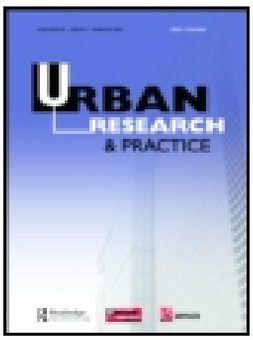

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ARTICLE

In search of determinants for quoted housing rents: Empirical evidence from major German cities

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Housing policy made a comeback on the German political agenda. Apartment rental prices increased drastically in most major cities over the last years. Despite wide agreement by policymakers regarding the need for regulation of the housing market, there is close to no empirical evidence on the drivers of rent prices. We follow a comparative, quantitative approach to determine the driving factors of rent prices in German cities, taking economic, societal and political variables into account and using time-series analysis. Our results show that the share of students and the local mean income account for differences in quoted rent prices.

Keywords: housing policy; housing market; rental prices; Germany; comparative

1. Introduction

During the last decade, rental prices for apartments in German cities have dramatically changed. In most cities, the mean rent prices increased, causing housing policy to be a top concern in politics. These developments indicate that we can observe a 'comeback' of German housing policy, overturning the policy fields' loss of importance since the late 1990ies. German housing policy mainly used to rest on four traditional policy instruments (see Heinelt and Egner, 2006), namely tenancy law (*Mietrecht*), housing benefits (*Wohngeld*), home ownership subsidy (*Eigenheimzulage*) and social housing (*Sozialer Wohnungsbau*). While those four instruments are the core of housing policy, there are various instruments supporting the policy field; i.e. programmes concerned with urban planning founded in the late 1990ies, like 'Social City' (*Soziale Stadt*) and 'City Conversion East' (*Stadtumbau Ost*). After a long period of stability and continuity, several, partly deep-rooted changes mark housing policy since the 1990ies, including the shift from subsidies or benefits for buildings (*Objektförderung*) to subsidies for individuals (*Subjektförderung*), and a general tendency to a process of marketization (Kofner 1997; Kofner 1999). Additionally, the regulation intensity of the rent markets was reduced in the early 2000ies but has slightly intensified since the introduction of new regulations in 2013 (for an extensive overview on regulation instruments and the institutional frame of regulation of rental markets in Germany, see Kholodilin 2016).

For the federal election in 2013, the Social Democratic Party (SPD) claimed 'affordable housing' as a core campaign topic (Höschle, Strielkowski, and Welkins 2015, 86). Within the frame of the following coalition negotiations, the party pressured the coalition partners to introduce a new regulatory instrument, the *Mietpreisbremse* (rent control law), which took effect in 2015. It limits the increase of the rent a landlord might impose in a

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new letting to 10% above the local reference rent. The *Mietpreisbremse* is not legally applied everywhere, but in municipalities or parts of municipalities which have been declared to have tense rental markets by the respective state government. New builds and apartments that have extensively been renovated are generally excluded from the law. Also, existing rental contracts are not affected by the law and thus, its rental prices are protected. Preliminary findings of the instrument's effectiveness are mainly negative. For example, studies about Berlin report that the rental prices are still higher than they should be. Many landlords increased the rents before the law was passed, now allowing them to still demand too much within the framework of the *Mietpreisbremse*, and a great share of tenants does not challenge illegal rent prices in court, being afraid to lose their apartment (Kholodilin, Mense, and Michelsen 2016; Kontext 2016). While there is considerable doubt if the regulation works, and while the rents are constantly rising, the importance of the topic still prevails.

Strikingly, housing rental markets differ a lot across German cities. While there are some cities where the rents actually became slightly cheaper over the last 10 years (e.g. Leverkusen with −2.2%), the vast majority of cities have become increasingly expensive to live in (see Table 1).

The effects of rising rents on the inner dynamics of a city are well known and mainly discussed under the headline of the 'gentrification' term (Atkinson 2000; Holm 2006). On the other hand, the causes and drivers for rental prices are often neglected in the literature. Even if there are some studies on single cities, most literature is dealing with buying or selling real estate and not with renting it (e.g. Butler and Lees 2006). The focus on the drivers of rental and not real estate prices is, in our opinion, crucial when it comes to analysing housing policy in Germany. Since the ownership occupation rate is strikingly low compared to other Western countries (see Table 2), renting makes up the largest part of the residential housing market.

In this article, we seek to fill a gap in the literature on housing policy from a political science perspective by explaining the level of housing rents in German cities with more than 100,000 inhabitants over the course of 10 years. Thus, the research question is: What are the driving forces for the development of quoted rents?

For this purpose, we will first present findings from the existing literature dealing with rental prices (Section 2). We will also explore data availability and discuss the operationalization (Section 3), before we finally set up time-series cross-sectional models for the

Table 1. Changes in rent prices in Germany.

