Divided Cities

UNDERSTANDING INTRA-URBAN INEQUALITIES

OECD

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OECD
BETTER POLICIES FOR BETTER LIVES

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Foreword

Cities are places of opportunity. In cities people can benefit from work and training opportunities, proximity to other people and physical access to many high-level services that are important for well-being. When cities are well-organised and inclusive, they allow people to access opportunities, regardless of their location within the city.

However, cities are often *divided*. In divided cities there are gaps and barriers that produce exclusive spaces and concentrations of disadvantage. Inequality in access to high-quality services and economic opportunities across social groups can exacerbate existing societal disparities. In this context, it becomes relevant to understand how social groups are organised within cities and how this relates to intra-urban inequalities.

International comparisons are helpful for putting measurements of such inequalities into perspective. Of particular relevance is the study of socio-economic spatial segregation, a situation where people of a similar background − in terms of income, culture, country of origin, etc.− live concentrated in certain parts of a city and clearly separated from other groups. Segregation can have both positive and negative sides, but it is deemed to be especially problematic when it is involuntary and when it leads to few interactions among the resident groups and less access to opportunities.

While segregation is a challenge in cities across the globe, international evidence and a systematic reflection on the different types of segregation and inequalities in access to opportunities is missing. As a response to the need for international comparable studies on intra-urban inequalities, the OECD, in partnership with the Gran Sasso Science Institute (GSSI), launched in 2016 a project to better understand the different dimensions of inequality within cities and metropolitan areas throughout OECD countries.

This report was realised as part of a larger effort of the Regional Development Policy Committee and its Working Party on Territorial Indicators and Working Party on Urban Policy to understand how to make cities more inclusive. Building on a previous report entitled *Making Cities Work for All* (2016), it provides an assessment of intra-urban inequalities in terms of income, migrant status and access to public transport in a subset of metropolitan areas in the OECD and beyond. Several indicators presented in this report at the scale of metropolitan areas will be included in the OECD Metropolitan Database and will contribute to making robust international comparisons of inequalities and segregation across cities in OECD countries.

The five authored chapters provide new insights on cross-cutting issues with respect to inequality and segregation from a multi-dimensional perspective. They examine, for example, the role of governance structures and housing types as determinants of segregation; the patterns of concentration of migrants across neighbourhoods; the role of public transport accessibility in widening intra-city inequalities; and expected path dependency on outcomes related to segregation. The report also discusses methodological alternatives for measuring different dimensions of inequality and segregation across cities and the limitations of these measurements.

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The publication has been co-ordinated and edited by Paolo Veneri, Acting Head of the Statistics and Territorial Analysis Unit under the supervision of Rudiger Ahrend, Head of the Economic Analysis, Statistics and Multi-level Governance Section of CFE. Ana Moreno Monroy, Policy Analyst, also helped to edit the final report. Chapter 1 was authored by Ana Moreno Monroy (OECD) and Paolo Veneri (OECD). Chapter 2 was authored by Andre Comandon (University of California, Los Angeles), Michiel Daams (University of Groningen), Miquel-Àngel Garcia-López (Autonomous University of Barcelona and Barcelona Institute of Economics, Spain) and Paolo Veneri (OECD). Chapter 3 was authored by Ana Moreno-Monroy (OECD). Chapter 4 was authored by Fabrizio Natale, Marco Scipioni and Alfredo Alessandrini (Joint Research Centre of the European Commission). Chapter 5 was authored by Ludovica Gazzé (University of Chicago). Chapter 6 was authored by Maarten van Ham (Delft University of Technology and University of St Andrews), Tiit Tammaru (University of Tartu) and Heleen J. Janssen (Delft University of Technology). Additional input was provided by Kevin Fourrey (University of Caen Normandy, France) for Box 2.3 and by Davide Luca and Mairie Carroline Magante (Gran Sasso Science Institute, Italy) for Box 4.3. Janine Treves provided editorial comments. Cicely Dupont-Nivore led the publication process. Eleonore Morena prepared the manuscript for publication.

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Executive summary

Cities bring together people of different backgrounds. Within this diversity, people sharing common characteristics are often found in close proximity to each other, and at the same time, separated from other social groups. Such a separation is also known as spatial segregation. There is no unique answer to the question of why segregation exists, as it is the outcome of a process that can involve preferences, as well as the availability of affordable housing in certain areas. At the same time, segregation does not necessarily represent a problem to be solved, as people that seek proximity to their own may do so precisely because there are benefits for them. In some instances, however, these positive effects can be outweighed by negative effects related to uneven access to opportunities and lack of diversity. Sustained exposure to concentrations of disadvantage at work, school and other domains have been found to affect individual outcomes, leading to vicious circles of disadvantage.

This report advances previous knowledge on how inequality plays out across city neighbourhoods by considering multiple cities in an international context. The report compares segregation levels to understand the extent of intra-country and inter-country differences. It also considers possible drivers of intra-urban inequalities, including housing type choices, urban size and productivity, and the consequences of unequal access to economic opportunities.

The concentration of people in particular neighbourhoods according to their socio-economic characteristics is a feature present across cities around the world to different degrees. A comparison across a sample of cities from ten OECD countries plus Brazil and South Africa reveals that income segregation levels vary considerably across cities, even within a country. For instance, in Canada, the United Kingdom and the United States, income segregation in the most segregated city is at least twice as high compared to the least segregated city.

Moreover, the extent to which households concentrate in specific neighbourhoods tends to increase with their income levels. In most of the countries considered, segregation was found to be highest at the top of the income distribution. In South Africa − the most extreme case − the rich are three times more segregated than the poor. The situation is the opposite in Denmark and the Netherlands, two countries with low income inequality levels, where the poor tend to be more segregated on average than the rich.

Income segregation levels tend to be higher in more affluent, more unequal, larger, more productive and younger cities; and also in cities with a high concentration of people and jobs around a unique centre. As an example, average income segregation in cities in the top 25% of income is more than double than in cities in the bottom 25%. Nevertheless, while the same determinants of average segregation seem to explain the segregation of the top income groups, not all of them apply for the segregation of the poor.

The type of housing where people of different income levels live can be associated to observed levels of segregation. In Brazil, whole neighbourhoods with only apartment buildings – or so-called vertical neighbourhoods – tend to emerge as cities get larger.

Across cities, a high concentration of affluent people in these vertical neighbourhoods is found to be associated with higher levels of income segregation. In Brazilian cities, the existence of areas almost exclusively dedicated to high-rise housing catering to the demands of higher-income groups can be at the basis of the observed income segregation.

Migrant background is another dimension which has become increasingly relevant in the study of intra-urban disparities in OECD countries. The comparison of the residential distribution of migrants in eight EU member states reveals that migrants not only concentrate in large metropolises, but also in small-size cities. In large cities (above 1 million inhabitants), 15% of residents are foreign-born on average and 9% of which come from outside the EU. The proportion of migrants in the total population in small cities (below 150 000 inhabitants) is smaller (9%), but some small cities in Europe are real magnets for migrants: four cities in the top five ranking in terms of share of foreign-born population are small cities. At the same time, migrant diversity – in terms of number of countries of origin and the distribution of migrants within cities – is an attribute of both large cities and small towns.

The concentration of lower-income and minority groups is deemed particularly problematic when it leads to worse economic outcomes. Evidence from cities in the Netherlands shows that a 1% increase in the share of migrants is associated to a 0.32% increase in the share of poverty. A related factor connecting intra-city location and outcomes is access to public infrastructure, particularly public transport. In the United States, lack of public transport connections between minority neighbourhoods and employment centres hinders job opportunities for residents of these neighbourhoods. A small difference of 1 percentage point higher share of white residents in US cities can translate into 18 more jobs available within a 30-minute commute on public transport. This can widen gaps in unemployment.

Policies can actively help to bridge divides for more equal and inclusive cities. As different dimensions of intra-urban inequality are strongly interlinked, making a city more inclusive requires a co ordinated effort between different strands of policy that matter at city level, such as access to services, housing and spatial planning. Affordable housing should be made available through inclusive land-use regulations and suitable social housing systems.

Policy makers can contribute to building more inclusive cities by:

- Making neighbourhoods more inclusive, for instance by creating places for interactions and new housing solutions that are both affordable and attractive for different groups.
- Broadening opportunities available for people lacking access to high-quality education and training by co ordinating local and national policies to ensure adequate provision across neighbourhoods.
- Better linking the most disadvantaged neighbourhoods with places of opportunity within cities through transport policies that better connect employment and residential locations where needed.

The design of policies to tackle intra-urban inequalities should take into account the right scale. An internationally comparable definition of cities, neighbourhoods and of the units used as building blocks for quantitative assessment of inequalities ensures consistency and sound comparisons of performance. The increasing availability of fine-scale urban data opens the possibility to analyse further the different forms that inequalities in cities can take, such as in terms of health, housing quality or education and their possible implications.

Chapter 1. Introduction

by

Ana I. Moreno-Monroy and Paolo Veneri

Cities are spaces of diversity where people of different backgrounds come together to share the benefits of proximity. In these diverse spaces, the daily experience of a given individual in terms of her contact with other socio-economic groups and her access to city services widely differs across people of different backgrounds. For some, their usual day-to-day social contact in their neighbourhood, workplace and leisure spaces can be confined to people that share roughly the same socio-economic characteristics, although the city they inhabit may be extremely diverse. Such separation is also known as spatial segregation.

Segregation as such is neither an accident nor necessarily a negative feature, as similar households are known to sort into similar neighbourhoods to maximise the benefits of contact with their social network and the type of access to quality services and amenities they value. At least, this is true for those living in the more affluent and higher quality neighbourhoods, which will likely have good education, health and other service provision. Nevertheless, with decreasing housing affordability in cities and policies that concentrate spatially the provision of social housing, lower income households may end up tied to neighbourhoods with characteristics that affect their present and future well-being. At the individual level, research has shown that the spatial concentration of disadvantage has a negative effect on educational and work outcomes. At the city level, higher levels of segregation can lower social cohesion by amplifying provision gaps across high and low income areas.

The relationship between segregation and economic outcomes can be understood as a story of vicious circles at the level of individuals and households, between generations and within urban regions. Vicious circles of sustained exposure to concentrations of disadvantage lead to segregation, and segregation leads to more inequality and disadvantage. In an unequal city, a low income household will likely live in a deprived neighbourhood. Deprivation in turn can impact school and work outcomes of children and adults, further deepening inequalities, even across generations.

If cities are to perform their role as spaces for socioeconomic mobility, the local socioeconomic divisions that shape how benefits of life and work in cities are distributed over inhabitants should be better understood. This report contributes to this effort by focusing on three dimensions of intra-urban divides: income, migrant background and access to services.

Income divide

The geographical concentration of people with a similar income level, known as income segregation, increasingly shapes how people live their lives within cities. Income segregation is intrinsically linked to urban development. As people choose a place to live, subject to their resource constraints, they often gravitate towards locations where similar people in terms of culture and socio-economic background live. Amongst these, income is usually found to be a relevant characteristic to describe the clustering of people in different neighbourhoods. Income is also highly related to other relevant personal and household characteristics, such as educational level and preference for certain amenities and housing types.

Are income segregation levels similar across and within countries?

City-level measures of income segregation that are internationally comparable allow a broadening of the debate on how income segregation and public policies relate. However, is it right to compare income segregation levels across cities within the same country and even between different countries? For inter-city and inter-country comparisons to be meaningful, income segregation in cities should be investigated by looking at the distributions of income across income-classes and local areas, in a granular way. This granularity is important because spatial scale is crucial in the analysis of segregation.

Although income inequality and income segregation often go hand-in-hand, a city with low overall inequality may display higher income segregation levels than a city with high overall inequality. This can happen for two reasons. First, as segregation levels vary with income level, average income segregation values may hide large disparities at the top and bottom of the income distribution. Second, cities come in various shapes and sizes, and so do their neighbourhoods. Comparable income segregation measures should then consider a fine grid pattern which can be then aggregated to same-sized 'neighbourhood' areas.

Once a meaningful measure of income segregation has been constructed, it is worth exploring whether income segregation levels significantly differ across and within countries. The evidence in this report for cities in ten OECD countries plus Brazil and South Africa reveals substantial variation on average income segregation levels across countries. Country-level averages show that income segregation is highest in Brazil, South Africa and the United States, three countries with histories of segregation; and lowest in cities in countries with low levels of overall inequality, such as Australia, Denmark, the Netherlands and New Zealand.

At the city level, an international comparison reveals striking differences in average income segregation levels. In the most extreme case, average income segregation levels in Brasilia, the most segregated city in Brazil, are seven times higher than in Auckland, the most segregated city in New Zealand. These differences are more nuanced across developed countries with low overall levels of inequality, such as Australia, Denmark and the Netherlands.

Segregation also varies within countries, the more so for countries with higher average levels of income segregation. In the United States, for instance, average income segregation levels in Memphis, the most segregated city, are twice as high as in Portland, the least segregated city.

Are the poor and the rich equally likely to be segregated?

Income segregation levels vary considerably across income groups. Usually, the top and bottom income groups are found to be more likely to experience higher levels of segregation than households in the middle of the income distribution. In this case, a plot of income percentiles against segregation levels displays a U-shaped form.

In many cities in the twelve countries considered, including the United States, segregation was found to be highest for the top income group. Segregation levels usually pick up after a certain income level threshold is reached. In all countries, households in the middle of the income group – which are also the most numerous – display the lowest levels of segregation.

In what kind of cities are the rich and the poor more likely to live separated?

Relatively higher average income segregation levels can be expected in more unequal, more affluent, larger, younger and more productive cities. The way in which population and jobs are distributed within the city also matters for segregation: high concentration of jobs and population around a unique center is associated with higher levels of income segregation. However, most of these determinants speak mostly to segregation of the top income groups.

Governance structures at the city level may also matter for income segregation. The organisation of the tax system at the local level might introduce incentives to households to concentrate in different neighbourhoods, with possible consequences on segregation levels. In France, income segregation levels were on average lower in metropolitan areas with less unequal housing tax arrangements across the different municipalities.

Higher levels of segregation of affluence are related to less exposure of apartment building dwellers to others

Across one hundred cities ranging from small cities of hundred thousand inhabitants to megacities such as São Paulo and Rio de Janeiro, segregation levels were found to be higher in larger cities and to increase sharply at the higher end of the income distribution.

Housing choices may be behind this pattern. In Brazil, whole neighbourhoods with only apartment buildings are more likely to arise as cities get larger. In some "vertical neighbourhoods" in Rio de Janeiro where more than 95% of households reside in apartment buildings, 30% of households earn 15 minimum wages or more while 2% earn one minimum wage or less.

The concentration of affluent people in these vertical neighbourhoods is linked to the observed segregation of affluence across cities in Brazil. Controlling for city size and overall level of inequality, a lower exposure of apartment dwellers to other types of dwellers is related to higher segregation of the affluent. Vertical neighbourhoods are not, however, related to the segregation of the poor, which is not surprising since apartment buildings are not the prevalent type of housing for low income people in Brazil.

Migrant divide

The location of people sharing a common country of origin across neighbourhoods in OECD cities has become increasingly important in understanding how migrant communities integrate into new urban settings.

The analysis of migrant settlement patterns has been traditionally focused on aggregated spatial scales, such as the municipal or regional level. At these levels, studies usually indicate that migrants gravitate towards large cities. However, the comparison of the residential distribution of immigrants in eight European countries using a detailed map of immigrant populations reveals a more nuanced picture.

Do migrants from all origins concentrate in small and large cities alike?

Although there is a general tendency of migrants to gravitate toward large cities, a relatively large share of migrants can also be found in some small cities. The likelihood that a migrant settles in a small city instead of a large one is attached to country of origin. The relationship between city size and migrant concentration is smaller for migrants from EU countries compared to migrants from outside the European Union. On the other hand, in the eight European countries analysed, the association between city size and non-EU migrant concentration is positive, although it is stronger in the Netherlands, Portugal and the United Kingdom and weaker in Italy.

At the same time, migrant diversity – measured in terms of number of countries of origin and the distribution of migrants within cities – is an attribute of both large cities such as London or Paris, and small towns such as Barazante in Italy and Monaghan in Ireland.

What factors contribute to a higher likelihood of isolation and spatial separation of migrants in cities?

Segregation can be related to two different dimensions: clustering and isolation. Clustering is related to the degree of concentration of distinct socio-economic group across neighbourhoods. In turn, isolation is related to how unlikely it is for a member of a group to meet a member of another group.

These two dimensions do not necessarily move in the same direction nor are related to the same factors. For instance, members of a large migrant community settled in different neighbourhoods in a large city can appear to be more isolated because they are less likely to encounter someone from another community. At the same time, they may appear less clustered as they live in several neighbourhoods within the city. As a matter of fact, across cities in the eight EU countries analysed, community size is positively related to isolation and negatively related to clustering.

Is there a link between the spatial concentration of migrants and urban poverty?

Evidence for sixteen cities in France and five cities in the Netherlands indicates that cities with a higher number of migrants as a percentage of the total population also display higher levels of segregation for the bottom 20% income group. More detailed evidence for five Dutch cities, confirms that neighbourhoods characterised by a large share of migrants show significantly higher levels of poverty, measured as the share of persons in the bottom income quintile at a fine-grained scale. Even according to the most conservative estimates, a 1% increase in the share of migrants is associated to a 0.32% increase in the share of poverty.

Access divide

An important factor connecting intra-city location and economic outcomes is access to public infrastructure, particularly public transport. The number of jobs that a person can reach within a certain commuting threshold captures how unequally distributed opportunities are within cities. The level of accessibility to jobs depends on both the relative distribution of jobs – that is, how concentrated or dispersed they are spatially – and also on the level of provision of public transit options across neighbourhoods.

Accessibility to jobs by public transport varies widely across and within cities

Absolute differences across one hundred US cities are stark. While in New York (NY) 44 jobs per person can be accessed within a 30 minute public transit commute, in Riverside (CA) only 1 job per person can be accessed. In fact, residents in 40 out of 46 cities have access to less than 10 jobs within a 30 minute transit commute.

Inequality in access to jobs is also large within cities: although on average residents from New York City have high access to jobs by public transit, accessibility from individual neighbourhoods varies considerably within the city. Across cities the Gini index for average number of jobs per capita that are available from a city census tract within a 30-minute commute by public transit varies from 0.5 in San José (California) to 0.83 in New York City.

Lack of transport connections between minority neighbourhoods and relevant employment centres hinders job opportunities

The concentration of lower income people and minorities in particular neighbourhoods within cities is deemed particularly problematic when it leads to worse economic outcomes.

Evidence has shown that in the United States intra-city location is linked to worse economic outcomes when areas lack appropriate public transit connections to jobs. In the United States, lack of transit connections between minority neighbourhoods and jobs seems to hinder job opportunities for residents of certain neighbourhoods, leading to more inequality in job outcomes. In fact, there is a strong association of workplace segregation along racial lines with inequality in job accessibility by transit.

Do minorities face constrained access to job opportunities by public transport because of their neighbourhood location?

Although in the United States minorities live in inner city areas that are relatively well-served by transit, the jobs available to them often lack appropriate transit connections. The concept of workplace segregation along racial lines describes the extent to which workers of different races work in the same or in different areas within a city. This is analogous to residential segregation: a city is segregated if residents of different races live mostly in different neighbourhoods. In fact, high levels of workplace segregation often go hand in hand with higher levels of residential segregation.

Jobs available to minorities are relatively less well served by public transit. As an example, in two neighbourhoods that differ by their share of non-white residents by 1%, each resident of the neighbourhood with the lower minority rate has access to 18 more jobs within a 30-minute commute on public transit than residents of the other neighbourhood. What's more: this holds only in cities where workers of different races work in different areas of the city.

Breaking divides

Current urban inequality levels call for policies for more inclusive cities**.** There is no simple answer to the question of why segregation exists, as it is the outcome of a process that can involve preferences, limitations in housing availability, and housing policies explicitly directing the location of specific socio-economic groups. For the same reason, policies should not be concerned with lowering average segregation levels, but with bridging the underlying divides that widen inequalities in access for disadvantageous groups.

What can policies do to break vicious circles of inequality?

The multi-dimensional nature of segregation calls for co-ordinated policies at the city level. Policy measures to increase access to services, housing and spatial planning should be designed in a more co-ordinated manner.

Policies to fight intra-urban inequalities should be designed at the right scale. A necessary step in this direction is the use of a comparable definition of functional urban areas, so that not only city cores but also their commuting zones in the suburbs are consistently included. The neighbourhood scale, which is usually the basis for segregation measures, should also be as homogenous as possible for comparisons to be meaningful.

To tackle intra-urban inequalities, policy makers can also contribute to more inclusive cities with planning initiatives to bridge access gaps in specific neighbourhoods. These initiatives can reinforce policies aiming to increase access to high-quality education and employment opportunities for all.

Chapter 2. Divided Cities: Understanding Income Segregation in OECD Metropolitan Areas

by

Andre Comandon, Michiel Daams, Miquel-Àngel Garcia-López, and Paolo Veneri

This chapter provides an assessment of income segregation levels within cities in 12 countries. It also provides an analysis of the characteristics of cities associated with income segregation. Within-city variation in income segregation is measured using a fine-grained method for obtaining spatial entropy indexes based on gridded income data. This measurement approach, applied to the EC-OECD functional urban areas, minimises the biases due to different administrative boundaries and allows robust international comparability. The results may inform public policy in domains connected to urban development, including housing and transport.

Introduction

The geographical concentration of households with a similar income level, known as spatial income segregation, increasingly shapes how people live their lives within cities. Recent research covering both Europe and the United States shows that the extent to which people live separated according to their level of income has increased during the last few decades (Marcińczak et al., 2016; Massey et al., 2009; Pendall and Hedman, 2015).

Income segregation is a phenomenon that is linked to urban development. As people choose a place to live, subject to their resources constraints, they often tend towards locations where people who are similar to them in terms of culture and socio-economic background live. Recent literature, mostly on US cities, shows that income is one of the dimensions that most explains the clustering of people in separated neighbourhoods (Glaeser and Vigdor, 2012; Logan and Stults, 2011), although there are some recent studies suggesting that race is still important (Sander and Kucheva, 2016). Income segregation can also be a result of free choice. In this case, a certain degree of spatial concentration of people with similar characteristics can be an efficient setting for enhancing social networks. It can also foster positive externalities, especially for those living in the most affluent and highest quality neighbourhoods (Morrison, 2015). Such neighbourhoods will likely have good schools and good teachers, as well as students that share similar values. This mechanism might explain the evidence for the United Kingdom suggesting higher levels of segregation to be associated with higher levels of inequality of individuals, which in turn is driven by higher performance at the top end of the social ladder (Gordon and Monastiriotis, 2006).

While income segregation is neutral in essence, it can, however, become problematic if it affects those that are less advantaged. This can be the case when disadvantages concentrate in space, which can typically be the case for neighbourhoods with low accessibility to jobs and quality services and amenities that also have a poor social environment. Such spatial concentration of disadvantages can be a life-long obstacle to opportunities available for those who live or grew up in such disadvantaged areas (Chetty and Hendren, 2015). Moreover, recent work showed that high spatial segregation might lower the cohesion of a city and as such lower the general well-being there (Novara et al., 2017). This is of increasing policy relevance as during the last couple of decades the processes that give rise to spatial segregation have been spurred by economic globalisation, immigration, and a widening gap between low-skilled and high-skilled jobs (OECD, 2016). If cities are to perform their role as locations for socioeconomic mobility, the local socioeconomic divisions that shape how benefits of life and work in cities are distributed over inhabitants should be better understood.

In response to this, the current paper introduces city-level measures of income segregation that are internationally comparable. The resulting international indicators allow a broadening of the debate on how income segregation and public policies relate. This is important and challenging at the same time because the character of both income segregation and related public policies may vary substantially across countries – and across their cities. What does it mean when segregation is higher in one city than in another? How may this be related to public policy? This paper brings systematic data to further advance on this debate. It contributes to understanding whether lower segregation in cities yields better aggregate outcomes for those living there, whether policy can promote a more inclusive and less segregated urban environment, and at what cost.

Income segregation in cities is investigated by looking at the distributions of income across income-classes and local areas, in a granular way. This granularity is important because spatial scale is crucial in the analysis of segregation. A city with low overall inequality may face deeper within-city divisions than a city with high overall inequality. This can be understood from the character of segregation in two main ways. First, segregation levels may vary with income level. This is addressed in the analysis by measuring segregation levels by income group. This then makes it possible to evaluate whether the average level of segregation in a city is driven by segregation of poorer households or segregation of wealthier households. Second, the geographical scale of segregation is considered by fitting geo-data on income to a fine grid pattern and then aggregating it to same-sized "neighbourhood" areas. Neighbourhood areas of different sizes are analysed to evaluate the appropriate geographical scale to capture income segregation within cities. Since cities come in various shapes and sizes, and so do the income data, the measurement approach is aimed to maximise the international comparability of its outcomes.

The analysis shows that segregation can vary substantially across cities in the same country and that it tends to be higher in cities with average higher household income. For example, some of the most affluent cities in the analysis also have amongst the highest levels of income segregation. While this might be interpreted as income segregation of people within cities being a natural consequence of economic growth and increased prosperity, previous studies suggest that this relationship varies. Cities with similar wealth levels can show levels of segregation that are very different, suggesting that other factors than wealth alone affect the way people cluster in space and the consequent neighbourhood divide. While understanding such divides would require contextual analysis of cities, a sound starting point for understanding segregation is systematic insight into how strongly income segregation varies across cities in different countries. For this reason, this paper assesses income segregation in metropolitan cities in 12 countries. While this analysis is mostly cross-sectional, trends in segregation over time are observed for a subset of countries for which the necessary data are available.

The last part of the chapter studies the determinants of income segregation. An econometric model where the main dependent variable is a measure of income segregation is regressed against measures of city size, different types of urban forms, types of city government and the economy of the city. The results confirm that not only city size but also urban form matter for explaining segregation levels. The main results vary by levels of income. While the level of segregation of the poor seems to be only related to the labour productivity of the city and to the degree of spatial centralisation, the segregation of the rich are related to the city size, the degree of spatial centralisation of the city, the labour productivity and the youth dependency ratio.

The remainder of the paper is organised as follows. The next section introduces the methods used to analyse income segregation, followed by an overview of the underlying data in section three. The fourth section presents the results. The fifth section presents some empirical evidence on the determinants of income segregation. The sixth section offers orientations for policy analysis, and the seventh section concludes.

Measuring income segregation

Income segregation in cities was assessed through the use of entropy indexes, consistently with the most adopted practices in the literature for the measurement of income segregation (Reardon et al., 2006). The entropy-based measurement approach requires working with fine-scale geographical data. This section provides the details on how income segregation is measured, by highlighting the issues of scale and international comparability.

The entropy measures capture how households at different income levels are spatially distributed within cities. In so doing, this study departs from conventional measures of segregation at the scale of fixed spatial units, such as census tracts or other predefined neighbourhood areas. This study establishes income-data at a 100 m x 100 m grid level (the underlying data and techniques are detailed in Box 2.2 in the next section), and uses these data to measure segregation within spatial units that are (in contrast to administratively defined neighbourhoods) consistent across countries. The consistent units are based on radii of varying length: 0.5 km, 1 km, 2 km, and 4 km. For each radii length, the segregation indexes capture how different from the city's distribution of income that unit is. The smaller units (0.5 km and 1 km) capture local variations more precisely. It indicates the degree to which people live surrounded by people of similar income levels within their immediate surroundings. The larger radii (2 km and 4 km) effectively smooth the measurement of segregation across larger spaces. That is, the level of segregation within a 4 km radius may be close to a city's average segregation level. However, there is no theoretical guidance on the optimal radius to measure segregation within a city. Therefore, the radius that best captures segregation in the observed data is established empirically (see Annex 2.A).

The entropy measures also capture how, at the city-level, the degree of segregation may vary for households with different levels of income. Doing so follows earlier work by Monkkonen and Zhang (2014) who compare segregation levels in San Francisco and Hong Kong. Because income data is ordinal, variation is measured as the spread of the distribution over income bins. An adaptation of the method developed by Monkkonen and Zhang (2014) is used to build a data base on entropy-based segregation within each of the observed metropolitan areas. The script was written in Python to integrate with ArcGIS and was modified to both increase its efficiency and be better adapted to comparative work (i.e. dealing with a large sample of cities). The first modification is that it offers the option of dasymetric mapping (See Box 2.2). This insures that only the parts of large sparsely populated areas with residents enter the entropy calculations. The other modification enables us to iterate over all metropolitan areas in a country, allowing the script to run automatically.

The analysis also uniquely considers segregation at the income-extremes. Patterns of income segregation often show that the highest levels are among the poorest and wealthiest residents (Reardon et al., 2006). Therefore, it could be so that overall segregation is much lower in one country compared to another, but that the poorest and wealthiest households in the two countries are similarly segregated.[1]

Data

Entropy indexes are obtained using data for cities across 12 countries; Australia, Brazil, Canada, Denmark, France, United Kingdom, Ireland, Mexico, the Netherlands, New Zealand, South Africa and the United States. Cities are defined based on the Functional Urban Areas (FUA) defined by the OECD in collaboration with the European Commission (OECD, 2012). The adopted method ensures the maximum comparability in terms of the spatial units of analysis as the same method was followed in all countries. Relying on a consistent definition of cities helps capture the outcomes of the mechanism that drives segregation at the appropriate spatial scale, as the FUA scale encloses the local economic dynamics that shape a city. This is important because if a city's boundary is considered in a too narrow way (which would be likely for an administrative boundary definition), or at a too high large scale, the level of segregation can be overstated or understated. Specifically, a FUA is a cluster of contiguous local administrative units (i.e. municipalities, ward, census tracts, etc.) composed by a high-density core and a surrounding commuting zone. In this work all FUAs with at least 500 000 inhabitants were selected for the analysis. For simplicity reasons and consistently with OECD (2012), these large FUAs are called metropolitan areas (MA) or cities in the rest of the paper. In the case of Brazil, New Zealand and South Africa, the FUA definition is not available. Therefore, the city boundaries that come closest to the FUA definition is applied in these countries: Metropolitan Regions in Brazil, Metropolitan Municipalities in South Africa.

The measures of city-level segregation draw from census data for most of the countries considered in this work. Data sources in each country are summarised in Table 2.1. Among the main challenges for international comparability is the consistency in the definition of income, income intervals, and scale at which data is available in each country. Countries use different definitions of income and collect income data in varying ways. This requires, in some cases, re-formatting the data provided by each National Statistical Office to maximise the level of cross-country comparability and combining data at different scales. Each country's definition of income, as well as the number of income classes, and scale are summarised in Table 2.1. Relevant to note is that income data are not available for the same years for all observed countries. Therefore, the most recent income data available are taken into account.[2]

The assessment of income segregation across cities in different countries requires considering a number of issues that are related to the data available in each country and that might limit the extent to which indicators are fully comparable. The following paragraph discusses such limitations and explains how, when possible, differences in data sources were addressed to maximise comparability.

The first issue is the spatial scale and coverage of income data. Table 2.1 shows how much variation exists in the size, both in terms of area and population, across cities within and across countries. For countries for which different small scale layers of data are available, it is possible to compute segregation indexes at the different scales to gain insight into the importance of consistent boundaries. This allows the degree to which modifiable areal unit problem possibly affects the precision of international comparison of cities to be assessed. This issue is further discussed in Annex 2.A.

Box 2.1. Spatial ordinal entropy index

The Spatial Ordinal Entropy Index can be computed using grid cells data to create local environments or neighbourhoods that are defined at different scales. For example, spatial entropy at a 1 000 m scale takes each grid cell and defines a 1000-meter area surrounding it as the neighbourhood. The outcome values of the Spatial Ordinal Entropy Index are between 0 and 1, and reflect the ratio between the proportion of the population from each income group in this neighbourhood to that in the city. Given the large number of cells that approximate a surface distribution, integrals are used for the calculations as specified by:

$$\tilde{\Lambda} = \int_{p \in R} \frac{t_p}{T} \cdot \frac{v - \tilde{v}_p}{v}$$

where T is the city population and t_p is the population of the neighbourhood, v and $\tilde{v}_p$ are the entropy for the city and the neighbourhood respectively, with the latter is calculated as follows:

$$\tilde{v}_p = -\frac{1}{M-1} \sum_{m=1}^{M-1} \tilde{c}_{pm} \, log_2 \tilde{c}_{pm} + \left(1 - \tilde{c}_{pm}\right) log_2 \left(1 - \tilde{c}_{pm}\right),$$

where M is the number of income groups and $\tilde{c}_{pm} = \sum_{k=1}^{m} \tilde{\pi}_{pk}$ is the cumulative income share in the neighbourhood p for each cell in the surface grid, with $\tilde{\pi}_{pk}$ being the share of the population in income group k. The same procedure is applied for each neighbourhood to obtain v.

It may be noted that the component of the index, or the raw entropy, has a maximum value equal to the log of the number of income categories (thus, in the case of 10 income categories the maximum value will be $log_2(10) = 1$). However, regardless of maximum values, the final index is between 0 and 1 because it gives a ratio that captures the relative deviation of the observed segregation from the observed maximum value.

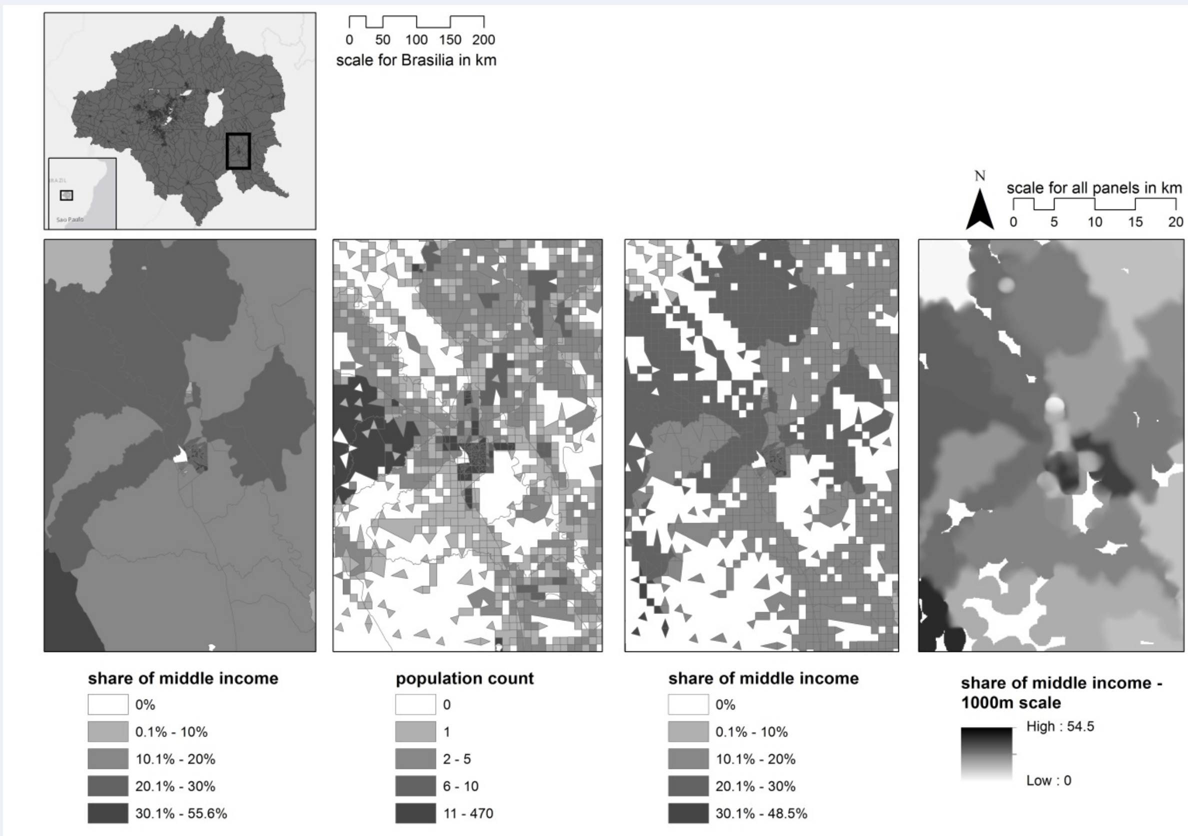
The Spatial Ordinal Entropy Index as a measure of income segregation has several advantages. For instance, it allows considering several income groups instead of only two and it minimises the modifiable areal unit problem by eliminating borders and relying on the surface distribution of individuals.

Box 2.2. Dasymetric mapping and spatial segregation measurement

Dasymetric mapping is the redistribution of a variable (income) that is measured at a certain administrative areas scale so that it follows population density. Using this method to down-scale spatial data is particularly useful for segregation analysis in urban regions that have a large catchment area. In such cities, overall density can be quite low and the geographic sub-units large, and dasymetric mapping allows analysis of segregation beneath the scale of those geographical sub-units.

The benefits are two-fold for the next steps of data processing. The first is the gains in processing time. The surface density approach to calculating entropy indexes draws a grid over the entire area of the urban region, therefore, the more area that can be eliminated because no people live there, the smaller the area for which the procedure needs to estimate surface density (Figure 2.1). Importantly, having a more precise distribution of the population can lead to better estimates at different scales, though not of the level of segregation. For example, at the border of two large adjacent sub-units, the surface density approach would weigh the distribution of population across the border similarly, even if one side happens to have no population within the area estimated. This is particularly relevant for areas where leapfrogging begins to take place.

Figure 2.1. Illustration of the observed income data (first and second panels), the outcomes of dasymetric mapping (third panel), and spatial entropies of income segregation (last panel)



There is also a caveat to dasymetric mapping. Applying this technique assumes that the distribution of the observed household incomes or income-levels is the same across the entire area considered by the original geographical data on income. Within this area, however, dasymetric mapping, apportions the frequency of household incomes to proportionally with population on a 100 m x 100 m Landscan data grid (i.e. all parts of the area have the same income distribution, the only thing that changes is how many people live there.) Evidence from previous studies shows that within small areas, the assumption of such income homogeneity does not hold (Tarozzi and Deaton, 2009). Therefore it is relevant to note that the resulting estimate of income distributions is no more accurate. But, it does add flexibility to the measurement of local spatial segregation as it transforms the scale of the income data from pre-defined (administrative) neighbourhoods to grid cells, which can be more freely aggregated using the spatial entropy technique.

Regarding the coverage of income data, countries like the United Kingdom and the United States make data available at a small scale for the entire country, making it possible to include all units within the boundaries of cities. However, countries like Canada, France, Mexico and the Netherlands have more limited coverage. There is a trade-off between coverage and accuracy as the units with missing data tend to be larger and contain less information about the location of households of different income. In the cases of Canada, France and the Netherlands, the next smallest administrative units are included in peripheral locations to increase coverage (see Table 2.1, Unit column).

In the cases of Mexican cities, however, data necessary to fill in those gaps are missing. In all cases, the coverage includes most of the population because areas with sparse data are those with the lowest density and overall population (i.e. small peripheral municipalities). The one case that deserves careful consideration is Mexico where available data, on average, cover less than 7% of the total FUA area. This limited coverage is not as much of a concern because data cover most of the urbanised area close to 75% of the total FUA population. Depending on the income distribution of the areas that are not included, this missing data could possibly lead to bias and should be taken into consideration when interpreting the results.

Table 2.1. Income data sources, the areal unit for the income data, and the number of income bins per country

Country		Census authority	Avg. areal unit population	Avg. area km2	Areal unit definition	Bins
Australia	2010	Australian Bureau of Statistics	134	1.57	Statistical Area level 1	15
Brazil	2010	Instituto Brasileiro de Geografía e Estatística	206	5.18	Setores Censitarios	10
Canada	2011, 2016	Statistics Canada – National Household Survey	2007	4.25	Census tract and district	13
Denmark	2013	Dansk Demografisk Database	1674	18.79	Sogne	5
France	2011, 2014	Institut National de la Statistique et des études économique	1318	5.62	IRIS and commune	11
Ireland	2006	Central Statistics Office	321	0.27	Census enumeration area	9
Ireland	2011	Central Statistics Office	98	0.77	Small area	9
Mexico	2000	Instituto Nacional de Estadística y Geografía (INEGI)	654	0.55	AGEB	12
Netherlands	2008	Statistics Netherlands	1637	2.82	Neighbourhood	5
New Zealand	2001-13	Statistics New Zealand	906	3.07	Mesh block / area unit	6
South Africa	2011	Statistics South Africa	189	1.08	Small Area	12
United Kingdom	2001	Office for National Statistics	109	0.37	Output areas	9
United Kingdom	2011	Office for National Statistics	228	0.35	Output areas	9
United States	2000	US.S. Census Bureau	1693	31.93	Census tract	16
United States	2014	US Census Bureau – ACS (5-year estimates) (1)	1681	27.63	Census tract	16

Note:
1. For more information on the American Community Survey (ACS), please consult: www.census.gov/programs-surveys/acs/methodology/design-and-methodology.html and www2.census.gov/programs-surveys/acs/tech_docs/accuracy/MultiyearACSAccuracyofData2016.pdf.

A second issue concerns the way income data are provided by each country, meaning the definition of income and the type of information on its distribution across individuals (see above). The comparisons made here are therefore based on the assumption that income levels correlate strongly across different definitions. In the case of Canada, for example, income data before and after tax are available and highly correlated. Still, all results should be interpreted with a certain level of cautiousness as small differences can come from these changes in collection methodologies.

