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Ageing by Feet? Regional Migration, Neighbourhood Choice and Local Demographic Change in German Cities

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Uwe Neumann[1]

Ageing by Feet? Regional Migration, Neighbourhood Choice and Local Demographic Change in German Cities

Abstract

In countries with an ageing population, regional migration may accentuate local progress in demographic change. This paper investigates whether and to what extent diversity in ageing among urban neighbourhoods in Germany was reinforced by regional migration during the past two decades. The old-industrialised Ruhr in North Rhine-Westphalia serves as a case study representing an advanced regional stage in ageing. The analysis proceeds in two steps. First, variation in the pace of neighbourhood-level demographic change over the period 1998-2008 is examined using KOSTAT, an annual time series compiled by municipal statistical offices. Second, a discrete choice model of household location preferences is applied to study the underlying demographic sorting process. The second step draws on microdata from a representative population survey carried out in 2010. During the 1990s and 2000s, in contrast to earlier decades, age differentials in location preferences became more profound and city centres became more popular as residential location. Rapid "ageing by feet" now affects neighbourhoods, where the influx is low, particularly low-density housing areas of the outer urban zone. Neighbourhood-level demographic sorting proceeds at a somewhat slower pace in the Ruhr than in the more prosperous cities of the nearby Rhineland (Bonn, Cologne and Dusseldorf). In the process of regional adaptation to demographic change, greater diversity in the age structure of neighbourhood populations may turn out to be an advantage in the long-run competition over mobile households.

JEL Classification: C21, C25, O18, R23

Keywords: Ageing; segregation; neighbourhood sorting; discrete choice

December 2016

1 *Uwe Neumann, RWI. –* *I am grateful to Rüdiger Budde, Christoph M. Schmidt and to participants of ERSA 2015 (Lisbon) conference for valuable comments. In 2009, the RAG-Stiftung commissioned RWI to conduct a study titled "Den Wandel gestalten. Anreize zu mehr Kooperationen im Ruhrgebiet" (Shaping Change. Incentives for Greater Cooperation in the Ruhr Region). Among other sources, this paper draws on data from a representative population survey that was carried out as part of this research project.* *– All correspondence to: Uwe Neumann, RWI, Hohenzollernstr. 1-3, 45128 Essen, Germany, e-mail: uwe.neumann@rwi-essen.de*

1. Introduction

In countries with an ageing population, regional migration may accentuate demographic change at the local level to a great extent. German cities differ from those in many other highly developed countries in that their population has stagnated or even begun to decline during the past decades. Apart from Eastern Germany, the old-industrialised Ruhr is one of the German regions which, due to long-term net migration to more prosperous regions, have already been affected by a severe loss in population and fundamental population change over the past decades. This paper examines

1. to what extent progress of neighbourhood-level demographic change in an ageing region differs from that in other comparable regions and
2. whether current location preferences of mobile households indicate an increase of demographic neighbourhood sorting.

The analysis finds that in the past decade proximity to urban amenities gained in importance among location preferences and migration concentrated more on neighbourhoods in close vicinity to city centres. In neighbourhoods, where the influx is low, the pace of ageing has increased considerably. Following a brief review of the relevant literature in section 2, section 3 presents the data and outlines the empirical approach. Section 4 examines neighbourhood-level demographic change and section 5 sorting at the household level. The final section 6 discusses the findings.

2. Literature review

In the literature on migration and demographic change, regional aspects so far have played a comparatively minor role. Even though it has been documented by many studies that segregation by age and household type (e.g. single person, family with children) is

typical of cities throughout the Western world (Coulson 1968; Heinritz and Lichtenberger 1991; Knox and Pinch 2010), in the more recent literature relatively little attention has been paid to demographic neighbourhood sorting.

Looking for and finding a new job is considered to be one of the key determinants of migration across the borders of cities, regions or countries (Jackman and Savouri 1992). Intra-regional migration, however, is more directly connected with the choice of housing and neighbourhood (Boehm et al. 1991, O´Loughlin and Glebe 1984). It can be expected that for younger migrants individual (particularly job-related) motives dominate, whereas family- and child-related considerations overlap with job-related matters at later stages in life (Kley 2010). Family ties also play a role for neighbourhood choice connected with short-distance mobility (Hedman 2013). Coulter and Scott (2014) find that the decision to move in the first place is more likely to be related to employment opportunities than to the desire for better neighbourhood characteristics.

Tiebout (1956) argues that the willingness to pay for local government services is an important influence on location decisions and that households "vote with their feet" regarding the quality of neighbourhood amenities. In urban economics, it remains largely unquestioned that the distance to commercial centres and sub-centres is a basic sorting mechanism of land uses across urban areas (Alonso 1964). While the price of land and housing generally decreases with growing distance to centres where amenities and jobs concentrate, house prices may be higher in some urban neighbourhoods with low-density housing than in other, more central neighbourhoods, if low density is equated with a good urban environment. Empirically, sorting analysis is a complex field of study, since the location decision may be predetermined by the individual characteristics of mobile households alongside with any specific "pull-factors" of the chosen location, comprising

attributes of the dwelling and local surroundings. Over the past two decades, a specific literature has started to overcome some of the identification problems arising for sorting analysis. A variety of studies have examined the role of the quality of public goods among the determinants of location decisions and shown how preferences vary by household characteristics (Kuminoff et al. 2013). Epple and Sieg (1999) draw on the properties of a sorting equilibrium in their strategy to estimate preferences for amenities, the quality of which is measured in terms of a public goods index. Bayer et al. (2004) develop an approach, which is founded on the microeconomics of discrete choice[1], in order to quantify the extent to which households differ in their preferences of housing and local amenities. The following analysis of sorting by demographic characteristics will adopt basic elements of this estimation strategy.