City	2004	2013	Change
Trier	5.46	7.67	+40.48
Freiburg	8.07	10.57	+30.98
Oldenburg	5.41	7.06	+30.5
Ingolstadt	7.1	9.21	+29.72
Erlangen	6.66	8.57	+28.68
Jena	6.63	8.51	+28.36
Fürth	6.04	7.7	+27.48
Berlin	5.94	7.57	+27.44
Würzburg	6.2	7.9	+27.42
Hamburg	7.98	10.11	+26.69

Cities with the greatest increases between 2004 and 2013; monthly (net cold) renting price in Euros per square metre.
Source: Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR).

Table 2. Owner occupation rate in selected countries.

Country	Year of inquiry	% Owners	Year of inquiry	% Owners	Change	Annual change
Ireland	1979	76.0	2013	69.9	−6.1	−.18
United States	1979	65.4	2009	67.2	+1.8	+.06
United Kingdom	1981	56.0	2014	64.8	+8.8	+.27
Denmark	1981	55.0	2015	62.7	+7.7	+.23
Italy	1979	55.0	2014	73.1	+18.1	+.52
France	1975	46.7	2014	65.0	+18.3	+.47
The Netherlands	1982	45.0	2015	67.8	+22.8	+.69
Germany[7]	1982	44.0	2011	48.9	+4.9	+.18
Sweden	1970	35.0	2014	69.3	+34.3	+.78

Source: McLeay (1984): 90, 104; European Mortgage Federation (2010): 73, 2016: 107; Federal Statistical Office (2013a).

explanation of the rental price level (Section 4). We will conclude by critically assessing the models developed and sketching out the need for future research on this topic (Section 5).

2. A multidisciplinary approach to housing rental markets

Housing policy is a field at the crossroad of disciplines. Economists, political scientists, sociologists and urban planners analyse housing from a scope of different vantage points. Studies in the field of housing policies in general differ widely from those which look at particular population groups in distinguished parts of cities (Höschle, Strielkowski, and Welkins 2015), to complex econometric models of real estate markets (Garmaise and Moskowitz 2004). The multidisciplinary of housing research so far led to more or less productive speculation about possible determinants on rent prices in the scientific literature. Interestingly, there is virtually no literature dealing with the comparison of housing rental prices *across cities*. The largest portion of the literature is instead focusing on real estate prices. Albeit some empirical research tries to determine the drivers of prices for buying real estate (e.g. Carrillo 2012), current research has a strong focus on the US real estate crisis ('housing bubble') and its macroeconomic effects (Congleton 2012; Kemme and Roy 2012). Sometimes, the real estate market of single cities is addressed in research, e.g. Mumbai (Whitehead and More 2007), Paris (Gregoir et al. 2012) or Richmond, VA (Rossi-Hansberg, Sarte, and Owens 2010).

Even though many studies can still be located within their discipline, some do combine different aspects, e.g. Arnott (2003) as well as Turner and Malpezzi (2003), who incorporated macroeconomic and political determinants into equilibrium models. As Kemeny (2001) argues, this variety of disciplinary approaches has also led to a 'atheoreticity' of housing research, in which theoretical groundings tend to be neglected and the focus of analysis is mainly descriptive. Our interest lies in explaining differences in rent prices across cities.[1]

From an economic perspective, factors which have a direct impact on the market by altering the supply and demand can be regarded as critical. The first is the number of housing units per capita, as it can be interpreted as a proxy for the supply that is faced by the demand on the market. This is the basic characteristic factor of housing in the city. Less units per inhabitant means a tighter housing market with renters competing for housing, more units per inhabitant

means landlords competing for renters, which should make housing cheaper. Prices for building land, the capital market and costs for building materials also have an impact on the supply side of the markets, as these are upstream markets of the actual housing markets (Kofner 2004). Similarly, the number of building completions and approvals is relevant. A large positive change signals that the supply of the market is going to expand, which should slow down price increases. In Germany, the number of social housing units has been decreasing for years (Deutscher Bundestag 2017). Effectively, only about 14,600 social housing units were newly built in 2015. Even though construction activity has generally increased in the last years, the balance between newly erected units and those which lose their price fixing is negative. An increasingly lower share of social housing units diminishes the supply for those in need for them. If the supply in the publicly funded market segment is too low, these groups may move to the privately financed sector – but only, if affordable units are available there, which is unlikely in tense markets. This increases the demand and leads to an increase in rent prices without an adjustment of supply (Institut für Wohnen und Umwelt (IWU) 2005). One could also argue that interconnected markets may trigger changes on the rental markets, especially when renters become owners of their dwelling either by buying existing units or by creating new units. Thus, it could be interesting to observe if the home-ownership rate has an effect on rents. Unfortunately, data about home ownership rates are not available on the city level as time series; thus, the model implicitly assumes that ownership rates are stable over time and space.

