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RESEARCH ARTICLE

Trajectories of ethnic neighbourhood change: Spatial patterns of increasing ethnic diversity

Merle Zwiers[1] | Maarten van Ham[1,2] | David Manley[3]

[1]OTB—Research for the Built Environment, Faculty of Architecture and the Built Environment, Delft University of Technology, Delft, The Netherlands

[2]School of Geography and Sustainable Development, University of St Andrews, St Andrews, Fife, UK

[3]School of Geographical Sciences, University of Bristol, Bristol, UK

Correspondence
Merle Zwiers, OTB—Research for the Built Environment, Faculty of Architecture and the Built Environment, Delft University of Technology, PO Box 5030, 2600 GA Delft, The Netherlands.
Email: m.d.zwiers@tudelft.nl

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Abstract

Western cities are increasingly ethnically diverse, and in most cities, the share of the population belonging to an ethnic minority is growing. Studies analysing changing ethnic geographies often limit their analysis to changes in ethnic concentrations in neighbourhoods between 2 points in time. Such a temporally limited approach limits our understanding of pathways of ethnic neighbourhood change and of the underlying factors contributing to change. This paper analyses full trajectories of neighbourhood change in the 4 largest cities in the Netherlands between 1999 and 2013. Our modelling strategy categorises neighbourhoods based on their unique growth trajectories of the ethnic population composition, providing insight in processes of ethnic segregation and its drivers. Our main conclusion is that the ethnic composition in neighbourhoods remains relatively stable over time. We however find evidence for a slow trend towards deconcentration of ethnic minorities and increased population mixing in most neighbourhoods. Spatial mixing appears to be driven by the selective mobility patterns of the native Dutch population as a result of urban restructuring programmes. However, these pathways towards deconcentration are mitigated by processes of ethnic natural growth that reinforce existing patterns of segregation. Despite an increasing inflow of the native Dutch into ethnic concentration neighbourhoods, segregation at the top and bottom ends of the distribution seems to be persistent: High concentrations of ethnic minorities in disadvantaged neighbourhoods versus high concentrations of the native population in more affluent neighbourhoods continue to be a feature of Dutch cities.

KEYWORDS

ethnic segregation, latent class growth modelling, longitudinal study, neighbourhood trajectories, population dynamics

1 | INTRODUCTION

The share of ethnic minority residents has been increasing in many major European cities during the past 2 decades, and these cities are experiencing increasing ethnic diversity (Vertovec, 2007). For example, in 1999, non-western ethnic minorities, such as Turks, Moroccans, Antilleans, and Surinamese, comprised 8.5% of the Dutch population. By 2015, the share of the same groups had increased to 12.1%, which, in absolute numbers, means that the number of ethnic minorities in the Netherlands has increased by almost 700,000 people in 16 years (Statistics Netherlands, 2016a). About 62.5% of this increase in the number of ethnic minorities is the result of natural growth (Statistics Netherlands, 2016a). Geographically, members of ethnic minorities tend to be overrepresented in large cities because of the services and the availability of affordable housing (cf. Borjas, 1999) and the presence of immigrant networks (Logan, Zhang, & Alba, 2002). Studies on ethnic segregation have focussed on the question of how ethnic minorities are sorting into different neighbourhoods in these cities and to what extent

they live together or apart from the native population (e.g., Bolt & Van Kempen, 2010; Johnston, Poulsen, & Forrest, 2009, 2010; Poulsen, Johnston, & Forrest, 2011). Although segregation is most often viewed as a condition of neighbourhoods and cities at a certain point in time, ethnic segregation is not a static phenomenon but is a dynamic process that develops through time without a specific end point (Johnston et al., 2010). An emerging body of research is therefore focussed on investigating segregation from the perspective of the changing ethnic population composition in neighbourhoods (e.g., Johnston et al., 2009; Poulsen et al., 2011). Analysing what types of neighbourhoods experience change in the ethnic population composition and identifying the drivers of these changes is crucial to our understanding of processes of ethnic segregation.

There are two main drivers of ethnic neighbourhood change. The first is residential mobility. The selective moving behaviour of different ethnic groups can affect ethnic neighbourhood change in different ways. Studies on segregation have argued that ethnic heterogeneity in neighbourhoods stimulates the out-mobility of the native (majority) population to more "white" neighbourhoods (e.g., Clark & Coulter, 2015; Kaufmann & Harris, 2015). "White avoidance" theories, however, argue that the native population avoids ethnically diverse areas in the first place (Clark, 1992; Quillian, 2002). In both cases, the moving behaviour of the native population affects the ethnic population composition in neighbourhoods. With regards to the residential mobility of ethnic minorities, studies on "spatial assimilation" have argued that as ethnic minorities become more assimilated into the host society over time, they tend to move away from concentration areas developing similar residential mobility patterns as the native population (Bolt & Van Kempen, 2010; Sabater, 2010; Simpson & Finney, 2009; Simpson, Gavalas, & Finney, 2008). However, there is evidence that indicates that ethnic minorities are less likely to leave and more likely to move into ethnically concentrated neighbourhoods (e.g., Bolt & Van Kempen, 2010), as a result of a lack of financial resources (Clark & Ledwith, 2007), institutional constraints (Galster, 1999; Musterd & de Winter, 1998), or specific ethnic preferences (Bolt, Van Kempen, & Van Ham, 2008).

A small body of research highlights a second driver and has argued that ethnic neighbourhood change is the result of both residential mobility and demographic change (Finney & Simpson, 2009; Simpson, 2004, 2007; Simpson & Finney, 2009). The share of ethnic minorities in a particular neighbourhoods can change without residential mobility. Demographic events such as birth and deaths can influence ethnic neighbourhood change in different ways. The relatively young age structure of many migrant groups often implies higher fertility rates when compared with the majority population (Finney & Simpson, 2009). When ethnic minorities have disproportionally more children than natives, the share of ethnic minorities in a neighbourhood increases irrespective of mobility patterns. Similarly, higher mortality rates among the native population as a result of ageing might lead to high natural decline among natives, thereby reducing the share of the native population in a neighbourhood (Finney & Simpson, 2009; Simpson & Finney, 2009).

Residential mobility and demographic change are important drivers of ethnic neighbourhood change, which affect ethnic segregation. In the context of growing ethnic diversity in many cities, it is important to question the extent to which this growth is evenly distributed over neighbourhoods within these cities. Are there, for instance, particular neighbourhoods that experience above average increases in their share of ethnic minorities, and if so, is this increase driven by selective sorting processes or natural growth? Or are ethnic minorities increasingly integrated, showing more variation in their residential mobility patterns over time? The present study aims to answer these questions by analysing full trajectories of ethnic neighbourhood change in the four largest cities in the Netherlands between 1999 and 2013. We employ a latent class growth model to categorise neighbourhoods based on their unique growth trajectories of the ethnic population composition over time. This modelling strategy offers an empirical contribution to segregation research by categorising patterns of ethnic neighbourhood change, contributing to our understanding of diverging processes of ethnic segregation over time. Theoretically, this paper bridges two important fields of literature on the drivers behind ethnic segregation: residential mobility and natural growth. By integrating these theories, we seek to better understand the relative impact of both mechanisms on various levels of ethnic neighbourhood change.