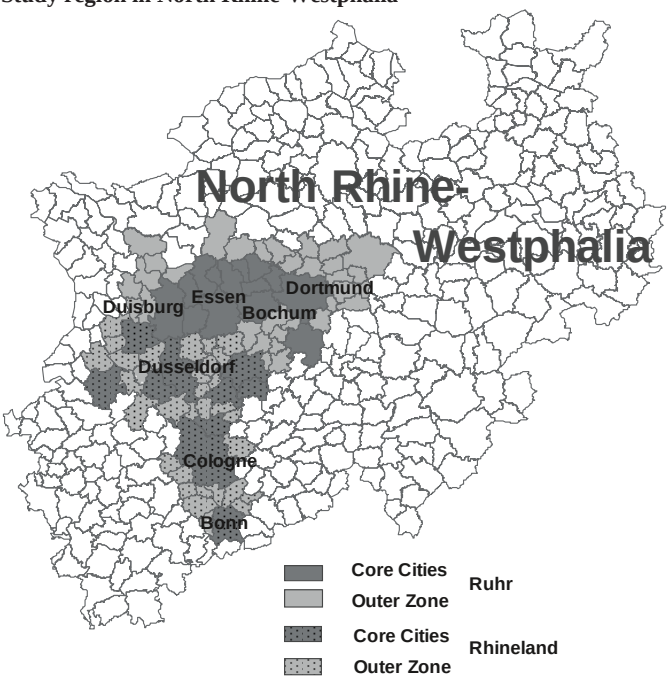
3. Data and approach

3.1 Case study

Due to a relatively advanced stage of ageing (Klemmer 2001) the Ruhr region in North Rhine Westphalia serves as a likely case study. Comparison of the Ruhr (commonly defined as the administrative area of the Ruhr Regional Association, RVR) with other cities in the nearby Rhineland of North Rhine-Westphalia (Figure 1) highlights the progress of ageing in the Ruhr. The large Rhineland cities Cologne and (particularly) Düsseldorf rank high above the average of North Rhine-Westphalia with respect to income (as measured in GDP per person employed). In these cities, there is also a relatively high concentration of working-age residents and immigrants, in this case represented by the share of foreign nationals (Table 1).

[1] The identification strategy was developed by Berry et al. (1995) with respect to the US automobile industry. It was applied to housing market analysis by Bayer et al. (2004).

Figure 1
Study region in North Rhine-Westphalia



Own cartography. Fine lines depict municipal boundaries. Ruhr: Territory of Regional Association Ruhr (RVR) in Rhine-Ruhr conurbation as defined by Regional Development Plan (MURL 1995); Rhineland: Rest of Rhine-Ruhr conurbation, except Märkischer Kreis

Table 1
Demographic and socioeconomic characteristics of cities in Rhine-Ruhr region
2015

	Dort-mund	Duisburg	Essen	Other Core Cities Ruhr[4]	Outer Districts Ruhr[5]	Cologne	Dussel-dorf
total population	586,181	491,231	582,624	1,646,757	1,802,460	1,060,582	612,178
thereof (in %)							
foreigners	15.7	17.8	13.7	14.4	9.2	18.3	18.7
< 18	15.9	16.5	15.5	15.8	15.7	15.9	15.6
18-29	16.4	15.3	15.6	14.8	13.1	17.1	15.2
30-59	41.4	41.4	41.2	41.3	41.9	44.5	44.3
> 59	26.3	26.8	27.7	28.1	29.2	22.5	24.9
pop. change since 1998 (in %)	-0.9	-6.1	-3.4	-6.4	-5.7	10.2	7.7
GDP/empl. in % of NRW av.[1]	92.6	106.9	112.9	88.6	91.8	114.1	132.4
employment in services (in %)[2]	80.8	70.8	82.8	73.1	69.6	84.2	86.5
unemployment rate (in %)[3]	12.5	13.2	12.1	10.1	8.5	9.4	8.5

Author´s calculation based on data from IT.NRW (Statistics North Rhine-Westphalia). [1]GDP per person employed, in relation to NRW average (2014); [2]employees at workplace (2014); [3]annual average; [4]Other Core Cities Ruhr: Bochum, Bottrop, Gelsenkirchen, Gladbeck, Hagen, Hamm, Herne, Mülheim/Ruhr, Oberhausen; [5]Outer Districts Ruhr: Ennepe-Ruhr-Kreis and Kreise Recklinghausen, Wesel, Unna – a slightly larger area than the Outer Zone as defined by the Regional Development Plan (MURL 1995)

Cities from the Ruhr rank lower in labour productivity and in in the share of working-age residents, but are characterised by a higher share of senior citizens aged above 60 (e.g. in 27.7% in Essen, but only 22.5% in Cologne). The share of seniors is even higher in smaller core cities and particularly in the outer zone of the Ruhr (29.2%) than in the large core cities.

As an outcome of job-related migration, particularly to the economically more dynamic regions of Southern Germany, sometime after the beginning of the decline of the then still dominant coal and steel industries, the total population of the Ruhr began to shrink in the 1960s (Steinberg 1978). The population declined from over 5.56 million (1962) to 5.15 million in 2010, i.e. by 417,000 inhabitants (-7.5%). In the rest of North Rhine-Westphalia, the total population increased by around 20% in this period (RVR 2016). Furthermore, in the 1980s and 1990s intra-regional migration resulted in a shift of the population from the core cities to the outer urban zone. During the past decade, net migration to the outer zone has come to a halt (Neumann 2013).

3.2 Data

The analysis draws on data from three different sources, combining observations at the individual and neighbourhood level:

1. Annual municipal data on demographic characteristics of the residential population (age, nationality, households), compiled at the level of 923 sub-city districts (Ruhr and Rhineland) for the period from 1998 to 2008 by a cooperation among municipal statistical offices in Germany (KOSTAT)[2],

[2] The KOSTAT data set currently comprises the following neighbourhood-level indicators: population at primary and secondary residence, male and female population, foreigners, age groups (under 18, 18-29, steps in tens up to 59, 60 and over), number of households.