Apart from determinants that are directly related to market configurations, several aspects of population characteristics are believed to have an impact on rent prices. The first is population growth. Since adjustments on the supply side of the housing market take a comparatively long time and are also not possible in all cases, a fast population growth puts pressure on the market and is likely to increase rent prices (DiPasquale and Wheaton 1996). The same can be said for population density. It is a standard variable from spatial economics which is frequently used in models. Given many people live on a small slice of land, the erection of new housing may be expensive and difficult. Since the supply side is not easily expandable, it may result in higher rental prices. In the same vein, a positive migration balance increases the population of the city and hence the need for housing (Saiz 2007). The demographic structure of the city population is interesting as well (Vornholz 2013). A high proportion of single households has a negative impact on the availability of housing in general and also leads to a higher demand for smaller housing units, in which the rent price per square metre is comparatively higher than in larger housing units. A growing share of elderly has a similar impact, as they have a tendency to live by themselves if their partners die, and in most cases, to stay in the respective housing units. The share of students in a city also influences rent prices via its impact on population growth. Besides, universities are a driving factor for housing prices. Universities typically attract not only high and middle-class incomes (professors and academic staff) but also a high number of young people who are populating the city (students). Thus, the demand for housing rises with the size of a university (Kosfeld, Eckey, and Martina 2010).

Socio-economic determinants that are named in the literature to have an impact on rental prices are the share of unemployment and average wages in a city as well as its attractiveness for companies and the share of commuters. A higher share of unemployed people increases the demand for housing units in lower priced market segments. According to Eekhoff (2002), unemployment can be used to measure the overall attractiveness of a city. When unemployment in a city is high, people do not tend to move there. If unemployment is low, the city is behaving like a magnet by attracting additional inhabitants. The average wages earned in the city tell us something about the general level of welfare and prices. A

city's attractiveness for companies potentially increases the number of companies, their employees and those who search jobs and therefore increases the demand for housing units (Eekhoff 2002). Commuting, precisely the number of people commuting into the city on an average day in proportion to the city population can also be deemed to have an impact on rent prices. The idea is that cities which have a high proportion of commuters versus inhabitants are more likely to have lower rents due to the fact that people who work in the city may also live in the suburbs, where the rents are lower. In cities where commuting is hindered by high costs for individual or collective transport, people tend to move to the city despite high rents (Benjamin and Sirmans 1996).

The last cluster of possible determinants for housing rent prices deals with the political city context. The political determinants of a city are the municipal debt and the power of the political left within a city's politics. First, the level of municipal debt may play a vital role for rents, because a city with high debts will not be able to spend funds on additional social housing, whereas 'rich' cities may at least think about additional spending to limit the growth of prices in order to keep the city attractive for an influx of people (political heritage, see Rose 1990). Studies from macroeconomics and political science show that parties follow different policy choices which are correlating to their political ideology (Hibbs 1977; Blais et al. 1993). Even though scholars have not dealt extensively with housing policy as an explicit field of the welfare state, one can still suspect that parties tending to the left of the political spectrum will put more emphasis on enhancing housing supply, whereas parties tending to the right will rely more on the mechanisms of the 'free market', refraining from using city funds to increase the housing supply.

3. Data and operationalization

3.1 The dependent variable

At the end of the year 2011, there were 80 cities in Germany with more than 100,000 inhabitants each, which makes them major cities (*Großstädte*) in terms of statistics (Federal Statistical Office 2013b). Not all of those cities can be incorporated into the analysis due to the fact that they are considered to be different in terms of the German two-tier system on the local level. Most of the statistical data which are crucial for our analysis are only collected on the upper level of the two-tier system, where the units are the counties (*Kreise*). This is uncomplicated for most cities, since major cities are often combining the functions of a city and a county at the same time (*kreisfreie Städte*). All other cities (which are *kreisangehörige Städte*) had to be excluded from the list due to the lack of data. Thus, 68 cities remain for analysis, which were inhabited by 23.4 million people altogether in 2014. That accounts for roughly 28% of Germany's population. The period under scrutiny is 10 years (2004–2013). The reason for the relatively short period is that comparable data for housing rental prices are only available from 2004 onwards.

It is not easy to measure housing rental prices in German cities. There is no legal obligation for the contractors (landlord and renter) to inform anyone about the terms and conditions of the rental contract. There are basically three ways for acquiring the data needed.

First, most of the cities we analyse have a current *Mietspiegel* (rent index). This instrument can be introduced by the city council in order to indicate 'standard' rental prices for different types of units in different locations within the city, but it is based on information about newly concluded contracts from recent years as well as contracts with an updated rent. Not all contracts are included, it is based on a random sample, mostly picked and analysed by a scientific counselling institute (for an overview over

methodology, see Cromm and Koch 2006: 65ff.). As the public lists are used for determining the 'regular price' in the city in order to e.g. be able to define where racketeering begins or to have an orientation for where to cap price increases, the lists are often subject to negotiation with tenants' and landlords' associations. Thus, the list represents more of a mix between a random sample of newly concluded (or updated) contracts and a political compromise between the two stakeholder associations and the city administration. From this perspective, the term 'Mietspiegel' is not entirely correct, because it does not report the current average rents on the market but instead is a political instrument to limit the increase of rents for existing contracts (see Lerbs and Sebastian 2015; Thomschke 2016). Additionally, there is no *Mietspiegel* for every city covered by this study, and those cities which have a *Mietspiegel* do not update it annually, making this data not suitable for time-series analysis.

