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Sorting in an Urban Housing Market – Is There a Response to Demographic Change?

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Uwe Neumann and Lisa Taruttis[1]

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Abstract

In urban areas, there is considerable neighbourhood-level variation in population characteristics. Using Dortmund as a case study we analyse whether and to what extent rents, housing prices and segregation dynamics corresponded with demographic ageing in urban neighbourhoods between 2007 and 2016. We find that in Dortmund so far there has been no slump of the housing market in neighbourhoods where the population ages more rapidly. Nevertheless, over the study period demographic segregation was on the rise and, according to a hedonic analysis, prices for apartments were higher in districts with a comparatively "younger" population. In the course of further demographic change in Germany, which has come to a contemporary halt due to immigration, the response to ageing on urban housing markets in terms of location choice and prices may therefore become more evident. A large-scale urban regeneration project has revitalised the housing market of a declining Dortmund community during this decade. Since local ageing has not affected housing markets severely so far, it appears to be within the scope of urban policy to upgrade the attractiveness of ageing neighbourhoods as perceived by younger generations.

JEL Classification: R21, R23, R31, R58, J61

Keywords: Neighbourhood sorting; demographic segregation; hedonic analysis; urban policy

December 2018

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1. Introduction

Residential segregation by demographic characteristics is a well-known feature of cities. A specific literature addresses the economics of neighbourhood sorting. This object of research has also been referred to as "Tiebout sorting", due to the argument of Tiebout (1956) that households "vote with their feet" when choosing a residential location. Considering the likely endogeneity of preferences with respect to neighbourhood amenities, the general willingness-to-pay for a local public good cannot simply be derived from information about the local population. In fact, the features of the population of neighbourhoods themselves are likely to determine further location decisions, in many cases attracting households with similar average characteristics. Over the past decades an expanding range of studies has developed methods to overcome the challenges confronting the empirical analysis of the determinants of neighbourhood sorting. So far most of this research has drawn on data from the United States. A European perspective is of interest also for many reasons, not least because European households are usually more reluctant to relocate than those in the United States. Europe´s largest national economy, Germany, should be in the focus due to this country´s extraordinary progress in ageing. In the course of an "urban revival" that has been observed in the U.S. and Germany (Couture and Handbury 2017, Haase et al. 2010) in Germany the desire of younger individuals to agglomerate in favourable neighbourhoods of large cities thus may be even greater than in other countries. An increase in demographic segregation may imply manifold challenges regarding the urban infrastructure, e.g. with respect to education, mobility, recreation. Considerable changes on local housing and service markets may abound. So far, however, evidence on the outcomes of an urban policy that addresses the local consequences of demographic change is scarce. In many large German cities, population change currently overlaps with a strong inflow of immigrants. While discussion of the consequences of this influx has been very dominant in the public debate

over the past few years, ageing has not been high on the agenda. Nevertheless, since continuing immigration at a rate that would compensate for demographic change is unlikely, a widening of regional and intra-urban disparities due to regional mobility can be expected. Using Dortmund as a case study from the ageing Ruhr region in North Rhine-Westphalia, we examine whether

- housing prices were affected by neighbourhood-level ageing during the past decade,
- it was less likely for households to locate in neighbourhoods where ageing had already proceeded more rapidly,
- the positioning of a specific declining community in the city-wide sorting process changed in the course of an urban regeneration scheme carried out nearby.

Following a literature review and an outline of the empirical approach, our analysis comprises a hedonic estimation incorporating neighbourhood effects with respect to housing prices and an estimation of the role of household- and neighbourhood-specific characteristics in city-wide sorting across residential communities. We find that no considerable slump of the housing trade took place between 2007 and 2016 in neighbourhoods where the population had aged more rapidly. Nevertheless, prices for apartments were higher in districts with a comparatively "young" population. In the course of a large environmental improvement scheme a newly-constructed high-quality housing development attracted higher-income households to the vicinity of a declining community. It is too early, however, to examine the effects on the surrounding neighbourhoods.

2. Literature Review

From the view of land use theory, household location decisions derive mainly from the strength of two forces, the demand for space and the costs of commuting. The latter represent a disutility

affecting leisure time (Alonso 1964). Since the price of housing varies in line with mean preferences concerning dwellings and neighbourhoods, residential segregation by income and tastes is a likely outcome. Tiebout (1956) argues that the willingness to pay for local government services will result in sorting by demographic characteristics (and preferences regarding local public goods). If it is assumed that the level of public goods supplied by each community is determined by the income of the community's households, the general demand for a public good can be estimated by regressing actual public expenditures related to the services of interest on mean demographic characteristics of the residential population. This is problematic if a sorting process based on preferences for the public good underlies the housing market equilibrium. Goldstein and Pauly (1981) labelled this identification problem "Tiebout bias", which has become the focus of a specific literature on "Tiebout sorting" (Kuminoff et al. 2013).

Hedonic price functions provide one way to characterise sorting equilibria. They maintain that under mild restrictions on preferences, the equilibrium price of an individual dwelling can be expressed as a function of its characteristics and the amenities it provides. Rosen (1974) observes that the hedonic price function reflects equilibrium stratification patterns that mirror those described by Tiebout (1956). Sorting models examine the way in which individual-specific and common preferences concerning neighbourhood attributes affect household utility, taking into consideration that neighbourhood amenities vary discretely and that households sort non-randomly. Two predominant frameworks have been developed by Epple and Sieg (1999) and Bayer et al. (2004). Epple and Sieg (1999) estimate the price of housing in each municipality within the Boston area as a community-specific fixed effect. It is central to their approach that households agree on a ranking of communities according to a public goods index. They observe a significant stratification of income along this index. Bayer et al. (2004) develop a

probabilistic approach that allows for the likelihood of households to differ in their relative preferences for housing and local amenities. Using Census microdata for the San Francisco Bay area, they find a strong preference by college-educated individuals to dwell close to neighbours with a similar education and by all households for neighbours from the same race. Tra (2010) applies this approach to an analysis of the effects of environmental improvement policy on household location choice in the Los Angeles area. Since it is suited for exploring simultaneous variation among housing and neighbourhood characteristics, we will adopt basic features of this empirical framework in our analysis (see below).

Recent research has begun to take into account that both households and neighbourhoods change over time and that expectations concerning this evolution are part of the household location decision (Bayer et al. 2016). In our data we will not be able to pursue individual households over time. We will, however, utilise repeated annual cross-sections in order to examine whether there is a change in mean preferences over time. After all, at the regional level ageing in Germany over the past decades coincided with an increase in disparities due to co-agglomeration of high-skilled and younger individuals (Gregory and Patuelli 2015). Using a representative household survey, Neumann (2018) finds that in the Ruhr study region so far younger individuals have not in principle objected to residence in "ageing" neighbourhood surroundings. Nevertheless, as ageing proceeds, the desire of younger adults to agglomerate in selected quarters may increase.