Another key element for the comparability of this data collection is the number of income bins that are made available by each country. All countries, with the exception of France, Ireland, the Netherlands and the United Kingdom collect data into income bins. Respondents are asked which range of income they fall within rather than a precise value. In the case of France, the results are reported for each decile. In the case of the Netherlands, the census reports how many respondents fall within each of the quantiles of the overall income distribution. For both countries, the data are still based on income and can be used either directly in the case of the Netherlands, or after reformatting in the case of France. Ireland and the United Kingdom do not collect income data. Instead, they use socio-economic classes that function as proxies for income. Those classes have shortcomings as the income range within each class could be high, but the data have the advantage of being ordinal, as for income data.

The range of each income bin is another issue that should be taken into account. The number of bins and the range of income that they represent vary from 6 in New Zealand to 16 in the United States. Fortunately, most countries where income data are available have 10 or more bins and as such offer a comprehensive indication of the income distribution. While there are methods to add further detail to the income data by estimating the entire income distribution, these are not used for this analysis. That is because they add more uncertainty but offer limited improvement since the current data offer considerable variation in income groups.

Furthermore, for those countries for which cities are defined using the FUA definition, the OECD Metropolitan Database provides several measures of socio-economic conditions and well-being that may relate to income segregation. Indicators of household income, an estimation of GDP and labour productivity, and employment rates amongst the working age population are among the variables that have been considered here.

Results: Segregation across countries

Entropy across countries

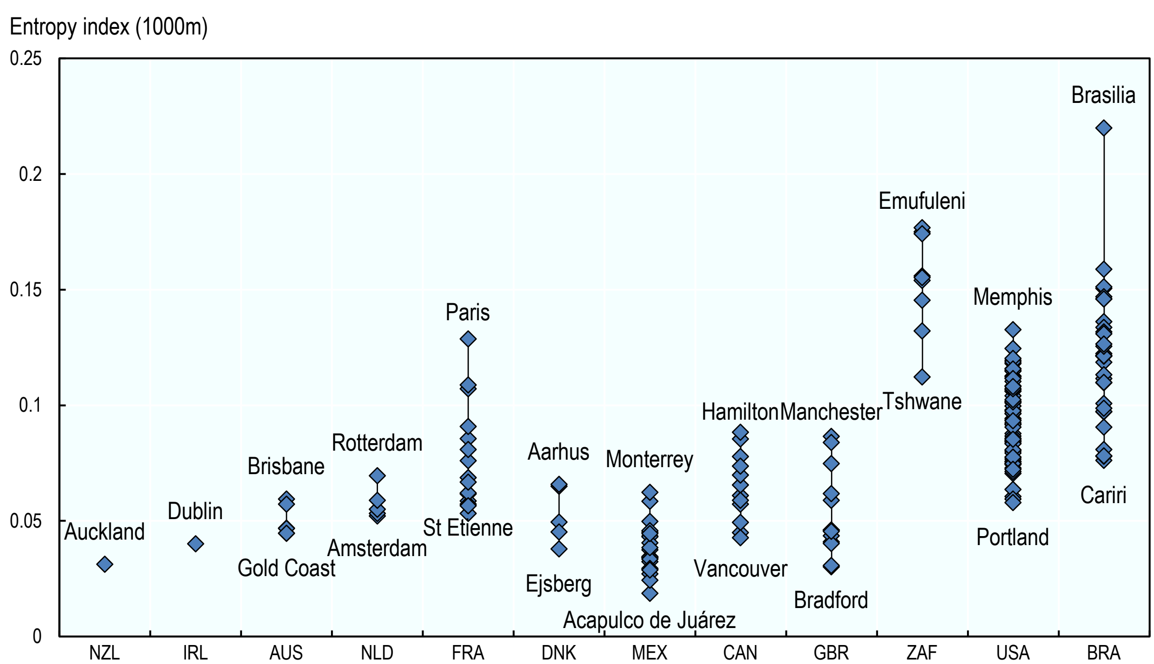
The overall levels of segregation across countries show substantial variation. Figure 2.2 shows the levels of income segregation of metropolitan areas in the different countries considered. The emerging picture is that countries differ in both the average level of metropolitan income segregation and the extent to which such segregation is different across cities. The countries appear to sort into two groups. One includes Brazil, South Africa and the United States, as those countries have considerably higher levels of segregation than the other countries in the sample. In each of the abovementioned countries with relatively high segregation levels, there are also relatively large cross-city differences in segregation levels. In contrast, amongst countries with lower segregation levels, with the exception of Canada and the United Kingdom, city-level differences in the level of income segregation appear limited. Even in countries with a large number of cities (e.g. Canada and Mexico) these differences are limited. Nevertheless, city-level averages may hide significant differences between inner and outer city areas, as those found for a recent study for France (Floch, 2017).

For the United Kingdom and the United States, income segregation is shown for the same cities at two points in time. For the United Kingdom a dramatic increase is observed over 2001-11. This increase comes from a limited number of cities experiencing relative large increases in their segregation levels. More specifically, segregation rose considerably in Leeds, Liverpool, Manchester, and Sheffield. Over the same period, segregation decreased in London and Newcastle. Interestingly, the UK-wide standard deviation for the level of segregation across cities nearly doubled from 0.009 to 0.017. This indicates that over time the variation in segregation levels in UK cities has increased, which is mostly caused by the cities that show the steepest growths and declines in their segregation levels. Noteworthy is that in nearly half of the UK cities segregation increased less than the national average and remained fairly constant.

The United States shows a relatively uniform and modest increase in the variation of segregation across cities between 2010 and 2014. The variation in segregation across cities increased only slightly, as indicated by the standard deviation of segregation levels increasing from 0.017 to 0.018. Over the same period, 28 out of 62 US cities saw an increase in segregation, while 20 saw a decrease. The remaining 22 cities were stable, as changes in their absolute levels of segregation are negligible.

Figure 2.2. Levels of income segregation in cities, by country (last year available)

Spatial entropy (1 000 m scale): higher levels indicate higher segregation



Source: Elaboration based on data detailed in Table 2.1.

Among all observed cities, cities in Brazil and South Africa have the highest average levels of segregation. This is in line with the association between segregation and relative high overall inequality in these countries. Both countries have among the highest inequality levels in the world as well as histories of segregation (Christopher, 2005; Telles, 2006). This combination of historical segregation and inequality partly explains why the United States, which shares these traits, has higher segregation levels than other OECD countries.

Results for Mexico should be interpreted cautiously especially when compared with other countries. Despite high levels of inequality, segregation in Mexico appears relatively low. Some features of income data in Mexico may partially explain this pattern. While the small area data covers a majority of households in urban areas, there might be some gaps in data collection as surveys likely leave out the most disadvantaged. This possibility is supported by the New Zealand data, which have measured how many household did not answer the underlying survey. These non-response issues suggest that reporting may be lower in low income areas. If a similar systematic underreporting occurred in the case of Mexico, this would result in a possible downward bias. It might also be the case that Mexico has a different pattern of segregation with respect to other countries. Research on specific cities suggest that segregation, especially at the scale of the current analysis, is generally low among low and middle-income households and higher among high income groups (Aguilar and Mateos, 2011). This is consistent with the results discussed in the following paragraphs and suggests that Mexico has a different pattern of spatial clustering of household in space with respect to most countries.

Australia and New Zealand as well as cities in Denmark and the Netherlands have relatively low levels of segregation compared to cities in Canada and in the United States (Figure 2.4). In contrast to the Anglo-Saxon countries,[3] these countries have low inequality levels, especially Denmark and the Netherlands. The similar levels of segregation across cities in these three countries suggest that the link between inequality and segregation is not straightforward. While there is a clear positive correlation, a significant degree of variation exists and many other factors could be at play. To better illustrate differences across countries more details are provided in the examination of segregation across income levels and other socio-economic characteristics of cities.

High segregation in wealthy and productive cities

Income segregation is known for being related to the economic development of cities. Given that due to the rise of economic globalisation wage gaps within cities may have increased, the relationship between segregation and labour productivity is interesting to consider (Cozzi and Impullitti, 2016). As shown in the upper left panel in Figure 2.4, labour productivity coheres with income segregation in a moderately strong way, as could be expected. Similar patterns are observed in Figure 2.4 for the relationship between income segregation and other measures of economic productivity, the estimated GDP at city-level and the average disposable income of households. The correlation between segregation and employment rate is instead weaker.

Segregation across the income distribution

The average level of income segregation for all income groups may overlook important patterns in segregation. As could be expected, across countries, segregation levels tend to be higher for households with higher income. However, the data also show that at the highest income levels, several countries have seen large decreases in segregation. To explore this further, consider the curves that show segregation levels for each income bin across countries (Figure 2.5). The curves reflect how segregated a specific income group is from the rest of the population. More concretely, the most left data-point on the segregation curve in Figure 2.5 (Panel A) reflects the segregation of households living in Australian cities below the first income threshold relative to the rest of their city's population. Then, the most right data-point on the same segregation curve shows segregation of households in the highest income bin from other households.[4]

However, as shown in Figure 2.5, low segregation levels are observed at the lower end of the income distribution.[5] Indeed, Reardon et al. (2006) show that for a number of Metropolitan Areas in the United States, the segregation levels at the lowest income levels are higher than for most of the population, but remain much lower than wealthier households. For France, Floch (2017) also finds higher levels of segregation for the highest income group across twelve French metropolises. This evidence suggests two possible explanations. One is that poorer residents might have more diverse spatial configurations than wealthier residents, as their higher segregation levels are nearly constant across all examined countries. On the other hand, scarcer information at the lowest end of the income distribution might cause an underestimation of segregation for low income households.

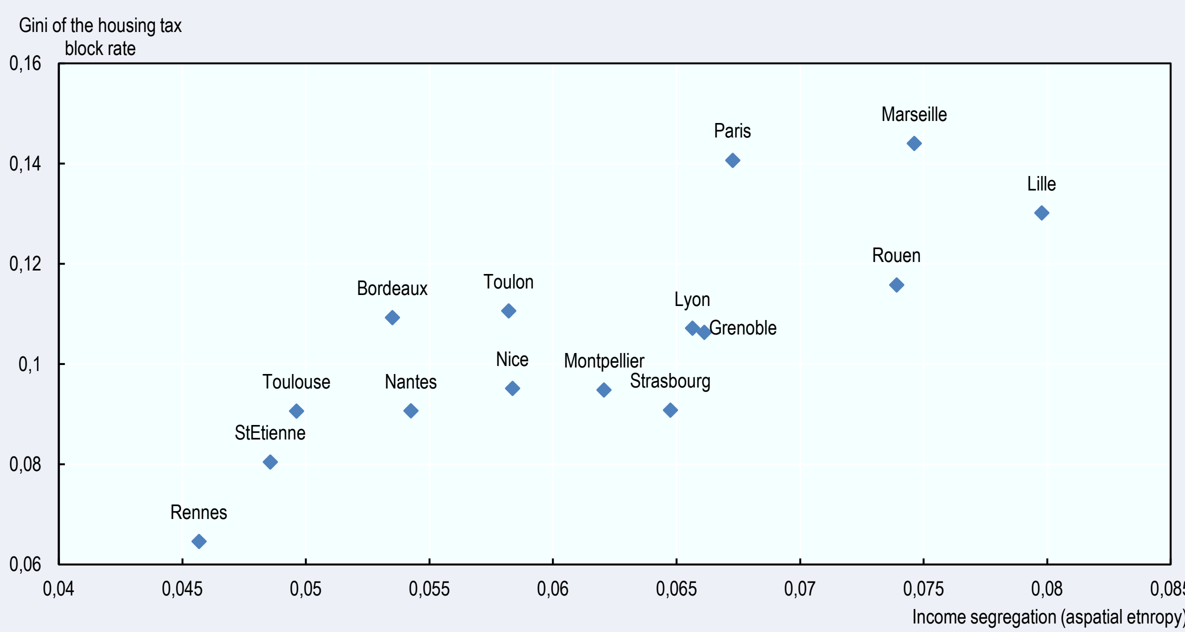
Box 2.3. Local taxation and income segregation in France

The organisation of the tax system at the local level might introduce incentives to household to concentrate in different neighbourhoods, with possible consequences on segregation levels. In France, there are four levels of local authorities: regions (NUTS 2), *département* (NUTS 3), public-establishments of inter-municipal co-operation (PEIC) and municipalities. At the municipal level (inter-municipal authorities and municipalities), four direct taxes are collected: the House Tax (HT), the Property Tax on Built Properties (PTBP) and non-Built Properties (PTNBP) and economics taxes. The HT is due for the principal dwelling and eventual secondary residence, and it is paid annually by owners, renters or occupier free of charge. The PTBP is only due by owners, even if the dwelling is leased. Both HT and PTBP are based on the cadastral locative value of the dwelling. These locative values have been defined in 1970 and they are updated each year by flat rate decided at the central government level. Local authorities are free to decrease or increase the rate of the HT and of the PTBP, but these decisions have an incidence on the setting of tax rates of the PTNBP and the CPT (Corporate Property Tax). In 2011, the average tax rate setting by municipal block is 23.76 for the HT and 19.89 for the PTBP (Direction générale des collectivités locales, 2013). Moreover, some tax rebates and tax ceiling can be applied under certain conditions.

Building on the work by Tiebout (1956), economic theory helps understand the impact of fiscal decentralisation on how heterogeneous agents sort in different municipalities of metropolitan areas.[6] If the public goods can be easily substituted by private ones, more affluent people will sort into municipalities with low housing prices and low public good provision. However, if it is not the case, more affluent people will sort into municipalities with high housing prices and high public good provision. Large differences in the taxation rates across municipalities of a metropolitan area might promote the sorting of different income groups in different neighbourhoods, fostering segregation. However, property taxes are set up on housing values. If relatively poor households go in wealthier municipalities by buying small dwellings to avoid taxes and benefit from high local public expenditures that would decrease levels of income segregation. Similarly, wealthy people with a preference for privates' goods can decide to live in relatively less affluent municipalities if the tax base is lower. This point should be especially considered in France where the tax base correspond to the cadastral rental values (computed in 1970) and no the real rental values.

Across French metropolitan areas, a high and positive correlation (coeff. 0.79) is observed between the heterogeneity in the HT block rate and levels of income segregation (Figure 2.3). Segregation is measured through the spatial entropy index with 2011 income data, while HT heterogeneity is measured through the Gini index of the HT block rate (sum of the inter-municipalities' rates and the municipalities' rates) across the different municipalities of each metropolitan area. On average, metropolitan areas with larger differences in HT rates across their municipalities show higher levels of income segregation. This finding might suggest that households are sensitive to the local taxation and sort into cities according to tax rates.

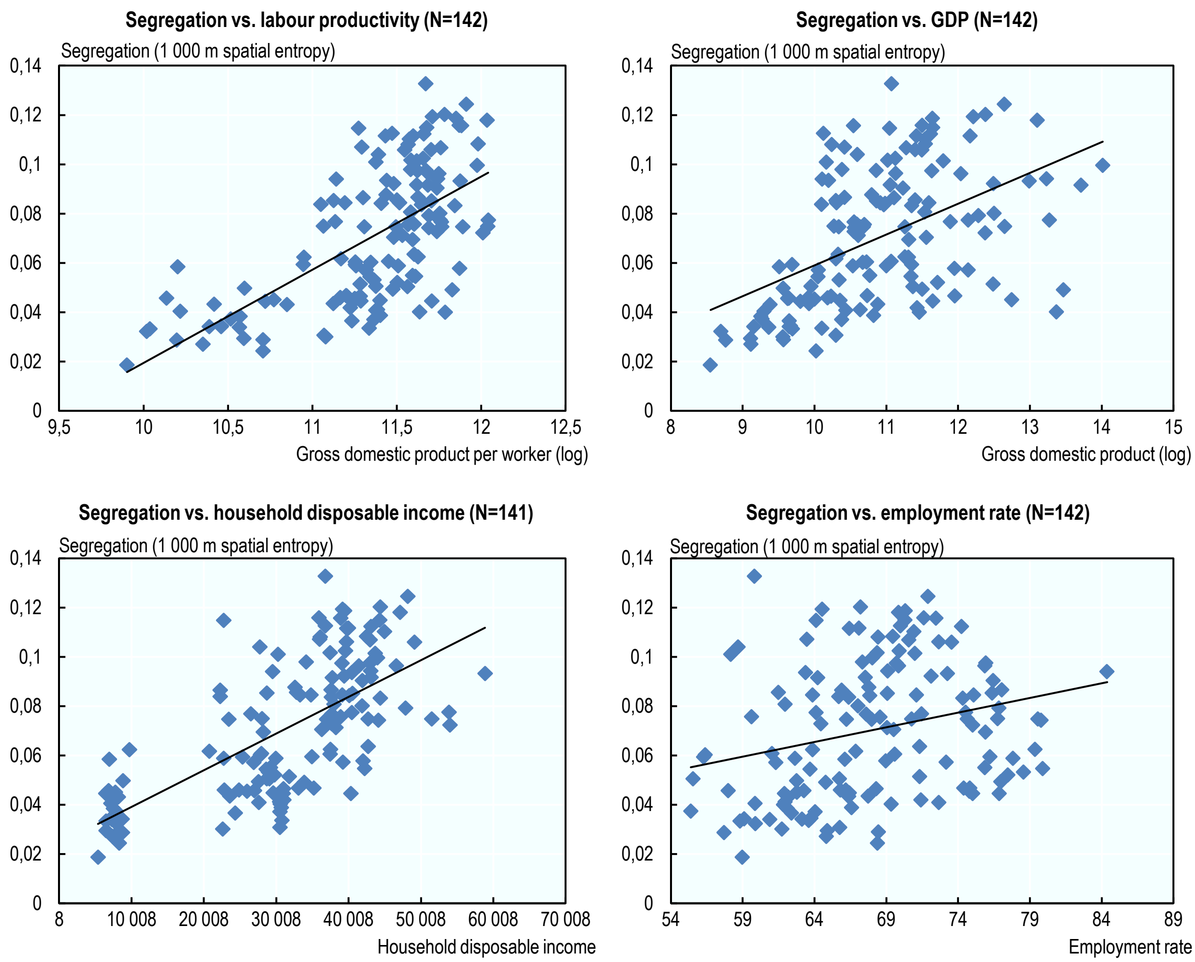
Figure 2.3. House tax heterogeneity and Income segregation, 2011



In France, reforms on House Tax are currently in discussions with a possible reduction of the share of contributors. In turn, such reduction might weaken the relationship between HT rates differences and observed income segregation, although further analysis is necessary to shed light on the possible mechanisms underlying such relationship.

Source: Fourrey, K. (2017), *Local Taxation Framework and Segregation in France*, mimeo.

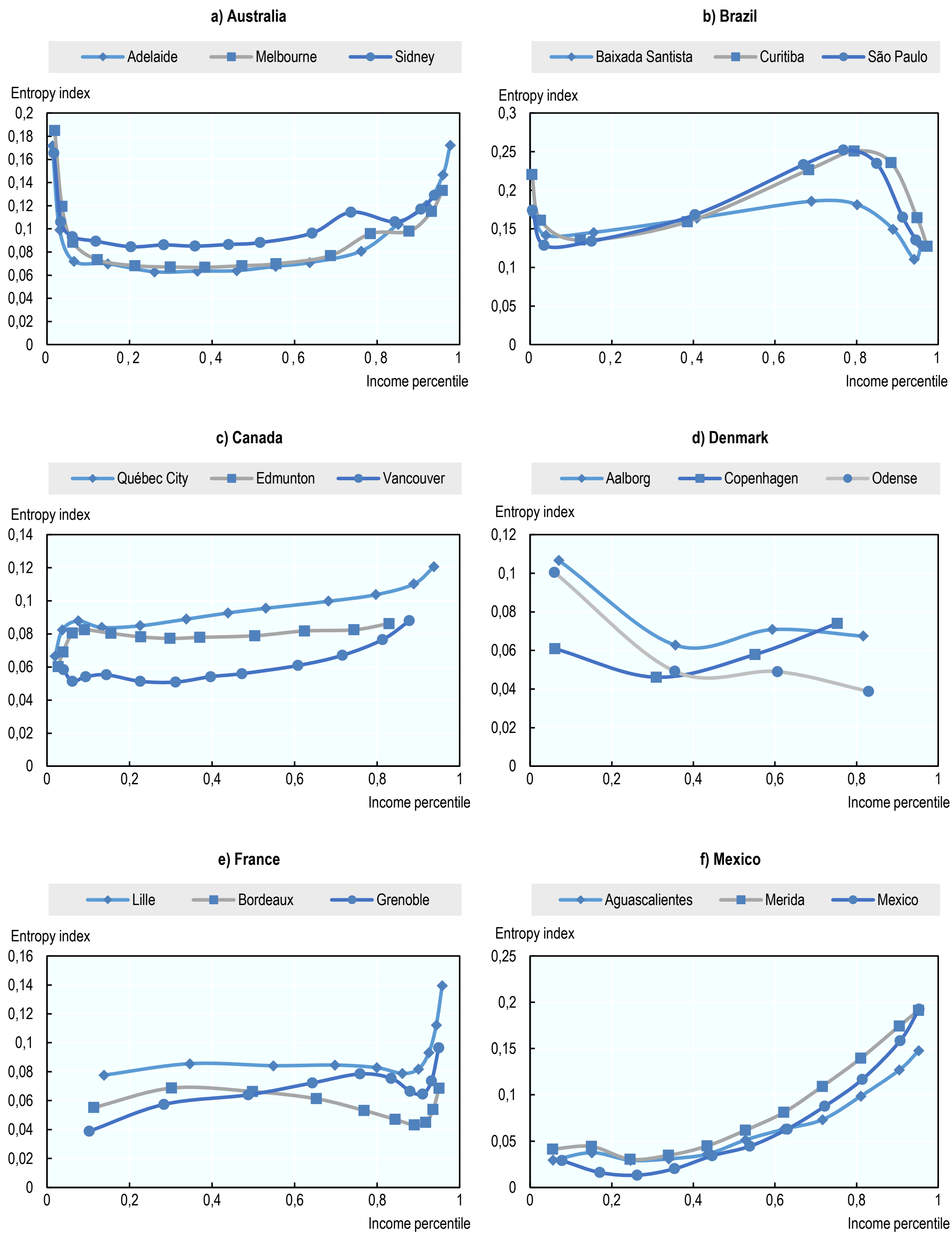
Figure 2.4. Scatterplots of income segregation and measures of economic productivity, FUA-level

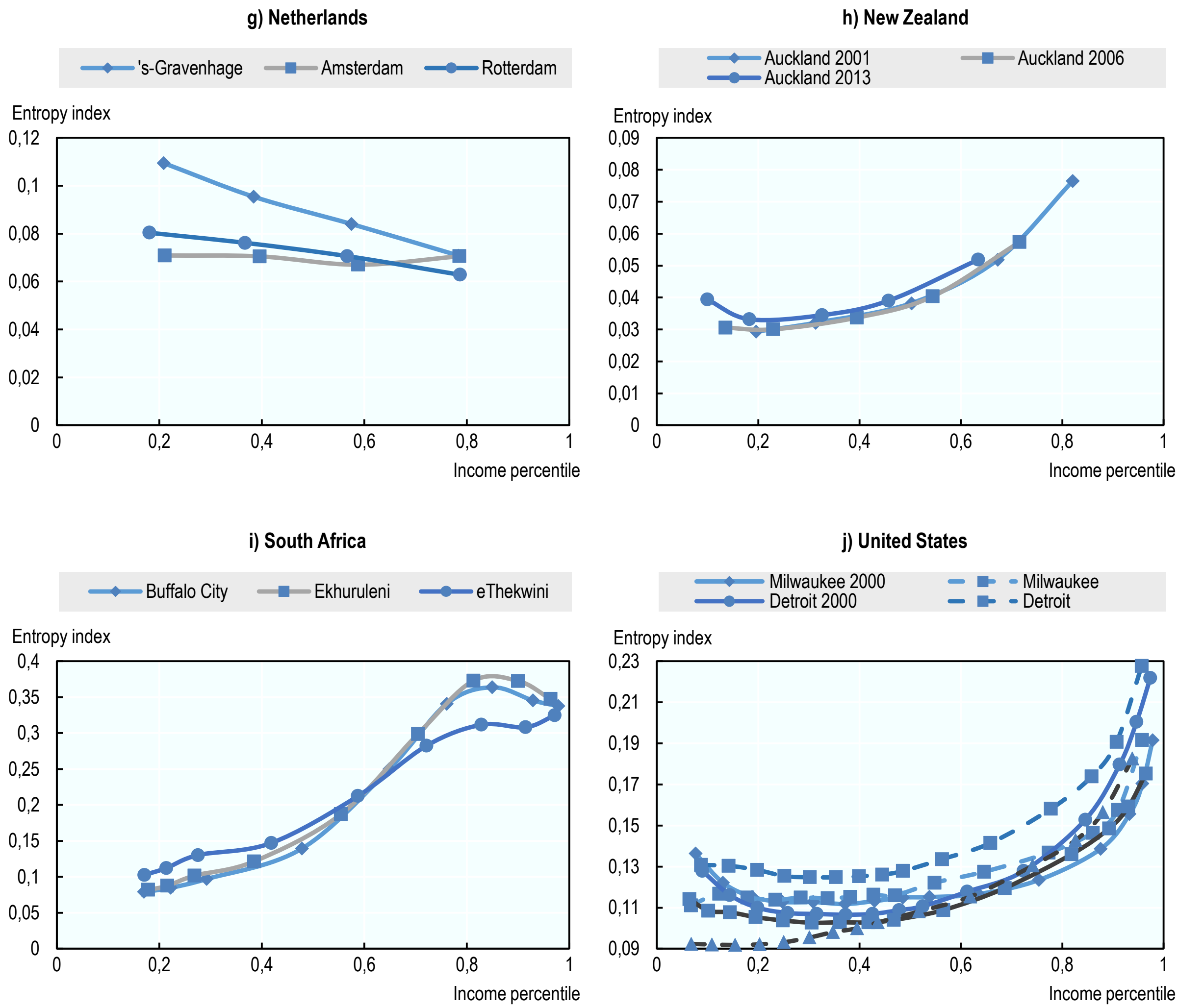


Source: Elaborations based on OECD (2018) OECD Metropolitan Database, http://stats.oecd.org/Index.aspx?Datasetcode=CITIES.

A deeper interpretation of the assessment of income segregation can benefit from looking at the countries for which additional information at the lower end of the income distribution are available. Australia, which is the only country along with South Africa to include a category for household with no reported income (rather than non-disclosed), has extremely high levels of segregation at the lowest end of the income distribution (see Figure 2.5, Panel A). This case illustrates another important point concerning segregation at the extremes. Sharp peaks at the extremes should be expected when the category is very small. In the case of Australia, very few people have no reported income. If people in this category concentrate in the same area, this will result in high observed segregation. South Africa (Figure 2.5, Panel I), on the other hand, has lower levels of segregation at the lower extreme, consistent with the patterns recorded in some United States cities. However, South Africa has a different set of confounding factors. The category for no income is either the largest or one of the largest for each city, hiding much variation, especially when considering the significance of the informal economy.

Figure 2.5. Income segregation in cities by income group





Note: The curves correspond to the segregation level between each income category. The marks on the curves correspond to the number of income bins. The income percentile is based on the cumulative population in that bin and all bins under it.
Source: Elaborations based on national data on income distribution at local level (see Table 2.1).

A main insight can be drawn from the shape of the curves of segregation depicted in Figure 2.5. While nearly all countries have higher segregation levels at higher income levels, this does not happen everywhere. It also shows that at the highest income levels the cities in some countries (e.g. Brazil and South Africa) have large segregation decreases relative to the segregation of adjacent income-groups with a lower income. An explanation for this is that the highest income groups may include a small absolute number of households. This then leaves open the possibility that the residential locations of a limited number of these households have a strong influence on the group's overall level of segregation. In other words, even if only a few of the highest-income households are located in areas of low segregation this could affect the group's observed segregation level. Such situation is likely to occur in Brazil and South Africa, where income levels have risen strongly in the first decade of 2000. In these countries, households who have experienced increases in income may not have moved to areas that are exclusively inhabited by high-income residents. Such residential behaviour may also have contributed to the low segregation level of Mexican cities.

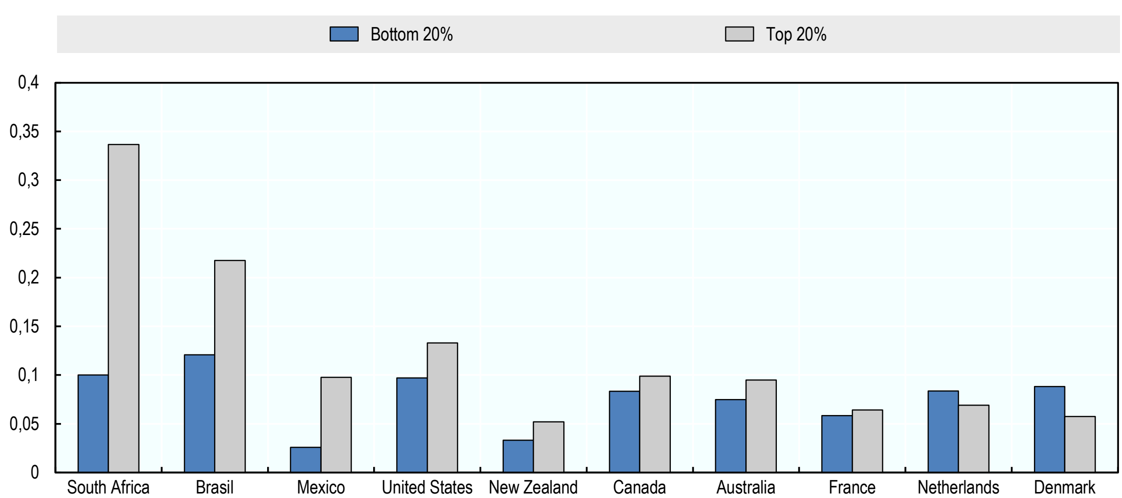
The remaining countries show a diversity of patterns, but also some consistencies. For example, Canada and New Zealand show the lowest segregation at the bottom of the income distribution and then a steadily increase along the income distribution. Australian and French cities, on the other hand, tend to have flatter levels in the middle income categories and steep increases at the very top of the income distribution. The United States, in 2000, falls somewhat in-between with a steady, but steep increase. By 2014, however, the pattern has changed towards a flatter curve increase more similar to the curve for Canada.

There is more variation at the bottom of the income distribution from Canada's steep decrease to Australia and the United States' upward curvature. The case of Canada stands out because of the clear difference in pattern between Edmonton and Québec City, and Vancouver. Such differences within country warrant closer examination, though in this case comparing with other countries can prove useful. Some cities (not shown here) in the United States have curves that resemble Vancouver's rather than the more usual US "U-shaped" curve observed here. It is this kind of comparison this work seeks to encourage.

Figure 2.6 shows how segregation levels compare between the top and bottom 20% income deciles in each country.[7] Figure 2.6 shows that in some countries segregation is similar at both ends of the income distribution (e.g. France) and that in other countries segregation is higher at the higher end of the income distribution (e.g. Mexico). Denmark and the Netherlands are the only countries where segregation is higher at the lower end of the income distribution – relative to the level of segregation of higher income groups.[8]

Figure 2.6. Income segregation in the bottom and top income groups

In most countries, income segregation is higher among the rich.



Note: Bottom 20% values for Denmark refer to the 6% percentile.
Source: Elaborations based on national data on income distribution (see Table 2.1).

Most countries show a consistent pattern of upper deciles ('d9' representing the highest income group) being considerably more segregated than lower deciles ('d1' representing the lowest income group). Ratios between these deciles are for most cities between 0.6 and 0.8. A much lower ratio is observed for Mexico and South Africa, where wealthier income groups tend to be more segregated than lower income groups.[9] Lastly, the United States, where segregation is measured at two points in time (2000 and 2014), show stable segregation levels over time (Figure 2.6). This indicates that the level of segregation of the rich relative to the level of segregation of the poor has remained relatively constant. This is interesting since the 2000-14 period includes the Global Financial Crisis, which had a profound impact on housing and urban economies.

Determinants of income segregation

Econometric approach

To study the main determinants of income segregation, the following equation is estimated:

$$ln(SE_t) = \delta_0 + \sum_i\left(\delta_{1,i} \times Size\ and\ Form_{i,t}\right) + \sum_i\left(\delta_{2,i} \times Government_{i,t}\right) + \sum_i(\delta_{3,i} \times Economy_{i,t}) + \sum_i(\delta_{4,i} \times Demography_{i,t}) + \sum_j(\mu_j \times Country\ dummy_j) + \sum_t(e_t \times Year_t) \quad (1)$$

In Equation (1), the main dependent variable is the log of the measure of income segregation (spatial entropy at 1 km scale). The explanatory variables are grouped in four categories and are based on previous empirical and theoretical literature.

First, following recent literature on inequality and city size (e.g. Baum-Snow and Pavan, 2013) the number of inhabitants is included as explanatory variable. Following Pendall and Carruthers (2003), Galster and Cutsinger (2007), and Ahlfeldt and Pietrostefani (2017a, 2017b), city size is defined in terms of city density by adding the city land area as a control variable. Literature shows that density is linked with multiple urban aspects. There is a positive link with productivity (so higher wages), houses prices, rents, services access, and efficiency of public services, which may lead to higher income segregation. Besides, according to Ahlfeldt and Pietrostefani (2017a), an increase in density leads to a decrease in net wages (higher wages but higher value of space) which is compensated by higher amenities. Thus, the impact of an increase of density on income segregation is ambiguous and it depends on how amenities are evaluated by the people, on how public goods can be replaced by private ones. Then, it may be assumed that wealthier households have a willingness to pay for amenities and public services higher than poorer ones, or at least they have the capacity to pay for them, leading to more income segregation.

The role of different types of urban forms: monocentric vs. polycentric cities, compact vs. disperse cities, centralised vs. decentralised cities is also considered. These urban forms are related to different spatial distributions of jobs within cities and, as a result, they might be related to different residential location patterns. For example, McMillen (2001) highlights that subcentres in a polycentric city enjoy some of the same agglomeration economies as the CBD (high wages), but offer lower commuting costs and housing prices for suburban workers. Thus, less segregation may be observed in polycentric cities (Garcia-López and Moreno-Monroy, 2016). However, if there is also job segregation, with qualified jobs in the CBD, less qualified jobs in the subcentres and non-qualified jobs elsewhere, polycentric cities might be related to more income segregation.

Based on Pendall and Carruthers (2003), the role of governments within the city is also studied. In this sense, Tiebout (1956) shows that people sort according to their preferences in terms of public goods, which is in part related to their income level. Thus, the more there are intra-city governments (e.g. municipalities), the more they might have preferences for segregation.

As usual, controls for the economy of the city are added. First, labour productivity, which is related to the abovementioned literature on inequality and city size (Baum-Snow and Pavan, 2013), is added. The idea is that higher productivity means higher wages, especially for skilled workers, leading to more relative wage differences between skilled and low skilled workers. This increasing difference in terms of wages may result in more differences in terms of preferences (commuting, public goods, amenities, etc.) and, as a result, more income segregation. It is important to notice that, when controlling for productivity, the density effect is interpreted for a give level of productivity, and vice-versa.

An additional variable for the economy of the city is the employment rate that allows controlling for the situation of the labour market (and the city capacity to integrate low skill workers) and, in general, for the level of development of the city (Pendall and Carruthers, 2003).

Finally, following Pendall and Carruthers (2003), Galster and Cutsinger (2007) and Garcia-López and Moreno-Monroy (2016), controls are included for city demography (youth and old age ratios). The idea is that families in different stages of their live cycle show different preferences that might affect their location patterns. For example, young people with children might compete for better school districts, leading to more income segregation.

Equation (1) is estimated by Ordinary Least Squares (OLS) pooling data for 107 cities in the years circa 2001 and 119 cities in the years circa 2011. The whole set of cities included in the analysis are reported in Table 2.2.

The role of city size, government, economy and demography

Equation (1) is estimated using gradual specifications in Table 2.3. That is, in the first step log of the city population is included as an explanatory variable in Column 1. Then, in Column 2, the log of the administrative fragmentation index is added, computed as the ratio between the number of local governments and the population in the city. Column 3 includes two variables related to the economy of the city in log form: Labour productivity, measured as the ratio between city GDP and total employment, and employment rate, measured as the percentage of city employment over total labour force. Finally, the log of two demographic variables is also added: the youth dependency ratio, measured as the ratio between the youth population (0–14 years old) over the working age population (15–64 years old), and the old dependency ratio, measured as the ratio between the elderly population (65+ years old) over the working age population (15-64 years old). All these explanatory variables are obtained from the OECD Metropolitan database.[10]

Results in Table 2.3 show a positive and significant relationship between income segregation and some of the explanatory variables. In particular, the results show that the higher the population, the labour productivity and the youth dependency ratio of a city, the higher its degree of income segregation.

Table 2.2. Countries, cities and years

Country	City	Year
Australia	Adelaide, Brisbane, Gold Coast-Tweed Heads, Melbourne, Perth, Sydney	2010
Canada	Calgary, Edmonton, Hamilton, Montreal, Ottawa-Gatineau, Quebec, Toronto, Vancouver, Winnipeg	2011
Denmark	Copenhagen	2013
France	Bordeaux, Grenoble, Lille, Lyon, Marseille, Montpellier, Nantes, Nice, Paris, Rennes, Rouen, Saint-Étienne, Strasbourg, Toulon, Toulouse	2011
Ireland	Dublin	2006 2011
Mexico	Acapulco, Aguascalientes, Centro, Chihuahua, Cuernavaca, Guadalajara, Juárez, León, Mexicali, Ciudad de México, Monterrey, Morelia, Mérida, Puebla, Querétaro, Reynosa, Saltillo, San Luis Potosí, Tampico, Tijuana, Toluca, Torreón, Veracruz	2000
Netherlands	Amsterdam, Eindhoven, Rotterdam, The Hague, Utrecht	2008
United Kingdom	Birmingham, Bradford, Bristol, Cardiff, Leeds, Leicester, Liverpool, London, Manchester, Newcastle, Nottingham, Portsmouth, Sheffield	2001 2011
United States	Akron, Albany, Albuquerque, Atlanta, Austin, Baltimore, Baton Rouge, Birmingham, Boston, Buffalo, Charleston, Charlotte, Chicago, Cincinnati, Clearwater/St Petersburg, Cleveland, Colorado Springs, Columbia, Columbus, Dallas, Dayton, Denver, Des Moines, Detroit, El Paso, Fort Worth, Fresno, Grand Rapids, Harrisburg, Houston, Indianapolis, Jacksonville, Kansas City, Las Vegas, Little Rock, Los Angeles, Louisville, Madison, McAllen, Memphis, Miami, Milwaukee, Minneapolis, Nashville, New Orleans, New York, Norfolk-Portsmouth-Chesapeake-Virginia Beach, Oklahoma City, Omaha, Orlando, Philadelphia, Phoenix, Pittsburgh, Portland, Providence, Raleigh, Richmond, Sacramento/Roseville, Saint Louis, Salt Lake City, San Antonio, San Diego, San Francisco, Seattle, Tampa, Toledo (only 2000 data), Tucson, Tulsa, Washington, Wichita	2000 2014

Table 2.3. Determinants of income segregation (I): City size, government, economy, demography

Dependent variable:	ln(SE 1-km index)			
	[1]	[2]	[3]	[4]
ln(Population)	0.062a (0.014)	0.065a (0.017)	0.052a (0.014)	0.050b (0.016)
ln(Fragmentation)		0.012 (0.026)	0.016 (0.026)	0.014 (0.028)
ln(Labour productivity)			0.154b (0.055)	0.203a (0.054)
ln(Employment rate)			-0.248 (0.200)	-0.100 (0.240)
ln(Youth dependency ratio)				0.391b (0.160)
ln(Old age dependency ratio)				0.066 (0.080)
Adjusted R2	0.725	0.725	0.729	0.735

Note: 226 observations (107 in 2011, 119 in 2011). All regressions include country and year fixed-effects. Robust standard errors in parenthesis clustered by country. [a], [b] and [c] indicates significant at 1%, 5%, and 10% level respectively.
Source: Elaborations based on national data on income distribution (see Table 2.1) and OECD (2018) OECD Metropolitan Database, http://stats.oecd.org/Index.aspx?Datasetcode=CITIES.

The role of urban form

In Table 2.4 alternative measures of urban form are tested. The idea is to test the effect of different types of urban spatial structures (e.g. monocentric vs. polycentric cities, compact vs. disperse cities, centralised vs. decentralised cities). Column 1 includes the log of the city land area. By doing so, the coefficient of the city size variable, the city population, can be interpreted in terms of population density (Combes and Gobillon, 2015). Column 2 proves this statement by substituting the population variable by the population density. In both cases, results for the log of population (Column 1) and the log of population density (Column 2) show that a higher population density is also directly related to a higher degree of income segregation.

Columns 3 to 4 test whether there are significant different effects between monocentric and polycentric cities. First, the log of population is interacted with a dummy for polycentric cities (and add also this dummy as explanatory variable) in Column 1. The polycentricity dummy is computed using the OECD variable named Polycentricity. The results show that the positive and significant relationship between population density and income segregation is clearly related to monocentric cities (0.066), whereas is much smaller for polycentric cities (0.001=0.066-0.065). Column 4 splits the overall city population between central city population (computed using OECD variable Population Core) and suburban population (computed using OECD variable Population Hinterland). Results for these variables show that 1) a higher central population is not different between monocentric and polycentric cities and is positively related to higher income segregation levels (0.064); 2) a higher suburban population is positively related to income segregation only in monocentric cities (0.011) whereas is negatively related to income segregation in polycentric cities (-0.056=0.011-0.067). Finally, Column 5 adds an additional interaction between the polycentricity dummy and the labour productivity. This interaction is significant and negative and, in absolute values, higher than the coefficient for monocentric cities. As a result, it seems that cities with higher labour productivity levels are related to higher income segregation levels in monocentric cities (0.255), and to lower income segregation in polycentric cities (-0.044=0.255-0.299).

