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Immigration, segregation, and attitudes toward immigrants: a longitudinal multiscalar analysis across egohoods

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Evidence on how proximity to ethnic outgroups shapes attitudes toward immigration remains inconclusive. We suggest this may be driven, in part, by the fact that studies rarely account for the role of residential segregation. We argue that how the minority-share in an environment affects majority-group attitudes will depend on how segregated groups are from one another. To explore this, we undertake fixed-effects modelling of nationally representative German panel data and contextual data (2005–2013), and generate bespoke, home-centred egohoods for respondents across 12 spatial scales (500–10,000 metres radius). Findings show that how egohood minority-share is related to immigration-attitudes is conditional on egohood segregation: only egohoods becoming ethnically diverse and segregated see anti-immigrant sentiment increase; egohoods becoming ethnically diverse and integrated actually see anti-immigrant sentiment decrease. This conditioning-relationship exhibits a (broadly monotonic) bell-curve relationship across egohood-scales, peaking around a 3500/4000 metres radius.

Introduction

There is growing concern we are (re-)entering a period of rising anxiety towards immigration across Western democracies (Norris and Inglehart, 2019). Immigration in new immigrant-destination countries is also opening new political cleavages (Laurence, Igarashi and Ishida, 2022). One posited driver of this trend is that many countries are experiencing historically high immigration, alongside growing ethnic diversity, potentially triggering a socio-political 'backlash' (Norris and Inglehart, 2019). While research has long sought to understand how far public attitudes toward immigration are shaped by immigration in people's spatial environments—their racial context—the evidence-base remains inconclusive (Hainmueller and Hopkins, 2014; Pottie-Sherman and Wilkes, 2017). However, a potentially key omission among studies is that while extensive work examines how the relative *size* of the immigrant-group in an area shapes immigration-attitudes, less research explores whether the residential *segregation* of groups matters (although see Rocha and Espino, 2009; Uslaner, 2012).

Segregation can play an important role in shaping intergroup attitudes (Kunovich and Hodson, 2002; Biggs and Knauss, 2012; Uslaner, 2012; Enos and Gidron, 2016; Enos and Celaya, 2018). Accordingly, focussing on the minority-share in an area alone may limit our understanding of how racial contexts shape immigration-attitudes, given measures of outgroup-size are blind to how (un)evenly those groups are distributed across an area, i.e. its segregation (Rocha and Espino, 2009; Uslaner, 2012; Laurence *et al.*, 2019). This omission may be problematic for two reasons. Firstly, it means we know little about how segregation shapes immigration-attitudes—the direct-effect of segregation. Secondly, it may also limit our understanding of how the minority-share of an area itself shapes immigrant-attitudes. As we will demonstrate, measures of minority-share tell us little about how segregated groups are across an area. Thus, over time, one can find

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areas that see an increasing minority-share and become segregated, such as when minority-group members remain clustered on a few streets. However, one can also find areas that see *equal* increases in their minority-share, but which become spatially integrated, where minority-groups are equally distributed across every street. If segregation also shapes intergroup-processes, then how increasing minority-share affects anti-immigrant sentiment may *depend on* (i.e. be moderated by) how unevenly groups are distributed across the area (Rocha and Espino, 2009; Uslaner, 2012; Enos and Gidron, 2016; Laurence *et al*., 2019), and it may only be areas becoming ethnically diverse and *segregated* which see immigration-attitudes worsen.

Alongside the under-consideration of segregation, two additional issues within the literature require further examination. Firstly, studies of racial contexts often draw on cross-sectional data (although see Lancee and Schaeffer, 2015; van Heerden and Ruedin, 2017; Weber, 2018). However, apparent contextual-effects could instead be driven by between-individual unobserved differences. Cross-sectional approaches are further complicated by residential-selection (Maxwell, 2019), or given segregation may be as much a product, as a cause, of intergroup tensions (Bobo and Zubrinsky, 1996; Krysan and Farley, 2002; Clark and Fossett, 2008; Enos and Celaya, 2018). Addressing such bias is critical to testing racial context effects.

The second issue requiring examination is an understanding of the spatial-scale(s) across which racial contexts matter for immigration-attitudes (Newman *et al*., 2013; Velez and Wong, 2017). Racial contexts have been measured at the neighbourhood-level up to regions/countries. However, applying different spatial-scales may drive heterogeneity in the direction/significance of relationships (Pottie-Sherman and Wilkes, 2017), consistent with the Modifiable Areal Unit Problem (MAUP) (Openshaw, 1977; Weber, 2015). Furthermore, relying on available administrative boundaries (e.g. census tracts) as proxies for individuals' spatial environments can generate spatial mismatch between available boundaries and the geographies, which matter in shaping political attitudes. Approaches that systematically test multiple spatial-scales, using boundaries more accurately reflecting individuals' spatial environments, are important to identify the 'true causally relevant geographic context' (Kwan, 2012: p. 959; Weber, 2015).

This paper incorporates segregation into debates on how the minority-share in an environment shapes immigration-attitudes. We employ nine-waves of nationally representative, yearly German panel data (2005–2013), linked to yearly data on the socio-demographic make-up of respondents' spatial environments, to test how changing patterns of both minority-share and segregation relate to immigration-attitudes. We employ fixed-effects panel data methods to address time-invariant unobserved heterogeneity. To measure respondents' racial context, we move away from 'quasi'-administrative-boundaries (e.g. census-boundaries). Instead, respondents are nested in their own unique 'egohood', constructed from small, contiguous 'postcode-8' areas (our spatial building blocks, containing, on average, around 500 households) surrounding their home at a given radius (e.g. 1500 metres). This reduces spatial-mismatch and allows us to explore at what spatial-scale intergroup processes are most salient by constructing 'egohoods' across multiple-radii (a distance of 500 to 10,000 metres from a respondent's home).

The findings confirm our conceptual framework: how increasing minority-share in an egohood relates to immigration-attitudes is highly conditional on how residentially segregated the minority-/majority-group are in the area. Over time, it is where areas become more ethnically diverse and segregated that anxiety toward immigration increases. Where areas are becoming more ethnically diverse and integrated, attitudes improve. The strength and significance of this conditioning-association of segregation exhibit a (broadly monotonic) bell-curve relationship across egohood spatial-scales: weaker at the smallest and largest spatial-scales but peaking in strength around a 3500/4000 metres radius from individuals' homes. This suggests that accounting for how segregated groups are in an area is critical to understand when increasing immigration engenders positive/negative attitudes toward immigrants.

Theoretical framework

Spatial environments and attitudes toward immigration

In understanding how racial contexts shape immigration-attitudes, studies largely draw on two theories: group-threat and intergroup contact (see Stein, Post *et al*., 2000; Hopkins, 2010; Schlueter and Scheepers, 2010). Theories of threat suggest larger minority-shares lead majority-groups to perceive minority-groups as a threat, fostering negative out-group attitudes (Key, 1949; Hopkins, 2010). Perceived threats include those to 'resources', such as political power, jobs, or welfare, alongside conflicting values and beliefs, where outgroups are perceived to threaten core ingroup values (Key, 1949; Kinder and Sears, 1981). Such perceived-threats, in turn, express themselves as anti-immigrant sentiment (Hopkins, 2010; Newman *et al*., 2013). Theories of intergroup contact, however, suggest larger minority-shares can improve intergroup relations (Wagner *et al*., 2006). Interethnic interactions can strengthen intergroup relations, especially when

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occurring under conditions of co-operation, common goal-orientation, equal status, and when sanctioned by authority (Allport, 1954). Larger shares of out-group increase opportunities for positive contact, thus fostering less immigration-anxiety (Schlueter and Scheepers, 2010); although, higher minority-shares can increase negative intergroup contact, worsening immigration-attitudes (Laurence and Bentley, 2018).

Extensive research applies this framework to understand how racial contexts affect immigration-attitudes. Such work demonstrates anti-immigrant sentiment is higher where the minority-share is higher, in both the United States (Butz and Kehrberg, 2016; Avery *et al*., 2017) and Europe (Semyonov *et al*., 2006; Weber, 2018). Yet, other work demonstrates minority-share is associated with positive immigration-attitudes (e.g. Wagner *et al*., 2006; Facchini *et al*., 2017; Pottie-Sherman and Wilkes, 2017). Further work identifies how minority-share effects are conditional on factors such as political/media-narratives (Hopkins, 2010), and macro-level socio-economic conditions (Branton and Jones, 2005). A related literature on ethnic fractionalization has also found competing evidence for how diversity shapes intergroup-attitudes (Putnam, 2007; Lancee and Schaeffer, 2015).

Research into the racial context/immigration-attitudes relationship therefore remains mixed (Pottie-Sherman and Wilkes, 2017). However, studies predominantly focus on how the *size* of the minority group in an area predicts attitudes. What has been largely overlooked is whether the *distribution* of groups across the area also matters, i.e. its residential segregation.

Minority-share, segregation, and attitudes toward immigration

Contact/threat theories presuppose that attitudes are a function of the relative *size* of minority-groups. However, as we will discuss, contact-/threat-processes could also be shaped by how segregated groups are as well (Rocha and Espino, 2009; Uslaner, 2012; Enos and Gidron, 2016; Laurence *et al*., 2019). The problem is that measuring outgroup size alone gives little indication of how (un)evenly groups are distributed across an area (Rocha and Espino, 2009; Uslaner, 2012; Laurence *et al*., 2019). Figure 1 illustrates this point, showing two trajectories that diversifying communities could take: towards greater spatial integration or segregation. Both areas begin as low-diversity areas with equal levels of segregation ($t1$). However, by $t2$, while both see an *equal* increase in minority-share, Area A sees increasing minority-share and increasing spatial segregation while Area B sees increasing minority-share but increasing spatial integration. At $t2$, this demonstrates a critical point: areas with an equal minority-share can have substantially different levels of segregation, and measures of minority-share alone give little indication of this. Solely modelling how the minority-share affects immigration-attitudes would treat the trajectories of A and B as identical. Differences in segregation, however, could have important implications for processes of contact/threat.