The second possibility is to rely on privately collected data, for which there are various sources. Three organizations do collect their own data on housing prices covering both rents and real estates. One of them is the German real estate association (IVD). It regularly surveys the real estate agents in order to calculate mean prices for buying or renting housing in most of the major cities. Unfortunately, data from this source are subject to possible manipulation, since the number of agents surveyed is comparatively low and the agents may tend to give higher prices than in reality, because the agent's commission as a reward for establishing a successful deal is calculated by using the monthly rent. Also, only a part of the market is covered since many landlords find renters without asking an agent for help. Thus, data may be unreliable and comparison over time and space may be precarious. The two other sources are private research companies which use their data to provide services as consultants for private and public customers ('empirica' and 'bulwiengesa').

The third possibility is the housing prices database maintained by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR), a research institution of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. The database provides mean housing rental prices for all major cities in Germany for each year. The data are harvested by a piece of software which scours major websites where apartments are offered. The downside of the data source is that only a part of the new rent contracts is included, because no one is obliged to use an internet portal to search for a tenant or apartment. Thus, only a part of the market is covered, namely quoted rents, i.e. the rent price the landlord wants to realize when he submits his offer to the market.[2] Another downside is that the data set only has one value per city and year, which means that the model is not able to calculate different housing prices within a city, i.e. for different segments of the market (small or big apartments, the location and quality of the facilities etc.). On the other hand, the database is providing the numbers based on thousands of offers during a year, which may be close enough to the market mean.

All three approaches for data collection have their assets and drawbacks. We chose the BBSR database because it is the most reliable data collection and it best fits the requirements for time-series analysis. This leaves us with 68 cities and 10 time points each, which make up 680 observations to use for the time-series model. In each case, we have taken the value measured by the BBSR, precisely the monthly renting price in Euros per square metre.[3]

3.2 The independent variables

As stated above, we will build a new model for the explanation of rental prices from scratch. For that purpose, we searched for single determinants named in the literature for having an impact on rental prices. These are our independent variables which will be used for setting up

the formal model. We are using variables that measure characteristics of the city, not of those of individual tenants or groups of market participants. The purpose is to explain the overall level of rental price within the city in comparison to other cities, not individual choice within a city's market. Typically, rental prices are estimated as a mirror of the demand side of the market as in equilibrium models, which are the classic way of economics for determining market prices (Malpezzi 1996). We argue that the logic of models only based on economic determinants is hardly applicable for the housing sector: Housing is no ordinary good like pork or a car but has certain attributes that lead to malfunctioning markets, which do not work like perfect markets where the interplay of demand and supply creates the price. The most important attributes of the housing market are (1) the impossibility to substitute the good, (2) lacking transparency of the market, (3) information asymmetry, i.e. an information advance of landlords and their agents, (4) long-lasting compensation processes within the market (e.g. the cattle cycle and the low elasticity of both supply and demand), (5) the immovability of the good, (6) the segmentation of the market and (7) the heterogeneity of the market (Kühne-Büning, Nordalm, and Steveling 2005). Those attributes may stick to other goods as well, but the commonness and combination of those attributes frequently leads to non-optimal prices on the housing market (Leonhardt 1996). Especially transparency of market processes and the homogeneity of goods are two major assumptions of equilibrium market models, which cannot be used as assumptions in a city-comparative model.

Following these considerations, we opted for a more encompassing approach in explaining varieties in rental prices. The literature reviewed in the last section of this paper names several determinants on rental prices. These can roughly be grouped into four categories: (1) supply side, (2) population, (3) socio-economic attributes of the city and (4) the city context.

Two independent variables will be used concerning the supply side, housing units per capita and the number of newly erected housing units. The first is measured as the number of housing units (apartments and houses) available per person. The number of newly erected units is incorporated into the model by calculating the number of new units against the stock, thus measuring the degree of growth within the supply.

For the population dimension, we will use three independent variables. The population density within the city, the share of persons who are 60 years or older and the share of students enrolled in the universities of a city compared with the overall number of inhabitants. Although not all students enrolled in a specific university live in the exact same city, we use this variable as proxy for the size of the academic population and its demand on the housing market.

The third dimension covers the socio-economic attributes of the city. Here, we focus on three variables: mean gross wages, unemployment and the share of commuters. The first is the mean gross wage per year of the people working in the city as measured by the Regional Accounts Working Group of the Federal Statistical Office (VGRdL). Of course, using this variable implies that the population working in the city is congruent with the population living in the city, which is obviously not true, because there is considerable amount of commuting going on. Nevertheless, since gross income on the city level is only measured by the 'principle of workplace' in Germany, there are no better figures. Again, the idea is not to compare people's income with people's rent within one city, but to give an overall estimate of economic wealth in the cities by measuring the mean gross income.

