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Accessibility in a multi-ethnic city: Residential trade-offs among first-time parents

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Highlights

- Accessibility is opted out in favour of house space and neighbourhood composition.
- Different trade-offs lead to lower accessibility levels for natives than immigrants.
- Higher income reduces the need to make residential trade-offs.
- Transport inequality is partly explained by varying residential preferences.

Abstract

Public transport accessibility is necessary to avoid transport disadvantage and car dependency. This study investigates how trade-offs between public transport accessibility, house size and the ethnic variation of neighbourhoods vary among residentially relocating first-time parents in the multi-ethnic Oslo region. The study employs structural equation models and observes *two* main patterns. First, households with higher income face, as expected, more opportunities and a reduced need to make difficult trade-offs. Second, as compared to immigrants, native Norwegians have a greater preference for spacious housing and ethnically uniform neighbourhoods, which leads to lower public transport accessibility levels. The results show how traditional theories of urban attractiveness and transport inequality are complicated in multi-ethnic cities. This knowledge is useful for policy makers developing policies intended to ensure a just transition to low-emission mobility.

Previous Next

Keywords

Public transport accessibility; Transport disadvantage; Residential location choice; Structural equation modelling

1. Introduction

Accessibility, defined as people's ease of reaching places and opportunities from a given location, is an important element in the assessment of the distributive justice of transport policies (Banister, 2018; Handy, 2020; Martens, 2016; Pereira et al., 2017), as well as in theories of social and spatial justice (Fainstein, 2010; Harvey, 1973; Rawls, 1971). Moreover, with the increasing attention being paid to sustainable urban development, accessibility with sustainable transport modes, such as public transport (PT), is becoming more important. PT accessibility is necessary to avoid car dependency and secure a socially just transition to low-emission mobility (Mattioli, 2021; Næss, 2006; Verlinghieri and Schwanen, 2020). Lucas (2012) describes how inaccessibility can lead to lower well-being, social exclusion and unemployment. A situation in which transport disadvantage (poor PT services and high transport costs) overlaps with social disadvantage (low income and poor health) can result in *transport poverty*, a state of "inaccessibility to essential goods and services, as well as 'lock-out' from planning and decision-making processes" (Lucas, 2012, page 106).

An individual's level of accessibility depends on her residential location. With the increasing attractiveness of the inner city and a tight housing market in many post-industrial cities, households with limited economic resources are forced to make a trade-off between a central residential location with good PT accessibility and more affordable housing in the urban peripheries, where PT accessibility is lower (Alonso, 1964; Rérat and Lees, 2011; Smith et al., 2020). In other words, a typical dilemma for households looking for a new residential location is the choice between accessibility and affordability. In combination with gentrification processes, urban regions across the world have witnessed a *suburbanisation of poverty* in recent years (see, for example, Cooke and Denton, 2015; Hochstenbach and Musterd, 2018). This process has also been linked to transport disadvantage, resulting in a *suburbanisation of transport poverty* (Allen and Farber, 2021). As cities witness increased immigration and become more multi-ethnic, the traditional patterns of trade-offs between accessibility and housing characteristics are changed in two ways. First, immigrants tend to have different residential preferences than the majority population, often preferring to cluster with other immigrants from the same origin country (Allen et al., 2021; Massey and Mullan, 1984; Zorlu and Mulder, 2008). Second, majority and minority groups tend to respond differently to increased ethnic variation in neighbourhoods, where the native population often avoids or flees areas with high ethnic heterogeneity (Schelling, 1971; Wilson, 1979).

This paper extends the existing literature on transport inequality and residential preferences by studying PT accessibility levels and residential trade-offs among first-time parents in the Oslo region. *The objective of the study is, first, to investigate to what extent PT accessibility is traded off against house size and neighbourhood ethnic diversity when households decide on a new residential location and, second, to determine whether these trade-offs vary with income level and between native Norwegians*[1] *and immigrants*.

Knowledge about how residential trade-offs influence PT accessibility in multi-ethnic cities is important for several reasons. First, it can shed light on how traditional theories of urban attractiveness are complicated in multi-ethnic contexts, as well as how this affects transport inequality. Second, for policy makers working to reduce transport disadvantage and secure a just transition to low-emission mobility, it is not obvious whether distributional differences in PT accessibility are a result of inadequate PT systems, a lack of preferable housing types, the wish to avoid certain neighbourhood types or a combination of the three. This study can help in designing informed policy on transport and land use development that take residential preferences into account and potentially reduce the social inequalities related to sustainable transport accessibility and the transition to low-emission mobility.

The population under study consists of individuals who have recently both had their first child *and* made a residential move within the Oslo region. There are several motivations for choosing this specific subgroup. The first is methodological: limiting the sample to recent or soon-to-be parents making local residential moves increases the likelihood that the relocation decision is mainly influenced by the event of childbirth. Having a child is an important explainer of residential mobility, influencing both the choice of residential location and the type of housing (Clark and Dieleman, 1996; Kulu and Steele, 2013). Second, parents usually experience limited time budgets (Jarvis et al., 2016), and good accessibility and proximity to daily activities is therefore a highly valued asset. Third, families with children tend to demand spacious and preferably single-family housing, while at the same time being sensitive to the ethnic composition of neighbourhoods (Courgeau, 1989; Wessel and Nordvik, 2019). The question of trade-offs between housing, neighbourhood and accessibility attributes is therefore especially relevant for this group. Lastly, following childbirth, households tend to settle in the same residential location for a longer time, as compared to moves conducted at other stages in the life course (Clark and Dieleman, 1996). This means that the residential behaviour of first-time parents has a substantial impact on residential patterns, PT accessibility levels, and transport inequality at the macro level.

The paper is organised as follows. Section 2 presents the relevant literature on accessibility, residential choice decisions and residential patterns in multi-ethnic cities. Section 3 presents the study area, data and analytical model, while the study results are presented in Section 4. The paper ends with concluding discussions (Section 5).

2. Literature review

2.1. The importance of housing and accessibility in residential choice decisions

Centrality and, especially PT, accessibility have traditionally been regarded as important factors in urban attractiveness. With better access to employment and other amenities, travel costs decrease, and housing becomes more popular and costly (Alonso, 1964; Rérat and Lees, 2011). The distributional differences in accessibility and travel costs have been central in urban studies since the introduction of the *spatial mismatch hypothesis* (Kain, 1968; Wilson, 1987) and gained renewed interest in recent years, given the increased attention paid to transport justice (Gössling, 2016; Martens, 2016; Pereira et al., 2017).

The choice of a residential location[2] is often a result of complicated trade-offs, which are assumed to change across the life course (Clark and Dieleman, 1996; Rossi, 1955). Previous research identifies three sets of attributes that are relevant in this decision-making process: housing attributes, neighbourhood attributes and accessibility (or *relative* location) (Chen et al., 2008). Among these, housing attributes are usually the dominant attribute in trade-off processes, followed by neighbourhood attributes. Households tend to value housing space and housing type highly and, thereafter, neighbourhood attributes such as population density and school quality (Hunt, 2001; Molin and Timmermans, 2003; Zondag and Pieters, 2005). Over the life course, households tend to progress to larger dwellings. Because spacious housing is less available in the inner city, many growing households move toward the suburbs (Clark and Dieleman, 1996; Rossi, 1955). In other words, for families with young children, the need for more housing space is likely a central factor in the residential choice process. The last set of attributes, related to accessibility and relative location, is usually less influential in the residential mobility process (Eliasson, 2010; Levine, 1998; Zondag and Pieters, 2005) and determining house price levels (Seo and Nam, 2019; Srour et al., 2002). Chen et al. (2008) also find that *prior* location plays an important role in the residential choice decision. People who have previously experienced good accessibility are more sensitive to a reduction in this attribute in future location choices (Chen et al., 2008, page 71). Other characteristics that have been found to influence residential mobility behaviour are age, employment status and household composition (Brazil and Clark, 2017), as well as the proximity to both core and extended family members (Hedman, 2013; Skifter Andersen, 2010; Spring et al., 2017).