2. Data on aggregate demographic neighbourhood and housing characteristics (in 2010) compiled by infas Institute of Applied Science[3], and
3. Microdata from a representative survey[4] among the (over 18-year-old) Ruhr population in 2010 (3,237 observations).

Municipal sub-city districts (data source 1) represent historical "neighbourhoods" or housing estates, which are perceived as spatial entities[5]. On a voluntary basis, over 100 cities (almost all with more than 100,000 inhabitants) have agreed to cooperate in a working group (KOSTAT) and to distribute a set of standardised sub-city data, which comprises information about the total population, sex, nationality, age and households, but conveys no direct reference to mobility (KOSIS Association Urban Audit (ed.) 2015). In the Ruhr study region, on average around 10,000 inhabitants live in these statistical districts. In addition, statistical data that covers a wider range of indicators (age, households size, income, housing) and refers to smaller districts (with an average population of around 1,300, representing a cross-section for 2010; data source 2) was provided by infas, a market research firm. This district-level data was linked with georeferenced microdata from a representative survey among the Ruhr population, carried out in 2010 (data source 3).

While there is no direct information about housing costs available in the data sources used in this analysis, a proxy for house prices is generated from information about housing

[3] Infas calculates data on sub-entities of municipal districts (with an average population of around 1,300) based on market research information compiled at the level of individual households and buildings (infas 2015). The dataset comprises demographic statistics for 2,318 districts.

[4] The survey was carried out as part of a study on behalf of the RAG-Stiftung in 2010 (RWI 2011).

[5] Methodical challenges arise for regional analysis using aggregate data. These have been described as the modifiable areal unit problem (MAUP) (Openshaw 1984). Municipal sub-city districts are assumed to represent intra-city differentials accurately, since they refer to those historical neighbourhoods, which are also referred to for purposes of municipal planning.

quality. A categorical variable characterising the type and quality of the housing stock in the immediate vicinity of the residential location of survey participants was generated by infas. Among a range of 53 categories, this typology separates between higher and lower quality housing stock[6]. A high price is assumed where the housing stock in the immediate vicinity of the residential location is assigned a high quality and in city centres, where high prices can be expected (see above).

3.3 Approach

The following analysis proceeds in two steps, focussing on i. neighbourhood-level demographic change, and ii. the household preferences relating to neighbourhood attributes. The production of novel evidence at the population level in the first step is thus complemented by testing how the migration and location decisions of households shape the aggregate outcome (Billari 2015).

It can be assumed that neighbourhoods have certain unobserved advantages (or disadvantages) making them attractive (or inattractive). In an analysis of demographic change over a specific period that does not account for such unobservable characteristics, it is likely for residuals to be correlated with any demographic outcome measure at the level of spatial entities. A specification that eliminates these neighbourhood-specific assets is the fixed effects approach, which utilises variation within individual districts over time in the form of

[6] The housing stock typology, which was registered for 2,891 survey participants, comprises the following categories: farms, rural settlements, posh neighbourhood of stately mansions, older (pre 1970) high-quality low-density residential area, older lower quality low-density residential area, newer (post 1970) high quality low-density residential area, newer low quality low-density residential area, city centre, older high quality multi-family homes, newer high quality multi-family homes, older low-quality multi-family homes, older very low quality multi-family homes, special zones (nursing homes, barracks, hospitals). These are further subdivided according to the age of buildings and city size, resulting in 53 categories altogether.

(1) $Y_{it} - \bar{Y}_i = ß_1(X_{it} - \bar{X}_i) + \varepsilon_{it} - \bar{\varepsilon}_i$ with i = 1,2,...N and t = 1, 2...11,

where Y_{it} is the population of neighbourhood i at time t, X_{it} is a set of demographic characteristics for each neighbourhood i, t comprises 11 observations for each year from 1998 to 2008, ε_{it} is disturbance at time t[7], $\bar{Y}_i$ is the average population of neighbourhood i during all annual observations over the study period, the $\bar{X}_i$ represent the corresponding averages of demographic characteristics and $\bar{\varepsilon}_i$ the residuals, averaged over time. In the following section 4, it will be investigated whether growth of the total population combined with change in the share of selected age groups (< 18, 18-30) or the share of immigrants among the neighbourhood residential population. They comprise newborn children and, arguably, those demographic groups, which are most mobile in a regional sense. Separate estimations according to equation (1) comprise the Ruhr and Rhineland (Figure 1), in order to identify the specifics of the Ruhr as an ageing region. Spatial autocorrelation in the residuals is accounted for by clustering standard errors at the level of municipalities[8].

In the analysis of household location preferences in section 5 it will be assumed that households choose their specific residential location in terms of the indirect utility function

(2) $V_h^i = \delta_h + \lambda_h^i + \varepsilon_h^i$

in which

[7]Outliers were deleted from the dependent variable, i.e. the total neighbourhood population. The estimations comprise observations between the 5th and the 95th percentiles of the dependent variable. In order to adjust for between-district differential in population size, the inverse of the total population is applied as a weight.

[8] Due to exogenous factors affecting municipalities as a whole (e.g. public debt, house prices), residuals may be correlated among the neighbourhoods of a city. Assuming uncorrelated standard errors would imply underestimating variance and overestimating the statistical significance of coefficients.

