Housing Rents and Integrated Rental Market Neighbourhood Impacts - Evidence from the City of Vienna

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Abstract

The local housing regime in Vienna is often regarded as one of the last examples of an integrated rental market as described by Kemeny. Thus, according to the theory, private landlords should be forced to charge lower rents due to direct competition from the social sector. We formally test this hypothesis on a very local level by linking the private rent price trajectories across Viennese subdistricts to their initial housing market structure while controlling for possible effects of location and socioeconomic variation. We indeed find significant evidence for a price dampening effect, as higher shares of municipal and non-profit housing within the rental sector substantially increase the probability of a subditrict joining a lower rent level path.

Keywords: Rental Market Integration, Social Housing, Vienna, Price Convergence, Log-t Test, Ordered Probit Model

JEL Codes: R30, R31, R38

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1 Introduction

In the terminology of Kemeny (1995) a *unitary* or *integrated* rental market is characterised by competition between for- and non-profit housing providers. According to the theory this should lower rents for all tenants, also those accommodated within the private segment of the market. Although originally put forth as a theory concerned with housing regimes on a national level, recent debates have emphasised the importance of the local level, meaning regions or cities when dealing with housing regimes. In this paper we go even further and empirically investigate the proposed relationship between non-profit supply and private housing rents on a neighbourhood level. The probably best possibility for such a case study is the city of Vienna.

Housing in the Austrian capitals is not only dominated by rental sector (70%) but has a substantial non-profit supply with a market share of 21% (Statistik Austria, 2020b). But most important, Vienna might be regarded as one of the last examples of a European city with an accommodation market that can truly be characterized by what Kemeny, Kersloot, and Thalmann (2005) refer to as an integrated rental market (Matznetter, 2020).

Critics of this view might point out the rapidly rising housing costs in Vienna, which have been especially pronounced in the aftermath of the financial crisis 2008 (Statistik Austria, 2020b). These recent developments can be traced back both to trends in market fundamentals as well as policy changes and possibly some processes of financialization. However, rent price developments might still be dampened by the large supply of social housing, especially in those neighbourhoods with a high level of competition between the market segments. The question is not if rents are rising or not, but where they are heading. To deal with this question, we draw on the econometric convergence literature, more specifically the idea of club convergence. Originally designed for questions of macroeconomic growth patterns between economies, Phillips and Sul (2007) developed a econometric toolbox enabling us to endogenously detect so called convergence clubs which are characterised by a similar growth trajectories. Applied to the case of local rent levels, we can detect neighbourhoods with common price trajectories.

To test whether higher social housing shares within a neighbourhood indeed bring down prices on the private rental market, we need to check if there are differences in those price trajectories associated to the local segmentation of the housing supply.

For this study we use a unique micro-dataset containing 111,749 rent price offerings between 2011 and 2019 partially provided by the *DataScienceService GmbH* as well as the *Research Unit Urban and Regional Studies* of the University of Technology Vienna. In order to combat sampling problems and outlier issues in the data, we use a multilevel approach to construct quarterly mean prices for 196 of the 250 Viennese subdistricts. We then perform the *log-t convergence test* suggested by Phillips and Sul (2007) to test for rent price convergence between the subdistricts in the panel. After rejecting the convergence hypothesis, we apply the clustering algorithm also developed by Phillips and Sul (2007) to detect different convergence clubs across the city. Exploiting the ordering in the outcome of the clustering process, we then use an ordered probit model to investigate the impacts of social housing shares in the local housing market onto club membership and thus rent price trajectories on the private market. Doing so, we also control for centrality, initial rent levels and socioeconomic differences within the spatial units.

We indeed find significant evidence against allover convergence of private rents between subdistricts. Instead we detect three different convergence clubs. We can also conclude a significant role of social housing supply in the local rental market onto club membership, with higher social housing shares beeing associated to lower price trajectories, even when controlling for variouse factors. Thus, drawing on the econometric convergence literature this paper is for the first time able to provide quantitative evidence on the price dampening effects of an integrated rental market. We are even able to this on a very local level using a novel and unique micro-dataset of Viennese rent offering prices. One of the main contributions of this paper is to add an appropriately sophisticated empirical approach to the otherwise rich discussion on housing regimes and the respective strand of literature from the field of critical housing studies.

The remainder of this paper is structured in the following way: Section 2 provides an overview of Kemenys housing market typology and a brief discussion of its relevance on the sub-national level as well as an introduction to the Viennese housing market. Section 3 describes the convergence test, clustering algorithm, ordered probit model and the micro-data used as well as the methods used to aggregate it. Section 4 summarises the empirical findings while Section 5 provides a short conclusio.

2 Kemenys Integrated Rental Market and the Case of Vienna

Kemeny (1995) uses the term *dualist rental systems* describing housing systems which are characterized by a rather small social housing sector with strict means testing and close state control. Their goal is to provide housing for those who simply can not afford to pay a market rent. Thus, in a given dualist rental system, non-profit and for-profit rental coexist without much interaction. The counterpart to the textitdualist rental systems would then be the *unitary rental market* which is closely associated to the social market approach applied to housing in the post-war Germany and neighbouring Countries such as Austria, Denmark and the Netherlands. in *unitary rental markets* non-profit housing providers are actually encouraged to compete with for-profit landlords by the regulatory setting.

