Ageing by feet? Regional migration, neighbourhood choice and local demographic change in German cities

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Abstract

In the literature on the economics of demographic change so far the regional and neighbourhood-level consequences have been out of the main focus. Yet, regional migration accentuates diversity in the progress of ageing. In fact, while households are known to "vote with their feet" when they choose a residential location, neighbourhood populations may experience "ageing by feet" as an outcome of a multitude of individual location decisions. The old-industrialised Ruhr region in North Rhine-Westphalia provides a suitable case study, because due to decades of net migration to more prosperous regions, it represents an advanced stage in demographic ageing. Drawing on municipal data at the sub-city level and microdata from a representative survey, this paper examines how change in the composition of neighbourhood populations relates to regional and intra-urban migration. The identification strategy is adopted from the recent literature on the microeconomics of discrete choice. The analysis finds that in the past decade proximity to urban amenities gained in importance among location preferences and migration concentrated more on selected neighbourhoods in close vicinity to the city centres. In neighbourhoods, where the influx of younger mobile inhabitants is low, the pace of ageing has increased considerably. Local demographic change implies new challenges for urban policy in many neighbourhoods, both in those facing accelerated ageing and in those with a high influx.

Keywords: demographic change, regional migration, segregation, location choice

JEL Classification: C21, C25, O18, R23

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1. Issues

In countries with an ageing population, regional migration may accentuate demographic change at the local level to a great extent. Changes in neighbourhood demography are likely to affect various markets, e.g. for housing, retail, catering, consumer services and the demand for infrastructure. 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. at what pace demographic change proceeds at the neighbourhood level in an ageing region and
2. to what extent household location decisions during the past decade have affected the demographic composition of urban neighbourhoods.

Since there is no standard of sub-city data aggregation, it is relatively difficult to analyse demographic neighbourhood change in Germany. For the purposes of this analysis, a comprehensive data set for the Rhine-Ruhr conurbation in North Rhine-Westphalia was compiled. The analysis starts with a brief review of the relevant literature in chapter 2. Chapter 3 presents the data and outlines the empirical framework. Chapter 4 examines changes in the composition of neighbourhood populations between 1998 and 2008. Chapter 5 examines neighbourhood choice and the final chapter 6 discusses the findings.

2. Literature review

In the literature on the economics of migration and demographic change, regional aspects so far have played a comparatively minor role. Furthermore, in regional and urban research, 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 (cf. Gans 1962; Coulson 1968; Heinritz and Lichtenberger 1991; Knox 1995), in the more recent literature relatively little attention has been paid to demographic sorting.

Looking for and finding a new job is considered to be one of the key determinants of migration across regions (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).

Tiebout (1956) argues that the willingness to pay for local government services is an important influence on location decisions. 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). In the model of land rent in urban environments

(1) $U = U(s, c, d)$

it is assumed that household utility U is a function of the lot size s that it occupies, the composite good c and distance to the Central Business District (CBD) d, a disutility affecting leisure time. Identical households maximise their utility subject to the budget constraint

(2) $y = zc + p_r s_r + t_r$ with $s_r > 0$

in which $y =$ income, z = price of composite consumption good, p_r = rent at distance r to the Central Business District (CBD), t_r = transport costs. While the price of land and housing therefore decreases with growing distance to centres, Richardson (1977) introduces an externality rent to the concept of household utility in the monocentric city. He reasons that the residential location choice involves consideration of externalities such as neighbourhood characteristics and low density may be equated with a good (urban) environment. House prices therefore may be higher in some low-density neighbourhoods than in other neighbourhoods, which are closer to the CBD.

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 decade, a specific literature on the microeconomics of discrete choice in housing markets has started to overcome some of the identification problems arising for sorting analysis (Berry et al. 1995, Bayer et al. 2004, Kuminoff et al. 2013). The following analysis will adopt basic elements of the estimation strategy developed in this literature in order to examine how utility considerations connected with location choice vary by household characteristics (see below) and to what extent mobility affects the pace of local demographic ageing.

The literature on residential segregation received a new impetus in the 1980s by a number of authors who argued that in the face of global and regional economic restructuring, urban industrial societies may experience increasing occupational and residential segregation

(Friedmann 1986, Sassen 1991). In the following, it will be of particular interest therefore to what extent local demographic change combines with sorting by skills and education. Due to a relatively advanced stage of ageing (Klemmer 2001) the Ruhr serves as a likely case study.