2 | ETHNIC NEIGHBOURHOOD CHANGE

Many studies on the spatial distribution of ethnic groups in urban areas have focussed on the clustering of ethnic minorities in particular (often disadvantaged) neighbourhoods and the potential hampering effects of segregation on social integration, mobility, and interethnic contact, posing a threat to inclusive diverse societies. An overwhelming body of research on ethnic segregation has used single-number indices to express the level of uneven spatial distribution of ethnic groups, or their isolation, centralisation, concentration, or clustering. These indices have been criticised for failing to provide insight into contemporary patterns and varying degrees of population mix (Johnston et al., 2010; Poulsen et al., 2011). To better understand to what extent different ethnic groups live together or apart in different urban areas, researchers have created typologies of neighbourhoods based on the ethnic population composition (e.g., Johnston et al., 2010; Marcuse, 1997; Poulsen, Johnston, & Forrest, 2001; Simpson, 2007). These typologies are based on different percentages of ethnic minorities or natives in neighbourhoods (Poulsen et al., 2001, 2011; Simpson, 2007). Although these typologies provide more insight in the population composition in neighbourhoods than indices, these typologies have been criticised for exaggerating segregation by using arbitrary thresholds (Peach, 2009). The present study therefore uses an alternative method to classify neighbourhoods: We categorise neighbourhoods that follow the same pattern of change in the ethnic population composition over time. As a result, we present an empirical typology of ethnic neighbourhood change that does not rely on predisposed definitions. A focus on ethnic neighbourhood change allows for a better understanding of the role of residential mobility and demographic change in reproducing or changing the ethnic geography (Simpson & Finney, 2009).

Residential mobility has long been seen as the most important driver behind ethnic segregation. The selective sorting of ethnic minorities can mostly be explained by the availability of affordable housing and the presence of ethnic networks. Researchers have argued that ethnic minorities tend to move to ethnically dense neighbourhoods after recent immigration, because of the benefits in terms of social

networks and support from other coethnics (Dunn, 1998; Peleman, 2002). However, over time, ethnic minorities tend to move away from concentration areas showing similar residential mobility patterns as the native population (Bolt & Van Kempen, 2010; Sabater, 2010; Simpson & Finney, 2009; Simpson et al., 2008). This process of "spatial assimilation" is arguably the result of increasing socio-economic and cultural assimilation (Alba & Logan, 1993; Fong & Wilkes, 1999; South & Crowder, 1998). Indeed, empirical research has shown that ethnic minorities are increasingly moving into high-status, native-majority neighbourhoods (Bader & Warkentien, 2016; Hussain & Stillwell, 2008; Sabater, 2010; Simpson et al., 2008) and are more likely to move away from concentration areas when their socio-economic situation improves (Bolt & Van Kempen, 2010; Catney & Simpson, 2010; Simpson et al., 2008; South & Crowder, 1998). However, spatial assimilation seems to be dependent on socio-economic status: After controlling for socio-economic differences, ethnic minorities continue to be more likely to move into concentration neighbourhoods (Bolt & Van Kempen, 2010; South & Crowder, 1998) and the existence of neighbourhoods characterised by concentrations of ethnic minorities and disadvantage seems to be persistent (Bolt & Van Kempen, 2010; Jivraj & Khan, 2015; Lymperopoulou & Finney, 2016).

The residential mobility behaviour of the native population also plays a role in the process of place stratification. Although the dominant theory has long been that natives tend to move away from ethnic minority neighbourhoods, the so-called process of "white flight" (Crowder & South, 2008; Galster, 1990; Massey & Denton, 1993), researchers have also focussed on processes of "white avoidance" where natives tend to avoid minority populated neighbourhoods (Farley, Steeh, Krysan, Jackson, & Reeves, 1994; South & Crowder, 1998). Research has shown that it is not "white flight" or "white avoidance" per se, but "wealth flight," arguing that high-income groups—regardless of ethnicity—tend to move away from, or avoid, disadvantaged areas (cf. Brama, 2006; Erdosi, Geroha, Teller, & Tosics, 2003; Johnston, Poulsen, & Forrest, 2015; Mezzetti, Mugano, & Zajczyk, 2003).

The effects of residential mobility on segregation, however, need to be understood in relation to demographic developments (e.g., Bader & Warkentien, 2016; Simpson et al., 2008). The population composition of neighbourhoods can change without in- and out-migration. Fertility rates are generally higher among immigrants, because of their relatively young age structure. In particular, the fact that ethnic minorities tend to have more children than natives, combined with a native population that is ageing, implies that ethnic minorities have a relatively high rate of natural increase (Simpson & Finney, 2009). Processes of family formation in the years after immigration can therefore lead to increasing ethnic concentrations in particular areas (Finney & Simpson, 2009). At the same time, residential mobility is not indifferent to demographic events. Research has shown that the native population is more likely to move out of diversity neighbourhoods as ethnic heterogeneity increases (Clark & Coulter, 2015; Crowder, Pais, & South, 2012; Kaufmann & Harris, 2015). However, over time, fertility rates are likely to decline as a greater spread of family stages can be expected among next generations (Simpson et al., 2008). As such, the effects of natural growth among minority populations on increasing or maintain levels of segregation is likely to decrease over time.

A recent body of research in the United Kingdom has analysed stability and change in the ethnic neighbourhood composition (e.g., Catney, 2016; Johnston et al., 2015; Johnston, Poulsen, & Forrest, 2016; Simpson & Finney, 2009). These studies have generally found evidence of increased ethnic diversity on the neighbourhood level and declining levels of ethnic segregation, mainly as a result of ethnic residential mobility (Simpson & Finney, 2009). There appears to be a tendency towards increased spatial mixing of different ethnic groups, showing that ethnic minorities are increasingly moving into "white" neighbourhoods, suggesting a process of spatial assimilation. At the same time, processes of "white flight" seem to have declined, meaning that the native population is less likely to move away from these neighbourhoods when ethnic minorities move in (Johnston et al., 2016; Simpson & Finney, 2009). These processes together lead to declining levels of segregation over time. In addition, as the role of natural growth in increasing or maintaining levels of segregation will most likely decrease over time, a further decline in segregation levels can be expected (Simpson et al., 2008). However, on the other hand, studies have shown that there continues to be persistent segregation at the top and bottom ends of the distribution, illustrated by the persistent existence of concentration neighbourhoods that are characterised by either a large native population or a large ethnic minority population (cf. Jivraj & Khan, 2015; Johnston et al., 2015, 2016; Lymperopoulou & Finney, 2016). The existence of these concentration neighbourhoods seem to be the result of processes of "white avoidance" on the one hand and socio-economic disadvantage among ethnic minorities on the other.

There are two gaps in the literature that the present study aims to address. First of all, most studies investigating ethnic segregation have either focussed on the degree of segregation at one point in time, or decreasing or increasing levels of segregation between two points in time. Studies in this vein have been limited by a lack of longitudinal analyses, failing to consider trajectories of ethnic neighbourhood change. Changes between two points in time provide insight in declining or increasing shares of ethnic minorities in neighbourhoods, but do not tell us anything about changing trends over time. As such, our understanding of changing spatial patterns of ethnic population change remains limited (Catney, 2015). By analysing full neighbourhood trajectories over time, the present study aims to provide a longitudinal view on segregation by identifying distinct spatial trajectories of ethnic population change. Second, most studies have focussed on residential mobility patterns as the main driver behind ethnic neighbourhood change. However, as ethnic neighbourhood change takes time to take effect, it is likely that births and deaths play an important role in changing the population composition of neighbourhoods (Finney & Simpson, 2009). Especially, the combination of specific patterns of residential mobility and natural change of different ethnic groups could have important effects on ethnic neighbourhood change. It is therefore necessary to analyse how different pathways, driven by different residential and/or demographic processes that occur simultaneously, affect segregation in cities.

3 | DATA AND METHODS

This study used longitudinal register data from the System of Social Statistical Datasets from Statistics Netherlands providing data on the full Dutch population from 1999 to 2013. Neighbourhoods are

operationalised using 500 by 500 m grids. The use of 500 by 500 m grids ensured the comparability of geographical units, keeping geographical boundaries constant over time and allowing for a detailed analysis of neighbourhood change on a low spatial scale. Individual level data have been aggregated to the level of 500 by 500 m grids. We focussed on the share of ethnic minorities in 500 by 500 m grids in the four largest cities in the Netherlands: Amsterdam, Rotterdam, Utrecht, and The Hague, leading to a total of 1,496 grids. Grids with less than 10 residents have been excluded from the analyses for privacy reasons.