While for-profit providers generally need to charge rents able to cover both interest towards outstanding debt as well as a given market return on their equity, non-profit providers can offer rents which are only covering costs, as they are not in need for a market return on their equity. Hence, non-profit housing providers financial costs are lower for a given ratio of equity to market value, measuring the solidity of the rental organization. Solidity should typically increase over time by debt amortisation and appreciation of market values - a process referred to as *maturation* (Kemeny, 1995; Kemeny, Kersloot, and Thalmann, 2005). For comparable levels of maturation the non-profit provider should be able to set rents lower than the private landlords. If they are not constraint by tight entry barriers, non-profit organizations should be able to attract more renters than their private competitors, forcing them to adapt and also lower rents. This spillover effect is however subject to several conditions. Accessibility must be given for a wide range of potential tenants and a wide distribution of housing stock in terms of location, size and quality must be provided matching the private supply. Maximum competition is achieved when the non-housing supply mirrors the private supply in all characteristics but the rent. According to the authors competitive power of the non-profit sector is given as an interaction of solidity and market representation.
While Kemeny used *unitary* and *integrated* interchangeably at first, Kemeny, Kersloot, and Thalmann (2005) later introduced a differentiation where the *integrated rental market* could be perceived as something like the highest stage of an unitary rental market. Thus, a unitary market in which non-profit suppliers are strong competitors is called integrated. As integration proceeds, rent control should be phased out in favour of a looser regime of rent regulation ac-

cording to the authors. According to Mundt and Amann (2010, p. 42) *'Austria's rental market comes close to Kemeny's prototype of an integrated rental market when measured by the legal framework within which it operates, as well as by the solidity and volume of the sector, the rent levels, and competition with the for-profit sector, and the orientation to large parts of the population.'* All these charactersitics are argueable even more pronounced in the Austrian capital.

Kemenys rather optimistic and in the end unfulfilled expectation of a wider development towards integrated systems has been a focal point of criticism from the likes of Stephens (2020a). He argues against the notion that the organization of cost-rental housing could shape the nature of a rental system and constitute a whole housing system and thus Kemenys theory could not be able to explain how housing systems are changing. Although there is some merit to Stephens argument with regard to the dynamic component at the national level, Matznetter (2020) points out that focusing too much on what is going on in the aggregate can lead to premature conclusions, as housing policies are nowadays more often devoluted to subnational entities such as regions or cities. Following Hoekstra et al. (2020) the appropriate scale of comparative housing studies would indeed be at a local level. Due to increasing price differentials in commodified and financialized housing, Matznetter argues, it is mostly the metropolitan regions where affordability deterioration is an increasing problem and thus housing policies are developed to counter or at least dampen these trends. Berlin would be an example of a local entity that is similar to Vienna in many regards. Both have a similar history in housing policies and welfare models and are recently facing growing population as well as rising house prices (Marquardt and Glaser, 2020). Nonetheless, in contrast to Vienna, Berlins tenants are still suffering from the dismantling of the unitary-type german housing regime through widespread privatisation (Aalbers, Holm, et al., 2008) and the regional parliament now started to use rent caps as means to get a grip on the affordability problem while there is also public discussion about expropriation of large housing companies (Stephens, 2020a). On the other hand, Matznetter (2020) singles out Vienna as a case of a city with an integrated local rental market, that kept its social housing stock in tact. Given their long tradition, Viennas social housing providers can further be thought of as mature and equipped with a substantial market representation. This both holds true for the municipality as well as the housing cooperatives.[1] The fact that Vienna indeed was able to maintain an integrated rental market is also acknowledged by (Stephens, 2020b) in the ongoing discussion. However, he points out that this system can only flourish as so long as the broader institutions of corporatism are maintained.

Despite recent debate about the actuality of Kemenys theoretical contributions his framework inspired a lot of research in the field of housing studies. Or as Blackwell and Kohl (2018, p. 299) put it: *'There are numerous exponents of the housing-welfare regime framework, operating under various different guises, but the most influential is assuredly Jim Kemeny.'* Independent of the strength and weaknesses of his ideas with regard to development paths of housing systems, Kemeny offers both a broader theoretical framework and a useful typology to empirical researchers. Thus, it seems even more surprising that hardly any work has been done to investigate the empirical outcomes of different rental market regimes. Some exceptions can be found in Borg (2015) or Hoekstra (2009). This paper aims to contribute to the discussion on rental market regimes by providing empirical evidence on the potential price dampening effect of an integrated rental market. We therefore take one of the last resorts of integrated rental markets, namely the city of Vienna to conduct an empirical study.

[1]For the remainder of the paper we thus consider both these social providers constituting the non-profit side of the integrated rental market.

2.1 The Case of the Viennese Housing Market

The City of Vienna is traditionally known for it's local welfare model, large decommodified social housing stock and policy of social equality which lead to a resilient housing market in international comparison (Hatz, Kohlbacher, and Reeger, 2016). The Viennese housing market is very much a rental market with only 19% of the housing units being owner occupied. Today, according to Statistik Austria (2020b) some 44% of the housing market belong to the social housing sector, which is either owned by the city (23%) or non-profit housing associations (21%) providing housing at below-market rents for a large share of the population. The city is actively targeting a better social mix through eligibility rules while private non-profit providers typically also provide housing to a wide range of income groups, both prioritising people in employment as well as people with long term residency in the city (Reinprecht, 2014). Although the concentration of the social sector is higher in the more peripheral districts, it can be found all over the city, thus enabling lower income households to reside in areas with higher market rents (Kadi, 2015). The social sector is designed to provide housing for large shares of the population and rather promotes then hinders social-mixing accoring to a recent study by Premrov and Schnetzer (n.d.). The private rental sector which makes up 34% of the housing supply in Vienna can also be subdivided into two parts. On the one hand a free pricing segment and a price controlled segment. The letter constitutes at least 78% of the private rental supply and mainly consists of so called *'Altbau'*[2] housing units with a construction permit before 1945 (Kadi and Verlič, 2019). This leaves only about 7.6% of the housing supply traded at free market rent (Simons and Tielkes, 2020).