3. Data and empirical framework

The analys draws on data from four different sources, combining observations at the individual, neighbourhood and city level:

1. Annual municipal data on demographic characteristics of the residential population (age, nationality, households), compiled at the level of (416) sub-city districts for the period from 1998 to 2008 by a cooperation among municipal statistical offices in Germany (AG KOSAT) [1]
2. Data on demographic characteristics and regional migration, compiled at the city-level by the Statistical Office of North Rhine-Westphalia (IT.NRW),
3. Microdata from a representative survey[2] among the (over 18-year-old) Ruhr population in 2010 (3,237 observations), and
4. Data on aggregate demographic characteristics of (2,318) neighbourhoods[3] at the place of residence of participants in the representative survey and information on the type of housing at the residence of 2,891 survey participants in the representative survey, provided by infas Institute of Applied Science (Bonn).

The analysis proceeds in two steps, focusing on

- demographic change and migration at the level of municipal districts, and
- neighbourhood choice.

The study of neighbourhood-level demographic change will focus on variation between the largest cities, smaller core cities and the outer urban zone of the Ruhr conurbation and on variation among different types of neighbourhood.

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[1] Municipal sub-city districts are assumed to represent intra-city differentials accurately, since they represent historical "neighbourhoods" or housing estates, which are perceived as spatial entities and referred to for purposes of municipal planning. On average, around 11,000 inhabitants live in these statistical districts. The KOSTAT data set currently comprises the following 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] The survey was carried out as part of a study on behalf of the RAG-Stiftung in 2010 (RWI 2011).

[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).

Sorting due to household preferences will be analysed using an identification strategy adopted from the literate on the microeconomics of discrete choice in the housing market (i.e. the random utility model developed by Berry et al. 1995 and applied to the housing market by Bayer et al. 2004), assuming that location choice can be described in terms of the indirect utility function

$$(1) \qquad V_h^i = \delta_h + \lambda_h^i + \varepsilon_h^i$$

in which

$$(2) \qquad \delta_h = \alpha_{0X} X_h + \alpha_{0Z} Z_h - \alpha_{0p} p_h + \xi_h.$$

The identification requires that the utility of location choice V_h comprises household-specific parameters λ_h^i and mean indirect utilities δ_h, which are common to all households[4]. In equation (4) 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. ξ_h comprises the proportion of unobserved preferences for housing and neighbourhood that is correlated across households and not related to sorting and ε_h^i represents idiosyncratic preferences.

Estimation 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 (3) in terms of a multinomial logit (MNL) model. The second stage estimates the mean taste parameters α_0, using the alternative constants as dependent variable in the estimation of equation (4).

Since house prices are likely to be correlated with unobserved neighbourhood characteristics, 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

[4] In order to measure the mean indirect utility δ_h , all individual and household characteristics in the model are constructed to have mean zero.

region. In the analysis, the housing quality at the non-chosen location alternatives, which affects equilibrium prices but not the utility gained from the location decision, 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. In the literature on housing choice, a variety of studies have found the MNL model to be an appropriate empirical framework (De Palma et al. 2005, Duncobe et al. 2001, Gabriel and Rosenthal 1999)[5], albeit fading out the feedback effects of household location decisions on neighbourhood characteristics. The mean indirect utility δ_h is represented by the alternative-specific constants estimated by the MNL model[6].

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.