Columns 6 to 9 analyse the effect of other measures of the spatial configuration of cities. Departing from specification in Column 1, a measure of the degree of spatial concentration, the Theil's entropy index, is added in Column 6; the average weighted distance to CBD to measure the degree of spatial centralisation in Column 7; and both measures of spatial concentration and decentralisation in Column 8; and, departing from specification in Column 8, the number of city centres (based on the OECD variable Polycentricity) in Column 9. Since the Theil's concentration index ranges between 0 and 1, with 0 indicating perfect concentration (see Veneri [2015] for further explanations), results for these regressions show that cities with lower (higher) spatial concentration indexes are related to lower (higher) levels of income segregation. Results for the average distance to CBD show that less (more) centralised cities are related to lower (higher) segregation levels. Finally, in line with the results in Columns 3 to 5, a higher (lower) number of city centres (with a minimum of 1 for monocentric cities, and more than 1 for polycentric cities) are related to lower (higher) levels of income segregation. All these results clearly show the important role of the urban form on the degree of income segregation at the city level. Furthermore, they also show significant different relationships between monocentric and polycentric cities, and between less and more spatially concentrated and centralised cities.

Table 2.4. Determinants of income segregation (II): Urban form

Dependent variable:	ln(SE 1-km index)								
	Land area and population dens		Monocentric and polycentric cities			Number of centres, Centralisation and concentration			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
ln(Population)	0.044[a] (0.010)		0.066[a] (0.014)			0.036[b] (0.016)	0.081[a] (0.017)	0.075[a] (0.018)	0.086[a] (0.013)
ln(Pop) x D Poly			-0.065 (0.034)						
ln(Central population)				0.064[a] (0.009)	0.062[a] (0.10)				
ln(Central pop) x D Poly				-0.020 (0.022)	0.025 (0.021)				
ln(Suburban pop)				0.011[a] (0.002)	0.011[a] (0.002)				
ln(Sub pop) x D Poly				-0.076[b] (0.024)	-0.067[a] (0.017)				
ln(Land area)	0.011 (0.024)	0.055[c] (0.026)	0.010 (0.026)	0.008 (0.031)	0.006 (0.030)	0.010 (0.023)	0.021 (0.022)	0.027 (0.025)	0.029 (0.026)
ln(Population density)		0.044[a] (0.010)							
Theil concentration index						0.118[c] (0.058)		0.147[b] (0.057)	0.168[b] (0.057)
Average distance to CBD							-0.008[b] (0.003)	-0.009[b] (0.003)	-0.009[b] (0.003)
Number of centres									-0.032[b] (0.014)
ln(Fragmentation)	0.013 (0.027)	0.013 (0.027)	0.016 (0.028)	0.001 (0.021)	0.000 (0.021)	0.002 (0.013)	0.009 (0.012)	0.010 (0.011)	0.013 (0.012)
ln(Labour productivity)	0.208[b] (0.053)	0.208[a] (0.053)	0.230[a] (0.061)	0.234[b] (0.064)	0.255[a] (0.057)	0.195[a] (0.051)	0.182[b] (0.062)	0.214[a] (0.044)	0.226[b] (0.044)
ln(LProd) X D Poly					-0.299[b] (0.128)				
ln(Employment rate)	-0.106 (0.243)	-0.106 (0.243)	-0.189 (0.262)	-0.167 (0.259)	-0.144 (0.238)	-0.023 (0.256)	-0.069 (0.237)	-0.075 (0.238)	-0.096 (0.231)
ln(Youth dependency ratio)	0.377[c] (0.174)	0.377[c] (0.174)	0.367[c] (0.165)	0.386[c] (0.187)	0.396[c] (0.173)	0.373[c] (0.192)	0.332[c] (0.173)	0.329[c] (0.175)	0.332[c] (0.166)
ln(Old age depen. ratio)	0.076 (0.097)	0.076 (0.097)	0.078 (0.098)	0.141 (0.097)	0.148 (0.094)	0.038 (0.067)	0.045 (0.075)	0.043 (0.975)	0.043 (0.077)
Dummy Polycentricity			0.885 (0.494)	1.189[a] (0.233)	3.844[b] (1.268)				
Adjusted R^2	0.736	0.736	0.740	0.750	0.752	0.719	0.723	0.725	0.727

Note: 226 observations (107 in 2011, 119 in 2011). All regressions include country and year fixed-effects. Robust standard errors in parenthesis clustered by country. [a], [b] and [c] indicates significant at 1%, 5%, and 10% level respectively.
Source: Elaborations based on national data on income distribution (see Table 2.1) and OECD (2018) OECD Metropolitan Database, http://stats.oecd.org/Index.aspx?Datasetcode=CITIES.

Finally, in all regressions in Table 2.4 the variables labour productivity and youth dependency ratio keep showing a positive and significant relationship with income segregation. The only exception is the above mentioned interaction of labour productivity and the dummy for polycentric cities (Column 5).

Different spatial scales

As a robustness check, Equation (1) is estimated using the income segregation measure computed at different spatial scales. This new set of regressions departs from the baseline specification in Table 2.4 Column 9.

Table 2.5 reports results when using a segregation index computed for a spatial scale of 500 meters in Column 1, of 2 000 meters in Column 2, and of 4 000 meters in Column 3. Column 4 uses the a-spatial segregation index computed using the smallest available intracity unit (i.e. municipalities, wards, or census tracts). In all regressions, results are not significantly different from the preferred specification in Table 2.4 Column 9 and show that cities with a higher (lower) population density, degree of spatial concentration and centralisation, labour productivity, and youth dependency ratio are related to higher (lower) levels of income (decrease) income segregation.

Table 2.5. Determinants of income segregation (III): Spatial vs. A-spatial income segregation indices

Dependent variable:	ln(SE 1-km index)			
	500 m	2 km	4 km	A-Spatial
	[1]	[2]	[3]	[4]
ln(Population)	0.080[a] (0.020)	0.107[a] (0.013)	0.164[b] (0.060)	0.080[b] (0.026)
ln(Land area)	0.028 (0.028)	0.028 (0.026)	0.025 (0.023)	0.025 (0.028)
Theil concentration index	0.166[b] (0.061)	0.175[b] (0.056)	0.202[b] (0.065)	0.159[c] (0.074)
Average distance to CBD	-0.008[b] (0.003)	-0.010[a] (0.003)	-0.016[a] (0.005)	-0.008[b] (0.003)
Number of centres	-0.027[c] (0.013)	-0.044[b] (0.016)	-0.072[b] (0.026)	-0.023[c] (0.011)
ln(Fragmentation)	0.009 (0.012)	0.020 (0.015)	0.035 (0.027)	0.005 (0.011)
ln(Labour productivity)	0.248[a] (0.040)	0.197[a] (0.055)	0.152 (0.117)	0.260[a] (0.048)
ln(Employment rate)	-0.118 (0.206)	-0.021 (0.256)	-0.033 (0.279)	-0.106 (0.167)
ln(Youth dependency ratio)	0.309[c] (0.158)	0.393[c] (0.180)	0.365 (0.354)	0.289[c] (0.127)
ln(Old age depen. ratio)	0.047 (0.075)	0.039 (0.082)	-0.003 (0.098)	0.058 (0.073)
Adjusted R^2	0.702	0.752	0.765	0.671

Note: 226 observations (107 in 2011, 119 in 2011). All regressions include country and year fixed-effects. Robust standard errors in parenthesis clustered by country. [a], [b] and [c] indicates significant at 1%, 5%, and 10% level respectively.
Source: Elaborations based on national data on income distribution (see Table 2.1) and OECD (2018) OECD Metropolitan Database, http://stats.oecd.org/Index.aspx?Datasetcode=CITIES.

The poor vs. the rich

Finally, Equation (1) is estimated for different types of population according to their income level. The idea is to test whether the above studied "average" relationships remain as such across the income distribution and, in particular, for the lowest and highest income levels (the poor and the rich).

Table 2.6 reports results for the lowest income levels (the poor) and for the highest income levels (the rich) using the income segregation index computed only for the 10th and 20th percentiles (Columns 1 and 2) and for the 80th and 90th percentiles (Columns 3 and 4) respectively. This new set of results clearly shows that the level of segregation of the poor is only (positively) related to the labour productivity of the city and to the degree of spatial centralisation. On the other hand, the results for the highest income levels are quite similar to the "average" results and show that the segregation of the rich are (positively) related to the city size (population density), the degree of spatial centralisation of the city, the labour productivity and the youth dependency ratio.

Table 2.6. Determinants of income segregation (IV): Poor vs. Rich

Dependent variable:	ln(SE 1-km index)			
	Poor		Rich	
Percentiles:	10th	20th	80th	90th
	[1]	[2]	[3]	[4]
ln(Population)	0.079 (0.052)	0.063 (0.059)	0.115[b] (0.030)	0.130[b] (0.033)
ln(Land area)	-0.016 (0.024)	0.038 (0.045)	0.011 (0.033)	0.002 (0.038)
Theil concentration index	0.235[a] (0.102)	0.173 (0.157)	0.064 (0.112)	0.065 (0.130)
Average distance to CBD	-0.010 (0.006)	-0.013[a] (0.003)	-0.006[c] (0.003)	-0.008[b] (0.003)
Number of centres	-0.083 (0.064)	-0.030 (0.033)	-0.025 (0.025)	0.010 (0.018)
ln(Fragmentation)	0.043[b] (0.009)	0.010 (0.013)	-0.013 (0.015)	-0.008 (0.014)
ln(Labour productivity)	0.361[a] (0.055)	0.403[a] (0.077)	0.261[a] (0.048)	0.319[a] (0.050)
ln(Employment rate)	-0.011 (0.296)	-0.080 (0.180)	-0.040 (0.160)	0.029 (0.163)
ln(Youth dependency ratio)	-0.165 (0.155)	0.002 (0.159)	0.479[c] (0.186)	0.527[b] (0.186)
ln(Old age depen. ratio)	0.011 (0.130)	-0.010 (0.143)	0.038 (0.067)	0.157 (0.085)
Adjusted R^2	0.762	0.787	0.659	0.749

Note: 226 observations (107 in 2011, 119 in 2011). All regressions include country and year fixed-effects. Robust standard errors in parenthesis clustered by country. [a], [b] and [c] indicates significant at 1%, 5%, and 10% level respectively.
Source: Elaborations based on national data on income distribution (see Table 2.1) OECD (2018) OECD Metropolitan Database, http://stats.oecd.org/Index.aspx?Datasetcode=CITIES.

Orientations for policy analysis

Income segregation may come in many varieties. It is the result of the sorting of people in space by some socio-economic or cultural criteria. On the causes of such process there is still much research to be done and the interaction of individual decisions with factors of global, national, and local nature, is likely to play a role. Even the process of economic growth and agglomeration economies generated in cities can be related to segregation. More specifically, income growth at the top of the income distribution can lead to increases in the spatial concentration of wealth – and thus add to segregation (Reardon and Bischoff, 2011). At the same time, however, the relation between income inequality and segregation is not necessarily systematic. An increase in inequality does not necessarily translate to an increase in segregation. Vice versa, changing segregation is not necessarily followed by a change in income inequality.

The functioning of the housing market is inherently connected to the extent to which people live segregated within cities. An obvious connection is that households tend to sort into areas where the other households have a similar income (Nguyen-Hoang and Yinger, 2011). Then, given their budget constraint, households that wish to relocate may be able to consider only houses in a limited range of locations. These are in turn shaped by several factors, including the competition for space between commercial, public, and residential uses (Alonso, 1964). Such competition can result in housing close to a city's centre, where jobs and services are most accessible and, as a consequence, land is most expensive. Individuals pay higher prices to live in the location with highest accessibility, closest to the CBD. If the cost of commuting is low, however, more individuals could accept a higher distance from the centre and afford larger homes. The above core economic factors are however not sufficient to explain patterns in where the rich and the poor live within cities.

Rich households concentrate within the centre of a city when this city-centre has a higher level of cultural, natural, or consumer amenities than the city's suburbs, and vice versa (Brueckner et al., 1999). Moreover, although differences in housing prices may be very high across city neighbourhoods, reflecting a certain level of segregation, housing policies may mitigate the segregation of income groups. For example, most US cities include a mix of expensive and cheap housing near their CBD. In addition to discrimination in access to finance, the lack of public transit connecting suburbs to job centres insured that most low income housing would be concentrated in a few central locations (Glaeser, Kahn and Rappaport, 2008). Such processes have long historical shadows. Today, areas of concentrated poverty persist because, among other factors, the high spatial concentration of subsidised housing and unemployed people creates an oversupply of low skilled workers in city centres (Lens, 2014). This case is not specific to the United States, as similar mechanisms can be found in peripheral areas of European cities.

The longevity of buildings is another factor linking income segregation with housing. Most residential buildings have a life span of decades, sometimes centuries. This longevity makes it difficult to replace the housing stock to match the intensity of land use that a location could support, as it effectively fixes the supply of housing in the short run (Di Pasquale and Wheaton, 1996; Glaeser and Gyourko, 2005). Because of this, housing can become more expensive quickly if the demand for its location surges. As a consequence, additional housing units in higher buildings could be developed to drive down housing prices through increasing the housing supply. While this could ensure local affordability of housing and mitigate segregation, this is typically prevented by a city's existing built structure and the cost of redevelopment. The slow adjustment of the housing market is particularly relevant in cities with rapid population growth, where poorer households may experience increasing barriers to living close to a centre of economic activity – resulting in income segregation.

An example that illustrates the flip side of how segregation may be influenced by building longevity is Tokyo. In Tokyo, land use restrictions and the clustering of affordable housing have led to levels of segregation and housing affordability that are amongst the lowest for metropolitan housing markets of a similar size (Cox and Pavletich, 2015). Until recently, the Japanese government supplied subsidised housing in central, high accessibility locations. While the supply of new subsidised housing has slowed to a trickle, creating long waiting lists, the existing stock maintains a greater degree of income diversity even in the most sought after neighbourhoods (Tiwari and Hasegawa, 2001). In addition to the state's role in providing affordable housing, another important factor is the role of the state in regulating housing supply. One of the recurrent findings on land use regulation is that stricter regulations drive up housing prices, see Kok, Monkkonen, and Quigley (2014), and increase the level of income segregation (Lens and Monkkonen, 2016). Again, Tokyo stands out as an example of policy intervention which, although not aimed at desegregation, likely contributed to the lower levels of segregation. The Tokyo Metropolitan government used its influence to push the national government to reform its land use legislation and enable greater flexibility, particularly in high density construction (Fujita, 2011). As a result, and in conjunction with Japan's tradition of shorter lived buildings, Tokyo has only 2% of its buildings pre-dating 1960 and over 30% have been built since 2000. In comparison, in Los Angeles, one of the most expensive housing markets, about 56% of buildings predate 1960 and only about 8% were built after 2000.

The case of Tokyo illustrates the importance of political structures for segregation. If it were not for the changes in land use regulation and proactive investments in affordable housing, Tokyo could have experienced recurring housing crises. More broadly, housing is an important component of welfare systems, regardless of their orientation (Kemeny, 2001). The state influences the structure of housing markets, in particular the balance between owner-occupied and rental housing. The funding strategies of countries can lead to imbalanced housing systems where the dominance of one housing type constrains the choices of those that do not have access to it. This is the case in the Netherlands where social housing sector is sizeable (Elsinga et al., 2008) and Southern Europe where home ownership stunts the rental market (Arbaci, 2008). In Spain, lower segregation levels often hide different forms of marginalisation that operate through the housing market (Arbaci, 2008). The above examples illustrate that political environments both influence the drivers of income segregation as well as how it is conceived. This underlines that international comparative research on income segregation can be highly beneficial as it may help to expose country-specific blind spots and may highlight a range of policy solutions from across the globe.

Discussion

This chapter has provided an assessment of income segregation within cities by maximising the comparability across countries. In the twelve observed countries, within-city segregation of households with different income-levels varies considerably across cities – even within cities. This finding suggests that region-specific factors might shape income segregation. The results also suggest that in several cities households at the extremes of the income distribution, the most and least affluent households, have the largest influence on segregation outcomes. In some cities segregation is driven by poorer rather than richer households, and vice versa. It is shown that income segregation is positively associated with the average household income in cities. A certain variation was observed between the income groups of the 2nd and 8th income deciles – those adjacent to the income groups at the extremes of the income distribution.

The econometric results show that: city size matters, as bigger and denser cities are related to income higher segregation levels; economy matters, as cities with higher labour productivity levels are related to higher income segregation levels; demography matters, as higher proportions of elderly population are related to higher income segregation levels.

The econometric results also show that urban form matters. First, income segregation levels related to bigger and denser cities are smaller in polycentric cities than in monocentric ones. Second, bigger central cities are related to higher income segregation levels, both in monocentric and polycentric cities. Third, while higher suburban population are related to higher income segregation levels in monocentric cities, it is related to lower income segregation levels in polycentric cities. Moreover, while a higher labour productivity is related to higher income segregation levels in monocentric cities, the opposite relationship is found for polycentric cities. In fact, less spatially concentrated and centralised cities are positively related to a lower degree of income segregation. Finally, the econometric results show that income levels matter: Labour productivity and the degree of spatial decentralisation of the city are related to income segregation levels of the poor and the rich. Other above mentioned determinants are only related to the segregation level of the rich.

With regards to improving the methods for studying segregation, more work could be done to take advantage of the strengths of individual country databases (e.g. New Zealand's consistent temporal data). This can help to test some of the assumptions made in comparing countries that use different methods of collection and lead to better tools to mitigate the influence of these differences in data collection.

More systematic explorations into methods for extrapolating entire income distributions from available data appear necessary. Using the highest detailed data that countries make available (e.g. Australia, where nearly the entire income distribution is included) allows to evaluate some of the assumptions built into methods of extrapolation and to make decisions about whether uncertainty of the precision of income extrapolation methods is worth increases in coverage.

Notes

[1] A lack of information on income-extremes is an issue for studying the spatial distribution of affluent households, especially in countries, such as Canada and New Zealand, where some cities have a sizeable proportion of the population above the highest threshold leading to substantial missing information. The lack of detail about the lower end of the income distribution is unfortunate, especially because it concerns a group of people who might be targeted by a specific policy. In many cases, the first income category includes a wide variety of households with very low incomes, sometimes as much as 15% of the population is included in that first category. The lack of information about the lowest and highest income residents tends to distort the picture for the overall segregation levels in cities because these tend to be the most segregated populations.

[2] As a result, time-stamps of the observed income data varies across the observed countries from 2008 to 2014, with exception of Mexico (2001).

[3] Some caution is necessary in the interpretation of results for Anglo-Saxon countries. Anglo-Saxon countries tend to have higher socio-economic inequality levels and generally more liberal form of welfare state (Esping Andersen, 1990). This generalization does not hold empirically, except for Australia, Canada, New Zealand, the United Kingdom and the United States all have very similar income inequality levels, as measured by the Gini coefficient, and do not differ markedly from other European countries (OECD (2015) Income Distribution Database). Australia and New Zealand's lower levels, as well as the compact distribution of Australian cities around the mean, point to the possibility of these two countries having different structure from other Anglo-Saxon countries. This is consistent with research on ethnic segregation, which shows that cities in Oceanian countries are less segregated than the rest of the Anglo-Saxon world (Johnston, Poulsen, and Forrest, 2007).

[4] Unfortunately, in most countries the bin for 'no income' does not exist and nor does the bin that would include all income above the highest threshold and is as such not comparable across countries. Due to this lack of data the segregation of households at the lower and upper tails of the income distribution remains unobserved for most countries (Australia is an exception as it has a 'no-income' bin.

[5] This holds even when rank-order entropy, a method designed to retrieve the entire income distribution, is used.

[6] See for instance the review in: Brülhart M., et al. (2015).

[7] This approach is chosen to minimize the influence of data at the extremes and because all countries have data available at the least between the 20th and 80th percentiles, making the data more comparable. Cut-offs are chosen by calculating the distance between the chosen deciles and the percentiles that correspond to each income bin. So, for example, if there is an income bin that represents 8% of the population and the next two bring the cumulative population to 15% and 26% respectively, the first is chosen as the first decile and the second as the second decile.

[8] However, consider that due to the lack of data for these countries on the upper and lower ends of the income distribution segregation at the 'true' extremes of income-classes remains unmeasured.

[9] Unfortunately, the Mexican census did not include an income survey in the 2010 iteration. It would be informative to test whether, as income rose in Mexico, particularly in the half of the income distribution, segregation increased in the middle, pushing segregation at the lower end higher in a process of revisualization (i.e. as middle income households move to areas with higher quality amenities, poorer areas become gradually poorer). As noted, this process does not appear to have taken place in Mexico and South Africa would provide a good comparative case since the two countries are at similar income levels.

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Annex 2.A.

The appropriate spatial scale of entropy measurement

Income data are not available on a fine spatial scale for all observed countries. Therefore, the extent to which variation in the scale of income data impacts results for entropy measures at different spatial scales was assessed in order to select the appropriate spatial entropy measure (as these are calculated at varying scales from 500 m to 4 000 m): for the main analysis.

Uniquely within the study area, New Zealand provides data at the very fine level of the mesh block, a unit that is smaller than any of the other units used in other country. The census also makes available data at the area unit (AU) level, which corresponds more closely to the scale of the units used in other countries. Therefore the cities in this country lend themselves well for evaluating the appropriate spatial scale of entropy measures.

The smaller scale data inflate the segregation index in a relative sense (the segregation index value becomes three times as large), but that this inflation is modest in an absolute sense (it increases from 0.04, when income data for common-sized AU-level subareas in cities are used, to 0.125 when the more fine-scale mesh areas are used). This means that as the common-sized areas are consistently used in the analysis, possible variation in the results due to the scale of the underlying data is mitigated, as the level of those data is kept relatively constant. This gives confidence that the results in the main analysis are comparable across cities and countries, as it applies data at the common-sized level.

Moreover, the spatial entropy indexes are found to minimise the sensitivity of results to the spatial scale. Again comparing segregation indexes at the two scales in New Zealand, the 500 m scale indexes are 0.018 apart and less than 0.008 at the 1 000 m scale. This gives confidence that the results for spatial entropy indexes are minimally sensitive to the spatial scale of the underlying data. Therefore the spatial indexes are used to evaluate differences across the cities in the observed countries. Specifically, in the main analysis the 1 000 m scale based spatial entropy index is used because it seems to be the one that is least sensitive to scale. The entropy indexes at the larger scales, 2 000 and 4 000 metres provide a different kind of information. They extend beyond what most people would consider as the size of a neighbourhood. These measures are more relevant to evaluating the structure of the city rather than draw conclusions about the experience of residents in their immediate environment.

Chapter 3. Income Segregation in Brazilian Cities: The role of vertical neighbourhoods

by

Ana I. Moreno-Monroy

This chapter investigates the role of vertical neighbourhoods in explaining income segregation at the bottom and top of the income distribution for 100 urban agglomerations in Brazil in 2000 and 2010. Income segregation is measured using rank-order income segregation measures for different neighbourhood definitions and income percentiles. An econometric model of income segregation is fitted for income segregation measures at the bottom and top of the income distribution against a new measure that aims to capture the isolation of apartment dwellers to other type of dwellers. The results show that this measure is significant in explaining the segregation of those at the top of the income distribution but not of those at the bottom.

Introduction

Income segregation is the uneven distribution of households of different income levels within cities (Reardon and Bischoff, 2011). As such, segregation does not represent a problem to be solved, but rather a manifestation of urban configuration forces at work at each stage of development (Sabatini, 2006). The possible implications of the segregation of affluence (i.e. of those in the top of the income distribution) and poverty (i.e. those at the bottom) in terms of social welfare have been documented in the literature. If present, they operate through channels such as the provision of public goods and amenities (Ross and Yinger, 1999; Cutler and Glaeser, 1997), peer effects on human capital and labour market outcomes (Åslund et al., 2010) and inter-generational effects on social mobility (Chetty et al., 2014). The existing literature on what determines segregation of poverty and affluence is based on studies for a limited number of metropolitan areas, mostly in European or US cities (Musterd et al. 2015). However, existing comprehensive accounts of the segregation of affluence and poverty across the urban hierarchy of a country are so far limited to the case of the United States (Bischoff and Reardon, 2014; Watson, 2009; Coulton et al., 1996).

This chapter studies the residential segregation of household by income levels in Brazilian cities, building on previous work by García-López and Moreno-Monroy (2017). Brazil offers an important case for the study of income segregation, as it is a large, highly urbanised and highly unequal country with a great variety of cities. In 2010, 84% of its population lived in cities, while the ratio of the average income of the richest 10% to the poorest 10% was 40.6. The vertiginous process of urbanisation set off by industrialisation has led to cities where luxurious apartment towers are found side-by-side densely populated *favelas*. Deep socio-economic changes starting from the 1980s have created more complex urban configurations that go beyond the traditional core-periphery pattern (Sabatini, 2006; Villaça, 2011).

The chapter starts by quantifying the extent of income segregation across Brazilian urban agglomerations in 2000 and 2010. Segregation is measured using a rich database of over 120 000 small areas in 100 urban agglomerations that house over 60% of the urban population of Brazil. In order to compare segregation across cities and over time in a meaningful way, (spatial) rank-ordered measures of income segregation are calculated at the urban agglomeration level. These measures, besides satisfying all the relevant desirable criteria for measures of the kind, use all available information on income distribution, do not confound changes in income segregation with shifts in the income distribution, are not sensitive to a particular choice of income threshold, and can accommodate different neighbourhood definitions (Reardon and O'Sullivan, 2004; Reardon, 2011). They also allow constructing comparable measures of segregation at different points of the income distribution (Reardon and Bischoff, 2011; Chetty et al., 2014). Importantly, the methodological approach is comparable to that used by Bischoff and Reardon (2014) for 117 metropolitan areas in the United States, which allows drawing some relevant parallels between the two cases.

Next, the chapter estimates an econometric model of the determinants of income segregation, including city size, income inequality, demographic and other usual controls (Pendall and Carruthers, 2003; Watson, 2009; Reardon, 2011). Segregation at the top and bottom of the income distribution is then related to a new measure that aims to capture the isolation of apartment dwellers from other type of dwellers. Apartment buildings were seen as a symbol of status when they first appeared in Brazilian cities at the end of the 19th century, and have been since then adopted as a preferred type of housing for the middle and high-income classes (Ficher, 1994). As will be shown, there is a clear spatial correlation between "vertical neighbourhoods" and neighbourhoods where the rich - and not the poor - concentrate in cities of different sizes.

The econometric results show that the exposure of apartment dwellers to other types of dwellers, which clearly decreases as cities grow, has an independent effect on the segregation of affluence and no relationship with the segregation of poverty. This results are in line with the fact that in Brazil, low-rising informal and public housing is more common than *cortiços* (rooms rented for entire families) in high-rises and public housing in groups of tall isolated buildings (a.k.a. "projects").

The chapter is structured as follows. After this introduction, the second section outlines the theoretical predictions on segregation. The third section details the data sources and definitions and explains the method for constructing the a-spatial rank-order segregation measures. The fourth section introduces the econometric approach for measuring the determinants of income segregation. Finally, the last section concludes.

Theoretical predictions

The urban economics literature has offered some theoretical explanations for the intra-urban location of households of different levels of income. Earlier models formalise a recurrent pattern in US metropolitan areas, where the rich flee decaying down-towns (or Central Business Districts) in search for larger and cheaper housing in the less populated suburbs (Glaeser, 2008). The seminal monocentric Alonso-Mills-Muth land use model replicates this spatial pattern as long as the willingness to pay for housing more distant from the CBD decreases more slowly for the rich than for the poor. Ultimately, this means that the rich are more willing to sacrifice commuting time, as long as they can have more housing space. The distribution and type of dwellings in which the rich and the poor reside in the US is consistent with this theory. As the level of income increases, so does the preference for detached, single-family dwellings. The supply of new suburban single-unit dwellings for the rich follows its demand, while old multi-family dwellings located in central areas previously occupied by the rich are "filtered down" to those with lower capacity to pay (Brueckner and Rosenthal, 2009).

Furthermore, this standard urban economics model assumes that all intra-urban locations are homogeneous in terms of amenities, including the provision of public infrastructure. While some works for Europe have incorporated central-city amenities to explain the location of the rich near historical centres in European capitals (Brueckner, Thisse, and Zenou, 1999), the assumption of unequal distribution of public infrastructure within urban areas is not been contested since it is not much of an issue in advanced economies. Including a spatial restriction on the provision of public infrastructure to central areas in the standard model can lead to the prediction that the affluent locate in central areas, well-provided areas, whereas the poor locate in under-provided peripheral areas (Griffin and Ford, 1980). A centralised provision of public infrastructure, especially transport infrastructure, also has implications for the supply of housing, since it can lead to segmented housing markets, where formal developers build tall buildings near the CBD, and informal developers build low-rise buildings outside the CBD (Posada and Moreno-Monroy, 2017).

The assumption of constrained provision affects the assumption of job location. Although the monocentric model assumes a unique employment centre, the suburbanisation of the rich in the US context has been accompanied by job suburbanisation. However, under-provision in areas far away from the CBD also can also affect the location decisions of firms, since they also make use and depend on the provision of basic services and infrastructures. If the provision of public infrastructure and amenities is incremental from the historical CBD towards an expanded CBD, both rich households and firms de-concentrate in the proximities of the historical CBD as a result. Under this scenario, the rich would segregate in more dense, vertical neighbourhoods located near the CBD (as opposed to the rich living in single-family houses in the suburbs), while the poor would scatter in low-rise informal constructions around the periphery (Henderson, Regan, and Venables, 2016; Feler and Henderson, 2011). It is likely then that mobility for the rich is spatially constrained to within the expanded CBD area, which is the best served area in the city in terms of jobs, services and infrastructure.

In models that consider the durability of housing stock (Brueckner and Rosenthal, 2009), the prediction that the older hosing stock located near the CBD previously used by the rich filters down to the poor may have restricted validity for the bottom income groups who have tight residential mobility restrictions related to the difficulty of accessing credit for informal workers, the insecurity of tenure and poor definition of property rights that increase permanence in informal plots, on top of the general effect of stagnating real incomes, persistent inequality and stricter regulations to build (Cavalcanti and Da Mata, 2013). The sheer scale of redevelopment in CBDs in Latin American and Brazilian cities, as well as the amount of self-built, self-improved dwellings in areas around the CBD, are testimony of the constrained mobility of the rich within central areas, and the low residential mobility of those at the bottom of the income distribution (Griffin and Ford, 1980).

Measurement

Segregation at different points of the income distribution is measured by means of the rank-order index of segregation. The sources and processing of the geo-statistical information are detailed in Annex 3.B. The rank-order information theory index captures the ratio of within-unit income rank variation to overall income rank variation (Reardon and Bischoff, 2011). Annex 3.B provides more technical details on the calculation of the indices. These measures use the full distribution of income and are independent of threshold choices (Reardon and Bischoff, 2011). Rank-order indices capture the extent of residential segregation by income levels, as opposed to capturing changes in income levels (resulting from changes in income inequality) even when no residential sorting takes place as a consequence in the change in income levels (Watson, 2009). Besides the a-spatial (HA) index, the spatial versions ($\widetilde{H}$) of the index are calculated for 100 and 500 meter bandwidths (see Box 3.1 for details). Here results are shown for different points of the distribution: the 10 and 25 percentiles ($HA(0.1)$, $HA(0.25)$), representing the *segregation of poverty*, and the 75 and 90 percentiles ($HA(0.75)$, $HA(0.9)$), representing the *segregation of affluence*.

Table 3.1 shows the average value of HA, $HA(0.1)$, $HA(0.25)$, $HA(0.75)$ and $HA(0.9)$ across the 100 urban agglomerations for 2000 and 2010, as well as the values for cities in four urban population quantiles. Evidently, the level of income segregation increases with city size. The value of $HA = 0.179$ for a 100 meter buffer for the urban agglomerations in the top size quantile (with populations ranging between 845 000 and 19.5 million) in Table 3.1 may be compared the value of 0.138 found by Monkkonen and Zhang (2014) for Hong Kong in 2001 using the same methodology and bandwidth. This evidence is consistent with the fact that although the inequality level in Hong Kong is high (the Gini index in 2001 was 0.49), it is much higher in large Brazilian metropolises (the Gini index was 0.59 in 2000 in the 10 largest cities).

Box 3.1. Spatial segregation measures

The spatial rank-order segregation indices $\widetilde{H}$ rely on surface-based smooth density approximations that allow adjusting for the spatial extend of local neighbourhoods, instead of relying on ad hoc boundaries (Reardon and O'Sullivan, 2004). The R package *seg* is used to calculate these indexes (Hong, O'Sullivan, and Sadahiro, 2014). A plausible population density surface is obtained using interpolation techniques. Basically, the package converts the discrete block-level data to a population density surface (implicitly assuming that the population of the census sector is uniformly distributed inside the sector), and approximates the true distribution with a Gaussian kernel density estimator. The value of the kernel bandwidth is varied between 100 to 500 meters. A simple inverse distance function is used to calculate the weight of each point.

It is important to notice, however, that spatial measures reflect the assumptions made on interpolation, which may not best reflect the actual connectivity between places. For instance, enumeration areas are often defined based on existing natural and man-made barriers, such as roads and rivers. For Brazilian cities, the average enumeration area falls within a radius of 100 to 500 meters, so in principle a-spatial measures and spatial measures at this spatial range should be more or less equivalent. The difference is that spatial measures in a way "blur" existing delimitations between areas that may correspond to actual barriers, and in this way are likely to under-estimate the actual level of separation between two places. On the other hand, it is possible that by taking into account that neighbourhoods extent beyond administrative boundaries, spatial measures correct for a possible upward bias in a-spatial measures of segregation. As the extent each of these cases applies is unknown, results using both types of measures are presented.

Table 3.1. Mean rank-order index by population quantile, 2000 and 2010

	Index	All cities (N=100)	Q1	Q2	Q3	Q4
	HA, 2000	0.144	0.115	0.127	0.142	0.191
	HA, 2010	0.137	0.104	0.129	0.130	0.187
2000	HA (0.1)	0.080	0.070	0.075	0.078	0.097
	HA (0.25)	0.087	0.071	0.075	0.088	0.112
	HA (0.75)	0.201	0.161	0.176	0.195	0.272
	HA (0.9)	0.249	0.201	0.220	0.242	0.332
2010	HA (0.1)	0.095	0.087	0.088	0.091	0.115
	HA (0.25)	0.083	0.056	0.081	0.079	0.116
	HA (0.75)	0.189	0.146	0.174	0.176	0.258
	HA (0.9)	0.245	0.190	0.230	0.232	0.326

Source: Elaborations based IBGE (2017) Demographic Census Universe Data (Dados do Universo, Censo Demográfico), ftp://ftp.ibge.gov.br/Censos/ and IBGE (2017) Digital Network (Malhas Digitais, Setores Censitarios), https://mapas.ibge.gov.br/bases-e-referenciais/bases-cartograficas/malhas-digitais.html.

Somewhat surprisingly, the average value of HA for 2010 is smaller than the value of 0.148 reported in Bischoff and Reardon (2014) for 117 metropolitan areas in the United States using the same methodology, even though the inequality level in Brazil is much higher: the average Gini in Brazil in 2000 was 0.57, compared to 0.4 in the United States. This may be due to the fact that the poorer experience higher levels of segregation in US metropolitan areas. Indeed, Bischoff and Reardon (2014) report average values of 0.146 and 0.163 for the segregation of poverty index for 2000 and 2010 respectively, while for Brazil the values are 0.08 and 0.096. In contrast, Bischoff and Reardon (2014) report values of 0.185 and 0.2 for the segregation of affluence in 2000 and 2010, while the mean values for Brazil are 0.249 and 0.245. Note that the much higher segregation of affluence is particularly salient in the largest cities.

Table 3.1 also shows that the value of the index is relatively stable across the size distribution, with the exception of the last quantile, where it shows a significant increase. Unlike the United States, where the average level of segregation increased by 9% between 2000 and 2009, the average level of income segregation in Brazilian cities decreased between 2000 and 2010 by 5%. This result is in line with a fall in the level of income inequality in Brazil between 2000 and 2010. This trend is also verified with respect to the segregation of affluence in all quantiles except the second. However, the segregation of poverty increased by 20%.

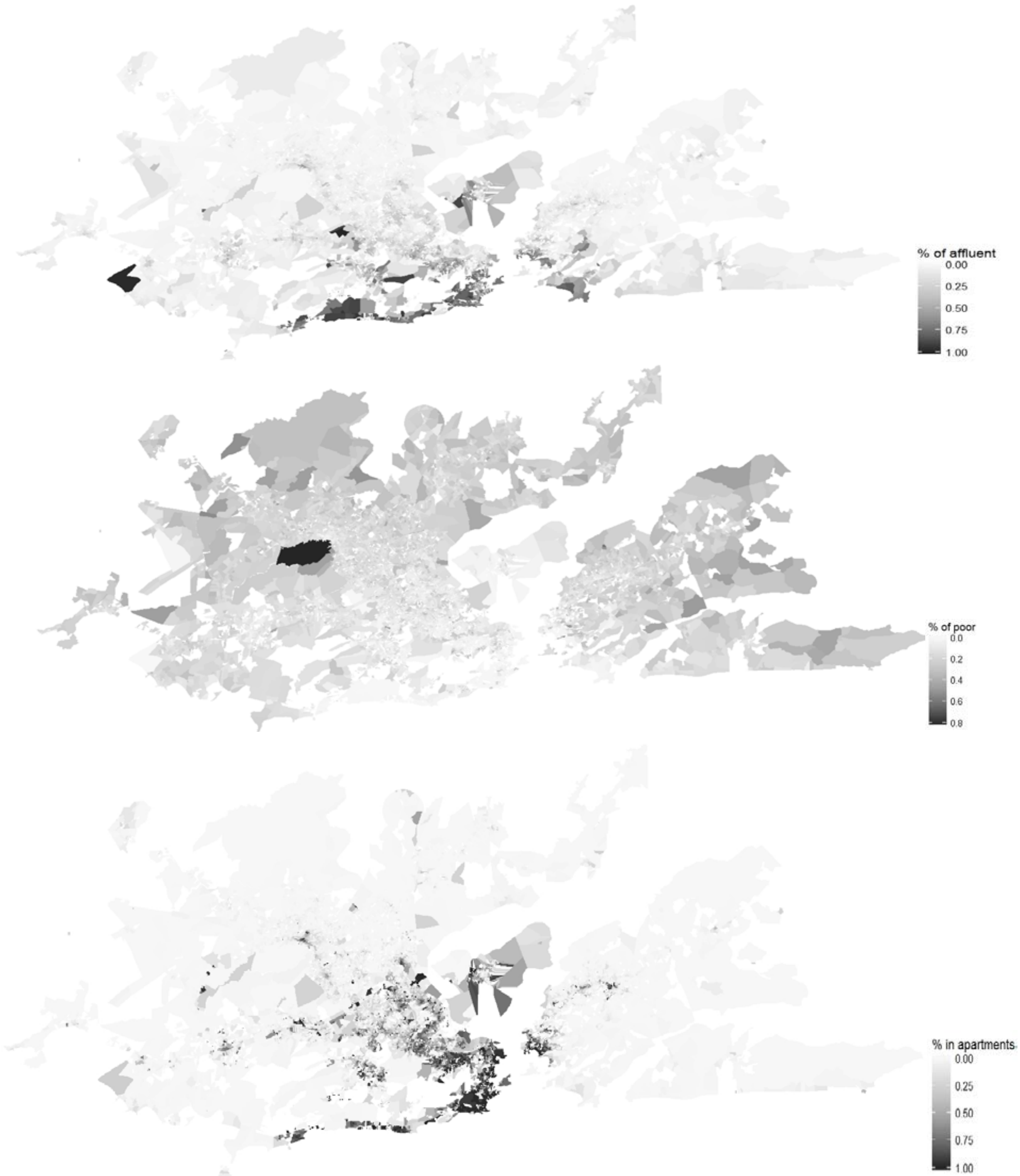
The relationship between vertical neighbourhoods and income segregation

A measure of exposure in vertical neighbourhoods

A question arising from the preliminary evidence is: what can explain the high levels of segregation of affluence? Because the rank-order information theory is an index that captures clustering in space, a high level of segregation means that the neighbourhoods where the affluent reside are the most coherent of all neighbourhoods in the city (Louf and Barthelemy, 2016). In other words, the affluent are not scattered across the city, but clustered in a small number of areas. As shown below, many of these areas can be characterised as "vertical neighbourhoods", because they contain a relatively high share of apartment buildings, as opposed to other types of housing units. The hypothesis is that an over-representation of the affluent in these vertical neighbourhoods partly explains their high levels of spatial concentration, because relatively small areas contain a high count of "stacked" affluent residents.

Unfortunately, the available data does not contain information on the place of residency of heads of household by income categories, but it does contain information on the type of building residents live in. Figure 2.1 to Figure 2.3show the percentage of high-income heads of household (i.e. those earning more than 15 minimum wages a month), the percentage of low-income heads of household (i.e. those earning one minimum wage or less a month) and the percentage of residents living in apartments for a large city (Rio de Janeiro), a medium sized city (Fortaleza) and a small city (Vitoria da Conquista).