However, the private segment subject to rent controls has undergone several transformations which do not provide rents at costs but mirror market developments through a complex set of

[2] roughly translates to 'old building'

regulations. Part of the rent increases can be traced back to a reform of the tenancy law that was already introduced in 1994, but became particularly relevant since the financial crisis. The reform enabled private landlords to add location bonuses on top of regulated rents in areas with high land prices. With land prices on the rise, location bonuses took off since 2010. In the city center, location bonuses went up from 4 Euros per square meter in 2010 to 12.21 Euros in 2019. Generally, location bonuses increased most in areas that already had high location bonuses in 2010 and vice versa. At the same time the number of short-term contracts massively increased, reinforcing upward price trends through the possibility to adapt to the fast changing market situation at a higher frequency (Kadi and Verlič, 2019; Kadi, 2015). Meanwhile, a rather longterm restructuring of the private supply from a "low-quality, low-priced sector, to a high-quality, high-priced sector" has taken place at least since the 1990s also leading to price increased (Bauer, 2006). Another major pricing factor of course is the increase in demand, reflected in steady population growth stemming from both internal as well as external migration towards Austria (Simons and Tielkes, 2020). However, the Viennese population has been growing since the late 1980s and not experienced similar upward shifts in rents (Statistik Austria, 2020a). Thus, not all trends in private sector pricing can be traced back to market fundamentals. Especially in the aftermath of the financial crisis Viennas real estate market experienced processes of financialization (Springler and Wöhl, 2020) and increasing deviation from fundamental prices. According to the fundamental price indicator by M. Schneider (2014) the Austrian National Bank (2020) reports that overpricing started in early 2011 and has been constantly rising ever since. This of course spills back to the private rental market in terms of rapidly increasing rents. Hence, Viennas housing market is experiencing some recommodification, upgradings in terms of housing quality, together with fast population growth and some processes of housing financialization. Altogether, average prices in the rental market rose from 6 Euros per square meter in 2009 by 40% to 8.4 Euros in 2019. The trend was even more pronounced in the private segment where prices rose by 50% in the same time span (Statistik Austria, 2020b). These changes and restructuring processes on the Viennese housing market also came hand in hand with increases in socio-spatial inequality during the post-crisis period (Kadi, Banabak, and A. Schneider, n.d.).

While going through all these processes that are challenging housing affordability in the Austrian capital, not only tenants in the social sector but also those subject to private landlords should still profit from the dampening effect the large social housing sector exerts onto the for profit sector. At least if we are to believe in Kemenys idea of the integrated rental market.

3 Methods and Data

We already know that prices were increasing in the Viennese post-crisis context but are all parts of the city heading in the same direction or are there different trajectories and if so, can we explain them by the rental market structure? Given a very dynamic market situation and ongoing upward trend in rent prices we are neither interested in momentarily differences in absolute prices nor price changes across the city. Lets assume a spatial unit with low shares of social housing may have entered the panel at a high price level and now faces small price increases while a formerly lower priced ones with high social housing share exhibits strong price increases. Both are similar in all other relevant characteristics. We could either come to the conclusion that more social housing leads to lower rents or to higher rents dependent on what we look at. However, if we could tell that the unit with low social housing share is approaching a higher rent price level than the high social housing unit in the medium to long run irrespective of where they are on that transition path, that would be much more informative about the effects of social housing shares onto the rent level. Thus, given the panel available to us, it would be much more revealing to compare price trajectories rather than crossectional information.

We therefore need to first identify those potentially diverging paths in rent price development, thus turning to the econometric convergence literature. In a second step we take a look at different characteristics of the convergence clubs we find and then formally link club membership to the local housing market structure. We take the 250 subdistricts of Vienna as units for the analysis as they allow for enough variation across the city while also still having the administrative data on rental market composition as well as socioeconomic information available.

3.1 Phillips and Suls Log-t Test of Convergence and Clustering Algorithm

To test whether private sector rent prices converge between Viennese subdistricts one could turn towards a variety of econometric convergence tests, with the *β convergence test* suggested by Barro, Sala-i-Martin, et al. (1991) and Barro and Sala-i-Martin (1992) being the most prominent. In this paper however, we choose to make use of the so called *log-t convergence test* developed by Phillips and Sul (2007) and Phillips and Sul (2009). The authors proposed a time-varying factor model that allows for both individual and transitional heterogeneity to model economic variables such as income or prices. Thus, the model allows for different time paths towards convergence. Furthermore the convergence test based on this time-varying factor model does not impose any restrictions regarding trend stationarity and is robust to heterogeneity which makes it a powerful tool for applied econometric convergence testing.

Suppose we have some panel data X_{it} then, according to Phillips and Sul, we can decompose it in the following way

$$X_{it} = g_{it} + a_{it} \tag{1}$$

where g_{it} is the systemic component and a_{it} is the so called transitory component. To separate idiosyncratic from common components we can rewrite equation 1 as

$$X_{it} = \frac{g_{it} + a_{it}}{\mu_t}\mu_t = b_{it}\mu_t \tag{2}$$

where μ_t is the common factor and b_{it} is the systemic idiosyncratic element, which is allowed to evolve over time and also includes the random component a_{it}. While μ_t determines the steady-state growth path, b_{it} gives us the transition path. Although we can not directly estimate b_{it}, it is possible to construct a statistic, the authors call the relative transition component,

$$h_{it} = \frac{X_{it}}{N^{-1}\sum_{i=1}^{N} X_{it}} = \frac{b_{it}}{N^{-1}\sum_{i=1}^{N} b_{it}} \tag{3}$$

which can be easily computed from the available data. In the case of overall convergence we expect the transition component h_{it} to converge towards unity for all i=*1,...,N* as $t \to \infty$. This implies that the cross-sectional variation[3]

$$H_t = N^{-1}\sum_{i=1}^{N}(h_{it} - 1)^2 \tag{4}$$

should converge to zero as $t \to \infty$. Decreasing cross-sectional variation by itself however, does not automatically imply convergence of the whole sample but could rather be due to convergence within subgroups.