Mankiw and Weil (1989) argue that due to varying demand for housing over the individual life-cycle demographic ageing may result in a considerable decrease in the price of housing altogether. While their work has initiated a controversial discussion about methodical issues that arise for the measurement of the impact of demographic change, subsequent studies corroborate

that population ageing is likely to exert downward pressure on house prices (Hiller and Lerbs 2016, Levin et al. 2009, Maenning and Dust 2008, Takáts 2012).

3. Data and methods

Our dataset combines data from three sources, which combine neighbourhood-level population characteristics with micro-level information on the prices and properties of housing that enters the market for rent and for sale:

1. ImmobilienScout24: offering prices for apartments (for rent and for sale) and residential houses (one- and two-family homes) from the internet platform. The dataset includes information about a variety of housing characteristics such as living space, type and condition of the building, and features like having a garden, balcony or cellar. All offerings posted on the platform between 2007 and 2016 are included[1]. Georeference is provided with respect to 1 km-spatial grids and 5-digit postal code zones;
2. Municipal statistics (Stadt Dortmund (2015), dortmunderstatistik and KOSTAT): annual data comprising information about the residential population (age, nationality, fertility and mortality), aggregated at the level of 5-digit postal code zones;
3. microm: data on the residential population, compiled at the level of 1 km-grids, was provided by microm Micromarketing-Systeme und Consult GmbH, a market research firm specialising in territorial analysis (microm 2017).

[1] The ImmobilienScout24 data was cleared from duplicates. From the monthly observations, only the last offering per object is kept in the dataset. It is assumed to represent the transaction price most closely.

The following section describes sorting across residential communities in Dortmund by population and housing characteristics. In the first step (section 5.1.), the (logarithmised) price of object i is described by the following equation (1):

$$(1) \qquad \log(P_{i,jkt}) = \beta_x X_i + \beta_N N_{j,t} + \sum_{k=1}^{7} \mu_k + \sum_{k=1}^{7} \sum_{t=2007}^{2016} \gamma_{t,k} T_t \mu_k + \varepsilon_{i,jkt}$$

X is a vector of object-specific characteristics[2] such as the year of construction, living space, the number of rooms and the state and quality of the dwelling. Neighbourhood characteristics in postal code zone j are described by vector *N* including the (log) total number of population, mortality rates and the share of foreigners. The total population of 27 postal code districts varies between 11,800 and 40,600 (in 2015). In our model two selected indicators represent demographic features. They refer to two out of three basic dimensions of urban neighbourhood populations as identified by research on urban social geography (Knox and Pinch 2010): age (household type) and ethnicity. A third dimension, income or socioeconomic status, is not controlled for explicitly, since it is likely to be correlated with the dependent variables. It is accounted for by dummies μ_k, which identify the k = 7 residential communities and thus control for locational fixed effects at a broader district level. T are time-dummies for 2008 to 2016 (with reference group 2007). The coefficients γ display the variation of price changes for the seven communities, identified by the interaction of time- and community-dummies. The individual-level residuals $\varepsilon_{i,jkt}$ may be correlated due to shocks[3], which occur in the whole area. They are therefore clustered[4] at the community level. Individual apartments and houses are

[2] Different categories of the year of construction, the age of the building, the living space and plot area, number of rooms, floor of the dwelling and total floors, type of house/apartment, different classes of state and furnishing, amenities: balcony, garden, kitchen, night storage heating, lift.

[3] E.g. public debt.

[4] The assumption of uncorrelated standard errors would lead to an underestimation of the variance and therefore to an overestimation of the parameter's significance.

assumed to be sufficiently small such as not to affect the prices of other objects. Common locational characteristics determining prices are captured via neighbourhood characteristics *N* and community fixed effects μ_k.

Analysis of residential segregation dynamics in sections 5.2 and 5.3 will draw on a discrete choice equilibrium framework that was utilised for housing market analysis by Bayer et al. (2004). In their model of residential location choice, each household chooses a residence in neighbourhood h to maximise the indirect household utility

$$V_{i,h} = \delta_h + \lambda_{i,h} + \varepsilon_{i,h}, \quad (2)$$

in which

$$\delta_h = \alpha_0 + \alpha_{1X} X_{i,h} + \alpha_{2Z} Z_h - \alpha_{3p} p_{i,h} + \xi_h. \quad (3)$$

In equation (2), the indirect utility of location choice, $V_{i,h}$, divides into household-specific parameters $\lambda_{i,h}$ and mean indirect utilities δ_h, which are common to all households. These mean indirect utilities are expected to relate to the observable characteristics of housing choice $X_{i,h}$ (e.g. size of dwelling), neighbourhood attributes Z_h, which result from a sorting equilibrium (and in our case will include the time fixed effects for Dortmund communities as estimated in the first step of the analysis, according to equation 1) and the price of housing choice, $p_{i,h}$ (equation 3). ξ_h comprises the location-specific proportion of unobserved preferences for housing and neighbourhood and $\varepsilon_{i,h}$ represents idiosyncratic preferences.

Although our data includes no information about final transaction prices or when a transaction or renting has finally occurred, there are several reasons to assume that it is suitable for the analysis of location choice. Our data source, ImmobilienScout24, is the biggest internet platform for real estate offerings in Germany. Its self-reported market share amounts to around 50%

of all offered dwellings for sale or rent in Germany (Georgi and Barkow 2010, an de Meulen et al. 2014). Dinkel and Kurzrock (2012) investigate asking prices and transaction prices for owner-occupied dwellings in six districts (Landkreise) of Rhineland-Palatine based on data provided by ImmobilienScout24. They find that asking prices are significantly higher than final transaction prices, but do not vary systematically among different property types. Furthermore, one possible way to control for the accuracy of asking prices is to add the advertisement duration to the estimation model. Presumably the longer the duration, the higher will be the difference between asking price and real transaction price and vice versa. Zuehlke (1987) argues that whereas the probability of sale may be expected to increase over time due to diminishing reservation prices, buyers may also interpret longer durations as longer time paths of reservation prices. They may then expect the seller to reduce the price in case of an even longer duration, which will decrease the probability of sale. To avoid measurement errors that may be connected to long durations, we exclude all offers for rent, apartments for sale and houses for sale beyond the 95th percentile in duration from each of these three categories in each year.

We expect the vast majority of offers to represent transactions, since vacancy rates in Dortmund are low (1.7% in 2016) and have been decreasing over the past years (Stadt Dortmund 2017). There is therefore no reason to suspect that supply on the different segments of the Dortmund housing market over the study period exceeded demand to a considerable extent, which would indicate a disequilibrium.