The first channel through which segregation may impact intergroup-attitudes is via inhibiting positive contact (Allport, 1954; Biggs and Knauss, 2012; Uslaner, 2012; Kasara, 2013). In segregated areas, more homogeneous neighbourhoods are likely to lead to fewer intergroup encounters. Segregated areas can also translate into segregated local institutions, such as civic groups, schools, and social spaces, further delimiting opportunities for sustained contact. As Uslaner (2012: p. 4) notes, '[w]hen people of different backgrounds live apart from each other, they will not… develop the sorts of ties–or the sorts of attitudes–that leads us to trust people…different from ourselves'.

The second set of pathways relates to what might be termed the 'optics and haptics' of segregated areas that affect those cognitive-processes shaping perceived-threat. In segregated areas, spatial concentrations of minorities may make the outgroup 'seem larger and more menacing than it is' (Allport, 1954: pp. 18–19), driving more hostility given perceptions of outgroup size are stronger predictors of attitudes than actual size (Hopkins, 2011). Greater concentrations of outgroups could also 'exaggerate the degree of [perceived] difference between groups' (Allport, 1954: pp. 18–19), making ethnic difference 'more visible, and…assimilation seems more uncertain' (Biggs and Knauss, 2012: p. 635). This process may be heightened where segregation leads to 'ethnic enclaves', which take on a stronger ethnic identity, as shops, schools, and civic/social organizations cater towards specific minority-group cultural needs, accentuating perceived group-differences and fostering feelings of exclusion among majority-groups (Laurence *et al*., 2019). Indeed, Enos and Celaya's (2018) experimental work suggests that majority-group residents may use segregation as a heuristic for the strength of group-difference: where groups are more spatially divided, the majority-group are more likely to categorize all outgroup members as a homogeneous entity, strengthening perceptions of difference (Enos and Celaya, 2018). The corollary of these processes is that where groups are spatially integrated, outgroups may appear less numerous, an area's character may take on a more ethnically heterogeneous nature, and group-differences may be viewed as smaller, engendering less threat.

In line with these theories, recent work finds that segregation is associated with inter-group hostility (Kasara, 2013; Enos and Gidron, 2016), violent conflict

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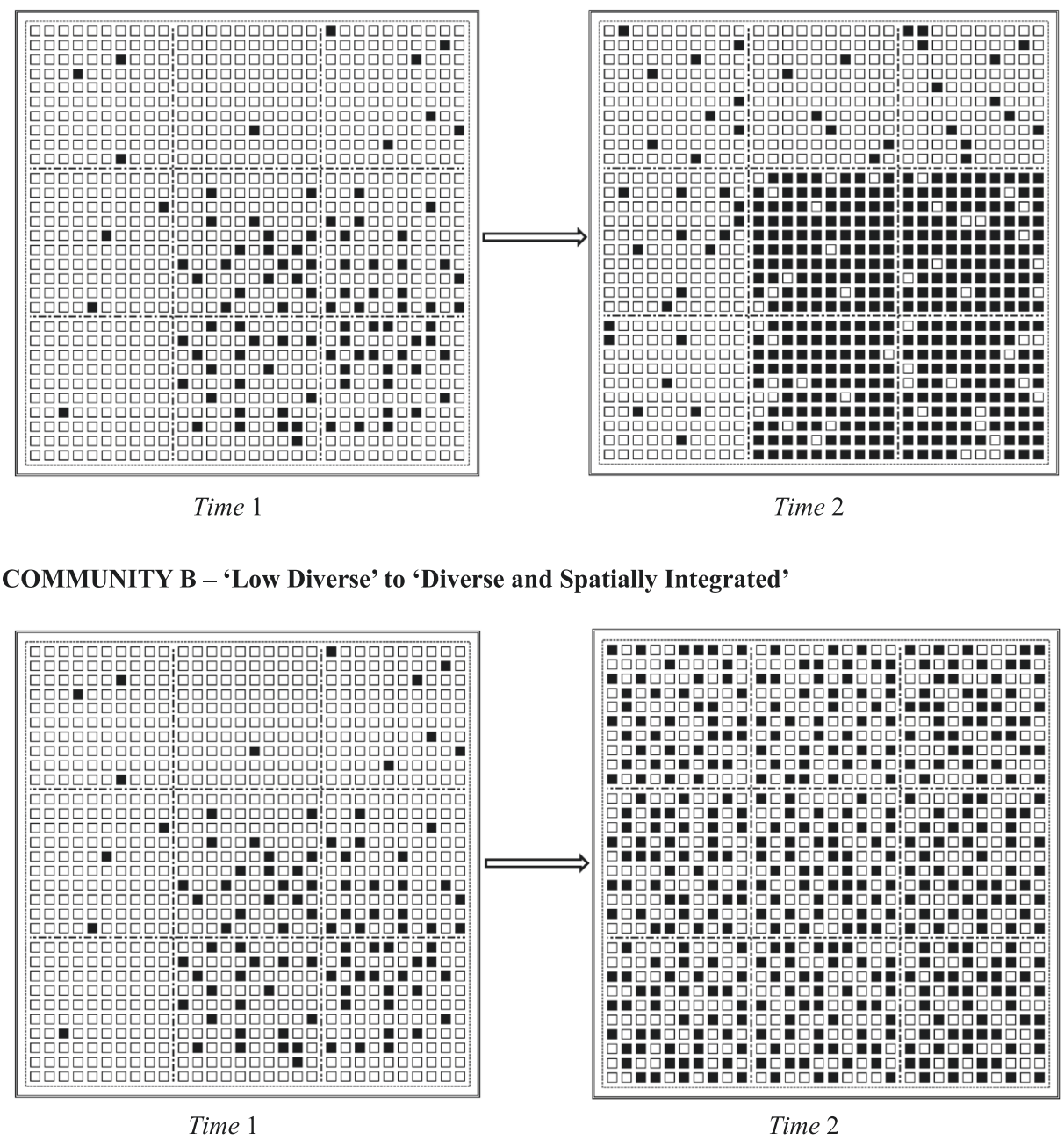

Figure 1 Two example communities transitioning from low diversity to (A) diverse and segregated or (B) diverse and integrated

(Kunovich and Hodson, 2002), lower cohesion (Uslaner, 2012), public goods inequalities (Trounstine, 2016), and perceived-threats (Kawalerowicz, 2021). Accordingly, through these intergroup-processes, segregation might also shape immigration-attitudes. Taking these literatures together, we therefore seek to understand:

Research Question 1a – Does minority-share have a direct relationship with attitudes toward immigration?

Research Question 1b – Does residential segregation have a direct relationship with attitudes toward immigration?

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An alternative formulation of segregation's role is that it may *condition* how residents respond to increasing minority-shares (Rocha and Espino, 2009; Biggs and Knauss, 2012; Laurence *et al*., 2019; Borkowska and Laurence, 2024). As outlined, area minority-share is posited to shape immigration-attitudes via processes of contact/threat. However, if segregation can also shape these processes (as outlined), then whether higher minority-shares trigger processes contact/threat processes could depend not only on the relative size of the outgroup but also on how segregated they are. Regarding intergroup contact, where areas are becomingly more ethnically diverse and *segregated* (Area A, Figure 1), segregation may limit how far higher minority-shares translate into contact, given residents will live apart from one another and local institutions are more likely to be segregated. Therefore, where higher minority-shares occur in segregated forms this may inhibit contact, and instead trigger threat (Rocha and Espino, 2009; Biggs and Knauss, 2012; Laurence *et al*., 2019).

Concurrently, whether a growing minority-share is viewed as threatening may also be conditional on how segregated it is. If segregation shapes how negatively residents perceive outgroups or raises the salience of ethnic difference (e.g. through spatial division triggering greater perceptions of group-difference/stereotyping), then where areas become more ethnically-diverse and *segregated* (Area A, Figure 1), majority-group residents, primed with these views of minority-groups, may experience greater perceived-threat from higher minority-shares. If spatial integration leads to more benign outgroup views (e.g. lower perceived group-difference/stereotyping), then where areas become more ethnically diverse but residentially *integrated* (Area B, Figure 1), higher minority-shares may be viewed as less threatening (Biggs and Knauss, 2012; Laurence *et al*., 2019). In addition, whether 'ethnic enclaves' develop is likely conditional not only on segregation but also on the size of the outgroup in an area, given they require a critical-mass of outgroup members before developing concentrations of institutions catering for their needs. Therefore, whether increasing minority-share leads to distinctly minority-identity spaces (and thus greater threat) may also depend on how segregated majority/minority groups are.

In sum, areas becoming ethnically diverse and *segregated* may trigger perceived-threat, limit contact, and worsen immigration-attitudes. Areas becoming ethnically diverse and *integrated* may yield comparatively greater contact, while threat-generating processes may be diminished, improving immigration-attitudes. Studies provide initial evidence that segregation moderates how outgroup-size affects intergroup relations: it is only in diverse/segregated areas where White turnout is higher (Zingher and Steen Thomas, 2014, Borkowska and Laurence, 2024), perceived-threat is greater (Laurence, Schmid *et al*., 2019), anti-immigrant sentiment is higher (Borkowska and Laurence, 2024), and belief in restrictionist-policies is higher (Rocha and Espino, 2009). Segregation could therefore condition (moderate) how minority-share affects immigration-attitudes:

> Research Question 2: Do minority-share and residential segregation interact to predict attitudes toward immigration?

Issues of causality

Two additional issues within racial context studies require examination. Firstly, the predominant use of cross-sectional data raises the spectre that apparent contextual effects are driven by unmeasured differences between individuals. Cross-sectional estimates of racial context effects are also susceptible to endogeneity-bias, particularly in residential-selection (Maxwell, 2019). Outgroup hostility may drive out-migration from (or reduce in-migration to) diverse areas (Bobo and Zubrinsky, 1996; Krysan, 2002). Endogeneity may be particularly acute for understanding segregation's effects. Prejudice/ethnocentrism are key drivers of segregation (Bobo and Zubrinsky, 1996; Krysan and Farley, 2002; Clark and Fossett, 2008). They not only shape majority-group residential-choice, increasing the likelihood of segregation emerging, but also may lead majority-group residents to employ means of preserving community-homogeneity, such as discriminatory housing practices or hate crime, increasing segregation (DeFina and Hannon, 2009). As such, apparent segregation effects on intergroup-attitudes may just as feasibly operate the other way around.