[3] note that the mean of h_{it} is 1 by definition

To construct a formal statistical convergence test based on the described factor model, it is necessary to impose some further assumptions on the behaviour of b_{it}. Phillips and Sul (2007) and Phillips and Sul (2009) therefore suppose the systemic idiosyncratic element to follow a semiparametric model that allows for heterogeneity over time and across individual units

$$b_{it} = b_i + \frac{\sigma_i \varepsilon_{it}}{L(t)t^{\alpha}} \tag{5}$$

with a time invariant component b_i being fixed, ε_{it} being i.i.d. (0,1) across i but may be weakly dependent over t. Together the terms σ_i and ε_{it} allow for the aforementioned heterogeneity over time and across individual units even if there is a common steady state. Meanwhile $L(t)$ is a slowly varying function converging towards infinity as $t \to \infty$. Here the authors suggest $L(t) = log(t)$ although other specifications might be possible. Last but not least, the parameter α gives us the convergence rate. It becomes apparent, that for X_{it} to converge as $t \to \infty$ two conditions have to be met. First the convergence rate parameter α has to be at least zero or greater for the second term to vanish over time. Which brings us the second condition that there actually is a common time invariant component. More formally we test the $H_0 : b_i = b \wedge \alpha \geq 0$ against the $H_A : b_i \neq b \; for \; some \; i \vee \alpha < 0$. The alternative hypothesis includes the possibilities of total divergence but also of club convergence. As we can not directly test whether $b_i = b$ we focus on the second part of the Null $\alpha \leq 0$. Thus, we need to get an estimate $\hat{\alpha}$.

As Phillips and Sul (2007) show we can obtain such an estimate for the convergence rate by running the following regression model:

$$log\frac{H_1}{H_t} - 2log(log(t)) = a + \gamma log(t) + u_t \quad \text{for } t = [rT], [rT]+1, \ldots, T \tag{6}$$

where the initial observation used is $[rT]$ with some $r > 0$, meaning we discard the first $r\%$ of the data in order to focus the attention onto what is going on at latter parts of the sample. As a result of Monte Carlo simulations the authors recommend the use of $r \in [0.2, 0.3]$ for a small sample size ($T < 50$). The second term on the left hand side of equation 6 acts as a penalty, giving the test discriminatory power between overall convergence and club convergence. Finally, $\gamma = 2\alpha$ which allows us to test the H_0 by looking at the heteroskedasticity and autocorrelation robust t-statistic of γ and conducting a standard one sided t-test of $\alpha \leq 0$. If $t_{\hat{\gamma}} < -1.65$ assuming a confidence level of 95%[4] the nullhypothesis of convergence is rejected.

In the case of rejecting the hypothesis of overall convergence, we could still have convergence clubs between some units. Therefore, Phillips and Sul (2007) provide us also with a clustering algorithm to detect such convergence clubs. If rejected for the whole sample, the test procedure can be repeated using the following steps:

1. Sort the units in descending order using the last observation of the panel

2. Select the k highest units to form the core of the first subgroup for some $2 \leq k < N$ and run the *log-t* regression from equation 6, calculate the corresponding robust convergence t-statistic t_k. Now choose the core group size k^* by

$$k^* = argmax_k\{t_k\} \text{ subject to } min\{t_k\} > -1.65 \tag{7}$$

   if the condition $min\{t_k\} > -1.65$ is not met for $k = 2$, then the highest unit of the core group can be dropped and a new core group is found. If $t_k > -1.65$ does not hold for any group, allover divergence is concluded.

[4]or of course using whatever critical t-value one wants to compare with

3. Add one by one additional units to the core-subgroup and rerun the log-t test. Include a unit if the associated t-statistic is greater than a criterion c^* which is set in advance[5].

4. Form a second group from those units not part of the first convergence club after step 3. Run the log-t test to see whether the second group shows convergence. If the nullhypothesis of convergence holds, conclude that there are two distinct convergence clubs in the sample. If there is divergence within the second group, repeat step 1-3 for the units not included in the first convergence club. If step 2 can not produce any k for which $t_k > -1.65$ we can conclude that the remaining units do not exhibit any convergence behaviour and are thus labeled as divergent.

As the clustering algorithm described is very much dependent on the arbitrarily set c^* the authors further suggest a club merging algorithm to avoid over determination. The merging algorithm can be described by the following steps

1. Combine the first two clubs detected and run the log-t convergence test. If the combined groups are not divergent, thus the t-statistic is larger than -1.65, they are merged to a new convergence club.

2. Take the next convergence club and add it to the newly merged group. Again run the log-t test and check whether the basic condition for convergence holds. If so, also add the new group to the merged convergence club.

3. If the Nullhypothesis of convergence is rejected at any point, the previous subgroups (of course excluding the last one) are thought to form a joint convergence club. Restart the

[5]The critical value c^* reflects the degree of conservativeness where higher values lead to a more conservative selection outcome. The higher c^* is set, the less likely it is that we will falsely accept a member, which in turn also implies that we are more likely to have a higher number of clubs than we should observe. However Phillips and Sul (2009) provide guidance for short panels ($T < 50$) suggesting to set $c^* = 0$

merging algorithm beginning with the last group for which the convergence hypothesis was rejected.

This concludes the three main steps of which the methodology suggested by Philipps and Sul consists.