The first stage is specified in our case as equation (4):

$$(4) \qquad V_{i,kt} = \delta_{k,t} + \log \lambda_{1i,t} + \log \lambda_{2i,t} + \varepsilon_{i,kt}.$$

$V_{i,kt}$ is observed as a categorical variable representing the choice probability among a given set of $k = 7$ communities, which is estimated in terms of a multinomial logit (MNL) model[5] for each year t =1, 2, ….10. For any combination of the housing-specific parameters $\lambda_{1i,t}$, $\lambda_{2i,t}$ and community-specific utilities $\delta_{k,t}$ the model predicts the probability that dwelling i will be on offer at location k in year t . The community-specific probability $\delta_{k,t}$ is estimated in the form of $k - 1$ (i.e. 6) alternative constants per year. In order to measure the mean probability $\delta_{k,t}$, the housing-specific characteristics in the model are constructed to have mean zero, such that the value zero represents the annual mean of each variable. The constant for the base category in each year is set to zero. $\lambda_{1i,t}$ is measured as a proxy for household size, here represented by the size of a dwelling´s residential floorspace in m², divided by the average residential housing floorspace per person in each of the seven Dortmund communities (Stadt Dortmund 2015: 97)[6]. $\lambda_{2i,t}$ enters as the total monthly rent or the total price of the dwelling on offer, serving as a proxy for household income[7].

The second stage (equation 5) estimates the community-specific parameters α using the annual alternative constants from the first stage as dependent variable, which enter the estimation as $\delta_{k,ijt}$.

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[5] In the MNL model, the "independence of irrelevant alternatives" (IIA) property implies that the unmeasured attributes of alternative choices are uncorrelated. In the literature on housing choice, a variety of studies have found the MNL model to be an appropriate empirical framework (Gabriel and Rosenthal 1999).

[6] The average residential floorspace per person in Dortmund varies by below 1% during the period under investigation. The average floorspace per person by Dortmund community is held constant at the value of 2013 in our analysis.

[7] In the literature on real estate economics, the price-to-income ratio is a common measure of housing market characteristics. While there is no consensus in explaining the precise mechanisms of this ratio, various studies have found a correlation (Tu et al. 2018).

$$(5) \qquad \delta_{k,ijt} = \alpha_0 + \alpha_1 \log X_{i,t} + \alpha_2 Z_{1j,t} + \alpha_3 Z_{2j,t} + \alpha_4 \gamma_k + \alpha_5 D_{Hörde,2012+} - \alpha_6 \, log \, p_{i,t} + \xi_{k,ijt}$$

Housing-specific characteristic $X_{i,t}$ enters as the total size of the dwelling, $Z_{1j,t}$. is represented by the annual share of foreigners among the residential population in each of the $j = 27$ postal code zones (Figure 1, see below). $Z_{2j,t}$ refers to the share of the 60+ year-old residential population in the postal code district in the year of the offer, γ_k measure unobservable average neighbourhood amenties $\bar{g}$ as represented by the hedonic price index characterising the price change (in terms of rent or price per m² of dwelling space) from 2007 to 2016 in each of $k = 7$ Dortmund communities in the estimates of equation (4). $D_{Hörde,2012+}$ enters as a dummy variable acquiring value 1 in case the dwelling on offer is located in Hörde and entered the market in 2012 or later, when a large-scale environmental improvement measure (Phoenix-See, see below) had been completed. $p_{i,t}$ represents the rent or price of the dwelling on offer per m².

Since rents and prices may be correlated with unobserved neighbourhood characteristics, an instrument will be applied. Drawing on the approach developed by Bayer et al. (2004), we utilise the equilibrium property associated with urban housing markets, in which the price of a house is determined not only by its own characteristics and the demand for housing in its neighbourhood, but also by the desirability of alternative houses and neighbourhoods in the same urban region. In the IV strategy, housing quality at 6 non-chosen out of 7 communities in each year is measured in terms of average rent or prices at these locations. The instrument requires that the utility from location choice would not be affected directly by the exogenous attributes determining costs in other communities (Kuminoff et al. 2013). Prices of non-chosen alternatives within the same community are assumed to correlate with the utility gained at the chosen location and thus left out of the analysis in the IV approach.

4. Basic features of Dortmund residential communities

Similar in size to Essen, Dortmund is currently the largest city in terms of population (601,150 in 2016) in the Ruhr and the third largest in North Rhine-Westphalia (following Cologne and Düsseldorf). In line with regional population ageing, in Dortmund the total number of citizens declined from 589,114 (1998) to 576,824 (2009). Since 2010 Dortmund's population has continued to increase due to migration gains, mainly driven by immigration from abroad. For purposes of urban planning, a basic city subdivision comprises seven residential communities (Stadt Dortmund 2017). In our analysis the seven residential communities represent the wider and postal code zones (and 1 km-grids) the immediate neighbourhood context.

Table 1
Demographic characteristics of Dortmund residential communities
in %

	2008				2015			
	inh./km²	<18	>59	foreign	inh./km²	<18	>59	Foreign
City Centre	5,276	11.4	25.2	12.2	5,601	11.6	24.1	13.8
Nordstadt	3,815	19.7	17.5	39.6	4,239	20.2	15.3	46.7
DO-West	2,064	17.8	24.3	10.2	2,066	16.8	25.6	13.5
DO-North	1,780	18.6	26.5	12.6	1,843	18.1	26.6	17.8
DO-East	2,229	15.5	29.4	6.4	2,247	14.8	30.3	8.6
DO-South	1,537	15.1	29.2	6.2	1,549	14.4	30.5	8.0
Hörde	3,190	15.9	25.0	17.8	3,343	15.2	24.5	20.5
Dortmund	2,619	15.9	26.5	11.5	2,718	15.5	26.7	14.6

Authors´ calculation based on KOSTAT and Stadt Dortmund 2015.

Even the relatively broad residential communities outline considerable differentials among Dortmund neighbourhood populations. A high population density, for example, characterises the City Centre, Nordstadt and Hörde as more "urban" than the Dortmund-East, North, West and South districts (Table 1). Nordstadt represents a high-density worker´s outskirt from the late 19th and early 20th century that became a deprived neighbourhood in the course of the decline of the nearby large-scale industrial plants. The Hörde history since the mid-19th century

was related closely to the local Phoenix steelworks. Following plant closure and dismantling of most industrial remains, a completely new neighbourhood comprising around 2,000 dwelling units was constructed on part of the industrial site (Phoenix East) over the past two decades. As an infrastructure project within the large-scale Emscher Conversion Scheme (Frank and Greiwe 2011), part of the site was flooded in 2011, now comprising a 24 ha water expanse called "Phoenix-See". Construction of housing in the new quarter surrounding the lake began in 2012. It has since become one of the most favoured housing locations in Dortmund (Stadt Dortmund 2017).

The shares of children (aged < 18 years) in particular and seniors (aged 60 and over) were below the Dortmund average in the City Centre, which is favoured obviously by working-age residents, in 2008 and 2015 (Table 1). In the adjacent Nordstadt community the share of children is highest and the share of seniors lowest. In Nordstadt the share of seniors declined between 2008 and 2015, whereas the share of foreign nationals increased from 39.6 to 46.7%. As in the City Centre and Nordstadt, population growth in Hörde combined with an increase in the share of foreigners (from 17.8 to 20.5%) and a slight decrease in the share of seniors. Ageing is most advanced in the Dortmund-East and –South communities, while families with children prevail more in the North and West.