Figure 3.1. Percentage of high income heads of household, percentage of low income heads of household and percentage of residents living in apartments, Rio de Janeiro 2000

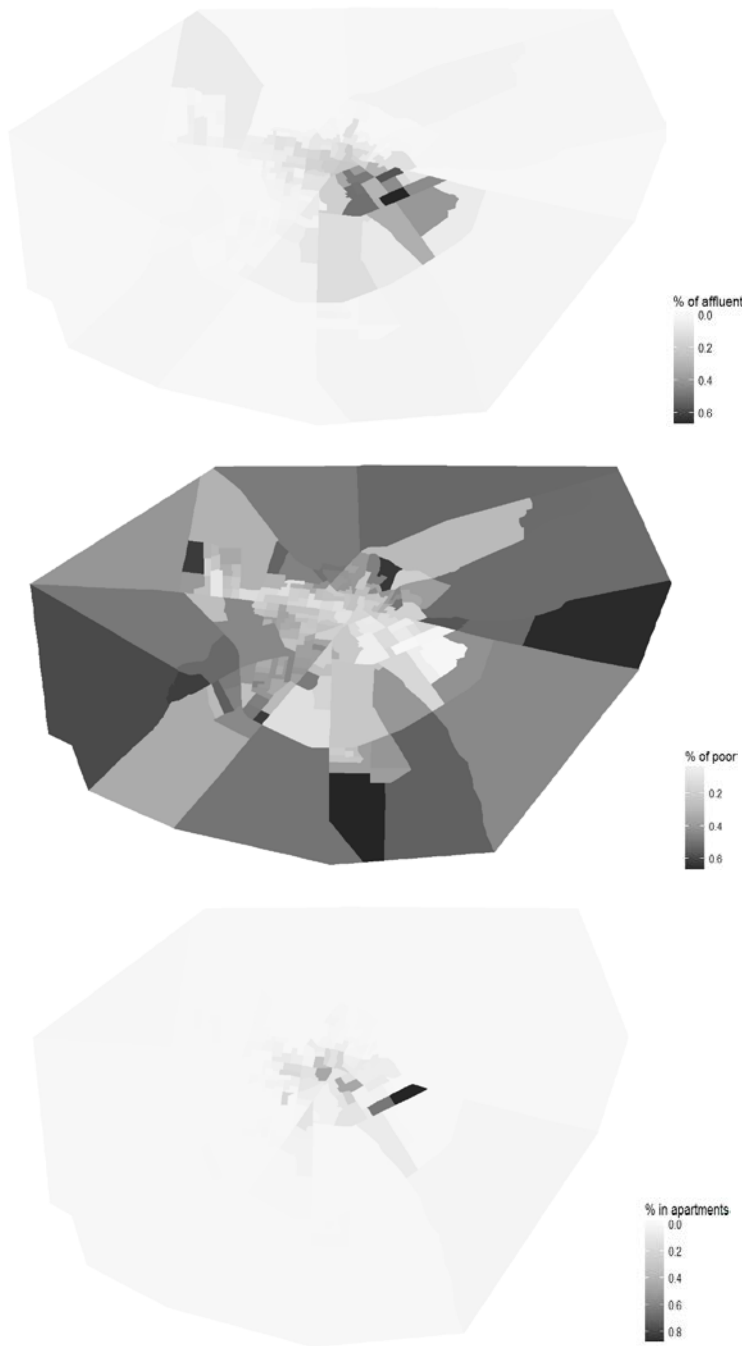


Source: Elaborations based IBGE (2017) Demographic Census Universe Data (Dados do Universo, Censo Demográfico), ftp://ftp.ibge.gov.br/Censos/ and IBGE (2017) Digital Network (Malhas Digitais, Setores Censitarios), https://mapas.ibge.gov.br/bases-e-referenciais/bases-cartograficas/malhas-digitais.html.

Figure 3.2. Percentage of high income heads of household, percentage of low income heads of household and percentage of residents living in apartments, Fortaleza 2000

Source: Elaborations based IBGE (2017) Demographic Census Universe Data (Dados do Universo, Censo Demográfico), ftp://ftp.ibge.gov.br/Censos/ and IBGE (2017) Digital Network (Malhas Digitais, Setores Censitarios), https://mapas.ibge.gov.br/bases-e-referenciais/bases-cartograficas/malhas-digitais.html.

Figure 3.3. Percentage of high income heads of household, percentage of low income heads of household and percentage of residents living in apartments, Vitoria da Conquista 2000



Source: Elaborations based IBGE (2017) Demographic Census Universe Data (Dados do Universo, Censo Demográfico), ftp://ftp.ibge.gov.br/Censos/ and IBGE (2017) Digital Network (Malhas Digitais, Setores Censitarios), https://mapas.ibge.gov.br/bases-e-referenciais/bases-cartograficas/malhas-digitais.html.

It is evident that many vertical neighbourhoods (i.e. those with a high share of residents living in apartments) coincide with neighbourhoods with a high percentage of affluent heads of household. Table 3.2 shows the 90th decile of the share of households residing in apartment buildings (i.e. the cut-off for defining a "vertical neighbourhood"), the share of high-income and the share of low heads of household residing in vertical neighbourhoods.

Table 3.2. Share of low income and high income heads of household residing in vertical neighbourhoods

Urban agglomeration	Vertical neighbourhood (%)	Percentage of high income	Percentage of low income
Rio de Janeiro	97.28	28.14	2.11
Fortaleza	53.02	45.82	2.37
Vitoria da Conquista	8.8	41.45	2.27

Note: Vertical neighbourhood (%) is the 90th percentile of the share of households in apartments.
Source: Elaborations based on IBGE Censo Demográfico 2000, "Dados do universo", ftp://ftp.ibge.gov.br/Censos/Censo_Demografico_2000/.

Vertical neighbourhoods seem to become more coherent as cities grow in size: in some areas of Rio de Janeiro, residents are virtually surrounded by apartment buildings, as 97% of more of households live in apartments. Interestingly, these areas concentrate 28% of the high-income households in Rio de Janeiro (i.e. 135 399 households), and only 2% of the low-income households (i.e. 8 445 households), meaning that vertical neighbourhoods host 16 times more high-income than low-income heads of household. Vertical neighbourhoods in smaller cities like Fortaleza and Vitoria become less coherent (i.e. apartment buildings and other types of dwellings are more mixed), but still those with a relatively high proportion of apartment dwellers contain a larger percentage of higher income heads of household.

To capture concentration in vertical neighbourhoods more formally, the following measure of exposure of residents living in apartment buildings b to residents living in other types of dwellings a is proposed:

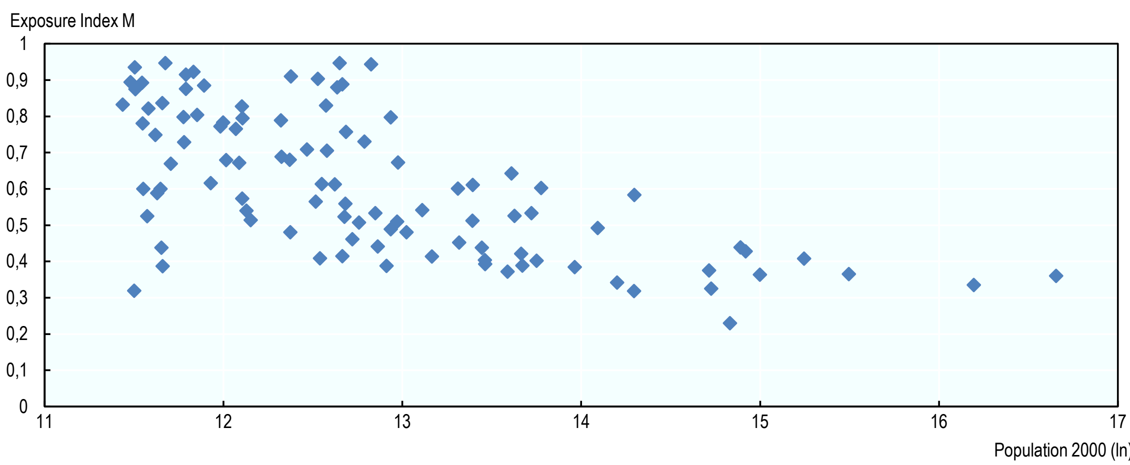
$$M^{ab} = \frac{1}{N_a}\sum^{j} t_{aj}\, r_{bj}$$

where $r_{bj} = \frac{t_{bj}/t_j}{T_b/T}$ is the representation of apartment dwellers in each local area j, equal to the share of apartment dwellers in the area over the share of apartment dwellers in the city, t_{aj} is the proportion of residents in other type of dwellings in area j and N_a is the total number of residents in other types of dwellings in the city. If $M^{ab} = 1$, the spatial co-location of building dwellers and other type of dwellers is random. If $M^{ab} > 1$, building dwellers and other types of dwellers co-locate or "attract" each other, whereas $M^{ab} < 1$ indicates the opposite, i.e., that apartment building dwellers "repel" other type of dwellers. The minimum value of the index is zero, which indicates that apartment dwellers and other types of dwellers are never present in the same area (Louf and Barthelemy 2016).

The average value of M^{ab} across the 100 urban agglomerations is 0.61, indicating that apartment dwellers and other types of dwellers tend to repel each other. Figure 2.4 plots the M^{ab} index for the 100 urban agglomerations against urban population levels in 2000. Given the preliminary evidence, the correlation between M^{ab} and the segregation of affluence is expected to be negative, indicating that cities where apartment dwellers weakly co-locate with other types of dwellers are also cities where the affluent segregate more intensively. This correlation is not expected to be significant for the segregation of poverty.

Figure 3.4. Exposure of apartment building dwellers versus population in urban agglomerations of Brazil, 2000

A zero value of the exposure of apartment dwellers index indicates no exposure to other types of dwellers.



Source: Elaborations based IBGE (2017) Demographic Census Universe Data (Dados do Universo, Censo Demográfico), ftp://ftp.ibge.gov.br/Censos/ and IBGE (2017) Digital Network (Malhas Digitais, Setores Censitarios), https://mapas.ibge.gov.br/bases-e-referenciais/bases-cartograficas/malhas-digitais.html

Evidently, the repulsion of apartment dwellers increases as cities get larger. This suggest that larger cities have more coherent neighbourhoods by type of dwelling, in the sense of having more areas where apartment buildings are the dominant type of dwelling, and where consequently apartment dwellers do not co-locate with other types of dwellers.

Econometric specification

An equation relating the level of income segregation to (lagged) levels of urban population, inequality levels and other determinants can be expressed as:

$$Seg_{i,t} = \alpha + \delta_1 UrbPop_{i,t-1} + \delta_2 Ineq_{i,t-1} + \mathbf{x}'_{\mathbf{i,t-1}}\boldsymbol{\beta} + \eta_i + \varepsilon_{i,t}$$

where $Seg_{i,t}$ is the HA a-spatial or $\widetilde{H}$ spatial rank-order information theory index for different bandwidths in city i in $t = 2010$, $UrbPop_{i,t-1}$ is the natural log of the urban population in 2000, $Ineq_{i,t-1}$ is an inequality index in 2000, **x** is a matrix of controls, η_i is a city-specific time invariant effect and $\varepsilon_{i,t}$ is an error term. $M^{ab}_{i,t-1}$, the index of concentration in vertical neighbourhoods in 2000 defined previously, is included in **x**. Following previous studies (Pendall and Carruthers, 2003; Cutler and Glaeser, 1997; Reardon and Bischoff, 2011; Monkkonen, 2012), controls are included for city size (population in logs), share of population with a university degree, share of employment in tertiary industry, percentage of renters, percentage of residents living in areas classified as slums, and number of homicides per 100 000 inhabitants. The percentage of migrants living in the city for 1-5 years, the percentage of the population under 25 and the percentage of the population over 55 are also included as demographic controls.

The proposed regression is informative about the correlation between the exposure of apartment dwellers and the levels of segregation at different points of the income distribution, controlling for other relevant factors such as urban size and inequality. The aim of the regressions is to confirm whether the exposure of apartment dwellers has an independent relationship with segregation (of poverty or affluence), or if its effect dissipates once other controls are included.

Further interpretation of the estimated coefficients is limited because the regression suffers from possible omitted variable and reversed causality biases. The effect of the latter may be somewhat mitigated by the use of lagged controls, but given the high persistence of segregation, it is likely that this bias, if present, persists. In the case of omitted variables, note that the error term will pick up any time-variant and time-invariant omitted variables. A natural omitted variable candidate is the lag of the segregation index, which has been included in previous specifications as a regressor (Monkkonen, 2012). However, including this lag is problematic because given the strong persistence of segregation, as past values of segregation are likely to be correlated with η and other unobserved covariates, affecting the consistence of the estimated parameters.

Results

Table 3.3 shows the results for the cross-section estimation for average income segregation, the segregation of poverty and the segregation of affluence. Annex Table 3.C.1 and Annex Table 3.C.2 in Annex 2.C show the results for the same specification using the spatial index for other neighbourhood definitions

The negative relationship between the measure of isolation of apartment dwellers and income segregation is significant for the segregation of affluence, and not for the segregation of poverty. Interestingly, this relationship holds once controls for city size and the homicide rates are introduced, suggesting that vertical neighbourhoods may have an independent effect on segregation.

As expected, the relationship between urban size and income segregation is in principle confirmed for all types of segregation: larger urban sizes are associated with higher levels of income segregation, and higher levels of segregation of poverty and segregation of affluence (Cutler and Glaeser, 1997; Reardon and Bischoff, 2011; Telles, 1995). The point estimate of urban size is higher for the segregation of affluence, a result that holds regardless of the neighbourhood definition (see Annex Table 3.C.1 and Annex Table 3.C.2 in Annex 2.C).

Regarding the relationship between income inequality and income segregation, in line with previous studies (Reardon and Bischoff, 2011; Telles, 1995), there seems to be a positive and significant relationship between inequality levels and average income segregation levels, and the segregation of affluence. However, this result is not confirmed for the segregation of poverty as measured by the HA index for the 10 percentile, regardless of the neighbourhood definition used. These results hold when an alternative measure of inequality (the Gini coefficient) is used.

Table 3.3. OLS regression results for equation in levels

	(1)	(2)	(3)	(4)	(5)
	HA 2010	HA (0.1)	HA (0.25)	HA (0.75)	HA (0.9)
Urban population (ln)	0.0147***	0.00993***	0.00982***	0.0217***	0.0295***
	(0.00248)	(0.00288)	(0.00340)	(0.00351)	(0.00456)
Theil inequality index	0.123***	-0.0175	0.154***	0.152**	0.216***
	(0.0379)	(0.0731)	(0.0514)	(0.0636)	(0.0774)
M_{ab}	-0.0385*	-0.0208	-0.0218	-0.0592*	-0.0886**
	(0.0227)	(0.0166)	(0.0180)	(0.0339)	(0.0380)
Percentage in slums	0.142***	-0.0277	0.143*	0.170**	0.219**
	(0.0468)	(0.0519)	(0.0799)	(0.0665)	(0.0884)
Percentage of renters	0.111*	0.0838	0.0624	0.222**	0.301***
	(0.0627)	(0.104)	(0.0865)	(0.0931)	(0.0906)
Percentage in tertiary employment	0.121***	0.156***	0.0375	0.190***	0.0856
	(0.0321)	(0.0530)	(0.0563)	(0.0573)	(0.0666)
Percentage with a university degree	0.00177	-0.00526**	0.000761	0.00131	-0.00276
	(0.00208)	(0.00240)	(0.00279)	(0.00339)	(0.00399)
Percentage of population under 25	-0.0123	0.532*	-0.170	0.0200	-0.297
	(0.122)	(0.277)	(0.181)	(0.216)	(0.248)
Percentage of population over 55	-0.387	0.514	-0.441	-0.504	-1.083***
	(0.237)	(0.416)	(0.288)	(0.381)	(0.406)
Percentage of homicides	8.51e-05**	1.64e-05	5.39e-05	0.000127**	0.000189***
	(4.24e-05)	(4.61e-05)	(6.42e-05)	(5.76e-05)	(6.33e-05)
Observations	100	100	100	100	100
R-squared	0.790	0.487	0.592	0.761	0.774

Note: Robust standard errors in parentheses. Constant term included but not reported.
*** p<0.01, ** p<0.05, * p<0.1.
Source: Elaborations based IBGE (2017) Demographic Census Universe Data (Dados do Universo, Censo Demográfico), ftp://ftp.ibge.gov.br/Censos/ and IBGE (2017) Digital Network (Malhas Digitais, Setores Censitarios), https://mapas.ibge.gov.br/bases-e-referenciais/bases-cartograficas/malhas-digitais.html.

The results in Table 2.3 indicate a positive and significant relationship between the percentage of residents in slum areas and homicide rates and the segregation of affluence. Interestingly, these partial correlations are not significant for the segregation of poverty. However, unlike the results discussed previously, this result is sensitive to the definition of neighbourhood: the point estimate becomes statistically not significant when using the spatial indices (see Annex Table 3.C.1 and Annex Table 3.C.2 in Annex 3.C). A similar result is obtained for the share of tertiary employment, which turns statistically insignificant once the definition of neighbourhood is changed. In any case, as evidenced by the R-square coefficients, the specified model is rather powerful in explaining average segregation levels and the segregation of affluence, but fails to capture more than half of the variation in the segregation of poverty across cities (and actually less when using spatial indices).

Discussion and Conclusions

The study of income segregation for 100 urban agglomerations in Brazil in 2000 and 2010 using the rank-order (spatial) information theory index has revealed interesting patterns. Income segregation increases with city size, especially after a certain size threshold. The econometric analysis shows that a measure of the co-location of apartment dwellers to other types of dwellers is indeed negatively correlated with the segregation of affluence. Neighbourhoods that go through a process of "verticalisation" disproportionally attract the rich, and not the poor. The causes or behavioural consequences of the concentration of groups of households of similar high levels of income in vertical dwellings are relevant topics for further research. A clear result emerging from the analysis is the positive relationship between segregation and income levels. The affluent experience the highest levels of segregation, regardless of the size of the urban area.

The results of this chapter make sense in the context of the measurement of the measure of segregation chosen, and the observed distribution of those at the bottom part of the income distribution. The rank-order information theory index is a measure of spatial clustering by income category, and as such, captures the observed spatial concentration of the rich in a handful of neighbourhoods, as well as the fact that the poorest are scattered in many different areas across the city. Thus, average levels of income segregation are not necessarily informative about the degree of residential segregation experienced by those at the bottom part of the income distribution.

The dispersed distribution of the poorest in cities of different sizes is consistent with the process of informal land occupation through scattered settlements, as well as with the low percentage of households in the bottom part of the income distribution that benefit from social housing, and the existence of height limitations in social housing in Brazil. These differences may be behind the puzzling lower levels of segregation of poverty in Brazil vis-à-vis the levels reported for metropolitan areas in the United States.

The results in this chapter highlight the fact that specific policy interventions against the segregation of the poor, such as punctual slum upgrading programmes, may have little impact on city-wide levels of income segregation. In this sense, income segregation levels as such should not be seen as a policy objective on its own right, but as an indicator of deeper spatial processes at work. The results also call for a conscientious analysis of policy interventions aiming at concentrating those at the bottom part of the income distribution in large vertical neighbourhoods, as they can become a source of increasing segregation of poverty.

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Annex 3.A.

Data and geoprocessing

The urban agglomeration-level measures of segregation use information on the income distribution information at the census sector (*setor censitario*) level from the 2000 and 2010 Population Census micro-data, freely distributed by the Brazilian Institute of Geography and Statistics (IBGE). The census sector unit is equivalent to enumeration areas defined for surveying purposes. Each unit contains on average 400 households. The individual unit of analysis is the head of household (i.e. a person responsible for the household who is older than 10 years old) categorised as belonging to one of nine ordered income categories. Income is defined as the level of nominal monthly income from work or other sources measured in minimum wages (m.w.).

Most urban agglomerations extent beyond the boundaries of a single municipality, and may include peri-urban areas and small towns that fall under the influence of a nearby urban centre. Besides the definition of 68 metropolitan regions, there is no official consistent definition of city boundaries from the Census. The grouping of municipalities by Da Mata et al. (2007) is used to define 123 urban agglomerations in 2000 and 2010. Urban agglomerations include metropolitan regions, non-metropolitan urban agglomerations (resulting from conurbation), and sub-regional urban centres. IBGE freely distributes the digital networks containing the boundaries of the enumeration areas for 2000 and 2010. The geoprocessing was done in the R statistical environment using the *maptools*, *sp*, *rgdal*, *rgeos* and *cleangeo* packages. After excluding census sectors classified as rural, there are 104 885 urban census sectors in 2000 hosting 88 302 526 inhabitants and 158 897 urban census sectors hosting 105 188 834 inhabitants in 2010. Restricting the urban population to 90 000 inhabitants in 2000 leads to a final sample of 100 urban agglomerations.

Annex 3.B.

Formal definition of the rank-order information theory index of segregation

Let p denote percentile ranks in a given income distribution. The pair-wise information theory index H is defined as:

$$H(p) = 1 - \sum^{j} \frac{t_j E_j(p)}{TE(p)}$$

where t_j is the population in the local environment j, T is the total population in the urban area, and E is the entropy of the total population given by $E(p) = plog_2 \frac{1}{p} + (1 - p)log_2 \frac{1}{(1-p)}$. The rank-order information theory index is defined as:

$$H = 2\ln 2 \int_0^1 E\,(p) H(p) dp$$

Following Reardon (2011) and Reardon and Bischoff (2011), the function $\widetilde{H}\,(p)$ is estimated in the following way. First, the pair-wise spatial index $\widetilde{H_k}$ is calculated for those above and below each $k - 1$ income threshold for each census sector. Then WLS regression of the $k - 1$ values of the segregation measures against the cumulative proportions of the population with incomes equal to or below k, p_k, and the necessary terms to find the best fitting polynomial is fitted. Finally, the vector of estimated coefficients is multiplied by a vector of scalars for the second-degree polynomial case, as detailed in Reardon (2011). Once the income profile for each urban agglomeration has been obtained - that is, the curve describing the relationship between H and the percentage of individuals in each income category- it is possible to define a measure of segregation as experienced by a given income percentile (Reardon and Bischoff, 2011).

Annex 3.C.

Annex Table 3.C.1. : OLS regression results for 100 meter bandwidth spatial rank-order index

	(1)	(2)	(3)	(4)	(5)
Urban population (ln)	0.0149***	0.00717*	0.0114*	0.0204***	0.0262***
	(0.00347)	(0.00367)	(0.00582)	(0.00473)	(0.00732)
Theil inequality index	0.126*	0.0477	0.121	0.188**	0.293**
	(0.0663)	(0.0959)	(0.0957)	(0.0916)	(0.133)
M_{ab}	-0.0520	-0.0525**	-0.0280	-0.0823*	-0.134**
	(0.0338)	(0.0230)	(0.0410)	(0.0429)	(0.0578)
Percentage in slums	0.216**	-0.0366	0.317	0.247**	0.298*
	(0.0846)	(0.0704)	(0.232)	(0.102)	(0.175)
Percentage of renters	0.273**	0.102	0.385	0.272**	0.415***
	(0.121)	(0.133)	(0.320)	(0.117)	(0.156)
Percentage in tertiary employment	0.0996	0.112	-0.121	0.224***	0.115
	(0.0778)	(0.0741)	(0.210)	(0.0810)	(0.114)
Percentage with a university degree	0.000357	-0.00444	0.00301	-0.00173	-0.0102*
	(0.00349)	(0.00298)	(0.00715)	(0.00442)	(0.00578)
Percentage of population under 25	-0.114	0.141	0.323	-0.457	-0.942**
	(0.261)	(0.350)	(0.573)	(0.298)	(0.423)
Percentage of population over 55	-0.704*	0.0490	-0.440	-1.067**	-2.266***
	(0.416)	(0.455)	(0.749)	(0.482)	(0.664)
Percentage of homicides	0.000230**	2.88e-05	0.000343	0.000197**	0.000371***
	(9.15e-05)	(7.26e-05)	(0.000258)	(9.14e-05)	(0.000107)
Observations	100	100	100	100	100
R-squared	0.589	0.263	0.288	0.660	0.573

Note: Robust standard errors in parentheses. Constant term included but not reported.
*** p<0.01, * p<0.05, * p<0.1.
Source: Elaborations based IBGE (2017) Demographic Census Universe Data (Dados do Universo, Censo Demográfico), ftp://ftp.ibge.gov.br/Censos/ and IBGE (2017) Digital Network (Malhas Digitais, Setores Censitarios), https://mapas.ibge.gov.br/bases-e-referenciais/bases-cartograficas/malhas-digitais.html.

Annex Table 3.C.2. OLS regression results for 500 meter bandwidth spatial rank-order index

	(1)	(2)	(3)	(4)	(5)
Urban population (ln)	0.0100***	0.00492*	0.00634**	0.0162***	0.0244***
	(0.00236)	(0.00274)	(0.00298)	(0.00317)	(0.00460)
Theil inequality index	0.0637	0.0592	0.0668	0.0932	0.166**
	(0.0399)	u(0.0400)	(0.0513)	(0.0569)	(0.0718)
M_{ab}	-0.0430*	-0.0175	-0.0325*	-0.0585*	-0.0889**
	(0.0218)	(0.0163)	(0.0168)	(0.0320)	(0.0397)
Percentage in slums	0.0551	-0.0258	0.0451	0.0776	0.118
	(0.0449)	(0.0441)	(0.0462)	(0.0674)	(0.0996)
Percentage of renters	0.0752	-0.0659	0.0480	0.137	0.195**
	(0.0613)	(0.0558)	(0.0636)	(0.0864)	(0.0943)
Percentage in tertiary employment	0.106***	0.0518	0.0689*	0.151***	0.0844
	(0.0344)	(0.0400)	(0.0406)	(0.0522)	(0.0650)
Percentage with a university degree	0.00259	-0.00249	-0.00110	0.00409	0.000107
	(0.00215)	(0.00232)	(0.00276)	(0.00333)	(0.00409)
Percentage of population under 25	0.0158	0.222	0.00656	-0.0442	-0.333
	(0.130)	(0.134)	(0.162)	(0.196)	(0.226)
Percentage of population over 55	-0.201	0.229	0.0281	-0.469	-1.031***
	(0.244)	(0.250)	(0.283)	(0.347)	(0.383)
Percentage of homicides	1.75e-05	-6.09e-08	-4.03e-05	7.21e-05	0.000124**
	(4.12e-05)	(3.70e-05)	(4.23e-05)	(5.53e-05)	(6.20e-05)
Observations	100	100	100	100	100
R-squared	0.694	0.384	0.421	0.702	0.707

Note: Robust standard errors in parentheses. Constant term included but not reported.
*** p<0.01, ** p<0.05, * p<0.1.
Source: Elaborations based IBGE (2017) Demographic Census Universe Data (Dados do Universo, Censo Demográfico), ftp://ftp.ibge.gov.br/Censos/ and IBGE (2017) Digital Network (Malhas Digitais, Setores Censitarios), https://mapas.ibge.gov.br/bases-e-referenciais/bases-cartograficas/malhas-digitais.html.

Chapter 4. Spatial segregation of migrants in EU cities

by

Fabrizio Natale, Marco Scipioni and Alfredo Alessandrini

This chapter provides a broad comparison of residential distribution and segregation of immigrants in Europe, covering around 45 000 local administrative units in 8 EU member states (France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain, and the United Kingdom). The analysis is based on a map of immigrant population with an unprecedented spatial resolution (i.e. cells) of 100 m by 100 m. Having discussed the importance of the local dimension for migrants' integration, the chapter then describes the method developed to create maps and presents empirical results on, respectively, the concentration, diversity and segregation indexes across cities of destination and countries of origin. The penultimate section presents the results on possible drivers of the observed segregation indexes. The last section concludes summing up the main results and outlining possible future avenues of research.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Introduction

This chapter compares the residential distribution and segregation of immigrants in Europe in 2011, covering around 45 000 Local Administrative Units (LAU)[1] in 8 EU member states (France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain and the United Kingdom). The analysis is based on a map of immigrant population (defined by either country of birth or nationality) with an unprecedented spatial resolution (i.e. cells) of 100 m by 100 m. This is a significant contribution to an academic literature on segregation which so far has relied mainly on case studies or limited comparisons, with a few exceptions (Musterd 2005b; Glikman and Semyonov 2012).

Common knowledge suggests that the great majority of migrants tend to gravitate around large cities (Diaz Ramirez et al. 2018; Hardman 2008; Sanderson et al. 2015; OECD, 2018). However, this chapter nuances this assumption by better specifying the relationship between the size of the city and the concentration of migrants. The attraction of large cities becomes less evident in the case of Portugal, Spain and Italy. This might be motivated by low skilled migration working in the agriculture sectors (Okólski, 2012), and retirement migration (Betts, 2011, 133–52; Bade and Eijl, 2011).

This chapter defines diversity based on two criteria: the number of countries of origin present in a defined territory; and how evenly the different migrants and native communities are distributed in the resident population. While there has long been interest in minorities' distribution and concentration in cities – the most recent example being the burgeoning field of research that revolves around the notion of superdiversity (Vertovec, 2007; Meissner and Vertovec, 2015) – this chapter finds that ethnic diversity is not only an attribute of large cities like Rotterdam and Berlin, but also of less-known medium and small size towns.

Furthermore, borrowing from the academic literature, in this chapter segregation is unpacked in two dimensions: clustering and isolation. The analysis on the combination of information on segregation of LAUs and countries of origin reveals that the level of clustering increases with the size of the population. Clustering is higher in general for migrants from non-EU countries, for migrants from South America and South-East Asia and for specific countries of origin which have a recent history of conflicts.

The results from the descriptive analyses are confirmed by regression models on the determinants of segregation. These models show that migrants coming from distant countries are more likely to be segregated with respect to migrants from neighbouring countries and that the diversity of the city has a positive relationship with segregation. The model also confirms a higher likelihood for segregation for groups of migrants with a high share of refugees.

Overall, our analysis tentatively corroborates empirically the observation that disadvantaged migrants tend to cluster at arrival and that their segregation often prevents them from an outwards (spatial) and upwards (socioeconomic) mobility. However, to provide a firmer claim in this regard, we would need longitudinal data which is currently missing.

There are two main limitations in the analysis. First, the data assembled are only relative to the 2011 Census and therefore do not allow to explore the evolution of segregation over time. Second, in order to provide an exhaustive picture of the complex phenomenon of residential segregation and its drivers, demographic data should be coupled with socioeconomic data, at the same level of analysis, something which is currently lacking due to data limitations.

The reminder of the chapter is structured as follows. The next section discusses the importance of the local dimension of integration from a conceptual point of view, and further elaborates on different segregation dynamics and models of integration. The third section discusses how data used in the empirical analysis was assembled and processed, and discusses methodological choices regarding the measurement of spatial segregation. The fourth section presents the results for concentration of migrants across cities, ethnic diversity in cities, segregation across cities and origins, and possible drivers of segregation. Finally, the last section concludes.

Literature review

The importance of the local dimension of integration

According to the data of the United Nations Population Division (United Nations, 2017), in 2017 in the world there were around 3.4% of migrants considering the foreign born criterion. The ratio of immigrants against the total population in EU Member States was between 1.66% in Poland and 45.19% in Luxembourg, and between 0.54% in the Slovak Republic and 13.82% in Latvia when considering only immigrants from non-EU countries.

These aggregated figures at the national level cloak the high diversity in the distribution of migrants across cities and regions within countries. It is a long acquisition of the literature that migrants tend to concentrate in cities (Sanderson et al., 2015; International Organization for Migration, 2015; Wright, Ellis, and Reibel 2008; OECD 2016a). In this light, it becomes essential to gather information on the geographical distribution of migrants at the local level, particularly when assessing both the impact of migration on the receiving societies and the outcomes of migrants' integration into the social fabric.

This study answers to the need of better understanding local integration dynamics and challenges by providing an accurate picture of immigrants' distribution across European cities and towns, the diversity in these geographical entities, and whether immigrants are residentially segregated therein. The literature on diversity has been extremely prolific in recent decades. For the purpose of this analysis, the focus will be on the variety of countries of origin in a given city or town and how evenly they are concentrated. While segregation has been defined in different ways and applied to different contexts (Iceland, 2014), here segregation is described as based on two dimensions, namely clustering and isolation. The former dimension captures how the ethnic groups are concentrated or evenly distributed in space. The latter dimension of isolation/exposure considers the spatial composition of the surrounding regions of each group. As a note of caution, the concept of segregation lends itself to widely different – and at times unpredictable – political uses. Further, the wide variety of methods used to measure it, as well as conceptual differences, may results in different results with diverging policy implications (Peach, 2009).

The literature on the subject has suggested that residential location has a strong influence on migrants' integration opportunities (e.g. Musterd, 2005; Friedrichs, Galster and Musterd, 2003). The expectation emerging from the literature is to observe a "strong relationship between social process and spatial pattern", where "highly segregated groups are unassimilated while assimilation is correlated with a high degree of residential diffusion" (Peach, 1999).

In general terms, residential segregation is negatively regarded in the literature as it is deemed to reduce the likelihood of interactions with the receiving society, which in turn may hinder the opportunities of vertical social mobility and may influence the outcomes in schooling, employment and income. Studies in the US have come to the conclusion that “high-poverty neighbourhoods are potentially stimulating negative outcomes”, as the lack of exposure to positive roles models[2] negatively affects children and absence of opportunities in “such neighbourhood exacerbates the problems of having low income” (Musterd, 2005, 342). More recent studies on residential segregation list impacts as diverse as “health and deprivation effects, employment prospects”, levels of “tolerance and intolerance” and “crime and violence”, as well as the “political and civic life of minority groups” (Kaplan and Douzet, 2011). Cutler and Glaeser showed that, in segregated cities, African-Americans have considerably worse outcomes in education, employment, and higher rates of single parenthood (Cutler and Glaeser, 1997).

Comparative studies of urban segregation in Europe are few, and tend to highlight the methodological difficulties in simultaneously account for “the varying impact of the welfare state, via the specific historical paths that have been followed in different cities, to differences in the cultural realm” (Musterd, 2005, 345). In a pioneering study comparing residential segregation in the UK and the US, Peach (1999) tracked different integration trajectories for different minorities in London and New York, with London's Afro-Caribbean population[3] and New York’s Latino communities advancing towards assimilation into the mainstream (“melting pot”[4]), while South Asian population in London converging towards a “structural pluralistic model”[5], and African-Americans in New York remaining segregated. Differently put, the comparison of residential patterns in these two cities coupled with a socioeconomic survey of these communities show that ethnic segregation[6] is not necessarily associated with income segregation. In any case, the very fact that Censuses started to track in a more accurate manner minorities – such as the UK census in 1991 (Glazer, 1999) – reveals how salient their integration had become in the eyes of policy-makers. More broadly, studies on segregation have now moved far beyond an exclusive residential focus, to include several other aspects such as workplace segregation, or the role played by social media (van Ham and Tammaru, 2016). Indeed, scholars have become increasingly interested in understanding whether residential segregation dynamics are replicated in other social spaces, which in turn may exacerbate or moderate the potentially negative effects of residential segregation (see the case of ethnic enclaves in Zhou, 2006).

The policy response to debates on segregation has recently focused on dispersal policies, particularly in the case of asylum seekers and refugees. Countries as diverse as Germany, Italy, Sweden, and the United Kingdom activated such policies at some point in the past to deal with what were perceived as large arrivals of asylum seekers (Boswell, 2003; Stewart, 2012; Bloch and Schuster, 2005; Bolt, Phillips, and Van Kempen, 2010). Public administrations have enacted such policies based on an assumption of a negative impact of an excessive concentration of migrants both in time and space on cities’ capabilities to cope with varying patterns of immigrant settlement (be it temporary or permanent). As a corollary, dispersal policies are regarded as offering better chances of effective migrant integration. In parallel, countries have highlighted that dispersal policies are also a form of solidarity among local administrative units in their efforts of receiving asylum seekers and immigrants.

Box 4.1. Social and political consequences of immigration at the local level

Insights from the academic literature

In sociology, the relationships between natives and migrant communities have been frequently framed under either "intergroup contact" or "group threat theory". Intergroup contact theory expects opposition to migration to wane as diversity increases. This is because "interpersonal interactions with [migrant communities] will decrease prejudice, as positive experiences with [immigrants] reduce both stereotypical thinking and anxiety about an out-group and enhances empathy towards its members" (Eger and Bohman, 2016, 879). Group threat theory posits that opposition between natives and immigrant communities is a result of a perceived or real threat "due to intergroup competition for scarce resources, such as jobs, welfare benefits, or political power" (Eger and Bohman, 2016, 878). Eger and Bohman run a simple correlation between migrant stocks (OECD data) and hostility towards migrants (measured through a set of questions in the European Social Survey), and find only very weak relationships ($R2=0.03$) between the two variables (Eger and Bohman, 2016). However, the level of aggregation might be an important factor here. In other words, it is possible that the relationship between migrant stocks and anti-immigrant attitudes is diluted to a considerable extent at country level. This is why it becomes essential to analyse this relationship a lower aggregation level. Weber (2015) approaches the problem of level of analysis from a different angle. He posits that group threat theory might work at the national level where subjective perceptions of volumes of migration may be at work, whereas at regional and local level contact theory should hold as this is the space where exchange between groups actually occur. In other words, according to the level of analysis, different result might emerge.

The assumption of much of the literature investigating the relationship of migrant communities and natives is that either the pace of settlement or the sheer size of these communities matter. A too rapid rate of immigration, or a too concentrated local presence might trigger a perception of migrants as a threat to the societal security and capacity. Pottie-Sherman and Wilkes (2017) reviewed the literature on the association between group sizes and attitudes towards immigration (55 studies) and noticed a lack of consensus on the magnitude and direction of this relationship. The authors boil down the likely reasons of such disagreement to three factors: 1) measurement issues (who is an immigrant? what is opposition?); 2) methodological differences in measuring the relationship; 3) geographical level upon which the relationship is measured.

Source: Pottie-Sherman, Y. and R. Wilkes (2017), "Does size really matter? On the relationship between immigrant group size and anti-immigrant prejudice", *International Migration Review*, 51 (1), pp. 218–50, https://doi.org/10.1111/imre.12191.

Dynamics of segregation and models of integration

The most often cited integration models, in the specialist literature and public debate alike, are the assimilations and multicultural (or pluralist) ones. The concept of spatial residential segregation has a correspondence in both, in that the assimilation (or melting-pot) is spatially translated into a process of gradual dispersion towards a more uniform distribution of the population and in a lower level of clustering (Peach, 1999), whereas multiculturalism could translate migrant communities that maintain patterns, often paired by visible and distinct sociocultural traits. In this latter hypothesis, the urban landscape would appear as a mosaic of closed communities. These insights are interesting for us as they provide a way of understanding settlement beyond the simple description of residential distribution.

Conventional narratives, confirmed by empirical evidence, hold that the process of integration can be regarded as a series of subsequent stages. After being admitted in a country, migrants tend to choose to (or are forced into) settle in areas where pre-existing contacts can reduce the costs and limit the challenges of moving into a new country. The key element is that the location choice for migrants is not random but affected even more than in the case of the domestic population by network effects, housing conditions and a starting position of disadvantage. This initial clustering of the migrants in first areas of arrival resonates with multiculturalist policies of recognition of minority groups' rights to difference (Iceland, 2014).

The expectation of assimilationist models is that as immigrants move up on the socioeconomic ladder, they also gradually detach from their "ethnic enclaves" and settle throughout the city – what Iceland called spatial assimilation (2014). These "up-ward and out-ward trajectories" (Zelinsky and Lee, 1998) result in an assimilation process that is both socio-economic and spatial. Theories of assimilation and their spatial counterparts often refer to the case of immigrants in the US before 1965, but similar outcomes have been registered also more recently for Canada (Fong and Hou, 2009). The academic literature tends to attribute the immigrants' relatively even distribution across cities to their socio-cultural proximity to the destination country and the vertical social mobility (Zelinsky and Lee, 1998). The important element to retain here is that proximity might be an important factor in determining segregation. The empirical analysis of this chapter proxies this with distance of each migrant community to the country of origin.

Nevertheless, past migratory trends have shown that this trajectory "is neither inevitable nor unidirectional" for immigrant communities (Peach, 1996). Immigrants might remain clustered into ethnic enclaves or neighbourhoods. In an ideal application of the multicultural model, this residential scenario involves ethnic minorities' full participation in the economic and social life of the country, while keeping their own culture, language, and values. Empirical studies, though, highlighted a possible negative side of multiculturalism, named pillarisation. Pillarisation is the outcome of multicultural policies, when immigrant groups result instead isolated from the host society and spatially segregated. When this assimilationist dispersal across the urban landscape or "multicultural" interaction between ethnic enclaves and the surrounding urban territory do not happen, segregation becomes especially problematic, as it might signal persistent integration difficulties and inequalities across generations (Iceland, 2014).

Arbaci and Malheiros (2010) challenged the assumption that dispersal across cities and peripheries is associated with upward mobility by focusing on immigrant experiences in Southern Europe, where de-segregation processes were accompanied by marginalisation (2010). Recent contributions regard the idea of spatial assimilation as outdated and incapable to fully grasp the increasing complexities of immigrant integration in European cities (Crul, 2016). Others question even more explicitly the links between immigrant integration and spatial assimilation (Bolt, Özüekren and Phillips, 2009).