(3) $\delta_h = \alpha_{0X} X_h + \alpha_{0Z} Z_h - \alpha_{0p} p_h + \xi_h.$

The identification strategy requires that the indirect utility of location choice, V_h, as characterised by equation (2), comprises household-specific parameters λ_h^i and mean indirect utilities δ_h, which are common to all households[9]. In equation (3), the X_h represent the observable characteristics of housing choice h, comprising attributes of the house (e.g. one- or multi-family) and neighbourhood (e.g. residential, commercial). Z_h represents average sociodemographic characteristics of the neighbourhood, which are determined in a sorting equilibrium, in which households sort according to their budget and preferences, and p_h denotes the price of housing choice h (which is a disutility). ξ_h comprises the proportion of unobserved preferences for housing and neighbourhood that is correlated across households and ε_h^i represents idiosyncratic preferences.

Estimation of equations (2) and (3) follows a two-step procedure. Assuming that households are sufficiently small not to interact strategically with respect to ε, the first stage derives the preference parameters λ and choice-specific constants δ by estimation of equation (2) in terms of a multinomial logit (MNL) model. In the literature on housing choice, a variety of studies have found the MNL approach to be an appropriate empirical framework (De Palma et al. 2005, Duncobe et al. 2001, Gabriel and Rosenthal 1999)[10], albeit fading out the feedback effects of household location decisions on neighbourhood characteristics, if the estimation is restricted to the first stage , i.e. equation (2).

[9]In order to measure the mean indirect utility δ_h , all individual and household characteristics in the model are constructed to have mean zero. The constant for the base category is set to zero. A test of the IIA properties according to the procedure suggested by Hausman and McFadden (1984) confirms applicability of the MNL estimation.

[10]A more comprehensive discussion of the methodical approach can be found in Neumann and Schmidt (2016).

The second stage estimates the mean taste parameters α_0, using the alternative constants from the first stage as dependent variable in the estimation of equation (3). Attributes of housing and neighbourhood, X_h, will be captured via the quality of local shopping facilities, average socioeconomic characteristics Z_h will be determined by whether the household resides in one of the four largest cities of the Ruhr (Bochum, Dortmund, Duisburg, Essen) or in a smaller municipality.

Since house prices are likely to be correlated with unobserved neighbourhood characteristics, in the second-stage estimation an instrument will be applied. Drawing on the IV approach developed by Bayer et al. (2004), the instrument utilises the equilibrium property of 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 region. In the analysis, the housing quality at the non-chosen location alternatives, which affects equilibrium prices but is uncorrelated with other neighbourhood characteristics determining the utility gained from the location decision itself, therefore will serve as an instrument for housing quality and price (see below).

For any combination of the household-specific parameters λ_h^i and mean indirect utilites δ_h the model predicts the probability that household i chooses location h. Obviously, definition of choice options may have a significant impact on the estimates of preference parameters. Since consideration of the characteristics of all non-chosen housing locations would render the estimation computationally intractable, it is common to focus on a restricted range of alternatives. For example, Bayer et al. (2004) define the alternatives from a 1-in-7 sample of non-chosen houses within the census district of the residential location in the San Francisco Bay area. Tra (2010) applies a random sample of 15 non-

chosen alternatives from a set of around 5,000 housing types in the Los Angeles area in his discrete choice equilibrium model of location preference.

In this analysis, the household´s choice set is restricted to three neighbourhood alternatives defined by characteristic of the residential population and a fourth category comprising all households not providing information about housing and neighbourhood (Section 5). Separate categories are defined for core cities and outer zone, thus resulting in eight neighbourhood choice options. In contrast to previous studies, which do not usually control for the length of stay at the current residence, the analysis concentrates on mobile households. Their preferences will be compared to those of households, which had not relocated within a predefined time span before the interview in 2010.

4. Neighbourhood-level demographic change 1998-2008

Over the survey period between 1998 and 2008, the total population of the Ruhr region decreased from 5.25 million to 5.06 million (-3.6%), whereas the population of the Rhineland (Figure 1) increased from just under 6 million to 6.02 million (+0.5%). On average, the population of the Ruhr districts decreased from 10,107 (1998), to 9,716 in 2008, while the Rhineland district population increased from 7,628 to 7,635 (Table 2). In both regions, in line with ageing of the “baby boomer” age cohorts born in the 1960s, the share of the 30-40 year-olds decreased and that of the 40-50 age group increased between 1998 and 2008. In 2008, however, the share of 30-40 year-olds was still higher (15.9%) in the Rhine than in the Ruhr (12.2%) region. Obviously, in the more prosperous Rhine region younger working-age residents account for a larger share of the total residential population.

Table 2
Demographic characteristics of neighbourhoods in the Ruhr and Rhine regions
1998 and 2008, averages by statistical district

	Ruhr		Rhine	
	1998	2008	1998	2008
total population	10,107	9,716	7,628	7,635
(standard deviation)	(6,613,4)	(6,543.0)	(6,564.5)	(6,484.3)
thereof (in %)				
foreigners	11.2	10.9	13.4	13.0
< 18	18.0	16.4	18.0	17.8
18–29	13.6	13.7	13.8	13.3
30–39	16.4	12.2	17.5	15.9
40-49	14.1	16.5	14.0	15.6
50-59	12.8	13.9	13.3	12.1
≥ 60	25.1	27.2	23.4	25.3
persons per household	2.1	2.0	2.1	2.0
observations	377		453	

Author´s calculation. Data source: KOSTAT. - Sample comprises observations between the 5th and the 95th percentiles of total population.

Table 3
Demographic change 1998 – 2008 in the Ruhr and Rhine regions
by basic neighbourhood characteristics

change 1998-2008 (in %) of	above-average share (in 1998) of…							
	Ruhr				Rhine			
	Foreigner	<18	18-30	≥60	foreigners	<18	18-30	≥60
total population	-5.2	-4.0	-4.6	-3.9	-0.1	-0.5	0.6	0.3
foreigners	-8.8	-10.5	-7.2	-1.3	-8.1	-9.0	-7.8	-1.0
< 18	-11.1	-13.4	-10.8	-10.9	-6.5	-9.3	-6.1	-2.1
18–30	-3.1	-4.4	-2.5	0.1	4.0	0.2	4.9	0.8
≥ 60	-1.8	5.6	-0.8	1.0	3.8	13.2	5.7	6.8
observations	145	181	168	182	184	217	195	230

Author´s calculation. Data source: KOSTAT. - Sample comprises observations between the 5th and the 95th percentiles of total population.

