Convergence in German Regional Housing Markets[1]

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The aim of this paper is to analyse the convergence of housing prices in German regions using spatial regional data. We provide empirical analysis on the panel data set of 397 German regions for the period 2004–2020 taking into account their relative geographical location and prices. The main contribution of our paper is the analysis of convergence in housing prices, considering the historical aspects of the divergence of German regions. We discover if the housing prices become more homogenous over the years or not and also study the effect of various factors on the housing market.

We build spatial econometric models for both selling and rental price, taking into account such demand factors as unemployment level, pendulum migration ratio, wages, number of employees, gross regional product, migration flow for regions, emigration and immigration for Bundesländer. Additionally, we consider the effect of price and determinants of neighboring regions. As the result of the analysis, we can conclude that factors which lead to personal income growth affect the price growth rate positively and vice versa. Emigration lowers the demand to-

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gether with the price growth rate. Immigration contrary rises the demand and price growth rate. In the paper, we show that convergence among German regions exists over past years, mostly for rental prices, as the speed for them is higher. The practical significance of the current work is its applicability to regional economic and migration policy formation. Moreover, the analysis can be extended to the housing policy of other countries in order to allow cross-country comparisons.

***Key words*:** housing markets; regional analysis; spatial econometrics; convergence.

JEL Classification: C51, C33, O18, R32.

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Introduction

Constant even development is crucial for economic growth of a country. Various economists have a common point of view that divergence between regions has to be reduced as it negatively affects labour market, human capital and destabilizes the economy overall because of less developed regions deterrent effect.

Germany was divided into two countries for nearly a half of a century, so the regions went their own ways of different economic systems, political ideas, consumption standards, overall freedom level, goods and services accessibility and housing market formation and renovation as well.

All these historical events caused such negative consequences as economical divergence, lack of education facilities in Eastern regions, outdated factories and so on. The unified country had to solve the problem of overall divergence and take all the regions to the same positive development trend. The intermediate tasks were to equalize education level and accessibility to it, update the infrastructure, make Eastern Länder more attractive for inner migration and make stimulus for population to stay there.

After three decades of unified economic development, we can make some conclusions about the reduction of regions divergence. The situation is getting better every year, as we can see from the declining of unemployment rate in Eastern part – from 14,8% in 1994 to 6,9% in 2018, that is close to Western level of 4,8% in 2018 [Bundesministerium für Wirtschaft und Energie (BMWi), 2019]. Disposable income in Eastern Länder reached 86% of Western indicator, in comparison it was only 61% in 1991, a year after the reunification of two Germanies [Bundesministerium für Wirtschaft und Energie (BMWi), 2018]. These indicators are important and relevant as they show labour market and income per capita development over years.

All above said bring us to the idea of convergence existence among German regions. The economic situation is getting more common for all the Länder, the level of basic economical indexes getting closer to each other for different regions.

Convergence is the process of moving towards uniform indicators of different markets. The housing market is not the exception. The construction activity tempo is getting uniform, the age-structure of the housing starts to vary not so much by the regions.

The convergence on the market is usually measured by housing prices equalization. In our paper we analyse both rental and selling prices of condominiums. We find out whether the convergence among German region exists and calculate the speed of convergence using non-spatial and spatial models. We control for labour market and income distribution determinants and study how they affect housing prices and demand. We also include data on migration to broaden the determinants list.

The convergence phenomena can be rather controversial. In fact, lower-income regions can suffer from the divergence of housing prices and household's incomes, which can worsen the housing affordability and economic and social attractiveness of the region. However, the housing price highly correlates with income factor, so it is assigned to economic level of the region and cannot differ so much from common income. Housing prices appear according to the demand-supply law, so in case the population of the region have overall low income, they will not be ready to pay high price or will have to move to another city. This way, income level is closely connected to prices of goods, except bubble-risk regions, but it is quite an exclusion and not the tendency. We analyse in this work the situation in general, so the convergence of housing prices is a mark of convergence in population average income.

The main policy implication of current work is its conclusions which are useful for regional economic policy formation. Housing prices tend to rise by years and big cities, such as Munich, Hamburg and Frankfurt are suffering with unaffordable for the most part of its population housing, which lead to social unrest and migration. The key factor of housing affordability is mass sufficient construction, that is not the case of nowadays Germany. In following part, we are going to explain and illustrate this fact.

The paper is constructed as follows. In the next section, we put some light on the German policy which was aimed to reduce the inequality between regions. After that, we consider literature devoted to analysis of regional convergence in housing and other markets. In the main section, we describe data and methodology used for the analysis. And finally, we discuss the conclusions on convergence provided by the estimation results.

German Overall Divergence Reducing Policy and Current Economic Situation

After the WW2, Germany was divided into occupation zones. It was a challenging time for the society as the new governments had to develop a policy to reconstruct the destructed economy. Later, three zones united into one that became Western Germany with capitalistic economic model and another, the one of the USSR, became absolutely independent and chose a socialistic way of economic development [Vatlin, 2002].

After the reunification of Western and Eastern Germany appeared another problem – how to reduce the divergence between regions as the former part of the USSR cluster was less economically developed. The housing stock was quite old, the factories had to be updated for nowadays use. Western regions were overall richer as there was high level of education, more economic freedom for free trading and individual entrepreneurship.

New government developed various policies to solve the problem. The most known and successful one is *Aufbau Ost*. The aim was to force Eastern regions to drive to Western economic miracle, the high living standards and the level of education. Eastern Germany did not take part as much in scientifical revolution of the second part of twentieth century because of political restrictions of the USSR, so many production plants were unprofitable. The currency was unconvertable. All these problems caused mass migration from "new" to "old" Länder of newly united Germany, and Aufbau Ost had to stop it and make new reasons for Eastern Germans to stay home and develop their own regions.

Firstly, we have to markup that the mass factory privatization took place. Autobahns were made wider, so it partly helped the logistic problems. Infrastructure was updated, housing reconstruction developed rapidly. But most important was unemployment policy, as new production technologies pushed many people away from former work, because of structural employment shift. Their provision was left to new government, moreover they had to be reprepared for new economic situation. By 1992 the unemployment in the East was around 1/3 of all working population [Khrishkevich, 2019]. The richer Western regions were like donors for Eastern neighbours, so the budget became more balanced. It was a heavy load for Bayern, Hamburg and so on, but it had to be done to equalize the situation.

The government gave big grants by the Pact of Solidarity to the East, but after the end of mass privatisation investment activity lowered. The subsidies worked well, but the aim was not only to extensively support the region, but to gain its own potential to hold its life by its own. So, the educational system was sponsored to conquer the unemployment and stimulate the appearance of new working places.

The policy was overall successful, as we can see by the time. The production is still growing. By 2016 was reached the highest level of employment. Annual unemployment level in Eastern Germany was 8,5% and in Western – 5,6%, that is quite close, so we can see the positive dynamics, as in the beginning of 2010 the difference was around 10% [Khrishkevich, 2019]. The number of recipients of unemployment benefits falls. The problem stays mostly in rural agrarian regions.