We concentrated on the four largest non-western migrant groups in the Netherlands: the Moroccans, Turks, Surinamese, and Antilleans. Moroccans and Turks immigrated to the Netherlands in the 1970s, mainly due to labour migration, whereas the postcolonial migration of the Surinamese and Antilleans largely occurred in the 1980s and 1990s. These four groups are often overrepresented in particular disadvantaged neighbourhoods, and academic and political debates on ethnic segregation have focussed on the spatial concentration of these four ethnic groups in particular neighbourhoods (Van Kempen & Bolt, 2009).

In the Dutch context, a person is considered to be an ethnic minority when he or she is born abroad or when one of his or her parents is born abroad (Statistics Netherlands, 2016b). We focussed on the share of non-western ethnic minorities relative to the total population in a neighbourhood. Native Dutch and ethnic residential mobility is measured by net migration rates (number of people moving in minus the number of people moving out). In this study, migration is defined as the move out of a neighbourhood into a different neighbourhood (so moves within the neighbourhood are ignored). We compared the population composition at the beginning of each year (January I) to the population composition at the beginning of the following year. This implies that, in the case of multiple moves in a year, we focus on a household's residence on January 1. Natural growth is defined as the number of births minus the number of deaths. We calculated the number of ethnic minority children born and the number of ethnic minorities that died in a neighbourhood for each year. In addition, individual level income information has been aggregated and added to our dataset to analyse the share of households at risk of poverty (household income 60% below the median), the average household income, and the average house prices.

How to classify neighbourhoods according to their ethnic composition has been a methodological challenge in many studies. Many studies on ethnic neighbourhood change have created typologies based on population thresholds (e.g., Poulsen et al., 2001); however, the relatively arbitrary definition of these typologies dependent on group sizes and composition remains a problem (cf. Farrell & Lee, 2011). To overcome this problem, we employ a latent class growth model (LGCM) to create an empirical typology of ethnic neighbourhood change over time. Our modelling strategy can be seen as an alternative to the classification scheme as developed by Poulsen et al. (2001) that allows for the identification of trends in the ethnic population composition over time. Instead of using arbitrary cut-off points, our approach facilitates the empirical categorisation of neighbourhoods based on their unique growth trajectories of the ethnic population composition. This means that our modelling strategy allows us to identify neighbourhoods that follow similar developments in the ethnic population composition over time.

LGCMs enable the analysis of longitudinal data where there may be qualitatively different trajectories over time that are not identifiable ex ante (Nagin, 2005). As such, LGCMs overcome the issue of arbitrary classifications but instead allow for the identification of common trajectories based on the timing and pace of ethnic neighbourhood change. LCGMs are finite mixture models that utilise a multinomial modelling strategy (Jones & Nagin, 2013). Where growth curve models assume that all individual units of analysis are drawn from the same population with the same growth trajectory over time, LGCMs are based on the idea that individual units belong to different subpopulations (latent classes) that each have a unique growth trajectory (Nagin, 2005; Perelli-Harris & Lyons-Amos, 2015). The main assumption is that the outcome variable is conditional on time and that there are a finite number of different outcome trajectories of unknown order (Jones & Nagin, 2013).

The dependent variable in this study was the share of ethnic minorities in a neighbourhood. Because of the large number of zeros in the data, a zero-inflated Poisson model provided the most appropriate specification:

$$\ln\left(\lambda_{it}^{j}\right) = \beta_0^j + \beta_1^j t + \beta_2^j t^2 + \beta_3^j t^3 + \beta_4^j t^4,$$

where λ_{it}^{j} is the expected share of ethnic minorities of neighbourhood *i* at time *t*, given membership in group *j*. The coefficients determine the shape of the trajectory and can be estimated up to a fourth-order polynomial (Jones & Nagin, 2007).

Model selection is a well-known issue with trajectory models (Bauer & Curran, 2003; Warren, Luo, Halpern-Manners, Raymo, & Palloni, 2015). The estimation of the correct number of latent classes together with the assignment of individual units to the trajectory groups can be problematic. Nagin (2005) advises that the most parsimonious model that provides distinctively different trajectory groups should be selected. In this study, model selection was determined in two stages with the initial stage used to assess the optimal number of classes by comparing the Akaike information criterion (AIC), the Bayesian information criterion (BIC), and the sample-size adjusted BIC. Model fit was compared after adding a trajectory in a stepwise approach. The model with the lowest fit statistics is preferred (Nylund, Asparouhov, & Muthén, 2007). Although the BIC has been found to be a good indicator for determining the number of classes when the sample size is large enough ($N > 1000$; Nylund et al., 2007),[1] model convergence is a well-known problem with these statistical criteria (Jung & Wickrama, 2008; Warren et al., 2015). An additional statistic to analyse model fit is the average posterior probability (AvePP). The AvePP reflects the average probability that individual units belong to a trajectory group. A high AvePP implies a high probability of group membership (Nagin, 2005). We have compared the BIC and AvePP for multiple models, ranging from models with three trajectory groups to models with eight trajectory groups (see Table A1). We have selected a five-class model. Although the six- and seven-group models have lower BIC values and high AvePP's, these additional trajectories did not substantially differ

[1]Some researchers favour the use of the bootstrap likelihood ratio test for identifying the optimal number of classes (Nylund et al., 2007); however, this test was computationally too intensive for our servers.

from those in the five-class model. The four-class model proved inappropriate because of a lack of model fit. Our five-class model produced well-populated classes (each class consists of more than 5% of all cases; Warren et al., 2015) and showed qualitatively different trajectories. Although we cannot be certain about the "true" number of latent trajectories, descriptive statistics (see Table 3) and geographical maps (see Figures 2 and 3) of our five classes correspond to the known ethnic distribution in Dutch cities. The uncertainty around the true number of latent trajectories is especially problematic when trajectories are used as dependent or independent variables in subsequent analyses (Warren et al., 2015). The goal of the present study is however mainly descriptive, and although we cannot be certain about the true number of trajectories, four- and six-class models showed similar trajectories over time. As such, we believe that our five-class model can be used to describe general patterns of ethnic neighbourhood change in Dutch cities.

The second stage of model assessment relates to the shape of each of the six trajectories. This was estimated by specifying the order of the polynomial (see Nagin, 2005).[2] The model output is presented in Table 1. The estimated trajectories are illustrated in Figure 1. The predicted trajectories for each of the five classes are presented in Table 2. We estimated our model in Stata 14 using the package "traj" (Jones & Nagin, 2013). We have checked the robustness of our findings by conducting the analyses on different subsets of the data, for each city separately, and by reproducing our full analyses in Mplus (version 6.0.0.1). All analyses yield similar results.

To explore the role of population dynamics in each of the identified trajectories, we have created a series of profile plots. We visualised the net migration rates and natural growth rates of ethnic minorities and the net migration rates of the native Dutch for each of the trajectories (Figure 4-6). In addition, we have created maps of the trajectories for each of the four cities (Figures 2 and 3).

4 | RESULTS

In 1999, the number of ethnic minorities in the four largest Dutch cities was 430,616, comprising 21.2% of the total population. In 2013, the number of ethnic minorities rose to 536,307, comprising 23.9% of the total population. In absolute terms, the rise in the number of ethnic minorities reflects a 24.5% increase. Despite this absolute increase, we generally find stable neighbourhood trajectories in terms of the relative ethnic population composition over time. Table 1 presents the maximum likelihood estimates from the zero-inflated Poisson LGCM. The five trajectories are illustrated in Figure 1.