During this decade, immigration to Germany increased considerably, culminating in a large number of refugees escaping from the war in Syria since 2015. The number of residents with a foreign passport increased in all Dortmund communities, particularly since 2012. In relative terms, the share of immigrants increased most rapidly in the outer districts (especially in Dortmund-North, -East and -South). The share of foreigners, however, is still considerably lower in the southern part of Dortmund (Dortmund-East and –South) than in the centre and north.

From 2008 to 2015 rents in Dortmund (in current prices) increased from 5.15 up to 6.28 €/m²

(+22%) on average, prices for owner-occupied apartments from 1,237.07 to 1,440.09 €/m² (+16.4%) and for 1- and 2-family houses from 1,700.84 to 1,764.95 €/m² (+3.7%) (Table 2).

As expected by land use theory, rents and prices for housing are highest in the City Centre. They are lowest in the West and North communities, where population density is comparatively low. Prices are higher in the South, however, where density is lowest among all districts. In line with a well-known North-South divide characterising the Ruhr due to its specific settlement history (Wehling 2003), the southern part of the city is preferred as location of residence.

Table 2
Selected housing market characteristics
Mean advertising price in €/m²

	2008 apartment/ rent	apartment/ sale	house/ Sale	2015 apartment/ rent	apartment/ sale	house/ sale
floorspace in m²						
< 50	5.34	984.00		6.68	1,017.61	
50-70	5.01	1,101.22		6.11	1,185.54	
70-90	5.08	1,301.43		5.95	1,443.21	
90-120	5.70	1,451,05		6.76	1,846,54	
>120	5.83	1,546.00		7.78	1,789.15	
year of construction						
< 1950	5.18	1,039.96	1,318.86	6.16	866,43	1,390.57
1950-1969	5.17	1,075.74	1,592.96	6.11	1,083.10	1,805.10
1970-1989	5.34	1,202.78	1,579.22	5.52	1,303.89	1,939.70
1990-1999	6.29	1,612.56	1,703.11	6.09	1,767.56	2.066.71
since 2000	5.09	1,465.22	2,046.66	7.08	2,036,45	2,193.43
residential comm.						
City Centre	5.70	1,424.95	1,540.71	7.31	1,819.54	2,232.57
Nordstadt	4.83	797.81	858.14	5.82	686,05	763.52
DO-West	4.85	1,095.35	1,668.67	5.68	1,085.24	1,778.95
DO-North	4.71	1,143.13	1,576.20	5.53	1,235.73	1,723.59
DO-East	5.26	1,262.20	1,869.89	6.04	1,436.93	1,929.62
DO-South	5.78	1,571.20	2,062.03	6.51	1,837.01	2,379.88
Hörde	4.97	1,055.90	1,295.42	6.93	2,162.84	2,202.83
all	5.15	1,237.07	1,700.84	6.28	1,440.09	1,764.95
total offerings	12,927	3,027	2,500	12,856	2,778	1,740

Authors´ calculation based on ImmobilienScout24.

Rents and prices in Hörde were below the Dortmund average in 2008. By 2015 prices had increased remarkably in this community. Rents per m² and prices for 1-/2-familiy homes now

were second only to those in the City Centre and apartments on offer for sale cost more than in any other community. Rents in Hörde on average increased from 4.97 to 6.93 €/m² (+ 39.4%), prices for apartments from 1,056 to 2,163 €/m² (+105%) and for houses from 1,295 to 2,203 €/m² (+70%).

5. Neighbourhood stratification

5.1 Hedonic price function

Estimation of hedonic price functions for rented and owner-occupied accommodation reveals a certain "size discount" on the rental market. With respect to the characteristics of neighbourhood populations in the surrounding postal code districts (Figure 1, see below) we find an increase in mortality by 1 death per 100 inhabitants to coincide with an average decrease in the price of apartments on offer for sale by around 6%. No other statistically significant interrelations between local population characteristics and house pricing were observed (Table 3).

By 2015 and 2016 rents and prices in comparison with 2007 had increased in all communities. Between 2007 and 2015, apartments for sale had experienced the strongest increase in prices per m² in Hörde (+25%). In 2016 the Hörde upswing accelerated even more, amounting to a 42.9% increase compared to 2007 (Table 3 and Figure 1). A hedonic price estimation using data from ImmobilienScout24 for the period from 2007 to 2011 by Bauer et al. (2015) finds that the prices for apartments in the Emscher conversion zone within Dortmund remained stable, while prices decreased in the rest of the municipal area on average. According to our estimation, there was also no significant change of prices in this category in Hörde between 2007 and 2011, while prices decreased in other communities (Nordstadt and Dortmund-North, Table 3).

Table 3
Estimates of hedonic price function for residential districts, 2007-2016

	(1) Rent	(2) Purchase: Apartments	(3) Purchase: 1-/2-Family Homes
housing characteristics			
age categories	yes	yes	yes
age	-0.00568***	-0.0124***	-0.00354**
	(0.00151)	(0.00282)	(0.00116)
age²	0.0000268***	0.0000408*	0.00000975**
	(0.00000587)	(0.0000167)	(0.00000387)
floor space (log)	-0.141***	0.127***	0.617***
	(0.0235)	(0.0321)	(0.0467)
no of rooms	0.0187**	-0.00479	-0.0192***
	(0.00547)	(0.00934)	(0.00400)
multi-family housing floor level	-0.0176***	-0.0310***	
	(0.00267)	(0.00462)	
multi-family housing: further characteristics	yes	yes	-
good state of house	0.0611***	0.0921***	0.0547***
	(0.00876)	(0.0157)	(0.0137)
bad state of house	-0.0509***	-0.0906*	-0.0909***
	(0.0120)	(0.0398)	(0.0144)
further characteristics of housing standard	yes	yes	yes
duration of offer	0.000185**	0.0000126	0.00000695
	(0.0000566)	(0.0000240)	(0.0000188)
annual district characteristics.			
population (log)	0.00691	0.0261	0.0514
	(0.0357)	(0.0286)	(0.0360)
mortality (deaths per 100 inhabitants)	-0.0267	-0.0583*	0.0428
	(0.0203)	(0.0252)	(0.0288)
foreigners (in %)	0.00120	-0.00686	-0.00282
	(0.00127)	(0.00362)	(0.00585)
residential communities: time effects (reference category 2007)			
time effects 2008-2010	yes	yes	yes
2011_City Centre	0.0358***	0.0153	0.000
	(0.00644)	(0.0106)	(0.000)
2011_Nordstadt	0.00829	-0.160***	0.000
	(0.00468)	(0.0116)	(0.000)
2011_DO-West	-0.108***	-0.0285	0.000
	(0.0189)	(0.0201)	(0.000)
2011_DO-North	0.0532***	-0.0784***	0.0119
	(0.0123)	(0.0173)	(0.00893)
2011_DO-East	-0.00583	0.00200	-0.0431***
	(0.0132)	(0.0137)	(0.00852)
2011_DO-South	0.0375***	0.0259	-0.0760***
	(0.00999)	(0.0184)	(0.00700)
2011_Hörde	0.0105	-0.0217	-0.0275*
	(0.00815)	(0.0345)	(0.0121)
time effects 2012-2014	yes	yes	yes