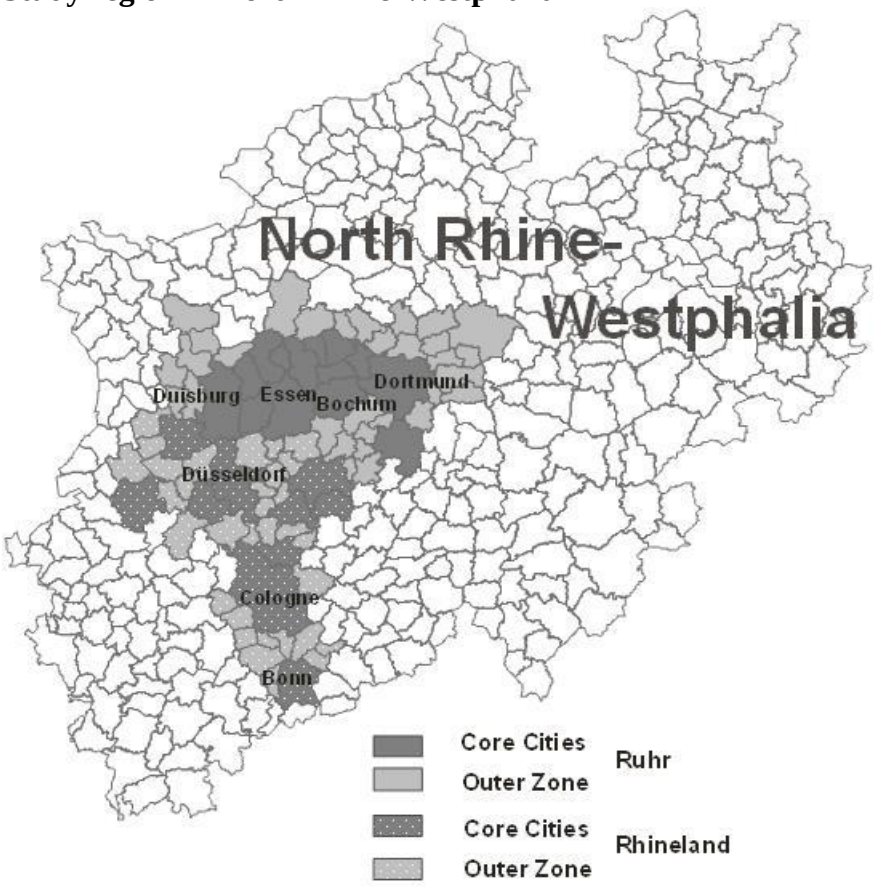
In this analysis, in order to interpret neighbourhood choice in relation to neighbourhood demography, the household´s choice set is restricted to a set of 3 housing and neighbourhood alternatives and a fourth category comprising all households not providing information about housing and neighbourhood. Among these four types separate groups are defined for location in the core cities and in the outer zone of the Ruhr region, resulting in a range of eight neighbourhood choice options. In contrast to previous studies of neighbourhood sorting, which do not usually control for the length of stay at the current residence, the analysis concentrates on mobility, i.e. the preferences of mobile households. These will be compared to the preferences of households, which did not relocate within a predefined time span before the interview in 2010. For interpretation of individual-specific preferences estimated in the first stage (equation 3), marginal effects for mobility into four (3+1) neighbourhood types will be calculated.

[5] A more comprehensive discussion of the methodical approach can be found in Neumann and Schmidt (2015).
[6] The constant for the base category is set to zero.

4. Characteristics of demographic change at the neighbourhood level

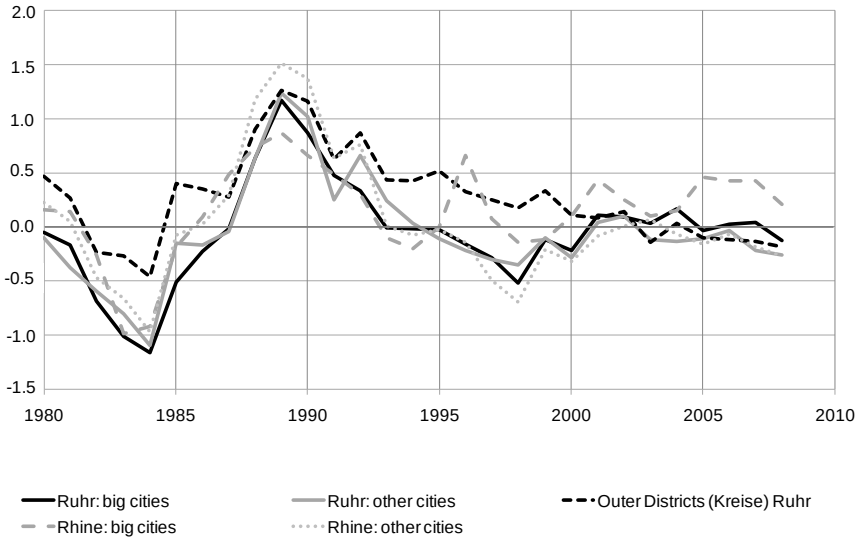
The German federal state of North Rhine-Westphalia serves as a case study of local demographic change under varying regional conditions. Comparison of the Ruhr (commonly defined as the administrative area of the Ruhr Regional Association, RVR) with other cities in the nearby Rhineland (Figure 1) highlights the progress of ageing in the Ruhr. The large cities of the Rhine subregion (Bonn, Cologne, Düsseldorf) rank high above the average of North Rhine-Westphalia with respect to income (as measured in GDP per head) (Table 1). Among the residential population of the Rhine cities, there is a relatively high concentration of 30-40 year-olds. Cities from the Ruhr rank lower in GDP per head and in in the share of 30-40 year-olds. Ruhr cities are characterised by a higher share of senior citizens aged above 60 (e.g. 27.6% in Essen, but only 23.2% in Cologne and 17.1% in Bonn), particularly in the outer zone of the agglomeration (32.1%).