Several studies have investigated the importance of accessibility in households' residential decision-making process. A study from the Netherlands found that accessibility, both via car and PT, has a significant influence on residential choice. However, these factors were not as influential as dwelling and neighbourhood characteristics (Blijie, 2005). Yan (2020) found that PT accessibility had a significant influence on residential location choice in several US regions. Moreover, Yan argues that households often live in a neighbourhood with lower accessibility than they actual prefer because of limited housing supply. This, in turn, can lead to a 'residential dissonance' among households with limited economic resources (Schwanen and Mokhtarian, 2005). A study from the Netherlands on households' moving intentions found that potential accessibility gains were overshadowed by the nuisances related to living close to highways (Hamersma et al., 2015). In other words, households trade good accessibility levels for a quieter residential location. Lund (2006) used a survey to investigate motivations for living in transit-oriented development areas in the US. She found that only one-third of the respondents reported access to PT as a top-three reason for their residential location choice. Other factors, such as house prices and the quality of the neighbourhood, were reportedly more important.

Baraklianos et al. (2020) suggests that a potential explanation for the low importance of accessibility in residential location choices is the methods used to measure accessibility. They conclude that local accessibility measures, such as the proximity to transport infrastructures and distance to the city centre, often result in accessibility becoming less important. On the other hand, accessibility more often remains a significant factor when global measures are used, such as the cumulative opportunities approach, which measures access to *all* opportunities of a specific type, such as employment (Handy and Niemeier, 1997). Other studies have found that individual measures of accessibility, especially commute distance, are more influential than general accessibility measures (Levine, 1998; Ta et al., 2017; Yan, 2020).

Most studies of accessibility trade-offs focus on car accessibility (Lee et al., 2010; Srour et al., 2002; Zondag and Pieters, 2005) or a combination of car and PT accessibility (Baraklianos et al., 2020). There are several reasons for studying the isolated role of PT access in residential choice decisions. First, PT accessibility is important to reduce car dependency, which, in turn, is necessary to secure a just shift to low-emission mobility (Mattioli, 2021; Schwanen, 2020). Second, PT use is available to everyone, including those who cannot afford a car or do not hold a driver's license, a situation that is often more widespread among immigrants than natives. PT accessibility is therefore considered more inclusive and equitable than car access (Pereira and Karner, 2020). Third, PT accessibility tends to be more unevenly distributed, geographically and socially, than car access. In inner city areas, PT accessibility is usually better than in the suburbs, which are more car-oriented (Cervero and Kockelman, 1997; Kwok and Yeh, 2004). With the increasing attractiveness of the inner city, good PT accessibility becomes harder to achieve for households with limited economic resources.

2.2. Residential mobility in multi-ethnic cities

Traditional theories on urban development (Alonso, 1964) and residential mobility (Clark and Dieleman, 1996; Rossi, 1955) are likely to be complicated by the increasingly multi-ethnic nature of urban regions. This complication can be explained by several mechanisms. First, immigrants' residential behaviour tends to differ from that of the majority population for various reasons. Relevant literature exists both on racial variations and variations between immigrants and natives. However, the patterns in both these research strands are broadly the same. Because many immigrants and ethnic minorities have limited economic resources, they often begin their housing career in inexpensive, rented dwellings (Hiebert, 2017). Moreover, immigrants and ethnic minorities tend to cluster with inhabitants of similar origin because of housing discrimination (Charles, 2003), a wish to live close to family and friends (Clark, 1992; Skifter Andersen, 2010; Zorlu and Mulder, 2008), and the

culturally specific businesses and institutions (grocery stores, community centres, and places of worship) offered in these agglomerations (Zhuang and Chen, 2017). Immigrants and ethnic minorities also benefit from the social networks and social capital that these clusters offer and, thus, integrate into the new society. Traditionally, such ethnic clusters emerged in the inner cities, where housing was less expensive and rental housing more accessible (Kain, 1968). Later research (Allen et al., 2021; Ehrenhalt, 2012; Massey and Mullan, 1984) has shown greater variation, with immigrant concentrations in both central and suburban areas.

A third mechanism that complicates residential patterns relates to how the majority population responds to increased multi-ethnicity in neighbourhoods. According to Schelling's tipping-point model (Schelling, 1971), different population groups vary in how tolerant they are of neighbours with different ethnic backgrounds than themselves. The literature on 'white flight' and 'white avoidance' documents that natives often move away from – or avoid altogether – mixed and immigrant-dense neighbourhoods (South and Crowder, 1997; Wilson, 1979). The reasons for this pattern lie in both the racial prejudice of natives (Gould Ellen, 1996) and the social problems often associated with mixed neighbourhoods, such as poverty and a lack of safety (Harris, 1999).

These mechanisms can lead to variations in the accessibility levels of natives and immigrant groups, as well as among individuals with different income levels. Because ethnic minorities have traditionally clustered in inner cities, we can expect that 'white flight' and 'white avoidance' lead native households to the suburbs, where accessibility is lower. Moreover, immigrants and ethnic minorities are often more dependent on PT than the majority population, partly because of lower car ownership rates (Blumenberg, 2009), and may therefore prefer to settle in central areas. While there is little evidence on immigrant group variations in PT accessibility for recent parents, there are several studies on how transport inequality varies with immigration status. Immigrants often enjoy better accessibility levels than the majority population, mainly because they tend to settle in high-density urban areas. This was found in a comparative study of 17 European cities (Bartzokas-Tsiompras and Photis, 2019), although there were clear ethnic variations: immigrants of African descent were found to suffer from the lowest accessibility, on average, while accessibility was highest among immigrants from American countries. In the US as well, different ethnic groups exhibit different residential patterns. In a study from Florida, Yan et al. (2022) documented that Black-majority neighbourhoods enjoyed high accessibility levels, while the opposite was the case in Hispanic-majority neighbourhoods. In Chicago, neighbourhoods with high percentages of African-Americans, Hispanics and Asians were characterised by low PT accessibility (Ermagun and Tilahun, 2020). The opposite was the case in a study of recent immigrants in Sydney and Toronto (Allen et al., 2021), where recent immigrants enjoyed higher PT accessibility than the majority population, on average.

3. Research design

3.1. Study area

The study area is the Oslo region, defined as the functional urban region, which includes the municipality of Oslo and all neighbouring municipalities in which at least 20% of the workforce commutes to Oslo.[3] The region is characterised by a tight housing market, where prices in the central areas increase more quickly than in the suburbs (Lindquist and Vatne, 2019). Moreover, PT accessibility and the competitiveness of PT versus private cars is relatively good as compared to other urban regions in Norway (Lunke et al., 2022), although there are clear social and geographical disparities (Lunke, 2022). In the last decades, the major planning strategy has been compact city development in central areas and around PT hubs in order to promote a shift away from private cars (Akershus Regional Municipality and Oslo Municipality, 2015).

The Oslo region has transformed from a mono-ethnic to a highly multi-ethnic city over the last 50years (Blom, 1999). The first waves of immigrants to Norway, from the early 1970s to the 1980s, consisted mostly of labour immigrants employed in low-skilled jobs, originating from countries such as Pakistan, Turkey, Morocco, Chile, Vietnam and Sri Lanka (Midtbøen, 2017). Later, much immigration from these countries have been in the form of family reunion. Since 2000, following the expansion of the European Union with several eastern European countries, Norway has witnessed a new wave of labour immigration, this time from countries such as Poland, Lithuania, Estonia and Latvia (Turner and Wessel, 2013). Many immigrants from new EU-countries are craftsmen, employed in the construction industry (Østby, 2003). Immigration from western, high-income countries has also been persistent for the past decades. Western immigrants are characterised by higher educational attainment and more high-skilled employment than those from non-western and new EU countries (Olsen and Snellingen Bye, 2020).

In terms of residential behaviour, there are some interesting patterns among immigrants and natives that should be noted for the study area. In the first immigration wave, in the 1970s, immigrants primarily settled in neighbourhoods in the inner east of Oslo. These parts of the city witnessed substantial gentrification in the 1990s and 2000s, and the immigrant population began to decrease, moving to more suburban areas. While immigrants tend to settle in the eastern suburbs, natives prefer the more affluent western parts of Oslo (Ljunggren, 2017; Turner and Wessel, 2013). Immigrants also display a higher preference for dense neighbourhoods than the native population (Wessel and Lunke, 2021). Lastly, previous research has shown that the majority population, especially those with small children, is sensitive to the ethnic composition of neighbourhoods (Wessel and Nordvik, 2019).