Table 3 continued

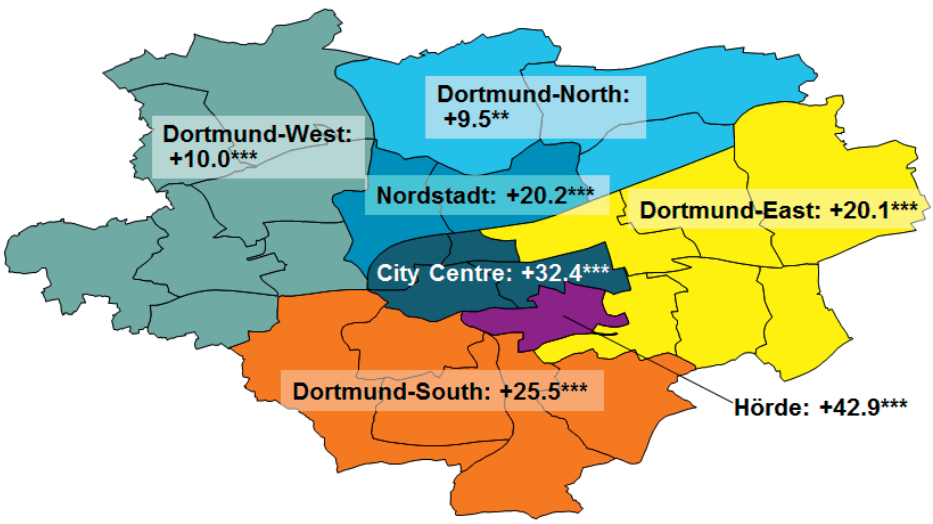
2015_City Centre	0.176***	0.170***	0.152***
	(0.00873)	(0.0166)	(0.00931)
2015_Nordstadt	0.153***	0.137***	0.319***
	(0.0108)	(0.0304)	(0.0275)
2015_DO-West	0.130***	0.0557*	0.140***
	(0.0153)	(0.0234)	(0.0121)
2015_DO-North	0.220***	0.0753**	0.128***
	(0.0120)	(0.0229)	(0.0202)
2015_DO-East	0.0952***	0.153***	0.0579***
	(0.0114)	(0.0184)	(0.00852)
2015_DO-South	0.127***	0.151***	0.0811***
	(0.0138)	(0.0203)	(0.0107)
2015_Hörde	0.186***	0.250***	0.132***
	(0.00817)	(0.0240)	(0.0157)
2016_City Centre	0.187***	0.324***	
	(0.00989)	(0.0182)	
2016_Nordstadt	0.164***	0.202***	
	(0.0135)	(0.0397)	
2016_DO-West	0.149***	0.100***	
	(0.0111)	(0.0174)	
2016_DO-North	0.218***	0.0951**	
	(0.0208)	(0.0327)	
2016_DO-East	0.130***	0.201***	
	(0.0114)	(0.0247)	
2016_DO-South	0.0957***	0.245***	
	(0.0119)	(0.0223)	
2016_Hörde	0.213***	0.429***	
	(0.0150)	(0.0349)	
further char. of plot	no	no	yes
constant	2.343***	7.065***	7.580***
	(0.291)	(0.468)	(0.308)
observations	53,177	15,787	25,352
adjusted R^2	0.542	0.674	0.683

Authors´ calculation based on Immobilienscout24, KOSTAT and dortmunderstatistik. Robust standard errors in parentheses. ***/**/* = significant at 0.01/0.05/0.1-level. Dependent variable: (logarithmised) price/rent in €/m² dwelling space (current prices, monthly observations, latest observation per object); age categories: pre-1905, 1905-1930, 1930-1944, 1944-1960, 1960-1970, 1970-1980, 1980-1990, 1990-2000, reference category: post-2000; further characteristics of dwellings in multi-family housing: cellar, lift, garden, balcony, fitted kitchen; further characteristics of 1-/2-family-homes: size of plot in m², terraced housing, building of new house is projected.

It is much likely therefore that prices in parts of Hörde had been affected by the anticipated improvements even before new housing at the Phoenix-See had entered the market. Yet, the main increase in prices took place after 2011. Rents increased most strongly in Dortmund-North (+22%), followed by Hörde (+21%). The pace of the increase in rents was somewhat lower in the ageing South (+9.6%) and East (+13%) than in the other parts of Dortmund, although these

"southern" communities are deemed more desirable and average rents are higher than in the "north".

Figure 1
Price change 2007-2016 per unit (€/m² in current prices) for apartments on offer for sale in Dortmund residential communities
in %, hedonic price function[1]



Own illustration. Map data: GeoBasis-DE/BKG, Google.
[1]Regression coefficients $\gamma_{t=2016,k} T_{t=2015,i} \mu_{k,i}$ for locational fixed effects by residential community (Table 3); Data source: Immobilienscout24, KOSTAT and dortmunderstatistik; ***/** = significant at 0.01/0.05-level; lines display the boundaries of 5-digit postal code zones.

5.2 Housing-specific choice probabilities (first stage)

Analysis of choice probabilities using information about housing units that enter the market (Table 4) shows that larger households are more likely to find accommodation in communities where total prices are comparatively low (Nordstadt, Dortmund-West and -North) (Table 5). In 2007 among rented accommodation mean sizes were smaller than in Dortmund-East (which was the base category) in the City Centre and in Dortmund-South and particularly large in Nordstadt. In Hörde in 2016 average household sizes were also comparatively small, whereas prices were high.

Table 4
Description of variables in the sorting estimation

Variable	Description
est. household size	floorspace of dwelling in m²/average floorspace per person in 2013, by Dortmund residential communities (Stadt Dortmund 2017)
total price	absolute total rent (without heating) or price of apartment/house on offer in Euro (current prices)
$\delta_{k,t}$	annual mean probability to locate in 1 out of 7 Dortmund residential communities, as indicated by characteristics of annual housing supply
floorspace	total residential floorspace of dwelling, in m²
housing cost	rent or price of dwelling in €/m² (current prices)
population density	inhabitants per ha in 5-digit postal code zones/1 km-grids
foreigners (in %)	share of foreign nationals among residential population in 5-digit postal code zones/1 km-grids, in %
60+ (in %)	share of persons aged 60 or older among residential population in 5-digit postal code zones/1 km-grids, in %
$\gamma_{t,k} T_{t=2016,i} \mu_{k,i}$	Regression coefficients γ for local fixed effects, as depicted by interaction between dummy variable μ_k representing Dortmund residential communities and dummy variable *T* representing the year 2016, in estimation of hedonic price function according to equation (1)
$D_{Hörde,2012+}$	1 if dwelling is offered for rent or purchase in Hörde in 2012 or later, 0 otherwise

The characteristics of housing offered in 2007 and 2016 indicate that segregation by household size (and age) between residential communities was reinforced over the study period, since smaller households were likely to choose the City Centre and the well-off Dortmund-South, larger households the North and West communities. After new housing at the Phoenix-See had begun to enter the market, the sorting equilibrium changed insofar as Hörde was no more the least likely choice of average households.