The biggest challenges remain demographic. The rate of elderly people rises (by 2050 it is predicted to be around 50%) as more and more young people prefer to move to Western regions for higher salaries and prestigious education. The retirement pensions are a big part of the budget expenses and the pension system of Germany is quite flexible as it is PAYG[2] [OECD, 2019], but still is not perfect. In Pact of Solidarity there is a statement for development of modern technologies. It can help to lower youth migration, but nowadays tendency for remote work can help greatly as well.

All in all, Aufbau Ost was successful even having some weak points. The global aims are almost reached as the divergence shifted. The demographic problem remains, but it can be so called natural. Housing stock is renewed. As the example, we can remember renovation of Eastern Berlin. Old Plattenbau are not destroyed, but modernized. City area is made more comfortable and new dwellers with higher social status are engaged to the districts.

The time period, considered in our work, was rather controversial and full of events. Let us mostly speak about Eastern regions, where changes were more obvious because of signifi-

[2] The system when agents can choose the amount to pay regularly for their future pension and then, after the retirement, choose whether to get monthly fixed payments or get the whole sum at once.

cant shift of political and economic environment after the re-unification. This process completely changed the structure of the market, as private housing property barely existed in GDR. The procedure of retrieving the property for former dwellers was rather complicated and challenged future actions – sale and renovation. It was simpler to construct new houses in the suburbs than renovate historical ones, so the mass investment was directed outside the cities [Michelsen, Weiß, 2010]. This policy resulted in a huge "sleeping" housing fund of Eastern cities, that needs investments nowadays.

To conquer the excess vacancy in former GDR regions, the policy named Stadtumbau Ost was introduced in 2001. Its aim was to demolish unneeded housing fund and develop cities' infrastructure. The vacancy was the result of mass emigration of Eastern population to the more economically developed West and mass construction of new housing in the suburbs. It was financed by governmental subsidies and via tax incentives. From 1991 to 1999 nearly 773000 new flats were constructed, 85% of them were "green field" projects [Bernt, 2009]. Old housing was mostly unneeded due to the complexity of its renovation and decreasing demand.

For all the time period of GDR the housing market was under strict control. After the Eastern regions were united with the Western, and regulation stopped, the new situation challenged the prices and the demand of society. Before the reunification prices were on the level of 1936 strictly, by 1995 prices became to form under the demand-supply market law [Kholodilin, 2020]. It resulted in sharp increase in percentage of rental costs in income distribution of households – 4,2% in 1990 rocketed to 25% in 2020, comparing to slight rise from 21,6% and 27,5% for Western regions [Kholodilin, 2020]. The rental burden differs considering the income quantile of households: in the East lower quantile's burden grew for 25% and 20% for higher, while in West – only 11% and 5% respectively. Another difference is the area of an average flat. Western citizens usually had 38% more spacious flats than Eastern neighbors, but it slightly converged by 2018 with the gap of 10%. But, surprisingly, Eastern society is overall happy with the change [Kholodilin, 2020], because it helped to adapt the housing for their own needs and control now is mostly needed for low-income households to make the housing affordable for them.

Overall, after 2009, real estate prices in Germany rose particularly sharply in metropolitan areas and at least in their immediate surroundings, and in some cases also further afield [Kauffmann, Nastansky, 2019]. There was an increase in regional dispersion over time, especially in the period following the global financial crisis of 2007–2009. There are clear differences between real estate prices in the old federal states and the area of the former GDR. So far, only Berlin (including the surrounding area) and the Baltic region have seen a clear upward trend after 2009, while the other regions, including the independent cities except Dresden and Leipzig, have hardly followed suit. There were also very sharp price rises in some regions away from main agglomerations, and this was the case if they have particular recreational and leisure value. These are primarily the coastal regions on the North Sea and Baltic Sea.

In Germany, the proportion of rented apartments in apartment buildings in the total housing stock is relatively high (54 percent of occupied apartments occupied by tenants). The structuring of rental agreements with regard to the rights and obligations of the contracting parties is limited by legislation and case law. In particular, rent indexes, cap limits and other measures are intended to prevent that rents are rising excessively. Kauffman and Nastansky [Kauffmann, Nastansky, 2022] provide a description of the regional rental prices development in Germany since 2004. Rising rents were registered in almost all independent cities and dis-

tricts. When looking at the regional distribution of rent levels, the top position of the centers Hamburg, Cologne, Frankfurt, Stuttgart and Munich on (each with their surroundings). Somewhat behind the centers of Berlin, Nuremberg and Freiburg (Breisgau), and – again at a lower level – the majority of the other independent cities. There are also high rent levels in many districts on the Baltic Sea and in the district of North Frisia.

We pay so much attention for unemployment rate and other demographic factors in current work as they are crucial determinants in housing market prices, because they affect greatly the wages of the population. Current situation is quite propitious as the growth rates of the East remain to move forward. So, the tendency is positive. In upcoming parts, we will prove it and calculate the coefficient of correlation between the Länder of two main clusters.

Now let us consider the quantitative indicators of regional inequality. The Lorenz curve shows the plot estimation of inequality, as the population is divided to groups by the income size. Lorenz curve combines two equation of theoretical distribution function and density function of income distribution [Gastwirth, 1971]. In the paper by Evseevicheva [Evseevicheva, 2019] the author presents graphs and maps based on various measures for different time periods, so we can make some conclusions not only for the current situation, but for its development as well. The author constructs the Lorenz curve for 1992 and 2017 and compares them. The second curve is much closer to the ideal bisector that shows the reduction of Gini coefficient in the Länder and significant drop of regional disproportion. Then there are the maps for advantage coefficient for the regions. With this measure and Lorenz curve we can count the percentage of GDP owned by the half of population of the less-advantageous regions. In 1992 it is 40% and is considered to be a good result and by 2017 it rises to 43%, so the dynamic is positive. The most relevant conclusion of these maps is that almost all the Eastern Länder get by now the advantage coefficient that is close to average. The divergence among Eastern and Western regions is not so visually obvious. 9 of 16 Bundesländer nowadays have common level of economic development [Evseevicheva, 2019], but at the same time the North-South polarization occurred, that is typical for almost all European countries. In the work was showed that overall GDP rose over the years, but the divergence got bigger as well, not only for East-West, but mostly for the Southern regions of Bavaria, Baden-Württemberg and Hessen. Average unemployment rate got lower by 25 years and again the divergence is more common for South-North division.

For 20 years the migration tendency remained from the Eastern regions to the Western. By 2012 the situation changed and Eastern part of the country became more attractive for inner migrants. This shift can be explained mostly by the influence of Berlin [Federal Institute for Population Research (BiB), 2021], because this city by these years asserted itself as the capital with wide educational and career prospects, various working places and relatively affordable housing. Statistical data show that the biggest migration rates were common for the first years of Germany reunification, then they remained in exact level and after reached close to natural level of migration [Listov, 2016]. People of middle age and retired ones find in the East calm districts with low population density and better ecological situation because of smaller number of factories. Moreover, satellites-cities gain popularity because of lower housing prices and good transportation facilities.