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

Figure 2
Net migration: Arrivals – departures in % of the total population



Author´s calculation based on data from IT. NRW. - Ruhr, big cities: Bochum, Dortmund, Duisburg, Essen; Ruhr, other cities: Bottrop, Gelsenkirchen, Hagen, Hamm, Herne, Mülheim/Ruhr, Oberhausen; Rhine, big cities: Bonn, Cologne, Düsseldorf; Rhine, other cities: Krefeld, Leverkusen, Mönchengladbach, Remscheid, Solingen, Wuppertal; Outer Districts (Kreise) Ruhr: Ennepe-Ruhr-Kreis and Kreise Recklinghausen, Wesel, Unna

Table 1
Demographic and socioeconomic characteristics of cities in Rhine-Ruhr region
2008

	Bonn	Cologne	Düssel-dorf	Dort-mund	Duis-burg	Essen	Smaller Cities Ruhr	Outer Zone Ruhr
total population	303,041	995,412	584,217	584,412	494,048	579,759	1,350,654	1,636,228
thereof (in %)								
foreigners	18.9	17.1	18.4	12.6	15.1	10.3	11.7	10.3
< 18	6.8	15.7	14.8	16.3	16.9	15.7	16.9	20.6
30-40	19.0	15.9	16.3	13.2	12.6	12.6	12.1	14.2
> 60	17.1	23.2	25.2	25.9	26.6	27.6	27.0	32.1
in central city quarters	30.9	40.5	44.8	16.7	14.5	19.1	0.4	0.0
pop. change 1998-2008 (in %)	4.7	2.6	2.3	-1.5	-5.7	-4.3	-4.7	-2.9
GDP/head in % of NRW	140.7	146.0	234.2	102.6	100.8	122.7	85.7	72.6
employment in services (in %)	89.8	82.1	82.9	80.0	66.6	78.0	68.6	64.7
Δ empl. serv. 1980-2008 (in %)	49.3	45.4	35.6	36.3	18.3	26.0	25.7	27.0
unemployment rate (in %)	8.4	12.0	10.7	15.1	14.4	13.6	12.8	10.0

Author´s calculation based on data from AG KOSTAT and IT. NRW (Statistics North Rhine-Westphalia). – employment in services = at workplace; Δ empl.serv. 1980-2008 (in %) = change of number of employees (at workplace) in service sector 1980-2008 in %; unemployment rate = annual average 2008; Smaller cities Ruhr: Bottrop, Gelsenkirchen, Gladbeck, Hagen, Hamm, Herne, Mülheim/Ruhr, Oberhausen, Witten; Outer zone Ruhr: Ennepe-Ruhr-Kreis (except Witten) and Kreise Recklinghausen (except Gladbeck), Wesel, Unna

As an outcome of job-related migration, particularly to the more dynamic regions of Southern Germany, sometime after the beginning of the decline of the coal and steel industries, the total population of the Ruhr began to shrink in the 1960s (Steinberg 1978: 146). The Ruhr population declined from over 5.7 million (1962) to under 5.2 million in 2007, i.e. by 540,000 inhabitants (-9.4%). In the rest of North Rhine-Westphalia, the total population increased by over 20% in

this period (RVR 2009).Apart from long-distance migration there was an ongoing suburbanisation process within the region, resulting in continued net migration gains (or comparatively lower losses than in the inner zone) in the outer urban zone during the 1980s and 1990s[7]. During the past decade, however, net migration to the outer zone has come to a halt (Figure 2). For the purposes of this study, based on data from 2008, a set of sub-city districts (neighbourhoods) of the Rhine-Ruhr conurbation were classified into characteristic "types" by regional factor and cluster analysis. According to the analysis, residential patterns observed in this region reflect a number of basic neighbourhood characteristics identified by previous research in other regions throughout the Western world (Neumann 2013). Six neighbourhood types (Table 2) were identified. They can be described as