Table 5
Mean characteristics of housing supply, by residential community
Multinomial logit, selected results for 2007 and 2016

	City Centre	Nordstadt	DO-West	DO-North	DO-East	DO-South	Hörde
2007							
rent							
est. household size	-0.337***	4.700***	1.764***	3.535***		-0.711***	1.638***
(log)	(0.0560)	(0.0906)	(0.0631)	(0.0848)		(0.0633)	(0.110)
total price (log)	0.642***	-4.645***	-1.881***	-3.750***		1.016***	-1.569***
	(0.0575)	(0.0924)	(0.0651)	(0.0876)		(0.0653)	(0.110)
$\delta_{k.t}$	-0.653***	-1.470***	-0.00240	-1.086***		-1.302***	-1.654***
	(0.0386)	(0.0536)	(0.0312)	(0.0466)		(0.0484)	(0.0531)
observations	12,391						
p^2MF	0.191						
apartments for sale							
est. household size	0.301**	3.701***	1.585***	2.490***		-0.602***	1.796***
(log)	(0.128)	(0.214)	(0.116)	(0.156)		(0.117)	(0.203)
total price (log)	-0.112	-4.307***	-1.840***	-2.512***		1.197***	-1.873***
	(0.138)	(0.226)	(0.130)	(0.171)		(0.126)	(0.226)
δ_h	-0.653***	-3.705***	-0.0622	-1.417***		-0.722***	-1.971***
	(0.0710)	(0.224)	(0.0604)	(0.0972)		(0.0768)	(0.120)
observations	2,604						
p^2MF	0.138						
houses for sale (2008)							
est. household size	1.099***	2.379***	0.466***	0.942***		-0.465***	1.543***
(log)	(0.128)	(0.195)	(0.0817)	(0.0987)		(0.0909)	(0.166)
total price (log)	0.118	-1.608***	-0.759***	-1.330***		1.150***	-1.292***
	(0.161)	(0.163)	(0.0903)	(0.116)		(0.0925)	(0.211)
δ_h	-2.551***	-5.345***	-0.160***	-1.344***		-0.483***	-3.709***
	(0.150)	(0.450)	(0.0578)	(0.0878)		(0.0661)	(0.249)
observations	2,373						
p^2MF	0.130						
2016							
Rent							
est. household size	-1.862***	2.254***		1.367***	-1.048***	-1.778***	-0.574***
(log)	(0.0571)	(0.0965)		(0.0730)	(0.0540)	(0.0626)	(0.0688)
total price (log)	2.598***	-2.098***		-1.194***	1.567***	2.490***	1.667***
	(0.0637)	(0.108)		(0.0813)	(0.0603)	(0.0688)	(0.0732)
δ_h	-0.242***	-2.751***		-1.572***	-0.0790**	-0.680***	-0.951***
	(0.0353)	(0.0918)		(0.0586)	(0.0326)	(0.0400)	(0.0431)
observations	11,143						
p^2MF	0.136						
apartments for sale							
est. household size	-0.181	2.667***	0.962***	2.041***		-0.616***	0.182
(log)	(0.116)	(0.150)	(0.103)	(0.148)		(0.118)	(0.141)
total price (log)	0.739***	-4.558***	-1.425***	-2.124***		1.362***	1.391***
	(0.134)	(0.214)	(0.123)	(0.177)		(0.142)	(0.167)
δ_h	-0.966***	-2.817***	-0.247***	-1.623***		-1.263***	-1.823***
	(0.0845)	(0.172)	(0.0648)	(0.109)		(0.0979)	(0.127)
observations	2,512						
p^2MF	0.204						

Table 5 continued

	City Centre	Nordstadt	DO-West	DO-North	DO-East	DO-South	Hörde
houses for sale (2015)							
est. household size	-0.446**	3.418***		0.105	-0.601***	-1.486***	-0.157
(log)	(0.193)	(0.456)		(0.0895)	(0.0985)	(0.139)	(0.206)
total price (log)	2.267***	-1.535***		-0.118	0.914***	2.450***	0.845***
	(0.195)	(0.347)		(0.108)	(0.114)	(0.151)	(0.250)
δ_h	-2.533***	-7.109***		-0.246***	0.0459	-0.819***	-2.220***
	(0.193)	(0.920)		(0.0812)	(0.0741)	(0.104)	(0.165)
observations	1,651						
p^2MF	0.152						

Authors´ calculation based on ImmobilienScout24, excluding annual top 5% of offer durations per category (rent, apartments/houses for sale). Standard errors in parentheses. ***/**/* = significant at 0.01/0.05/0.1-level, p^2MF = McFadden´s Pseudo-R^2.

5.3 Neighbourhood choice probabilities (second stage)

In line with land use theory the second stage OLS estimations corroborate rent or housing prices per unit to be related inversely to annual mean choice probabilities (equation 5). Yet, the coefficient is statistically significant only with respect to houses offered for sale after 2011 (Table 6, estimation in column 3 below). Concerning rented accommodation, the IV regressions even find a change in sign, i.e. an increase in rent correlating with a higher neighbourhood-level choice probability (estimations in column 4). Since the likeliness to rent in relatively high-cost areas (City Centre and Hörde) had somewhat increased by 2016 compared to 2007, accepting higher rents per m² may represent a trade-off between price and size, i.e. a shift to smaller dwellings at locations that are more central or generally more desirable . Statistically significant coefficients for dwelling space and population density confirm this hypothesis for owner-occupied apartments (columns 2 and 5 in Table 6).

Among demographic neighbourhood characteristics measured at the postal code level, both OLS and IV regressions find a reduced mean probability to settle in apartments in case the share of foreigners in the neighbourhood is high. Possibly this result is driven by a considerable agglomeration of foreigners in Nordstadt, which appears to be an unlikely choice from the view of households with an average income. A high index value for the quality of local amenities, as

measured by the time-fixed effects for 2016, $\gamma_{t,k}T_{t=2016,i}\mu_{k,i}$, in the hedonic price regressions, reduces mean households´ likelihood to have chosen housing in this community during the study period.

Since the index value is high for Hörde, to avoid multicollinearity the hedonic index was left out of the analysis in a first robustness check (Table 7). Indeed, both OLS and IV regressions now measure a significant and negative coefficient for Hörde post-2011, which suggests a low likelihood of average households to have found accommodation in this community once the newly-constructed housing had entered the market. Otherwise, the results from the first robustness check are similar in terms of the magnitude and signs of coefficients to the estimations that include the index.