Population change in neighbourhoods characterised by an above-average share of selected demographic groups (foreigners, age cohorts <18, 18-30, ≥ 60) in relation to the respective regional average in 1998 outlines the pace of neighbourhood-level demographic ageing during the study period (Table 3). In both regions, the number of under-18 year-olds declined in all of these neighbourhoods, but at the highest rate where their share was high in 1998. In the Rhineland cities, agglomeration of young adults (18-30) and agglomeration of foreigners continued to focus on neighbourhoods, where they

were overrepresented already in 1998. The total population increased in none of the selected kinds of neighbourhood in the Ruhr. In the Rhineland, the population increased in neighbourhoods with a high share of 18-30 year-olds (+0.6%) and in those with a high share of seniors (+0.3%). The number of seniors (≥ 60) increased in all neighbourhood types in the Rhineland, particularly (+13.2%) where the share of children (<18) was high in 1998, but also where their share was high already. In the Ruhr, the number of seniors also increased at the highest rate (+5.6%) in those neighbourhoods, where children were overrepresented in 1998. Obviously, neighbourhoods with a high share of households with children were among those where ageing, i.e. a decline in the number of children and an increase in the number of seniors, proceeded most rapidly. During the period from 1998 to 2008, this rapid ageing of family-dominated neighbourhoods was even more profound in the Rhineland than in the Ruhr.

As expected, neighbourhood-level population growth between 1998 and 2008 coincided with growth in the number of children, young adults, and (in the Rhineland) foreigners (Table 4). The fixed effects regressions according to equation (1) therefore corroborate fertility and the mobility of young adults (in contrast to the location choices of older age groups) as components of neighbourhood population growth.

5. Regional migration and neighbourhood choice

5.1 Descriptive overview

For the purpose of analysing (intra-)regional migration and neighbourhood choice, georeferenced micro-level information from a representative survey among the Ruhr population, carried out in 2010, was combined with aggregate neighbourhood data, provided by infas.

Table 4
Neighbourhood-level population change 1998-2008
Panel regression coefficients[1], fixed effects

	total population (neighbourhood) (log)	
	Ruhr	Rhine
share (in % of neighbourhood population))		
foreigners	0.00735	0.00337**
	(0.00766)	(0.00136)
< 18	0.0168***	0.0160***
	(0.00460)	(0.00197)
18-30	0.00971**	0.00788***
	(0.00482)	(0.00163)
total population at city level (log)	0.219*	0.703***
	(0.130)	(0.0785)
constant	5.308***	-1.125
	(1.500)	(0.971)
R^2 (within)	0.0771	0.3855
observations	4,146	4,994

Author´s calculation based on KOSTAT. [1]Robust standard errors in parentheses; */**/*** = significant at 10/5/1%-level; sample comprises observations between the 5th and the 95th percentiles of total annual population; weighted by total neighbourhood population.

Choice options were identified in terms of a statistical classification of demographic neighbourhood characteristics (in 2010) (data source 2, see above). Based on the results of a regional factor and cluster analysis[11], three neighbourhood types were identified (Table 5)[12]. They can be described as

1. densely populated central city areas with small households and an above-average share of working-age (25-50 year-old) residents,
2. "ageing" areas with a high share of seniors (above 65), a comparatively low population density and an above-average income,
3. low-density residential areas, inhabited mainly by families.

[11]According to the results of a principal component analysis, three dimensions (factors) represent most of the cross-sectional differentiation observable by a set of eight demographic indicators (four age categories, household size, population density, population per building and average income (purchasing power) per person). The first is a family factor representing a high share of children (under 15), under 25-year-olds, an above-average household-size and a low share of seniors. The second is an "urbanity" factor correlating with a high population density, a large number of inhabitants per building and small households. Factor three represents "ageing" areas with a low share of younger working-age residents (25-50) but a relatively high average income.

[12]The typology is based on a three-step analysis: 1. Principal component analysis (varimax rotation), 2. Hierarchical cluster analysis (Ward´s method), 3. Optimisation of cluster analysis by k-means clustering.

Table 5
Demographic neighbourhood types of Ruhr region
2009

	1	**2**	**3**	**Total**
	"central"	**"ageing"**	**"families"**	
total population	873,741	946,500	1,210,931	3,031,172
thereof (in %)				
under 15	12.5	11.8	15.7	13.6
15 – 25	10.1	9.3	13.8	11.3
25 – 50	35.9	34.9	33.8	34.8
50-65	19.6	20.8	17.8	19.3
≥ 65	21.9	23.2	18.8	21.1
population per km²	5,040	1,064	654	1,040
household size	1.9	2.1	2.1	2.0
persons per building	7.3	4.1	4.4	4.9
annual purchasing power (€/person)	17,919	19,744	17,983	18,514

Author´s calculation. Data source: infas regional data - Typology: 1 = city centre, 2 = ageing, 3 = families, n.a. = no neighbourhood information available. Cluster analysis (Ward´s method), optimised by k-means clustering using factor values of three factors derived from infas neighbourhood statistics

Since neighbourhood statistics was only provided for 2,318 out of 3,237 survey participants, in the following a lack of neighbourhood information will be considered as a separate category. "Migration" in the analysis refers to all individuals (the basic level of observation is the individual), who had moved to the city, in which they lived in 2010, during the previous 15 years[13]. This "mobile" group comprises 22% of the total survey population, i.e. the vast majority had not moved across city boundaries for over 15 years. Analysis of individual-specific location preferences takes into account demographic characteristics at the household (income, household size, homeownership) and individual (age, migration background, job mobility, commuting) level (Table 6).

