expressed by Equations (2) and (3) in contrast to the origin in Equation (1), applies to Germany. As a result, we will refer to Model (3) in our discussion.

In addition to clarifying the model specifications, the test procedure also provides information that helps us to determine whether unconditional or conditional convergence exists. The significance of fixed effects indicates a conditional adjustment process with region-specific characteristics, which holds true because the lagged rental price variables are all significant as well.

Based on Model (3), the average convergence rates for East-German independent cities, *lagRentCE*, and counties, *lagRentCoE*, at -0.231 and -0.185, are much higher than those in West-German districts, which have rates of -0.116 and -0.146, respectively. The parameters significantly differ from each other except between independent cities and counties in East Germany. Inherent to the model's design, a faster convergence speed means that the region is further away from its individual steady state. In our case, West Germany, in comparison to the East German regions, seems to be much closer to its own equilibrium state.

An explanation can be found in the recent market developments in the housing and labor markets as mentioned in Section 2.1 above. There is also a gap between the administrative bodies in power, at least in West Germany, where the speed of adjustment of prospering cities is lower than that of less-developed counties. For East-Germany, no significant differences are detected, and counties and independent cities might be exposed to the same socio-economic challenges.

Table 3 Rental Dynamics with Various Panel Econometrics

Rent Growth	FE(1)	FE (2)	FE (3)	FE (4)	FE(5)	RE (6)	Pooling (7)
Year07	-0.030*** (-17.22)	-0.031*** (-20.88)	-0.031*** (-20.88)	-	-0.031*** (-20.90)	-0.011*** (-8.48)	-0.011*** (-8.46)
Year06	-0.013*** (-14.25)	-0.014*** (-14.23)	-0.014*** (-14.30)	-	-0.014*** (-14.28)	-0.006*** (-4.67)	-0.006*** (-4.67)
lagRent	-0.141*** (-12.28)	-	-	-	-	-	-
Lag RentCE	-	-0.231*** (-4.56)	-0.231*** (-4.58)	-0.189*** (-2.65)	-0.231*** (-4.56)	-0.003*** (-4.08)	-0.003*** (-3.96)
Lag RentCW	-	-0.116*** (-16.06)	-0.116*** (16.08)	-0.064*** (-6.44)	-0.116*** (-16.05)	-0.003*** (-6.72)	-0.003*** (-6.58)
Lag RentCoE	-	-0.185*** (-11.93)	-0.185*** (-12.10)	-0.032 (-1.45)	-0.185*** (-11.83)	-0.004*** (-5.85)	-0.003*** (-5.69)
Lag RentCoW	-	-0.147*** (-15.81)	-0.146*** (-15.92)	-0.028*** (-4.79)	-0.146*** (-15.80)	-0.003*** (-6.63)	-0.003*** (-6.57)
lagVac	-0.085 (-1.14)	-0.013 (-0.18)	-	-0.113 (-0.96)	-0.012 (-0.22)	-0.053*** (-2.98)	-0.051*** (-2.95)
lagAbs	0.032 (0.56)	0.001 (0.02)	-	0.069 (0.93)	-	-0.006 (-0.12)	-0.013 (-0.27)
Intercept	0.770*** (12.09)	0.817*** (20.43)	0.816*** (20.37)	0.244*** (6.68)	0.817*** (20.47)	0.011*** (3.61)	0.010*** (3.38)
N	1212	1212	1212	1212	1212	1212	1212
Groups	404	404	404	404	404	404	404
F- Statistic	67.24***	72.40***	96.60***	12.58***	82.81***	1605.59	15.15***
Adj. R^2	0.454	0.485	0.486	0.151	0.485	-	0.074
Schwarz	-7343.01	-7395.85	-7409.99	-6801.88	-7402.95	-	-6330.47
Wald (FE vs. Po)	2.50***	2.77***	2.80***	1.07	2.77***	-	-
Hausman (FE vs. RE)	540.12***	628.27***	635.43***	141.15***	632.83***	-	-

***Notes*:** Sample units correspond to those in Figure 1. FE describes the fixed-effects method, RE describes the random-effects method and Po describes the pooling cross-section method. Clustered standard errors are used. Schwarz denotes Schwarz criteria. CE and CoE indicate independent cities and counties in East Germany, CW and CoW mean the same for West Germany. For estimation, standard errors are clustered. The asterisks ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

A comparison of the calculated convergence speed with that of prior research reveals similarities between the figures. The span of 0.12 to 0.23 approximately corresponds to the range of values published in U.S. studies of the residential (Gabriel and Nothaft 2001) and the commercial rental markets (Wheaton and Torto 1994). Hence, no remarkable discrepancies between residential and commercial rental markets seem to prevail, even if real estate markets in different countries are compared.