These diversified integration trajectories suggest that integration models and their spatial counterparts may follow very different dynamics, depending on a variety of factors. With a specific focus on segregation, the academic literature singles out several determinants of segregation. The characteristics of the receiving society or city may be important, as well as the socio-cultural distance between the migrant community and the receiving society (mentioned above). Socio-economic characteristics of immigrants are also relevant in determining segregation (Iceland and Wilkes, 2006), but to a limited extent, according to Peach (1999). In his analysis of segregation in Germany, Sager observed that "differences in income, education, language skills and village/city size have the potential to account for 29%–84% of the residential isolation" for four migrant groups, i.e. immigrants from the Balkans, Italy, Turkey and Eastern Europe (2012). In a comparative study of segregation in Australia, Canada, New Zealand, the United Kingdom and the United States, other factors weighted in shaping segregation outcomes, namely "size of the group being considered as a percentage of the urban total, but also urban size and urban ethnic diversity" (Johnston, Poulsen, and Forrest, 2007).

As a general hypothesis, it should be expected that the higher the gaps, the more difficult will be for migrants to achieve out-ward and up-ward mobility. In addition, at the contextual level, housing markets might force minorities into relatively deprived neighbourhoods, sheer discrimination from landlords might make it difficult to find accommodation, and natives might flight from areas where immigrants start to settle ("white flight"). An agent based model developed in 1969 by the Nobel prize winner Thomas Schelling (1971) shows how the patterns of intra-urban mobility may be explained on the basis of the individual preferences to live close to persons of the same race or homophily. The model shows how individual preferences can produce striking collective results and bring to the collapse of mixed neighbourhoods and high levels of segregation. Further, minorities can willingly isolate themselves, and here cultural and historical factors play a role (Musterd, 2005).

Box 4.2. Segregation in geographical and social spaces

Besides the classical assimilation versus pluralist models of integration a third model introduced by Zelinsky (Zelinsky and Lee, 1998) and named heterolocalism considers how the increasing availability of means of communication allow establishing and preserving strong socio cultural ties independently from residential locations. Although formulated in 1998 this model anticipated the importance of social media in maintaining relations and defining a social space which overcomes geographical proximity constrains. With this model a pluralist society may coexist with a spatial pattern of dispersion.

The heterolocalism model has a correspondence at international level in the idea of transnationalism, whereby identity and cohesive communities are formed and maintained across national boundaries. Both heterolocalism and transationalism show the importance of considering a more encompassing dimension of social space than just focusing on where people live. In fact, the research frontier about segregation is moving ahead from measures of residential segregation based on census data to consider how people with migrant background interact with the receiving society also through work, education and leisure activities (Wong and Shaw, 2011; van Ham and Tammaru, 2016).

One important dimension of segregation relates to the level of exposure between the migrant and the host population. This exposure which allows confrontation between different culture and opinions can be seen as an essential condition to maintain democratic participation process and avoid polarisation and radicalism. Sunstein (2017) points out how virtual communities emerging in social media are increasingly characterised by phenomena of self-insulation. Social media like Facebook and Twitter have the undisputed merit of greatly enhancing the possibilities to access information and communicate with person all over the globe, and in this sense they are contributing to improve exposure to diverse opinions and to connect with others, overcoming the limits of the geographical proximity. However, social media have an explicit objective of tailoring the provision of information on an individual basis and are designed to favour the formation of communities of like-minded. This filtering of information and contacts results in a self-insulation from those who don't share the same interest and set of values. In this way social media create echo chambers in which the more extreme ideas are amplified, public opinion is polarised.

Data processing and measurement

Assembling and processing the data

Despite the advancement of methods and wealth of indexes and tools to measure segregation there have been few empirical applications to compare the patterns of spatial segregation between cities in different countries (for recent examples see: Peach, 2009; Musterd, 2005). In most empirical applications the calculation of the segregation indexes is limited to few large cities and considers aggregate ethnic groups. The main reasons for the few cross-country comparisons reside in: the difficulty of assembling data from several national statistical institutes; the lack of standardisation in the aggregation levels, geometries, definitions; and confidentiality requirements.

To address these challenges, this study uses a data set that provides for the first time the possibility of mapping migrant communities in several EU Member States, at high spatial resolution. The uniqueness of the data set consists both in the high level of spatial resolution and the large geographical coverage which includes almost 45 000 LAU in France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain and the United Kingdom. The original data used to produce the high resolution map was obtained through ad hoc extraction of 2011 national census statistics. These ad hoc extractions provided data on the resident population broken down by country of birth and/or citizenships at the lowest possible level of geographical detail.

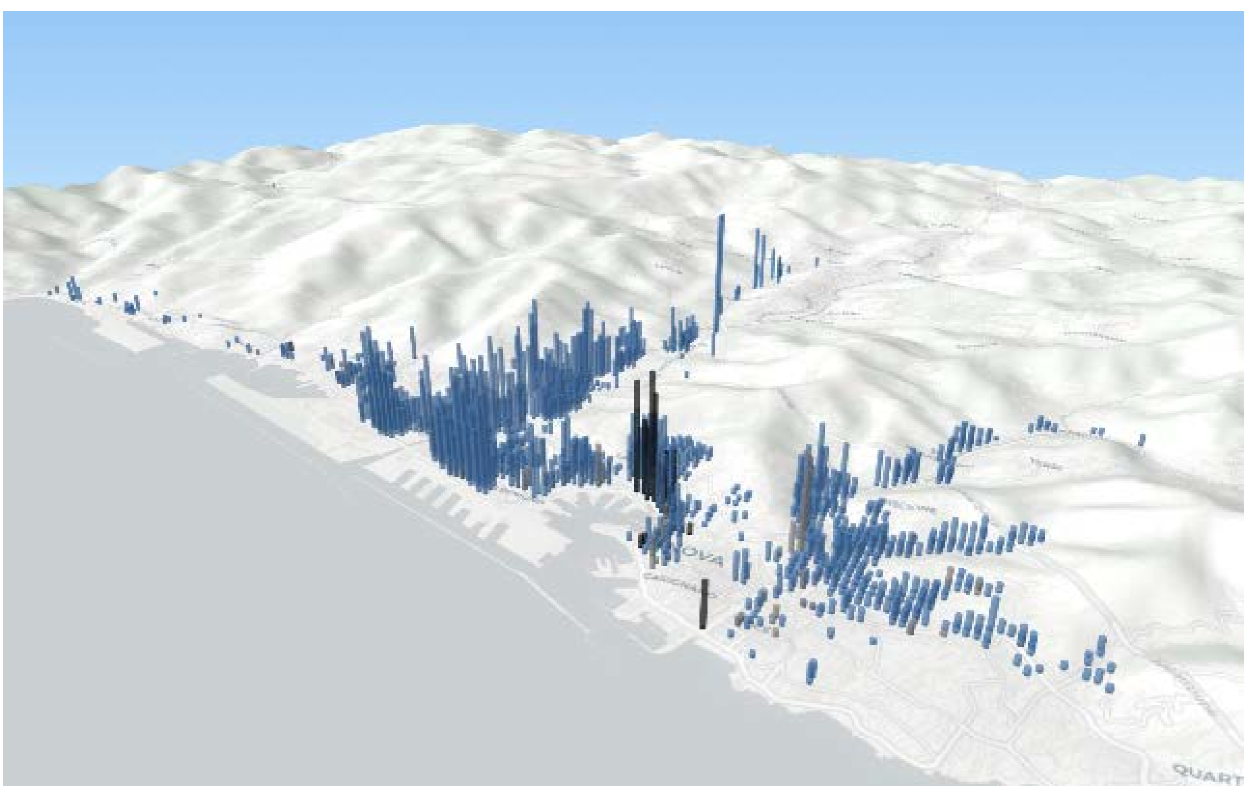
The geometries used to represent the data were polygons corresponding to census sampling areas in the case of France (TRIRIS and IRIS), Italy, Portugal and Spain, a spatial grid with cells of 100 by 100 m in the case of Germany, postal codes in the case of the Netherlands and so-called output areas in the case of Ireland and the United Kingdom. Differences in geometries and resolution were harmonised through a spatial processing method called dasymetric mapping. With this method the population by origin from the original census data was redistributed and spatially disaggregated into a uniform grid using as ancillary information the land cover classes (CORINE land cover) and the presence of built up areas (European Settlement Map) in each cell. The basic idea behind the process of dasymetric mapping is that the total population of the census area is proportionally allocated to the cells included in the polygon if these are characterised by the presence of built up areas and a residential land cover, rather than for example green areas and agricultural land.

The result of the spatial processing was a grid covering the entire territory of the 8 Member States included in the study, where each cell reports the residential population by origin at three different levels of aggregation (country, continent, EU vs. third country origin). From such data it was possible to calculate the concentration of migrants for LAU, FUA, at the different levels of the Nomenclature of territorial units for statistics classification (NUTS 1, 2 and 3) or for hoc grouping of specific cells.

The main limitation in the final data set is that while it provides information at high spatial resolution it can only reproduce partially the aggregated figures at national and regional level. The high level of detail in the data implies that for many cells the data falls below confidentiality thresholds and therefore either the data is completely missing or it is presented in aggregated form in respect of the country of origin dimension.

Figure 4.1 exemplifies a calculation of the share of migrants from China, Ecuador and Senegal in each cell falling in the boundary of the LAU of Genoa in Italy.

Figure 4.1. Example of a calculation of the share of migrants from Ecuador, China and Senegal in each cell falling in the boundary of the LAU of Genoa in Italy



Note: The bars represent the ratio of migrants from Ecuador (blue), China (grey) and Senegal (black) to the total population. The highest bars indicate the presence of migrants with a ratio of up to 45% in respect of the total population in the cell.
Source: Elaborations based on data sources detailed in section "Data processing and measurement".

The simple visual inspection of the figure indicates that: the Ecuadorian community - the largest in the city - is both clustered in at least two areas as well as marginally present in other parts of the city; the Chinese community is much smaller and tends to spread rather evenly along the coast, with a very narrow displaying of peaks of concentration; and the Senegalese community is the most segregated, with a presence almost exclusively delimited in a narrow area of the city.

Measuring spatial segregation

A large body of research on residential spatial segregation has contributed to develop several indexes to measure spatial residential segregation. These indexes range from very simple and a-spatial measures of diversity to more advanced indexes which consider the spatial structure of the distribution of populations in census tracts or in continuous spatial distributions. See Annex 3.A for technical details on the measures used in this chapter.

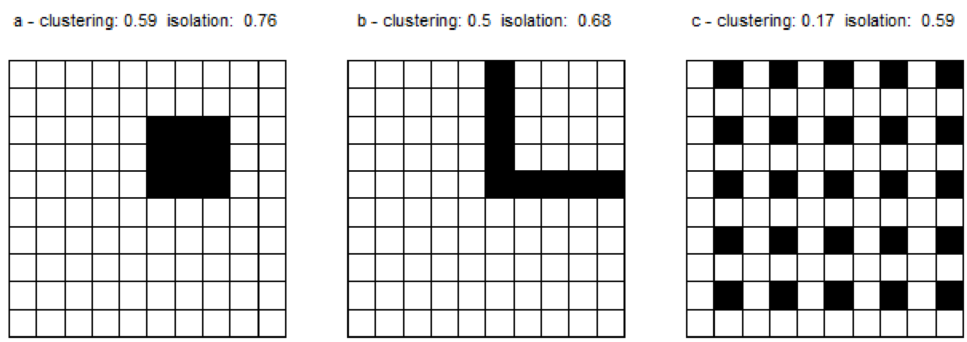
Segregation indexes introduced since the 1950s and 1960s (dissimilarity, exposure index, variance ratio index, entropy-based information theory index) typically measure the dissimilarity in the ethnic composition of the residential areas, without considering the spatial relations between the residential areas. This leads to two flaws which have been described as checkerboard problem and modifiable areal unit problem.

Figure 4.2 exemplifies the checkerboard problem with a toy example representing three cities and two ethnic groups of “black” and “white”. The “black” group has the same ratio to the total population in ‘a’ and ‘b’. A-spatial dissimilarity indexes and concentration profiles calculated for the three cities would show identical values while it is self-evident that the “black” group has very different spatial patterns of clustering.

A seminal paper by Massey and Denton (1988) identifies five main dimensions to measure spatial segregation. Further to this paper Reardon and O’Sullivan (2004) collapse the segregation measure along two main dimensions of isolation/exposure and clustering/evenness.[7] The clustering/evenness dimension captures how the ethnic groups are concentrated or evenly distributed in space. In the examples in Figure 4.2, the clustering is highest in ‘a’ and decreasing progressively in the examples in the ‘b’ and ‘c’. The second dimension of isolation/exposure considers the spatial composition of the surrounding regions of each group. The black group in ‘b’ although preserving a certain level of clustering has a higher number of “whites” in its surrounding and is therefore less isolated in respect of ‘a’. Intuitively, exposure can be seen as a measure of the probability of the group of entering in contact with other groups, which is influenced by the amount of shared boundaries of the regions.[8]

The modifiable areal unit problem is determined by the use of aggregated data by census areas. The anomaly produced in this case consists in the fact that distant groups within the same census area are considered more clustered than geographically closer groups falling in two distinct census areas. Ideally this anomaly could be addressed by using point data on the exact residential locations; however, this data is normally not available in the census statistics, since it would violate data protection rules. Another solution is to redistribute the population of the census area into a continuous density surface through a spatial smoothing process based on an equal distribution or kernel density. This is similar to the method of dasymetric mapping which was adopted in this study to harmonise the different census geometries into a uniform grid. This grid, considering its high spatial resolution, approximates a continuous spatial distribution of population and at least partly addressees the modifiable areal unit problem.

Figure 4.2. Toy example of segregation measures calculated for three ideal cities



Results

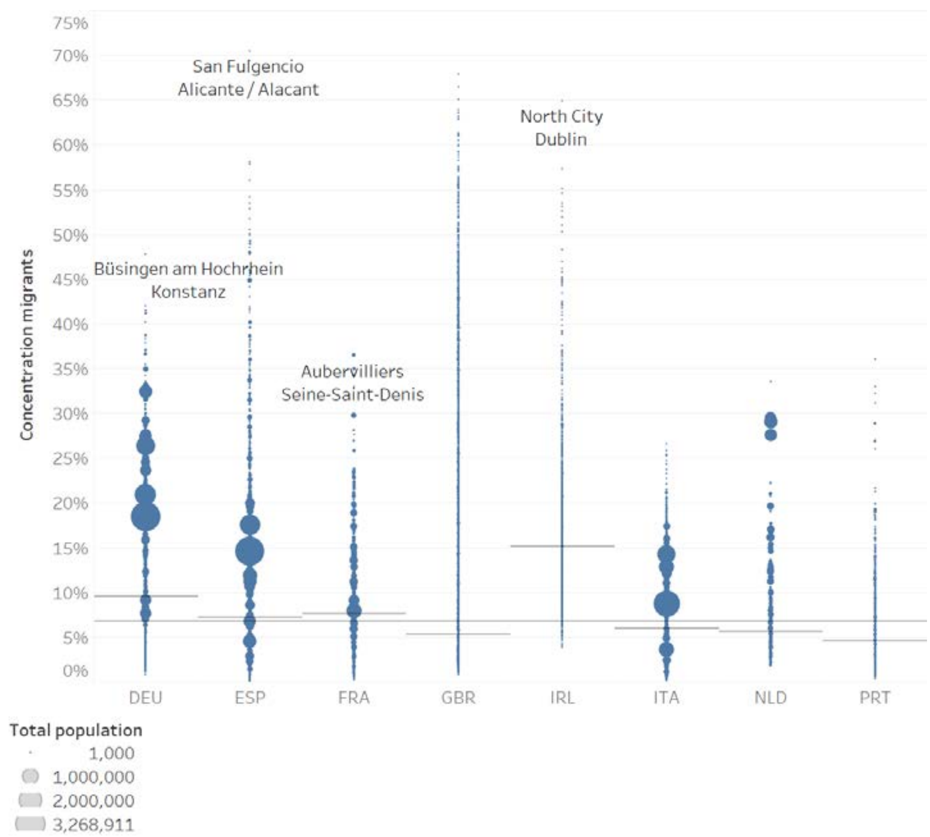
Concentration of migrants across cities

A very simple measure of concentration of migrants can be calculated by dividing the migrant population by the total population in each city. Considering this ratio at the level of single LAU gives a considerable refinement in respect of the statistics aggregated at higher administrative levels of provinces, regions and nations. All the results refer to the year 2011.

The distribution of the concentration of migrants across LAU shows an extremely variegated picture (Figure 3.3). In the case of LAUs with a population of more than 1 000 inhabitants, the median value of concentration of migrants, considering both intra-EU and third countries origins, for all countries considered, is of 7%, and the upper quartile of 23%. Values of concentration above the median are recorded in France, Germany, Ireland and Spain. Some examples of LAUs with the highest values of concentration are San Fulgencio in Spain (70%), Wembley in the UK (68%), Dublin North in Ireland (65%), Büsingen am Hochrhein in Germany (48%) and Aubervilliers in France (37%).

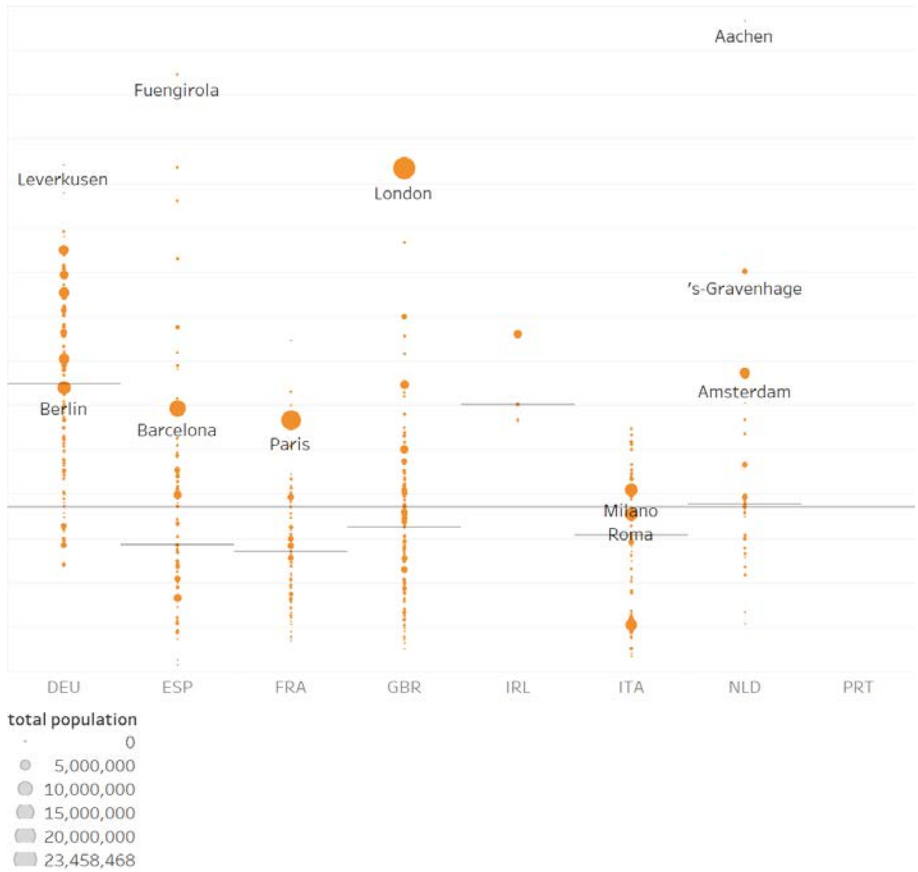
These high values of concentration are less evident in the case of FUA (Figure 4.4) where the median values range between 16% in Germany and 7% in France and Portugal. A high level of concentration of migrants is present in Achen in the Netherlands (73%), Fuengirola in Spain (67%), Leverkusen in Germany (57%) and London in the UK (57%). Box 4.3 discusses the link between the spatial concentration of migrants and urban poverty for the case of five Dutch cities.

Figure 4.3. Concentration of migrants in LAUs with a total population of more than 1000 persons



Note: Size of circles shows total population, horizontal bars show median values in each country and across all countries).
Source: Elaborations based on data sources detailed in section "Data processing and measurement".

Figure 4.4. Concentration of migrants by FUA



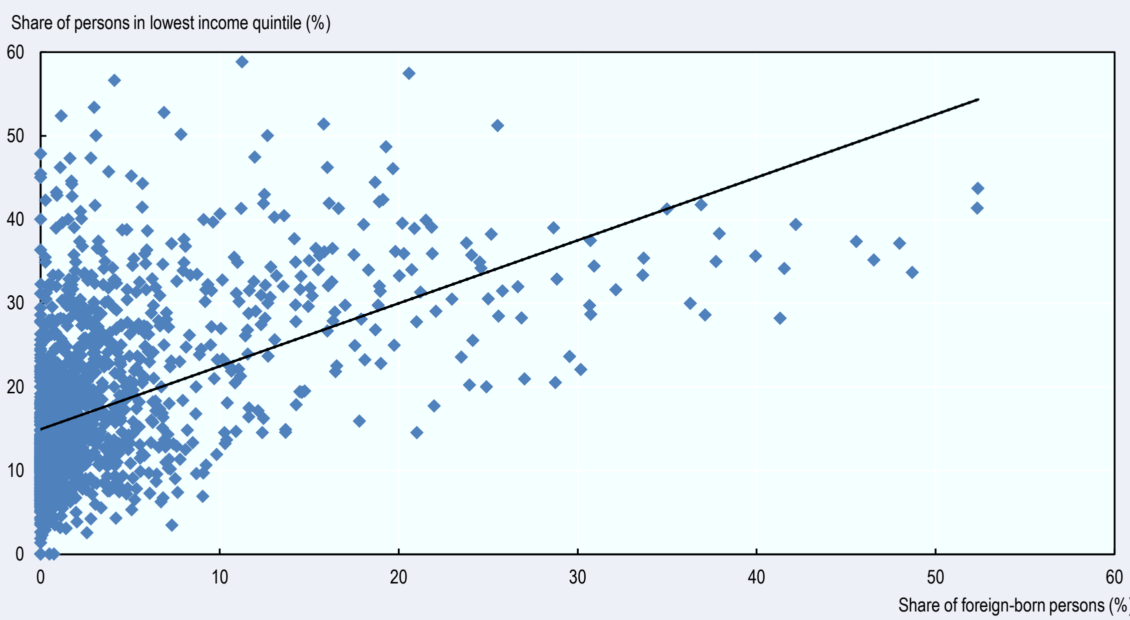
Note: Size of circles shows total population, horizontal bars show median values.
Source: Elaborations based on data sources detailed in section "Data processing and measurement".

Box 4.3. Is there a link between the spatial concentration of migrants and urban poverty? Evidence from the Netherlands

While there is growing evidence of how, across Europe, migrants are on average more likely to be at risk of poverty (Eurostat, 2018), fewer studies have explored the spatial dimension of such relationship in contemporary European cities.

Magante and Luca (2018) explore the case of the Netherlands, and ask: is there a link between the residential concentration of immigrants and urban poverty? They provide robust exploratory analysis on the country's five biggest cities, namely Amsterdam, Eindhoven, The Hague, Rotterdam and Utrecht. Their analysis combines novel fine-grained data on the residential distribution of immigrants in urban neighbourhoods with data on income distribution. The results confirm how areas characterised by a large share of migrants show significantly higher levels of poverty, measured as the share of persons in the bottom income quintile. Neighbourhoods with a higher concentration of migrants also feature higher income inequality, possibly reflecting the heterogeneous socioeconomic structure of areas inhabited by both natives and foreign-born people.

Figure 4.5. Migrants' residential concentration and poverty rates in Dutch urban neighbourhoods



Source: Elaborations based on data sources detailed in section "Data processing and measurement".

Econometric results confirmed the positive relationship between migrants' concentration and poverty, which is robust to controlling for city fixed-effects, neighbourhood population, income inequality (a proxy for gentrifying areas), and level of ethnic diversity. Even according to the most conservative estimates, a 1% increase in the share of migrants is correlated to a 0.32% increase in the share of poverty. With the exception of The Hague, the link between migrants and poverty is stronger outside of the capital city and increases inversely to city size. Besides, the intensity and the sign of the relationship is greatly affected by the composition of immigrant communities. Controlling for covariates, the relationship is insignificant for migrants from 'old' EU member states (EU15 countries). By contrast, it is significant for migrants from both the 'new' member states which have joined the EU in 2004 (EU13 countries) and non-EU countries. EU13 natives, in particular, are the ones for whom the link is strongest.

The integration of migrants is among the top priorities for both national and local governments in many OECD countries. There is significant research on neighbourhood effects, i.e. on how the spatial concentration of disadvantage may perpetuate social exclusion and negatively influence the integration of migrants (Bolt and van Kempen, 2003; Friedrichs, Galster, and Musterd, 2003; Musterd, 2005). The importance of the local level as a locus where integration can occur is also embodied in the EU Action Plan on the integration of third country nationals (EC, 2016). While results do not find systematic cases of spatial concentration of specific communities and poverty as in the contexts of American and Asian cities (cf. Massey and Denton, 1993; Garcia-Lopez and Moreno-Monroy, 2016), they nevertheless underline the importance of policy solutions that ensure the full integration of migrant communities into host societies (cf. Musterd, 2005; OECD, 2008).

Source: Bolt, G. and R. van Kempen (2003), "Escaping poverty neighbourhoods in the Netherlands", *Housing, Theory and Society*, 20, pp. 209-222; EC, (2016), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM 2016, 377 FINAL, Brussels; Eurostat (2018), Migration integration statistics – at risk of poverty and social exclusion, http://ec.europa.eu/eurostat, (accessed on 15 March 2018); Friedrichs, J., G. Galster and S. Musterd (2003), "Neighbourhood effects on social opportunities: The European and American research and policy context", *Housing Studies*, 18(6), p. 797–806, https://doi.org/10.1080/0267303032000156291; Garcia-Lopez, M.A. and A. Moreno-Monroy (2016), "Income segregation and urban spatial structure: evidence from Brazil", *CAF Working papers*, 08(2016); Magante, C. and D. Luca (2018), "Testing the link between migrants' spatial concentration, poverty, and inequality: new micro-geographical evidence from the Netherlands", Unpublished working paper, Gran Sasso Science Institute, L'Aquila; Massey, D. and N. Denton (1993), *American Apartheid. Segregation and the Making of the Underclass*, Harvard University Press, Cambridge, MA; Musterd, S. (2005b), "Social and ethnic segregation in Europe: Levels, causes, and effects", *Journal of Urban Affairs*, 27(3), pp. 331–48, https://doi.org/10.1111/j.0735-2166.2005.00239.x; OECD (2008), *Jobs for Immigrants (Vol. 2): Labour Market Integration in Belgium, France, the Netherlands and Portugal,* OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264055605-en.

By considering the data of the eight countries together there is no apparent relation between the size of LAUs, measured in terms of total population, and the concentration of migrants. However, Figure 4.6 shows that differences in correlations between population size of the administrative unit and migrant concentration emerge when analysing each country separately. In particular, in decreasing order, the Netherlands, the United Kingdom, Portugal, show moderate to strong positive correlations (r approximately 0.45 and above) between LAUs population size and concentration of Third Country Nationals (TC), while lower values are recorded in the cases of France, Germany Ireland, Italy and Spain. This relationship between size and concentration is weaker for EU nationals, if not negative (in Portugal and Spain).

As shown in Section 3.3, past studies have tested for associations between cities' sizes and migrant concentration and segregation (Sager, 2012; Johnston, Poulsen, and Forrest, 2007). The high correlations for some of the countries in the sample support the hypothesis that that migrants preferably settle in large cities. That said, the lower values in the case of France, Germany, Italy and Spain, as well as the negative results for Portugal and Spain, alert us that the relationship is not straightforward, and other intervening factors might be at play, as migrants in those countries tend to be more dispersed in smaller cities.

To explain these contrasting results, one has to consider that national characteristics of the receiving countries and the type and origin of migration may affect the likelihood that migrants will settle in large rather than medium and small size cities. For example, the negative correlation for intra-EU migration in Portugal and Spain may be explained by the fact that among migrants for these two countries there are many retirees in particular coming from the United Kingdom which privilege touristic destinations along the coastline rather than living in Madrid or Lisbon (Betts, 2011; Bade and Eijl, 2011). Similarly, the lower correlation for extra-EU migrants in Italy and Spain in respect of the other countries in the sample may be related to the relatively high share of unskilled labour force employed in farming activities.

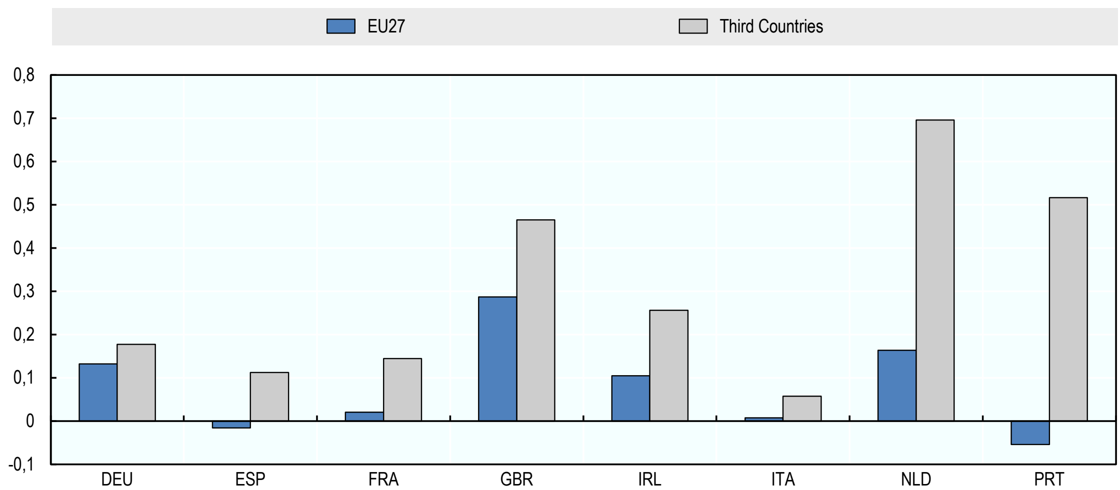
Here labour market dynamics are at play. According to the dual market theory (Piore, 1986), the labour market of developed industrial economies is segmented in two types of jobs. Jobs in the secondary sector are characterised by low wages, lower social status and employment instability. Migrants tend to fill these jobs since they typically view their migration as temporary. Empirical analyses of the EU labour market identified three distinct segments on the EU labour market describing the coexistence of “good” jobs on one side and “bad” jobs on another. In such labour market structure, non-EU immigrants have higher probability than natives of being employed in “bad” jobs, although the immigrants-natives gap varies significantly among MS (Grubanov-Boskovic and Natale, 2017). This chapter postulates that the observed patterns of geographical substitution between nationals and migrants in some countries may have a relation to the substitution which is taking place at the level of the labour market.

To sum up, the geographical patterns of migration and the level of concentration in small versus large cities and rural areas versus urban areas may reveal a more nuanced view of the mobility transition theory (Zelinsky, 1971) and the general view of a higher likelihood for migrant to move towards large cities.

The somehow surprising evidence that in some countries migrants are also likely to settle in small cities gives a new perspective on the territorial aspects of migration. The prevailing narrative on migration indicates that migrants are attracted by the large and global cities, which in turn witness a constant increase in their diversity and level of multiculturalism (Meissner and Vertovec, 2015; Vertovec, 2007). In fact, this chapter suggests that this process may be happening also in smaller cities.

Although the data set does not record age structures and population changes over time, it is plausible to imagine that in some cities the increasing share of migrants is substituting the native population and compensating for ongoing trends in depopulation and population aging. At lower geographical scales, a similar effect is frequently observed in the mobility dynamics in neighbourhoods, where migrants settle in urban peripheries and more deprived parts of the city replacing the national population. In fact, the idea of migrants compensating for the depopulation of small towns in eastern Germany and southern Italy emerged during public discussions about the reallocation of the large inflows of asylum seekers in 2015 in Germany and Italy.

Figure 4.6. Correlations between city size and the concentration of migrants from third countries and intra-EU



Source: Elaborations based on data sources detailed in section "Data processing and measurement".

Ethnic diversity of cities

The diversity of cities can be measured by considering both the variety of migrants' origins (Vertovec, 2007) and the evenness in the distribution of population across different countries of origin. Among the several diversity indexes available in the literature (for instance: Simpson, Rao - Stirling, Gini, Blau) one of the most commonly used is the Shannon entropy index (Shannon, 1948). Similarly to other indexes, the value of diversity measured through the Shannon entropy index increases with the increase in the number of countries of origin and when there are equal population shares across the different migrants' origins. In other words, on one side of the spectrum, the index approaches zero if the majority of the population is represented in one dominant group (most likely the domestic population) and shares in the other groups are extremely small. At the other side of the spectrum, the index reaches the maximum when all groups composing the population are of equal size.

Although the countries of origin of migrants do not necessarily correspond to different socio-cultural characteristics, it is common practice for quantitative measures of diversity to be based on the distribution of population shares across countries of origin, which can be taken as proxy of the sociological concept of diversity within cities. Similarly to the results regarding the concentration of migrants, the values of the diversity index across LAU also show a highly variegated picture (Figure 4.7).[9]

The figure confirms the common perception of some European cities as "superdiverse", like Berlin and Rotterdam. However, what is interesting to notice is that also medium and small size cities like for example Baranzate in Italy, Forest Gate South in the United Kingdom, Monaghan in Ireland and Teulada in Spain exhibit high values of diversity. The relation between diversity and the total population of the LAU follows a similar pattern encountered in the case of the concentration of migrants. In general, there is a positive correlation between the diversity and total population of the LAU. High correlation are present in the case of the Netherlands (0.6), the United Kingdom (0.4), small correlation in the case of France (0.2), Germany (0.2), Ireland (0.2), and almost no correlation in the case of Italy (0.08) and Spain (0.06).

The positive correlation between the size of the city and values of diversity holds also if diversity is calculated using FUAs as geographical units, instead of the LAUs. FUAs have across all countries higher median values of diversity in respects of LAUs (Figure 4.7). As in the case of LAUs (Figure 4.6), values of diversity are higher than the overall median in the case of France, Germany and Ireland, and lower in the case of the Netherlands, Spain and the United Kingdom.

Looking at specific countries, Germany nearly doubles its median diversity, driven by the relatively high diversity recorded in large cities such as Frankfurt and Munich. The role of capitals and very large cities also emerges more clearly when considering FUAs (e.g. Amsterdam, London, Milan, Paris), supporting insights in the literature about superdiversity in Europe. These results are, however, also conditioned by the definition of LAUs, which in some countries is fragmented in specific neighbourhoods within the larger boundaries of the FUA. This is clearest in the case of London and Paris, which in Figure 4.6 are divided in several units, while they appear as single entities in in Figure 4.7.

Segregation across cities and origins

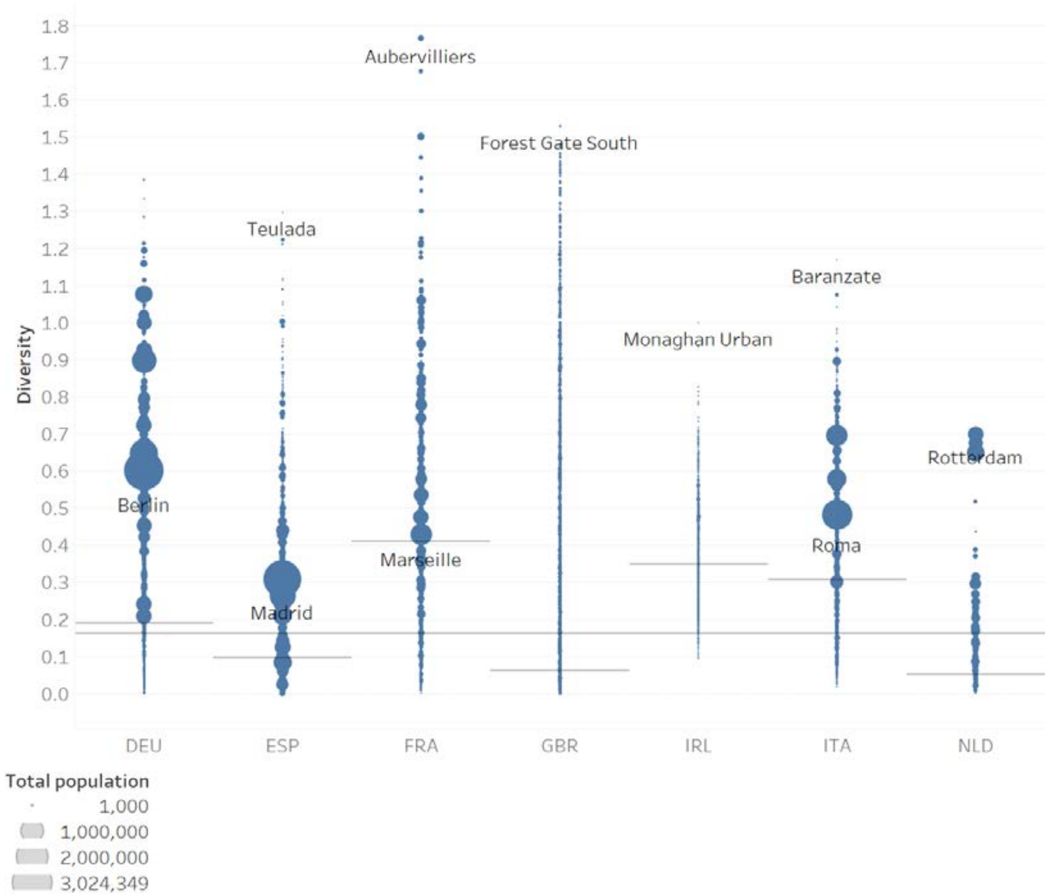
Besides calculating simple concentrations of migrants and diversity indexes for each LAU, the spatial segregation measures of spatial information theory index and general spatial exposure/isolation proposed by Reardon and O'Sullivan (2004) were calculated for each LAU with more than 1 000 inhabitants and each country of origins of the migrants.

Segregation indexes were calculated for a total of 267 280 combinations of 41 532 unique LAU and 186 unique countries of origins.[10] For confidentiality reasons, the data for Spain, UK and Ireland only includes 21, 20 and 5 major countries of origin.

Figure 4.8 shows the two measures of segregation for a sample of large cities (top 20 by size of the population), and for the origin countries which recorded the highest level of clustering in each of city. Although the sample represents only a small part of the entire data set, it shows that it is difficult to identify a consistent pattern of segregation by origin and cities. Origins which may appear segregated in one city do not feature among the most segregated in other cases. The only exception in the sample is the Chinese community, which appears as the most clustered in Berlin, Munich, Naples, Stuttgart, Toulouse and Turin.

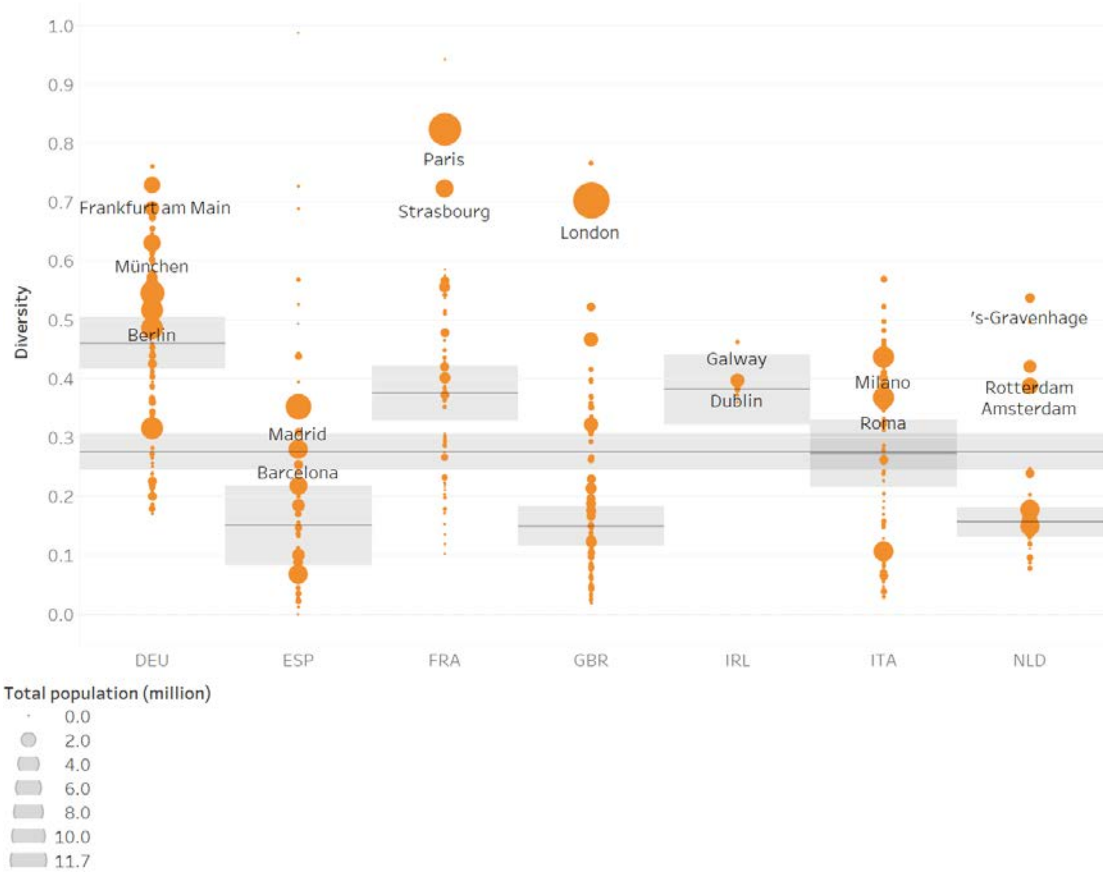
In general, there is not a uniform behaviour between the two measures of isolation and clustering with the exception of migrants from the Philippines in Hamburg and from Bulgaria in Madrid. This is to be expected since the two dimensions proposed by Reardon and O'Sullivan are designed to capture two distinct aspects of segregation.