Taking up a new job, which is expected to be a main motive of migration, is considered among the explanatory variables. A job is defined here as "new" if it was taken up within five years before the survey.

[13] Duration of residence in the current municipality was recorded in terms of six categories: 1. <6 months; 2. 6 months – 2 years; 3. 2-5 years; 4. 5-10 years; 5. 10-15 years; 6. >15 years. Categories 1-5 combined comprise 22% of all observations, category 6 accounts for 78%.

Table 6
Location choice - micro-level variables

Variable	Description
migration	1 if person moved to this city during past 15 years; 0 otherwise
demographic neighbourhood type 1 (2, 3, 4)	1 (2, 3, 4) for demographic neighbourhood type 1 (2, 3, unspecified neighbourhood type)
income (log)	monthly net household income (log) in Euro
persons in household	number of persons in the household
owner	1 if household resides in owner-occupied accommodation; 0 otherwise
under 40	1 if age is < 40; 0 otherwise
male	1 if person is male; 0 otherwise
born abroad	1 if person was born outside of Germany; 0 otherwise
upper secondary school	1 if persons holds an upper secondary school degree (Abitur); 0 otherwise
new job	1 if current job was taken up within past 5 years; 0 otherwise
no commuting	1 if person is working in city of residence, i.e. does not commute to other city; 0 otherwise (commuting or not working)
large city	1 if person lives in Bochum, Dortmund, Duisburg, Essen; 0 otherwise
shopping in neighbourhood	1 if food and consumables are purchases predominantly in the neighbourhood; 0 otherwise
house price high	1 if infas housing area category = “high quality” or “city centre”; 0 otherwise

Source: Own survey (2010)

In the Ruhr, commuting across municipal boundaries between outer zone and core cities, but also among core cities, is common. Since commuting may affect the choice of neighbourhood, a dummy variable depicts whether a person works in the city of residence. The descriptive statistics show that migration in the core cities focusses on central areas (8.5% of the core city but only 1.4% of the outer zone population lived in households that had moved into the city during the previous 15 years and lived in a central area in 2010, Table 7). As a whole, an above-average share of the population in central areas is “mobile” (27.8% as opposed to 22% on average, Table 8). Immigrants and job-starters are overrepresented in core cities, homeowners and commuters in the outer zone.

Table 7
Descriptive statistics by subregion
in %*, except as indicated

	Ruhr	Core Cities	Outer Zone
migration	22.0	21.6	22.6[a]
to demographic neighbourhood type			
1 (centre)	5.9	8.5	1.4[a]
2 (ageing)	4.5	2.6	7.7[a]
3 (families)	5.6	4.2	8.1[a]
n.a.	5.9	6.2	5.5[a]
household income in € (median)	2,200	2,200	2,300[a]
persons in household (mean)	3.0	2.8	3.3
age (mean)	49.1	48.6	49.9
under 40	31.7	33.7	28.2[a]
born abroad	13.9	15.7	10.7[a]
upper secondary school	26.3	27.8	23.6[a]
Owner	44.4	39.1	53.7[a]
work in city of residence	31.3	34.8	25.1[a]
new job	23.8	25.4	21.2
large city	38.5	68.6	0.0[a]
shopping in neighbourhood	52.7	58.3	43.0[a]
house price high	22.8	22.2	23.8
observations	3,237	2,045	1,192

Author´s calculations. Own survey (2010) - * weighted using weights provided by infas; [a]significantly (10%-level or higher) different from value in core cities according to t-test (income, persons in household, age) or Chi^2 statistics (other variables)

Table 8
Descriptive statistics by demographic neighbourhood type
in %*, except as indicated

	Ruhr	Type 1 (centre)	Type 2 (ageing)	Type 3 (families)	n.a.
household income in € (median)	2,200	2,000	2,500[a]	2,500[ab]	2,000[bc]
persons in household (mean)	3.0	2.5	2.7[a]	2.8[ab]	3.8[ab]
age (mean)	49.1	47.1	51.1[a]	48.1[b]	50.0[a]
migration	22.0	27.8	20.2[a]	20.6[a]	20.3[a]
under 40	31.7	39.4	25.8[a]	33.9[ab]	28.4[ab]
born abroad	13.9	18.5	10.9[a]	10.6[a]	15.8[bc]
upper secondary school	26.3	30.0	25.4	25.1[a]	25.4[a]
owner	44.4	27.3	55.5[a]	48.9[ab]	44.2[ab]
work in city of residence	31.3	36.7	31.7	30.2	27.9[ab]
new job	23.8	30.5	21.7[a]	23.2[a]	21.2[a]
large city	38.5	60.3	28.5[a]	29.7[a]	38.4[abc]
shopping in neighbourhood	52.7	56.5	51.4[a]	52.5[a]	51.1[a]
house price high	22.8	22.8	47.4[a]	27.3[b]	n.a.
observations	3,237	714	721	883	919

Author´s calculations. Own survey (2010) - * weighted using weights provided by infas; n.a.: housing area information not available; [a/b/c]significantly (10%-level or higher) different from value in type 1/2/3 according to t-test (income, persons in household, age) or Chi^2 statistics (other variables)

Table 9
Descriptive statistics, mobile and non-mobile individuals
in %*, except as indicated