Several studies account for such bias by examining how within-person changes in minority-share over time affect immigration-attitudes (Lancee and Pardos-Prado, 2013; Lancee and Schaeffer, 2015; van Heerden and Ruedin, 2017; Weber, 2018). However, no study has applied such approaches to test the impact of segregation. Tests for how minority-share/segregation affects immigration-attitudes thus require approaches that address these causality issues:

> Research Question 3: Can we identify significant associations of minority-share and segregation under more causally robust approaches?

Spatial-scale and the modifiable areal unit problem

The second issue requiring further examination is an understanding of the spatial-scale across which processes linking racial contexts to immigration-attitudes operate (Newman *et al*., 2013; Weber, 2015, 2018;

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Pottie-Sherman and Wilkes, 2017; Velez and Wong, 2017). Studies have operationalized racial context across multiple scales (e.g. neighbourhoods, towns/cities, and regions), using various administrative/census/political units of analysis. However, measuring the same concept at different spatial-scales or using alternative boundaries can drive differences in the direction/significance of relationships in contextual-studies—the MAUP (see Openshaw, 1977; Velez and Wong, 2017). Reviews of the immigration-attitudes literature suggest this may be the case, identifying more consistent negative relationships at higher scales and more positive/absent effects at smaller scales (Pottie-Sherman and Wilkes, 2017). More formal tests of scale (testing relationships across multiple-scales *within* the same sample) have led to divergent conclusions. Some work finds positive-effects at smaller scales but negative-effects at larger scales, suggesting smaller scales pick up contact-potential while larger scales pick up the 'diffuse exposure' triggering threat (Stein *et al*., 2000; Della Posta, 2013; Weber, 2015). However, others identify more negative effects at smaller scales, and absent-effects at larger aggregations, suggesting that if exposure to outgroups triggers threat then negative-effects should be stronger at small-scales (Dinesen and Sønderskov, 2015; Weber, 2018). Yet, these works face an additional issue: the use of pre-defined quasi-administrative spatial units, which may operate as weak proxies for the spatial environments that individuals inhabit (and are cognizant of) (Weber, 2015; Velez and Wong, 2017; Lee and Rogers, 2019). This becomes particularly problematic for individuals residing at the boundaries between pre-defined areas, where they are attributed to the racial context of one area but likely affected by the characteristics of adjacent areas. Analyses thus need to systematically examine the spatial-scales at which processes linking racial-context to immigration-attitudes are most salient, using ego-centric areal-units designed to better reflect individuals' spatial environment. Indeed, a study applying egohood measures of ethnic diversity (radii of 80–2500 metres) demonstrates how effects become weaker at higher spatial scales (Dinesen and Sønderskov, 2015). This leads us to Research Question 4:

> Research Question 4: At what spatial-scale are processes linking racial context to individuals' immigration-attitudes most salient?

Data and methods

Data

This study utilizes the German Socio-Economic Panel Survey (SOEP, 10.5684/soep.core.v36eu), a nationally representative, annual panel-dataset (Goebel *et al*., 2019). Analysis is based on nine-waves of data (2005–2013), given yearly contextual-level data for every micro geographic-unit (Postcode-8 area) in Germany with consistent boundary-shapes over time were only available for these years (see Section Research context: Germany). Attrition-rates have remained relatively low (e.g. 4–14 per cent across various subsamples) (Goebel *et al*., 2019). Key predictors of attrition include younger age, not in employment, lower income, lower education, and living with a partner. Weights were tested returning substantively similar findings and we report unweighted results due to sample loss under weighting strategies[1]. All analyses are restricted to 'native Germans' (born in Germany, with German citizenship, with both parents born in Germany). The final unbalanced analytical sample is n = 122,294 observations nested within n = 30,903 individuals, averaging four-waves per individual.

Information on respondents' spatial context is drawn from Microm[2], providing socio-demographic data on the composition of German postcode-8 areas. We exploit a unique version of the data containing yearly demographic data covering all postcode-8 areas in Germany between 2005 and 2013, which maintain the same boundaries over time. This yearly, national-coverage data are critical to construct bespoke egohoods for each respondent (see Section Research context: Germany).

Research context: Germany

Germany is a useful context to explore how racial context shapes immigration-attitudes. Germany shares key similarities with other studied contexts (e.g. United States/United Kingdom). It is a wealthy, developed democracy, with similarly high-shares of foreign-born residents. Accordingly, insights across Germany are likely to be generalizable. The 2005–2013 period also predates the influx of refugees, and rise of the German far-right political party (*Alternative für Deutschland*) while the salience of immigration issues during this period remained relatively stable (Czymara and Dochow, 2018). East and West Germany have distinct social and political histories, along with different patterns of immigration (in 2013, 4.2 per cent of East residents were foreign-born while 12 per cent of West residents were), and recent studies have shown residents in East Germany tend to have more negative immigration-attitudes (Bundeszentrale fur politische Bildung, 2018; Weisskircher, 2020). We therefore explore whether differences exist across regions.

Key variables

Dependent variables

The main outcome is respondents' anxiety towards immigration. Respondents were asked: 'How worried are you about the following issues?'; one issue was: 'immigration to Germany'. Extensive work mobilizes

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this variable for anti-immigration sentiment, which responds to known-predictors of perceived-threat[3] (Lancee and Pardos-Prado, 2013; Lancee and Schaeffer, 2015; Maxwell, 2019). Response categories included: 'very concerned' (23 per cent), 'somewhat concerned' (54 per cent), and 'not concerned at all' (23 per cent) (Fournier *et al.*, 2003; Lancee and Pardos-Prado, 2013). We recode this variable such that 0 is 'very concerned'/'somewhat concerned' and 1 is 'not concerned at all' (alternative specifications yield similar results).

Although the outcome does not specify attitudes towards local immigration, research shows how people's experiences in local contexts inform generalized political attitudes (Cutler, 2007). This can emerge when individuals use their local environment as the primary source of information about the nation, or where individuals are more vested in their localities than the country as a whole (Cutler, 2007).

Geographic-scale(s) of analysis: egohoods

To examine the saliency of spatial-scale and address shortcomings of quasi-administrative boundaries, we generate bespoke spatial environments ('egohoods') for each respondent, centred around their home. The basic spatial building block for these is the smallest spatial-area available in the data: postcode-8 areas. Postcode-8 areas are constructed by Microm using cluster analysis to contain, on average, 500 households. To generate an egohood a circle is drawn around each respondent's household at a given radius (e.g. 1500 metres), with all Postcode-8 areas fully (or partially—see Section Independent variables) contributing information to the characteristics of the spatial environment. We defined egohoods at 500, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000, 7500 and 10,000 metres radii from a respondent's home.

This approach helps ensure comparability across spatial units, compared to quasi-administrative boundaries, because the shape and area of an egohood is held constant. It more accurately captures the surrounding spatial environment of an individual; especially those at the boundaries between administrative areas. We can also better examine the relationship between spatial-scale and contextual-processes, varying egohoods by size.

Independent variables

Minority-share

Yearly data on the size of the minority-group across postcode-8 areas are produced by Microm based on name-based identification of residents' ethnic background, with additional bias-corrections (Mateos, 2014). Name-based approaches are effective measures of non-native composition in Germany, although not without bias (see e.g. Kruse and Dollmann, 2017). To calculate the proportion of non-natives within a respondent's egohood across the full range of radii we first identify all postcode-8 areas that fall fully or partially within the circle's radius. Where postcode-8 areas fall fully within the circle, all population statistics of such postcode-8 areas contribute to the composition of the egohood. Where postcode-8 areas partially fall within the circle, we calculate the proportion of the postcode area located within the egohood and adjust measures by this proportion. For instance, if 50 per cent of the postcode-8 area is located within the boundaries of one's egohood, we multiply the population size by 0.5[4]. Then we sum the values of constituent postcode-8 areas (completely/partially placed within egohoods) to obtain egohood-level statistics.
Consequently, egohood minority-share is estimated in the following manner:

$$P_i = \sum_{j=1}^{n} w_j \frac{f_{ij}}{t_{ij}},$$

where P_i is an egohood level proportion of ethnic minority, n is the number of postcode-8 areas within egohood, w_j is the share of postcode-8 area within egohood, f_{ij} is the number of ethnic minorities in the postal code area, andt_{ij} is the number of inhabitants in the postal code area.

It is arguable, however, that postcode-8 areas located closer to a person's home have a stronger influence on attitudes than areas located farther away. We thus calculate a spatially weighted minority-share by assigning higher importance to the postcode-8 areas, which are geographically closer to the household (Quillian, 2014). Weighted egohood minority-share is defined as the sum of spatially weighted postal code area proportions of minorities, which is divided by the sum spatial weights.

$$\hat{P}_i = \frac{1}{\sum_{j=1}^{n} c_{ij}} \sum_{j=1}^{n} c_{ij} p_{ij}, \tag{1}$$

where $\hat{P}_i$ is the spatially weighted egohood level minority-share, n is the number of postcode-8 areas within egohoods, p_{ij} is the area-weighted share of minorities in the postcode-8 area, and c_{ij} is the spatial weight.
Spatial weights are calculated using the distance decay function (see Quillian, 2014):

$$c_{ij} = \left[1 - \left(\frac{d_{ij}}{r_i}\right)^2\right]^2 \text{ if } d_{ij} < r_i \tag{2}$$

$$0 \text{ if } d_{ij} > r_i,$$

where r_i is the radius of an egohood and d_{ij} is a conditional value. It is the Euclidean distance between each household and centroid of each postcode-8 within a given egohood if the centroid of the postcode-8 is within egohood boundaries. It is equal to an egohood radius if centroid of postcode-8 areas is outside egohood boundary.