Figure 4.7. Diversity (Shannon entropy) by LAU



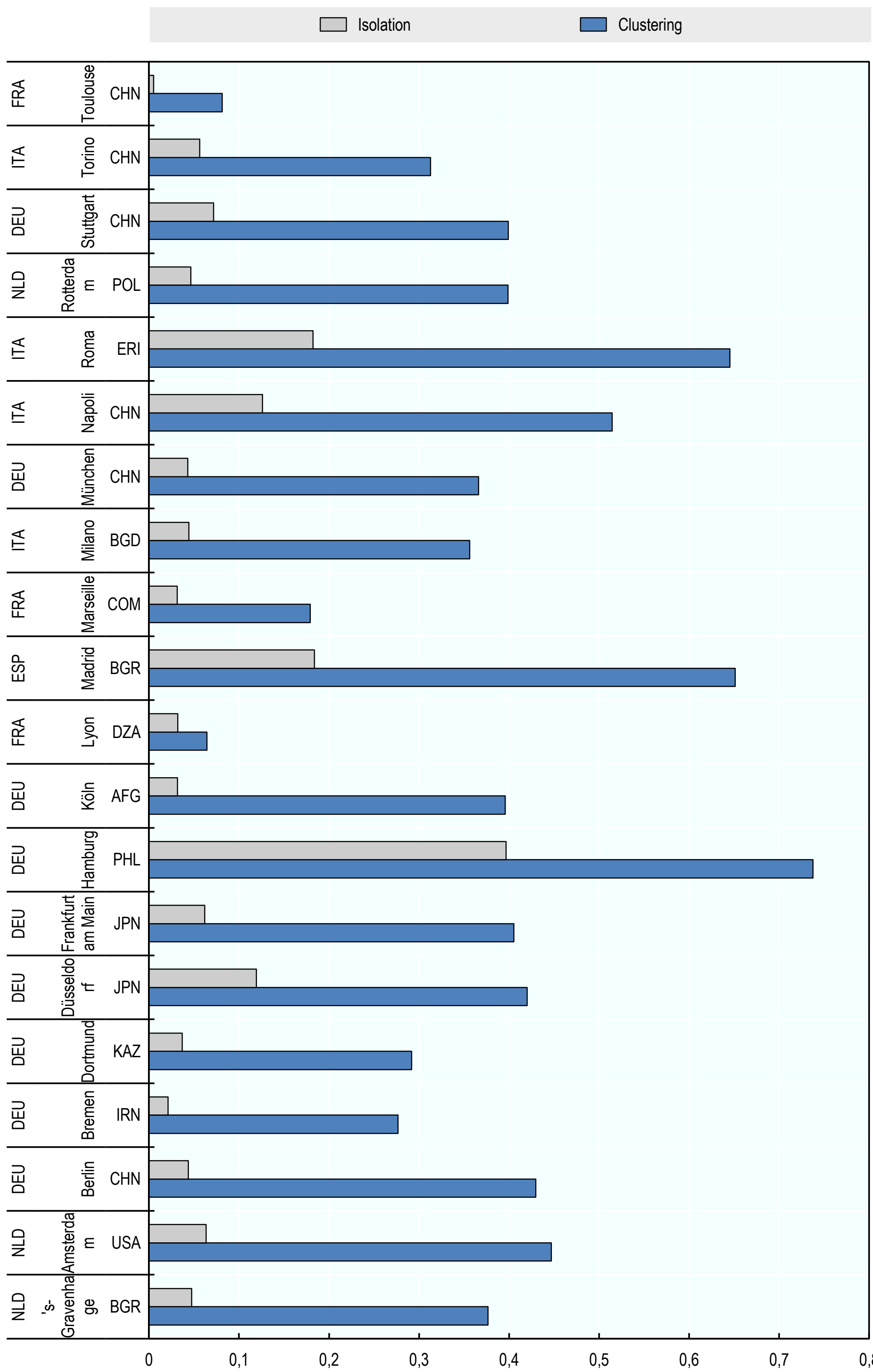
Note: Size of circles shows total population, horizontal bars show median values.
Source: Elaborations based on data sources detailed in section "Data processing and measurement".

Figure 4.8. Diversity (Shannon entropy) by FUA



Note: Size of circles shows total population in millions, horizontal bars show median values.
Source: Elaborations based on data sources detailed in section "Data processing and measurement".

Figure 4.9. Values of segregation (clustering and isolation) for selected cities

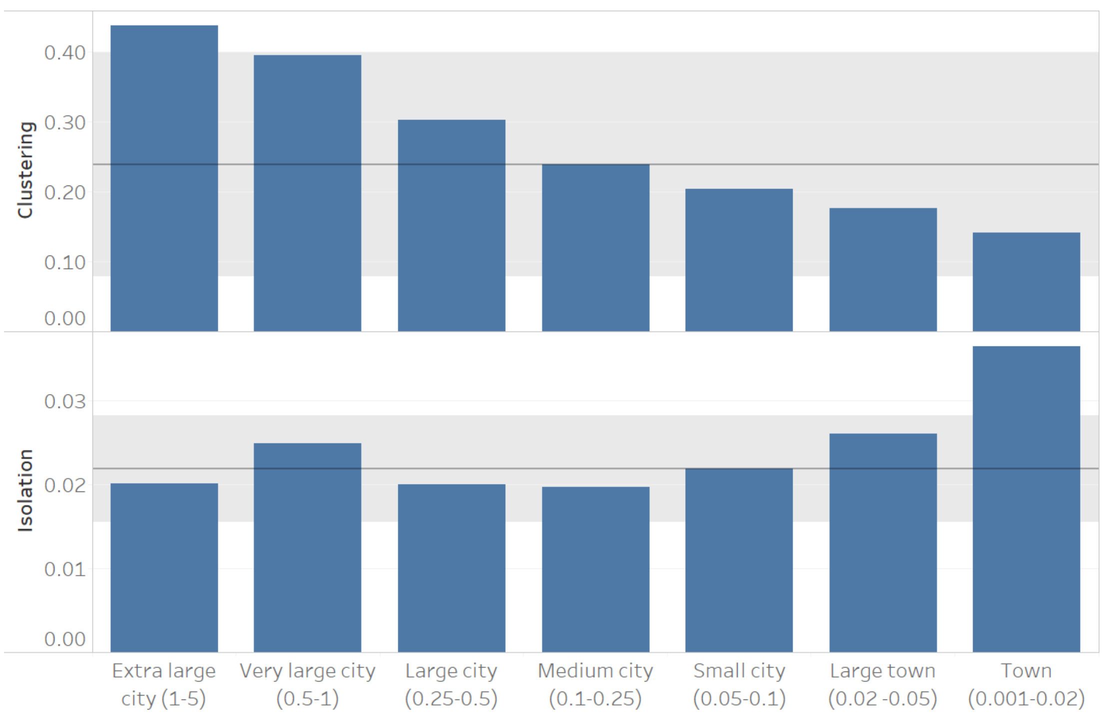


Note: The countries of origin shown are the ones having the highest clustering in each city and a population of at least 1 000 migrants.
Source: Elaborations based on data sources detailed in section "Data processing and measurement".

Figure 4.9 and 4.10 provide an overview of descriptive statistics on clustering and isolation. The graphs respectively represent the values of segregation and isolation for all combinations of cities and origins considering a breakdown by classes of cities on the basis of their population and by continents and world regions. Figure 4.9 suggests a negative relationship between the size of the city and clustering dimension. In other words, the bigger the city, the lower immigrant communities tend to cluster. On the other hand, there is no clear pattern of association in the case of isolation.

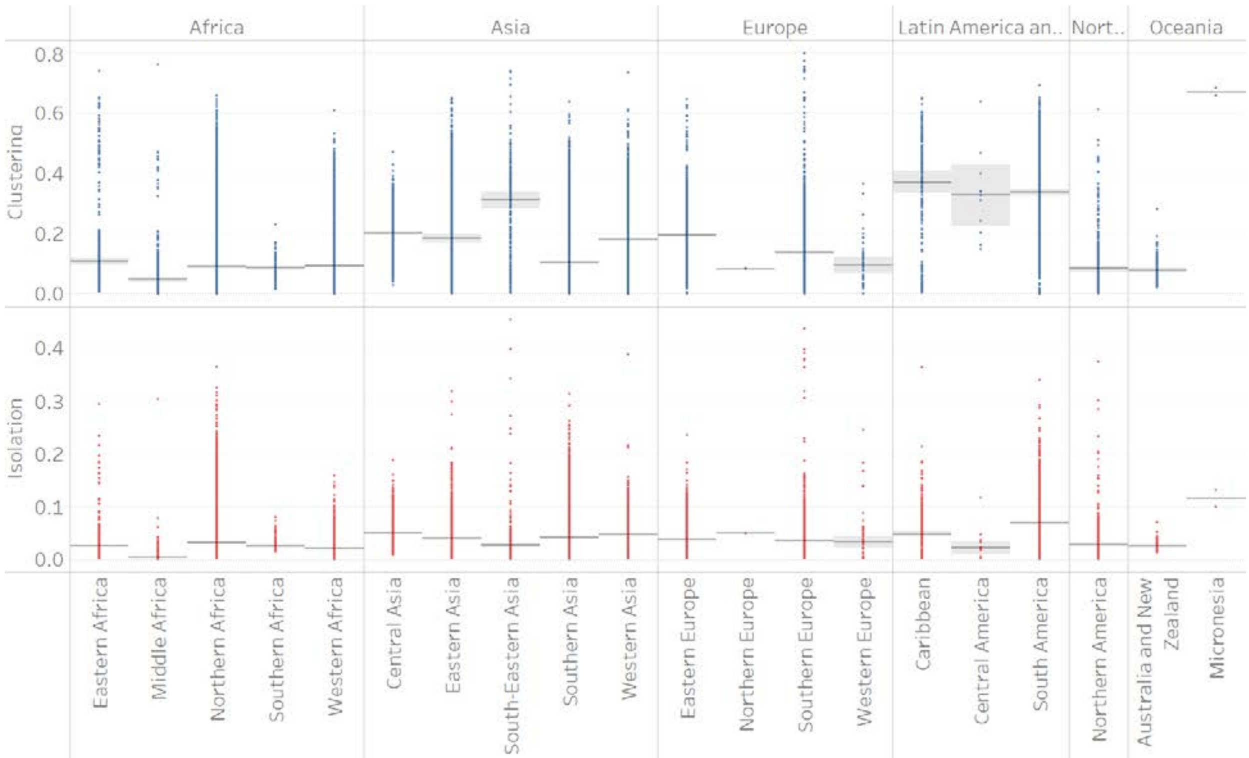
Differences in clustering also emerge considering the intra-EU versus third country origin (data not shown for brevity). In particular, the median clustering is lower in the case of intra-EU migrants (0.09) in respect of the third-country origin (0.14). This difference may be indicative of the fact that in general intra-EU migrants are facing fewer obstacles in settling in and therefore are more likely to spread spatially. No meaningful difference is recorded when it comes to isolation.

Figure 4.10. Clustering and isolation by city size classes



Note: Median values of clustering and isolation by city classes defined on the basis of total population in millions. The horizontal line shows the median across all city classes with 95% confidence intervals.
Source: Elaborations based on data sources detailed in section "Data processing and measurement".

Figure 4.11. Clustering and isolation by continent and regions of origin



Note: Each dot represents a combination of LAU and origin, bars show median values with 95% confidence intervals.
Source: Elaborations based on data sources detailed in section "Data processing and measurement".

From Figure 4.10 it emerges that there are also specific differences in the level of segregation by continents and sub-regions of origin. Migrants from Latin America have in general higher median levels of segregation, according to both the isolation and clustering dimensions, followed by migrants from Asia and Europe. Lower clustering is found in the case of migrants originating from Northern America and Oceania, as well as for migrants coming from Africa. That said, there is substantial within-continent variation which can be observed at the sub-regional level. For instance, migrants from Eastern Europe have a higher tendency to be clustered in respect of migrants from other regions in the same continents, whereas migrants from South-Eastern Asia show the same tendency with regards to clustering, but have the lowest isolation median values for the continent. While migrants from Latin America have the highest median clustering values, their isolation values are not radically different from other sub-regions in other continents.

Table 3.1 shows more in details the five top countries recording the highest level of clustering in each continent. An interesting finding which emerges from this table is that some of the countries in Africa and Asia which have the highest median values of clustering are also countries which produced relatively large flows of refugees. This is the case of, inter alia, Afghanistan, Eritrea, Myanmar, Somalia, and Sudan (UNHCR, 2015). A possible explanation may be that migrants from these origins are more likely to be part of a fragile group escaping from wars and violence, thus relying even more from the support of existing diaspora besides host-states support. As a consequence, they could have a tendency to concentrate in areas where their communities are already rooted, hence resulting in higher clustering values. This would be in line with the idea that segregation, particularly at first, is a way for recently arrived immigrants – in this case, refugees – to cope with what might be a difficult transition and integration process (Peach, 1996). In addition, this trend could also be fuelled by internal relocation policies for asylum seekers by some countries (Boswell, 2003). On the other hand, these countries' clustering values are on a par with states that are not major source countries of refugees, such as Argentina, Indonesia or Israel, again suggesting heterogeneity in the factors driving segregation of migrants in Europe. To better understanding these dynamics, the following section turns to the likely determinants of segregation in the eight countries analysed in this section.

Drivers of segregation

The determinants of segregation described in the literature can be broadly classified in three groups: drivers at individual level, structural characteristics of the receiving society, and structural characteristics of the migrant group. At the individual, socioeconomic characteristics such as education, income, occupation may play a role. Group characteristics include cultural and ethnic features such as religion, language proximity and visibility of the minority.

The role of the different drivers for segregation is analysed through two multivariate regression models in which the observed segregation indexes of isolation and clustering are put in relation with the following explanatory variables: size of the city, relative size of the migrant community in respect of the population of the city, diversity of the city, geographical distance and contiguity between country of origin and destination, share of refugees from the country of origin to the total migrants population in the country of destinations.

The inclusion of the bilateral distance and contiguity variables is intended to capture socio-cultural differences between the migrants and the receiving society. In particular, the hypothesis to be tested is whether geographical distance, which may be considered a proxy also of socio-cultural differences, may favour a high level of spatial segregation. For instance, if migrants from African or Asian countries are more spatially segregated than migrants coming from within the EU and in particular from neighbouring countries.

As copiously argued in the academic literature (Vertovec, 2007; Meissner and Vertovec, 2015; OECD, 2016b; Sanderson et al., 2015), and confirmed in the previous sections, immigration is gradually changing the character of most EU cities by increasing their diversity. One key question is if more diversity is associated with an increase of segregation and the formation of separate clusters in the urban landscape, or if diversity is evolving along the line of the assimilation model in which migrants tend to be dispersed in the city. We address this question by including among the explanatory variables the overall diversity of the city measured through the Shannon index described in the previous section.

The last explanatory variable is represented by the share of refugees in respect of the total migrant population. The variable is aligned to the same combinations of the LAU and country of origin pairs for which segregation measures were computed. The reference year for this variable is 2010 and therefore it provides lagged values in respect of the 2011 reference year of the census data. The variable can be interpreted as the likelihood that a migrant included in the high resolution map is a refugee.

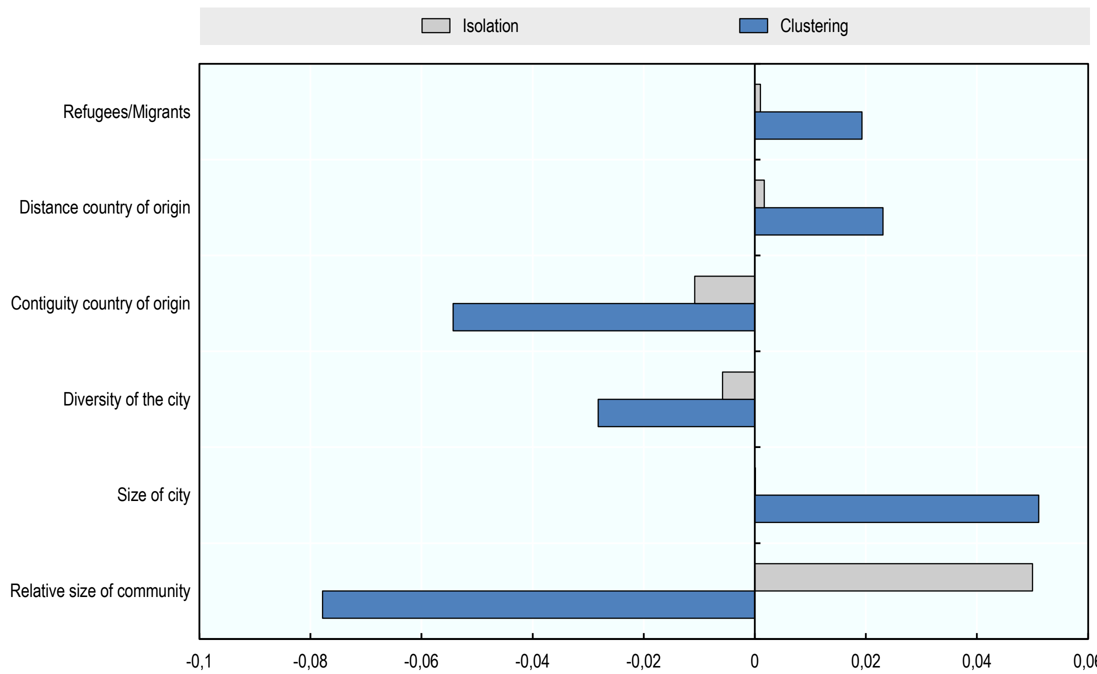
Figure 4.12 shows the results of the two models in terms of standardised regression coefficients (more summary statistics are shown in Annex 4.B).

Table 4.1. Countries of origin with the highest level of clustering

Continent	Country of origin	Clustering	Isolation
Africa	Uganda	0.5985	0.0539
	Somalia	0.5288	0.0905
	Sierra Leone	0.4599	0.0073
	Ethiopia	0.4292	0.0209
	Eritrea	0.4071	0.0207
	Sudan	0.3536	0.0394
	Burundi	0.312	0.0057
	Djibouti	0.2385	0.0027
	Liberia	0.2384	0.0314
	Rwanda	0.2289	0.0041
Asia	Myanmar	0.6407	0.0891
	Nepal	0.5007	0.0274
	Brunei	0.4808	0.1477
	Jordan	0.4404	0.0047
	Indonesia	0.4318	0.0484
	Afghanistan	0.4107	0.0402
	Iraq	0.4044	0.0419
	Israel	0.4032	0.0338
	Uzbekistan	0.3897	0.0044
	Syrian Arab Republic	0.3758	0.0185
Europe	Montenegro	0.6003	0.0624
	Belarus	0.3512	0.0044
	Norway	0.2553	0.0041
	Bosnia and Herzegovina	0.249	0.019
	Ukraine	0.2464	0.0194
	Russia	0.1956	0.0383
	Macedonia	0.1858	0.0392
	Moldova	0.1731	0.0191
	Albania	0.1359	0.0336
	Serbia	0.1109	0.0099
Latin America and the Caribbean	Paraguay	0.4512	0.08
	Dominica	0.4377	0.0615
	Argentina	0.42	0.083
	Cuba	0.4061	0.0535
	Aruba	0.398	0.042
	Dominican Republic	0.3801	0.0201
	Bolivia	0.3367	0.0571
	El Salvador	0.3252	0.0218
	Suriname	0.3195	0.0361
	Colombia	0.3177	0.055
Northern America	United States	0.1139	0.025
	Canada	0.1071	0.0021
Oceania	Kiribati	0.6678	0.1152
	Australia	0.0991	0.0212

Source: Elaborations based on data sources detailed in section "Data processing and measurement".

Figure 4.12. Drivers of isolation and clustering



Note: Values show standardised coefficients.
Source: Elaborations based on data sources detailed in section "Data processing and measurement".

What emerges from the figure is that on the one hand, the relative size of the community drives to more isolation of the migrant communities. On the other, the bigger the immigrant community, the more it tends to be scattered throughout the city. The negative relationship of this variable on clustering is consistent with the idea that a large migrant community may occupy several areas of the city and exhibit therefore a pattern of higher spatial dispersion than a small community. At the same time, the bigger this community, the less there is a chance of exposure with other communities in the area, simply because of its sheer size. At least from a geographical perspective, being member of a large community is related to a lower probability of encounters with the national population also if the community is not clustered. The fact that the relative size of the community affects the clustering and isolation in opposite directions confirms the usefulness of considering two distinct dimensions when assessing segregation as proposed by Reardon and O'Sullivan (2004).

The variable which has the strongest positive relationship with clustering is the size of the city. The positive sign indicates that communities in large cities tend to remain more geographically circumscribed. This is in line with the literature on ethnic enclaves, where immigrants recreate part of the social and economic fabric of the countries of origin, but are not necessarily isolated from the outside.

The coefficients for the distance variables have all the expected signs (negative for contiguity and positive for distance) to confirm the hypothesis that the likelihood for segregation is increasing for migrants coming from countries of origin which are geographically far from the receiving country. The negative relationship is particularly strong in the case of the contiguity variable. This is telling that migrants coming from neighbouring countries will have a higher geographical dispersion and are not necessarily confined in few specific neighbourhoods.

The diversity of the city has a negative relationship both on the clustering and isolation. This is indicating that cities which have both large migrant communities and migrants coming from several origins drive immigrants to spread across the urban territory and not to isolate themselves.

The coefficients of the last variable measuring the level of forced migration from a specific country of origin have a positive sign both for clustering and isolation. This confirms the hypothesis that fragility and disadvantage may determine at least in initial phase of immigration the conditions for agglomeration and spatial segregation. These conditions may be linked to the reception policies for asylum seekers which force people to reside in assigned reception centres or to integration policies where public administration provides housing in specific geographical areas.

Another factor at play may be represented by the tendency to settle closer to pre-existing diasporas to benefit of the supports of the network of migrants. The evidence provided in this study albeit at a much lower geographical scale would be in line with the effect of diasporas as a pull factor for migration which is well documented for aggregated migration flows at national level. Whatever the reasons for agglomeration, one conclusion is that the outward and upward or assimilation trajectories which are described for other type of migrants are probably less applicable for migrants who given their countries of origin are more likely to be in a condition of disadvantage.

A highly skilled migrant from the US to Rome will have freedom of choice about where to settle while an Eritrean escaping war will initially go close to his/her community or where public administration would provide housing opportunities. The high values of segregation encountered indicate that initial places were refugees are more or less forcibly landing creates a focus of attraction and concentration also in the long term.

Conclusions

This chapter has illustrated an analysis of a new data set mapping the concentration of migrants in EU cities at high spatial resolution. The analysis showed that diversity is not only a characteristic of well-known large cities, but also of less-studied medium and small size towns. Furthermore, clustering is higher in general for migrants from third countries, for migrants from South America and South-East Asia and for specific countries of origin which have a recent history of conflicts.

The large size of the migrant community reduces the clustering, but it increases its isolation. Migrants coming from distant countries are more likely to be isolated compared to migrants from neighbouring countries, which are more evenly dispersed. In fact, the diversity of the city has a positive effect in contrasting isolation. All in all, groups of migrants with a high share of refugees/asylum seekers are more likely to be isolated.

To further expand this research, one of the most pressing needs is to combine the data on geographical distribution with other socioeconomic data at the same level of analysis. While this exercise has granted us a wealth of information on immigrants' distribution across Europe, it has also shown that to answer more elaborated academic- and policy-related questions on immigrants housing, education, residential patterns, we need to combine such information with other data which could provide a more refined picture as well as control for other intervening factors. So far, this has proven to be a challenge, and only further access to administrative data at the local level can fully realise the potential of this mapping exercise. As a second avenue of research, there is the opportunity of complementing the large amount of information provided by this mapping exercise for the year 2011 with results from past Census rounds. This will offer the possibility of having a time perspective that so far has been missing, and hence enable us to start talking about trends and not only provide a snapshot of immigrant settlement patterns.

Notes

[1] Throughout the text the term city is often used in alternative to LAU. The LAU represent the main unit of analysis of our study. In some cases, LAU may correspond to portions of a large city (see London or Paris) and this determines the absence from charts and tables of specific measures for such cities. LAU stands for Local Administrative Unit, while FUA is a shorthand for Functional Urban Area. For a more extensive explanation, see (OECD, 2013). Eurostat defines LAUs as "a low level administrative division of a country, ranked below a province, region, or state. Not all countries describe their locally governed areas this way, but it can be descriptively applied anywhere to refer to counties, municipalities, etc." (Eurostat, 2015).

[2] Particularly in the context of a comparatively high incidence of single-parent families.

[3] Musterd reaches similar conclusions for the Surinamese in Dutch cities (Musterd, 2005, 335).

[4] "The 'melting pot' model […] envisages a progressive assimilation and convergence of the autochthonous white and minority populations over time. Its spatial concomitant is a progressive reduction in the level of segregation of the minority from the rest of the population over time" (Peach, 1999, 320).

[5] "The structural pluralist model, on the other hand […], envisages economic integration, but also social distinctiveness or closure, which would be manifested in continuing high levels of spatial segregation. Upward movement in class terms would not produce regular spatial diffusion throughout the class, but the maintenance of distinct ethnic enclaves within the class" (Peach, 1999, 320).

[6] Musterd (2005b, 332) defines ethnic segregation as "the spatial separation of population categories that are characterized by different countries of origin"

[7] The measures of segregation - along the two dimensions of isolation/exposure and clustering/evenness - presented in this report are respectively based on the Spatial Isolation Index and the Information Theory Segregation Index (Reardon and O'Sullivan 2004). The Spatial Isolation Index ranges between 0 and 1. The highest value of isolation of 1 is obtained when all local environments of a LAU are composed only by a migrant group and no natives. The Information Theory Segregation Index again ranges between 0 and 1. The maximum value of 1 is obtained when each local environment has only one group of migrants, and the minimum value of 0 when each local environment has the same composition of the LAU.

[8] This makes this measure directly dependent on the size of the group (this is not the case for the clustering measures because they are relative), as explained in Reardon and O'Sullivan (2004).

[9] Portugal was excluded from the calculation of the diversity indexes since the original data from the census statistics was only providing figures aggregated by continent and not by specific countries of origin.

[10] Portugal was excluded from the calculation of the segregation indexes since the original data from the census statistics was only providing figures aggregated by continent and not by specific countries of origin.

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Annex 4.A.

Calculation of the segregation and diversity indexes

The calculation of segregation along the two dimensions of isolation and clustering was done using the Spatial Isolation index I_A and the Spatial Information Theory Index H defined by Reardon and O'Sullivan (2014) and using the R package *seg*.

The spatial Isolation of a group A is defined as:

$$I_A = \int_{p \in R} \frac{D_{Ap}}{T_A} P_{A\,p\,loc}\; d_p$$

Where:

- D_{Ap} is the population density of the group A at the point p (cell centroid)
- T_A is the total population in the region R (LAU)
- $P_{A\,p\,loc}$ is the proportion of a group A in the local neighbourhood for the point p

$$P_{A\,p\,loc} = \frac{Population\ of\ a\ origin\ group\ A\ in\ the\ loc. neigh.}{Total\ population\ in\ the\ loc. neigh.}$$

The Spatial Information Theory Index H is defined as:

$$H = 1 - \frac{1}{TE}\int_{p \in R} D_p\, E_p\, d_p$$

Where:

- T is the total population in the region (LAU)
- D_p is the population density at point p
- E_p is the Entropy of the local neighbourhood for the point p for G mutually exclusive groups:

$$E_p = -\sum_{G=1}^{G} (P_{A\,p\,loc})\ \log_G(P_{A\,p\,loc})$$

- E is the Entropy of the total population for the entire region R:

$$E = -\sum_{G=1}^{G} (P_A)\ \log_G(P_A)$$

- P_A is the proportion of the group A:

$$P_A = \frac{Population\ of\ the\ A\ group}{Total\ population}$$

The input dataset is the residential population by origin at 100 m x100 m resolution. The grid data is considered as a population density surface. It is assumed that the population data is located at the centroid of the cell and that the population is uniformly distributed across the entire cell.

The local neighbourhood population of each grid cell corresponds to the total population included in a search radius (max distance) from the cell centroid weighted using a distance function:

$$w(d) = e^{-2d}$$

where d is the Euclidean distance between two cell centroids.

The Spatial Isolation Index ranges between 0 and 1. The highest value of isolation of 1 is obtained when all local environments of a LAU are composed only by a migrant group and no natives. The Information Theory Segregation Index again ranges between 0 and 1. The maximum value of 1 is obtained when each local environment has only one group of migrants, and the minimum value of 0 when each local environment has the same composition of the LAU.

For the calculation of the diversity indexes, the Shannon entropy index which is calculated according to the following formula:

$$H = -\sum_{i=1}^{R} p_i \log p_i$$

where p_i is the proportion of population in the region (LAU or FUA) of a given country of origin i.

Annex 4.B.

Regression estimates for clustering and isolation of migrants

Sample: 24 495 combinations between 9 297 LAU in France, Ireland, Italy, the Netherlands, Portugal, Spain, the United Kingdom and 115 countries of origin.

Method: OLS regression

Explanatory variables:

- Relative size of community: migrant population by country of origin/total population of the LAU;
- Size of city: total population of the LAU;
- Diversity of the city: Shannon entropy index of the LAU;
- Contiguity country of origin: dummy variable, equals 1 if countries of origin and residence have a shared border;
- Distance country of origin: weighted geographical distance between the country of origin of the migrants and their country of residence;
- Refugees/Migrants: share of refugees in respect of the total migrant population in 2010.

Annex Figure 4.B.1. Regression coefficients and standard errors

	Clustering	Isolation
Relative size of community	-0.0778*** (0.0010)	0.0500*** (0.0003)
Size of city	0.0511*** (0.0009)	0.0001 (0.0003)
Diversity of the city	-0.0282*** (0.0010)	-0.0058*** (0.0003)
Contiguity country of origin	-0.0543*** (0.0014)	-0.0108*** (0.0005)
Distance country of origin	0.0231*** (0.0011)	0.0017*** (0.0004)
Refugees/Migrants	0.0193*** (0.0010)	0.0010** (0.0003)
R2	0.6817	0.6521
Observations	23402	23402

Note: Stars indicate statistical significance of the variable (* $P \leqslant 0.05$, ** $P \leqslant 0.01$, *** $P \leqslant 0.001$).
Both models include fixed effects for countries of destination to control amongst others for systematic differences in the segregation indexes due to the characteristics of the original data sets.
Explanatory variables are rescaled to have a mean of 0 and a standard deviation of 0.5.
Source: Elaborations based on data sources detailed in section "Data processing and measurement".

Chapter 5. Inequality in Job Accessibility via Transit in US Cities

by

Ludovica Gazzé

This chapter studies patterns in job accessibility via transit, that is the number of jobs that are accessible with a 30-minute commute from a given census tract, across and within 46 US Core Based Statistical Areas (CBSAs). The Gini Index is used to measure inequality in job accessibility. Census and administrative data are used to construct several indices of racial segregation, concentration, and centralisation. The chapter examines the correlation between the observed inequality in job accessibility via transit and the spatial distribution of CBSAs' residents and jobs, as measured by these indices, as well as economic outcomes such as economic inequality and unemployment. Finally, the chapter characterises tracts enjoying different levels of job accessibility, both in terms of residents' characteristics and of geographic location within CBSAs.

Introduction

The spatial mismatch hypothesis posits that minorities' high unemployment rates and low wages are due to the fact that minorities reside in areas with low employment, or low employment growth (Kain, 1965, 1968; Raphael, 1998). After World War II, improvements in road transportation allowed industries with high land and transportation costs to relocate to the suburbs, areas that provided high land availability and proximity to highways (Glaeser and Kahn, 2001). In the US, white households were able to follow jobs to the suburbs, while African-Americans initially faced strong barriers to suburban residence (Boustan and Margo, 2009).

In a review of the literature on spatial mismatch, Ihlanfeldt and Sjoquist (1998) conclude that job accessibility is correlated to employment outcomes. However, causality is hard to establish, given concerns of reverse causality and selection. Moreover, several mechanisms other than commuting might drive the correlation between job accessibility and employment outcomes, such as lack of information about distant jobs, or (perceived) discrimination by employers (Hellerstein et al., 2008).

Public transit infrastructure, including bus and rail, could help mitigate this mismatch by allowing individuals to reach job opportunities located in different neighbourhoods at a low monetary cost. Blumenberg and Pierce (2014) show that beneficiaries of the Moving to Opportunities (MTO) programme who move to a neighbourhood with better public transit access appear to be better able to maintain employment. While beneficiaries' endogenous selection into neighbourhoods could be correlated with other factors influencing employment histories, this finding might help explain why MTO vouchers appear to have no impact on adult self-sufficiency, employment, earnings, or welfare receipt (Katz et al., 2001; Kling et al., 2007; Ludwig et al., 2013). This chapter examines the extent to which variation in job accessibility by transit is associated to better local economic outcomes, and if so, for whom.

Using data from 100 US Metropolitan Statistical Areas (MSAs), Tomer et al. (2011) document that job accessibility via transit differs considerably across metro areas, reflecting variable transit coverage levels and service frequencies, and variable levels of employment and population decentralisation. Moreover, fewer low- and middle-skill jobs are accessible via transit for the typical metropolitan commuter. These findings are in line with research showing that the recent urban revival is related to shifts in preferences of high skilled workers for amenities as well as for shorter commutes, which has lead them to move closer to Central Business Districts (CBDs) where high-skill jobs tend to be concentrated (Edlund et al., 2015; Couture and Handbury, 2017). Building on these findings, this chapter examines how patterns in job accessibility via transit within Core Based Statistical Areas (CBSAs) relate to inequality and economic outcomes within CBSAs.[1]

The main data source employed here defines job accessibility by transit as the number of jobs that are accessible with a 30-minute commute by transit from a given census tract. See Annex Table 5.A.1 for a list of data sources. Building on these data, this chapter constructs a measure of inequality in job accessibility by transit, the Gini index, to document the extent to which job accessibility by transit varies within the 46 US CBSAs in the study sample.

Second, this chapter investigates the role that residential and workplace location, as well as geographic and regulatory constraints to housing supply, play in determining the observed inequality in job accessibility via transit. Intuitively, the number of jobs accessible by transit from a given tract depends on the location of jobs within the CBSA and the transit network. Based on the available employment and commuting opportunities and the resulting equilibrium housing prices, households will select where to live. From a policy perspective, it is important to disentangle which factors are more strongly related to inequality in job accessibility.

Third, this chapter investigates the impact inequality in job accessibility via transit has on economic outcomes, both at the CBSA and at the tract level, and asks the following question. To what extent does inequality in job accessibility via transit translate into economic inequality? Finally, this chapter identifies tracts that appear to enjoy better job access as well as those that might be left behind.

Several aspects of urban shape as well as residential and workplace location may matter to understand the implications of inequality in job accessibility by transit. To investigate the importance of the geographic location of homes and jobs, this chapter constructs indicators of residential and job concentration that measure the extent to which people and jobs are more concentrated in certain tracts than land area would suggest. To investigate the relevance of the spatial mismatch hypothesis in accounting for inequality in job accessibility by transit, this chapter constructs indicators of residential and workplace segregation along racial lines that measure the extent to which white and minority households and jobs held by white and minority workers are evenly distributed across census tracts or appear to be segregated.

The main results include the following. In cities where employment is more concentrated, high workplace segregation along racial lines, rather than residential segregation, is associated with high inequality in job accessibility via transit. In these cities, public transit might fail to serve important centres of employment for minorities. Also in these cities, inequality in job accessibility via transit is associated with inequality in unemployment rates across tracts, suggesting that lack of transit might hinder job opportunities for residents of certain neighbourhood. The tract level analysis corroborates this hypothesis. In cities with high levels of workplace segregation, tracts with better access to jobs saw lower rates of growth in unemployment between 2000 and 2010. Tracts with higher minority rates appear to have access to fewer jobs within a 30-minute transit commute, in line with the spatial mismatch hypothesis. In contrast, income levels appear to be negatively correlated with job accessibility by transit reflecting the fact that wealthier households might sort into less served suburbs that are further away from jobs.

The chapter is structured as follows. After this introduction the next section discusses possible measures of job accessibility by transit, provides preliminary evidence on the relationship between inequality in job accessibility and workplace segregation and economic outcomes. The third section investigates which neighbourhoods within a given CBSA appear to suffer the most from poor public connections to jobs, and establishes both the characteristics of residents of tracts with better and worse access to jobs by transit and the location of these tracts located within cities. Finally, the last section concludes.

Inequality in job accessibility by transit across US cities

Measuring inequality in job accessibility by transit

This chapter investigates the role inequality in job accessibility by transit plays in shaping the spatial distribution of economic development in US CBSAs. The primary sub-CBSA unit of observation in this study is the census tract, a small, relatively permanent statistical subdivision of a county or equivalent entity, with a population size between 1 200 and 8 000 people. The data source for the measure of job accessibility counts the number of job accessible with a 30-minute transit commute between centroids of census blocks, statistical subdivisions fully contained within a census tract.[2] Transit modes include bus and rail. Travel times are computed using transit schedules valid for January 29, 2014, a Wednesday, and assuming perfect adherence to the schedule and a walking speed of 5 km/hour. Specifically, transit times between destinations are computed for each minute in the time interval between 7am and 9am, and averaged within this interval to take into account transit service frequency. To obtain the tract-level values, this chapter sums the measure for individual blocks within each tract. Finally, to define inequality in job accessibility by transit, the Gini index for this measure is constructed as explained in Box 5.1.

Box 5.1. Measuring the Spatial Distribution of Jobs and Residences

Gini Coefficient: The Gini coefficient is a measure of inequality of a distribution. It is defined as a ratio with values between 0 and 1, where 0 corresponds to perfect equality and 1 corresponds to perfect inequality. The numerator is the area between the Lorenz curve of the distribution and the uniform distribution line; the denominator is the area under the uniform distribution line. To construct the measure of inequality across tracts used in this chapter, each variable of interest is weighted by the share of the CBSA population that resides in the tract. The resulting formula is as follows:

$$G = \frac{\sum_i \sum_j \left| x_i w_i - x_j w_j \right|}{2n \sum_i x_i w_i}$$

where x_i is the tract-level variable of interest, *n* is the number of tracts in the CBSA, and $w_i = \frac{P_i}{P}$ is the share of the city population, *P*, that resides in tract *i*.

Dissimilarity Index: The Dissimilarity index is a measure of segregation that represents the proportion of the population or jobs that would have to move to create a perfectly homogeneous distribution. It ranges between 0 and 100, where 0 indicates an even distribution of minorities, and 100 indicates perfect segregation. The Dissimilarity index is computed as follows:

$$D = \frac{1}{2} \sum_i \left(\frac{k_i}{K} - \frac{1 - k_i}{1 - K} \right)$$

where k_i is the number of people or jobs in the majority group in tract *i* and *K* is the number of majority people or jobs in the whole CBSA.

Delta Index: The Delta index is a measure of concentration. It ranges between 0 and 1, where 0 indicates perfectly even distribution and 1 a concentration of all the population or jobs in one local unit only. It is computed as follows:

$$\Delta = \frac{1}{2} \sum_i \left| \frac{p_i}{P} - \frac{a_i}{A} \right|$$

where $\frac{p_i}{P}$ is the share of the city population, P, that resides in tract i and $\frac{a_i}{A}$ is the share of the city area, A, that is included in tract i.

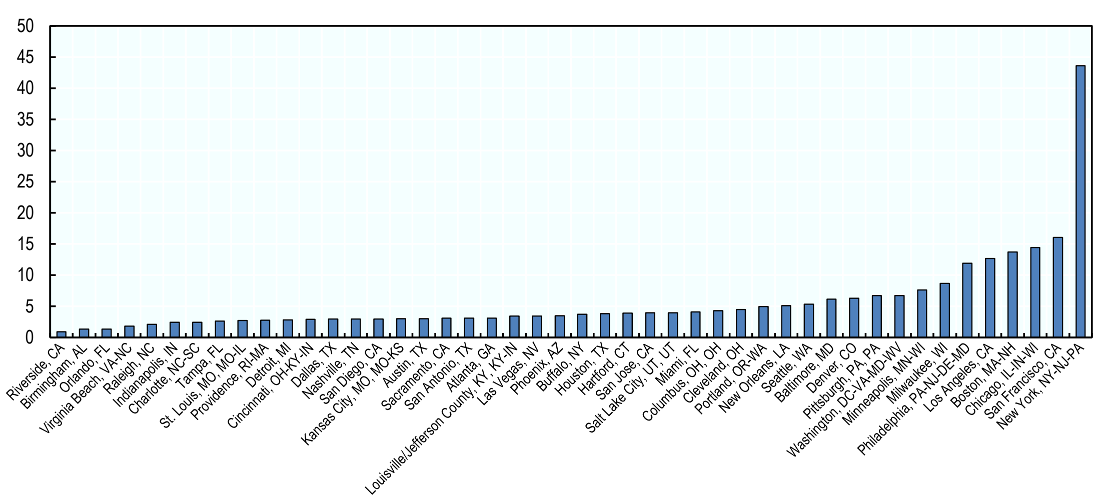
Modified Wheaton Index: The Modified Wheaton index is a measure of centralisation. It ranges between -1 and 1, where -1 indicates an even distribution of the population or jobs across the city, and 1 indicates perfect centralisation. To construct this index each tract's distance from the Central Business District (CBD) is computed. Annex Table 5.A.1 discusses data sources for tracts and CBD co-ordinates. Then ordering each tract from the closest to the farthest from the CBD, the index is computed as follows:

$$MWI = \frac{\sum_i (CumP_{i-1}Dist_i - CumP_i Dist_{i-1})}{MaxDist}.$$

Figure 5.1 shows that there is ample variation across CBSAs in the average number of jobs per capita that are available within a 30-minute transit commute. Specifically, the distribution of job availability is quite left-skewed, with residents of three-quarters of the CBSAs in the sample having access, on average, to fewer than ten jobs per capita within a 30-minute transit commute. Figure 5.2 shows similar variation in the level of inequality in jobs accessibility via transit at the CBSA level.