To sum up, immigrants in the Oslo region can be reasonably divided into three groups: immigrants from high-income countries, mainly Western Europe, Northern America and Oceania, those from new EU countries (in Eastern Europe) and those from low-income countries (mainly Asia, Latin America and Africa). In addition to residential patterns, these groups also vary in terms of their reason for immigration, connection to the labour market and plans for a permanent stay in Norway.

3.2. Data

This study uses annual registry data comprising all Norwegian inhabitants, with information on income, household characteristics, immigrant background, employment status and residential and workplace locations. The data were gathered from several national registers collected by Statistics Norway. The study sample consists of *all individuals who 1) lived within the Oslo region from 2015 to 2018, 2) had their first child in 2017 and 3) made a residential move within the region during this period.* This approach captures people who made a residential move either in anticipation of or shortly after family formation. Thus, we can be reasonably certain that childbirth is a significant cause for the move itself and the residential location choice.

PT accessibility is measured by a weighted cumulative opportunity model of access to employment opportunities (Handy and Niemeier, 1997). This approach is generally considered a better measure of accessibility in the residential choice process than simpler methods, such as travel time to the city centre (Baraklianos et al., 2020; Geurs and van Wee, 2004). The model calculates the number of workplaces reachable from each person's residential location (at the census tract level), weighted by travel time. Accessibility, $A_{o,t}$, for residents in census tract[4] o is measured as follows:

$$A_{o,T} = \sum_d O_d \; df(t_{od}) \tag{1}$$

where O_d is the number of opportunities (workplaces) in location d. $df(t_{od})$ is the distance decay function, reducing the weight of accessible opportunities at location d based on the travel time (t_{od}) between origin o and destination d census tracts. In this case, a negative exponential function is used to weight opportunities, as recommended by Handy and Niemeier (1997).

$$df(t_{od}) = e^{\beta t_{od}} \tag{2}$$

The distance decay function (β=−0.03) was found by investigating the distribution of commute trip durations in the study region with data from the Norwegian National Travel Survey (Grue et al., 2021). The accessibility calculations are based on travel times between the building-weighted centroids of census tracts, calculated with PT timetable and road network data[5] using R statistical software (Pereira et al., 2021). Travel times are measured with a departure time of 08:00am. To account for the sensitivity to departure times (Pereira, 2019), travel time is measured as the median travel time of several departures within a time window.[6] The calculated travel time also includes walking to, from and between stops.[7]

While it could be useful to measure access to other services than employment, there are several reasons why measuring employment accessibility is relevant in this study. First, work trips represent a substantial portion of daily trips. In Norway, one out of four trips are work related (Grue et al., 2021). Second, access to employment is a central factor in residential choice modelling (Alonso, 1964) and studies of the spatial mismatch hypothesis (Ihlanfeldt and Sjoquist, 1998). Third, employment accessibility is a good proxy for access to other activities: Baraklianos et al. (2020) find that accessibility to employment is highly correlated (0.97–0.99) with access to shopping and leisure. Finally, while a general measure of accessibility to *all* employment opportunities could be inaccurate, as different workplaces are not equally relevant for all workers, recent work suggests that this operationalization is valid: A previous study from the Oslo region tested a more detailed measure of accessibility, differentiated by employment sector (Lunke, 2022). This study found that the general measure of accessibility yielded similar results as the more specific one.

The size of housing is, to repeat, an important quality in residential choice decisions, especially for families with children (Clark and Dieleman, 1996; Clark and Huang, 2003; Rossi, 1955). Compared to accessibility, the size of housing can be considered 'the other side of the coin' in residential trade-off decisions (Alonso, 1964). With an increased desire for housing space, growing households often trade away centrality and accessibility for more affordable and spacious housing in the less central suburbs. In this study, house size is measured as the usable floor space in square meters.

To consider how sensitivity to the population composition of neighbourhoods affects residential trade-off decisions, a variable representing neighbourhood population is included. Because previous research from Oslo has found that native families tend to prefer neighbourhoods with few ethnic minorities (Wessel and Nordvik, 2019), in this study, neighbourhood population composition is measured as the share of native Norwegian inhabitants at the census tract level (ranging from 0 to 1). Alternative measures of neighbourhood composition were considered, such as poverty and crime level. However, native share was used as this is arguably an important factor in households' residential decision-making process, especially when considering families with small children, both because of the likely correlation with other socioeconomic characteristics (Harris, 1999), but also independently of this, as households tend to associate a growing minority share with more general structural decline of neighbourhoods (Gould Ellen, 2000). Neighbourhood poverty was nevertheless included in a robustness check.

Tenure is measured with a dummy variable, equalling 1 for renters, in order to account for the fact that owners and renters exhibit different residential mobility patterns (Clark et al., 1994; Deurloo et al., 1994; Haque et al., 2020).

Income is measured as household income after taxes, weighted by household size using the OECD's square root scale.[8] To account for non-linearity and to ensure that observations with zero or negative values are included, income is rank transformed to percentiles (Chetty et al., 2014).

Immigrants are defined as both first-generation immigrants and children of immigrants (second generation). Four immigrant groups are defined based on country of origin, as described in Section 3.1: Native Norwegians, immigrants from high-income countries, immigrants from new EU countries and immigrants from low-income countries.[9]

Research shows that mobility levels and housing preferences are affected by marriage and union dissolution (Withers, 1998). Moreover, students behave differently than employed individuals in terms of the housing market (Feijten et al., 2008). Therefore, dummy variables measuring single parents and students (measured as full-time students without full-time employment) are included. Residential mobility is also affected by education level (Clark and Dieleman, 1996), and dummy variables for medium and high educational attainment are therefore included.[10] Because the income variable is weighted by household size, a separate variable for household size is *not* included. However, because the sample consists of recent parents, most households consist of either two persons (single parents) or three persons (couples).

Finally, earlier research documents that the prior situation in terms of housing and neighbourhood characteristics and accessibility plays an important role in residential choice decisions (Blijie, 2005; Chen et al., 2008). To account for this, four control variables (representing previous tenure, house size, native share and PT access) are included.

3.3. Analytical model

Structural equation modelling (SEM) is used to study how the residential relocation of households leads to different levels of PT access, as well as whether this outcome is mediated by the desire for spacious dwellings and ethnically homogenous neighbourhoods. The model applied here is a subtype of SEM ('path model') in which all variables are directly observed. The reason for using SEM, as compared to conventional regression modelling techniques, is that it allows for the inclusion of several dependent (endogenous) variables in the same model. One may thus evaluate both *direct* and *indirect* (mediated) effects between various factors (Acock, 2013). Fig. 1 shows an overview of the analytical model, with endogenous variables (solid lines) and exogenous variables (dotted lines).

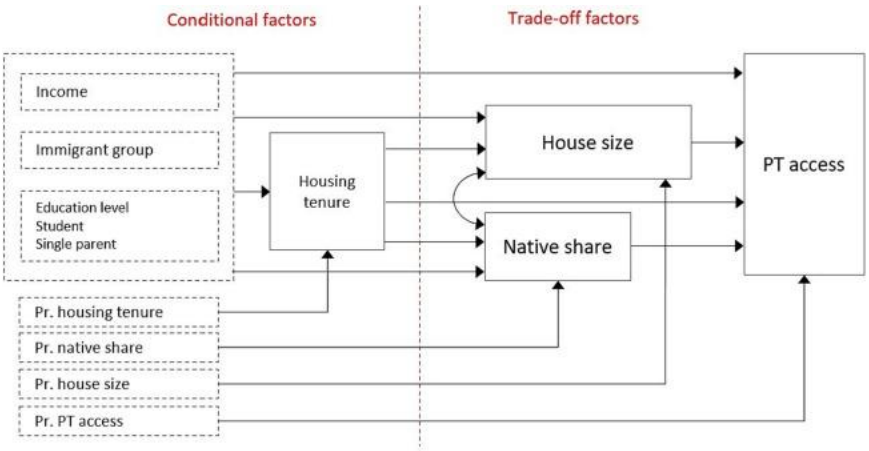

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Fig. 1. Analytical (SEM) model of the study.