One more feature of current situation in German housing market is agglomeration formation. Agglomeration is a compact union of municipalities around a big city with common price and living standard levels. Nowadays they form around scientifical developed megapolises. People often work in the agglomeration centre and live in the suburb. Overall, it is quite

good for the economy as it develops labour market. Employees are ready to spend more as they get higher salary then if they have worked in their small home-towns [Glaeser, 2010]. The housing prices get higher because of demand growth, especially rental ones. Around a half of German population lives in main agglomerations [Hennig, 2018] such as Cologne, Berlin, Hamburg, Dresden, Munich and so on. Overall, this phenomenon can be attributed to convergence in a local way as neighbouring regions get closer to economic development level of the core-city with a higher-than-average speed.

Literature Review

The results of divergence reducing policy can be evaluated by the convergence model assessment. Convergence was started to be studied because its close connection to the problem of the economic gap among developed and developing countries. Convergence indicates that poorer counties or regions tend to have more significant growth rate than their richer neighbours. In the long-run economic development levels are likely to converge. It can be explained by the fact that poor counties have better growth potential because the diminishing returns, mostly to capital, are weaker. Moreover, such countries or regions can copy technologies and economic policies tested by developed ones.

The best reflection of the idea is showed in the Solow-Swan growth model. In the long-run economies are predicted to converge to their steady state equilibrium and the only relevant driver for economies is progress of production technologies. So poor countries grow faster and catch the level of rich ones. The convergence in this case is caused by higher rate of return on capital in poor countries [Romer, 2006], the fact that in the model poor countries are not at their steady state and divergence of knowledges across countries.

One of the first relevant works on convergence of regional markets of one country is “Convergence” by Barro and Sala-i-Martin [Barro, Sala-i-Martin, 1992]. In this paper authors exploit cross section of gross state product for U.S. states in 1963–1986 and per capita personal income since 1840 or 1929 to 1988 for different states. Their research claimed that the convergence of states exists and the regions grow faster when they are far from the steady state, so the Solow model works. Then the authors consider 98 countries across the world and again, they find the convergence, but not as high as for U.S. states. In further works, the authors want to discover whether returns on capital, capital and labour mobility or technology spread form the result.

In another work named “Convergence across States and Regions” Barro and Sala-i-Martin [Barro er al., 1991] consider German regions, which is more relevant to our analysis. Convergence is divided into two types, so called β- and σ-convergence. The first one describes poor countries with higher growth rates than the ones of rich regions, and the idea of the second one is that convergence is assumed if the variance measured by the standard deviation σ of cross-economy per capita income declines over time. In this work, the model implies the first type. The results for Germany are quite predictable – the dispersion is one of the highest in Europe, the divergence slightly declines over years. Other European countries show the existence of convergence of regions as well. The authors highlight that the effect of labour mobility and the other factors, which affect economic development level, is larger for the regions within one country than across countries.

There are many papers discovering convergence across regions in different markets of various countries, as well for housing. Authors use different estimation and test facilities and apply various econometric models to the data. Many authors use data not of the only country, but a bundle of them and then compare the results. Yunus [Yunus, 2015] evaluates the convergence for 10 markets of main countries in Europe, Asia and North America. The results claim that in the long-run various crisis of housing markets makes them even more dependent from each other and in short-run the connection of global housing markets and the economy of the USA is significant, so the changes are highly exogenous. The U.S. market itself is affected by inner shocks and innovations and is not so sensitive to the global market. Moreover, the author concludes that the housing markets all over the world converge and have common development trends.

Weddige-Haaf and Kool [Weddige-Haaf, Kool, 2017] analyse the determinants of regional growth and convergence in Germany using panel data. The authors examine 16 Bundesländer in the time period of 1995–2014 and conclude the existence of significant but slow convergence across regions. Inner migration forces the economic growth of the Eastern Länder, which contribute to the overall process of economic equalization of the regions.

Kholodilin et al. [Kholodilin, Siliverstovs, Kooths, 2008] examine dynamic panel data for the German Bundesländer to forecast the annual real GDP growth rates. In their analysis the authors found out, that the inclusion of spatial dependencies helps to increase the forecast horizon greatly.

Kubis and Schneider [Kubis, Schneider, 2016] build a panel data model for German regions to discover how migration across regions affect the convergence and growth rates after the re-unification. The authors estimate β-convergence with spatial effects. The outflow negatively affects the growth rate of the regions, the inflow of migrants increases it separately of human capital effect in Eastern regions and in Western the decrease of the growth rate is offset by migrants' skills growth-stimulating effect.

Pichler-Milanovich [Pichler-Milanovich, 2001] examines privatization in Central and Eastern Europe in 1990s. The author analyses the consequences of economic and political events for the housing market overall. Privatization differs not only by types and means but by effects, such as migration, regulations, accommodation features, market structure, building activity and so on. The conclusion is rather unusual for such papers – convergence is not so significant and there exist polarization of various housing markets of the regions. Policy is observed by the public economics point of view, by means of equity and efficiency of markets.

Researchers often discover the U.S. market, because this country has a long period of data observation and good quality of estimations. Gallet [Gallet, 2004] investigates Los Angeles region housing market in 1992–2001. Using time-series data, the author finds the convergence of the parts of the market, but at the same time the prices diverge in East-West classical way. Convergence is believed to be the feature of cluster of countries or regions and not to be the essential. Los Angeles market has unique and converging parts at the same time.

Apergis and Payne [Apergis, Payne, 2012] explore prices in U.S. housing market in 1975–2010 in the aspects of clusterisation and convergence clubs formation using Phillips-Sul procedure. They use panel data converted to natural logarithms and conclude that the regions are divided into three convergence clubs on nearly located regions with alike market structure and tendencies.

Gong et al. [Gong, Hu, Boelhouwer, 2016] test regional housing markets in China. The authors choose 10 territories and using pairwise Toda-Yamamoto Granger causality test. They find

interrelationships between regions and allows to assume the affection direction from East-Central part to the West. The important conclusion is that in the short-run the spillover effect exists and helps to predict the prices in housing markets of neighbouring areas. The authors find impulse response function for cities to understand the mechanism of changes. Shocks in the region affect firstly the closest neighbours and then move as a ripple forward.

A spatial convergence analysis of Russian regions is provided by Vakulenko. Vakulenko [Vakulenko, 2013] discovers how migration affects wages, per capita income and unemployment rate across the regions of Russia. The author uses dynamic panel data model with spatial effects for regions in 1995–2010. The results show that migration weakly affects unemployment rate, but the spatial effects on wages and unemployment are significantly positive. An opposite effect of migration is observed for income and wages, because they rise with the migration outflow. Gini coefficients of wages are quite statistically uniform for all the regions. So, the author concludes, that migration do not greatly affects regional convergence by these determinants.

Russian regional convergence was examined by Kholodilin et al. [Kholodilin, Oshchepkov, Siliverstovs, 2012]. The authors analyse the income convergence across regions in 1998–2006 using spatial data. They conclude that the speed of convergence in Russia of this period is slow, comparing to other countries, but is significant for high-income regions. Spatial effects are strong among neighbouring high-income regions. The authors consider that exclusion of spatial effects can mislead the results of convergence analysis in Russia.