Figure 5.1. Dispersion in Job Accessibility via Transit

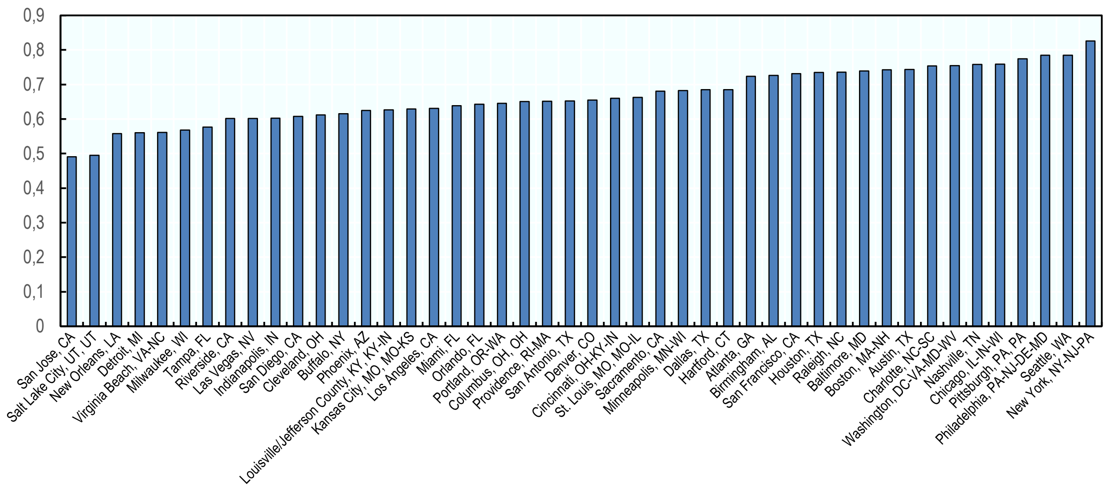
Jobs per capita within 30 minutes' transit



Note: This figure plots the average number of jobs per capita that are available from a CBSA's census tracts within a 30-minute commute on public transit, with averages calculated weighting by population. CBSAs on the x-axis are ranked based on the available number of jobs per capita within a 30-minute commute on public transit.
Source: Elaborations based on sources detailed in Annex 5.A.

Figure 5.2. Variation in Inequality in Job Accessibility via Transit

Weighted Gini, Accessibility



Note: This figure plots the Gini index for average number of jobs per capita that are available from a CBSA's census tracts within a 30-minute commute on public transit weighted by the tract's population share. CBSAs on the x-axis are ranked based on the weighted Gini index for the number of jobs per capita within a 30-minute commute on public transit.
Source: Elaborations based on sources detailed in Annex 5.A.

Workplace segregation is associated with inequality in job accessibility by transit

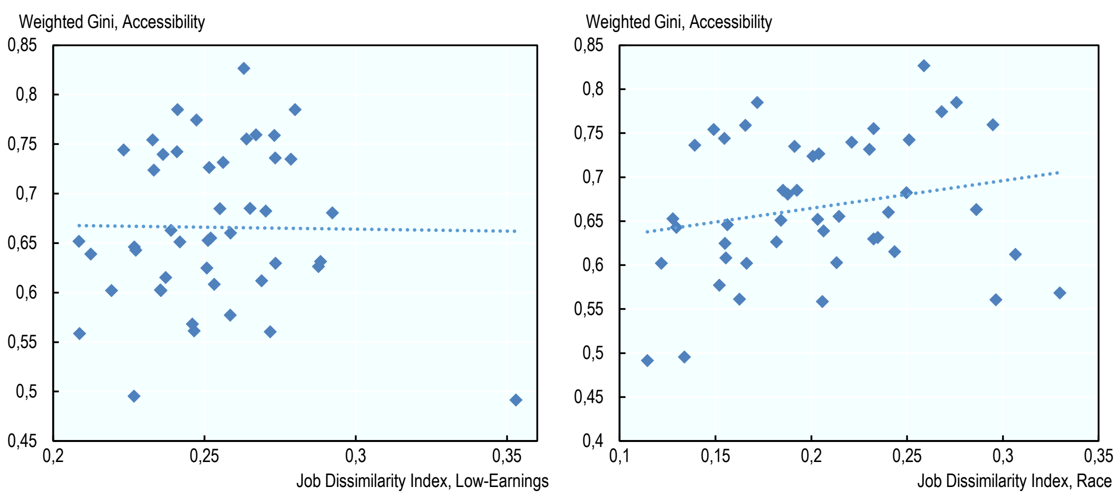
The measure of job accessibility by transit describes the interaction between the location of jobs within a CBSA and the extent of the transit network. Moreover, households select which neighbourhood they want to live in based on the available employment and commuting opportunities (Alonso, 1964; LeRoy and Sonstelie, 1983; Muth 1969). As CBSAs evolve, local governments invest in public transit based on the needs of their constituency. Thus, households' residence and employment location decisions, as well as public investments in transit infrastructure, are jointly determined in equilibrium. This section explores the characteristics of CBSAs that have a more unequal distribution of job accessibility via transit along these different equilibrium dimensions. Specifically, this section looks at the role played by workplace and residential location choices, as well as housing policies.

The main goal of this analysis is to investigate the extent to which the spatial distribution of jobs and residences might explain inequality in job accessibility by transit. Census data are used to describe the socioeconomic characteristics of tract residents, and matched employer-employee administrative records to derive the spatial distribution of jobs.[3] Annex Table 5.A.1 provides more details about these data sources. The main focus of this chapter is segregation along racial lines, both at the workplace and at the residential level, as measured by dissimilarity indices. For the purposes of this work, the population was divided between non-Hispanic whites and minorities. In addition, this section explores the role played by workplace and residential concentration and centralisation, as measured by Delta and Modified Wheaton indices respectively. Box 4.1 details the construction of these indices.

Finally, this section investigates the role played by land availability and land use regulations in determining residential and job locations. For example, areas with less land available for development due to geographic constraints will tend to be more spatially concentrated, thus simplifying commute by transit (Saiz, 2010). Similarly, stricter land use regulations might increase housing prices and make it more difficult for people to find accessible employment (Saks, 2008).

The left panel of Figure 5.3 shows that a higher index of job dissimilarity along race lines is associated with higher inequality in job accessibility via transit. In other words, cities that have more segregated employment locations exhibit also higher levels of inequality in job accessibility by transit. The right panel of Figure 5.3 shows that, if anything, the opposite appears to be true when segregation is measured according to earnings.

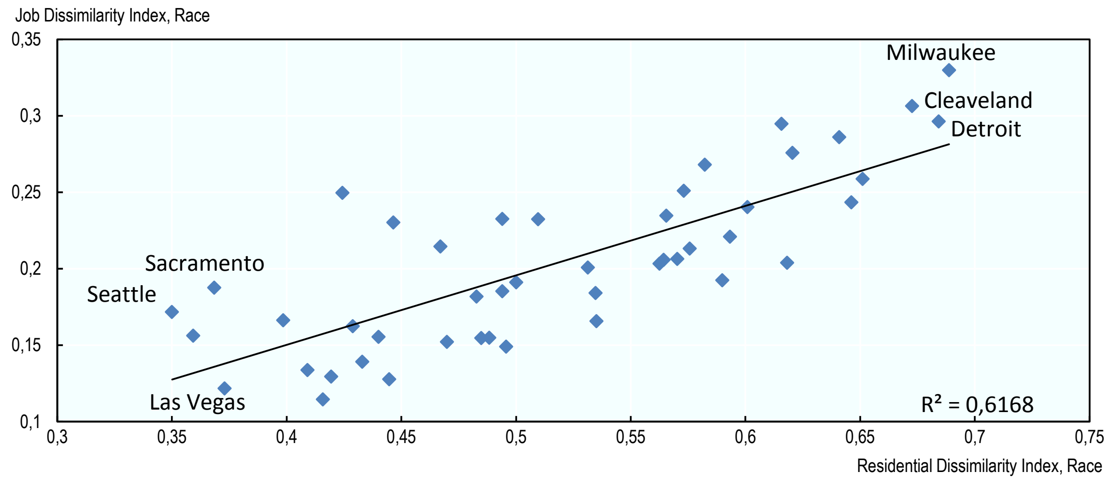
Figure 5.3. Accessibility Inequality and Workplace Segregation



Note: This figure plots CBSA-level Dissimilarity Indices calculated on the characteristics of jobs in each tract on the x-axis against the CBSA-level Gini Index in Job Accessibility by Transit on the y-axis, and fits a linear regression line. Specifically, the left panel constructs a racial Dissimilarity Index, while the right constructs an earnings Dissimilarity Index.
Source: Elaborations based on sources detailed in Annex 5.A.

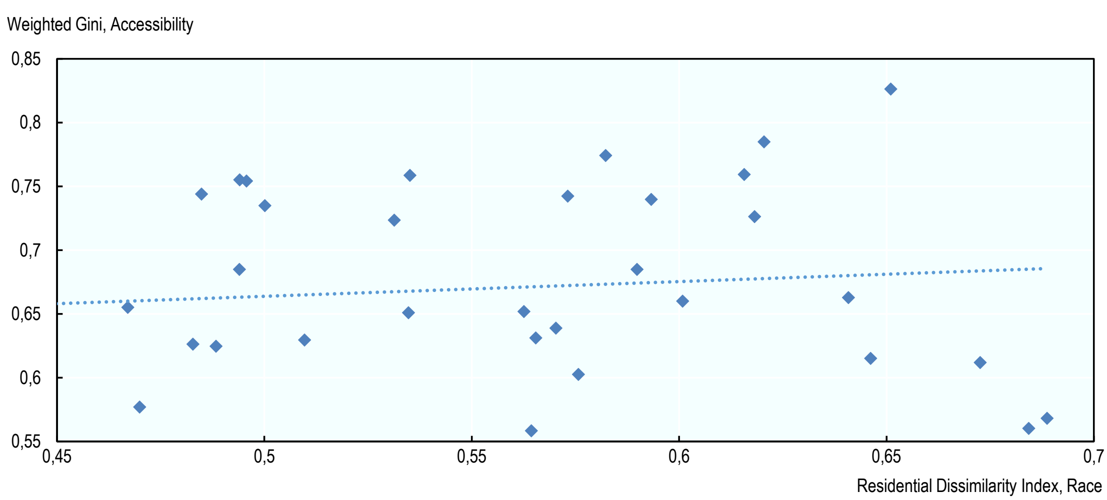
A potential explanation for the more prominent role of race in explaining inequality in job accessibility via transit is that workplace segregation and residential segregation along racial lines are positively correlated. Indeed, Figure 5.5 presents a similar pattern of positive correlation between residential segregation along racial lines and inequality in job accessibility via transit. Wilson (2008) notes that minority neighbourhoods "typically lack basic services and amenities, such as banks, grocery stores and other retail establishments, parks, and quality transit." In addition, Raphael and Stoll (2010) remark that among the poor, blacks appear to have suffered more from job suburbanisation. For example poor blacks are less suburbanised than poor whites and Latinos in metro areas with high job sprawl. And those poor black and Latinos who live in the suburbs live disproportionally in jobs-poor communities, particularly in higher-poverty metropolitan areas.

Figure 5.4. Workplace and Residential Segregation along Racial Lines



Note: This figure plots CBSA-level racial Dissimilarity Index calculated on the characteristics of residents in each tract on the x-axis against the CBSA-level racial Dissimilarity Index calculated on the characteristics of jobs on the y-axis, and fits a linear regression line.
Source: Elaborations based on sources detailed in Annex 5.A.

Figure 5.5. Accessibility Inequality and Residential Segregation

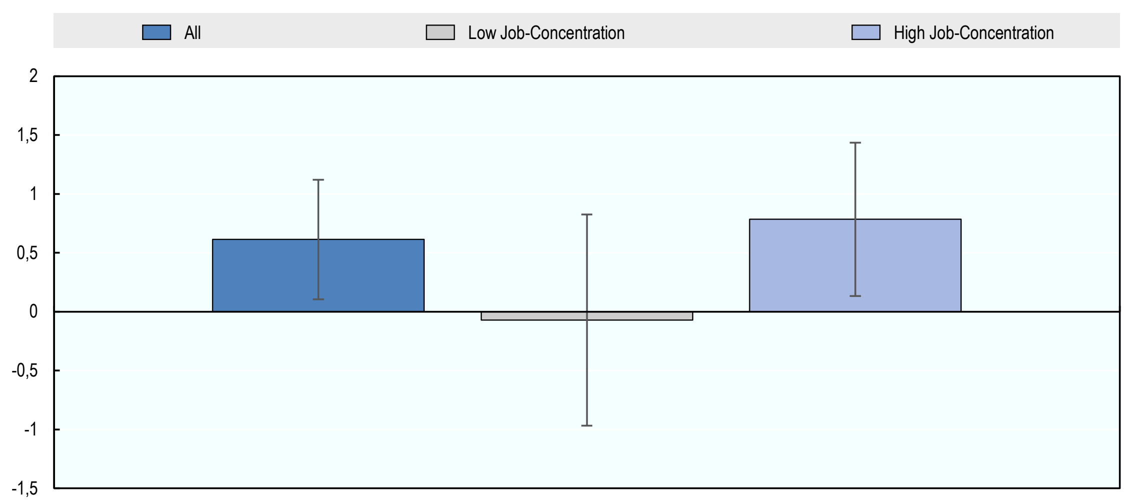


Note: This figure plots CBSA-level racial Dissimilarity Index calculated on the characteristics of residents in each tract on the x-axis against the Gini Index in Job Accessibility by Transit on the y-axis, and fits a linear regression line.
Source: Elaborations based on sources detailed in Annex 5.A.

Workplace segregation along racial lines appears to be strongly positively correlated with inequality in job accessibility by transit also in a regression analysis that considers all predictors of inequality in job accessibility via transit jointly. Figure 5.6 displays the coefficient on workplace segregation in this regression. To investigate the extent to which a city's productive structure might affect the relationship between workplace segregation and inequality in job accessibility via transit, the regression analysis divides CBSAs according to their degree of job concentration as measured by the Delta Index for jobs. On the one hand, a more dispersed spatial distribution of jobs might allow residents of different neighbourhoods to have easy access to jobs at different locations, resulting in a more equal job access distribution. On the other hand, job agglomeration might allow for better transit planning in a hub and spoke transit system, which is the structure of the transit network in many US CBSAs.

Notably, a comparison of the coefficients displayed in Figure 5.6 shows that the correlation between workplace segregation and inequality in job access is entirely driven by cities with a high concentration of jobs. This finding suggests that high-density employment centres might still lack essential transit connections that would allow minority neighbourhoods to access these jobs.

Figure 5.6. Effect of Workplace Segregation on Inequality in Job Accessibility by Transit



Note: This figure plots the coefficients on the job Dissimilarity Index along racial lines from a CBSA-level regression that includes also the residential Dissimilarity Index along racial lines, the residential Delta Index, the residential Modified Wheaton Index, the job Dissimilarity Index along earnings lines, the job Delta Index, and the job Modified Wheaton Index, as well as controls for population density, the share of land unavailable for development, and a housing Regulatory Index. The dependent variable is the Gini index for average number of jobs per capita that are available from a CBSA's census tracts within a 30-minute commute on public transit weighted by the tract's population share. The first bar is estimated on the entire sample of CBSAs, while the second bar is estimated on the sample of CBSAs with a below-median Delta Index for jobs, and the third bar is estimated on the sample of CBSAs with an above-median Delta Index for jobs. The bars represent confidence intervals at the 10% level.
Source: Elaborations based on sources detailed in Annex 5.A.

Table 5.1 presents coefficients for variables describing residential sorting (the first three variables) and job location (rows 4-7).[4] Strikingly, when controlling for other CBSA-level factors, residential segregation appears to be negatively correlated with inequality in job accessibility by transit. One potential explanation that is explored further in the within-CBSA analysis below is that residential segregation is correlated with minorities being concentrated in inner cities, which might have better public transit. The fact that workplace segregation appears to be positively correlated with inequality in job accessibility by transit suggests that although minorities might be living in neighbourhoods that are relatively well served after controlling for other socio-demographic characteristics, the jobs available to them might be in areas that have disproportionately worse public transit, lending support to the spatial mismatch hypothesis. Finally, it is worth to reiterate that these results do not appear to be driven by demand for skills. In fact, workplace segregation by earnings does not appear to be significantly correlated with inequality in job accessibility by transit.

This analysis considers also other metrics that describe the spatial distribution of households and jobs within a CBSA, that is, measures of concentration and centralisation of both residential and job locations. Specifically, centralisation indicates high density of people or jobs around the Central Business District (CBD), as identified by the geocode returned when entering the central city name in Google Earth.[5] Intuitively, higher residential concentration, as measured by the Delta Index is also associated with lower levels of transit inequality, as conditional on the existing transit network, more people might live close to transportation hubs in a highly concentrated city. Perhaps less intuitively, a high level of job centralisation, as measured by the Modified Wheaton Index is correlated with high levels of inequality in job accessibility by transit. This result suggests that, other things equal, the concentration of employment opportunities near the CBD does not guarantee equality of accessibility. One potential explanation is that urban shape might still play an important role, for example some cities might have multiple centres of employment.

Moreover, as inner cities gentrify and poor and minority residents suburbanise, concentration of jobs near the CBD might not improve job accessibility for some low-income and minority people, as discussed in Raphael and Stoll (2010) and Couture and Handbury (2017). In fact, Schuetz et al. (2017) emphasise that in most metropolitan areas, both central city and suburban neighbourhoods have increasingly become economically and ethnically diverse. Section 4.3 below analyses the characteristics of tracts that are farther from employment opportunities in the CBSA to validate these speculations.

Finally, it is worth noting that housing supply constraints reduce inequality in job accessibility by transit. Intuitively, differences in transit access across tracts are smaller in compact cities. On the other hand, housing regulations do not appear to have any additional explanatory power for inequality in jobs accessibility by transit. This is consistent with the findings that job location matters relatively more for job accessibility than residential sorting.

Inequality in Job Accessibility by Transit and Economic Outcomes

Given the correlation found in the previous section between inequality in job accessibility via transit and workplace segregation, it is natural to ask whether this inequality is reflected in economic outcomes as well. The left panel of Figure 4.7 shows that higher inequality in job accessibility via transit is associated with higher inequality in unemployment rates. The right panel of Figure 5.7 shows that inequality in job accessibility does not necessarily lead to higher levels of unemployment overall at the CBSA level. If anything CBSAs with higher levels of inequality in job accessibility via transit exhibit lower unemployment rates.

Table 5.1. Predictors of Inequality in Job Accessibility

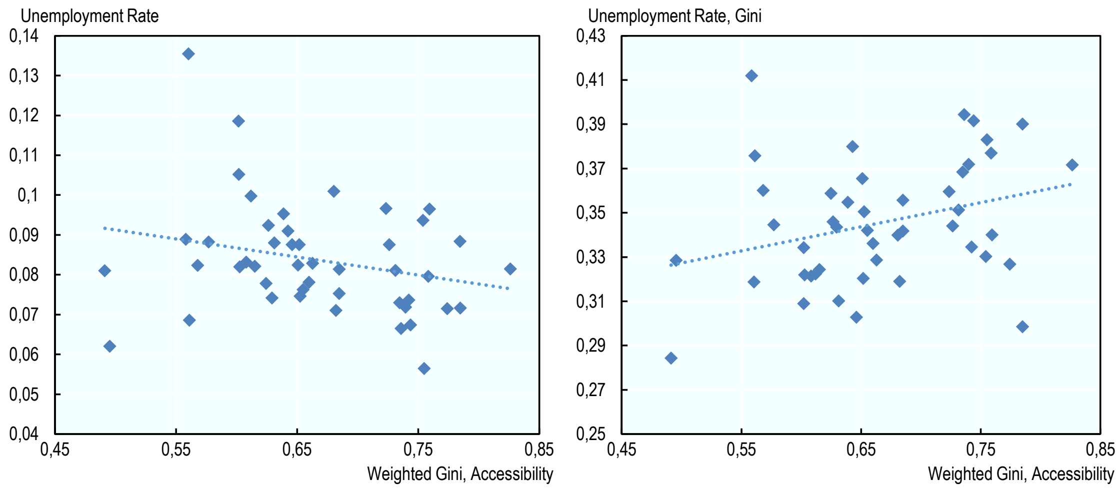
	(1)	(2)	(3)	(4)
Residential Dissimilarity Index, Race	-0.337*	-0.240	-0.129	-0.399
	(0.180)	(0.206)	(0.291)	(0.246)
Delta Index, Population	-0.735**	-0.562	-0.804*	-0.275
	(0.318)	(0.356)	(0.428)	(0.728)
Modified Wheaton Index, Population	-0.191	-0.265	0.143	-0.791
	(0.242)	(0.281)	(0.356)	(0.452)
Job Dissimilarity Index, Race	0.605*	0.612*	-0.071	0.784*
	(0.302)	(0.307)	(0.543)	(0.394)
Job Dissimilarity Index, Low-Skill	-0.257	-0.388	0.318	0.071
	(0.379)	(0.409)	(1.117)	(0.397)
Delta Index, Jobs	0.415	0.480	-0.110	0.157
	(0.477)	(0.499)	(0.846)	(1.040)
Modified Wheaton Index, Jobs	0.586**	0.546*	0.474	0.896*
	(0.266)	(0.313)	(0.412)	(0.480)
Population per Square Mile, 10,000	0.034*	0.041*	0.014	0.022
	(0.019)	(0.022)	(0.030)	(0.029)
Share Unavailable for Development		-0.132*		
		(0.070)		
Regulatory Index		0.021		
		(0.015)		
Constant	0.675***	0.584**	0.901**	0.594
	(0.229)	(0.247)	(0.358)	(0.395)
Observations	46	43	23	23
Adjusted R Squared	0.382	0.383	0.424	0.482

Note: This table shows regression coefficients from OLS models. The dependent variable is the Gini index for average number of jobs per capita that are available from a CBSA's census tracts within a 30-minute commute on public transit weighted by the tract's population share. Columns 1 and 2 are estimated on the entire sample of CBSAs, while Column 3 is estimated on the sample of CBSAs with a below-median Delta Index for jobs, and Column 4 is estimated on the sample of CBSAs with an above-median Delta Index for jobs.

*** implies significance at 0.01 level, ** 0.5, * 0.1.

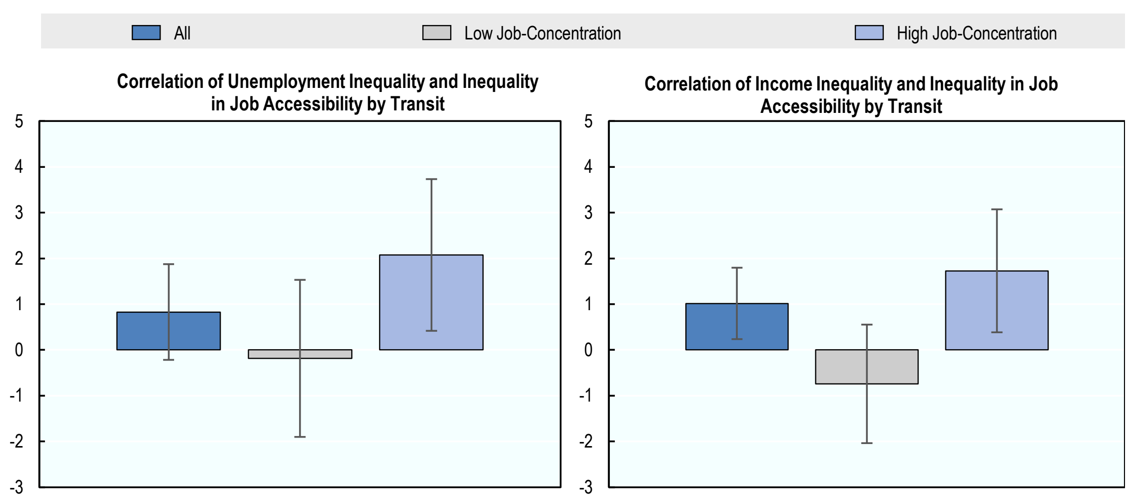
Source: Elaborations based on sources detailed in Annex 5.A.

Figure 5.7. Accessibility Inequality and Unemployment



Note: This figure plots the CBSA-level Gini Index in Job Accessibility by Transit on the x-axis against the CBSA-level Gini Index in unemployment rate (left panel) and the CBSA-level average unemployment rate (right panel) on the y-axis, and fits a linear regression line.
Source: Elaborations based on sources detailed in Annex 5.A.

Figure 5.8. Economic Inequality and Inequality in Job Accessibility



Note: This figure plots the coefficients on unemployment inequality (left panel) and income inequality (right panel) from a CBSA-level regression that includes also average household income, unemployment rate, minority share and Gini Index in minority share, share of high-school dropouts and Gini Index in share of high-school dropouts, share of households with cars and Gini Index in share of households with cars, and population density. The dependent variable is the Gini index for average number of jobs per capita that are available from a CBSA's census tracts within a 30-minute commute on public transit weighted by the tract's population share. The first bar is estimated on the entire sample of CBSAs, while the second bar is estimated on the sample of CBSAs with a below-median Delta Index for jobs, and the third bar is estimated on the sample of CBSAs with an above-median Delta Index for jobs. The bars represent confidence intervals at the 10% level.
Source: Elaborations based on sources detailed in Annex 5.A.

A regression analysis confirms that inequality in job accessibility appears to still be correlated with inequality in some economic outcomes after controlling for overall levels. The left panel of Figure 5.8 shows that in CBSAs with above-median levels of job concentration, higher inequality in job accessibility via transit is associated with higher inequality in unemployment rate. One potential explanation for this finding is that in cities where employment is less dispersed, workplace segregation might result in fewer employment opportunities available by transit for residents of minority neighbourhoods, thus creating pockets of unemployment at the neighbourhood level, and giving raise to the observed inequality in unemployment rates at the CBSA level. This channel is analysed further in Section 5.3 below, exploiting data at the census tract level.

Table 5.2. Inequality in Job Accessibility and Economic Outcomes

	(1)	(2)	(3)	(4)
Average HH Income, 1,000USD	-0.000	0.000	0.001	0.000
	(0.001)	(0.001)	(0.002)	(0.002)
Unemployment Rate	-0.826	-0.509	1.547	-1.030
	(0.812)	(0.883)	(1.564)	(1.828)
Minority Share	0.156	0.182	0.146	-0.093
	(0.114)	(0.213)	(0.405)	(0.264)
Share of HS Dropouts	-0.493	-0.337	0.754	0.101
	(0.420)	(0.445)	(0.818)	(0.678)
Share of HHs with Cars	-0.876***	-1.404***	-1.824**	-1.881**
	(0.245)	(0.329)	(0.617)	(0.638)
Population per Square Mile, 10,000	-0.036	-0.048*	-0.259***	-0.033
	(0.023)	(0.024)	(0.069)	(0.041)
Weighted Gini, Average HH Income		1.014**	-0.742	1.728*
		(0.474)	(0.783)	(0.813)
Weighted Gini, Unemployment Rate		0.828	-0.186	2.076*
		(0.633)	(1.040)	(1.006)
Weighted Gini, Minority Share		0.143	-0.308	-0.261
		(0.286)	(0.489)	(0.412)
Weighted Gini, Share of HS Dropouts		-0.211	0.557	-0.742*
		(0.250)	(0.433)	(0.383)
Weighted Gini, Share of HHs with Cars		-1.347**	1.202	-2.688**
		(0.599)	(0.967)	(0.959)
Constant	1.578***	1.659***	2.185**	2.245***
	(0.282)	(0.407)	(0.891)	(0.640)
Observations	46	46	23	23
Adjusted R Squared	0.252	0.334	0.586	0.284

Note: This table shows regression coefficients from OLS models. The dependent variable is the Gini index for average number of jobs per capita that are available from a CBSA's census tracts within a 30-minute commute on public transit weighted by the tract's population share. Columns 1 and 2 are estimated on the entire sample of CBSAs, while Column 3 is estimated on the sample of CBSAs with a below-median Delta Index for jobs, and Column 4 is estimated on the sample of CBSAs with an above-median Delta Index for jobs.
*** implies significance at 0.01 level, ** 0.5, * 0.1.
Source: Elaborations based on sources detailed in Annex 5.A.

In addition, inequality in job accessibility appears to be associated with disparities in income across tracts, as measured by the tract-level Gini Index, as shown in the right panel of Figure 4.8. In contrast, inequality in job accessibility does not appear to be correlated with levels of economic development overall (Table 5.2). Finally, one would expect car ownership rates to respond to the (lack of) availability of transit, creating a positive correlation between inequality in job accessibility by transit and car ownership. In contrast, Table 5.2 shows a negative correlation between levels of car ownership and inequality in job accessibility via transit, suggesting that households might not be able to substitute for the absence of public infrastructure by privately investing in cars.

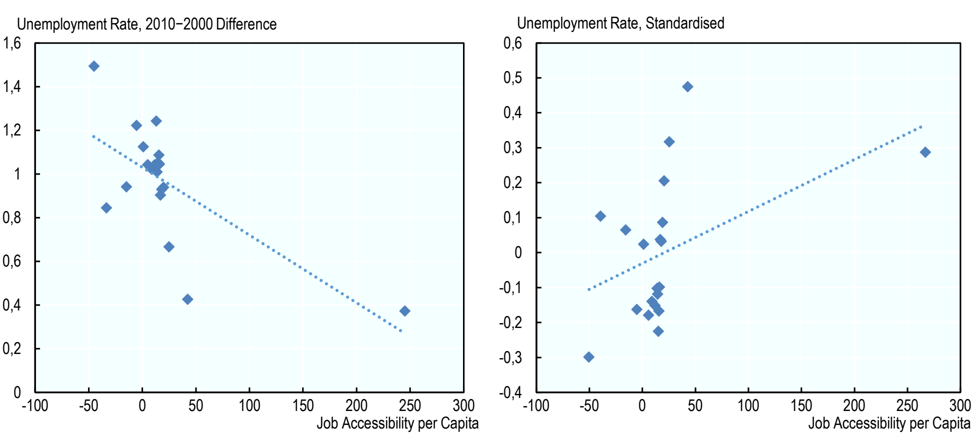
Inequality in job accessibility via transit within US cities

Access to jobs via public transit is correlated with employment growth

This section investigates which neighbourhoods within a given CBSA appear to suffer the most from poor public connections to jobs. Specifically, this section explores the characteristics of census tracts with different levels of job accessibility by transit within the same CBSA. The sample includes 33 624 census tracts in the 46 CBSAs studied above. Section 4.2.2 above suggests that workplace segregation along racial lines is associated with inequality in job accessibility by transit at the CBSA level. Therefore, the regression analysis distinguishes between cities with below- and above-median levels of workplace segregation as measured by the race Dissimilarity Index.

Tracts that have access to more jobs via public transit have generally been associated with lower rates of growth in unemployment in the years 2000s. In other words, where job opportunities are more segregated, access to public transit appears to enable workers to find and keep employment at higher rates. This pattern is shown in the left panel of Figure 4.9, while the right panel of Figure 4.9 shows that these tracts do not necessarily have lower levels of unemployment in absolute terms. Table 5.3 confirms that this pattern holds also after controlling for tracts' socioeconomic characteristics and absorbing CBSA fixed effects. Specifically, this relationship holds only in cities with high levels of workplace segregation.

Figure 5.9. Unemployment Growth and Job Accessibility



Note: This figure plots the tract-level number of jobs accessible per tract on the x-axis against the tract-level growth in unemployment rate between 2000 and 2010 (left panel) and the tract-level unemployment rate, standardised (right panel) on the y-axis after partialling out CBSA fixed effects, and fits a linear regression line.
Source: Elaborations based on sources detailed in Annex 5.A.

Table 5.3. Predictors of Job Accessibility at the Tract Level

	(1)	(2)	(3)	(4)
Average HH Income, Standardised	-11.912	-4.314	-1.860***	-5.980
	(10.592)	(8.499)	(0.308)	(12.594)
Unemployment Rate, Standardised	1.093	0.956	-0.585	2.660
	(6.772)	(8.330)	(0.494)	(11.351)
Minority Share, Standardised	-16.686**	-17.993**	-0.868*	-23.359**
	(6.736)	(7.131)	(0.504)	(8.405)
Share of HS Dropouts, Standardised	-6.750	-3.258	-0.432	-7.034
	(4.090)	(3.518)	(0.341)	(5.994)
Share of HHs with Cars, Standardised	-38.217***	-49.950***	-14.485***	-55.501***
	(9.116)	(7.527)	(1.200)	(8.250)
Distance from CBD, Standardised	-12.012***	-7.539***	-2.994***	-9.109***
	(3.623)	(1.657)	(0.536)	(2.102)
Distance from Nearest Subcentre, Standardised	-112.066*	-87.864	-35.274***	-120.186
	(59.894)	(59.238)	(6.832)	(92.769)
Average HH Income, 2010-2000 Difference		-44.280	4.825***	-64.238
		(36.639)	(1.242)	(54.559)
Unemployment Rate, 2010-2000 Difference		-0.908*	0.054	-1.272**
		(0.495)	(0.050)	(0.565)
Minority Share, 2010-2000 Difference		-0.319	-0.360*	-0.366
		(0.406)	(0.182)	(0.422)
Share of HS Dropouts, 2010-2000 Difference		-4.389	-0.336	-6.283
		(3.209)	(0.298)	(4.580)
Share of HHs with Cars, 2010-2000 Difference		133.722	33.583***	145.759
		(129.274)	(4.840)	(152.304)
Constant	20.259***	32.696***	18.798***	19.400
	(0.063)	(10.794)	(1.957)	(23.364)
Observations	33624	33471	11202	22269
Adjusted R Squared	0.020	0.029	0.308	0.030

Note: This table shows regression coefficients from OLS models that absorb CBSA fixed effects. The dependent variable is the number of jobs per capita that are available from a CBSA's census tracts within a 30-minute commute on public transit weighted by the tract's population share. Columns 1 and 2 are estimated on the entire sample of CBSAs, while Column 3 is estimated on the sample of CBSAs with a below-median racial dissimilarity index for jobs, and Column 4 is estimated on the sample of CBSAs with an above-median racial dissimilarity index for jobs.

*** implies significance at 0.01 level, ** 0.5, * 0.1.

Source: Elaborations based on sources detailed in Annex 5.A.

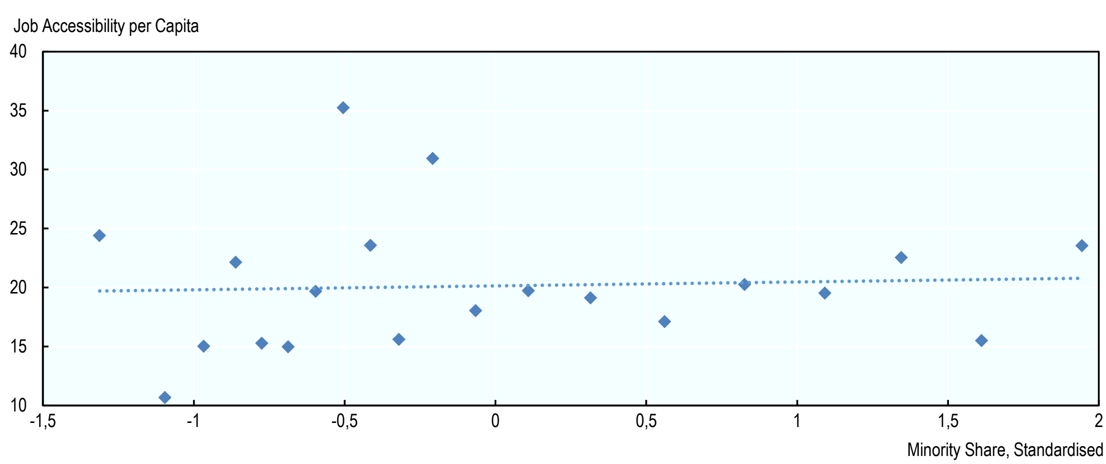
Tracts with better job access have fewer minority residents and are closer to employment centres

This last section asks the following questions. What are the characteristics of residents of tracts with better and worse access to jobs by transit? And where are these tracts located within cities' geographies?

Tracts with higher minority rates appear to have access to fewer jobs by transit, consistent with the spatial mismatch hypothesis (Figure 5.10). Table 5.3 confirms that this racial pattern holds after controlling for income. In fact, income appears to be negatively correlated with job accessibility by transit, likely reflecting the fact that wealthier households might sort into less served suburbs. To this point, car ownership rates are also negatively correlated with job access via public transit.

Intuitively, geographic location relative to employment centres matters for access to jobs. To analyse the spatial distribution of tracts with better and worse access to jobs within CBSAs, each tract's distance to the CBD and to the closest economic subcentre is computed. Specifically, tracts with an abnormal job density are identified as economic subcentres, following Veneri (2015). Table 5.4 shows that on average, close to 10% of tracts in a given city are identified as subcentres. Table 5.3 shows that a tract's distance from the CBD and other employment subcentres is negatively correlated with job access by transit. What's more, distance to the nearest subcentre appears to matter relatively more than distance to the CBD, suggesting that polycentric cities might result in a more equal distribution of job accessibility.

Figure 5.10. Accessibility Inequality and Neighbourhood Composition



Note: This figure plots the tract-level minority share, standardised, on the x-axis against the tract-level number of jobs accessible per tract on the y-axis after partialling out CBSA fixed effects, and fits a linear regression line.
Source: Elaborations based on sources detailed in Annex 5.A.

The identification of economic subcentres within a CBSA allows to further investigate the spatial mismatch hypothesis and the finding that tracts with higher minority rates appear to have access to fewer jobs by transit. Figure 5.11 shows that the relationship between a tract's distance from the closes economic subcentre and the share of minorities in that tract is nonlinear. Specifically, for tracts that are relatively close to economic subcentres, the minority share increases with distance.

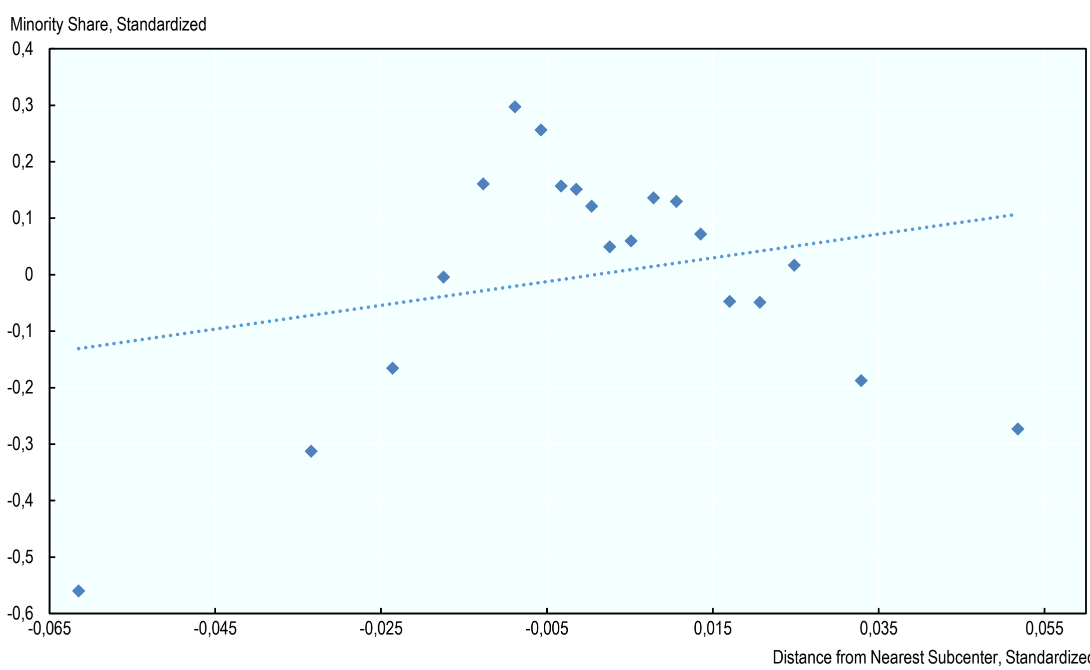
Table 5.4. Summary Statistics: Accessibility and Demographic Inequality

	Low-Density CBSAs	High-Density CBSAs
Jobs Per Capita within 30 Minutes Transit	3.488	7.958
	(1.475)	(8.948)
Weighted Gini, Accessibility	0.667	0.665
	(0.0624)	(0.0936)
Share of Subcentres	0.0956	0.0967
	(0.00554)	(0.00479)
Observations	23	23

Note: This table shows summary statistics at the CBSA level for job accessibility per capita, inequality in job accessibility, and share of tracts that are economic subcentres.
Source: Elaborations based on sources detailed in Annex 5.A.