The first trajectory group accounts for 24.6% of the neighbourhoods in the four largest cities and is characterised by an intercept-only polynomial (b = 0.354, $p < .0001$). This means that, unlike the other trajectory groups, there has been no change in the share of ethnic minorities in this group of neighbourhoods over the entire 15-year observation period. Despite the general increase in the number of ethnic minorities in these four cities, this first trajectory group consists of neighbourhoods with hardly any ethnic minorities.

[2]The final model will have lower BIC values as a result of specifying the shape of the appropriate polynomials.

TABLE 1 Maximum likelihood estimates for a zero-inflated Poisson latent class growth model

	Parameter	Estimate	Standard error	T for H0 parameter = 0
Group				
1	Intercept	0.354	0.016	22.153****
2	Intercept	1.561	0.013	116.991****
	Linear	0.043	0.001	31.692****
3	Intercept	2.440	0.012	205.527****
	Linear	0.067	0.003	19.215****
	Quadratic	−0.002	0.000	−10.653****
4	Intercept	3.244	0.008	390.383****
	Linear	0.041	0.003	15.785****
	Quadratic	−0.002	0.000	−8.789****
5	Intercept	3.877	0.008	459.131****
	Linear	0.027	0.003	10.037****
	Quadratic	−0.002	0.000	−8.237****
Group membership				
1		24.6%	1.133	21.742****
2		25.6%	1.148	22.312****
3		22.1%	1.087	20.318****
4		18.4%	1.007	18.268****
5		9.3%	0.753	12.313****
BIC = −63345.2 (*N* = 21,733)				
BIC = −63323.8 (*N* = 1,496)				
AIC = −63281.3				
L = −63265.3				

*$p < .10$.

**$p < .05$.

***$p < .01$.

****$p < .001$.

The second trajectory group is estimated to account for 25.6% of the neighbourhoods and follows a linear trajectory of an increasing share of ethnic minorities, albeit slightly (b = 0.043, $p < .0001$). The third trajectory group shows an increasing linear trajectory (b = 0.067, $p < .0001$) together with a quadratic trajectory (b = −0.002, $p < .0001$). The predicted trajectories are presented in Table 2.

The third trajectory group first experiences a slight increase in the share of ethnic minorities but, over time, shows a modestly decreasing

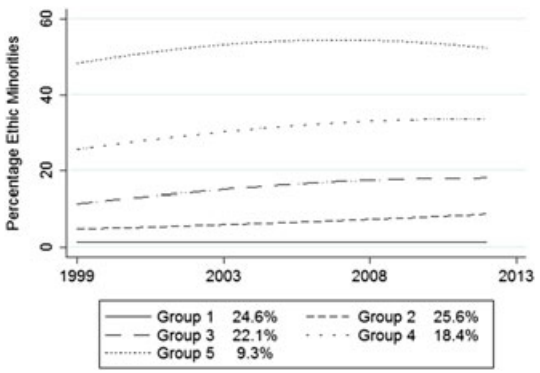

FIGURE 1 Trajectories of the five neighbourhood groups

TABLE 2 Predicted change in the share of ethnic minorities by trajectory group

	Group 1	Group 2	Group 3	Group 4	Group 5
1999	0.354	1.561	2.440	3.244	3.877
2000	0.354	1.604	3.000	3.000	4.000
2001	0.354	1.647	2.497	3.279	3.898
2002	0.354	1.691	2.485	3.271	3.891
2003	0.354	1.734	2.467	3.260	3.880
2004	0.354	1.777	2.445	3.247	3.866
2005	0.354	1.820	2.418	3.230	3.850
2006	0.354	1.863	2.387	3.210	3.830
2007	0.354	1.907	2.350	3.187	3.807
2008	0.354	1.950	2.308	3.161	3.781
2009	0.354	1.993	2.262	3.132	3.752
2010	0.354	2.036	2.210	3.100	3.720
2011	0.354	2.079	2.154	3.065	3.685
2012	0.354	2.122	2.093	3.026	3.647
2013	0.354	2.166	2.026	2.985	3.606

trend in the share of ethnic minorities. The third trajectory group comprises 22.1% of all neighbourhoods. Almost 75% of the neighbourhoods in the four largest Dutch cities are characterised by low shares of ethnic minorities, although some of these neighbourhoods have experienced slight increases in the share of ethnic minorities over time. The fourth trajectory group accounts for 18.4% of the neighbourhoods and has a linear coefficient (b = 0.041, $p < .0001$) and a quadratic coefficient (b = −0.002, $p < .0001$). The fifth trajectory group shows a similar linear (b = 0.027, $p < .0001$) and quadratic trajectory (b = −0.002, $p < .0001$), accounting for 9.3% of all neighbourhoods. The share of ethnic minorities is the highest in this latter group of neighbourhoods, illustrating that 9.3% of all neighbourhoods in the four largest Dutch cities are characterised by an ethnic majority population. The predicted trajectories in Table 2 show that neighbourhoods in trajectory groups four and five first experienced a small increase in the share of ethnic minorities but that they have seen a slight decrease in the share of ethnic minorities over time.

Table 3 shows the average characteristics of the neighbourhoods in each of the five classes in 2013. The first trajectory group is characterised by very few ethnic minorities and a high share of native Dutch (79.3%). Despite a high average household income of 71,243 euros a year, 19.6% of the households in these neighbourhoods are at risk of poverty. This might be explained by the Dutch tradition of social mixing, where social housing is located in a variety of different neighbourhoods (Van Kempen & Priemus, 2002). The average housing value in the first trajectory group lies at 435,850 euros. As such, these neighbourhoods can be seen as "white citadels" (Marcuse, 1997): neighbourhoods that are populated by a large native majority and are characterised by above average incomes and house values.

Each subsequent trajectory group shows an increase in the share of ethnic minorities and a decrease in the share of native Dutch. Similarly, the average household income and the average housing value decreases with each trajectory, whereas the share of households at risk of poverty increases. Neighbourhoods in the fifth trajectory with the highest share of ethnic minorities are characterised by a 52.3% ethnic minority population in 2013. About 23.1% of the population in these neighbourhoods is native Dutch. The average household income lies at 31,309 euros a year, which is less than half of the average income in the first trajectory group. The average house value of 139,817 is almost 4 times lower than the average house values in the first trajectory group. The share of households at risk of poverty is 44.1% in these neighbourhoods. This group of neighbourhoods can be seen as ethnic concentration neighbourhoods characterised by relative disadvantage. These findings confirm the assumption that the spatial patterning of ethnic minorities is strongly related to income.

Figure 2 and 3 show the geography of the five trajectories in each of the four cities. The maps show that neighbourhoods that experience the same trajectory over time are generally clustered together.