Speaking about prices of housing in Germany, it is impossible to pass the theme of speculative bubbles in this market. Kajuth et al. [Kajuth, Knetsch, Pinkwart, 2016] analyse the tock-flow model of the housing market of 402 regions of Germany using panel data. They conclude, that single-family houses have justified price, while apartments are overpriced. This fact mostly characterises major cities of Germany. Kholodilin et al. [Kholodin, Michelsen, Ulbricht, 2018] examine data set for 127 large cities of Germany in 1990–2013 and test their financial bubble risk on city and national levels. The authors conclude an explosive price rise in many of them, but there is no evidence of bubble risk in national level.

Data and Methodology

Because of the historical factors described in previous parts, we examine convergence. We can predict that there is the convergence across German regions in the years after the reunification of 1990. Moreover, we are going to find its speed for rental and selling price and compare it. Such way, we will be able to interpret how "close" the price of the regions gets to a uniform level.

We base our analysis of convergence on the model of absolute convergence by Barro, Sala-I-Martin (1992) represented by the equation (1):

$$\frac{1}{T}\ln\frac{y_{it}}{y_{i,T-1}} = \alpha + \left[\ln\left(y_{i,t-T}\right)\right]\left[\left(1-e^{-\beta T}\right)/T\right] + u_{i,t-T,t}, \quad (1)$$

where T is the number of periods; y_{it} is the analysed variable; α and β are parameters; $u_{i,t-T,t}$ is the distributed lag of the error terms, in the considered time period. By the error term we understand $\frac{1}{T}$ sums for T between 0 and T of the error terms, $u_{i,t-\tau}$, weighted by $e^{-\beta(T-\tau)}$.

The coefficient β in the equation should be less than 0 to get convergence, otherwise we observe the divergence of variable y_{it} in studied regions. By adding control variables to this model, we get a model of conditional convergence. It assumes that balanced-growth path of the regions may vary. We add lag of dependant variable – rental and selling prices – $\ln(P_{it-1})$ to both models for valuation of convergence of the regions. The coefficient β should be less than 0 to conclude a convergence existence [Vakulenko, 2013].

In our analysis we use panel data for 397 regions (NUTS3 level) of Germany in 2004–2020. We start at the year 2004 due to the availability of information for all variables for these years. The data for regional prices and rents are provided by the firm BulwienGesa AG (RIWIS) and data for migration and other determinants was collected from Regional Statistik Genesis. Kauffmann and Nastansky [Kauffmann, Nastansky, 2007] provide a description of the property data and the calculation methodology. In the case of rents, the net cold rent (i.e. excluding incidental expenses and other benefits) is shown. The selling prices of owner-occupied apartments are shown without incidental costs. The calculation of average rents and prices includes those cases that can be assigned to a typical group for the respective segment.

The prices in housing markets are formed by supply and demand factors, such as incomes and migration, and their dynamic by the years [Case, Mayer, 1996]. Demand sided factors are interest rates and demographic because such shifts affect the quantity of buyers, the structure of market, as housing prefe-rences of social groups differ. Supply is usually defined by existing housing stock and infrastructure of economy, and new construction drivers, such as investment climate and law shifts.

Demand factors are easier to observe and analyse. Interest rates affect property prices negatively. Lower mortgage rates are making apartment purchases more affordable. Population growth and positive migration flows affect prices positively as they broaden the demand for housing naturally. High unemployment rates make future income uncertain, so lowers the demand for housing, as it is usually paid with the help of borrowed money. Unemployment is a label of economically weak regions, so the migration flow tends to be negative. GDP or GRP shows the economic development level of the region, so positively correlate with the price because of growth of overall price level and higher demand. High taxes cut households' income, so the demand drops. But from the supply side, we can observe an opposite effect, because developers get higher expenses, lower supply or ask for a higher price. Good infrastructure makes apartments houses more attractive to consumers, demand rises and so do the prices.

Dependent variables are selling and rental price growth rate for apartments. We consider rent of the existing apartment price in euro/sqm (Wiedervermietung Wohnung) and sale prices of existing condominium in euro/sqm (Wiederverkaufspreis Eigentumswohnung). Selling price indicate the overall economic situation of the regions. Rental prices in contrast are more flexible and react to changes in economic conditions more rapidly. In such a way, we would like to comprehend the housing prices change from different perspective. We analyse two types of prices, because the results vary for selling and rental process. Moreover, in our previous work we found out that the determinants can affect prices differently. Interestingly, the maps showing prices for selling (fig. 1 and 2) and rent (fig. 3 and 4) in 2004 and 2020 are quite different, so the prices should be considered independently.

Following maps of fig. 1–4 are showing housing price distribution for regions in 2004 and 2020. The darker the colour of the region, the higher the price. Via these maps can be con-

cluded that prices for sell and rent converged by these years as the difference between colours diminish. It can be seen, that there are still clusters of high-price regions, but they are getting lighter colours in 2020. Mostly we can notice the difference for rental prices, as the map looks much more uniform in 2020 than in 2004.

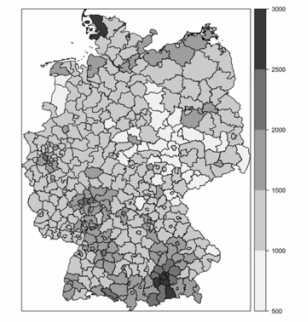

Fig. 1. Map of selling prices in euro/sqm in 2004

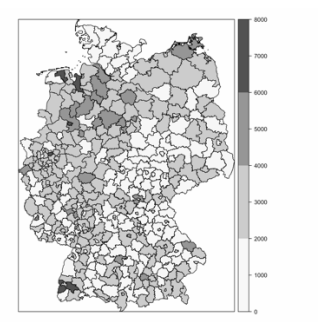

Fig. 2. Map of selling prices in euro/sqm in 2020

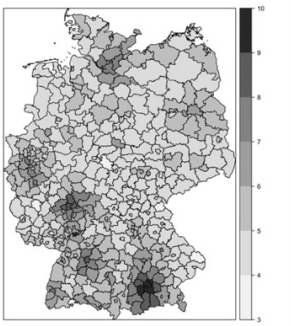

Fig. 3. Map of rental prices in euro/sqm in 2004

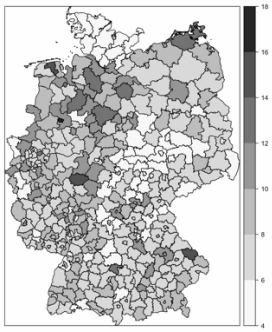

Fig. 4. Map of rental prices in euro/sqm in 2020

Independent variables are mostly demand factors, describing employment, income level and migration. All these variables are described in table 1.

To choose the determinants for the analysis, we evaluate the factors affecting housing market. Firstly, it is demographic, because population shift, like birth, death, aging, marriage and so on have an effect on demand for housing and its vacancy in the region. We use data by Genesis to collect needed information. Migration of the population plays important role not only because of demand fluctuation, but because it shows the economic attractiveness of the region. Gross regional income shows income distribution among regions, wages – economic microeconomic situation for households. Gross wages of full-time employees who are subject to social security contributions data can be found at the Federal Employment Agency. Unfortunately, the series only begins in 2010. Therefore, it is unusable in current work. Pendulum mi-

gration is important, because we include spatial effect to the analysis and its balance shows the employment environment of the region. Unemployment rate directly affects the market by income effect of the households and overall economy of the region. To collect data considering employment we use statistics of the Bundesagentur für Arbeit.