The model consists of a *conditional* part and a *trade-off* part. The former includes variables that are assumed to condition the trade-offs between the three variables in the latter part. Tenure (whether individuals rent or own their houses) is placed in the conditional part, even though it is defined as an endogenous variable. This choice is motivated by the large share of home ownership in Norway (86% among parents with small children[11]). In this context, housing tenure is usually determined *before* the residential location decision is taken, for example, because of problems with acquiring a mortgage. Furthermore, whether an individual chooses (or is forced) to buy or rent necessarily influences her options in terms of house size, neighbourhood type and accessibility level.

PT access is placed as the final endogenous variable, mediated by the other trade-off variables. Theoretically, all three variables are relevant outcomes of the residential relocation process, and which are true 'mediators' is not clear cut. However, there are two important reasons for

placing PT accessibility after the other two variables in this study. First, as mentioned in the previous section, PT accessibility is usually less important in the residential decision-making process (Chen et al., 2008; Molin and Timmermans, 2003; Zondag and Pieters, 2005). We can thus assume that parents pay more attention to the other trade-off variables when deciding where to move. Secondly, because the purpose of this paper is to investigate residential trade-offs within a transport and environmental justice perspective (Martens, 2016; Verlinghieri and Schwanen, 2020), the outcome in terms of PT accessibility is more relevant than outcomes in terms of housing and neighbourhood characteristics.

All exogenous variables are measured in 2017, i.e., before the residential move took place, while the endogenous variables are measured after the residential move, in 2018. Income level, immigrant group and other control variables (to the left in Fig. 1) are assumed to directly affect all the endogenous variables, as well as to indirectly affect PT accessibility via tenure, house size and native share. Moreover, the 2017 situation, in terms of PT access, tenure, house size and native share, is linked to the corresponding 2018 situation. For example, it is assumed that previous PT access influences current PT access but not current house size or native share. The unit of analysis is the individual. However, because several variables are measured at the household level, clustered standard errors were estimated.

Because house size and native share are correlated in the study area, their error terms are correlated in the model. While the correlation of error terms in SEM is debated (Hermida, 2015), in this situation, it is theoretically based because we assume that the preferences for both attributes in terms of residential choice are correlated. To display how the relationship between residential trade-offs and income varies with immigration background, separate models for the four immigrant groups are also created.

3.4. Descriptive statistics

The spatial distribution of the three trade-off variables are presented in Fig. 2, showing that the variables are spatially clustered to a certain degree. In the central parts of the Oslo region, especially in the inner city of Oslo, PT accessibility is higher, and house sizes are lower, than in the suburbs. The share of native Norwegian inhabitants is especially low in the north-eastern and south-eastern parts of the municipality of Oslo. These are areas with relatively high PT accessibility (mostly within the fourth quantile) and medium average house size (within 50 to 150 square meters on average).

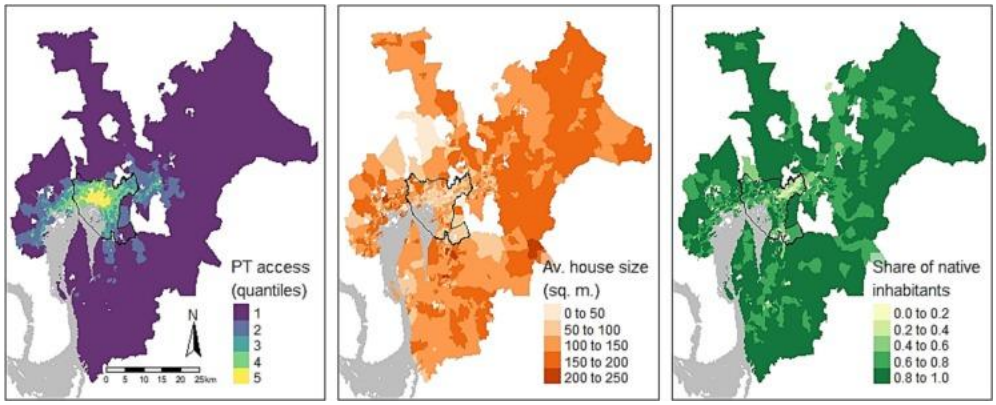

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Fig. 2. Map of study area with PT accessibility, average house size and share of native inhabitants at the census tract level. Oslo municipality is marked with a black line.

Table 1 reports descriptive statistics for the entire sample and each immigrant group. A majority (64%) of the sample are native Norwegians, while the largest immigrant group is the one originating from low-income countries. On average, the sample has moved toward lower PT accessibility and larger housing from 2015 to 2018, which indicates that the trade-off between accessibility and house size is altered after family formation. Average native share is not changed drastically, while the share of renters decreased from 32 to 22% between 2015 and 2018. Native Norwegians have higher income and education levels than immigrants, and they move to larger houses, on average.

Table 1. Descriptive statistics. Means and shares with standard deviations in parentheses.

	Full sample	Native Norwegians	Imm. high-inc. countries	Imm. new EU countries	Imm. low-inc. countries
PT access (1000) (mean)	142.8 (61.1)	141.0 (62.5)	150.5 (62.2)	132.8 (63.5)	148.4 (55.0)
Weighted hh income (1000 NOK) (mean)	497.0 (332.3)	549.4 (359.3)	505.9 (330.6)	378.2 (232.8)	377.9 (217.1)

	Full sample	Native Norwegians	Imm. high-inc. countries	Imm. new EU countries	Imm. low-inc. countries
High school education (share)	0.31 (0.46)	0.27 (0.44)	0.19 (0.39)	0.33 (0.47)	0.45 (0.50)
Medium education (share)	0.33 (0.47)	0.39 (0.49)	0.27 (0.45)	0.21 (0.40)	0.24 (0.43)
High education (share)	0.27 (0.45)	0.31 (0.46)	0.28 (0.45)	0.21 (0.41)	0.18 (0.39)
Student (share)	0.02 (0.15)	0.02 (0.13)	0.01 (0.10)	0.01 (0.10)	0.04 (0.19)
Single parent (share)	0.27 (0.44)	0.24 (0.43)	0.24 (0.43)	0.29 (0.46)	0.34 (0.47)
Tenure (renter, share)	0.22 (0.42)	0.14 (0.35)	0.22 (0.42)	0.45 (0.50)	0.39 (0.49)
House size (sq. m.) (mean)	104.6 (62.0)	114.3 (64.6)	99.5 (56.1)	87.4 (57.1)	83.6 (50.4)
Native share in neighbourhood (mean)	0.72 (0.15)	0.76 (0.12)	0.73 (0.14)	0.71 (0.15)	0.61 (0.18)
Pr. PT access (1000) (mean)	170.3 (62.5)	173.4 (64.4)	190.6 (58.8)	154.5 (62.9)	160.0 (54.7)
Pr. House size (sq. m.) (mean)	77.1 (51.7)	79.5 (53.0)	69.5 (39.5)	74.6 (57.1)	73.7 (48.8)
Pr. Native share in neighbourhood (mean)	0.70 (0.15)	0.73 (0.12)	0.70 (0.12)	0.68 (0.16)	0.61 (0.18)
Pr. Tenure (renter, share)	0.32 (0.47)	0.23 (0.42)	0.50 (0.50)	0.55 (0.50)	0.45 (0.50)
N	*9212*	*5937*	*667*	*647*	*1961*

To obtain a better view of how the level of PT accessibility changes after childbirth, Fig. 3 shows the distribution of accessibility quantiles regarding the previous and current residential location for the full sample (B) and the four immigrant groups (C). The chart colours correspond with the colours in the map (A).