Trajectory groups four and five are composed of neighbourhoods with the highest shares of ethnic minorities that tend to be located on the outskirts of all four cities. Many of these areas are postwar neighbourhoods and are characterised by high shares of low-quality (social-rented) housing. This finding is in line with previous studies on segregation in the Netherlands and shows considerable overlap with income segregation (Hochstenbach & Van Gent, 2015; Zwiers, Kleinhans, & Van Ham, 2016). Neighbourhoods in trajectory group one seem to be clustered together with neighbourhoods in trajectory group two. These white citadels are located in the most expensive parts of each city, such as neighbourhoods in the southern part of Amsterdam, and coastal neighbourhoods in The Hague. These geographies show that neighbourhoods with high shares of native Dutch and neighbourhoods with high shares of ethnic minorities are characterised by spatial concentrations. All four cities appear to show extreme clustering of trajectories where neighbourhoods with high

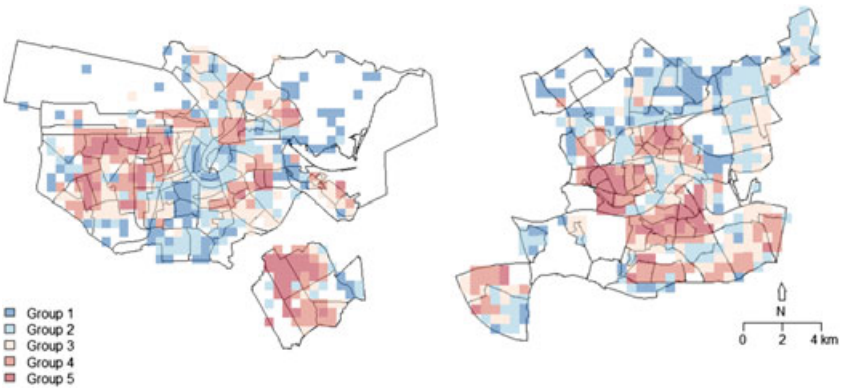

FIGURE 2 Geography of the trajectory groups in Amsterdam and Rotterdam

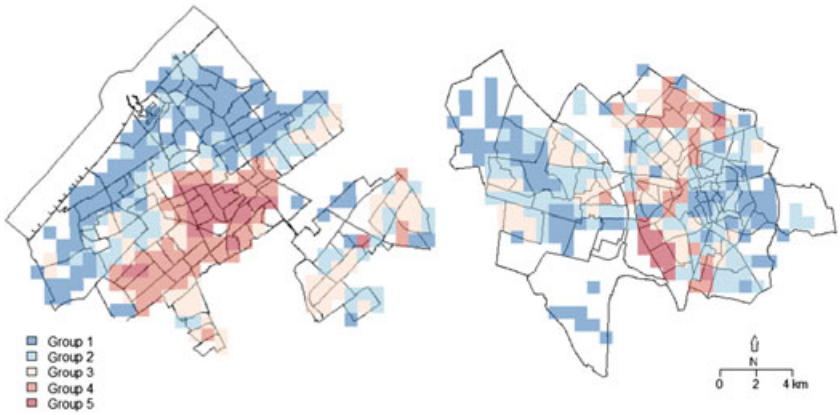

FIGURE 3 Geography of the trajectory groups in The Hague and Utrecht

TABLE 3 Socio-economic characteristics of the five trajectory groups in 2013

	Group 1	Group 2	Group 3	Group 4	Group 5
Average % Moroccans	0.3 (0.6)	1.8 (2.2)	4.9 (3.8)	10.8 (7.0)	18.6 (13.3)
Average % Turks	0.3 (0.6)	1.6 (1.7)	4.1 (2.8)	8.14 (5.4)	14.6 (9.5)
Average % Surinamese	0.8 (1.4)	3.6 (2.5)	7.3 (3.9)	11.1 (6.7)	15.3 (10.9)
Average % Antillean	0.4 (0.7)	1.3 (1.3)	2.0 (2.0)	3.7 (3.6)	4.1 (3.9)
Average % Dutch	79.3 (14.7)	71.7 (9.7)	60.8 (9.4)	42.7 (9.9)	23.1 (9.9)
Average % households at risk of poverty	19.6 (12.4)	23.8 (11.4)[a]	28.8 (12.2)	39.0 (11.7)	44.1 (9.1)[b]
Average income in euros	71243.4 (29757.1)	56892.0 (21578.5)[a]	48351.1 (20143.6)	36848.6 (10787.2)	31309.4 (6384.0)[b]
Average housing values in euros	435849.6 (214397.4)[c]	267152.7 (127105.9)[d]	211931.2 (85492.9)[e]	165598.2 (57601.9)[f]	139816.8 (35234.3)[b]
N	**367**	**385**	**330**	**275**	**139**

Note. Standard deviations in parentheses.

[a]*N* = 384.

[b]*N* = 137.

[c]*N* = 354.

[d]*N* = 379.

[e]*N* = 329.

[f]*N* = 274.

shares of native Dutch are spatially segregated from neighbourhoods with high shares of ethnic minorities. Especially, The Hague shows extreme clustering of white citadels along the more expensive coastal area and ethnically concentrated postwar neighbourhoods to the south east.

To understand how patterns of ethnic neighbourhood change can be explained, we analyse the role of residential mobility and natural population change. Figure 4 shows the mean net migration rates of ethnic minorities in each of the five trajectories. The figure shows that there is no ethnic migration in the first trajectory group. This finding seems to suggest that these white citadels are exclusionary spaces that are inaccessible to ethnic minorities. The second and third trajectory group have experienced positive net migration over our 15-year observation period. These positive migration rates seem to be more or less stable over time. The fourth and fifth trajectory groups experience declining migration rates of ethnic minorities. The negative net migration rates of ethnic minorities in these trajectory groups illustrate that there are more ethnic minorities moving out of these neighbourhoods than in. This trend is most pronounced in the fifth trajectory group, meaning that the most ethnically concentrated neighbourhoods show a decrease in the share of ethnic minorities as a result of ethnic out-mobility. The sharp decline in net migration rates in the fifth trajectory group between 1999 and 2005 is most likely the result of the Dutch policy of urban restructuring. Since the 1990s, many disadvantaged postwar neighbourhoods with high concentrations of ethnic minorities were targeted for urban restructuring to improve the socio-economic situation of these neighbourhoods. The main tool of urban restructuring was the large-scale demolition of low-quality social housing and the construction of more expensive

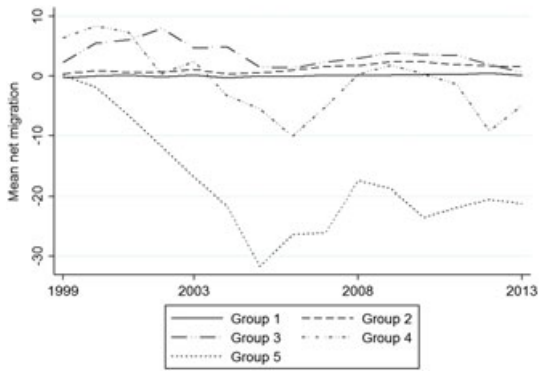

FIGURE 4 Ethnic net migration rates by trajectory group

owner-occupied or private-rented dwellings that forced many households to find affordable housing in other nearby neighbourhoods (Zwiers, Van Ham, & Kleinhans, 2017).

Figure 5 illustrates the role of natural population change in each of the trajectories. The figure first of all shows that fertility rates among the first generation of ethnic minorities have declined over time. This makes sense, as the age structure of the immigrant population matures over time, fertility rates will decline (see for instance Simpson et al., 2008). Figure 5 demonstrates that natural growth has remained stable in the first three trajectory groups, with no natural growth in the first trajectory group and general stable natural growth in the second and third trajectory groups. The other two trajectory groups have seen a decrease in natural growth over time, yet there is still positive natural change, meaning that the number of births still exceeds the number of deaths among ethnic minorities in these neighbourhoods.

Figure 4 suggests that selective mobility is an important driver behind changing ethnic residential patterns. Many individuals and households belonging to ethnic minority groups are moving out of the neighbourhoods with the highest ethnic concentrations and are simultaneously moving into more mixed areas. However, at the same time, Figure 5 shows that although natural growth rates among the first generation of migrants have declined over time, it is still an important explanation for the growth in the number of ethnic minorities in the four largest cities. Positive natural growth tends to reinforce existing patterns of ethnic segregation in the strongest concentration neighbourhoods. The combination of stable positive natural growth and ethnic in-mobility in neighbourhoods in trajectory groups two and three is likely to lead to a growth in ethnic diversity over time.