3.2 Explaining Club Membership using an Ordered Probit Model

In the next step, we try to explain club memberships by local rental market structures, also controlling for initial rent levels, socioeconomic differences and centrality of the subdistrict. We can exploit the ordered nature of the clustering algorithm described in subsection 3.1 using an ordered probit model as first described by McKelvey and Zavoina (1975). Similar approaches can be found for example in Bartkowska and Riedl (2012) and Li et al. (2018) or Basel, Gopakumar, and Rao (2020). Assuming that club membership is associated to a continuous latent variable y_i^* we can write down a linear model to explain this latent variable

$$y^* = X\beta + \epsilon \tag{8}$$

where X contains the explanatory variables of initial conditions in the subdistrict. The observed ordinal variable y indicating club membership, then takes on the values $\{0, 1, \ldots, J\}$ dependent on the corresponding thresholds $\{\theta_1, \theta_2, \ldots, \theta_{J-1}\}$. Thus, we can write

$$P(y = J - 1) = P(y^* \leq \theta_{J-1}) = P(\epsilon > \theta_{J-1} - X\beta) \tag{9}$$

By artificially setting $\theta_0 = -\infty$ and $\theta_J = \infty$ we can write down equation 9 more generally as

$$P(y = J) = P(\epsilon \leq \theta_{J+1} - X\beta) - P(\epsilon \leq \theta_J - X\beta) \tag{10}$$

which under normality of the error term translates into

$$P(y = J) = \Phi(\theta_{J+1} - X\beta) - \Phi(\theta_J - X\beta) \tag{11}$$

Due to the nonlinearities involved, the model can not be estimate by OLS, however Maximum Liklihood estimation is possible. For the same reason we cannot directly interpret β as a *ceteris paribus* effect onto y, thus report average marginal effects as is common in the literature. Furthermore we present the predicted probabilities of each club membership given varying levels of the explanatory variables including prediction intervals based on bootstrapping.

3.3 Data and Aggregation

Unfortunately rent price information from the Austrian census can not be disaggregated on a sub province level. As Vienna is both the Austrian capital and an own province we do have city wide survey information but no small scale data. Hence, we have to construct our own rent price time series for each subdistrict. We therefore use data collected by the *DataScienceService GmbH* as well as data from the *Research Unit Urban and Regional Studies* of the TU Vienna. Both Sets of Data together contain offering prices for 111,749 flats offered on the Viennese private rental market between the first quarter of 2011 and the third quarter of 2019. After controlling for duplicates we aggregate microdata for every subdistrict and quarter. The easiest way to do this would of course be to just take the mean of the observations within each areal unit and for every point in time. However, the amount of data available varies significantly between subdistricts and over time, leaving us prone to outlier problems. Without any knowledge about the underlying distribution of the actually offered amount and types of flats, we can not resolve the issue by properly weighting the observations.

We therefore turn to multilevel models to obtain more realistic aggregates in areas and periods with a low number of observations. We thus want to shrink outlying subdistricts with little observations more towards the city and time independent unit average.[6] There are indeed many ways to write down such a multilevel or random effects model, for this paper we decided to follow the notation suggested by Gelman and Hill (2006).

$$\begin{aligned} log(y_i) = \alpha + \alpha_{j[i]} + \alpha_{jt[i]} + \epsilon_i, \quad \epsilon \sim N(0, \sigma) \\ \alpha_j \sim N(\mu_{\alpha_j}, \sigma_{\alpha_j}), \quad \alpha_{jt} \sim N(\mu_{\alpha_{jt}}, \sigma_{\alpha_{jt}}) \end{aligned} \tag{12}$$

where y is the rent price, i denotes the observed flat, j denotes the subdistrict it belongs to and t is the period in which the observation was made. Aggregate prices per squaremeter are then obtained as the exponential of $\alpha + \alpha_j + \alpha_{jt}$. Missing values of up to two years per subdistrict are then imputed by moving averages. Subdistricts with more consecutive missing values are discarded leaving us with 196 of 250 subdistricts. However, those units discarded are mostly peripheral and accommodate only a very small proportion of Viennese residents.

4 Results

After aggregating the microdata we start by running the *log-t convergence test* with the Nullhypothesis of rentprice convergence across all subdistricts. With $\hat{\gamma} = -0.297$ and $t = -21.473$ we find significant evidence against price convergence. We thus apply the

[6] of course it would alternatively be also be possible to have shrinkage towards the time trend but then the normality assumption makes little sense and as units with low priced units tend to have lower representation in the sample this would unjustifiably increase estimated mean prices for those units.

clustering algorithm described in section 3.1 to detect convergence clubs within the panel. The results of the clustering steps are reported in table 1. We initially detect three convergence clubs with positive convergence parameter and no divergent units. Applying the merging algorithm club does not change the outcome.

The first club with the highest rent price trajectory consists of only nine subdistricts while the second club contains 118 subdistricts and the below average developing club has 69 subditricts. All of the convergence clubs do have a positive convergence parameter.

Table 1: Price Converence Club Classification

Initial Club & Units	Initial $\hat{\gamma}$ (SE)	Merged $\hat{\gamma}$ (SE)	
Club 1 [9]	0.142 (0.041)	Club 1 + 2 0.233 (0.016)	
Club 2 [118]	0.131 (0.039)		Club 2 + 3 0.192 (0.014)
Club 3 [69]	0.232 (0.057)		

Note: ***p≤ 0.01, **p≤ 0.05, *p≤ 0.1
Log-t test based on 196 Subdistricts 2011 Q1-2020 Q4

The relative transition paths of each subdistricts rent prices are plotted in Figure 1. The plot clearly shows, that club one is composed of two types of subdistricts. There are five initially high priced units all located in the city center and four subdistricts with strong upgrading during the observation period. Club two and three both accomodate initially above average as well as below average units. However, club two subdistricts converge towards an above average rent price level while club three subdistricts move towards an below average rent price level.