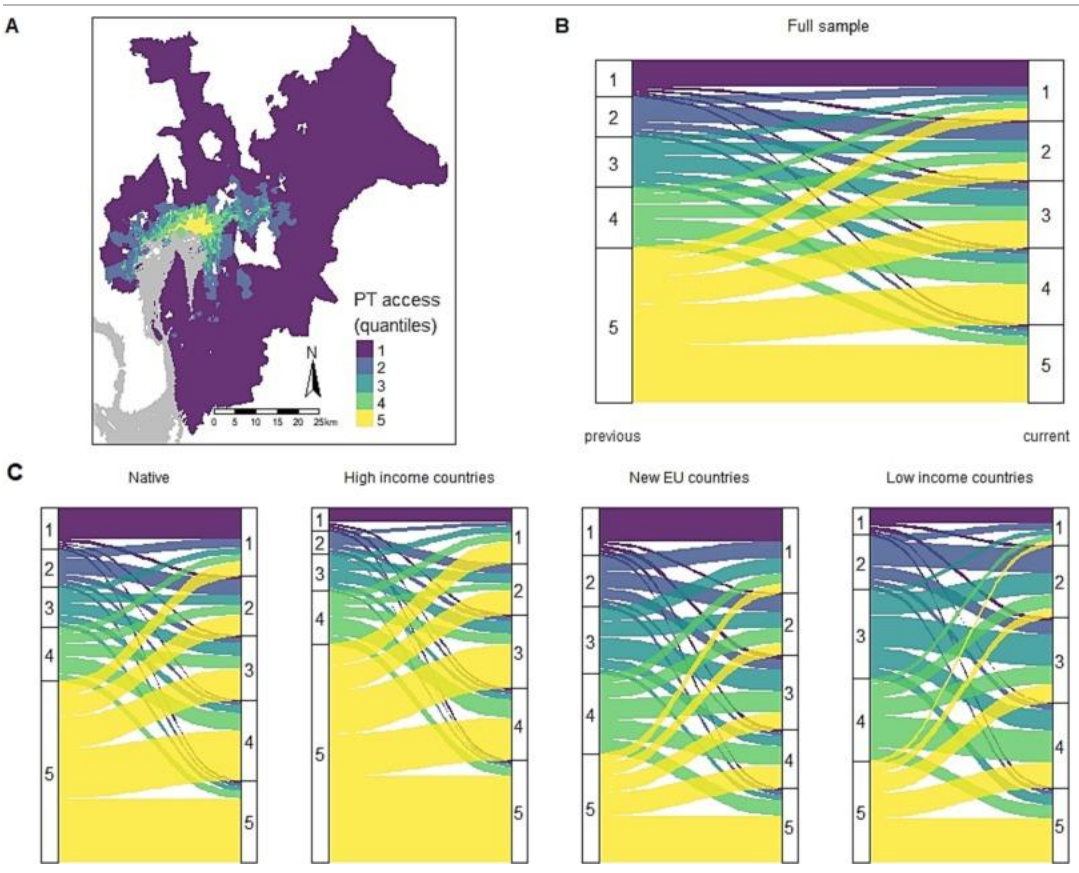

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Fig. 3. PT accessibility quantiles in the study area (A), residential flows from previous to current situation for the full sample (B) and for separate immigrant groups (C).

Before family formation, in 2015, almost half of the study sample lived in areas within the fifth PT access quantile. This share decreased to 23% in the year after childbirth (2018). One senses the importance of trade-offs based on the fact that levels of accessibility decreased substantially through the process of relocation. The chart in 3B clearly shows that most residential flows involved moving from higher to lower accessibility, while a few people move in the opposite direction.

While native Norwegians and immigrants from high-income countries resemble the full sample, immigrants from new EU and low-income countries show quite different residential patterns (Fig. 3C). For these two immigrant groups, the average accessibility level before family formation was lower than for the other groups: only around 25% of new EU and low-income country immigrants lived in the highest PT accessibility quantile before family formation. Moreover, the reduction in average PT accessibility levels from 2015 to 2018 is clearly lower for these groups than for native Norwegians and immigrants from high-income countries.

4. Results

Table 2 shows the results derived from the SEM models for the entire sample. The table presents the total effects on house size and native share, as well as total, direct and indirect effects (via house size and native share) on PT accessibility. Total, direct and indirect effects on all endogenous variables are presented in appendix (Table A1). The model shows good model fit, with RMSEA below 0.5, CFI above 0.95 and SRMR below 0.08. The CD value is also quite good, showing that the model explains 56% of the variance.[12]

Table 2. Summary results from structural equation model with standard errors clustered on households.

	House size	Native share	PT accessibility			
	Total effects	**Total effects**	**Total effects**	**Direct effects**	**Ind. via house size**	**Ind. via native share**
Income rank	0.519***	0.005***	0.045**	0.155***	−0.065***	−0.020***
Native Norwegians	ref.	ref.	ref.	ref.	ref.	ref.
Imm. high-inc.	−10.002***	−0.025***	1.230	−1.193	1.247***	1.023***
Imm. new EU	−11.115***	−0.031***	1.151	−2.732*	1.386***	1.246***
Imm. low-inc.	−14.478***	−0.106***	5.332***	−1.678*	1.805***	4.325***
Low education	ref.	ref.	ref.	ref.	ref.	ref.
Medium education	4.735**	0.002	2.994***	4.334***	−0.590**	−0.064
High education	4.554*	0.008*	5.702***	7.061***	−0.568*	−0.323*
Student	−11.566**	−0.027*	9.569***	5.769**	1.442**	1.086*
Single parent	−9.994***	−0.012**	8.051***	5.926***	1.246***	0.475**
House size			−0.125***	−0.125***		
Native share			−40.846***	−40.846***		
Tenure	−24.006***	−0.018***	11.153***	7.404***	3.000***	0.750***
Pr. PT access			0.389***	0.389***		
Pr. House size	0.125***		−0.016***		−0.016***	
Pr. Native share		0.224***	−9.153***			−9.153***
Pr. Tenure	−2.874***	−0.002***	1.332***		0.358***	0.090***

*N=9212; DF=6; CFI=0.979; RMSEA=0.045 (90% CI=0.040–0.050); SRMR=0.013; CD=0.561; *p<.05, **p<.01, ***p<.001.*

Income level has a significant effect on what housing conditions first-time parents achieve after relocating. This indicates that, with more economic resources, parents have less need to make trade-offs between different residential attributes. While the total effect of income on PT access is significant, it is substantially lower than the direct effect. This is explained by the indirect effects on PT access via house size and native share, which are both significant and negative. With higher income, PT accessibility increases, but the effect is slightly reduced by the increasing propensity for spacious housing and ethnically uniform neighbourhoods.

Immigrants achieve significantly lower house size and native share than native Norwegians after relocating. Compared to natives, immigrants from low-income countries move to houses that are almost 15 square meters smaller, as well as to neighbourhoods where the native share is

10 percentage points lower, on average. While neither high-income-country nor new-EU-country immigrants show a significant total effect on PT access, the effect of immigrants from low-income countries is highly significant as compared to that of native Norwegians. The direct effect on PT access, however, is significantly negative for immigrants both from new EU and low-income countries. This indicates that these groups trade away residential PT accessibility more than native Norwegians. However, because of a lower propensity for spacious housing and high native shares (indirect effects are significant and positive), they ultimately have either positive (low-income countries) or non-significant (new EU countries) total effects. Immigrants from high-income countries also show significant (positive) indirect effects on PT access. However, neither the total nor direct effects are significant. To sum up, native Norwegians display higher propensity for both housing space and neighbourhood uniformity than immigrants. This results in significantly different effects on PT accessibility among natives and immigrants from low-income countries – the largest immigrant group in the Oslo region.

For the control variables, higher educational attainment is related to higher PT accessibility. Moreover, in line with previous research (Feijten et al., 2008; Withers, 1998), both students and single parents show different residential behaviour than the reference category (workers and couples). Both groups have a quite high propensity for accessibility (with significant direct effects), and the total effects on PT access are amplified by the relatively lower trade-off of access on behalf of housing size and native share. Parents who rent their home experience higher accessibility levels than owners. Moreover, the effect of tenure on PT access is amplified by the mediating effect of house size and native share. In other words, owners more often move to larger dwellings and avoid ethnically varied neighbourhoods than renters. Tenure is also somewhat determined by both income and immigration background: with higher income, ownership increases. In addition, home ownership is slightly more widespread among natives.