The last dimension is what we call city context. It is made up of three variables which capture the political context in the city. The first is public debt of the city, which is measured in Euros per capita and gives an impression of financial constraints.

We measure the tendency of local politics to the left by calculating the share of council seats for left parties (SPD, the green party and the party 'the left') and if the mayor is member of one of the aforementioned parties. We know that those three parties differ regarding their orientation to the left and one could also argue that branches within a party may differ significantly in terms of ideology (Egner 2016). Since we have no city-specific data available, let alone time series, we simply add the three parties up.

Not all relevant determinants discussed in the literature could be incorporated into our statistical analysis due to data availability and quality. We feel that we should give notice what we would have liked to include into the analysis but could not due to missing data. First, we could not include prices for building land in the cities. Unfortunately, there are no statistics for prices for building land offering reliable and valid numbers for German cities, which can be incorporated in a time-series model. Of course, there are data (table 400-51-4 of the Federal Statistical Office), but the data suggest that prices are bouncing up and down in each city over the years. This reflects the process of data collection: The data presented here are actually the mean price for regular deals in real estate per square metre closed in the respective year. Since trade can vary significantly over time and since real estate prices do vary within large ranges even within one city, the numbers are not representative for the city as such. Unfortunately, we have to leave this variable out of the model. Second, we were not able to include the share of publicly funded housing within a city into the model. We believe that publicly funded housing is having a depressant effect on housing rents since social housing is in most cases aiming at low-income tenants. Unfortunately, there is no statistic of the number of publicly funded housing units on the city level which is meeting the requirements of a time-series model; i.e. reliable numbers are only available for a small number of cities for some years.

All data for the model were acquired by different public sources which are documented in Table 3. For most of them, there are no gaps in the data set. Small gaps are present on some variables, due to gaps in the data collection by the responsible public agency.

3.3 Choice of the formal model

As we have already pointed out, the data set consists of 68 municipalities. Since we have data for 10 years for most of the variables, the data set is based on 680 observations. The data set thus spans over a panel of cities and several points in time and is suitable for time-series cross-sectional analysis (*TSCS*).

Since the middle of the 1990s, usage of TSCS data sets has increased in social science. In TSCS models, the assumption of unit homogeneity is applied to both the spatial and the time dimension (Green, Kim, and Yoon 2001, 441; 458). Admittedly, those data sets are not suitable for ordinary regression analysis, since they violate various model assumptions of OLS regression models:

- Typically, the variable values in time-series data sets are autocorrelated, which means that consecutive observations are dependent on each other (Cochrane and Orcutt 1949, 33).
- Even more problematic is the autocorrelation of the error term (ε), which means that consecutive prediction errors are dependent on each other. This is not acceptable, since the error term is the random component of the equation and thus should not correlate with other error terms.
- The estimation of traditional regression coefficients is further biased by heteroscedasticity, which means that the error terms are correlated to the values of the

Table 3. Descriptive statistics.

Variable	*N*	min	max	mean	Std. dev.	Data source
Rental price per square metre	680	4.18	13.24	6.37	1.46	BBSR
Rental price as index (2004 = 100)	680	87.26	140.48	102.99	7.41	(derived from BBSR)
Housing units density	680	.45	.64	.53	.04	Federal Statistical Office, 035-21-5
Growth in housing supply	680	.06	1.98	.39	.26	Federal Statistical Office, 031-11-5
Population density	665	438.08	4530.59	1721.54	760.61	Federal Statistical Office, 173-01-4
Share of elderly people	680	20.16	34.51	25.64	2.33	Federal Statistical Office, 173-21-5
Share of students	680	.00	31.02	7.37	6.60	Federal Statistical Office, 21311-0002
Mean gross wage p.c.	680	21,002.00	48,631.00	29,811.46	4601.40	AK volksw. Gesamtrechnung, R2B2
Unemployment	677	3.50	23.70	10.43	3.54	Federal Statistical Office, 659-71-4,
Commuting	650	−6.37	55.26	13.19	11.40	Federal Statistical Office, 254-04-5
Municipal debt p.c.	676	.00	18,452.10	2410.05	2966.36	Federal Statistical Office, 358-71-4
Council tendency to the left	680	.25	.76	.49	.10	Own calculation
Mayor tendency to the left	680	.00	1.00	.56	.49	Own calculation

dependent variables or – even more difficult to handle – the error terms are uniformly moving along the time axis over panels (Plümper, Troeger, and Manow 2005, 329).

- There can also be statistical relationships between the independent variables (multicollinearity), which is supporting the bias in estimating coefficients in time-series (Judge et al. 1985, 275).

In consequence, time-series cross-sectional data sets cannot be used to test hypotheses by ordinary regression models. Instead, we need a model both accounting for contemporaneous trends and unit-specific effects (Baltagi 1995, 3ff.). As standard tests show, the data set used is characterized both by strong unit roots and cross-sectional dependence.[4]

The standard choice for a model is to build a generalized least squares regression (GLS) model (Gujarati 2003, 394ff., Lloyd 2005), which is an adaption of the OLS regression for usage with time-series cross-sectional data sets. GLS models attenuate biased estimation of regression coefficients by correcting for autocorrelation both of the residuals and among the independent variables and for multicollinearity. Additionally, the model takes into account that the effect caused by the independent variables on the dependent variable may be lagging.