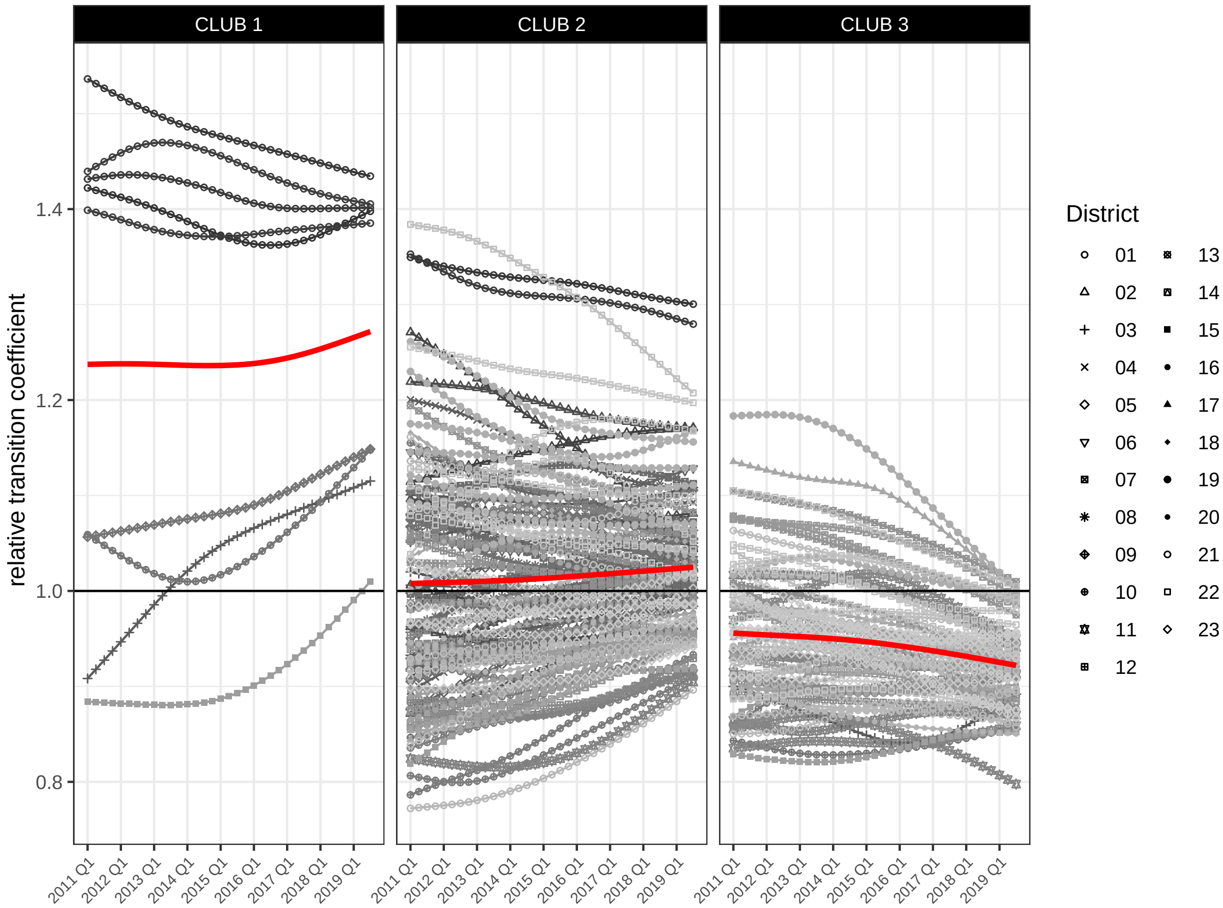

Figure 1: Relative Transition Paths of Subdistricts by Club
Dotted black line shows clubs average transition path. Each line representing a Subdistrict.
Symbols indicate the district to which a subdistrict belongs

Figure 2 depicts the spatial distribution of the respective convergence clubs across Vienna. It becomes apparent that those subdistricts with the highest rent price trajectory are either clustered centrally within the *Ringstraße* or more towards the south, their rise in rent prices is most likely associated to the opening of the new Viennese main station in 2012 and the ongoing upgrading of the *Landstraße* district. One can further be found in the ninth district and one is located in the fifteenth district just across the imperial *Schönbrun* palace. Club two subdistricts are clustered around the aforementioned *Ringstraße* surrounding the city center, up till the *Gürtel* which is usually perceived as the border between the inner and outer districts. Club three subdistricts are mostly found in the outer districts, however this area is much more heterogeneous. With the exception of the very upper class districts of *Währing* and *Döbling* in the north we see that with increasingly peripheral location the share of club three districts increases.

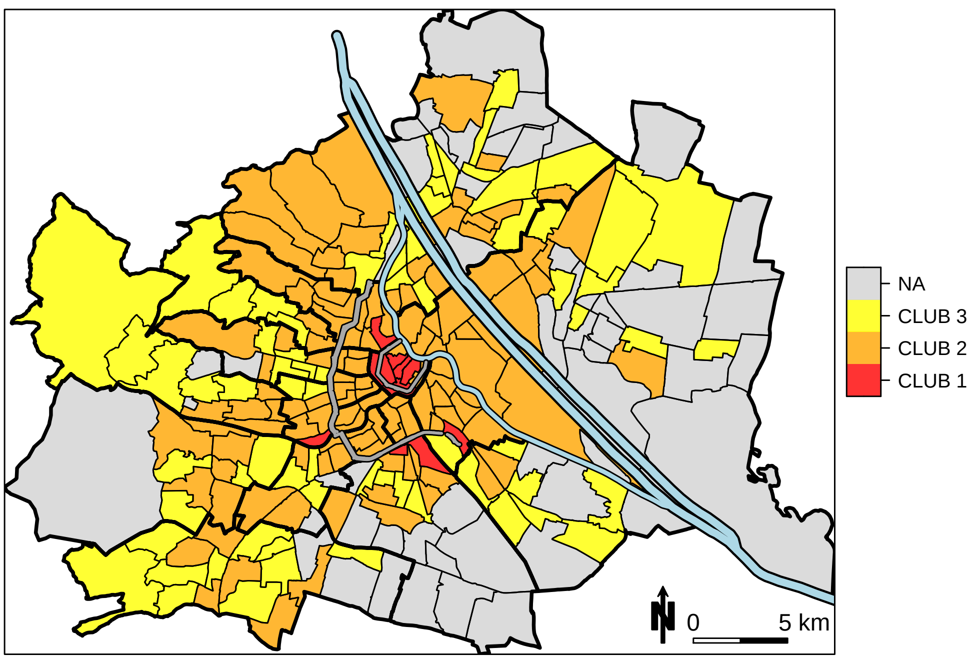

Figure 2: Private Rent Price Convergence Map
Private Rent Price Convergence Clubs of Viennese Subdistricts. Map also depicts the Danube (lightblue) and the Ringstraße as well as the Gürtel (darkgrey) as geographic references.