1. central city commercial areas and surrounding neighbourhoods with a high share of one-person-households, few children and a relatively high share of foreign nationals,
2. "urban" areas with a mixed composition of age groups and household types,
3. "ageing" urban areas with a mixed household structure, a low share of foreign nationals and an above-average share of senior citizens (over 60),
4. "aged" (and relatively wealthy) urban residential areas with a very high share of seniors (over 60),
5. urban with a very high share of foreigners (and children), and
6. low-density residential areas, inhabited mainly by (high income German) families.

While typical central city neighbourhoods with very small households, few children and a high share of working-age residents emerge in all of the large cities, in Düsseldorf they dominate among the total spectrum of neighbourhoods to a much greater extent than in the large cities of the Ruhr (Table 1). In the Ruhr, these central city quarters are a characteristic of the large cities, but rarely of smaller cities or the outer urban zone. In the outer zone, "ageing" areas are most common.

Between 1998 and 2008, the number of the - arguably highly mobile - 18-30 year-olds increased particularly in central areas (+12.6), which were also the only neighbourhoods with a slight increase (+0.9%) in the number of foreigners (Table 3). Due to further ageing of the now 40-50 year-old "baby-boomers" born in the 1960s, in about one and a half decades, low-density

[7]Due to immigration from former Eastern Bloc countries and the former Yugoslavia, there were temporary migration gains in all regions between 1987 and 1992.

(type 6) neighbourhoods will belong to those with a high share of over 60 year-olds, unless many of them decide to move elsewhere in the near future. In these neighbourhoods, ageing of the residential population will, in combination with a lack of an influx of mobile inhabitants, account for considerable changes of local demographic characteristics. Already in the study period from 1998 to 2008, the over 60-year-old population increased most rapidly (+16%) in these low-density residential neighbourhoods. Most likely, this demographic ageing process will affect (among others) local service and housing markets.

Table 2
Demographic characteristics of sub-city district types in Ruhr region
2008, statistical districts

	Type						
	1	**2**	**3**	**4**	**5**	**6**	**Total**
total	309.058	1.682.125	1.670.357	847.726	308.415	967.68	4.914.449
thereof (in %)							
foreigners	14.8	13.2	7.0	6.8	25.6	4.5	10.7
under 18	12.7	17.6	16.5	14.1	21.1	18.5	16.6
18 – 30	18.8	14.6	12.6	12.1	16.8	12.0	13.8
30 – 40	16.2	12.6	11.5	11.0	13.8	11.9	12.2
40 – 50	15.6	16.0	17.4	15.7	14.8	19.6	16.4
50 – 60	12.3	13.8	14.8	14.1	12.1	14.7	14.0
over 60	24.3	25.4	27.2	31.2	21.3	23.3	26.6
persons per household	1.6	2.1	2.1	2.0	2.1	2.3	2.0

Author´s calculation based on data from AG KOSTAT und IT.NRW - Typology: 1 = city centre, 2 = "urban mix", 3 = ageing, 4 = high-age, 5 = migrant families, 6 = German families, 417 observations

Table 3
Population change in sub-city district types of Ruhr region
1998-2008, statistical districts, in %

	Type						
	1	**2**	**3**	**4**	**5**	**6**	**total**
total	-3.3	-4.9	-2.6	-4.5	-3.9	5.8	-3.7
foreigners	0.9	-8.2	-15.9	-4.6	-9.5	-8.0	-9.2
under 18	-8.9	-13.0	-14.6	-15.1	-9.0	-4.5	-13.2
18 – 30	12.6	-4.7	-5.4	-4.6	-4.1	1.8	-3.5
30 – 40	-17.3	-26.7	-33.2	-33.2	-15.4	-30.3	-28.7
40 – 50	11.8	8.3	14.0	6.9	8.2	33.5	10.8
50 – 60	-1.4	8.6	11.6	-0.1	-0.6	28.2	7.2
over 60	-8.8	1.9	11.7	3.3	1.0	16.0	4.8

Author´s calculation based on data from AG KOSTAT und IT.NRW - Typology: cf. Table 2, 417 observations