When looking into the literature, the accuracy of GLS models is challenged with two important arguments. The first argument is directly attacking the calculation of unit-specific effects in the GLS model, stating that the calculation of different unit intercepts drives the attention away from the common ground of the cases (i.e. the slope) to the individual cases. The second argument is based on empirical research by Beck and Katz (1995), who performed a replication study with TSCS data sets used in previously published articles. They found that GLS models systematically underestimate the regression coefficients' standard errors and describe them as being 'overconfident' (1995, 634). Instead, Beck and Katz suggest that the regression model developed by Prais and Winsten (1954) with panel corrected standard errors is suitable for those data sets. Unfortunately, this model is not providing the calculation of unit-specific intercepts.

The latter are interesting for us in two different respects. First, they are needed to separate the estimation of the overall coefficient of the model from unit-specific effects, since municipalities may differ on characteristics we either do not measure (omitted variables) or cannot measure (e.g. local political or economic culture, historical preconditions etc.). Second, the unit-specific effects can inspire us in search for variables which are omitted by the model. There are two possibilities for the calculation of unit-specific effects: If the heterogeneity of municipalities is assumed to be correlated with the variables within the model, we have to calculate *fixed effects*. If the heterogeneity of the municipality is assumed to be uncorrelated, *random effects* would have to be calculated. Since we aim on fixed effects, but GLS implies random effects, we may use a fixed effects regression model with AR-1 disturbance instead (XTREGAR, see Baltagi and Wu 1999).

As demonstrated, both choices (Prais–Winsten and the fixed effects model) are not completely satisfactory for us. Since we do not want to choose one disadvantage over the other, we will start with calculating models using both methods to see if they agree on the basic determinants of housing rents, and the direction and the size of the effects. What both models have in common is that the coefficients can be interpreted as ordinary regression coefficients, i.e. that the coefficients display the value which is added to the dependent variable if we increase the respective independent variable by a margin of one.

Before calculation, we transform the dependent variable to an index where in each city, the housing rent is set to the value 100 in the year 2004 and the following values in the time-series are recalculated to the base value of 2004. For example, if the level of rents

in a city was 5 Euros per square metre in 2004 and is 6 Euros per square metre in 2005, the values for the year 2005 is recalculated to '120', because the rent is 120% of the 2004 base. This allows us to compare the rent increase independently from the starting level of rents in the respective cities.

It should be noted that even though we will set up explanatory models, the character of this study is mainly explorative due to the lack of theoretical groundwork, as already discussed.

As Table 3 depicts, there is plenty of variation between the cities altogether. Since the lowest number of cases on the variables is 650 (commuting numbers are not measured for all the cities), the number of cities which will be used using the full load of variables is 65.

4. Models and discussion

In this section, we present the statistical models set up using the variables described above. For that purpose, we will develop separate models for the explanation of the housing rent price. The first group of models is based on fixed effects regressions and the second is based on Prais–Winsten regressions, both specified with AR-1 disturbance and single-lag of residuals. For both groups, we follow the same strategy: To begin, we will estimate a model for the housing rent index for each of the four dimensions (supply side, population, economic attributes, city context) separately. After that, we set up a model using all predictors, regardless if they proved to produce significant effects on the dependent variable. Finally, we will estimate a model including all those independent variables which show consistent significant effects both in the single dimension model and the general model. This leads to models with a high explanatory power while using as little significant variables as possible. At the end, we are able to compare two 'lean' models, one from each group.

We begin with the fixed effects models.

As Table 4 depicts, the linear model with fixed effects performs rather well in the population model (II), where all three items are found to have an impact on the housing rent index, with elderly people and students strongly driving up the index with comparable factor sizes (1.94 resp. 1.52 index points). The economy model (III) performs even stronger, but only based on one variable, which is the mean gross wage. The models for supply side (I) and city context (IV) perform rather weak in respect to the overall explanatory power. Additionally, the tendency of the council to the left seems to have a positive effect on housing rents, which suggests that left parties drive the rent index up – contrary to our expectation. The combined model (V) shows several variables to be consistently significant with the single-sector models (housing units per capita, population density, share of students and mean gross wage), which means that they are feasible for use in the final model. All other variables had to be dropped from the list. Among them is the share of the elderly, which changed its direction of the effect dramatically while losing significance. Additionally, council ideology had to be removed from the final model, because its size drastically decreased and it is not significant in the full model. The final model is thus based on four independent variables which explain variation quite good as long as the variation occurs *within* cities *over time*. However, the model fails explaining variation *between* the cities sufficiently. Three coefficients are pointing in the expected direction and the sizes of the effects are plausible. We expected only the predictor of housing units per capita to point in the other direction, but the model suggests that the index is rising if there is more housing per capita.