Not surprisingly, the direct effects of house size and native share on PT access are significant (negative). Moreover, the effects of previous residential characteristics (PT accessibility, house size, native share and tenure) on the current characteristics are also significant. In other words, prior experience influences residential behaviour, which is in line with findings in earlier research (Chen et al., 2008).

Next, separate models for each immigrant group were conducted to investigate whether the effect of income on PT accessibility trade-offs varies between them (Table 3). The full model results are available in the appendix (Table A2, Table A3, Table A4, Table A5). The models for natives and immigrants from low-income countries show good model fit. The model fit is slightly poorer for immigrants from high-income countries and new EU countries, which is explained by the smaller samples for these two groups.

Table 3. Summary results from separate structural equation models for each immigrant group, with standard errors clustered on households. Full model results in appendix.

	House size	**Native share**	**PT accessibility**			
	Total effects	**Total effects**	**Total effects**	**Direct effects**	**Ind. via house size**	**Ind. via native share**
Native Norwegians						
Income rank	0.549***	0.000***	0.070***	0.168***	−0.069***	−0.029***
House size			−0.123***	−0.123***		
Native share			−61.715***	−61.715***		
Imm. high-inc.						
Income rank	0.482***	0.001**	0.037	0.156**	−0.097**	−0.223**
House size			−0.200***	−0.200***		
Native share			−33.091***	−33.091***		
Imm. new EU						
Income rank	0.431**	0.000	0.022	0.081	−0.043**	−0.016
House size			−0.100***	−0.100***		
Native share			−48.358***	−48.358***		
Imm. low-income						
Income rank	0.418***	0.001***	−0.034	0.036	−0.061***	−0.009**
House size			−0.141***	−0.141***		
Native share			−13.607***	−13.607***		

*p<.05, **p<.01, ***p<.001.

The total effect of income on PT accessibility is only significant for native Norwegians. Natives achieve higher PT access with higher incomes, even though they also value house size and native share highly. Immigrants, on the other hand, do not display a significant (total) effect on the part of income (on PT access). A related detail is that natives and immigrants from high-income countries show a significant direct effect on the part of income, which is not the case for the other two groups. Finally, the mediating effects of house size and native share on PT access are significant (negative) for all groups, except for the effect via native share for immigrants from new EU countries.

4.1. Robustness checks

Robustness checks were conducted to determine whether the results persisted with different variable specifications, as shown in Table A6 in the appendix. House type (house or apartment) was tested as an alternative to house size (Table A6A). Moreover, an alternative accessibility variable has also been tested. Instead of absolute PT accessibility, the relative accessibility between PT and cars was used in this control, defined as the PT/car ratio (Table A6B). This variable is often referred to as the modal disparity or modal accessibility gap, and it measures the ability of individuals to travel without cars (Kwok and Yeh, 2004; Lunke, 2022). Both checks showed similar results as those reported in Table 2. Finally, to account for the general socioeconomic status of neighbourhoods, a third robustness check includes control for neighbourhood poverty (Table A6C).[13] The results show that the effects of the native share variable are still significant after controlling for poverty, although they are somewhat weakened. This suggests, firstly, that majority share is an important factor independently of the general socioeconomic status of neighbourhoods, and, secondly, that the effect of majority share found in this study (Table 2) reflects a combined trade-off based on both ethnic composition and poverty in neighbourhoods. The model in Table A6C explains more of the variance in the model (CD is 7 percentage points higher). However, the goodness of fit statistics are clearly poorer in this model, which indicates that the model in Table 2 is well suited to answer the research questions in this study.

5. Discussion and conclusions

This study has shown that, among native Norwegians, PT accessibility is often traded off against other residential attributes when households decide on a new residential location. After having their first child, parents tend to move to less central locations, not least because they seek more spacious housing, which is difficult to combine with good PT accessibility. Moreover, the analysis has highlighted the importance of ethnic neighbourhood variation. Native first-time parents tend to avoid neighbourhoods with a high share of ethnic minorities. This picture becomes more nuanced with the third robustness check, which shows that the effect of ethnic variation on PT access is partly explained by neighbourhood poverty. For immigrants, the picture is clearly different. The mediating effects of both house size and native share show that immigrants value these attributes less than natives do. At the same time, immigrants from low-income countries seem to value PT accessibility less than natives. The outcome is nevertheless that immigrants from low-income countries achieve relatively high PT accessibility as compared to natives.

The results illustrate the complexity of residential mobility and transport disadvantage in a multi-ethnic European context. Traditional models of urban attractiveness lose relevance when the differing residential preferences of individual immigrant groups are considered. Firstly, immigrants do not display the same positive effect of income on PT accessibility as native Norwegians. This may be partly explained by immigrants' propensity to settle in areas that the majority population tends to avoid, which in the Oslo context are located relatively close to the city centre. Secondly, while first-time parents tend to prefer to settle close to their own family and relatives, research have found substantial heterogeneity between natives and immigrants in this phenomenon, suggesting that immigrants more often settle close to their own kin than natives do (Hedman, 2013; Skifter Andersen, 2010; Spring et al., 2017).

Finally, the notion of spacious housing in the suburbs as the ideal environment for raising children may be more widespread among native Norwegians than immigrants from more urbanised countries (Wessel and Lunke, 2021). In addition to the differing patterns of individual groups, relationships *between* groups also play an important role. With increasing multi-ethnicity, the majority population's residential behaviour is changed. The results of this study show that native Norwegians clearly avoid neighbourhoods with many ethnic minorities. The sensitivity to ethnically varied neighbourhoods is also significantly stronger among owners than renters. This finding is in line with the *race-based neighbourhood projection hypothesis* (Gould Ellen, 2000), which describes how segregation occurs because the majority population fears that increasing multi-ethnicity may lead to a wider structural decline in neighbourhoods. This fear may strike more strongly among owners, who fear a decline in property values.

To sum up, the prioritisation of accessibility is partly overshadowed by other residential preferences, both factors that are specific to individual groups and relationships between groups. This finding suggests that the theory of the suburbanisation of (transport) poverty requires nuance in a multi-ethnic European context. It is well established that poor PT accessibility threatens employment opportunities, well-being and the possibility to transition from cars to sustainable transport. However, as this study illustrates, the conditions that restrict and enable certain behaviour on the housing market – both structural, in terms of financial constraints and the supply of acceptable housing, and individual, in terms of preferences for certain types of housing and neighbourhoods – vary between natives and immigrants. In Oslo, the inner suburbs to the east and south of the city centre serve as attractive residential areas for the immigrant population because of relatively low housing prices,

proximity to the city centre and its employment opportunities, and large minority population shares. For the native population, these inner suburbs become less attractive, partly because of the large share of immigrants. Those natives that cannot afford acceptable housing elsewhere in the municipality of Oslo then choose to move further out to the outer, more car-dependent suburbs in the neighbouring municipalities. The finding that families with children prefer spacious housing and ethnically homogenous neighbourhoods is in line with previous research. However, this study sheds light on how these mechanisms also result in inequalities in access to opportunities, transport disadvantage and vulnerability to car restrictive measures and the transition to low-emission mobility.

From a policy perspective, the results highlight a potentially unintended consequence of compact city development. When first-time parents are unable to find affordable and sufficiently spacious housing in the central parts of the region, they choose to move to more peripheral areas, which typically results in a more car-based lifestyle.

However, this study is not without limitations, and future studies could investigate the relationship between (sustainable) planning strategies and residential preferences further. One important limitation is the lack of additional variables on residential and neighbourhood characteristics. This study investigated certain residential qualities, but more knowledge is needed on the role of other attributes in residential trade-offs. Other structural characteristics than ethnic variation, such as neighbourhood poverty, safety and crime, and school quality, could be further investigated. The narrow sample of first-time parents is also a limitation that is worth mentioning. In future studies, other sub-groups of the population could be studied to determine whether trade-offs vary over the life course. For example, residential mobility tends to decrease substantially when children reach school age. A follow-up study could document whether the preferences uncovered in this study are changed (or reinforced) when children grow older. Another limitation is that the analysis does not cover proximity to kin, a factor that have been found to be important in households' residential location decisions. Finally, as this study has used data on observed residential mobility, it does not answer questions about residential preferences or attitudes among first-time parents. Future research could explore this topic further by using surveys or more qualitative data sources.