Figure 3 gives insight into the distribution of various variables across subdistricts within each convergence club in the base year 2011. We can observe that a higher price trajectory is associated with higher initial rent levels, but a smaller share of municipal and non-profit housing units within the rental sector. If we take a look at the socioeconomic structure of the subdistricts, we can also observe that more expensive convergence clubs tend to inhabit relatively more academics. The relationship regarding unemployed population however, is less clear with club one subdistricts showing the lowest and club two the highest rates. This should give us a first intuition about possible drivers of differences in rent price trajectories. However, we do not want to remain on the purely descriptive level but formally test the relationship between club membership and the composition of the local housing market, while also controlling for centrality and socioeconomic factors that might drive differences in club memberships. As described in subsection 3.2, we therefore use an ordered probit model. We start by explaining club membership merely by initial housing market characteristics (M1). We then add dummy variables indicating whether the subdistrict is located within the the city center or within the inner districts (M2). We further expand the model by controlling for variation in the initial price level (M3). Last but not least, we also add the share of academics and unemployed as socioeconomic control variables (M4).

In M1 both social-housing variables are highly significant across clubs. On average, they clearly increase the probability of a subdistrict to follow a lower price trajectory and decrease the probability of a subdistrict to join Club one and two. After controlling for location, the municipal housing and non-profit housing coefficients keep their sign and stay significant in all cases. Also adding the log of initial rents as an explanatory variable does not change direction of the social housing coefficients across clubs. Somewhat surprisingly controlling

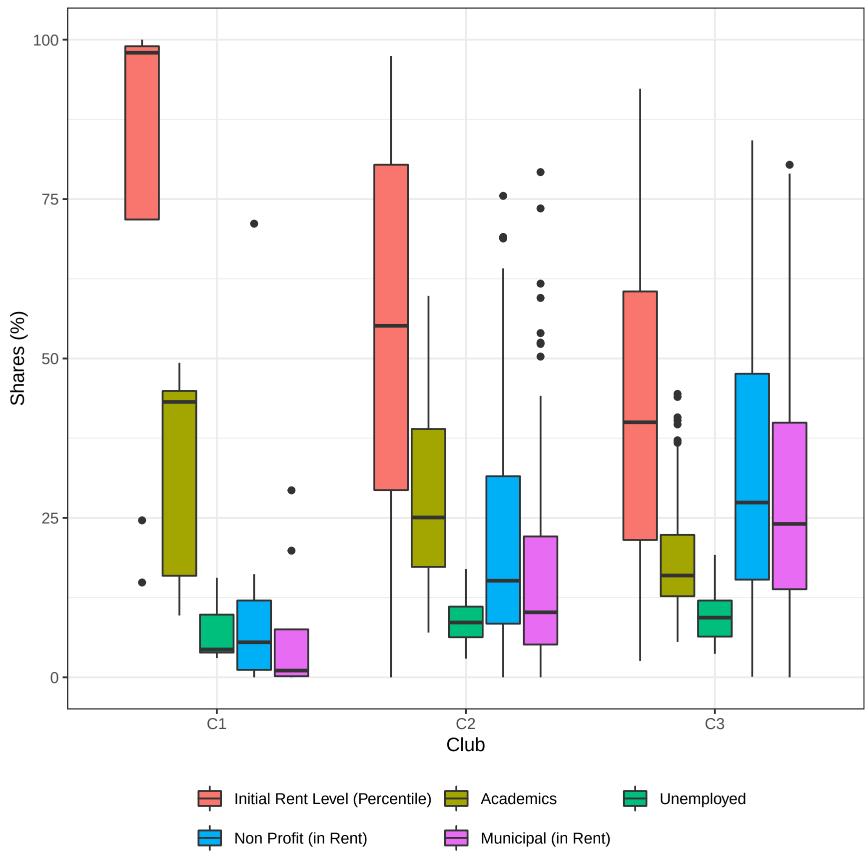

Figure 3: Subdistrict Characteristics
Data from base year 2011 provided by the City of Vienna

for socioeconomic characteristics such as share of academics and unemployed do not show a significant impact onto club membership. Adding the variables therefore does not significantly increase the goodness of fit compared to M3 as confirmed by Likelihood Ratio tests.

In Addition to reporting the average marginal effects we use the ordered probit model (M3) to predict conditional probabilities of club membership. We do this by evaluating the model outcomes varying one of the housing market variables at a time while holding the other two at their respective mean. This is done separately conditioning on either a location in an outer district, one of the inner districts or within the city center. The changes in probability can be interpreted as the result of a redistribution from the private sector[7] to the respective segment. The predicted probabilites along with their prediction intervals based on bootstrapping, are depicted in Figure 4. If we let the share of Non-Profit units within the rental market rise, we observe an substantial increase in probability of membership in club three and a decrease in club two membership if outside the city center. For cases situated in the city center, we only observe a small impact onto club three membership but a decrease in probability of club one and an increased probability of membership in club two. This of course implies a strong impact onto lower rent price trajectories across the city. Very much the same relationship between clubs holds true if we take a look at variation in the Municipal share across all three possible locations. However, the effects are all a bit weaker in comparison.