Table 4. Linear Regression models (XTREGAR) with fixed effects for indexed housing rental prices.

Model	I	II	III	IV	V	VI
Overall model figures						
No of obs.	612	597	585	608	585	597
No of cities	68	68	65	68	65	68
R^2 within	.046	.189	.283	.018	.388	.448
R^2 between	.002	.007	.011	.001	.001	.006
F	13.1	40.7	68.0	3.2	29.3	106.6
$p(F)$	.000	.000	.000	.023	.000	.000
Variables						
Constant	***70.92	***19.29	***36.37	***101.54	***−17.63	***−8.76
Housing units per capita	***74.31				***78.93	***39.82
Growth in housing supply	.57				−.18	
Population density		***.02			***.02	***.01
Share of elderly people		***1.94			−1.11	
Share of students		***1.52			***.80	***.89
Mean gross wage p.c.			***2.307		***2.175	***1.998
Unemployment			.05		.01	
Commuting			−.17		−.30	
Municipal debt p.c.				.000	−.000	
Council tendency to left				**19.25	11.10	
Mayor tendency to left				.22	.41	

Cells in the variables section show the regression coefficients fixed effects regression with AR-1 disturbance and Durbin–Watson autocorrelation. Asterisks indicate significance levels as follows: ***<.001; **<.01; *<.05.

After reviewing the fixed effects model, we will now examine the Prais–Winsten regression models (see table 5).

As many time-series models, the 'empty' model (without any variables crossing the cases) ends up with a relatively large R^2 (=.881), which is inherent in standard time-series models. As the table depicts, none of the single dimension models adds a large share to the overall explanatory power. The models for the supply side (VII) and city context (X) show no significant effect at all, only the population model (VIII) and the economy model show one significant effect each. The combined model drives R^2 up to .936 but shows inconsistencies for most of the predictors.[5] Again, the share of the elderly shows a switch in direction. There are only two predictors left which produce consistently significant results, and those are the share of students and the mean gross wage. The directions of both coefficients are as expected and the size of both effects is plausible again.

If we compare the two final models, it is striking that they have a lot in common.[6] In both cases, the share of students and the mean gross wage are significant drivers of the rental price index. The fixed effects model additionally incorporates housing units per capita and population density as predictors, but it has to be stressed again that the coefficient for housing units per capita points to the wrong direction. The other variables neither produce consistent effects across model families nor within one of the model families. Thus, their impact on rental prices is questionable.

If we compare the coefficients of the two models, the effects arising from the share of students are of different magnitude (.89 in the fixed effects model, .56 in the Prais–Winsten model). If we recalculate the values to real market prices, we can estimate whether the

Table 5. Prais–Winsten models (XTPCSE) for indexed housing rental prices.

Model	Zero	VII	VIII	IX	X	XI	XII
Overall model figures							
No. of obs	680	680	665	650	676	650	680
No. of cities	68	68	65	65	68	65	68
R^2	.884	.910	.903	.914	.893	.936	.910
Wald chi^2		3.0	10.0	15.8	3.8	32.1	20.0
$p(chi^2)$		.228	.018	.001	.289	.001	.000
Variables							
Constant	***105.36	***74.24	***95.77	***70.46	***96.86	***65.26	***62.80
Housing units per capita		57.00				*65.13	
Growth in housing supply		.96				.14	
Population density			.002			***−.003	
Share of elderly people			.05			*−1.25	
Share of students			**.71			*.36	**.56
Mean gross wage p.c.				***1.242		***1.242	***1.269
Unemployment				−.18		−.21	
Commuting				−.09		**−.32	
Municipal debt p.c.					.000	−.000	
Council tendency to left					15.39	**17.61	
Mayor tendency to left					.90	1.09	

Cells in the variables section show the regression coefficients (z) for XTPCSE models, calculated with autoregression type AR-1 and single-lag of residuals. Asterisks indicate significance levels as follows: ***<.001; **<.01; *<.05.

difference is big. Let us take the municipality with the median share of students, Dortmund (5.21% students in 2004, 8.17% students in 2013). According to the fixed effect model, a rise of 1 percentage point in students leads to a .89 point rise in the housing index. In Dortmund, the share of students has risen 2.96 percentage points within the last 10 years, which drove the rent index up for 2.63 points. Concerning the housing rents in Dortmund in 2004 (5.17 Euros per square metre), this means a rise to 5.31 Euros per square metre between 2003 and 2014. For an average apartment of 70 square metres, the monthly net cold rental price climbed by 9.52 Euros in total, which seems to be a rather moderate change. If we look at the top of the board instead, the relationship is quite different. The share of students in Erlangen is generally high (23.5% in 2004, 26.8% in 2013). The difference is 3.3 percentage points, which is, according to the fixed effects model, a raise in the index of 2.94 points. For the housing rents in Erlangen, this effect means a rise from 6.66 Euros per square metre in 2004 to 6.86 Euros per square metre in 2013. So for an average 70 square metre apartment in Erlangen, the net cold rental price is raised by 14 Euros per month.