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Residential segregation

Figures 2 and 3 outline two exemplar communities: a high minority-share/segregated egohood (Figure 2) and a high minority-share/integrated egohood (Figure 3) (radius 3000 metres), taken from the data.

These communities demonstrate how similarly diverse areas can be residentially integrated or segregated. Prior work predominantly applies the Index of Dissimilarity (D) to capture segregation differences between areas (Rocha and Espino, 2009; Biggs and Knauss, 2012; Uslaner, 2012; Kasara, 2013; Enos and Gidron, 2016; Laurence *et al*., 2019). However, D is not sensitive to the spatial arrangement of postcode-8 areas (although see Wong, 2005 for D that distinguishes spatial patterns). Potentially, the impact of segregation will come *not only* where groups live in separate neighbourhoods *but also* where these neighbourhoods tend to be clustered together, e.g. ethnic enclaves. To account for this, we apply the index of relative clustering, capturing how far 'areal units inhabited by minority members adjoin one another, or cluster, in space' (Iceland *et al*., 2002: p. 121). The relative clustering index 'compares the average distance between [minority] members... with the average distance between [majority] members' (Iceland *et al*., 2002: p. 121). Values greater than 0 signify areas where minority residents exhibit greater clustering than native Germans. The relative clustering index (2) is thus calculated[5] (Massey and Denton, 1988):

$$\mathrm{RCL} = \frac{P_{xx}}{P_{yy}} - 1,$$

where the two proximity measures (P_{xx} and P_{yy}) are defined as (3) and (4):

$$P_{xx} = \sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j c_{ij}/x^2$$

and

$$P_{xy} = \sum_{i=1}^{n}\sum_{j=1}^{n} x_i y_j c_{ij}/xy$$

where x is the minority population and y is the majority population. The measure looks at the clustering of Postcode-8 areal units, which make up a specified egohood (defined at various radii, as noted above). As outlined, segregation might not only exert a negative impact on immigration-attitudes but also moderate how the minority-share impacts attitudes. To test whether it is the intersection of *both* higher minority-share and segregation we include an interaction-term between the two.

Several issues emerge in the calculation of segregation across egohoods. The first is how to handle egohoods with no immigrants. A second issue is where an egohood contains only one postcode-8 area, preventing the calculation of segregation. For such egohoods, we experimented with imputing values of 0 (no segregation) and mean-segregation, under various assumptions; however, the results remained substantively the same and we report the results of imputations of 0.

Covariates

At the individual-level, we adjust models for: sex, marital status, tenancy, subjective household living space,

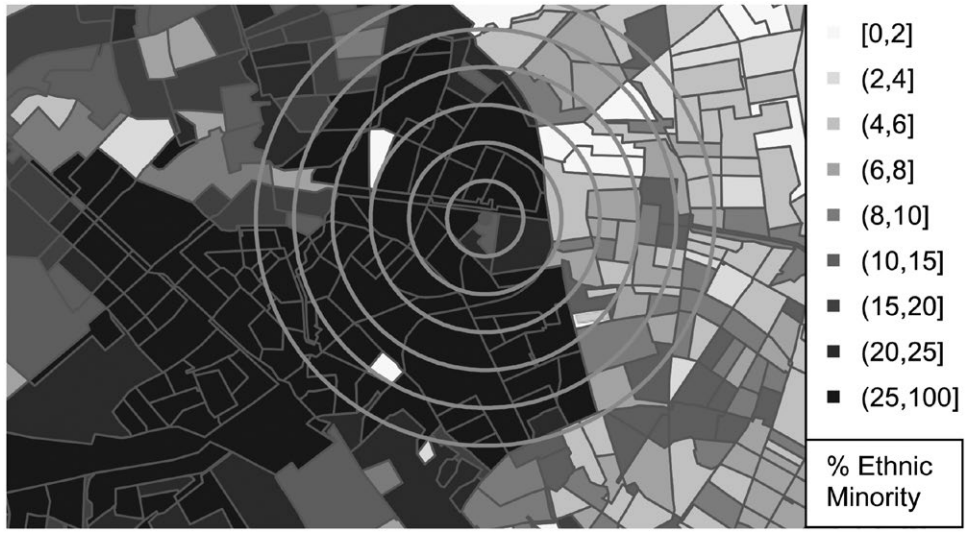

Figure 2 Diverse and segregated egohood: minority-share (35 per cent); index of dissimilarity (0.42); and relative clustering (0.47)

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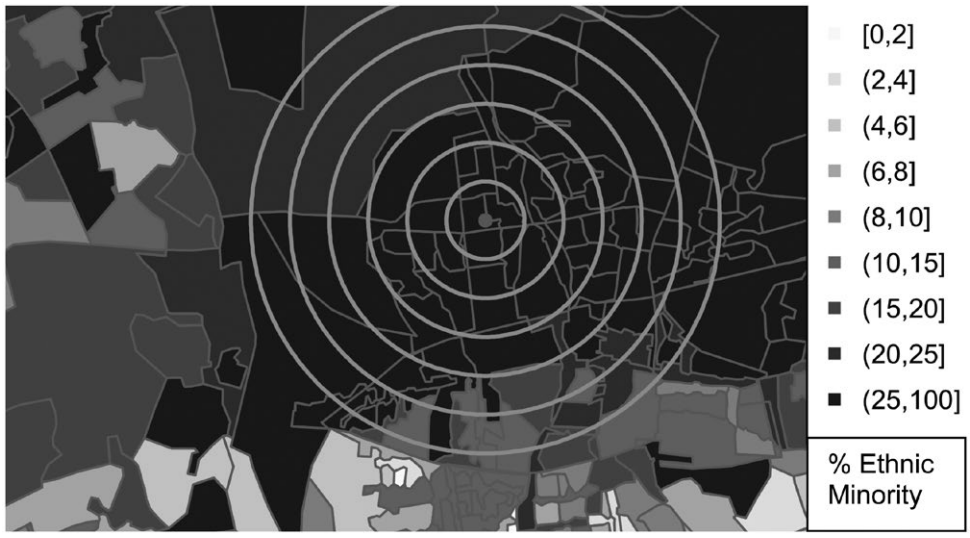

Figure 3 Diverse and integrated egohood: minority-share (41 per cent); index of dissimilarity (0.13); and relative clustering (0.09)

employment status, household income, household condition, highest-qualification, and self-rated health (see Supplementary Appendix A.1 for descriptive statistics). We include dummy variables for the survey year, for living in the pre-unification East/West of Germany, and urban/rural location. Yearly data on the socio-demographic composition of all postcode-8 areas in Germany (necessary for the construction of egohoods) are limited in the data to the proportion in the bottom decile of the income distribution, included as a control.

Methods and analytic approach

To model the binary immigration-anxiety outcome, we apply linear probability models, allowing greater ease of interpretation and comparability across model specifications[6] (Beiser-McGrath *et al*., 2020). With observations nested within individuals, multilevel models will correct standard errors for clustering of residuals. The use of egohoods with a national representative sample of around 15,000 households leads to very low levels of overlapping egohoods between individuals.

The first analytic stage applies multilevel pooled regression models, treating the panel data like cross-sectional data to replicate the analytical approach of cross-sectional research. This can identify whether such approaches bias analyses by subsequently applying more causally robust approaches. The second analytic stage aims to strengthen claims of causality by applying fixed-effects panel data modelling. Through time-demeaning the data, this approach adjusts estimates for time-invariant unobserved individual-level heterogeneity. Such methods are weaker at adjusting for unobserved contextual-level heterogeneity, which may continue to bias estimates. In particular, at the contextual-level, a change in area characteristics has two sources: it can stem from changing demographics of an area which occur around individuals who remain in the same area over time; or, from an individual moving between areas with different characteristics. In the latter case, models do not adjust for unmeasured time-invariant contextual-level characteristics.

This issue can be summarized in Figure 4, showing the trajectory of a single individual over 10-waves of data. In each wave, it shows the minority-share in the community in which they live, along with the time-demeaned values. In waves 1–4, the individual remains in the same community and sees the minority-share positively change. In wave 5, they see a substantial increase in minority-share but this stems from moving between areas in waves 4–5. Similarly, between waves 8 and 9, they see a substantial decrease in minority-share from a move between communities. Pursuing 'method 1' (Figure 4), in which all observations contribute to the models, means such changes may be correlated with unobserved time-invariant contextual heterogeneity.

We propose two methods to address this. The first method (labelled 'method 2', Figure 4), keeps individuals in the sample until their first move, after which they drop out. In the present case, only the first four-waves would be included in the analytic sample. This way, any change in contextual characteristics stems solely from changes in the population occurring around a respondent. The second method (labelled 'method 3') essentially creates 'synthetic individuals' based on consecutive periods in which an individual was present in the same area. As shown in Figure 4, the individual would therefore be split into three synthetic-cases, with a new case beginning when an individual moves

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Wave of data	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
Community name	C1	C1	C1	C1	C2	C2	C2	C2	C3	C3
Community % minority	20%	25%	30%	35%	70%	75%	80%	85%	0%	5%
Individual Present in address one year before	YES	YES	YES	YES	NO	YES	YES	YES	NO	YES
METHOD 1 – All observations	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mean % minority					42.5					
Time-demeaned % minority	-22.5	-17.5	-12.5	-7.5	27.5	32.5	37.5	42.5	-42.5	-37.5
METHOD 2 – Dropped after first move	✓	✓	✓	✓						
Mean % minority		27.5								
Time-demeaned % minority	-7.5	-2.5	2.5	7.5						
METHOD 3 – Synthetic Individuals										
Synthetic individual 1	✓	✓	✓	✓						
Mean % minority		27.5								
Time-demeaned % minority	-7.5	-2.5	2.5	7.5						
Synthetic individual 2					✓	✓	✓	✓		
Mean % minority						35				
Time-demeaned % minority					-7.5	-2.5	2.5	7.5		
Synthetic individual 3									✓	✓
Mean % minority									2.5	
Time-demeaned % minority									-2.5	2.5

Figure 4 Addressing unobserved time-invariant contextual-level heterogeneity

home. In this approach, any variance in contextual demographics is driven by population-change occurring around an individual during their staying-periods within a community. This approach also preserves the full number of observations. To model this, hybrid modelling is applied to estimate a fixed-effects component while applying a multilevel framework, nesting observations within 'synthetic-cases' within individuals.