Table 1.

Dependent and independent variables

Variable name	Description
Dependent variable	
Selling prices	Sale prices of existing condominium in €/m²
Rental prices	Existing apartment rent prices in €/m²
Independent variables	
Unemployment rate	Unemployment rate, in %
Pendulum migration	Number of pendulum migrants by the place of living, in thousands
Number of employees	In 1000
Wages	€, in current prices
Gross Regional Income	€, per capita
Immigration for regions	Shares, number of migrants divided by population size for each region in each year
Emigration for regions	
Emigration for Bundesländer	
Immigration for Bundesländer	

All the factors are included to the model in logarithms (as well as lag of price, except migration factors).

Our econometric analysis is consisted of two parts: basic panel data analysis which does not include spatial components. In the second part, we consider also spatial econometrics model for panel data, estimating Spatial Autoregressive model (SAR) and Spatial Durbin model (SDM).

Analysis without spatial correlation

We consider a panel data model with fixed individual effects and time effects without spatial components:

$$\ln\left(\frac{P_{it}}{P_{it-1}}\right) = \alpha_0 + \ln \mathbf{X}_{it-1}\boldsymbol{\alpha}_1 + \mathbf{Z}_{it-1}\boldsymbol{\alpha}_2 + \beta \ln\left(P_{it-1}\right) + \eta_t + \mu_i + \varepsilon_{it}, \quad (2)$$

where $i = 1,\ldots,N$, $t = 1,\ldots,T$; ε_{it} – disturbance term; P_{it} – selling/rental prices for housing in period *t*; P_{it-1} – selling/rental prices for period *t* – 1 (lags); $\mathbf{X}_{it-1}$ – lags of exogenous explanatory variables; $\mathbf{Z}_{it-1}$ – lags of pendulum migration rate, immigration and emigration.

Due to the results of the Hausman test (Chi-squared statistic is 247,71 for rent price and 448,02 for selling price) the fixed effects model is always applied. The Hausman test suggests to use fixed effects instead of random ones.

Analysis with spatial correlation

To take into account spatial interconnectedness of regional housing markets we estimate two spatial panel data models: SAR and SDM.

Spatial Autoregressive Model:

$$(3)\quad \ln\left(\frac{P_{it}}{P_{it-1}}\right) = \alpha_0 + \ln \mathbf{X}_{it-1}\boldsymbol{\alpha}_1 + \mathbf{Z}_{it-1}\boldsymbol{\alpha}_2 + \beta \ln\left(P_{it-1}\right) + \alpha_3 \mathbf{W} \ln(\frac{P_{it}}{P_{it-1}}) + \eta_t + \mu_i + \varepsilon_{it}.$$

Spatial Durbin Model:

$$(4)\quad \ln\left(\frac{P_{it}}{P_{it-1}}\right) = \alpha_0 + \ln \mathbf{X}_{it-1}\boldsymbol{\alpha}_1 + \mathbf{Z}_{it-1}\boldsymbol{\alpha}_2 + \beta \ln\left(P_{it-1}\right) + \alpha_3 \mathbf{W} \ln\left(\frac{P_{it}}{P_{it-1}}\right) + \\ + \mathbf{W} \ln \mathbf{X}_{it-1}\boldsymbol{\alpha}_4 + \mathbf{W}\mathbf{Z}_{it-1}\boldsymbol{\alpha}_5 + \eta_t + \mu_i + \varepsilon_{it},$$

where P_{it} is a selling/rental price; $\mathbf{X}_{it-1}$ are lags of explanatory variables; $\mathbf{Z}_{it-1}$ – lags of pendulum migration rate, immigration and emigration; η_t – time effects; μ_i – fixed individual effects; P_{it-1} – lag of prices with a coefficient β. The coefficient should be $\beta < 0$ in case of convergence. Otherwise, the coefficient would show us differentiation and divergence of the regions [Vakulenko, 2013].

W is a spatial inverse distance weight matrix 397 × 397. The diagonal of the matrix consists of zeros. The matrix is standardized by the rows, the weight of neighbouring regions is 1. Such way we get weighted prices for neighbouring regions – spatial lag of dependent variable $\mathbf{W} \ln\left(\frac{P_{it}}{P_{it-1}}\right)$ and spatial lag of independent variables $\mathbf{W} \ln \mathbf{X}_{it-1}$. We also provide for robustness check estimations with other types of matrices: binary and inverse distance matrix with threshold 100 km: the elements of the matrix are equal to zero when distance between regions is greater than 100 km (see Appendix).

Method of maximal likelihood in case of dynamic models is used for model estimations. The tests of residuals for autocorrelation, normality and heteroskedasticity are conducted. The hypothesis of the normality is not rejected for all observation except outlier regions, where prices are enormously high or low. Models include heteroskedasticity for both groups of prices and autocorrelation for selling price, so we use robust errors. Multicollinearity is not present in the model.

The SAR model, described in equation (3), is a Spatial Autoregressive Model, which include spatial correlation for housing prices. By autoregressive lag $\mathbf{W}P_{it}$ it shows global spatial correlation and so-called ripple effect as housing prices change in one region affects the neighbours and so on.

The SDM model of equation (4) is a Spatial Durbin Model including spatial lags of independent variables. It demarcates shocks in different regions and helps to valuate effect of the shock in *X* region to the neighbouring ones.

To choose between SAR and SDM models, we conduct diagnostic tests. According to the results the SDM model does not have to be reduced to SAR model for both rental and selling prices. So SDM model is preferable because it takes neighbouring regions characteristics into account.

Results and Interpretation

In table 2 the results of selling price models estimations are shown. All three models include selling price in € for a square meter. FE model is linear and non-spatial, SAR model includes spatial correlation among regions, SDM model shows not only spatial interconnection of prices and determinants for one region, but the effect from neighbouring ones as well.

Calculations of the variance inflation factors do not show the presence of multicollinearity. White test shows the presence of heteroskedasticity in the models. For models of selling prices the autocorrelation exists in all considered confidence levels, while for rent models exist only on 5% level and do not for 1%. To avoid these problems of invalid estimation of variance, we use robust standard errors.

Table 2.