Author statement

Erik Bjørnson Lunke is the sole author of this article.

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Appendix A. Appendix

Table A1. Total, direct and indirect effects on each endogenous variable.

	Tenure			House size			Native share			PT accessibility		
	Total	**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**
Income rank	−0.003***	−0.003***		0.519***	0.440***	0.080***	0.005***	0.000***	0.000***	0.045**	0.155***	−0.110***
Native Norwegians	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Imm. high-inc.	0.021	0.021		−10.002***	−9.504***	−0.499	−0.025***	−0.025***	−0.000	1.230	−1.193	2.423***
Imm. New EU	0.169***	0.169***		−11.115***	−7.049*	−4.066***	−0.031***	−0.027***	−0.003**	1.151	−2.732*	3.882***
Imm. low-inc.	0.119***	0.119***		−14.478***	−11.619***	−2.859***	−0.106***	−0.104***	−0.002**	5.332***	−1.678*	7.010***
Low education	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Medium education	−0.093***	−0.093***		4.735**	2.508	2.227***	0.002	−0.000	0.002**	2.994***	4.334***	−1.340***
High education	−0.063***	−0.063***		4.554*	3.032	1.522***	0.008*	0.007	0.001**	5.702***	7.061***	−1.359***
Student	0.172***	0.172***		−11.566**	−7.432	−4.134***	−0.027*	−0.023*	−0.003**	9.569***	5.769**	3.799***
Single parent	0.055***	0.055***		−9.994***	−8.679***	−1.315***	−0.012**	−0.011**	−0.001**	8.051***	5.926***	2.125***
House size										−0.125***	−0.125***	
Native share										−40.846***	−40.846***	
Tenure				−24.006***			−0.018***	−0.018***		11.153***	7.404***	3.749***
Pr. PT access										0.389***	0.389***	

	Tenure			House size			Native share			PT accessibility		
	Total	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect
Pr. House size				0.125***	0.125***					−0.016***		−0.016***
Pr. Native share							0.224***	0.224***		−9.153***		−9.153***
Pr. Tenure	0.119***	0.119***		−2.874***		−2.874***	−0.002***		−0.002***	1.332***		1.332***

Table A2. Native Norwegians. Summary results from structural equation model with standard errors clustered on households.

	House size	Native share	PT accessibility			
	Total effects	Total effects	Total effects	Direct effects	Ind. via house size	Ind. via native share
Income rank	0.549***	0.000***	0.073***	0.179***	−0.065***	−0.028***
Low education	ref.	ref.	ref.	ref.	ref.	ref.
Medium education	5.110*	−0.006	4.306***	5.163***	−0.604*	0.389
High education	6.411*	−0.004	6.954***	8.018***	−0.758**	0.236
Student	−17.704**	−0.037**	13.499***	7.750**	2.093**	2.245**
Single parent	−12.971***	−0.012**	9.221***	6.650***	1.533***	0.752**
House size			−0.118***	−0.118***	n/a	n/a
Native share			−61.368***	−61.368***	n/a	n/a
Tenure	−29.740***	−0.018**	10.953***	6.318***	3.516***	1.118**
Pr. PT access			0.380***	0.380***	n/a	n/a
Pr. House size	0.145***		−0.017***	n/a	−0.017***	n/a
Pr. Native share		0.185***	−11.363***	n/a	n/a	−11.363***
Pr. Tenure	−3.125***	−0.002**	1.151***	n/a	0.369***	0.118**

*N=5937; DF=6; CFI=0.955; RMSEA=0.059 (90% CI=0.053–0.065); SRMR=0.022; CD=0.438; *p<.05, **p<.01, ***p<.001.*

Table A3. Immigrants from high-income countries. Summary results from structural equation model with standard errors clustered on households.

	House size	Native share	PT accessibility			
	Total effects	Total effects	Total effects	Direct effects	Ind. via house size	Ind. via native share
Income rank	0.482***	0.001**	0.038	0.180***	−0.092**	−0.021*
Low education	ref.	ref.	ref.	ref.	ref.	ref.
Medium education	5.521	0.008	1.736	3.567	−1.057	−0.233
High education	3.622	0.003	8.584**	9.554***	−0.693	−0.090
Student	−25.064**	−0.161	−2.296	−12.779	4.798**	4.960
Single parent	−11.299*	−0.003	11.021***	8.442**	2.163*	0.100
House size			−0.191***	−0.191***	n/a	n/a
Native share			−30.825**	−30.825**	n/a	n/a
Tenure	−26.980***	−0.044*	13.954***	7.433**	5.165***	1.356*
Pr. PT access			0.319***	0.319***	n/a	n/a
Pr. House size	0.218**		−0.042***	n/a	−0.042***	n/a
Pr. Native share		0.193***	−5.954**	n/a	n/a	−5.954**

	House size	Native share	PT accessibility			
	Total effects	**Total effects**	**Total effects**	**Direct effects**	**Ind. via house size**	**Ind. via native share**
Pr. Tenure	−1.524	−0.002	0.788	n/a	0.292	0.077

*N=667; DF=6; CFI=0.925; RMSEA=0.075 (90% CI=0.056–0.095); SRMR=0.026; CD=0.376; *p<.05, **p<.01, ***p<.001.*

Table A4. Immigrants from new EU countries. Summary results from structural equation model with standard errors clustered on households.

	House size	Native share	PT accessibility			
	Total effects	**Total effects**	**Total effects**	**Direct effects**	**Ind. via house size**	**Ind. via native share**
Income rank	0.431**	0.000	0.024	0.135**	−0.040**	−0.016
Low education	ref.	ref.	ref.	ref.	ref.	ref.
Medium education	2.537	−0.016	6.986**	7.256**	−0.237	0.738
High education	−6.739	0.006	4.905	5.569*	0.629	−0.290
Student	−19.956*	0.049	28.426**	29.993**	1.862*	−2.301
Single parent	−2.191	−0.025	4.841	2.562	0.204	1.197
House size			−0.093***	−0.093***	n/a	n/a
Native share			−46.959***	−46.959***	n/a	n/a
Tenure	−12.256*	−0.026	11.556***	9.181***	1.144*	1.231
Pr. PT access			0.434***	0.434***	n/a	n/a
Pr. House size	0.045		−0.004	n/a	−0.004	n/a
Pr. Native share		0.183***	−8.615***	n/a	n/a	−8.615***
Pr. Tenure	−0.932	−0.002	0.879	n/a	0.087	0.094

*N=647; DF=6; CFI=0.957; RMSEA=0.055 (90% CI=0.034–0.076); SRMR=0.023; CD=0.430; *p<.05, **p<.01, ***p<.001.*

Table A5. Immigrants from low-income countries. Summary results from structural equation model with standard errors clustered on households.

	House size	Native share	PT accessibility			
	Total effects	**Total effects**	**Total effects**	**Direct effects**	**Ind. via house size**	**Ind. via native share**
Income rank	0.418***	0.001***	−0.026	0.083**	−0.053***	−0.010**
Low education	ref.	ref.	ref.	ref.	ref.	ref.
Medium education	7.368**	0.019*	−0.451	1.249	−0.929**	−0.273
High education	1.857	0.045***	1.918	2.882	−0.234	−0.632**
Student	−3.515	−0.008	3.390	2.022	0.443	0.112
Single parent	−5.019	−0.008	5.486***	4.190**	0.633	0.116
House size			−0.126***	−0.126***	n/a	n/a
Native share			−14.030***	−14.030***	n/a	n/a
Tenure	−23.770***	−0.007	10.699***	7.602***	2.996***	0.101
Pr. PT access			0.371***	0.371***	n/a	n/a
Pr. House size	0.065*		−0.008*	n/a	−0.008*	n/a
Pr. Native share		0.281***	−3.948***	n/a	n/a	−3.948***
Pr. Tenure	−4.318***	−0.001	−0.001	n/a	0.544***	0.018

*N=1961; DF=6; CFI=0.983; RMSEA=0.035 (90% CI=0.023–0.047); SRMR=0.016; CD=0.439; *p<.05, **p<.01, ***p<.001.*

Table A6. Robustness tests with house type as control variable (A), PT/car ratio as final endogenous variable (B), and control for neighbourhood poverty (C).