Results

Egohood minority-share, segregation, and immigration-attitudes: pooled cross-sectional approach

The first stage applies a pooled regression approach across all nine-waves of data, testing the direct relationships between minority-share (coded 0–1, where 1 equals 100 per cent) and relative clustering with native Germans' immigration-attitudes (where higher values equate to less worry)[7]. We run 13 models to test these relationships across the 13-scales of respondents' egohood (from the postcode-8 area (smallest-scale) to egohoods of 500 up to 10,000 metres radius). Coefficients for minority-share and segregation across all 13 models[8] are displayed in Figure 5 (see Supplementary Appendix A.2 for model results). Egohood minority-share is positively related to immigration-attitudes, and thus less immigration-anxiety. Broadly similar associations are observed across all spatial-scales. Segregation appears largely unrelated to immigration-attitudes, although an association emerges at the highest spatial-scales.

These results suggest increasing minority-share improves immigration-attitudes, but segregation has little consistent relationship with immigration-attitudes. However, as discussed, segregation could condition how minority-share relates to immigration-attitudes. To test this, we repeat the modelling behind Figure 5 but include an interaction-term between minority-share and relative clustering. Figure 6 reports the coefficients, including the interaction-term, for all 13 spatial scales (see Supplementary Appendix A.3 for model results). Firstly, there is a strong and relatively consistent negative interaction-effect between minority-share and segregation, suggesting the previously observed positive association of minority-share becomes more negative as segregation increases. Secondly, at the smallest spatial-scales (≤1000 metres) any interaction tends to be weak and non-significant. However, at scales of ≥1500 metres, the interaction-term becomes significant, exhibiting a largely monotonic increase in association-size, which peaks between egohoods with a 3500–4000 metres radius, before a broadly monotonic decline at larger radius egohoods.

To explore the implications of this conditioning role of segregation, Figure 7 plots predicted margins of immigration-attitudes across egohood minority-share values (between the 1st and 99th percentile) but examines this relationship for egohoods with low clustering (1st percentile) and high clustering (99th percentile) (based on the results from Figure 6). We use egohoods of a radius of 3500 metres, where the interaction-term is at one of its strongest values. In low minority-share egohoods,

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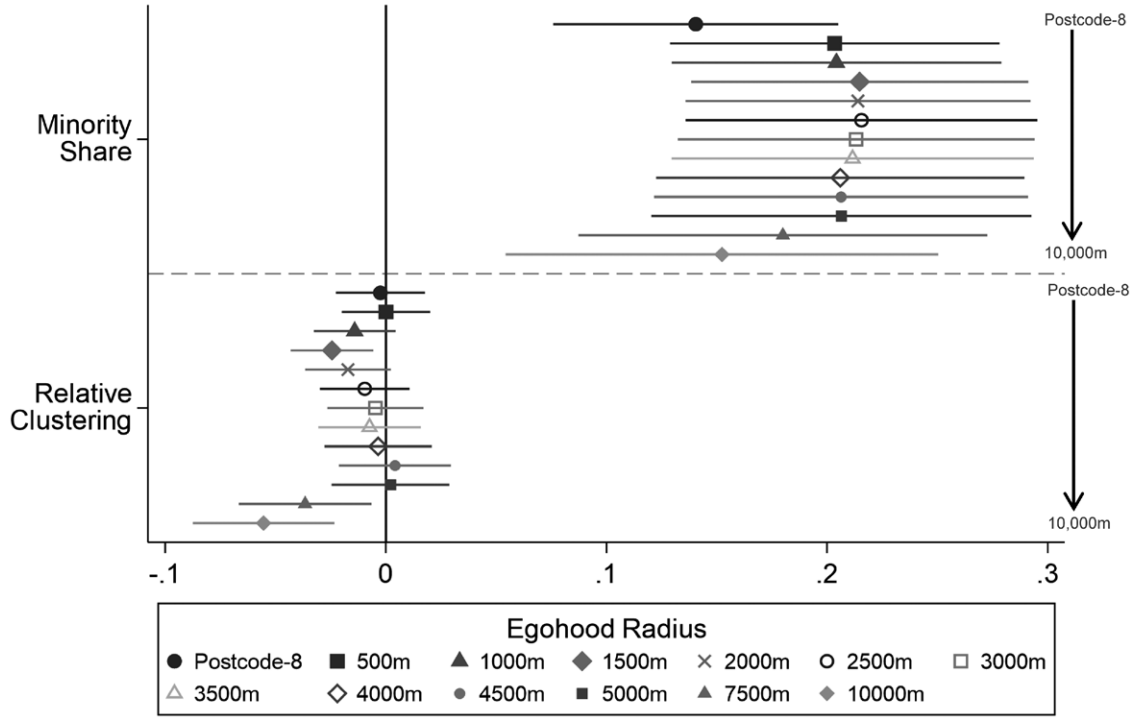

Figure 5 Coefficient plot of direct-effects of minority-share and relative clustering on immigration-attitudes (pooled cross-sectional approach); SOEP. Notes: Model using 'postcode-8 areas' as the egohood radius measures minority-share at the postcode-8 level and relative clustering at the 500 metres egohood radius level; 95% confidence intervals; full model results are located in Supplementary Appendix A.2

there is little difference in attitudes between higher/lower segregation areas. However, in low-segregated egohoods, increasing minority-share is associated with more positive immigration-attitudes, while in high-segregation egohoods, increasing minority-share is associated with more negative immigration-attitudes. This also demonstrates that the relationship between segregation and immigration-attitudes is conditional on the minority-share in an area, becoming stronger as the minority-share increases.

Fixed-effects approach

We next replicate these models using fixed-effects modelling, testing within-person change in minority-share, segregation and immigration-attitudes. Figure 8 tests the direct-relationships of minority-share and segregation with immigration-attitudes across all spatial-scales (replicating Figure 5 but using fixed-effects) (see Supplementary Appendix A.4 for model results). Firstly, minority-share now exerts a negative, albeit non-significant, relationship, broadly similar across spatial-scales. Segregation again has little association with immigration-attitudes. Contrary to the pooled-approach therefore, minority-share does not have a positive-relationship with immigration-attitudes, suggesting prior estimates may be biased.

Figure 9 shows the findings from the models including an interaction between minority-share and segregation but within a fixed-effects framework[9] (replicating Figure 6 but using fixed-effects) (see Supplementary Appendix A.5 for model results). Here, even applying more causally robust methods, the interaction-term between changes in minority-share and relative clustering is significant and negative. We also observe a similar bell-curve relationship across egohood size, with the negative interaction effect increasing (and becoming more significant) as egohood size increases to around a 3500/4000 metres radius, before decreasing and becoming non-significant in higher radii egohoods.

Based on this fixed-effects approach, Figure 10 plots predicted margins of immigration-attitudes across egohood minority-share (radius of 3500 metres) between the 1st and 99th percentile but examines this relationship for egohoods with low relative clustering (1st percentile) and high relative clustering (99th percentile) (based on the models behind Figure 9). Where egohoods are becoming both higher minority-share and more segregated, individuals become increasingly less positive

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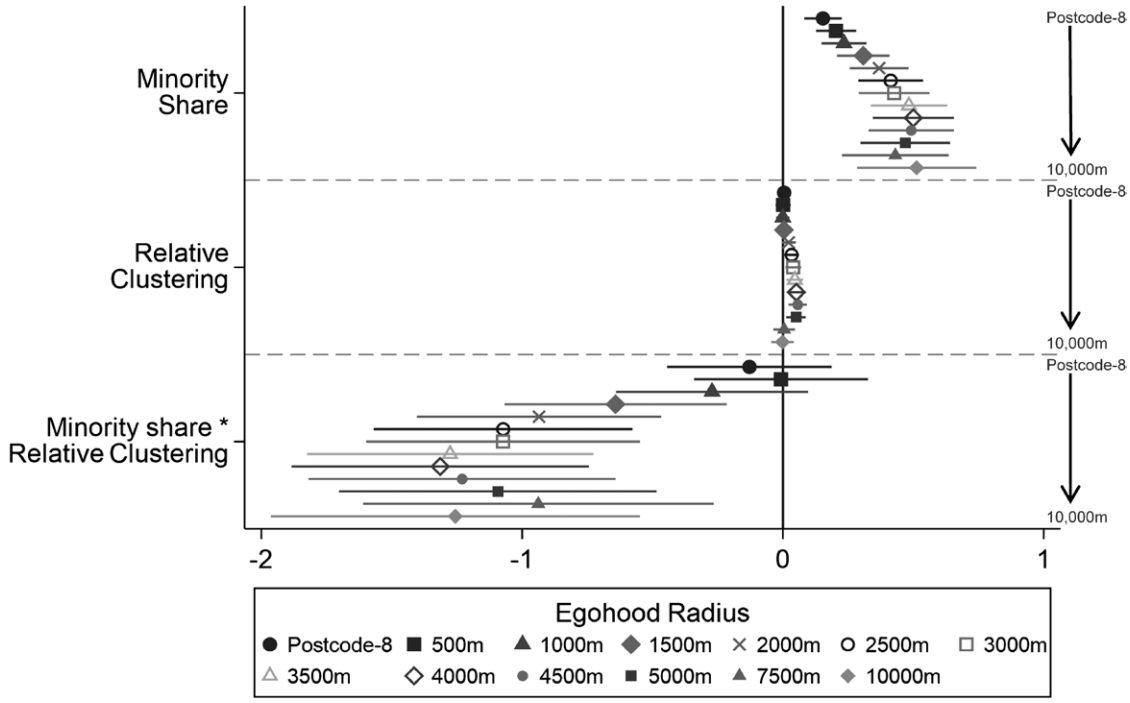

Figure 6 Coefficients of the moderating role of relative clustering on the relationship between minority-share and immigration-attitudes (pooled cross-sectional). Notes: Model using 'postcode-8 areas' as the egohood radius measures minority-share at the postcode-8 level and relative clustering at the 500 metres egohood radius level; 95% confidence intervals; full model results are located in Supplementary Appendix A.3

about immigration. However, where egohoods are becoming higher minority-share *and* more integrated, attitudes somewhat improve[10]. Therefore, even under more causally robust approaches, segregation conditions how minority-share is related to immigration-attitudes. The corollary is that the relationship between segregation and immigration-attitudes becomes stronger/significant as the minority-share increases.