Figure 6 presents the net migration rates of the native Dutch population. The migration rates of the native Dutch have remained relatively stable in the first three trajectory groups, whereas trajectory groups four and five have seen an increasing inflow of the native Dutch population. At the beginning of our observation period, neighbourhoods in trajectory groups four and five experienced a substantial outflow of the native Dutch population. However, over time, it seems that these neighbourhoods have become more successful in attracting or maintaining the native Dutch population. It is very likely that the inflow of the native Dutch in these neighbourhoods is the result of urban restructuring in these neighbourhoods. Large-scale demolition and new construction has proven to be a successful tool to attract more middle- and high-class native Dutch residents to previously disadvantaged neighbourhoods

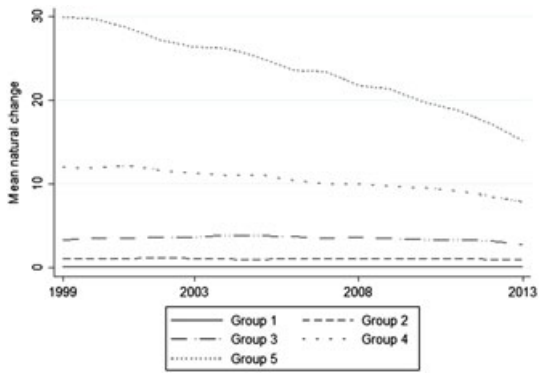

FIGURE 5 Ethnic natural change by trajectory group

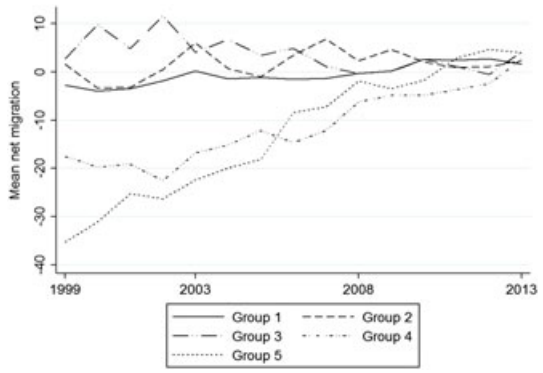

FIGURE 6 Native Dutch's net migration rates by trajectory group

(Zwiers et al., 2017). Together with an increasing outflow of ethnic minorities, these residential mobility patterns might lead to declining levels of segregation over time.

5 | DISCUSSION AND CONCLUSION

This paper has argued that to better understand ethnic segregation in cities, it is necessary to analyse the changing ethnic population composition in neighbourhoods as a result of residential mobility patterns and demographic changes. Although many studies have investigated changes in segregation levels, very few have actually investigated ethnic neighbourhood change over a longer time and with a high temporal resolution of data. In light of increasing ethnic diversity in most cities, it is especially important to investigate how this increasing diversity is being expressed geographically. The present study has investigated trajectories of ethnic neighbourhood change in the four largest cities in the Netherlands between 1999 and 2013 by using LGCMs. The use of annual data has the advantage over point-in-time measures to capture trends in ethnic neighbourhood change. Instead of using a predefined typology, our modelling strategy allowed us to create an empirical typology of ethnic neighbourhood change, identifying neighbourhoods that follow similar trajectories of change over time.

Our main conclusion is that neighbourhoods show relative stability in the ethnic population composition over a 15-year period. This finding is in line with previous studies that argue that neighbourhoods are rather "slothful" and that significant changes, if they occur at all, take long to take effect (Meen, Nygaard, & Meen, 2013; Tunstall, 2016; Zwiers et al., 2016). We have identified five different clusters of neighbourhoods based on their trajectories. Although these neighbourhood groups are generally characterised by stability, we find some indications of trends of change. We have shown that these neighbourhood trajectories are experiencing large population dynamics, even though this has not yet resulted in substantial ethnic neighbourhood change. These population dynamics might not have fundamentally changed the ethnic neighbourhood trajectories in the short run but might have an effect on ethnic neighbourhood change over a longer time horizon.

Our approach has yielded various interesting findings. First, we have identified a group of neighbourhoods in the four largest cities in the Netherlands with hardly any ethnic minorities over the entire

observation period. Almost 25% of all neighbourhoods in these cities are characterised by a high average income, a high average housing value, and a high share of native Dutch. As such, these neighbourhoods can be labelled "white citadels": "A citadel is a spatially concentrated area in which members of a particular population group, defined by its position of superiority, in power, in wealth, or status, in relation to its neighbours, congregate as a means of protecting or enhancing that position" (Marcuse, 1997, p. 247). The maps of the four cities show that these white citadels are located in the most expensive parts of each city, and our analysis suggests that these neighbourhoods are residentially inaccessible to ethnic minorities, illustrating the spatial manifestation of exclusionary elitism in increasingly ethnically diverse cities. This exclusive separation of the native population from ethnic minorities has been found in other studies as well (Johnston, Forrest, & Poulsen, 2002; Johnston et al., 2015; Marcuse, 1997). The question remains, however, to what extent this exclusionary elitism in these increasingly ethnically diverse cities is the result of "white avoidance or flight" or "wealth flight" and to what extent these neighbourhoods are accessible to other (ethnic) groups. Future research could provide more insight in the residential patterns of these native elites and analyse to what extent these white citadels are the result of native self-segregation.

Second, the share of ethnic minorities in those neighbourhoods with already high shares is actually decreasing (the fourth and fifth trajectory groups). This trend is most advanced in neighbourhoods with the highest share of ethnic minorities. Ethnic minorities are the majority group in these neighbourhoods, which are characterised by a low average income, a low average housing value, and a low share of native Dutch. We find that the deconcentrating trend can be explained by negative migration rates of ethnic minorities and positive net migration rates of the native Dutch. Although the outflow of ethnic minorities could be interpreted as an indication of processes of spatial assimilation, this outflow of ethnic minorities can most likely be explained by the Dutch policy of urban restructuring where large-scale demolition and new construction has fundamentally changed the housing stock in these disadvantaged neighbourhoods. This has resulted in an outflow of low-income households to a wide variety of other neighbourhoods and an inflow of middle-class native Dutch. The Dutch policy of urban restructuring has been successful in decreasing levels of ethnic and income segregation by creating socio-economically mixed neighbourhoods (Zwiers et al., 2017).

Third, most of the growth of ethnic minorities in these four Dutch cities can be explained by natural growth. We find that although ethnic minorities are increasingly moving away from concentration neighbourhoods in trajectory groups four and five, positive natural growth seems to slow the trend of declining concentration down. The increases in the share of ethnic minorities in trajectory groups two and three also appear to be the result of positive natural growth. An important conclusion is that the increasing number of ethnic minorities in the four largest Dutch cities has not lead to increasing levels of segregation or concentration. The ethnic population composition has remained stable in most neighbourhoods. The Dutch policy of urban restructuring has played an important role in maintaining stability in trajectory groups four and five by stimulating selective residential mobility. Without large-scale demolition and new construction, these neighbourhoods would probably have seen increasing ethnic concentrations as a result of natural growth.

Last, our results confirm that there is a strong relation between the spatial patterning of ethnic minorities and socio-economic status. Neighbourhoods with high shares of ethnic minorities are generally characterised by lower incomes, lower housing values, and more households at risk of poverty, whereas neighbourhoods with hardly any ethnic minorities are characterised by relative advantage. Dutch cities continue to be characterised by disadvantaged, ethnically concentrated neighbourhoods on the one hand and relatively expensive, native Dutch neighbourhoods on the other. Especially, the map of The Hague shows a geographically divided city with relatively disadvantaged neighbourhoods with high shares of ethnic minorities on the one side and advantaged neighbourhoods with high shares of native Dutch on the other. The fact that these latter groups of neighbourhoods appear to be inaccessible to ethnic minorities raises questions about the exclusion of certain groups in particular parts of cities. Although we find a trend towards ethnic deconcentration and increased spatial mixing, this can most likely be ascribed to urban restructuring programmes. It remains a question how recent budget cuts and declining government involvement will affect processes of ethnic segregation in the future.