	Ruhr	migration = 1	migration = 0
household income in € (median)	2,200	2,000	2,300
persons in household (mean)	3.0	2.8	3.0
age (mean)	49.1	40.0	51.7[a]
under 40	31.7	52.6	25.8[a]
born abroad	13.9	26.5	10.3[a]
upper secondary school	26.3	35.1	23.8[a]
owner	44.4	31.7	48.0[a]
work in city of residence	31.3	29.3	31.8[a]
new job	23.8	39.8	19.4[a]
large city	38.5	39.9	38.1
shopping in neighbourhood	52.7	48.2	54.0[a]
house price (too) high	22.8	25.2	22.1
observations	3,237	744	2,493

Author´s calculations. Own survey (2010) - * weighted using weights provided by infas; 3,237 observations; [a]significantly (10%-level or higher) different from value among mobile individuals (migration = 1) according to t-test (income, persons in household, age) or Chi^2 statistics (other variables)

According to the survey from 2010, around 53% of the over 18 year-old Ruhr population acquire food and consumables predominantly within their neighbourhood. Most other goods are purchased outside of the neighbourhood, but within the city of residence. In the following, households will be assumed to perceive neighbourhood amenities to be of high quality if they shop locally. Among the more "mobile" group, working-age adults, foreign-born persons and job-starters are overrepresented, whereas the share of homeowners, the average household income and the average age of household members are lower than among the "non-mobile" population (Table 9)[14].

5.2 Household-specific preferences (first stage of the estimation)

Among households moving to central areas (type 1), there was an above-average share of young adults and job-starters (who are unlikely to move to family areas, type 3) (Table 10).

[14] Since homeownership correlates with income, housing cost and residential location, it will not be controlled for in the analysis. In contrast to the U.S., where the tenure status is one of the key characteristics of housing quality, segregation between housing for rent and for sale is less distinguished.

Table 10

First Stage: Individual preferences of mobile persons, by demographic neighbourhood type

Multinomial logit[1]

	1	2	3	n.a.
	dy/dx	dy/dx	dy/dx	dy/dx
income (log)	-0.073**	0.122***	-0.017	-0.032
	(0.037)	(0.034)	(0.035)	(0.030)
persons in household	-0.019	-0.012	0.015	0.016
	(0.018)	(0.016)	(0.017)	(0.014)
under 40	0.081*	-0.095**	0.088**	-0.074*
	(0.045)	(0.038)	(0.043)	(0.038)
male	-0.028	-0.051	0.047	0.031
	(0.045)	(0.038)	(0.043)	(0.037)
born abroad	0.026	0.069	-0.038	-0.057
	(0.056)	(0.048)	(0.054)	(0.051)
upper secondary school	0.069	-0.112***	0.067	-0.024
	(0.047)	(0.043)	(0.045)	(0.040)
new job	0.093**	-0.001	-0.108**	0.017
	(0.047)	(0.039)	(0.045)	(0.039)
no commuting	-0.012	0.049	0.064	-0.101**
	(0.050)	(0.042)	(0.047)	(0.046)
Pr(Y = 1, … , 3, n.a.)	0.333	0.204	0.279	0.185
observations		436		
p^2_{MF}		0.0438		

[1]marginal effects, standard errors in parentheses; weighted using weights provided by infas, ***/**/* = significant at 0.01/0.05/0.1-level, p^2_{MF} = McFadden´s Pseudo-R²; Pr(Y = 1, … , 3, n.a.) = predicted probability of Y = 1,2,3, n.a. given independent variables at their mean; n.a. = housing are information not available

Author´s calculations. - Own Survey

Table 11

First Stage: Individual preferences of non-mobile persons, by demographic neighbourhood type

Multinomial logit[1]

	1	2	3	n.a.
	dy/dx	dy/dx	dy/dx	dy/dx
income (log)	-0.004	0.036*	0.040*	-0.072***
	(0.018)	(0.021)	(0.022)	(0.013)
persons in household	-0.050***	0.014**	0.020***	0.016***
	(0.010)	(0.006)	(0.007)	(0.004)
under 40	0.046	-0.068**	0.017	0.005
	(0.028)	(0.030)	(0.031)	(0.026)
male	0.022	-0.019	-0.004	0.001
	(0.024)	(0.025)	(0.027)	(0.022)
born abroad	0.104***	-0.084*	-0.088*	0.068**
	(0.039)	(0.045)	(0.047)	(0.033)
upper secondary school	0.022	0.018	-0.029	-0.010
	(0.029)	(0.029)	(0.032)	(0.028)
new job	0.052*	-0.022	-0.035	0.005
	(0.030)	(0.032)	(0.034)	(0.028)
no commuting	0.058**	-0.010	-0.055**	0.008
	(0.025)	(0.025)	(0.027)	(0.023)
Pr(Y = 1, … , 3, n.a.)	0.247	0.246	0.310	0.197
observations		1,221		
p^2_{MF}		0.0289		

[1]marginal effects, standard errors in parentheses; weighted using weights provided by infas; ***/**/* = significant at 0.01/0.05/0.1-level, p^2_{MF} = McFadden´s Pseudo-R²; Pr(Y = 1, … , 3, n.a.) = predicted probability of Y = 1,2,3, n.a. given independent variables at their mean; n.a. = housing are information not available

Author´s calculations. - Own Survey

Households moving to ageing areas (type 2) earned an above-average income and are more likely to own their dwelling. Working-age adults (18-40) are underrepresented among households choosing to locate in ageing areas. For households that were "mobile" in the 15 years before the survey, the average probability of choosing central areas (type 1) as residential location (33%) was higher than the probability of choosing types 2 or 3. Households that had not crossed city boundaries, on the other hand, were most likely to reside in "family" areas (type 3).

In comparison, "mobile" individuals sort across neighbourhood types more distinctly than others by age and education, since they are relatively unlikely to settle in "ageing" areas. "Non-mobile" households, on the other hand, are sorted more distinctly by household size, provenance and commuting. Among the "non-mobile" group larger households prefer "ageing" or "family" type areas, immigrants are unlikely to settle anywhere but in central areas and commuting is unlikely for people living in central quarters but likely for those in family neighbourhoods (Table 11).