Robustness and sensitivity

Several issues require further scrutiny. Firstly, we examine how conditional the findings are on using relative clustering versus other measures of segregation. Figure 11 replicates Figure 10 (fixed-effects modelling of the moderating effect of relative clustering) but uses egohood index of dissimilarity instead of clustering (see Supplementary Appendix A.6). Similar patterns emerge.

Secondly, as outlined, we can further adjust models for time-invariant unobserved contextual-level heterogeneity via our two outlined approaches (see Figure 4). Model 1 (Table 1) limits the sample to all observations prior to an individual's first move (after which they drop out) (see Supplementary Appendix A.7 for full results of all models in Table 1). Model 2 (Table 1) performs the 'synthetic individual' approach (multi-level hybrid-modelling, nesting observations in synthetic-cases within individuals). Under both approaches, even accounting for contextual-level unobserved time-invariant heterogeneity and residential selection between areas the minority-share/segregation interaction persists.

Thirdly, fixed effects modelling implicitly captures how *changes* over time in minority-share/segregation relate to attitudes. However, highly segregated/integrated areas with a low minority-share can see their minority-share increase while still remaining highly segregated/integrated, i.e. areas can become more diverse over time while levels of segregation remain stable. To further examine the conditioning-role of segregation we test (fixed-effects modelling) whether a *change* in minority-share over time has a stronger negative association with immigration-attitudes in egohoods with a higher *level* of segregation (calculated by taking the average level of segregation in an egohood over time). Model 3 (Table 1) shows that the interaction-term between minority-share and *level of* segregation is significant and negative, i.e. *changes* in minority-share have a more negative association in areas with a higher *level* of segregation.

Fourthly, certain minority-groups are more represented in more segregated areas, e.g. Turks/Arabs

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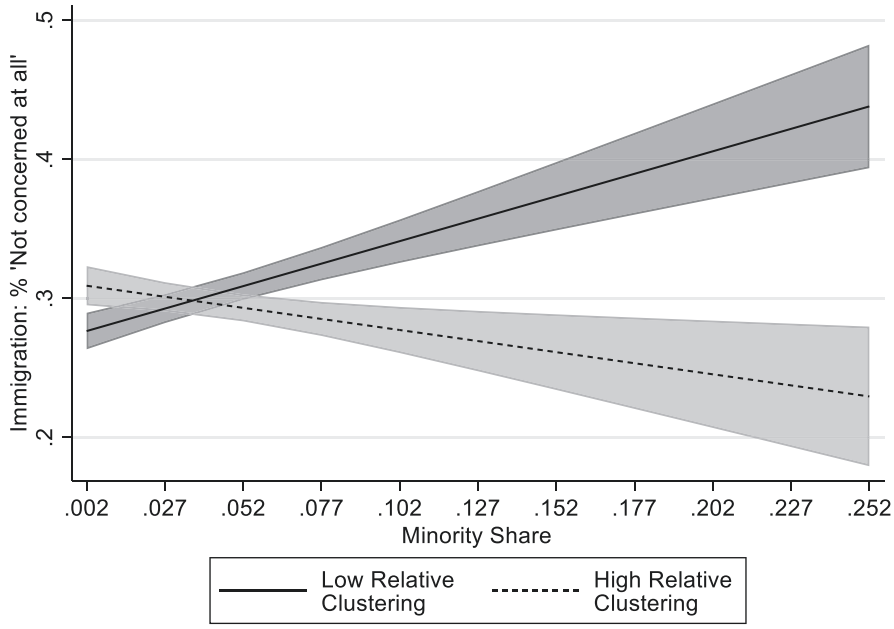

Figure 7 Predicted immigration-attitudes between 1st and 99th percentile of minority-share in egohoods with low (1st percentile) and high (99th percentile) relative clustering (pooled cross-sectional); egohood radius 3500 metres. Notes: Full model results used to generate Figure 6 located in Supplementary Appendix A.3 (model 8)

are more segregated than Central/South Americans (Helbig and Jähnen, 2018). Potentially, segregation may be a proxy for the presence of particular ethnic groups, exposure to which differentially affects immigration-attitudes. Model 4, therefore, replicates our key model (fixed-effects modelling, including the 3500 metres egohood radius minority-share/segregation interaction) but includes the proportion of ethnic minority sub-groups within a respondent's local area (defined using German 'Marktzellen' areas: on average, 400 households) (limited to waves 2006–2011). Increases in the share of Greeks/Asians are (weakly) related to positive immigration-attitudes, while increases in the share of Turks/Other groups are related to negative attitudes. However, even accounting for the local ethnic composition of the minority-group, the egohood minority-share/segregation interaction remains significant. Fifthly, tests for heterogeneity across urban/rural areas show that the minority-share/segregation interaction-term is present in both (models 5 and 6). Sixthly, we ran separate models on the East and West Germany samples (models 7 and 8). The interaction-effect is somewhat weaker in the West and stronger in the East, although it is only significant in the West. However, given the stronger association in the East this non-significance may be driven by the smaller East German sample and lower proportion of immigrants in the region[11].

Discussion

This paper sought to advance our understanding of how individuals' racial context shapes their anti-immigrant sentiment by analysing how minority-share and residential segregation are related to immigration-attitudes. Minority-share alone is not directly related to immigration-attitudes and a positive association identified under pooled cross-sectional analysis becomes negative/non-significant under fixed-effects. Segregation is also not directly associated with immigration-attitudes.

We do observe, however, that the association between minority-share and immigration-attitudes is highly conditional on how segregated majority/minority groups are. As areas evolve to become more diverse and *integrated*, immigration-attitudes improve. However, as areas become more diverse and *segregated*, immigration-attitudes progressively worsen. This suggests processes of intergroup contact and perceived-threat may not only be contingent on the relative size of ethnic outgroups but also how (un)equally they are distributed across an area. Observing this dynamic in fixed-effects modelling increases confidence in this

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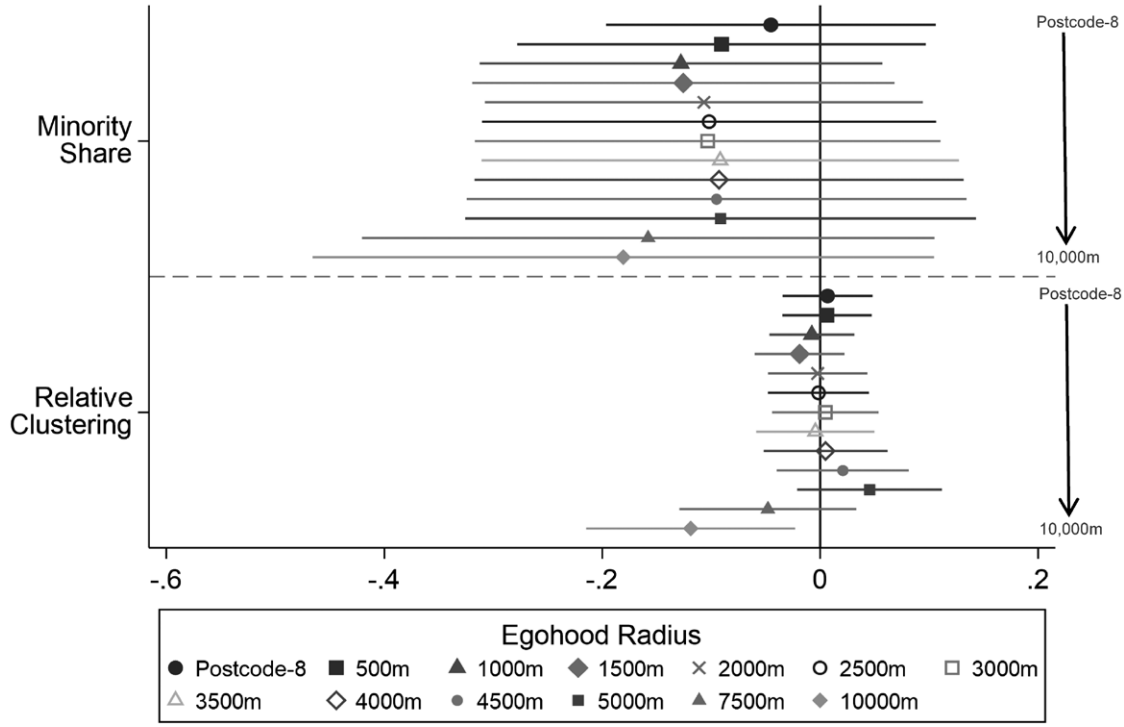

Figure 8 Coefficient plot of direct-effects of minority-share and relative clustering on immigration-attitudes (fixed-effects approach); SOEP. Notes: Model using 'postcode-8 areas' as the egohood radius measures minority-share at the postcode-8 level and relative clustering at the 500 metres egohood radius level; 95% confidence intervals; full model results are located in Supplementary Appendix A.4

contextual-effect, while restricting the sample to 'stayers' or using the 'synthetic stayer' sample increases confidence the relationships are not solely a product of residential selection. This also suggests increasing segregation alone is not associated with immigration-attitudes but is itself conditional on the minority-share in an area; segregation only appears to shape immigration-attitudes in areas with a larger minority-share.