Results of selling prices models estimations

Variables	FE sell	SAR Main	SDM Main	SDM Wx
Lag P_{it-1}	–0,00970*	–0,0633***	–0,103***	0,415***
	(0,00503)	(0,00663)	(0,00786)	(0,0423)
Unemployment	–0,0424***	0,00254	0,00213	0,0552*
	(0,00382)	(0,00484)	(0,00530)	(0,0331)
Pendulum migration	–0,133***	–0,145***	–0,0859*	1,455**
	(0,0491)	(0,0484)	(0,0471)	(0,705)
Number of employees	0,000724	0,00706**	0,00525*	–0,0281
	(0,00369)	(0,00306)	(0,00313)	(0,0344)
Wages	0,00306	0,00214	0,00258	–0,0585***
	(0,00287)	(0,00225)	(0,00257)	(0,0194)
GRI	0,0725***	–0,0193**	–0,0201**	0,148
	(0,0130)	(0,00928)	(0,00928)	(0,109)
Immigration region	–0,164	0,0775	0,475	–8,763*
	(0,579)	(0,321)	(0,360)	(5,039)

Continues

Variables	FE sell	SAR Main	SDM Main	SDM Wx
Immigration Länder	2,804***	0,140	–0,317	14,60**
	(0,559)	(0,367)	(0,402)	(5,759)
Emigration Länder	–2,303***	–0,263	–0,146	–7,476***
	(0,231)	(0,188)	(0,193)	(2,171)
Emigration region	0,192***	0,000923	–0,0207	0,175
	(0,0372)	(0,0318)	(0,0423)	(0,243)
Time effects	Yes	Yes	Yes	Yes
ρ		0,627***	0,566***	
		(0,0418)	(0,0482)	
σ^2		0,00195***	0,00190***	
		(6,22e–05)	(6,10e–05)	
Constant	–0,689***			
	(0,137)			
Observations	6,352	6,352	6,352	6,352
R^2	0,286	0,144	0,247	0,247
Number of names	397	397	397	397
AIC		–21518	–21676	–21676
BIC		–21335	–21426	–21426

Note: Robust standard errors in parentheses: *** p < 0,01, ** p < 0,05, * p < 0,1.
Direct, indirect and total effects are available upon request.

Our main conclusion from these results is the existence of convergence between German regions. As it was mentioned above, to determine it, we look at the coefficient before lag of price. If it is less than zero, we can observe that regions gradual approaching each other in economic sense. Our coefficients are negative, so the hypothesis of convergence among German regions in selling prices, is confirmed and the policy of German government of reducing inequality was successful.

Moreover, by this coefficient we see the speed of convergence across regions. The coefficient β shows the convergence rate – in average speed β × 100% of the region abridgement of distance between steady state and current point of economic development [Peter, Rodriguez-Clare, 1997]. So, in our case we can say, that in non-spatial model the speed of convergence is approximately 1% for FE model, 6% for SAR and 10% for SDM, that is quite a high convergence rate. The coefficients are statistically significant at 1% for spatial models. We do not pay attention to the measurement in SDM as we do not consider neighbouring regions convergence separately.

Another way to estimate the convergence speed is to analyse it via the half-life of the convergence. It is defined as the number of years that it takes for the income gap to be cut in half [Hazem, 2021] and is calculated as: $\text{half-life} = \frac{-\ln(2)}{\ln(1+\beta)}$.

The results of the FE model show that the half-time (the number of years that it takes to close the half of the prices gap) is equal to 71,1 years. However, in the spatial models the convergence is much faster: 10,6 years for the SAR model and 6,5 years for the SDM model.

Let us move on to the determinants of the selling prices. Results are quite common for all models. Unemployment rate negatively affects price growth rate for sell, that is quite an expectable result. High unemployment level decreases households' income and make them uncertain about their future liabilities. However, in spatial models the effect disappears, which could be explain by the bias in the estimates.

Pendulum migration affects the prices growth rate negatively. It may be explained by the fact, that high percentage of people who work in the other region is the mark of economic weakness of the region, in case the population have to work in the neighbouring one.

Wages in neighbouring regions negatively correlate with selling price growth rate in SDM results, meaning that increase of wages in other regions decrease the demand for housing in the considered region.

The number of employees is significant only in SAR models, the effect of the number on price growth rate is positive, because it makes demand higher as people are quite sure about future income and are ready to buy housing.

Gross regional income positively correlates with selling price growth rate of apartments in non-spatial model, as high GRI shows a good level of economic development of the region, that affect overall employment, economic activity of the region, total income and so on, so rises the demand for goods, including housing. In spatial models, correlation with price growth rate is negative. It is quite a surprising result, but it can be explained by a common for developed countries tendency: in richer and more advanced regions people prefer to rent housing instead of buying it because of enormous prices and sometimes even financial bubbles. GRI in neighbouring regions affects the prices in the considered region positively. GRI in neighbouring regions represents the overall level of economic development and therefore high housing prices for regions closely located to each other.

Immigration rate for Bundesländer (statistically significant only in non-spatial FE model) has a positive impact on price growth rate as it rises population of the region because of migrant flow, and so the demand. Moreover, migrants tend to choose economically developed regions to move to, so overall positive economic climate make price growth rate higher.

Emigration rate for Bundesländer is negatively correlated with selling apartment price growth rate, because negative population flow cuts down the demand and usually shows the weakness of the economy of the region. The coefficient is significant for FE non-spatial model.

Emigration rate for regions in Germany has a positive effect on selling price growth rate. This result is quite hard to explain as it is not logically clear. The coefficient is significant on 5% level in the FE model. The results may be explained as the estimations of non-spatial model are biased because the spatial lags are not included.

Table 3.

Results of rental prices models estimations

Variables	FE rent	SAR Main	SDM Main	SDM Wx
Lag P_{it-1}	−0,0170***	−0,0988***	−0,129***	0,466***
	(0,00537)	(0,00721)	(0,00827)	(0,0481)
Unemployment	−0,0160***	−0,000668	−0,00221	0,0404**
	(0,00178)	(0,00218)	(0,00227)	(0,0167)
Pendulum migration	−0,0620***	−0,0530***	−0,0203	0,468*
	(0,0204)	(0,0195)	(0,0184)	(0,272)
Number of employees	−7,33e−05	0,00221*	0,000390	0,0105
	(0,00151)	(0,00127)	(0,00129)	(0,0124)
Wages	0,00177	0,00240**	0,00334***	−0,0215**
	(0,00118)	(0,00104)	(0,00117)	(0,00856)
GRI	0,0271***	−0,00745*	−0,00841**	0,0120
	(0,00492)	(0,00421)	(0,00391)	(0,0586)
Immigration region	0,276	0,500**	0,641***	−3,922*
	(0,324)	(0,209)	(0,197)	(2,356)
Immigration Länder	1,055***	−0,145	−0,239	5,006*
	(0,316)	(0,235)	(0,222)	(2,665)
Emigration Länder	−1,194***	−0,331***	−0,363***	−2,296**
	(0,121)	(0,115)	(0,118)	(1,063)
Emigration region	0,107***	0,00509	0,00457	0,00660
	(0,0226)	(0,0201)	(0,0182)	(0,117)
Time effects	Yes	Yes	Yes	Yes
ρ		0,677***	0,662***	
		(0,0363)	(0,0363)	
σ^2		0,000486***	0,000473***	
		(1,72e−05)	(1,71e−05)	
Constant	−0,242***			
	(0,0533)			
Observations	6,352	6,352	6,352	6,352
R^2	0,209	0,037	0,108	0,108
Number of names	397	397	397	397
AIC		−30348	−30503	−30503
BIC		−30165	−30253	−30253

Note: Robust standard errors in parentheses: *** p < 0,01, ** p < 0,05, * p < 0,1.
Direct, indirect and total effects are available upon request.

In models for rental prices analysis (table 3) the results are overall alike to selling ones, but have some distinctions. Here again exists the convergence as β-coefficient is less than zero for FE, SAR and SDM in considering regions. The speed of this phenomenon for non-spatial model is 2%, 10% for SAR and approximately 13% for SDM, that is higher than for selling price. The result coincides with the maps from fig. 3–4, as we see, that rental map for 2020 is more uniform than the one for selling prices.