5. Regional migration and neighbourhood choice

5.1 Descriptive overview

For the purpose of analysing (intra-)regional migration and neighbourhood choice, micro-level information from a representative survey among the Ruhr population, carried out in 2010, was

combined with aggregate data about the demographic composition of neighbourhoods of survey participants. Since the aggregate-level demographic statistics provided by infas (see above) refers to smaller territorial entities than the municipal sub-city districts referred to in the previous section, a separate analysis of the demographic characteristics of infas neighbourhoods was carried out. Since in the micro-level analysis, infas neighbourhood types represent choice options, the statistical classification procedure is outlined in the following. According to the results of a principal component analysis three dimensions (factors) represent most of the differentiation observable by a set of eight original indicators (comprising four age categories, household size, population density, population per building and average purchasing power per person, Table 4)[8]. Based on the factor values of each statistical district, three neighbourhood types (Table 5) were identified[9]. 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.

Type 1 (central city areas) corresponds with types 1 (central), 2 (urban residential) and 5 (foreigners) of the typology derived from municipal sub-city districts in the previous chapter (see above). During the past decade, these districts were the main target of household relocations by the mobile working-age population (see above). Type 2 comprises types 3 and 4 of the municipal typology and type 3 corresponds with type 6, although in the infas typology a larger share (over a third in 2010) of the residential population is assigned to "family" neighbourhoods than in the municipal typology (under a fourth in 2008, Tables 2 and 5). Since neighbourhood statistics was only provided for 2,318 out of 3,237 survey participants, in the analysis of mobility a lack of housing area information will be considered as a separate category.

[8]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.

[9]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 4
Factor analysis*of neighbourhood demography in of Ruhr region
2010, infas neighbourhoods of participants in representative survey

Variable	communality**	factor loadings***		
		factor 1	factor 2	factor 3
household size	0.63	0.11	-0.50	0.04
population per km²	0.71	-0.02	0.58	0.04
persons per building	0.73	0.05	0.60	0.03
purchasing power (€/person)	0.41	-0.33	-0.21	0.29
population < 15	0.96	0.53	-0.01	0.24
population 15-25	0.93	0.52	0.03	0.27
population 25-50	0.94	-0.02	-0.02	-0.82
population ≥ 65	0.90	-0.57	0.07	0.23
explained variance (in %)		33.9	26.5	17.2

Author´s calculation. Data source: infas - *principal component analysis, varimax rotation, **variance explained by factor model, values between 0 and 1 possible, ***correlation between variables and factors, 2318 observations

Table 5
Demographic neighbourhood types of Ruhr region
2010, infas neighbourhoods of participants in representative survey

	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
purchasing power (€ per person)	17,919	19,744	17,983	18,514

Author´s calculation. Data source: infas - Typology: 1 = city centre, 2 = ageing, 3 = families, 2318 observations

In addition to demographic statistics at the neighbourhood level, the infas data base provides a categorical variable characterising the type and quality of the housing stock in the immediate vicinity of the residential location of 2,891 survey participants (see above). Among a range of 53 categories, this typology separates between higher and lower quality housing stock[10]. Since 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 the information about housing quality. A

[10] The housing stock typology comprises the following categories: farms, rural settlements, small town: high quality residential area, small town: centre, small town: lower quality residential area, 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 age and city size, resulting in 53 categories altogether.

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.

"Migration" in the analysis refers to all individuals (the basic level of observation is the individual), who have moved to the city, in which they live in now, during the past 15 years[11]. This "mobile" group comprises 22% of the total survey population (Tables 6 and 7).

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)

Analysis of individual-specific location preferences takes into account demographic characteristics at the household (household income, household size, homeownership, local

[11] 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 24% of all observations, category 6 accounts for 76%. Migration was defined as moving to this city during the past 15 years, since not a sufficient number of observations represents more recent mobility.