The strength/significance of this conditioning-effect of segregation/minority-share exhibits a bell-curve relationship across egohood spatial-scales, peaking around a 3500/4000 metres radius. Racial contexts are expected to shape attitudes via two processes: firstly, through residents' cognizance of their racial context (e.g. the size/segregation of groups in an area) (Stein *et al.*, 2000), garnered through their everyday exposure to their environments alongside information from local social networks (Velez and Wong, 2017); and secondly, through actual social interactions structured by the make-up of racial contexts (Stein *et al.*, 2000; Hopkins, 2010). The greater saliency of meso-level environments may reflect the spatial-scale at which the posited effects of segregation optimally condition these mechanisms to shape processes of contact/threat. In smaller diverse egohoods (≤1500 metres), even when segregation is high, opportunities for positive-contact may not be significantly curtailed. For example, everyday encounters could still occur in the street, while the use of local services/institutions is still likely shared in smaller areas. Similarly, smaller diverse/segregated egohoods may not contain the critical-mass of minority population to lead to the formation of a high density of ethnic-specific institutions/services; hallmarks of 'ethnic enclaves'. As such, the processes linking minority-share and segregation to contact/threat may be weaker across smaller scales. In larger diverse egohoods (≥5000 metres), individuals' cognizance of their wider spatial environment may increasingly weaken, with a poorer sense of the surrounding size/segregation of minority groups, posited to affect threat. For example, if an ethnic enclave exists in a larger egohood (e.g. ≥5000 metres), it may trigger less perceived-threat given residents may be less frequently exposed to it. Instead, meso-level egohoods may be the optimal scale at which the interactive processes stemming from both increasing minority-share and segregation operate.

These findings make important contributions to the literature on segregation/minority-share and

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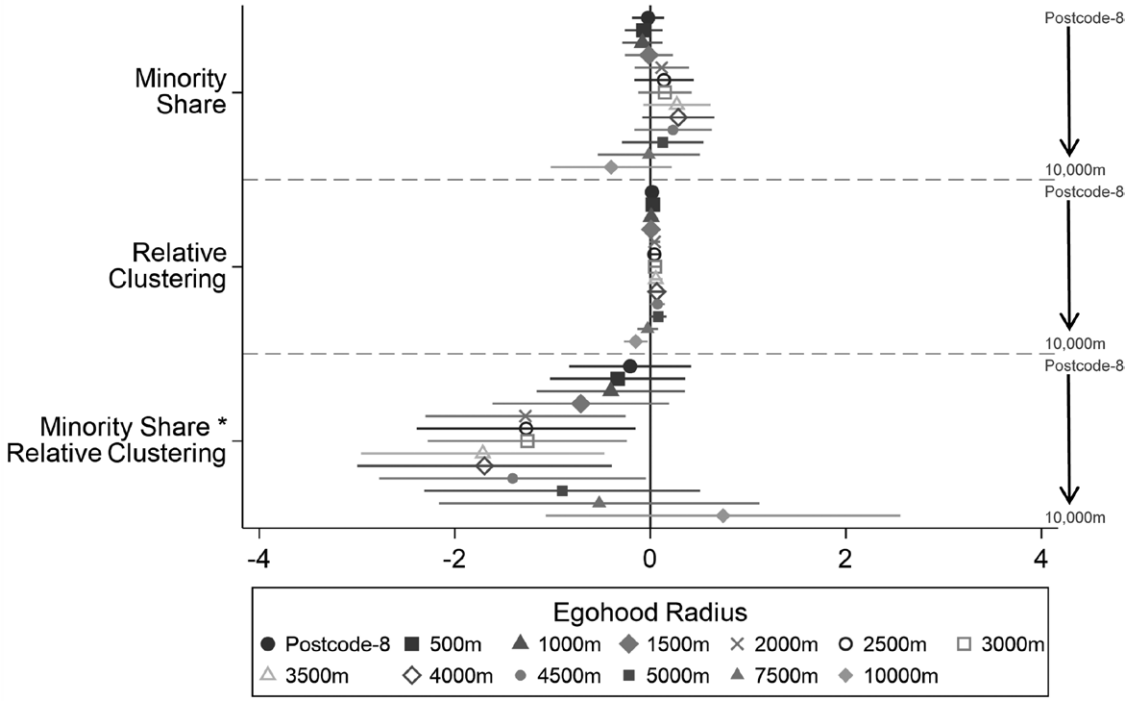

Figure 9 Coefficient plot of the moderating role of relative clustering on the relationship between minority-share and immigration-attitudes (fixed-effects approach); SOEP. Notes: Model using 'postcode-8 areas' as the egohood radius measures minority-share at the postcode-8 level and relative clustering at the 500 metres egohood radius level; 95% confidence intervals; full model results are located in Supplementary Appendix A.5

intergroup relations. Firstly, the use of fixed-effects longitudinal analysis among stayers goes a long way to addressing potential bias from neighbourhood-selection effects present in prior studies. Secondly, testing relationships using egohoods across multiple radii helps better identify the spatial-scale at which the processes of minority-share/segregation are most salient for intergroup relations. In addition, through comparing pooled cross-sectional estimates with more robust fixed-effects analyses, the need for the latter to account for bias within the former is highlighted.

The study also has important implications for understanding how racial context shapes immigration-attitudes more generally. We highlight how any level of minority-share has a corollary level of segregation, and accounting for this has significant implications for understanding how group-size relates to immigration-attitudes. This provides another potential explanation for divergent findings on the minority-share/anti-immigrant sentiment relationship across studies. Different average levels of segregation across contexts could (partly) explain different reported associations. The study also shows how any level of segregation in an area also has a corollary level of migrant-share and accounting for this has implications for understanding when segregation likely shapes residents' attitudes as well.

Lastly, the study builds on previous innovative research on the link between racial context and anti-immigrant sentiment in Germany conducted by Lancee and Schaeffer (2015). The present study used the same SOEP panel survey, similar contextual-level data, and the same measure of immigration-attitudes as their study, and also takes a longitudinal approach. Lancee and Schaeffer (2015) demonstrated how changes in the ethnic fractionalization of individuals' small areas in response to moving between neighbourhoods is linked to anti-immigrant sentiment: moving to more ethnically diverse areas increases anxiety about immigration, although those moving to less diverse areas see no change (Lancee and Schaeffer, 2015). Our study adds a complementary dimension to this picture: that increases in the share of migrants in an area which occur around residents ('stayers') can also shape their anti-immigrant sentiment, but how it does depends on how segregated areas are. Future research could further develop these complementary approaches to explore whether any effects of moving between more/less diverse areas on immigration-attitudes may depend on how segregated these areas are, and whether effects also differ across egohood size.

Notwithstanding the insights gleaned, this study has limitations. Only a single outcome variable was

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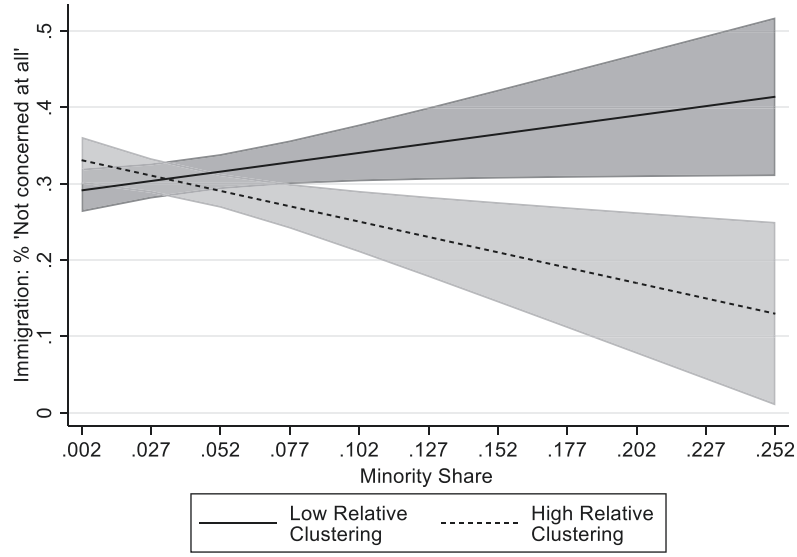

Figure 10 Predicted immigration-attitudes at 1st and 99th percentile of minority-share in egohoods with low (1st percentile) and high (99th percentile) relative clustering (fixed-effects); egohood radius 3500 metres. Notes: Full model results used to generate Figure 9 located in Supplementary Appendix A.5 (model 8)

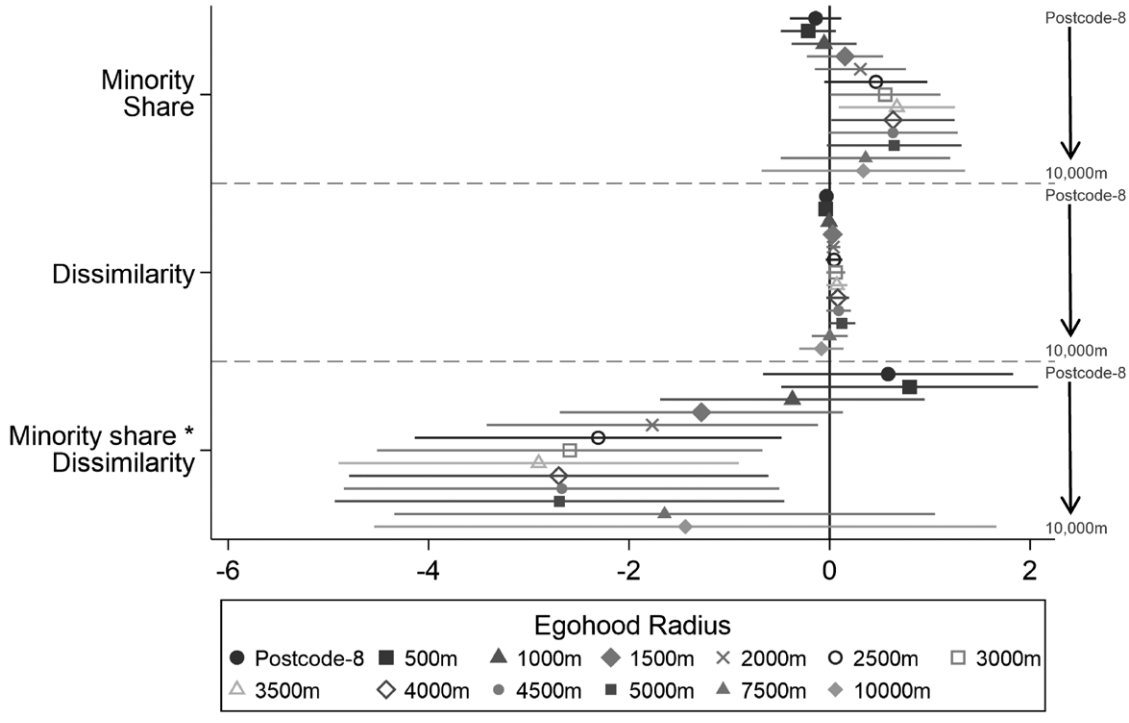

Figure 11 Coefficient plot of the moderating role of index of dissimilarity on the relationship between minority-share and immigration-attitudes (fixed-effects approach); SOEP. Notes: Model using 'postcode-8 areas' as the egohood radius measures minority-share at the postcode-8 level and the index of dissimilarity at the 500 metres egohood radius level; 95% confidence intervals; full model results are located in Supplementary Appendix A.6