The lagged vacancy rate *lagVac* and the absorption variable *lagAbs* are both insignificant, even though they exhibit the expected signs in Model (2). The very short panel is supposed to constrain time variation and increase the problem of collinearity of the exogenous determinants with the fixed effects. Evidence that support our conjecture comes from Models (5), (6) and (7). In Model (5), the parameter of the vacancy rate does not change without including rental absorption, while when assuming random and pooling effects in (6) and (7), both suddenly become highly significant. In summary, the insignificance in Model (3) of high degrees of correlation among the variables is less a problem than of the short time horizon.

Despite or perhaps because of, the short time span, it is important to control for time effects as justified by the highly significant coefficients of *year06* and *year07*. These variables can capture unexpected annual-based macroeconomic proceedings, especially in an environment like that of Germany. Neglecting this factor leads to estimation bias and misinterpretation as shown in Model (4) because the coefficients and standard errors distinctly change.

3.3 The Natural Vacancy Rate

When the adjustment is completed, the market expectations remain the same and the vacancy stock is equal to its natural level. Then, the natural vacancy rate can be calculated from Equation (5) as follows:

$$\hat{v}_i^* = \frac{\alpha_0 + \theta_i}{\mu_{3,j,l}} \,. \tag{6}$$

Based on the settings in Table 3, Table 4 presents the calculations for the natural vacancy rates.

Initially, it is apparent that a market turnaround appears. Although conditional convergence is accomplished, the sizes of the vacant stocks change among the administration bodies between the short and the long term[8]. Based on Table 2, independent cities in West Germany have the lowest and East German counties the highest vacancy rates, whereas in equilibrium, the opposite holds true. For Models (1) – (5), the range decreases from 2.5% –8.9% to 4.56%–

[8] This overshooting effect is a special case of convergence (Sala-i-Martin 1996).

5.96%, which is below the values for the commercial markets (Sivitanides 1997, Wheaton and Torto 1994), but roughly equivalent to the values for the U.S. residential market (Gabriel and Nothaft 2001).

Table 4 Natural Vacancy Rates

Model	East Cities	West Cities	East Counties	West Counties
(1)	5.32%	5.96%	4.76%	5.51%
(2)	5.28%	5.95%	4.72%	5.50%
(3)	5.28%	5.95%	4.72%	5.50%
(4)	5.25%	5.80%	4.56%	5.19%
(5)	5.28%	5.95%	4.72%	5.50%
(6)	3.81%	3.45%	3.15%	3.33%
(7)	3.67%	3.30%	3.00%	3.20%
Obs	72	258	228	654

Notes: Based on the calculations of Models 1–7 in Table 4 for the time period 2004 –2007. The numbers of observations have to be divided by the number of waves to obtain the specific number of districts.

To further investigate that outcome, we regress the estimated natural vacancy rates $\hat{v}_i^*$ from Model (3) in Table 4 on structural determinants. Following Gabriel and Nothaft (1988), Rosen and Smith (1983) and Shilling et al. (1987), we obtain average values, in our case, for the 2004 – 2006 period[9]. In our variable selection, we attempt to account for market expectations, heterogeneity and mobility, primarily according to Gabriel and Nothaft (2001). Aside from using the common mean-based method of OLS, like Zietz et al. (2008), we perform quantile regression to obtain detailed information about the differences in parameter impacts on different quartiles when analyzing the natural vacancy rate. Due to the nature of data, we also estimate a SAR lag model, which captures spatial correlation (Anselin 1988)[10].