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REFERENCES

Alba, R. D., & Logan, J. R. (1993). Minority proximity to whites in suburbs: An individual-level analysis of segregation. *American Journal of Sociology*, *98*(6), 1388–1427. https://doi.org/10.1086/230193

Bader, M. D., & Warkentien, S. (2016). The fragmented evolution of racial integration since the civil rights movement. *Sociological Science*, *3*, 135–166. https://doi.org/10.15195/v3.a8

Bauer, D. J., & Curran, P. J. (2003). Distributional assumptions of growth mixture models: Implications for overextraction of latent trajectory classes. *Psychological Methods*, *8*(3), 338–363. https://doi.org/10.1037/1082-989X.8.3.338

Bolt, G., & Van Kempen, R. (2010). Ethnic segregation and residential mobility: Relocations of minority ethnic groups in the Netherlands. *Journal of Ethnic and Migration Studies*, *36*(2), 333–354. https://doi.org/10.1080/13691830903387451

Bolt, G., Van Kempen, R., & Van Ham, M. (2008). Minority ethnic groups in the Dutch housing market: Spatial segregation, relocation dynamics and housing policy. *Urban Studies*, *45*(7), 1359–1138. https://doi.org/10.1177/0042098008090678

Borjas, G. J. (1999). The economic analysis of immigration. *Handbook of Labor Economics*, *3*, 1697–1760. https://doi.org/10.1016/S1573-4463(99)03009-6

Brama, A. (2006). 'White flight'? The production and reproduction of immigrant concentration areas in Swedish cities, 1990–2000. *Urban Studies*, *43*(7), 1127–1146. https://doi.org/10.1080/00420980500406736

Catney, G. (2015). Towards an enhanced understanding of ethnic group geographies using measures of clustering and unevenness. *The Geographical Journal*. https://doi.org/10.1111/geoj.12162

Catney, G. (2016). Exploring a decade of small area ethnic (de-)segregation in England and Wales. *Urban Studies*, *53*(8), 1691–1709. https://doi.org/10.1177/0042098015576855

Catney, G., & Simpson, L. (2010). Settlement area migration in England and Wales: Assessing evidence for a social gradient. *Transactions of the Institute of British Geographers*, *NS35*, 571–584. https://doi.org/10.1111/j.1475-5661.2010.00400.x

Clark, W. A. (1992). Residential preferences and residential choices in a multiethnic context. *Demography*, *29*, 451–466. https://doi.org/10.2307/2061828

Clark, W. A., & Coulter, R. (2015). Who wants to move? The role of neighbourhood change. *Environment and Planning A*, *47*(12), 2683–2709. https://doi.org/10.1177/0308518X15615367

Clark, W. A., & Ledwith, V. (2007). How much does income matter in neighbourhood choice? *Population Research and Policy Review*, *26*(2), 145–161. https://doi.org/10.1007/s11113-007-9026-9

Crowder, K., Pais, J., & South, S. J. (2012). Neighbourhood diversity, metropolitan constraints, and household migration. *American Sociological Review*, *77*(3), 325–353. https://doi.org/10.1177/0003122412441791

Crowder, K., & South, S. J. (2008). Spatial dynamics of white flight: The effects of local and extralocal racial conditions on neighbourhood outmigration. *American Sociological Review*, *73*(5), 792–812. https://doi.org/10.1177/000312240807300505

Dunn, K. (1998). Rethinking ethnic concentration: The case of Cabramatta, Sydney. *Urban Studies*, *35*(3), 503–370. https://doi.org/10.1080/0042098984880

Erdosi, S., Geroha, Z., Teller, N., & Tosics, I. (2003). Large housing estates in Hungary: Overview of developments and problems in Budapest and Nyıregyhaza. Restate Report 2c. Urban and Regional Research Centre, Faculty of Geosciences, University of Utrecht.

Farley, R., Steeh, C., Krysan, M., Jackson, T., & Reeves, K. (1994). Stereotypes and segregation: Neighbourhoods in the Detroit area. *American Journal of Sociology*, *100*(3), 750–780. https://doi.org/10.1086/230580

Farrell, C. R., & Lee, B. A. (2011). Racial diversity and change in metropolitan neighbourhoods. *Social Science Research*, *40*(4), 1108–1123. https://doi.org/10.1016/j.ssresearch.2011.04.003

Finney, N., & Simpson, L. (2009). Population dynamics: The roles of natural change and migration in producing the ethnic mosaic. *Journal of Ethnic and Migration Studies*, *35*(9), 1479–1496. https://doi.org/10.1080/13691830903125935

Fong, E., & Wilkes, R. (1999). The spatial assimilation model reexamined: An assessment by Canadian data. *International Migration Review*, *33*(3), 594–620. https://doi.org/10.2307/2547527

Galster, G. C. (1990). White flight from racially integrated neighbourhoods in the 1970s: The Cleveland experience. *Urban Studies*, *27*(3), 385–399. https://doi.org/10.1080/00420989020080341

Galster, G. C. (1999). The evolving challenges of fair housing since 1968: Open housing, integration, and the reduction of ghettoization. *Cityscape*, *4*(3), 123–138.

Hochstenbach, C., & Van Gent, W. P. C. (2015). An anatomy of gentrification processes: Variegating causes of neighbourhood change. *Environment and Planning A*, *47*(7), 1480–1501. https://doi.org/10.1177/0308518X15595771

Hussain, S., & Stillwell, J. (2008). Internal migration of ethnic groups in England and Wales by age and district type. Working Paper 08/3, School of Geography, University of Leeds, Leeds.

Jivraj, S., & Khan, O. (2015). How likely are ethnic minorities to live in deprived neighbourhoods? In S. Jivraj, & L. Simpson (Eds.), *Ethnic identity and inequalities in Britain: The dynamics of diversity* (pp. 199–214). Bristol: Policy Press.

Johnston, R., Forrest, J., & Poulsen, M. (2002). Are there ethnic enclaves/ghettos in English cities? *Urban Studies*, *39*(4), 591–618. https://doi.org/10.1080/00420980220119480

Johnston, R., Poulsen, M., & Forrest, J. (2009). Research note—Measuring ethnic residential segregation: Putting some more geography. *Urban Geography*, *30*(1), 91–109. https://doi.org/10.2747/0272-3638.30.1.91

Johnston, R., Poulsen, M., & Forrest, J. (2010). Moving on from indices, refocusing on mix: On measuring and understanding ethnic patterns of residential segregation. *Journal of Ethnic and Migration Studies*, *36*(4), 697–706. https://doi.org/10.1080/13691830903505045

Johnston, R., Poulsen, M., & Forrest, J. (2015). Increasing diversity within increasing diversity: The changing ethnic composition of London's neighbourhoods, 2001-2011. *Population, Space and Place*, *21*(1), 38–53. https://doi.org/10.1002/psp.1838

Johnston, R., Poulsen, M., & Forrest, J. (2016). Ethnic residential patterns in urban England and Wales, 2001-2011: A system-wide analysis. *Tijdschrift voor Economische en Sociale Geografie*, *107*(1), 1–15. https://doi.org/10.1111/tesg.12128

Jones, B., & Nagin, D. (2007). Advances in group-based trajectory modeling and an SAS procedure for estimating them. *Sociological Methods & Research*, *35*(4), 542–571. https://doi.org/10.1177/0049124106292364

Jones, B., & Nagin, D. (2013). A note on a Stata plugin for estimating group-based trajectory models. *Sociological Research Methods*, *42*(4), 608–613. https://doi.org/10.1177/0049124113503141

Jung, T., & Wickrama, K. A. S. (2008). An introduction to latent class growth analysis and growth mixture modeling. *Social and Personality Psychology Compass*, *2*(1), 302–317. https://doi.org/10.1111/j.1751-9004.2007.00054.x

Kaufmann, E., & Harris, G. (2015). "White flight" or positive contact? Local diversity and attitudes to immigration in Britain. *Comparative Political Studies*, *48*(12), 1563–1590. https://doi.org/10.1177/0010414015581684

Logan, J., Zhang, W., & Alba, R. (2002). Immigrant enclaves and ethnic communities in New York and Los Angeles. *American Sociological Review*, *67*(2), 299–322. https://doi.org/10.2307/3088897

Lymperopoulou, K., & Finney, N. (2016). Socio-spatial factors associated with ethnic inequalities in districts of England and Wales, 2001-2011. *Urban Studies*. https://doi.org/10.1177/0042098016653725

Marcuse, P. (1997). The enclave, the citadel, and the ghetto: What has changed in the post-fordist US city. *Urban Affairs Review*, *33*(2), 228–264. https://doi.org/10.1177/107808749703300206

Massey, D. S., & Denton, N. A. (1993). *American apartheid*. Cambridge, MA: Harvard University Press.