5.3 Mean preferences (second stage of the estimation)

Given the individual-specific preferences of all households, persons living in one of the largest cities (Bochum, Dortmund, Duisburg or Essen) are likely to have chosen a highly popular choice option, i.e. a central area, as residential location. While the desirability of central locations has increased, so has residence in a large city, as comparison between "mobile" and "non-mobile" households reveals (Table 12). It is unlikely, however, for households at such popular locations to dwell in high-cost housing[15].

[15] Apparently, only 8.7% of persons living in mobile households in type 1 (central area) actually reside in housing classified as "city centre" by the infas housing category. It is plausible therefore that residence in the most popular neighbourhood type, i.e. type 1 (central areas) rarely combines with the "high price" housing category, of which the infas "city centre" housing category is part. Most people in type 1 apparently live in housing that is near to centres, but not necessarily located in a mixed residential/commercial housing environment.

Table 12
Mean preferences δ_h (Second Stage)
OLS and 2SLS

	mobile households (migration = 1)		non-mobile households (migration = 0)		all	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	2SLS	OLS	2SLS	OLS	2SLS
large city	0.368***	0.355***	0.301***	0.277***	0.270***	0.245***
	(0.0481)	(0.107)	(0.0224)	(0.0320)	(0.0183)	(0.0322)
shopping in neighbourhood	0.0119	0.275**	0.0477**	0.0506	0.0339*	0.0687**
	(0.0473)	(0.116)	(0.0219)	(0.0312)	(0.0179)	(0.0315)
house price high	-0.193***	-2.461***	-0.0879***	-1.083***	-0.105***	-1.415***
	(0.0489)	(0.442)	(0.0232)	(0.121)	(0.0189)	(0.126)
instrument for house prices	No	Yes	No	Yes	No	Yes
constant	-0.661***	0.00483	-0.486***	-0.164***	-0.497***	-0.0847*
	(0.0378)	(0.151)	(0.0191)	(0.0463)	(0.0153)	(0.0467)
observations	547	547	1,771	1,771	2,318	2,318
adjusted R^2	0.118		0.106		0.102	
F-statistics (1st) (2SLS)		34.90		143.92		173.03

Author´s calculations. - Own survey. * weighted using weights provided by infas, standard errors in parentheses; ***/**/* = significant at 0.01/0.05/0.1-level; δ_h derived from multinomial logit model for (standardised) individual preference parameters including income (log), number of persons in household, age (<40 = 1), sex (male = 1), migrant background (born abroad = 1), upper secondary school certificate (yes = 1), new job (yes = 1), commuting (no = 1)

Since house prices are likely to be correlated with unobserved neighbourhood characteristics ξ_h, a 2SLS-estimation using the share of high-quality housing in the seven respective non-chosen residential location alternatives as an instrument in its IV strategy, is carried out as a robustness check (estimations 2, 4 and 6). The IV regressions corroborate most of the OLS results. However, in the 2SLS estimations the disutility of high prices, particularly for mobile households, is found to be more fundamental than in the corresponding OLS regressions. The 2SLS estimations point out shopping - as an indicator of neighbourhood amenities - to be a utility characteristic, particularly from the point of view of mobile households. Whereas housing at the most popular locations, i.e. at central urban areas, is not necessarily characterised by an immediate “city centre” environment comprising a mix of residential and commercial land uses, it is likely to be situated relatively near to retail facilities.

5. Conclusions

In the Ruhr region over the past decades demographic change coincided with a strong preference of mobile households for central locations. After several decades of suburbanisation, in the 1990s net migration to suburban municipalities came to a halt. Within urban areas, mobility now concentrates more on selected neighbourhoods in close vicinity to the city centres. In other neighbourhoods, due to low fertility and a comparatively low influx of mobile households, the average age has begun to increase.

Since the location choices of younger adults focused more on central areas, “ageing by feet” implies changes in the degree to which certain goods or services are perceived to be desirable and “scarce” within neighbourhoods. This may affect, specifically, ageing neighbourhoods characterised by low-density housing, where local communities so far have been accustomed with the provision of amenities for growing populations. An increasing agglomeration of younger, working-age residents in central city areas might attract even more young people and, in turn, accelerate ageing of the less popular neighbourhoods. Adaptation of local markets for housing, services and retail to an ageing population will provide an additional incentive for younger generations to leave or to avoid moving to ageing neighbourhoods.

In comparison with the more prosperous nearby Rhinefront cities (Bonn, Cologne, Düsseldorf), however, so far a comparatively lower agglomeration of working-age residents has emerged in the central areas of large cities of the Ruhr region and “ageing by feet” of low-density residential areas proceeds at a slower pace, even though ageing of the region as a whole is more advanced. Possibly, this somewhat more balanced progress of ageing across neighbourhoods in the Ruhr can be explained in part by its settlement geography. It is a specific characteristic of the Ruhr to be less densely

populated than other urban agglomerations in Germany. Less overall density makes it easier for different types of housing environment (e.g. low- and high density, purely residential and mixed residential/commercial) to co-exist in close vicinity, even in core cities. The Ruhr therefore may be better equipped than other regions to avoid neighbourhood-level demographic segregation while adapting to ageing.

Part of the greater mix of generations and household types in the Ruhr, on the other hand, is also due to a comparatively lower influx of working-age residents than to the more prosperous Rhineland cities. Economic change and revitalisation of the Ruhr, which is still in progress, therefore could combine with greater demographic segregation. All in all, greater neighbourhood-level demographic variety, which is, in part, an outcome of lower regional prosperity, may become an economic advantage for the Ruhr, if the word gets around and mobile households appreciate this diversity as an asset.

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