For rental prices half-time of convergence is equal to 40,4 years in case of FE model, 6,7 years for SAR model and 5 years for SDM model.

As we can see, half-life convergence speed is more rapid for rental prices than for selling. The rate is quite fast comparing to other studies like Hazem [Hazem, 2021] and Eckey et al. [Eckey, Kosfeld, Türck, 2007], but the first author analyse North Africa which is not a developed rich region as Germany, and Eckey et al. consider the situation in Germany of 1995–2002, so the results can be not relevant for nowadays.

Pendulum migration saldo negatively effects the rent prices, since commuting makes the market more mobile and flexible to housing allocation. Wages as well have positive effect on price growth rate in FE, but negative for neighbourring regions in SDM. It may be explained by the fact that people would potentially move to work to these regions to get higher income and rent housing there. So, the demand will shift as well. Number of employees is positively correlated with price growth rate in SAR model, meaning that higher employment increases demand for housing and hence the price.

Immigration rate for German regions is significant for SAR and considered region in SDM. It has a positive correlation with price growth rate, because such way the population and demand for housing rises. Moreover, newly-came migrants tend to rent housing by the first time.

Immigration rate for Bundeslander has a positive effect on price growth rate in FE model. The explanation is, that immigrants tend to rent housing. The demand for rent increases, so the price rises.

Emigration rate for Bundesländer has a negative effect on rental price growth rate, because it lowers the number of population and so the demand. The emigration rate for German region is significant for FE non-spatial model, SAR and SDM. Emigration for German regions positively correlates with price growth rate in FE model and insignificant for the spatial models.

The results overall correspond with the existing literature. The existence of convergence was concluded by [Weddige-Haaf, Kool, 2017]. The convergence for selling prices is slower than for rental. The migration effect is divided into two: the outflow lowers the prices growth rate, while the inflow increases it, like in the work by Kubis, Schneider, 2016. The negative impact of unemployment rate is described in the work by Sunde, Muzindutsi [Sunde, Muzindutsi, 2017]. The results for GRI are rather ambiguos and hard to be compared to the literature. However, the level of economic development is represented by wages and employment. Number of employees positively correlates with the price growth rate. The same effect is described in the work by Belke and Keil [Belke, Keil, 2017]. The positive effect of wages coincides with the conclusions of work by Sunde, Muzindutsi (2017). Overall, the results are logical and be supported by the literature. The rare facts of mismatch are explained during the results' discussion above.

It is interesting to look at time effects. If we consider its dynamic, it is obvious that in 2009 the prices go down. This fact can be explained by the global financial crisis of 2008, which affected not only the countries' economies, but industries and households' confidence in future income and liabilities. After 2010, the prices rose and in 2011 occurred the price boom, that

some even identify as a speculative bubble, which matches with the conclusions of Kauffmann, Nastansky (2019). Price-to-rent ration increased that is a mark of increasing speculative component in the real estate selling price. The governmental response was rent control policy Mietpreisbremse (rental brake), the aim of which was to stop the unnatural increase in rent prices. This policy is still working in some Bundesländer. Moreover, in 2015 the new residential real estate loans program of preferences via covered bonds was introduced, which decreased the interest rates for borrowers [Just et al., 2017]. However, the prices gradually rose because of demand increase. This dynamic is confirmed by evaluated time effects.

It is important to account, that rental market is regulated by government. Kholodilin [Kholodilin, 2017] presents the overview of German police of rental price regulation over XX–XXI centuries. He corresponds that from early 1970 the social-democrats-led coalition increased the level of governmental interventions to the market to make prices more stable until 2000. After 2000 the price control slightly decreased, but from 2013 the interventions became to rise. In many cities with tense housing markets like Berlin, Munich and Hamburg Mietpreisbremse has been standardized under civil law since June 1, 2015 in § 556d Para. 1 of the German Civil Code (BGB) 2 and regulates the permissible rent for living space at the beginning of the tenancy in certain areas with a "tense housing market". This may not exceed the local comparative rent by more than ten percent.

Conclusion

Since the reunification in 1990 Germany has achieved significant results in divergence among regions reduction. The main economic indicators have converged. Some Eastern regions are attractive for inner migrants, especially for young ones, as there they can find good education there, new working places and cheaper housing.

In this work, we proved that convergence among German regions over past years exists, mostly for rental prices, as the speed for them is higher and is approximately 2–13%. The speed of selling prices convergence is around 1–10%, that is slower, but not much.

The determinants from our previous research are remaining significant: number of employees have positive effect on price growth rate for rent and selling. Income connected variables, such as wages and gross regional income, overall are positively correlated with the price growth rate as it is a label of a developed economy and inspire people to buy more goods, including housing.

Migration determinants have various and heterogeneous effect on price growth rate. Overall, the logical and easy-to-explain conclusion is that immigration adds new population to the region and broaden the demand, and emigration moves the demand to other regions. Migration is more difficult to explain. This phenomenon is not uniform in Germany – inner migration varies by years, crises of international migrants, such as one in 2015–2016, occur.

All in all, Germany has a very strong economy and develops rapidly. The divergence among regions gets less by years, the convergence exists and have quite quick tempos. Overall regions are getting to a uniform price level, except cities with high economic bubbles risk, such and Frankfurt and Munich. But divergence reducing policy is still performing, so we are able to predict further convergence of prices and living standards for German regions.

Appendix.

Table A1.

Results of selling prices models estimations with binary matrix

Variables	FE sell	SAR Main	SDM Main	SDM Wx
Lag P_{it-1}	−0,00970*	−0,0622***	−0,0776***	0,0732***
	(0,00503)	(0,00663)	(0,00717)	(0,0109)
Unemployment	−0,0424***	0,00242	1,78e−05	−0,00364
	(0,00382)	(0,00488)	(0,00494)	(0,00839)
Pendulum migration	−0,133***	−0,130***	−0,118**	−0,151*
	(0,0491)	(0,0491)	(0,0492)	(0,0816)
Number of employees	0,000724	0,00658**	0,00549*	0,00565
	(0,00369)	(0,00316)	(0,00320)	(0,00520)
Wages	0,00306	0,00174	0,00216	−0,00133
	(0,00287)	(0,00228)	(0,00252)	(0,00439)
GRI	0,0725***	−0,0186**	−0,0163*	−0,0232
	(0,0130)	(0,00938)	(0,00969)	(0,0192)
Immigration region	−0,164	0,0962	0,200	−0,0227
	(0,579)	(0,320)	(0,311)	(0,843)
Immigration Länder	2,804***	0,162	0,0601	0,332
	(0,559)	(0,366)	(0,352)	(0,981)
Emigration Länder	−2,303***	−0,304	−0,324*	−0,384
	(0,231)	(0,189)	(0,187)	(0,438)
Emigration region	0,192***	0,00217	0,00624	−0,0295
	(0,0372)	(0,0319)	(0,0359)	(0,0634)
Time effects	Yes	Yes	Yes	Yes
ρ		0,0984***	0,108***	
		(0,0174)	(0,0176)	
σ^2		0,00197***	0,00194***	
		(6,22e−05)	(6,13e−05)	
Constant	−0,689***			
	(0,137)			
Observations	6,352	6,352	6,352	6,352
R^2	0,286	0,172	0,190	0,190
Number of names	397	397	397	397
AIC		−21487	−21544	−21544
BIC		−21304	−21294	−21294

Note: Robust standard errors in parentheses: *** p < 0,01, ** p < 0,05, * p < 0,1.
Direct, indirect and total effects are available upon request.