Meen, G., Nygaard, C., & Meen, J. (2013). The causes of long-term neighbourhood change. In M. Van Ham, D. Manley, N. Bailey, L. Simpson, & D. Maclennan (Eds.), *Understanding neighbourhood dynamics: New insights for neighbourhood effects research* (pp. 43–62). Dordrecht, the Netherlands: Springer.

Mezzetti, P., Mugano, S., & Zajczyk, F. (2003). Large housing estates in Italy: Overview of developments and problems in Milan. Restate Report 2d, Urban and Regional Research Centre, Faculty of Geosciences, University of Utrecht.

Musterd, S., & de Winter, M. (1998). Conditions for spatial segregation: Some European perspectives. *International Journal of Urban and Regional Research*, *22*(4), 665–673. https://doi.org/10.1111/1468-2427.00168

Nagin, D. (2005). *Group-based modeling of development*. Cambridge/London: Harvard University Press.

Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the number of classes in latent class analysis and growth mixture modelling: A Monte Carlo simulation study. *Structural Equation Modeling*, *14*(4), 535–569. https://doi.org/10.1080/10705510701575396

Peach, C. (2009). Slippery segregation: Discovering or manufacturing ghettos? *Journal of Ethnic and Migration Studies*, *35*(9), 1381–1395. https://doi.org/10.1080/13691830903125885

Peleman, K. (2002). The impact of residential segregation on participation in associations: The case of Moroccan women in Belgium. *Urban Studies*, *39*(4), 727–747. https://doi.org/10.1080/00420980220119543

Perelli-Harris, B., & Lyons-Amos, M. (2015). Changes in partnership patterns across the life course: An examination of 14 countries in Europe

and the United States. *Demographic Research*, *33*(6), 1–36. https://doi.org/10.4054/DemRes.2015.33.6

Poulsen, M., Johnston, R., & Forrest, J. (2001). Intraurban ethnic enclaves: Introducing a knowledge-based classification method. *Environment and Planning A*, *33*(11), 2071–2082. https://doi.org/10.1068/a34124

Poulsen, M., Johnston, R., & Forrest, J. (2011). Using local statistics and neighbourhood classifications to portray ethnic residential segregation: A London example. *Environment and Planning B: Planning and Design*, *38*(4), 636–658. https://doi.org/10.1068/b36094

Quillian, L. (2002). Why is black–white residential segregation so persistent? Evidence on three theories from migration data. *Social Science Research*, *31*(2), 197–202. https://doi.org/10.1006/ssre.2001.0726

Sabater, A. (2010). Ethnic residential segregation change in England and Wales. In J. Stillwell, & M. Van Ham (Eds.), *Ethnicity and integration* (pp. 47–62). Dordrecht: Springer Netherlands.

Simpson, L. (2004). Statistics of racial segregation: Measures, evidence and policy. *Urban Studies*, *41*(3), 661–681. https://doi.org/10.1080/0042098042000178735

Simpson, L. (2007). Ghettos of the mind: The empirical behaviour of indices of segregation and diversity. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, *170*(2), 405–424. https://doi.org/10.1111/j.1467-985X.2007.00465.x

Simpson, L., & Finney, N. (2009). Spatial patterns of internal migration: Evidence for ethnic groups in Britain. *Population, Space and Place*, *15*(1), 37–56. https://doi.org/10.1002/psp.497

Simpson, L., Gavalas, V., & Finney, N. (2008). Population dynamics in ethnically diverse towns: The long-term implications of immigration. *Urban Studies*, *45*(1), 163–183. https://doi.org/10.1177/0042098007085106

South, S. J., & Crowder, K. D. (1998). Leaving the 'hood: Residential mobility between black, white, and integrated neighbourhoods. *American Sociological Review*, *63*(1), 17–26. https://doi.org/10.2307/2657474

Statistics Netherlands (2016a). Bevolking; kerncijfers. Retrieved from http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=37296NED&D1=27-28&D2=49,l&VW=T

Statistics Netherlands (2016b). Begrippen: Allochtoon. Retrieved from https://www.cbs.nl/nl-nl/onze-diensten/methoden/begrippen#id=allochtoon

Tunstall, R. (2016). Are neighbourhoods dynamic or are they slothful? The limited prevalence and extent of change in neighbourhood socio-economic status, and its implications for regeneration policy. *Urban Geography*, *37*(5), 769–784. https://doi.org/10.1080/02723638.2015.1096119

Van Kempen, R., & Bolt, G. (2009). Social cohesion, social mix, and urban policies in the Netherlands. *Journal of Housing and the Built Environment*, *24*, 457–475. https://doi.org/10.1007/s10901-009-9161-1

Van Kempen, R., & Priemus, H. (2002). Revolution in social housing in the Netherlands: Possible effects of new housing policies. *Urban Studies*, *39*(2), 247–253. https://doi.org/10.1080/00420980120102948

Vertovec, S. (2007). Super-diversity and its implications. *Ethnic and Racial Studies*, *30*(6), 1024–1054. https://doi.org/10.1080/01419870701599465

Warren, J. R., Luo, L., Halpern-Manners, A., Raymo, J. M., & Palloni, A. (2015). Do different methods for modeling age-graded trajectories yield consistent and valid results? *American Journal of Sociology*, *120*(6), 1809–1856. https://doi.org/10.1086/681962

Zwiers, M. D., Kleinhans, R. J., & Van Ham, M. (2016). The path-dependency of low-income neighbourhood trajectories: An approach for analysing neighbourhood change. *Applied Spatial Analysis and Policy*. https://doi.org/10.1007/s12061-016-9189-z

Zwiers, M.D., Van Ham, M. & Kleinhans, R. (2017). The effects of physical restructuring on the socioeconomic status of neighbourhoods: Selective migration and upgrading. *IZA Discussion Paper No. 10697*, Bonn: Institute for the Study of Labor.

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APPENDIX A.

TABLE A1 Average posterior probabilities of group assignment and Bayesian information criterion (BIC) statistics of model fit

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	BIC (*N* = 2,1733)	BIC (*N* = 1,496)
3 groups	0.998	0.997	0.996						−76889.4	−76878.7
4 groups	0.997	0.994	0.994	0.997					−68143.1	−68128.3
5 groups	**0.992**	**0.992**	**0.991**	**0.995**	**0.998**				**−63393.2**	**−63374.5**
6 groups	0.996	0.986	0.982	0.992	0.992	0.996			−60828.6	−60805.9
7 groups	0.989	0.997	0.979	0.983	0.974	0.992	0.990		−59184.6	−59157.9
8 groups	0.982	0.988	0.966	0.967	0.983	0.979	0.989	0.996	−58147.7	−58116.9

The bold emphasis illustrates the model that has been selected for the analyses.