The estimation results are presented in Table 5. In a comparison of the four OLS settings, we find that we prefer Model (1) based on information criteria, and hence, we estimate that setting with quantile regression again. In addition, the Wald and the Lagrange multiplier tests indicate the presence of spatial

[9] Note that the period has changed from 2005–2007 to 2004–2006, because rent and vacancies were lagged variables and the natural rate was assumed to be time – invariant.
[10] To choose the appropriate spatial pattern, we obtain the robust Lagrange multiplier test for the spatial lag and the spatial error model following Anselin and Bera (1996). The test prefers the spatial lag approach, hence for this reason, we only present results for the spatial lag approach.

correlation[11]. However, the differences between the OLS and the SAR setting are relatively small, so model implications remain approximately valid.

Beginning by considering *income*, we find that the coefficient is ca. 0.002 and steadily significantly positive at the 1% level regardless of the estimation method. This simply means that districts with a higher income level also have a higher natural vacancy rate. From the viewpoint of the landlords, in well-developed districts, the opportunity costs of holding vacancies are relatively lower than in below-average developed regions ceteris paribus[12]. Otherwise, vacancies reflect a waste of resources contrary to the rational calculus of landlords and owners because future rent increases in poor regions can not be expected to emerge in the same way as in wealthy areas. Thus, higher incomes and better economic conditions attract people and raises housing demand, which in turn, raises rental prices. The market position of the landlords improves because a larger pool of potential tenants enlarges their “room to maneuver”. By building up their vacant stock, they are in a position to select the appropriate point of time at which to rent out their apartments Guasch and Marshall (1987).

Mankiw and Weil (1989) show that the birth rate is generally a key driver of future housing demand. Therefore, the significantly positive parameter of *NetNatCh* also supports the relevance of market expectation to explain the natural vacancy rate. In particular, for a country like Germany which is characterized by a decrease in natural population, regions that exhibit development contrary to that trend are supposed to have higher market potential. Nevertheless, the net birth rate could capture further region-specific attributes. For example, natural or public amenities affect the quality of life in a region and thus determine location decisions and housing prices (Roback 1982). While the coefficient in the OLS-Model (1) corresponds to 2.152, and 0.914 in the SAR model, its impact increases from 1.491 in the 25% quartile to 2.333 in the 90% percentile. Thus, a higher impact of the net birth rate implies a higher amount of vacant stock, which indicates the strategy of landlords in increasing the stock buffer when market expectations are positive.

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[11] According to the stock flow model, market adjustment also implies the validity of the spatial equilibrium approach from Roback (1982), where regional externalities are already considered in individual location decisions. Thus, spatial autocorrelation can not actually be present from a theoretical point of view in the stock flow model.

[12] This is roughly in line with the significantly positive impact of the rental prices on the natural vacancy rate in Gabriel and Nothaft (1988). Due to a potential interdependent relationship between rental prices and vacancy stocks in equilibrium, we try to circumvent the endogenous bias by replacing rental prices with household income. We do not have suitable instruments for an (instrumental variable) IV estimation. Thus, following Mayo (1981), we assume income to be exogenous.