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Table 1 Robustness testing of the interactive-relationship between minority-share, segregation, and immigration-attitudes

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Outcome	Immigration attitudes							
Test type	Staying sample	Synthetic staying sample	Level of relative clustering fixed at mean	Sub-group controls	Urban sample only	Rural sample only	West Germany only	East Germany only
Modelling approach	Fixed effects	Hybrid model	Fixed effects	Fixed effects	Fixed effects	Fixed effects	Fixed effects	Fixed effects
Within-effects								
% Minority	0.322	–0.094	0.461+	0.148	0.316	0.782	0.113	1.158
	(0.300)	(0.163)	(0.279)	(0.245)	(0.243)	(0.563)	(0.137)	(0.654)
Relative clustering	0.031	–0.026	—	0.053	–0.001	0.097*	0.071+	0.09
	(0.045)	(0.034)	—	(0.043)	(0.074)	(0.046)	(0.043)	(0.043)
% Minority* relative clustering	–2.521*	–6.849**	–2.408*	–2.298**	–2.113*	–3.140*	–1.493**	–2.833
	(1.042)	(2.895)	(1.096)	(0.838)	(0.926)	(1.572)	(0.567)	(1.755)
Sub-group within-effects								
% Sub-Saharan				0.013				
				(0.017)				
% South/East/ Southeast Asia				0.044+				
				(0.024)				
% Balkan region				0.008				
				(0.006)				
% Greece				0.014+				
				(0.008)				
% non-European Islamic States				–0.004				
				(0.014)				
% Italian				–0.009				
				(0.007)				
% Eastern Europe				0.002				
				(0.007)				
% 'Spaetaussiedler' from USSR				–0.016				
				(0.015)				
% Spain/Portugal/ Latin America				0.008				
				(0.014)				

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Table 1. Continued

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Outcome				Immigration attitudes				
Test type	Staying sample	Synthetic staying sample	Level of relative clustering fixed at mean	Sub-group controls	Urban sample only	Rural sample only	West Germany only	East Germany only
Modelling approach	Fixed effects	Hybrid model	Fixed effects	Fixed effects	Fixed effects	Fixed effects	Fixed effects	Fixed effects
% Turkish				–0.004+				
				(0.002)				
% Other group				–0.012*				
				(0.006)				
Between-effects								
% Minority		0.461***						
		(0.078)						
Relative clustering		0.042						
		(0.029)						
% Minority* relative clustering		–0.750*						
		(0.306)						
Constant	0.270	0.032	0.226	0.526	0.050	1.061***	–0.252	–0.087
	(0.272)	(0.088)	(0.277)	(0.323)	(0.177)	(0.057)	(0.204)	(0.068)
N	108,666	122,294	122,294	99,080	76,495	45,799	89,277	32,156

Significance levels: +0.1;
*0.05;
**0.01; and
***0.001; models contain all individual-level and contextual-level variables (although not shown); full model results are located in Supplementary Appendix A.7.

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available to analyse, limiting our understanding of people's specific feelings towards immigration. To our knowledge, the survey did not include other outgroup attitudes measures over a similar period (to allow us to use the same spatial approach) that could have served as useful proxies. In addition, the generalized nature of the variable may make it sensitive to shifting national conditions than local conditions, given the impact of local racial context can be shaped by immigration salience at a national-level (Hopkins, 2011). Furthermore, the data did not contain consistent measures of the mechanisms posited to account for the observed relationships—contact/perceived-threat.

Data limitations prevent us from capturing more detailed covariates across individuals' egohoods, beyond poverty. Accordingly, while our methodological approach adjusts for time-invariant unobserved heterogeneity, it does not account for time-variant unobserved heterogeneity and other factors may still be confounding the observed relationship. Furthermore, we model how contemporaneous changes in diversity/segregation are associated with changes in attitudes. This may be problematic given theories suggesting increasing in-migration of non-natives may trigger perceived-threat which, in turn, triggers segregation, e.g. residents exerting discriminatory housing policies/intimidation to limit the residential choice of minority-groups (DeFina and Hannon, 2009). Lastly, the current study also focussed primarily on the minority-share across contexts, while a related literature suggests that the degree of ethnic fractionalization is also salient for intergroup relations and found to be important in Germany (Lancee and Schaeffer, 2015). Further research will explore whether diversity within the outgroup-population may also matter.

Perhaps the most compelling limitation is understanding why some areas evolve over time to become more diverse and segregated or integrated, and how far factors determining these trajectories could provide an alternative explanation for our findings. For example, segregation may emerge where particular minority groups (or more recent arrivals) evince greater ethnocentrism, or where minority groups are more economically/socially disadvantaged. Ultimately, the current approach still relies on the assumption that exposure to changes in minority-share/segregation is random. Potentially, the individuals/communities experiencing changes could differ in meaningful ways, accounting for the findings. Future work will look at applying alternative approaches, such as difference-in-differences (Lancee and Schaeffer, 2015) or natural experiments (Hangartner *et al.*, 2019) to better identify the posited causal effects.

In sum, the size of the ethnic minority-group in an environment does play a key role in shaping attitudes toward immigration, but understanding this relationship requires accounting for patterns of residential segregation as well. Solely measuring the relative size of ethnic groups does not fully capture how racial context shapes people's experiences and can instead mask a posited polarizing effect that immigration can have on attitudes depending on levels of segregation. These diverging effects across diverse-segregated and diverse-integrated areas may help, in turn, understand processes of growing polarization in immigration-attitudes both within and between countries, which appear to be ever more salient in society.

Notes

1. The first method took the cross-sectional weight for the first wave and multiplied this by the reciprocal staying factor for each following wave that the respondent remains in the sample. The second method applies the SOEP design-weights, to adjust the sample for the complex sampling design of the SOEP.
2. https://www.microm.de.
3. Prior work has shown how this measure predicts right-wing party identification (see Pardos-Prado, Lancee and Sagarzazu, 2013). Other work has shown how items which measure people's concern about immigration form valid indicators of negative immigration-attitudes (see McGhee and Neiman, 2009).
4. This strategy assumes that the population is evenly distributed within postcode-8 areas.
5. Relative clustering index was calculated using the OasisR package (Tivadar, 2019).
6. Replication using conditional logistic regression analyses returned identical findings.
7. Minority-share and segregation are correlated at around $r = 0.2$ (varying somewhat across egohood-scales).
8. When testing the effect of postcode-8 non-native share the corollary segregation measure is the 500 metres radius ego-hood.
9. Various polynomial terms tested for both minority-share and segregation in the interaction were non-significant.
10. We calculated per cent reporting 'not concerned at all' at the 5th/95th percentiles of minority-share/relative clustering: low-minority-share/low-segregation (28 per cent 'not concerned at all'), low-minority-share/high-segregation (30 per cent), high-minority-share/low-segregation (36 per cent), high-minority-share/high-segregation (25 per cent). We also calculated per cent reporting 'not concerned at all' at the 10th/90th percentiles of minority-share/relative clustering: low-minority-share/low-segregation (29 per cent), low-minority-share/high-segregation (31 per cent), high-minority-share/low-segregation (34 per cent), and high-minority-share/high-segregation (27 per cent).
11. As discussed, migrants compose a smaller proportion of East Germany, which may limit our ability to run analyses on East Germany. However, there is a similar range in minority-share/segregation at smaller egohood-scales

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(albeit skewed to lower values in the East). Prior work has shown similar tests can yield important insights into East/West differences. The stronger negative relationships in the East may stem from multiple factors, one being that immigration is more novel in the East and therefore groups may see it as more threatening (see Weisskircher, 2020).

Supplementary data

Supplementary data are available at *ESR* online.

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Data availability

The paper uses two datasets. The first is the German Socio-Economic Panel (SOEP) data (owned and managed by Deutsches Institut für Wirtschaftsforschung (DIW), Berlin). To measure the effects of spatial context and construct bespoke egohoods for every respondent in the data, we use a unique version of the SOEP data that contains the geocoded locations and addresses for each respondent. Given such data have a high risk of identity disclosure, accessing it requires, in the first instance, an application to the DIW. Subsequently, access to the data for analysis can only be undertaken on-site at the DIW in Berlin, Germany. As such, a copy of the SOEP data that contains the necessary geocodes for respondents is not available to be shared and can only be accessed on-site at the DIW, Berlin. The second dataset used in the paper is the 2005–2013 Microm postcode-8 data. These data were used to create the bespoke neighbourhoods for each respondent in the SOEP data, which were then subsequently matched to respondents' SOEP data. These data can similarly only be accessed via application to the DIW and can only be analysed on-site at the DIW.

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