Table A2.

Results of rental prices models estimations with binary matrix

Variables	FE rent	SAR Main	SDM Main	SDM Wx
Lag P_{it-1}	−0,0170***	−0,0981***	−0,122***	0,102***
	(0,00537)	(0,00729)	(0,00770)	(0,0127)
Unemployment	−0,0160***	−0,000411	−0,00224	0,00183
	(0,00178)	(0,00219)	(0,00215)	(0,00360)
Pendulum migration	−0,0620***	−0,0467**	−0,0402**	−0,0245
	(0,0204)	(0,0198)	(0,0185)	(0,0422)
Number of employees	−7,33e−05	0,00221*	0,00156	0,000753
	(0,00151)	(0,00127)	(0,00128)	(0,00231)
Wages	0,00177	0,00211**	0,00236**	−0,00109
	(0,00118)	(0,00105)	(0,00106)	(0,00169)
GRI	0,0271***	−0,00735*	−0,00584	−0,00872
	(0,00492)	(0,00425)	(0,00400)	(0,00889)
Immigration region	0,276	0,519**	0,628***	−0,399
	(0,324)	(0,213)	(0,186)	(0,347)
Immigration Länder	1,055***	−0,147	−0,231	0,284
	(0,316)	(0,239)	(0,216)	(0,374)
Emigration Länder	−1,194***	−0,342***	−0,369***	−0,0763
	(0,121)	(0,116)	(0,113)	(0,172)
Emigration region	0,107***	0,00381	0,0206	−0,0418
	(0,0226)	(0,0203)	(0,0209)	(0,0315)
Time effects	Yes	Yes	Yes	Yes
ρ		0,0931***	0,118***	
		(0,0165)	(0,0167)	
σ^2		0,000492***	0,000482***	
		(1,71e−05)	(1,67e−05)	
Constant	−0,242***			
	(0,0533)			
Observations	6,352	6,352	6,352	6,352
R^2	0,209	0,054	0,058	0,058
Number of names	397	397	397	397
AIC		−30294	−30397	−30397
BIC		−30111	−30147	−30147

Note: Robust standard errors in parentheses: *** p < 0,01, ** p < 0,05, * p < 0,1.
Direct, indirect and total effects are available upon request.

Table A3.

Results of selling prices models estimations with inverse distance matrix with threshold 100 km

Variables	FE sell	SAR Main	SDM Main	SDM Wx
Lag P_{it-1}	−0,00970*	−0,0639***	−0,109***	0,148***
	(0,00503)	(0,00662)	(0,00826)	(0,0163)
Unemployment	−0,0424***	0,00211	0,000370	0,0183
	(0,00382)	(0,00480)	(0,00517)	(0,0120)
Pendulum migration	−0,133***	−0,146***	−0,0754*	0,518*
	(0,0491)	(0,0477)	(0,0448)	(0,272)
Number of employees	0,000724	0,00690**	0,00515*	−0,0138
	(0,00369)	(0,00302)	(0,00308)	(0,0107)
Wages	0,00306	0,00221	0,00215	−0,0124**
	(0,00287)	(0,00224)	(0,00256)	(0,00628)
GRI	0,0725***	−0,0184**	−0,0176*	0,0531
	(0,0130)	(0,00922)	(0,00922)	(0,0357)
Immigration region	−0,164	0,0368	0,706*	−0,967
	(0,579)	(0,326)	(0,421)	(1,197)
Immigration Länder	2,804***	0,176	−0,553	2,476*
	(0,559)	(0,370)	(0,456)	(1,444)
Emigration Länder	−2,303***	−0,255	−0,136	−1,745**
	(0,231)	(0,186)	(0,197)	(0,783)
Emigration region	0,192***	0,00226	−0,0111	0,00454
	(0,0372)	(0,0318)	(0,0474)	(0,0907)
Time effects	Yes	Yes	Yes	Yes
ρ		0,291***	0,282***	
		(0,0250)	(0,0258)	
σ^2		0,00194***	0,00189***	
		(6,17e−05)	(6,17e−05)	
Constant	−0,689***			
	(0,137)			
Observations	6,352	6,352	6,352	6,352
R^2	0,286	0,133	0,264	0,264
Number of names	397	397	397	397
AIC		−21546	−21707	−21707
BIC		−21363	−21457	−21457

Note: Robust standard errors in parentheses: *** p < 0,01, ** p < 0,05, * p < 0,1.
Direct, indirect and total effects are available upon request.

Table A4.

Results of rental prices models estimations with inverse distance matrix with threshold 100 km

Variables	FE rent	SAR Main	SDM Main	SDM Wx
Lag P_{it-1}	−0,0170***	−0,0995***	−0,138***	0,181***
	(0,00537)	(0,00711)	(0,00865)	(0,0165)
Unemployment	−0,0160***	−0,000854	−0,00219	0,0118**
	(0,00178)	(0,00216)	(0,00222)	(0,00573)
Pendulum migration	−0,0620***	−0,0536***	−0,0138	0,160
	(0,0204)	(0,0192)	(0,0183)	(0,118)
Number of employees	−7,33e−05	0,00216*	0,000329	9,19e−05
	(0,00151)	(0,00126)	(0,00129)	(0,00428)
Wages	0,00177	0,00239**	0,00276**	−0,00500*
	(0,00118)	(0,00104)	(0,00121)	(0,00274)
GRI	0,0271***	−0,00705*	−0,00637	0,00666
	(0,00492)	(0,00419)	(0,00396)	(0,0184)
Immigration region	0,276	0,452**	0,638***	−0,733
	(0,324)	(0,199)	(0,205)	(0,513)
Immigration Länder	1,055***	−0,0996	−0,236	1,043*
	(0,316)	(0,226)	(0,227)	(0,604)
Emigration Länder	−1,194***	−0,328***	−0,365***	−0,516
	(0,121)	(0,114)	(0,119)	(0,339)
Emigration region	0,107***	0,00785	0,0129	−0,0138
	(0,0226)	(0,0200)	(0,0193)	(0,0413)
Time effects	Yes	Yes	Yes	Yes
ρ		0,317***	0,320***	
		(0,0244)	(0,0239)	
σ^2		0,000483***	0,000468***	
		(1,72e−05)	(1,72e−05)	
Constant	−0,242***			
	(0,0533)			
Observations	6,352	6,352	6,352	6,352
R^2	0,209	0,033	0,109	0,109
Number of names	397	397	397	397
AIC		−30379	−30552	−30552
BIC		−30196	−30302	−30302

Note: Robust standard errors in parentheses: *** p < 0,01, ** p < 0,05, * p < 0,1.
Direct, indirect and total effects are available upon request.

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