Table 5 Long Run Fundamentals

N_Vac	OLS(1)	OLS(2)	OLS(3)	25th Quartil	50th Quartil	90th Quartil	SAR
SpZo	0.000 (0.16)	-0.000 (-0.14)	0.001 (0.35)	-0.005 (-0.50)	-0.003 (-0.21)	-0.001 (-0.07)	0.003*** (4.70)
Room3	-0.134*** (-5.68)	-	-0.161*** (-6.08)	-0.092*** (-4.03)	-0.150*** (-3.88)	-0.144*** (-4.75)	-0.135*** (-7.64)
Room4	-0.105*** (-5.36)	-	-0.125*** (-5.86)	-0.055*** (-3.04)	-0.113*** (-4.19)	-0.129*** (-5.79)	-0.089*** (-7.03)
Room5	-0.189*** (-6.42)	-	-0.180*** (-5.07)	-0.134*** (-4.82)	-0.161*** (-4.54)	-0.230*** (-6.05)	-0.134*** (-6.80)
Room6	-0.044 (-1.43)	-	-0.032 (-0.93)	0.027 (0.80)	-0.072* (-1.73)	-0.109** (-2.41)	-0.057** (-2.47)
Room7	-0.212*** (-8.79)	-	-0.227*** (-8.48)	-0.152*** (-7.02)	-0.203*** (-5.96)	-0.220*** (-8.27)	-0.158*** (-9.55)
Income	0.002*** (7.20)	0.002*** (5.27)	-	0.001*** (4.21)	0.002*** (6.30)	0.003*** (9.75)	0.001*** (6.74)
NetNatCh	2.152*** (6.60)	1.954*** (5.39)	2.855*** (6.77)	1.491*** (5.13)	1.429*** (3.60)	2.333*** (4.33)	0.914*** (4.33)
NetInflow	0.010 (0.23)	0.057 (1.05)	0.024 (0.42)	0.025 (0.30)	0.067 (0.69)	0.030 (0.32)	0.038 (1.37)
Fam_ house	0.028*** (3.79)	-0.025*** (-6.99)	0.026*** (3.05)	0.012 (1.59)	0.017* (1.92)	0.039*** (3.99)	0.006 (1.09)
Pop65	0.002 (0.07)	-0.031 (-0.94)	0.077** (2.05)	-0.006 (-0.24)	-0.016 (-0.48)	-0.042 (-1.01)	-0.010 (-0.50)
Foreigners	0.021** (2.03)	0.023* (1.91)	0.074*** (7.90)	0.026** (2.31)	0.019* (1.85)	0.005 (0.28)	-0.010 (-1.42)
Intercept	0.130*** (6.96)	0.056*** (7.18)	0.154*** (8.04)	0.104*** (6.51)	0.142*** (4.64)	0.146*** (7.16)	0.106*** (8.22)
Rho	-	-	-	-	-	-	0.629*** (18.12)
Adj. R^2/ Pseudo R^2	0.7404	0.6081	0.6666	0.4140	0.4707	0.6474	0.839
N	394	394	394	394	394	394	394
F- Test	55.49***	52.11***	52.69***	-	-	-	-
SC	-2933.8	-2796.1	-2840.0	-	-	-	-
Wald Test (rho=0)	-	-	-	-	-	-	328.4***
LM Test (rho=0)	-	-	-	-	-	-	184.9***

Notes: The number of observations is smaller due to missing income data. Calculations are based on the natural rate of vacancy of Model (3) in Table 4. T and Z-statistics are in parentheses. SAR denotes the spatial autoregressive lag model, where rho describes the spatial lag parameter. The elements of the spatial weights matrix are 1 if two districts have the same border, otherwise the elements are 0.OLS and SAR lag estimates are calculated with robust standard errors. For quantile regressions, bootstrapped standard errors as in Koenker and Bassett Jr. (1978) are estimated with 1000 replications. The asterisks ***, ** and * denote significance at the 1%, 5% and 10% levels.

A less important factor seems to be migration flows, *NetInflow*, which reflects unexpected changes in housing demand. They are clearly insignificant.

At this point, we want to suggest that there are the differences in interpretation between the two population variables. To our understanding, *NetInflow* reflects the labor economic qualities of one region that attract people to move there rather than capturing quality of life when already controlling for the factor that seems to be more suitable for reflecting housing environment: *NetNatCh*. Thus, the splitting of population change into two modules permits various conclusions to be drawn.

Interpretations with regards to the proportion of residential buildings that contain up to two apartments *Fam_house* are manifold as well. This variable can be a proxy for market expectations and also for market heterogeneity. If we include further similar factors, such as *Room* and *Foreigners,* the meaning becomes more concrete. In Model (1) as well as the quantile regressions, they are both specified and significant, and for these reasons, *Fam_house* could indirectly represent the owner-occupied rate and location attractiveness[13]. At the 50% quartile and 90% percentile, this variable is significant, while at the 25% quartile, it does not statistically matter. Obviously, landlords are willing to restrict supply most notably in those areas, taking into account, the quality of life and influence on future demand. Nevertheless, such a conclusion has to be taken with caution because when controlling for spatial correlation, the variable becomes insignificant.