(A)	House type*	Native share	PT accessibility			
	Total effects	Total effects	Total effects	Direct effects	Ind. via house type*	Ind. via native share
Income rank	0.002***	0.000****	0.046**	0.131***	−0.049***	−0.011***
Native Norwegians	ref.	ref.	ref.	ref.	ref.	ref.
Imm. high-inc.	−0.108***	−0.025***	1.729	−1.830*	2.847***	0.553***
Imm. New EU	−0.064*	−0.031***	1.301	−2.304*	1.689*	0.679***
Imm. low-inc.	−0.175***	0.107***	5.470***	−2.353**	4.603***	2.360***
Low education	ref.	ref.	ref.	ref.	ref.	ref.
Medium education	−0.015	0.001	3.238***	3.559***	0.393	−0.026
High education	−0.019	0.008*	6.229***	6.384***	0.500	−0.182*
Student	−0.167***	−0.027*	9.535***	3.352	4.388***	0.592*
Single parent	−0.131***	−0.012**	8.165***	4.044***	3.452***	0.257**
House type*			−26.291***	−26.291***	n/a	n/a
Native share			−22.135***	−22.135***	n/a	n/a
Tenure	−0.130***	−0.019***	11.216***	7.391***	3.405***	0.419***
Pr. PT access			0.327***	0.327***	n/a	n/a
Pr. House type*	0.149***		−3.918***	n/a	−3.918***	n/a
Pr. Native share		0.215***	−4.764***	n/a	n/a	−4.764***
Pr. Tenure	−0.015***	−0.002***	1.309***	n/a	0.398***	0.049***

(B)	House size	Native share	PT accessibility			
	Total effects	Total effects	Total effects	Direct effects	Ind. via house size	Ind. via native share
Income rank	0.520***	0.001***	0.000**	0.001***	−0.000***	−0.000***
Native Norwegians	ref.	ref.	ref.	ref.	ref.	ref.
Imm. high-inc.	−9.997***	−0.025***	0.007	−0.004	0.005***	0.005***
Imm. New EU	−11.107***	−0.031***	0.009	−0.008	0.005***	0.006***
Imm. low-inc.	−14.470***	−0.106***	0.029***	−0.004	0.007***	0.022***
Low education	ref.	ref.	ref.	ref.	ref.	ref.
Medium education	4.742**	0.002	0.015***	0.021***	−0.002**	−0.000
High education	4.560*	0.008*	0.026***	0.032***	−0.002*	−0.002*
Student	−11.561**	−0.027*	0.040***	0.023**	0.006**	0.006*
Single parent	−10.002***	−0.012**	0.035***	0.026***	0.005***	0.002**
House size			−0.001***	−0.001***	n/a	n/a
Native share			−0.207***	−0.207***	n/a	n/a
Tenure	−24.063***	−0.018***	0.049***	0.033***	0.012***	0.003***
Pr. PT access			0.388***	0.388***	n/a	n/a
Pr. House size	0.125***		−0.000***	n/a	−0.000***	n/a

(B)	House size	Native share	PT accessibility			
	Total effects	Total effects	Total effects	Direct effects	Ind. via house size	Ind. via native share
Pr. Native share		0.224***	−0.047***	n/a	n/a	−0.047***
Pr. Tenure	−2.877***	−0.002***	0.006***	n/a	0.001***	0.000***

(C)	House size	Native share	PT accessibility			
	Total effects	Total effects	Total effects	Direct effects	Ind. via house size	Ind. via native share
Income rank	0.519***	0.005***	0,080***	0,151***	−0,054***	0,006***
Native Norwegians	ref.	ref.	ref.	ref.	ref.	ref.
Imm. high-inc.	−10.002***	−0.025***	0,091	−1313	1047***	0,291**
Imm. new EU	−11.115***	−0.031***	0,312	−1748	1163***	0,355**
Imm. low-inc.	−14.478***	−0.106***	2016**	−1112	1515***	1231***
Low education	ref.	ref.	ref.	ref.	ref.	ref.
Medium education	4.735**	0.002	3004***	3815***	−0,495**	−0,018
High education	4.554*	0.008*	4567***	5338***	−0,477*	−0,092
Student	−11.566**	−0.027*	3141	1070	1210**	0,309*
Single parent	−9.994***	−0.012**	5901***	4545***	1046***	0,135*
House size			0,105***	−0,105***		
Native share			−11,627***	−11,627***		
Tenure	−24.006***	−0.018***	5943***	3211***	2518***	0213**
Pr. PT access			0,338***	0,338***		
Pr. House size	0.125***		−0,013***		−0,013***	
Pr. Native share		0.224***	−2605***			−2605***
Pr. Tenure	−2.874***	−0.002***	0,710***		0,301***	0,025**

N=9211; DF=6; CFI=0.976; RMSEA=0.048 (90% CI=0.043–0.053); SRMR=0.014; CD=0.552.

N=9212; DF=6; CFI=0.822; RMSEA=0.137 (90% CI=0.133–0.142); SRMR=0.042; CD=0.631.

* *Dummy variable: Detached or row house=1, apartment=0. N=9313; DF=6; CFI=0.970; RMSEA=0.059 (90% CI=0.054–0.064); SRMR=0.019; CD=0.530.*

Data availability

The data that has been used is confidential.

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1 In this paper, *native Norwegians* (or "natives") is used for individuals born in Norway with Norwegian-born parents.

2 In this paper, residential choice / residential mobility is defined as (local) mobility within the same functional region, as opposed to *migration* (mobility between urban regions).

3 The following municipalities are included: Oslo, Vestby, Oppegård, Ås, Frogn, Nesodden, Bærum, Asker, Lørenskog, Skedsmo, Fet, Sørum, Rælingen, Enebakk, Ullensaker, Nes, Hobøl, Eidsvoll, Nittedal, Gjerdrum, Lunner.

4 The term "census tract" refers to the smallest geographical units reported by Statistics Norway, other times referred to as "basic statistical units" ("grunnkretser" in Norwegian). The study area consists of approximately 2700 census tracts, with a median population of 600.

5 Publicly available data from Entur (www.entur.no ↗) and Open Street Map (www.openstreetmap.org ↗).

6 The median of 60 departure times is used, calculated for each minute within a one-hour time window, stretching from 07:30 am to 08:30 am.

7 A maximum walking distance of 800 m is used, as was recommended and used in previous studies (see for example Liao et al. 2020). This means that opportunities within 800 m of the residential location are accessible either by walking alone or in combination with PT. In addition, up to 800 m' walking distance to, from and between PT stops is accepted.

8 https://www.oecd.org/economy/growth/OECD-Note-EquivalenceScales.pdf ↗

9 High-income countries are those with a GNI of $12,696 or more, according to the World Bank's classification (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups ↗). New EU countries are (eastern European) countries that became EU members after 2000: Bulgaria, The Czech Republic, Croatia, Cyprus, Estonia, Hungary, Latvia, Malta, Poland, Romania, Lithuania, Slovenia.

10 Medium education is equivalent to a bachelor's degree. High education corresponds to a master's or PhD degree. The reference category is lower education (up to high school level).

11 https://www.ssb.no/bygg-bolig-og-eiendom/artikler-og-publikasjoner/stort-flertall-eier-boligen ↗ (accessed 20. June 2022).

12 Separate R2 for each endogenous variable: PT access = 0.35, house size = 0.16, native share = 0.23, tenure = 0.20.

13 A variable measuring the share of poor inhabitants in the neighbourhood – defined by OECD's definition of poverty, at 50% of median income – was included orthogonally on PT access.