housing stock) and individual (age, migration background, job mobility, commuting) level (Table 6). Taking up a new job is expected to be a main motive of migration. A job is defined here as "new" if it was taken up within five years before the survey. 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. Mobility in the core cities focuses on central areas (out of 21.6% of the core city population, who were "mobile", 8.5% had moved to a central area, in the outer zone only 1.4% out of 22.6%, Table 7). As a consequence, an above-average share of the population in central areas is "mobile" (27.8% as opposed to 22% in the Ruhr as a whole, Table 8). The shares persons who were born abroad and job starters are above the Ruhr average in the core cities, whereas the shares of homeowners and commuters are higher 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
to demographic neighbourhood type			
1 (centre)	5.9	8.5	1.4
2 (ageing)	4.5	2.6	7.7
3 (families)	5.6	4.2	8.1
n.a.	5.9	6.2	5.5
household income in € (median)	2,200	2,200	2,300
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
born abroad	13.9	15.7	10.7
upper secondary school	26.3	27.8	23.6
Owner	44.4	39.1	53.7
work in city of residence	31.3	34.8	25.1
new job	23.8	25.4	21.2
large city	38.5	68.6	0.0
shopping in neighbourhood	52.7	58.3	43.0
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

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	2,500	2,000
persons in household (mean)	3.0	2.5	2.7	2.8	3.8
age (mean)	49.1	47.1	51.1	48.1	50.0
Migration	22.0	27.8	20.2	20.6	20.3
under 40	31.7	39.4	25.8	33.9	28.4
born abroad	13.9	18.5	10.9	10.6	15.8
upper secondary school	26.3	30.0	25.4	25.1	25.4
owner	44.4	27.3	55.5	48.9	44.2
work in city of residence	31.3	36.7	31.7	30.2	27.9
new job	23.8	30.5	21.7	23.2	21.2
large city	38.5	60.3	28.5	29.7	38.4
shopping in neighbourhood	52.7	56.5	51.4	52.5	51.1
house price high	22.8	22.8	47.4	27.3	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

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
under 40	31.7	52.6	25.8
born abroad	13.9	26.5	10.3
upper secondary school	26.3	35.1	23.8
Owner	44.4	31.7	48.0
work in city of residence	31.3	29.3	31.8
new job	23.8	39.8	19.4
large city	38.5	39.9	38.1
shopping in neighbourhood	52.7	48.2	54.0
house price 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

Neighbourhood amenities are characterised according to the self-assessed shopping behaviour of survey participants. 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. Shopping within the neighbourhood will be interpreted as an indicator of neighbourhood amenities.

The mobile population is more “urban” than other people in the Ruhr, insofar as the shares of working-age adults, foreign-born persons and job-starters are considerably higher, whereas the

share of homeowners, the average household income and the average age of household members are lower (Table 9)[12].

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

Among those 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). Migrants to ageing areas (type 2) earned an above-average household income and are more likely to own their dwelling. Working-age adults (18-40) are underrepresented among migrants to ageing areas. While mobility as a whole during the past two decades in the Ruhr has reinforced long-established sorting patterns, people with a migrant background have begun to settle in higher-income neighbourhoods (type 2), where the share of foreigners is still low. As found by the neighbourhood-level analysis in the previous section, location preferences of foreigners changed in the past decade (see above).

Job-related and other mobility among young adults focused on central areas of the large core cities. Well-off households continue to settle in well-off areas, but to some extent an inflow of people with a migrant background may change the characteristics of these neighbourhoods. Apart from an above-average age and a higher inclination to commute, no specific characteristics separate mobile persons with unknown neighbourhood destinations from other mobile people.

Migration analysis thus corroborates a strong focus of mobility on central city areas, which is likely to reinforce demographic differentials within the large cities and between cities and surrounding smaller municipalities in the Ruhr and possibly other large urban agglomerations.

In comparison, mobile individuals sort across neighbourhood types more distinctly than non-mobiles according to age and education (under 40 year-olds and highly educated individuals preferring either central or family neighbourhoods). Non-mobile persons are sorted more distinctly by household size, the migrant background and commuting (commuting being unlikely in central quarters but likely in family neighbourhoods) (Table 11). Along with

[12] 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.

segregation by age, regional mobility therefore reinforces segregation by education, as expected by a number of authors (see above).