The figures of the *Room*-variables are assumed to capture market heterogeneity even though they can also depict market potential. With reference to Section 2.1, all market agents are experiencing the transfer of the recent permanent shrinking of household size into demand and supply; this especially holds true at equilibrium. On this basis, landlords could have an incentive to increase their vacant stock of very small apartments. Another interpretation has to do with stock heterogeneity and search costs. The probability of finding a suitable apartment varies with apartment size according to individual preferences. Assuming the rationality of all agents and the household preferences mentioned above, the search-process in Germany might be more costly for small-size apartments.

However, the *Room* coefficients are almost all significantly negative at the 1% level, independent of the estimation method, which sustains the former line of argument.

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[13] The share of single- and double-family houses for rent ought to be less price intensive due to the relatively high opportunity costs of owning.

A proxy that exclusively captures market heterogeneity is the proportion of foreigners. Due to a comparatively shorter employment biography connected with lower average income, and discrimination by landlords and owners (Ahmed and Hammarstedt 2008, Bosch et al. 2010), foreign households tend to demand apartments that have below-average quality. Rental prices for that class of apartments are higher, as are prices for apartments of higher quality, which eventually leads to an increase in the vacancy stock. Although the coefficient *Foreigners* is significantly positive across all OLS-models, its impact on individual quartiles differs. These figures are only significant in 50% of the districts that exhibit the lowest vacancy rate; they do not play an important role in the other 50% and the spatial setting. Therefore, we can not support the discrimination thesis for Germany.

With *Pop65*, we attempt to describe the mobility potential of one district; an older average age of the population means lower mobility frequency, at least for Germany (Kemper 2004)[14]. Higher tenant mobility rates in turn, increase vacancy incidence and simultaneously, the natural vacancy rate. In a comparison of Model (1) with Models (3) and (4), we obtain remarkable changes in magnitudes and standard errors. It is quite evident that *Pop65* primarily captures population changes and income differentials when no further control is included; otherwise, it becomes insignificant as also shown in the spatial setting. Thus, household mobility seems to be less relevant for the German natural vacancy rate.

4. Conclusion

This paper has analyzed rental price convergence and determinants of the natural vacancy rate by using the stock flow model of Wheaton and Torto (1994) for the German residential rental market based on data that cover approximately 90% of all NUTS 3 regions for the 2004-2007 period.

Starting with the adjustment process, we distinguish between administrative bodies located in East and West Germany to account for structural disparities. The results indicate on the one hand, that conditional convergence is accomplished and on the other hand, that economically less developed districts in the East exhibit distinctly higher convergence rates.

Due to the very limited panel data and contrary to theoretical suggestions, short-term deviations of vacancy stock from the natural vacancy rate and rental absorption exert no significant rental price pressure. Instead, time

[14] This is contrary to the work of Gabriel and Nothaft (2001), who detect a positive relationship between population age, mobility and vacancy incidence.

dummies become highly significant because they control for various housing subsidies paid during that period of time.

In a comparison of recent vacancy rates with natural vacancy rates calculated at equilibrium, one can see completely opposite developments for the administrative bodies in East and West Germany. While East German counties have the highest and West German independent cities the lowest vacant stocks in the short term, the exact opposite becomes true in the long run. The market expectations of landlords on future returns primarily explain that turnaround, in addition to market heterogeneity and tenant mobility. At equilibrium, landlords are willing to increase their vacant stock in economically highly developed districts because their "room to maneuver" in renting out apartments improves. The relatively better socio-economic environment affects (future) housing demand, which in turn raises (expected) rental prices. We indirectly prove supply strategy by finding significantly positive impacts of average household income and net birth rate on the natural vacancy rate. Moreover, market heterogeneity is also important for the natural stock, but no considerable influence is detected on population mobility.

Future research could attempt to extend the stock flow model by specifying the transition from the dynamic to the static analysis more concretely. Rental absorption is only included in the adjustment process and not at equilibrium. Although the maximization calculus of market agents influences price and quantity decisions equally in the short and long terms, this is not explicitly captured in the stock flow model. To consider market power in both states might lead to an improvement in the understanding of rental markets.

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