Concerning the mean gross wage, there is also some variation. If the mean wage for a year in a city rises by 1000 Euros, the housing rental price index is going up 1.2 points (Prais–Winsten model XII) or even 2.0 points (fixed effects model VI). Let us take the city of Munich as an example, which is known for its high mean income. In 2004, the mean gross income in the city was 33,211 Euros per capita, growing to 40,504 Euros per capita in 2013. The difference is 7293 Euros, which transforms to 9.25 points on the housing rental index following model XII or 14.57 points following model VI. For Munich, recalculated into rents per square metre, the latter means a rise of 1.57 Euros per square metre, which for an average apartment results in additional rental costs of 110 Euros per month (1320 a year). This is really a significant amount, since it exceeds the growth in income (1000 Euros annually). Therefore, the level of local wealth in Munich (via rental prices) even hurts people with an average income.

5. Conclusion

In recent years, housing policy made a comeback on the German political agenda. It is a major campaign topic in elections on federal, state and municipal level. The political call for the regulation of rent prices is a reaction to ongoing reports of non-affordable rent prices across major cities in Germany. Despite the political popularity of the topic and the widespread unity among policymakers that housing markets need to be regulated, there is almost no empirical evidence on factors that drive rents from comparative studies.

We designed a model incorporating determinants that have been named in the literature to have an impact on rent prices. We chose not to follow an economics-based approach as the literature on housing policy states that rent markets are imperfect markets but opted for a macromodel with independent variables accounting for supply side and population aspects, as well as economic attributes and the city context. Our models show that mean incomes and the size of the academic community in the city are drivers of quoted housing rental prices, while housing units per capita and population density also play a role in one of the models.

Some determinants, which we expected to have an impact, remain either insignificant (like the political variables) or are inconclusive as they point to the direction we did not expect. There are two possible explanations for these findings: The first explanation points to weaknesses of a quantitative approach in general: Rent markets are long-term markets, where impacts of certain decisions or events might only be visible years later. Here, it

seems promising to conduct further qualitative research to examine the processes and impact of policy-decisions on the housing market more thoroughly. Additionally, we were not able to include important determinants, like the share of social housing units, because of lack of data availability or quality of the data. The lack of important data for research remains a major barrier to produce valid empirical evidence for cities across Germany in the field of housing policy. The second explanation points to the lack of theoretical groundwork for housing rental markets. As mentioned in Section 2, there is no comprehensive, consistent theory of housing rental markets. As we have shown, most of the determinants mentioned in the literature do not exert measurable influence on quoted housing rents when tested in a comparative, statistical model. The conclusion could be either that the model is not good enough in capturing the decisive factors or that the literature so far may be more based on educated guessing about the housing markets rather than on the observation of the real markets.

Independently of the scientific debate about housing rental markets, real estate markets and the determinants of rents and prices, it is astonishing that the obvious political problem of rising housing rents currently does not produce an echo in the political sphere. For example, the SPD as the major party on the political left in Germany has not chosen housing policy as a core field for neither its electoral platform nor the electoral campaign for the federal election in 2017. Although the party was successful in pushing the topic in the federal election of 2013, it refrains from using the topic again in the current campaign. This may be due to a strategic choice of the party, e.g. focusing on other policies concerning the campaign, or it may be the result of a lack of attention for the problem of rising rents from the perspective of party politics in general.

However, we think that the article shows that much more research on housing rental markets in Germany is needed for coming closer to an explanatory model. We hope that the empirical findings in this article will inspire further research about rental prices and the political debate about regulation of housing markets.

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Notes

1. This means that we will also not account for variation within cities, since most of the data used in this paper are not available for levels below the aggregate city level.
2. As Grenadier (2005: 1208) discusses for real estate leases, quoted rents are somewhat different from real market rents since they are representing the price the landlord reports to the public in contrary to the (secret) actual price which is codified in the contract later. It may be part of the landlord's strategy to give reasonable discount concerning the price in the contract and not reporting this to the public, since he does not want to delegitimize higher quoted rents in future offers.

3. It has to be noted, though, that the price resembles the 'net cold rental price', which means that it does only include renting the estate, but not additional cost like janitors, waste disposal, street cleaning, water, heating, electricity etc.
4. Both the Im–Pesaran–Shin test for unit roots as well as Pesaran's test of cross-sectional independence for the dependent variable result in $p = .000$.
5. In order to control for variation between the western and the eastern part of the country, we also set up a model using a dummy to the cities in two categories. The dummy is significant and takes away explanatory power from the other variables but does not add explanatory power to the overall model. This means that the west/east divide seems only to represent large parts of what we already have in the other data. We therefore do not use the separator dummy in the models presented.
6. We also tested GLS regression models with correlated disturbances (XTGLS) using the same data. It turned out that the models do also confirm the importance of the share of the elderly and the impact of the mean gross wage.
7. 1982: Federal Republic only. 2011: Only western Länder.

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