Table 10
First Stage: Individual preferences of mobile persons, by demographic neighbourhood type
Multinomial logit[1]

	1 dy/dx	2 dy/dx	3 dy/dx	n.a. 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 dy/dx	2 dy/dx	3 dy/dx	n.a. dy/dx
income (log)	-0.005	0.039*	0.038*	-0.072***
	(0.018)	(0.021)	(0.022)	(0.013)
persons in household	-0.050***	0.012*	0.021***	0.017***
	(0.010)	(0.007)	(0.007)	(0.005)
under 40	0.046	-0.067**	0.016	0.005
	(0.028)	(0.030)	(0.031)	(0.026)
Male	0.022	-0.023	-0.002	0.003
	(0.024)	(0.025)	(0.027)	(0.022)
born abroad	0.103***	-0.081*	-0.090*	0.068**
	(0.039)	(0.045)	(0.047)	(0.033)
upper secondary school	0.023	0.019	-0.029	-0.013
	(0.029)	(0.029)	(0.032)	(0.028)
new job	0.052*	-0.021	-0.036	0.005
	(0.030)	(0.032)	(0.034)	(0.028)
no commuting	0.058**	-0.008	-0.056**	0.006
	(0.025)	(0.025)	(0.027)	(0.023)
Pr(Y = 1, … , 3, n.a.)	0.247	0.245	0.311	0.197
observations		1,219		
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

5.3 Parameters of mean indirect utility (second stage of the estimation)

Comparison between preferences and utility related to location choices of mobile and (recently) non-mobile households suggests that changes of location preferences in combination with ageing result in considerable variation of the pace of neighbourhood-level demographic change.

As a whole, in the utility considerations relating to housing choices in the Ruhr agglomeration, given individual-specific preferences of all households, currently residence in one of the largest cities (Bochum, Dortmund, Duisburg or Essen) turns out to be more desirable than in the smaller core cities or in the outer zone. Utility of residence in the largest cities appears to be even more distinct among mobile households than among non-mobile households.

Table 12
Mean indirect utility 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	0.473***	0.463***	0.248***	0.232***	0.248***	0.229***
	(0.0722)	(0.104)	(0.0189)	(0.0246)	(0.0159)	(0.0255)
shopping in neighbourhood	-0.0129	0.195*	0.0435**	0.0454*	0.0322**	0.0585**
	(0.0710)	(0.113)	(0.0185)	(0.0239)	(0.0156)	(0.0250)
house price high	-0.191***	-1.986***	-0.0595***	-0.737***	-0.0797***	-1.065***
	(0.0734)	(0.431)	(0.0196)	(0.0925)	(0.0164)	(0.0995)
instrument for house prices	No	Yes	No	Yes	No	Yes
constant	-0.955***	-0.955***	-0.420***	-0.955***	-0.491***	-0.955***
	(0.0546)	(0.0546)	(0.0156)	(0.0546)	(0.0127)	(0.0546)
observations	547	547	1,771	1,771	2,318	2,318
adjusted R^2	0.109		0.119		0.142	

Author´s calculations. - * 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)

In line with the expectations derived from urban economic theory, housing cost is inversely related to overall utility, i.e. given the budget a high price corresponding to a utility reduction (equation 4). Among mobile households finding accommodation at reasonable prices accounts for an even greater weight in the utility considerations relating to residential location than among the Ruhr population as a whole.

In the OLS regressions a dummy variable accounting for a high housing quality within the immediate vicinity of the residence is used as a proxy for (high) prices (estimations 1, 3 and 5

in Table 12). 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.

Among the 2SLS estimations shopping as an indicator of neighbourhood amenities is found to be a utility characteristic of both mobile and non-mobile households, but is assigned an even greater importance among mobile households.

In line with the results of the first-stage estimation and the analysis of neighbourhood-level demographic change during the period from 1998 to 2008, the second stage outlines a strong preferences among the younger (and on average, relatively highly educated) mobile population for central city locations providing urban amenities.

6. Conclusions

In the Ruhr region over the past decades demographic change coincided with a change in the location decisions of mobile households. 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. In comparison with the more prosperous nearby Rhinefront cities (Bonn, Cologne, Düsseldorf) this relative population shift to city centres in the Ruhr so far has been more moderate. It is a specific characteristic of the Ruhr, which is an amalgam of neighbouring cities, to be less densely populated than other urban agglomerations in Germany (Budde and Neumann 2015). Lower overall density here combines with a somewhat wider diversity of neighbourhood populations.

Since mobility of younger adults has focused 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. Local economies in various markets, e.g. housing, health care, consumer services, and retail, have begun to adapt to demographic change. In different European countries, e.g. Germany, the Netherlands and the U.K., over the past decades support

to local communities has been provided by neighbourhood-oriented renewal policy. The outcomes suggest that local economic development can be supported quite effectively by a public policy, which seeks to activate local potential, keeping in mind the advantages and disadvantages of different types of urban location (North and Syrett 2008).

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