These outcomes confirm the idea of a price dampening effect exerted by both the non-profit as well as municipal supply over the private rents. Higher shares of social sector supply within the local rental markets substantially increase the probability of subdistricts membership in a convergence club with a lower price trajectory on the private market irrespectively of whether a subdistrict is placed in the city center, the inner districts or the outer districts. The small differences in impact between the two social housing sectors, actually fit Kemenys idea quite well, as the Municipal sector has stronger entry barriers compared to the Non-Profit sector.

[7]either in terms of owner occupied towards rental or private rental towards municipal or non-profit rental. The limits of the variables are set accordingly.

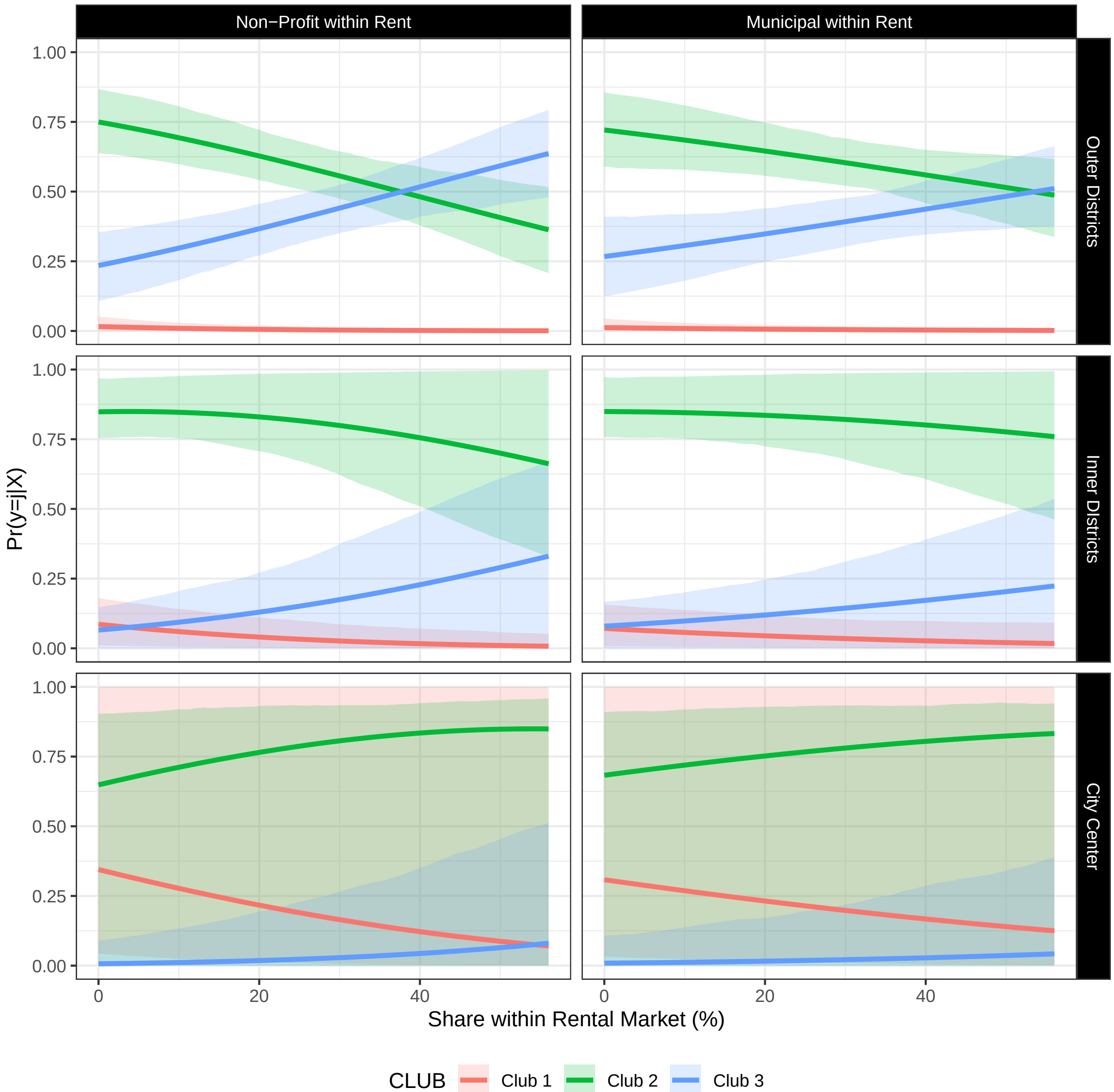

Figure 4: Probability of Club Memberships
Probabilities based on ordered probit model, evaluated at the mean of the currently non-varying variables. The range of the depicted x-axis are set in a way to ensure market shares add up to a maximum of 100 %. Shaded areas correspond to the 95% prediction interval based on bootstrapping

5 Conclusion

Vienna has all of main characteristics of Kemenys integrated rental market and is possibly one of the last examples where we can empirically test the proclaimed price dampening effect of a large social housing sector onto the private rents. Although rents were strongly on the rise across the city in our observation period between 2011 and 2020, we should not get carried away looking at very recent price levels or changes in order to asses a potentially price dampening effect. Instead such an effect can be detectable through lower private market rent trajectories over the medium to long run in those neighbourhoods with a higher social sector share in the rental market. Using a novel dataset of offering prices, we construct quarterly meanprices on subdistrict level based on a simple hierarchical model to combat sampling problems and outlier issues. Based upon this data, we reject the hypothesis of rent price convergence across the city using Phillips and Sul's log-t convergence test and instead find three main convergence clubs with different price trajectories. By means of an ordered probit model, it can be shown, that higher shares of either municipal or non-profit supply within the local rental market, translate into significantly and substantially increased probabilities of a subdistricts membership in a convergence club with a lower path of private rent development. This holds true for different possible locations within the city and controlling for socioeconomic factors that could also impact prices. Thus, there indeed is a price dampening effect stemming from the social sector onto the development of private rents in Vienna.

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