A second robustness check draws on a database representing a different neighbourhood context. Instead of statistics compiled at the level of postal code districts, the analysis now refers to these indicators aggregated at the 1 km-grid-level. In this second robustness check the OLS estimation corroborates a high neighbourhood-level share of immigrants to reduce mean choice probabilities as regards rented or owner-occupied apartments (Table 8).

The IV regression now finds a low mean probability to choose rented accommodation in Hörde after 2011. The period of observation may be too short to capture the complete impact of the Phoenix-See urban regeneration project on sorting across Dortmund communities. On the market for owner-occupied apartments, for example, the Hörde share among all offers only increased up to 6.5% in 2014, after having remained at around 4% since 2007. The share of apartments from Hörde increased further to over 10% in 2015 and remained at this level in 2016. Rents and prices in Hörde have only increased faster than in the adjacent East and South communities since 2014. It appears therefore that this increase is mainly due to the new housing

that was constructed as part of the urban regeneration scheme. In any case, from the point of view of households with a mean size and income, so far this extension of the Dortmund housing stock has affected location choice considerations only to a minor degree.

Table 6
Annual mean choice probabilities $\delta_{k,t}$ and neighbourhood characteristics

	OLS			2SLS		
	rent	for sale apartments	houses	rent	for sale apartments	houses
	(1)	(2)	(3)	(4)	(5)	(6)
2007/08-2015/16						
individual housing characteristics						
floorspace (log)	-0.0567	-0.110*	-0.130	0.112	-0.149	27.14
	(0.0516)	(0.0539)	(0.0699)	(0.114)	(0.270)	(54.97)
housing cost (log)	-0.142	-0.0661	-0.242	2.750**	0.0679	-49.21
	(0.151)	(0.0379)	(0.149)	(1.097)	(0.775)	(103.4)
pop. density	0.00261	0.0154**	-0.0173	-0.0131	0.0153***	0.0207
	(0.00629)	(0.00599)	(0.0153)	(0.0116)	(0.00523)	(0.232)
foreigners (in %)	-0.0619***	-0.0738***	-0.0966	-0.0573***	-0.0709***	-0.609
	(0.0122)	(0.00523)	(0.0538)	(0.0179)	(0.0127)	(1.066)
60+ (in %)	-0.0512	-0.0145	-0.110*	-0.0732	-0.0147	0.895
	(0.0341)	(0.0145)	(0.0476)	(0.0537)	(0.0138)	(2.066)
$\gamma_{t,k}T_{t=2016,i}\mu_{k,i}$	-1.885	-3.370**	-8.473	1.435	-3.504**	-11.73
	(5.081)	(1.370)	(5.599)	(7.132)	(1.432)	(27.94)
$D_{Hörde,2012+}$	-0.262	-0.0672	-0.580	-0.873*	-0.104	7.038
	(0.226)	(0.238)	(0.310)	(0.468)	(0.312)	(15.91)
constant	2.264	1.838***	8.302**	-2.907	1.066	453.5
	(1.586)	(0.374)	(2.398)	(2.988)	(4.341)	(951.6)
instrument for cost	no	no	no	yes	yes	yes
observations	126,933	34,060	16,020	126,933	34,060	16,020
R^2	0.471	0.704	0.668			
First Stage F				170.875	27.547	0.175
2012-2015/16						
individual housing characteristics						
floorspace (log)	-0.0671	-0.120	-0.0920	0.275*	-0.305	-31.62
	(0.0586)	(0.0847)	(0.0841)	(0.165)	(0.297)	(87.25)
housing cost (log)	-0.124	-0.0474	-0.373*	4.181***	0.633	56.08
	(0.173)	(0.0469)	(0.172)	(1.595)	(0.728)	(149.5)
neighbourhood characteritics						
pop. density	0.00680	0.0101**	-0.0235	-0.0154	0.00939**	-0.0848
	(0.00676)	(0.00405)	(0.0150)	(0.0143)	(0.00432)	(0.288)
foreigners (in %)	-0.0667***	-0.0719***	-0.101	-0.0568***	-0.0575***	0.357
	(0.0122)	(0.00615)	(0.0638)	(0.0188)	(0.0129)	(1.447)
60+ (in %)	-0.0314	-0.00994	-0.128*	-0.0548	-0.0108	-1.566
	(0.0297)	(0.0130)	(0.0625)	(0.0550)	(0.0154)	(3.966)
$\gamma_{t,k}T_{t=2016,i}\mu_{k,i}$	-1.792	-3.509*	-9.157	3.089	-4.493***	8.002
	(5.181)	(1.572)	(6.391)	(8.354)	(1.083)	(70.14)
$D_{Hörde,2012+}$	-0.358	-0.0170	-0.617	-0.996*	-0.104	-8.827
	(0.284)	(0.288)	(0.346)	(0.546)	(0.362)	(22.01)
constant	1.812	1.781**	10.59**	-6.856*	-2.172	-494.6
	(1.576)	(0.511)	(3.490)	(3.982)	(3.857)	(1320.2)

Table 6 continued

	OLS			2SLS		
	rent	for sale Apartments	Houses	rent	for sale apartments	houses
	(1)	(2)	(3)	(4)	(5)	(6)
instrument for cost	no	no	no	yes	yes	yes
observations	65,085	17,896	7,388	65,085	17,896	7,388
R^2	0.578	0.769	0.687			
First Stage F				34.965	13.480	0.138

Authors´ calculation based on ImmobilienScout24 and KOSTAT, excluding annual top 5% of offer durations per category (rent, apartments/houses for sale). Robust standard errors in parentheses. ***/**/* = significant at 0.01/0.05/0.1-level.

Table 7

Robustness check 1: annual mean choice probabilities $\delta_{k,t}$, no hedonic price index

	OLS			2SLS		
	rent	for sale apartments	houses	rent	for sale apartments	houses
	(1)	(2)	(3)	(4)	(5)	(6)
2007-2015/16						
individual housing characteritics						
floorspace (log)	-0.0485	-0.150***	-0.173	0.106	-0.522	26.44
	(0.0608)	(0.0369)	(0.0898)	(0.112)	(0.454)	(53.76)
housing cost (log)	-0.0959	-0.139**	-0.239	2.729***	1.051	-48.06
	(0.227)	(0.0502)	(0.151)	(1.007)	(1.275)	(101.0)
neighbourhood characteritics						
pop. density	0.00132	0.00240	-0.0187	0.106	-0.00318	0.0178
	(0.00703)	(0.00746)	(0.0197)	(0.112)	(0.00734)	(0.228)
foreigners (in %)	-0.0625***	-0.0785***	-0.140***	-0.0122	-0.0544**	-0.657
	(0.0124)	(0.00860)	(0.0337)	(0.00963)	(0.0215)	(1.037)
60+ (in %)	-0.0492	-0.0440	-0.0907*	-0.0568***	-0.0561	0.898
	(0.0345)	(0.0284)	(0.0464)	(0.0182)	(0.0438)	(2.031)
$D_{Hörde,2012+}$	-0.366**	-0.738***	-0.357	-0.797***	-1.311**	7.165
	(0.141)	(0.130)	(0.389)	(0.174)	(0.623)	(15.56)
constant	1.850	3.040**	7.481**	-2.615	-3.539	442.0
	(1.521)	(1.056)	(2.573)	(2.062)	(6.455)	(927.9)
instrument f. cost	no	no	no	yes	yes	yes
observations	126,933	34,060	16,020	126,933	34,060	16,020
R^2	0.464	0.645	0.630			
First Stage F				147.793	8.514	0.174

Authors´ calculation based on ImmobilienScout24 and KOSTAT, excluding annual top 5% of offer durations per category (rent, apartments/houses for sale). Robust standard errors in parentheses. ***/**/* = significant at 0.01/0.05/0.1-level.

Table 8
Robustness check 2: annual mean choice probabilities $\delta_{k,t}$, neighbourhood characteristics observed at 1 km-grid-level

	OLS			2SLS		
	rent	for sale apartments	houses	rent	for sale apartments	houses
	(1)	(2)	(3)	(4)	(5)	(6)
2009-2015/16						
individual housing characteritics						
floorspace (log)	-0.0797	-0.119	-0.231	0.232	2.522	36.71
	(0.0716)	(0.0641)	(0.147)	(0.209)	(2.818)	(79.09)
housing cost (log)	-0.345	0.0850	-0.307	4.948	-8.937	-64.92
	(0.256)	(0.0460)	(0.176)	(3.530)	(10.25)	(145.3)
neighbourhood characteritics						
pop. density	0.0114	0.168**	-0.0537	-0.373	0.379	-1.457
	(0.102)	(0.0471)	(0.0639)	(0.384)	(0.525)	(3.026)
foreigners (in %)	-0.0555***	-0.0550***	-0.0353	-0.00998	-0.279	-0.514
	(0.0132)	(0.0100)	(0.0221)	(0.0443)	(0.277)	(1.038)
60+ (in %)	-0.0521*	-0.0188	-0.0537	-0.00723	-0.0738	0.662
	(0.0248)	(0.0146)	(0.0373)	(0.0534)	(0.0581)	(1.511)
$\gamma_{t,k} T_{t=2016,i} \mu_{k,i}$	-1.538	-2.309	-13.69**	2.172	8.971	-72.47
	(5.583)	(1.757)	(5.517)	(9.008)	(12.38)	(129.7)
$D_{Hörde,2012+}$	-0.637**	-0.687*	-1.083**	-1.269**	-0.233	4.545
	(0.244)	(0.335)	(0.388)	(0.620)	(1.185)	(14.42)
constant	2.637	-0.419	8.112**	-6.897	51.80	623.4
	(1.968)	(0.669)	(3.055)	(7.126)	(57.76)	(1401.3)
instrument f. cost	no	no	no	yes	yes	yes
observations	89,224	25,645	13,519	89,224	25,645	13,519
R^2	0.346	0.504	0.573			
First Stage F				38.712	1.594	0.154

Authors´ calculation based on ImmobilienScout24 and microm, excluding annual top 5% of offer durations per category (rent, apartments/houses for sale). Robust standard errors in parentheses. ***/**/* = significant at 0.01/0.05/0.1-level.

Concerning neighbourhood ageing the coefficients are negative in almost all estimations, which would suggest that an increase in the share of senior citizens corresponds with a reduced mean choice probability. However, in many cases the coefficients are insignificant. It is not surprising to find a negative and significant coefficient with respect to one or- two-family homes on offer for sale, since such houses are relatively unlikely to be located in the neighbourhoods where ageing has proceeded most rapidly already (column 3 in Tables 6 and 7). A negative and significant coefficient in the IV regression that corresponds to the first robustness check indicates a reduced mean choice probability also for rented accommodation in ageing neighbourhoods (column 4 in Table 7). In the second robustness check the OLS estimation finds a reduced mean choice probability in line with an increase in the share of seniors among the population at the 1

km-grid level (column 1 in Table 8). There is thus evidence for rental markets to have begun to adapt to ageing by a somewhat reduced likeliness of mean households seeking new accommodation to settle in neighbourhoods where ageing is more advanced. Since no similar evidence was found with respect to owner-occupied apartments, it can be argued that during the study period demographic segregation increased only on a limited scale. For the time being, apparently no explicit aversion to local ageing characterises sorting on the Dortmund housing market.

6. Conclusions

We analyse whether housing prices and the characteristics of housing supply in Dortmund over the period from 2007 to 2016 indicate a response of local housing markets to demographic change. Hedonic price analysis reveals that prices for owner-occupied apartments are higher in neighbourhoods where population ageing so far has proceeded less rapidly. As far as the housing that entered the market during the study period is concerned, it was unlikely for mean income households to rent or purchase apartments in neighbourhoods, where the share of migrants is high (particularly in Nordstadt). In contrast, neighbourhood-level variation in population ageing was less crucial. Yet, on rental markets a reduced mean choice probability coincides with an increase in the share of seniors among the local population. Furthermore, sorting by age continues as mean choice probabilities are lower when it comes to ageing neighbourhoods in the south of Dortmund, compared to other neighbourhoods, e.g. the City Centre, Dortmund-North or –East. In the further process of ageing sorting by age and household size thus may become more prominent.

Concerning the scope of urban policy to improve the location characteristics of unfavourable neighbourhoods, the Hörde example demonstrates that large potentials are connected to environmental improvement schemes. Yet, in Hörde regeneration met with an overall desire of well-

off households to reside in the southern part of the city. High-income households may not be as willing to settle at other sections of the Emscher conversion scheme. In Hörde, an overall increase in prices was attributable mainly to housing on offer within a newly-constructed quarter in the vicinity of an artificial water expanse. While it is too early to examine whether prices in nearby areas will increase also, a gentrification process is likely.

If immigration to Germany decreases, rapid ageing will become a prominent issue in urban development and many other issues of public policy once again. The Phoenix-See scheme demonstrates that it is possible for cities to meet the challenges of ageing by pro-active policy measures. Local ageing so far has not been met with explicit aversion. It is thus a perspective of cities to motivate a stronger inflow to ageing neighbourhoods in order to prevent demographic segregation. Of course, while it is a characteristic of cities to compete over mobile investment and population, attracting households will only be part of an urban policy that is designed to overcome demographic change. Other fields comprise, for example, (continuing) education, integration, health and support of entrepreneurship.

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Data sources

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ImmobilienScout24 - Real Estate Data (RWI-GEO-RED), georeferenced microdata provided by the internet platform.

KOSTAT - Municipal statistical data for sub-city districts, provided by KOSIS Association KOSTAT, Bremen.

microm - RWI-GEO-GRID, Socio-economic data on grid level. Population by age and gender, DOI: 10.7807/microm:einwGeAl:v5; Share of foreigners, DOI: 10.7807/microm:auslaender:V5.