However, for tracts that are further from economic subcentres than the CBSA's average, minority share decreases with distance. This pattern confirms that minorities might indeed suffer from poorer connections to jobs than their white counterparts, with the exception of those wealthier households who sort into less served suburbs and commute by car.

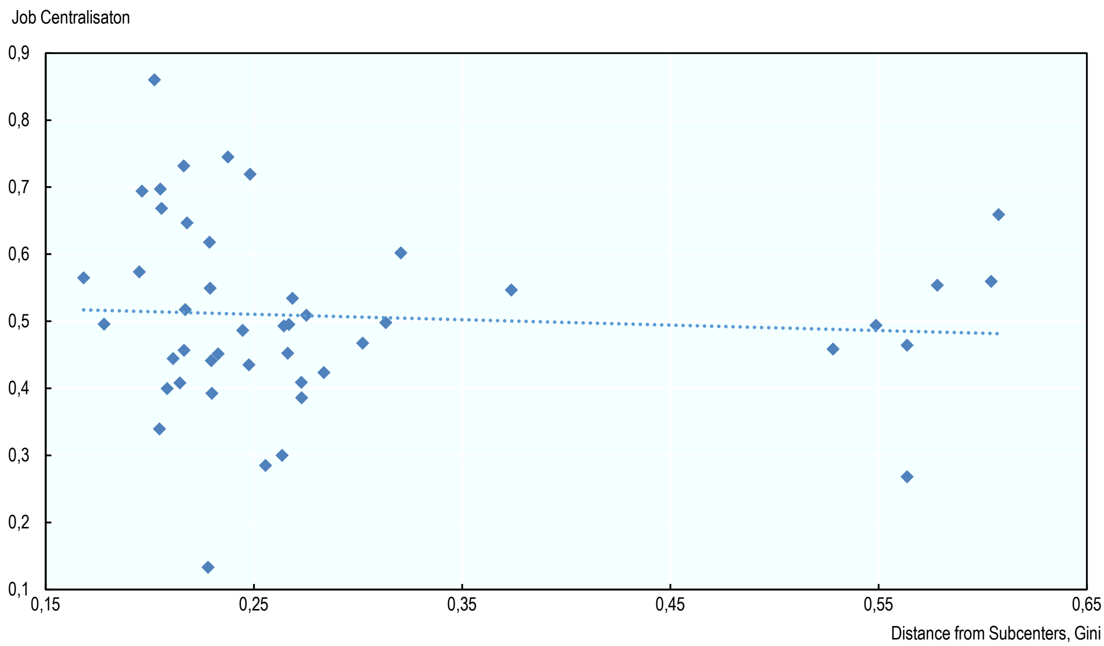
Figure 5.11. Distance from Economic Subcentres and Neighbourhood Composition



Note: This figure plots tracts' standardised distance from economic subcentres on the x-axis against the tracts' standardised minority share on the y-axis, after partialling out CBSA fixed effects, and fits a linear regression line.
Source: Elaborations based on sources detailed in Annex 5.A.

Finally, this section analyses the implications of polycentric CBSAs. As shown above, a high level of job centralisation, as measured by the Modified Wheaton Index is correlated with high levels of inequality in job accessibility by transit. One potential explanation is that when cities have multiple centres of employment, the distance from the CBD might not be the relevant metric for some workers. In fact, job centralisation is only moderately negatively correlated with distance from the nearest subcentre of employment, as shown in Figure 5.12.

Figure 5.12. Inequality in Distance from Economic Subcentres and Job Centralisation



Note: This figure plots CBSA-level Gini Index for tracts' distance from economic subcentres on the x-axis against the CBSA-level Modified Wheaton Index for jobs on the y-axis, and fits a linear regression line.
Source: Elaborations based on sources detailed in Annex 5.A.

Conclusion

This chapter examines how patterns in job accessibility via transit within 46 US Core Based Statistical Areas (CBSAs) relate to inequality and economic development within CBSAs. This work exploits a variety of administrative and survey data sources for 33 624 census tracts in these 46 CBSAs, including demographic characteristics and employment counts, as well as information on the number of jobs that are accessible with a 30-minute commute by transit from a given census tract. The analysis relies on measures of socioeconomic inequality, as well as a measure of inequality in job accessibility by transit.

First, this chapter documents the extent to which job accessibility by transit varies within the 46 US CBSAs in the sample. Second, it explores the role that residential and workplace location, as well as housing policies, play in determining the observed inequality in job accessibility via transit. Third, this chapter investigates the impact inequality in job accessibility via transit has on economic outcomes, both at the CBSA and at the tract level. Specifically, it studies the extent to which inequality in job accessibility via transit translates into economic inequality. Finally, this chapter asks which tracts appear to enjoy better job access and who, instead, might be left behind.

The results in this chapter show that in CBSAs where there is high inequality in job accessibility by transit, most jobs within a given tract are more likely to be held either by whites or by minorities than the overall CBSA-level racial composition would suggest. In fact workplace segregation along racial lines, rather than residential segregation, exhibits a stronger association with inequality in job accessibility by transit. In these cities, public transit might fail to serve important centres of employment for minorities, thus leading to higher inequality in unemployment rates across tracts. Moreover, in cities with high levels of workplace segregation, tracts with better access to jobs saw lower rates of growth in unemployment between 2000 and 2010. These findings together suggest that lack of transit might hinder job opportunities for residents of certain neighbourhoods. Finally, tracts with higher minority rates appear to have access to fewer jobs by transit, in line with the spatial mismatch hypothesis. In contrast, income levels appear to be negatively correlated with job accessibility by transit reflecting the fact that wealthier households might sort into less served suburbs.

Notes

[1] According to the US Census Bureau, Core Based Statistical Areas (CBSAs) consist of the county or counties or equivalent entities associated with at least one core (urbanised area or urban cluster) of at least 10 000 population, plus adjacent counties having a high degree of social and economic integration with the core as measured through commuting ties with the counties associated with the core. The general concept of a CBSA is that of a core area containing a substantial population nucleus, together with adjacent communities having a high degree of economic and social integration with that core. CBSAs include metropolitan statistical areas and micropolitan statistical areas.

[2] Owen and Levinson (2014) count the number of jobs within 10, 20, 30, 40, 50, and 60 minutes. However, they only publish data about the number of jobs available within a 30-minute commute, which limits the scope of the analysis in this chapter. According to their study, between a fifth and a tenth of the jobs available within an hour commute are available within a 30-minute commute. For reference, the 2009 American Community Survey data show that workers took an average of 25.1 minutes to get to work, an increase from 1980 when average commute was just under 22 minutes. While 62.2% of workers reported commuting for 29 minutes or less, average commutes by public transit is longer, 47.8 minutes (McKenzie and Rapino, 2011).

[3] In these data, a place of work is defined by the physical or mailing address reported by employers in the QCEW (formerly ES-202) or Multiple Worksite Reports. In other words, if employers report multiple worksites, jobs are allocated accordingly. However, if employers fail to report these, then all jobs will be allocated to headquarters.

[4] The regression analysis also controls for population density to account for the fact that less dense cities might rely on different transit networks and might exhibit different residential and job distribution patterns.

[5] Data on the location of the CBD comes from Holian and Kahn (2015).

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Annex 5.A.

Annex Table 5.A.1. Data Sources

Description	Data Source	Data Granularity	Year
Number of jobs accessible with a 30 minutes transit commute	Owen, A. and D.M. Levinson (2014)	Census Block	2014
Race, Average Household Income, Unemployment Rates, Share of High School Dropouts, Share of Households Owning Cars	Geolytics (2018) Neighborhood Change Database, http://www.geolytics.com/USCensus,Neighborhood-Change-Database-1970-2000,Products.asp	Census Tract	2010 2000-2010 Difference
Number of jobs, Race, Earnings, Industry	Census Bureau (2018) Workplace Area Characteristics Files, LODES Data, https://lehd.ces.census.gov/data/	Census Block	2014
Share of land unavailable for development within a 50 km radius	Saiz (2010), Kindly shared by the author	MSA	
Index of housing supply regulations	Saks (2008). Kindly shared by the author	MSA	
Tact Co-ordinates	Census Bureau (2018) U.S. Gazetteer Files https://www.census.gov/geo/maps-data/data/gazetteer.html	Census Tract	2010
CBD Co-ordinates	Holian and Kahn (2015) http://mattholian.blogspot.com/2013/05/central-business-district-geocodes.html		

Chapter 6. A multi-level model of vicious circles of socio-economic segregation

by

Maarten van Ham, Tiit Tammaru and Heleen J. Jannsen

This chapter develops a multi-level conceptual model of segregation, by using three conceptual levels – individuals and households, generations, and urban regions. Different socio-economic groups sort into different types of neighbourhoods and other domains, leading to patterns of segregation at the urban regional level. At the same time exposure to different socio-economic contexts also affects individual outcomes, and this subsequently leads to sorting processes into neighbourhoods and other domains. This vicious circle of sorting and contextual effects continuously crosses the three levels, and leads to higher levels of segregation. The chapter concludes with a discussion of several intervention strategies that focus on breaking the vicious circles to improve cities as places of opportunities by investing in people, in places and in transport.

Introduction

Income inequality has increased in many countries and as a result the gap between the poorest and the richest in society is the largest in 30 years (OECD, 2015). Although there are differences in the timing, intensity and directions of changes across countries (OECD, 2008), generally speaking higher income groups have benefited more from economic growth than lower income households. In particular, higher skilled people have seen their incomes rise, while those with fewer skills have not kept up (OECD, 2015).

Rising inequality in incomes and wealth (Piketty, 2013) is a major concern because it also influences inequality in other life domains, and has consequences for the education, health, life expectancy, employment prospects and wages of individuals. It can be expected that the higher the level of social inequalities in a society, the more difficult it is to experience upward social mobility because of the large socio-economic distance between lower and higher status groups. This is related to the idea that higher social inequalities reduce intergenerational social mobility (as in the Great Gatsby Curve phenomenon, see Krueger, 2012). On a societal level, inequality can harm social stability, and reduce trust in governments and institutions, and could even put at risk democratic processes as lower income groups become disengaged with politics (OECD, 2015).

Inequality has a clear spatial footprint in cities, where rich and poor people often live segregated in different neighbourhoods (Tammaru et al., 2016). In this chapter, the term segregation is used for the spatial separation of two or more groups in different domains of daily life, including residential neighbourhoods, schools and workplaces. Segregation can also occur in flows, for example when different population groups use different transport modes or the same transport at different times, as well as in digital space, for example in the form of digital communities (Tubergen, 2017). The main focus of this chapter is on spatial segregation in residential neighbourhoods, but segregation in schools and workplaces is also discussed.

Since 2001, socio-economic residential segregation of the rich and the poor has increased in many European cities. The international comparative study "Socio-Economic Segregation in European Capital Cities. East Meet West" (Tammaru et al., 2016) compares levels of socio-economic segregation in 2001 with that of 2011 in 12 European cities: Madrid, Tallinn, London, Stockholm, Vienna, Athens, Amsterdam, Budapest, Riga, Vilnius, Prague and Oslo (in order of decreasing levels of segregation). To put this in perspective it is important to mention that segregation in European cities is still relatively low compared to cities in, for example, Asia or North America. The comparative study identifies rising inequality as a major cause of increasing segregation (Musterd et al., 2017).

Like in most US cities, also in many European cities the rich live more concentrated than the poor (Florida, 2015); this is largely the case because higher income groups have more freedom in choosing where they want to live than lower income groups. Those with money sort into the most desirable neighbourhoods and communities by "voting with their feet". Households with similar tastes and incomes choose to live together in the same communities where (public) services are best. Similarly, local communities compete to attract households by providing high quality services. This so-called Tiebout sorting effect (Tiebout, 1956) leads to the unequal distribution of services and segregation by income and social status (Corcoran, 2014). The sorting of higher income households into the most desirable neighbourhoods and communities increases house prices in these areas. This limits the choice of lower income groups who end up concentrated in those neighbourhoods where housing is cheap.

For those who live in the poorest neighbourhoods in cities, their residential neighbourhood is often the result of a lack of choice; they live there where there is a spatial concentration of affordable housing. The more clustered affordable housing is in a city, the more rapidly segregation levels rise. Segregation is deemed to be especially problematic when it is involuntary and when there are negative side effects of growing up and living in large spatial concentrations of poverty (Tammaru et al., 2016). Although the negative effects of the Tiebout sorting process are mediated by centrally co-ordinated provision of services, such as schools (Corcoran, 2014), it is still the case that in deprived communities, for example, school quality is lower than in more affluent communities.

The spatial concentration of poverty in neighbourhoods can have negative effects on the outcomes of individuals, especially for children. There is an ongoing debate on whether high levels of deprivation in certain neighbourhoods simply reflect the population composition of these neighbourhoods, or whether there are also additional negative contextual neighbourhood effects on individual outcomes. There is increasing evidence of negative neighbourhood effects of growing up in deprived neighbourhoods on outcomes of children, adolescents and adults (Hedman et al., 2015; Chetty et al., 2016). In many places, segregation by income also has ethnic and racial dimensions and it is often the case that non-Western immigrants and their descendants live concentrated in low income areas. Immigrants might therefore be more likely to suffer the consequences of negative neighbourhood effects.

The aim of this chapter is to come to a better understanding of the links between social inequalities and socio-economic segregation. Most of the segregation literature focusses on better understanding ethnic and racial dimensions of separation and processes behind socio-economic segregation have received less attention. As said before, the two dimensions of segregation are strongly connected; income differences are often also at the heart of ethnic and racial inequalities and as a result of differential sorting of ethnic and social groups into different housing and neighbourhood types of the city; overlapping overlap social, ethnic, housing and spatial disadvantages is the outcome.

This chapter will develop a multi-level conceptual model of segregation, by using three conceptual levels – individuals and households, generations, and urban regions – and the idea of vicious circles. As different socio-economic groups sort into different housing segments and residential neighbourhoods and other domains (work, school, leisure), at the aggregate level of urban regions patterns of segregation emerge. As a result of the sorting processes, individuals are exposed to concentrations of higher and lower income groups in their residential neighbourhood and other life domains. This sorting of people into different domains is not independent as, for example, children often go to a nearby school. As a result, children who grow up in a poverty neighbourhood often also go to a school with a low socio-economic status. The exposure to poverty concentrations in different domains affects individual outcomes through negative contextual (neighbourhood) effects. This creates vicious circles of sorting and contextual effects, which continuously cross levels and generations, and which leads to segregation at the level of cities and regions. For example, the concentration of poverty of the neighbourhood where parents live influences (or is related to) the concentration of poverty of their children's school, and this will affect the outcomes of these children later in life (through contextual school and neighbourhood effects). There is strong intergenerational transmission of poverty and living in poverty neighbourhoods from parents to children, and these children affect their own children as they grow up (van Ham et al., 2014; De Vuijst et al., 2017; Hedman et al., 2017). These individual outcomes, in turn, reinforce the sorting of different socio-economic groups into different neighbourhoods. At the aggregate level of cities and regions this vicious circle contributes to spatial segregation by income in each of the domains (van Ham and Tammaru, 2016). Hence, housing and spatial inequalities have become a crucial part of the structures of inequalities in European cities.

The remainder of this chapter is structured as follows. The next section presents a brief summary of changes of socio-economic segregation in European cities is presented. The third section outlines the main contours of a multi-level conceptual model of socio-economic segregation. Finally, the last section discusses some of the policy implications with a focus on breaking the vicious circles of segregation and improving cities as places of opportunities by investing in people, places and transport.

Background

Fundamentally, socio-economic segregation in cities is a symptom of income and wealth inequality (Tammaru et al., 2016; van Ham et al., 2016). The extent to which inequality leads to spatial segregation is strongly related to welfare and housing market systems, and to the spatial organisation of the urban housing market (van Ham et al., 2016). The type of welfare and housing market system in a country can either soften or enhance the effects of income inequality (Musterd and Ostendorf, 1998). Europe generally has a tradition of strong welfare states compared to the rest of the world (Esping Andersen 1990), and because of this, the level of segregation in European cities, although growing, is still low compared to the rest of the world; the most segregated cities in Europe are still less segregated than most major cities in the United States (Florida, 2015).

Urban planning shapes segregation patterns as well. Every city has spatial concentrations of low and high cost housing. In many European cities, from the 1950s to the 1980s, there was a great demand for affordable housing related to rapid industrialisation and urbanisation. Especially in the 1960s and 1970s, this resulted in the development of large housing estates, often consisting of social or public housing, and often at the edges of cities (Hess et al., 2018). A good example is the "million home programme" in Sweden, where one million (mostly public rented) homes were built in only 15 years (Andersson and Bråmå, 2018). Initially these housing estates housed the middle classes, but from the late 1970s these estates became the areas of residence of lower income households and immigrant families (due to relative depreciation as a result of better alternatives for the middle classes). The strong spatial clustering of social and public housing has led to very high levels of segregation by income and ethnicity in many cities.

Not only income differences but also the housing allocation systems in the social housing sector can contribute to segregation. In, for example, the Netherlands and the UK, social housing was originally allocated through waiting lists, but now most social housing is allocated using choice-based letting systems. In these systems households can express preferences with regard to the dwelling and neighbourhoods, and as a result, those most in need of urgent housing, end up in the least desirable housing stock (Manley and Van Ham, 2011). The choice-based letting system also contributes to segregation by ethnic background (van Ham and Manley, 2009). Especially upon arrival, immigrants have the most urgent need of housing. In European cities, among the inhabitants of affordable housing, people with an immigration background are often overrepresented, and hence, social, ethnic, housing and neighbourhood inequalities overlap, reinforced by the increase of marketisation of the housing sector. In some cities, such as Stockholm, where low cost housing is highly concentrated in some parts of the city, and where marketisation of the housing sector is high, levels of segregation have risen quickly as well (Andersson and Kährik, 2016).

Although segregation by income as a social phenomenon is often seen as problematic, this is not necessarily the case from the perspective of individuals. Segregation can also be positive if it is the result of free choice. The most affluent households often live the most segregated as they have the income to choose neighbourhoods of their own preference. But also less affluent households can live segregated by choice. The literature clearly shows that households tend to choose neighbourhoods with people who are very similar to themselves in terms of income, class, ethnicity and religion (Feijten and van Ham, 2009; Schelling, 1969, 1971; Clark, 1991). Living among similar people can have major benefits as it can reduce conflict, give people a sense of safety, and foster social networks. Living in enclaves with people with similar preferences, needs, and life styles can also have the benefit of shared services and facilities (such as shops, cultural and religious facilities).

Extreme levels of ethnic and socio-economic segregation are often perceived as undesirable by (local) governments, even more so when such segregation is involuntary. When individual choice gets restricted or when people face discrimination on the housing market, segregation becomes problematic also from the individuals' perspective. Especially the process of residualisation of social housing, as is quite common in many European countries, has limited the housing choice of low-income groups (Kleinhans and van Ham, 2013). Citizens, but also local and national governments, express concern over increasing inequality and spatial segregation in European cities. There is the risk that when the more affluent and the poor live more and more separate lives, this might lead to estrangement and fear for others. This is especially the case when there are very clear spatial borders within cities; such as gated communities for the affluent who separate themselves from the rest of the population, and so-called no-go-areas with extreme concentrations of poverty and high levels of crime. It has been argued that such extreme spatial separation can lead to social unrest, and even conflict and riots (Tammaru et al., 2016). The riots in Paris (2005), London (2011) and Stockholm (2013) cannot be seen separate from high concentrations of poverty in these cities, often in combination with high levels of ethnic segregation (Tammaru et al., 2016).

There is also a large literature on neighbourhood effects which suggests that living in poverty concentration neighbourhoods can have negative effects on individual outcomes such as health, income, education and general well-being (van Ham et al., 2012). There is increasing evidence that such effects especially harm children who grow up in poverty concentration neighbourhoods (Hedman et al., 2015; Chetty et al., 2016). And there is also recent evidence that living in deprived neighbourhoods harms the earnings of adults, even after controlling for non-random selection into residential neighbourhoods (van Ham et al., 2017). Potential causal mechanisms run through socialisation effects, negative peer group effects, but also stigma effects, and a lack of social networks to find a job. Also living in neighbourhoods which are spatially cut off from centres of employment are expected to harm the employment prospects of residents. As a result, living in poverty concentration neighbourhoods can harm the potential of adults and children.

Recent studies by van Ham et al. (2017), and a re-evaluation of the Moving to Opportunity experiment by Chetty et al. (2016) have shown strong evidence of neighbourhood effects. These results give reason for concern about increasing levels of socio-economic segregation. These concerns are further fuelled by the fact that socio-economic and ethnic segregation are often strongly connected to each other, and segregation is repeated over multiple life domains. For example, residential segregation in Sweden was found to be strongly related to workplace segregation (van Ham and Tammaru, 2016). There is no simple one-on-one relationship, but many first and second generation immigrants from outside the European Union belong to the lowest income groups and live concentrated in the lowest income neighbourhoods of cities (see Kahanec et al., 2010). Research clearly shows that, especially for low income non-western ethnic minorities, there is strong intergenerational transmission of living in low income neighbourhoods: children who grow up in low income neighbourhoods are very likely to live in similar low income neighbourhoods as adults (Hedman et al., 2015; De Vuijst et al., 2017).

To conclude, the most important cause of socio-economic segregation is income inequality, which has increased in Europe in the last 30 years. This increase is strongly connected with macro-level factors such as globalisation and restructuring of the labour market (Sassen, 1991; Hamnett, 1994; Tammaru et al., 2016). In a globalised economy, highly-skilled workers can sell their labour across the globe that drives up their incomes, while low-skilled workers face the competition with workers from other countries that put their wages under pressure or leaves them without a job. Those who are not able to adapt to a changing economy and labour market, can thus fall into long term poverty. Globalisation of the labour market has happened in parallel with the marketisation of the housing sector. Generally speaking it can be expected that more market involvement in housing contributes to a firmer relation between income disparities and segregation as the lowest income households sort into the cheapest housing stock which is often spatially concentrated in certain neighbourhoods. Hence, both income inequalities and levels of socio-economic segregation have risen in European cities.

Vicious circles of segregation at the individual and household level

Segregation, in the sense of spatial separation of two or more groups, does not only take place in residential neighbourhoods, but also in other domains such as schools and workplaces. Segregation is traditionally measured at the level of residential neighbourhoods, which makes sense both conceptually and empirically (van Ham and Tammaru, 2016). The home is where people live, it is the starting point of their daily activities and their neighbourhood strongly reflects their socio-economic status. Neighbourhoods are also still a crucial place of interaction with others, especially for certain groups such as children, parents of children, the elderly, and ethnic minorities (Van Kempen and Wissink, 2014). Empirically, most census based countries only collect data on the residential locations of households (census tracts, postcode areas, or grid cells), and not for other domains in life, such as work, school and leisure. So residential neighbourhoods have been the natural units to measure segregation.

However, the concept of segregation (by income, ethnic background, etc.) is also relevant for other domains in life (van Ham and Tammaru, 2016). Segregation has also been found in work places (Bygren, 2013; Ellis, Wright and Parks, 2004, 2007; Glitz, 2014; Strömgren et al., 2014), at the level of individual households (Dribe and Lundh, 2008; Haandrikman, 2014; Houston et al., 2005; Kalmijn, 1998), for places of leisure time activities (Kamenik, Tammaru and Toomet, 2015; Schnell and Yoav, 2001; Silm and Ahas, 2014), schools (Andersson, Osth, and Malmberg, 2010; Malmberg, Andersson and

Bergsten, 2014; Reardon, Yun and McNulty Eitle, 2000), and transport (Schwanen and Kwan, 2012). Different socio-economic or ethnic groups use different modes of transport, or travel at different times of the day. Very early in the morning, the underground system in major cities is populated by cleaners and other lower status service workers, while during the traditional rush hour times, the system is populated by white collar workers. Also different lines in the same city are populated by different groups at the same time of the day. Segregation can also take more a-spatial forms in social networks and virtual domains such as social media (Joassart-Marcelli, 2014). Using data from Facebook, Hofstra et al. (2017) showed that large online networks are more strongly segregated by ethnicity than by gender.

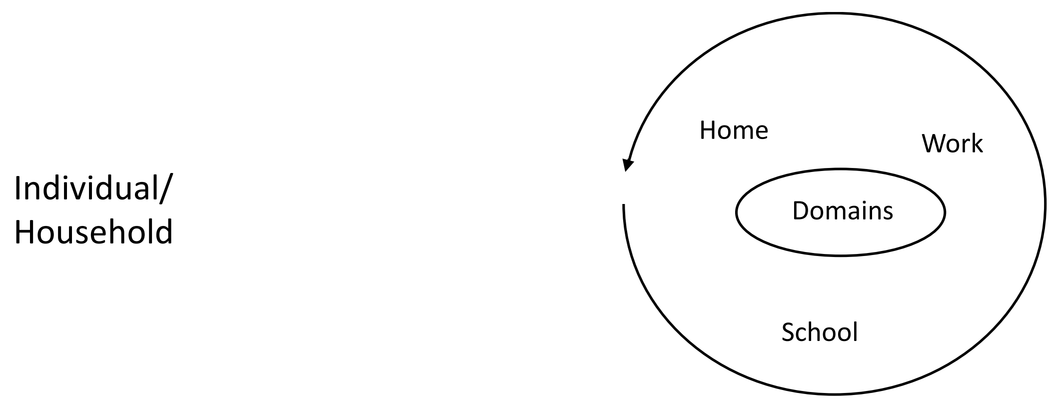
Socio-economic segregation and ethnic segregation are strongly connected since immigration tends to bring along polarising effects on the labour market (Sassen, 1991). Ethnic minorities are often overrepresented in certain niches of the labour market with less secure labour contracts and lower pay levels and, as a consequence, they sort into the poorest neighbourhoods of cities where affordable housing is available. These low cost neighbourhoods used to be in the inner cities, but in the last three decades, the highest concentrations of poverty groups and ethnic minorities have formed in modernist high-rise housing estates built in the late 1950s through the early 1980s. As the gentrification process of many inner cities proceeds, the suburbanisation of low-income groups has become a new important trend in European cities (Musterd et al., 2017).

A study in Sweden found that segregation in residential neighbourhoods is connected with segregation at workplaces (Strömgren et al., 2014). This study used longitudinal, georeferenced Swedish population register data, which enabled them to observe all immigrants in Sweden in the 1990–2005 period, and fixed-effects regressions. In line with previous research they found lower levels of workplace ethnic segregation than residential segregation (Strömgren et al., 2014). Their main finding was that low levels of residential segregation reduce workplace segregation, even after taking into account unobserved characteristics of immigrants' such as willingness and ability to integrate into the host society. Differences in labour market outcomes, in turn, affect housing choice or the lack of thereof and, hence, residential segregation. A recent book from the United States by Krysan and Crowder (2017) describes cycles of racial segregation in the US. Analyses of national-level surveys and in-depth interviews with people in Chicago showed that everyday social processes shape residential segregation, and that everyday life domains are heavily intertwined.

A domains approach to understanding linked residential, school and workplace careers over the life course, focussing on ethnic and racial segregation is presented in van Ham and Tammaru (2016). This framework can also be used to understand socio-economic segregation. There are two mechanisms through which the exposure of individuals and households to poverty concentrations in different domains is connected. The first mechanism runs largely through direct spatial proximity. For example, children often go to a school close to their home, and as a result the socio-economic composition of the neighbourhood and local schools often overlap. This is even more the case in systems with school districts. The very concept of neighbourhood was based on the idea of school districts (Perry, 1929) and until today, schools are often neighbourhood based. Also leisure time activities often take place close to home (Kukk et al., 2017) and as a result people often socialise with people from the same urban areas.

The second mechanism runs through contextual effects (see also next section on intergenerational mechanisms). For example, children growing up in neighbourhoods with high concentrations of low income households will mostly go to schools where most children come from low income families. The school composition is likely to affect the test scores of children, their social networks, the educational choices that they make later in life, and ultimately their job finding networks and opportunities later in life. This will in turn have an effect on sorting of these children as adults into different residential neighbourhoods and other domains. And as a result there is a vicious circle of exposure to poverty concentrations through sorting, contextual effects and subsequently sorting. On the aggregate level this vicious circle will contribute to patterns of segregation in multiple domains, as illustrated in Figure 5.1.

Figure 6.1. Vicious circles of segregation between domains



An important element of the domains approach is time. Individual lives consist of a sequence of residential episodes in different neighbourhoods. Living in a poverty concentration neighbourhood for a short period of time in a certain stage of your life can be expected to have a widely different effect on individual outcomes than a lifelong exposure to high poverty neighbourhoods or poverty in other domains. When taking a life course approach, the interlinkages of exposure to poverty in different domains can be seen within a longer time period and over the generations.

Intergenerational vicious circles of segregation

The idea of the vicious circle of exposure to poverty concentrations partly runs from parents to children. It is well known from the sociological literature that "the fortunes of children are linked to their parents" (Becker and Tomes, 1979, 1153), and that individual characteristics, such as incomes and educational attainment, correlate strongly between parents and their children (D'Addio, 2007). The extent to which socioeconomic (dis)advantage is transmitted between generations is receiving increasing attention (van Ham et al., 2014). According to the UK government report Opening Doors, Breaking Barriers: A Strategy for Social Mobility "In Britain today, life chances are narrowed for too many by the circumstances of their birth: the home they're born into, the neighbourhood they grow up in or the jobs their parents do. Patterns of inequality are imprinted from one generation to the next" (Nick Clegg, Cabinet Office, 2011). The liberal objective to break the links between ascribed or inherited characteristics and individual outcomes is now an important policy objective in many countries, and advocated for both equity and efficiency reasons (OECD, 2010; see also van Ham et al., 2014).

It has been suggested that the intergenerational transmission of socio-economic status also has a spatial dimension (Duncan and Raudenbush, 2001; Jencks and Mayer, 1990; Samson and Wilson, 1995; van Ham et al., 2012; van Ham et al., 2014). And indeed it has been found repeatedly that children who grow up in a deprived neighbourhood are more likely than others to live in a similar neighbourhood when they become adults (van Ham et al., 2014). As a consequence, exposure to poverty concentrations reproduces itself over generations, and hence also segregation itself is reproduced. The neighbourhood outcomes of children are related to the neighbourhood status of their parents, and when these children become adults themselves, their neighbourhood status will affect the type of neighbourhoods their children will live in.

An important mediator of intergenerational transmission of poverty pertains to education. Children who grow up in a deprived neighbourhood are likely to also go to a school with children from low income family backgrounds, which subsequently can have an effect on their level of education, their job finding networks, and eventually their labour career. Ultimately this then affects the type of neighbourhoods they will live in as adults. So intergenerational transmission of living in poverty concentration neighbourhoods might cause neighbourhood effects on individual outcomes, and subsequently influence neighbourhood outcomes, leading to intergenerational neighbourhood effects.

Studies on the intergenerational transmission of neighbourhood type have only emerged in the last ten years. One of the first studies is by Vartanian et al. (2007), using data from the Panel Study of Income Dynamics linked with US Census data (see also van Ham et al., 2014). This study showed that childhood neighbourhood disadvantage has negative effects on adult neighbourhood type for those growing up in the poorest neighbourhoods. Vartanian et al. (2007) argue that family poverty and the likelihood of living in disadvantaged neighbourhoods is inherited across generations and they explain this intergenerational transmission using neighbourhood effects theory. They suggest that children growing up in poverty areas will experience negative neighbourhood effects on their income and employment opportunities, limiting their subsequent options in the housing market as an independent adult (see also van Ham et al., 2014).

Another US study showed that the intergenerational transmission of living in poverty neighbourhoods results in intergenerational transmission of racial inequality in individual outcomes, as black Americans were more likely to continuously live in deprived neighbourhoods than others, and thus to be exposed to local concentrations of deprivation (Sharkey, 2008). Sharkey (2008) shows that more than 70% of the African-American children who grow up in the most deprived areas of the US live in very similar types of neighbourhoods when they are adults. In another study it was suggested that intergenerational transmission of neighbourhood might run over multiple generations (Sharkey and Elwert, 2011). In his book "Stuck in place", Sharkey (2013) emphasises the racial dimensions for especially the poor African-American families in the United States (see also Hedman et al., 2017). "The problem of urban poverty […] is not only that concentrated poverty has intensified and racial segregation has persisted *but that the same families have experienced the consequences of life in the most disadvantaged environments for multiple generations*" (Sharkey, 2013, 26, italics in original as quoted in Hedman et al., 2017).

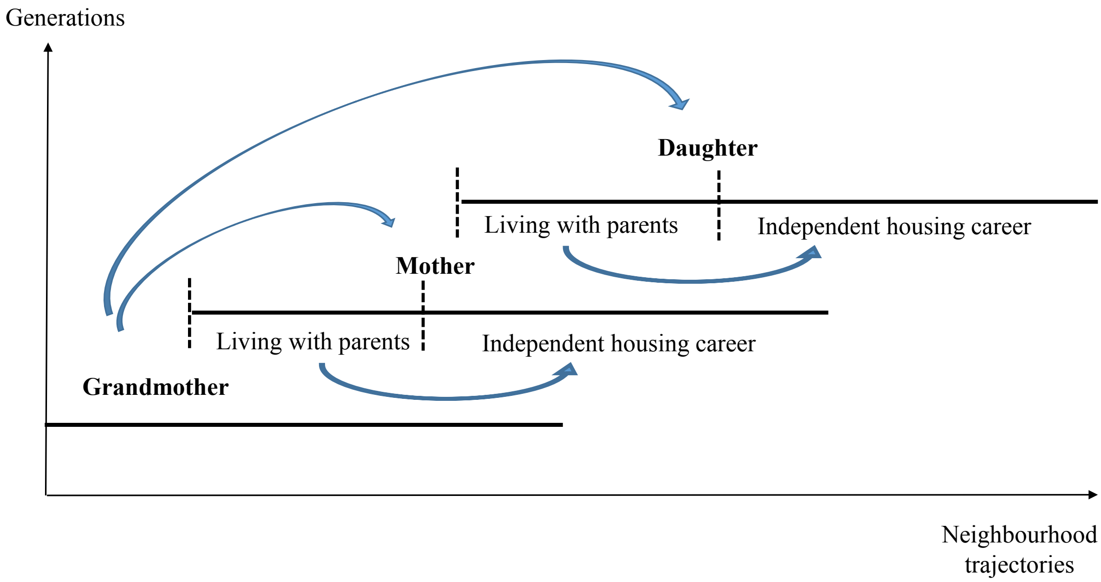
A study using Swedish individual level geo-coded longitudinal register data by van Ham et al. (2014) also showed strong evidence of intergenerational transmission of living in poverty concentration neighbourhoods. It was found that after leaving the parental home, the characteristics of the parental neighbourhood continue to affect the neighbourhood outcomes of children, even after controlling for parental income levels and the education of children. Very similar effects were found for the Netherlands by De Vuijst et al. (2017). Interestingly, while spatial patterns of ethnic minority groups within Dutch and Swedish society are not directly comparable to American "black neighbourhoods", intergenerational neighbourhood patterns were still shown to be much stronger for ethnic minorities than for other groups (van Ham et al., 2014; De Vuijst et al., 2017). The study by De Vuijst et al. (2017) on data from the Netherlands also showed that obtaining a degree in higher education is a way to break the link between neighbourhood outcomes for parents and children, but only for the native Dutch population, and not for individuals from ethnic minority groups (De Vuijst et al., 2017).

Sharkey (2013) provides compelling theoretical arguments to support the idea of multi-generational transmission of neighbourhoods, but his study is based on a theoretical model and does not actually use data for more than two generations. The first study to actually use data for three generations is by Hedman et al. (2017) who use Swedish data on the residential locations of grandmothers, their daughters and granddaughters. They found that the share of low-income people in the neighbourhoods for the youngest generation is correlated with the neighbourhood environments of their mothers and, to some extent, grandmothers. They also found an effect of geographical distance between the three generation of women; intergenerational transmission is stronger for those living in close spatial proximity. But whereas women whose mothers and grandmothers live in high-income areas benefit from staying close, women whose mothers and grandmothers live in low-income areas do better if they move further away (Hedman et al., 2017).

A recent study by Chetty et al. (2016) shows that the parental neighbourhood has important and long lasting effects on the outcomes of their children. Chetty et al. set out to re-study data from the famous Moving to Opportunity (MTO) experiment in the United States. This experiment was started in 1994 by the Department of Housing and Urban Development (HUD) in a number of US cities. Thousands of public housing tenants were randomly assigned to three groups: an experimental group that received a voucher to move to a better neighbourhood, a group that received a voucher but was free to move where they wanted, and a group that received no voucher. The idea was that moving to a better neighbourhood would show positive effects on income and employment for adults, and on the behaviour and school results of children. The initial outcomes showed no effects of moving to a better neighbourhood (only some minor effects on mental health, see Katz et al. (2000) and several follow-up studies). But the recent study by Chetty et al. (2016) revealed that children who moved from a high poverty neighbourhood to a low poverty neighbourhood before the age of 13 earned 31% more as adults compared to those who did not move to a better neighbourhood. There was no effect for children who moved after the age of 13. The fact that Chetty et al. found these effects where previous studies found none was likely due to the fact that they had a much longer time series of data which revealed the effect of the age at which children moved to a better neighbourhood.

In conclusion, there is a strong connection between the neighbourhoods people live in, and the neighbourhood they grew up in, and there is even a relationship with the neighbourhood status between multiple generations. These intergenerational transmissions of the residential neighbourhood suggest important vicious circles of exposure to poverty between generations where children are affected by where their parents lived, and subsequently they then affect their own children later in life. These vicious circles of multi-generational transmissions of exposure to poverty neighbourhoods are illustrated Figure 5.2 (from Hedman et al., 2017).

Figure 6.2. Intergenerational transmission of segregation



Source: Hedman et al. (2017), "Three generations of intergenerational transmission of neighbourhood context", IZA working paper.

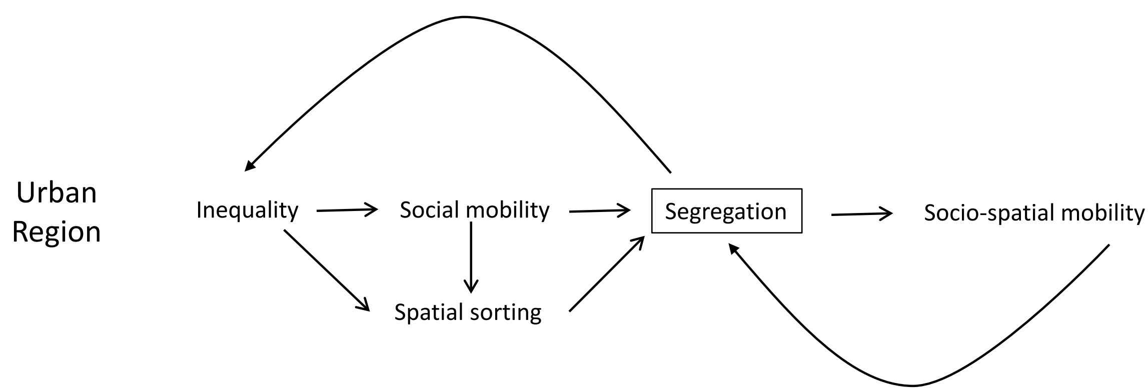
Vicious circles of segregation at the urban regional level

A recent study by Nieuwenhuis et al. (2017) found that "the combination of high levels of social inequalities and high levels of spatial segregation tend to lead to a vicious circle of segregation for low income groups, where it is difficult to undertake both upward social mobility and upward spatial mobility". This research suggests that there are vicious circles of segregation at the level of urban regions. The idea is that rising inequality in cities leads to reduced social mobility because the "socio-economic distance" between the lowest and the highest income groups is large and as a consequence it is difficult to move up the social ladder. Both a high level of inequality and a lack of social mobility lead to spatial sorting of households into neighbourhoods, where the lowest income groups tend to concentrate in neighbourhoods where housing is cheap. This leads to segregation by socio-economic class.

Segregation then has a negative effect on the probability of upward socio-spatial mobility of individuals, because in segregated cities it is hard to move to a better neighbourhood. This is likely the case because of the social "distance" between poor and rich neighbourhoods, which is reflected in house price levels. In many larger European cities, and especially in inner city areas, housing prices start to get beyond the reach of middle-income households, and as a result, low-income groups, and lower middle income groups, are pushed more and more to the edges of the metropolitan region (Atkinson, 2016; Beaverstock et al., 2004; Musterd et al., 2017). David Hulchanski (2010) describes this process for the metropolitan area of Toronto where three cities have emerged: a central city for the wealthy, an in between city for the middle classes, and a suburban city for the poor. Sometimes, the emergence of such new spatial patterns of socio-economic classes is not yet visible because of ongoing processes of gentrification (see Marcinczak et al., 2013; Sykora, 2009 on the segregation paradox) or because of time lags between growing inequalities and growing socio-economic segregation (Tammaru et al., 2017; Wessel, 2016).

Nieuwenhuis et al. (2017) suggest that when segregation reduces the level of socio-spatial mobility this (re)produces segregation by petrifying the existing socio-spatial patterns in the city, which in turn is likely to affect inequality through negative neighbourhood effects of living in deprived neighbourhoods (see Figure 5.3 for an illustration of this mechanism). In their comparative study of Estonia, the Netherlands, Sweden and the United Kingdom, they further explain that the stronger the role of markets, the more intense the socio-spatial mobility as both the top and the bottom socioeconomic groups start to sort into different types of neighbourhoods. Socio-spatial structures start to petrify once high levels of segregation have emerged, making it more difficult to move to a better neighbourhood. This urban spatial mechanism is related to the idea of The Great Gatsby Curve phenomenon; higher social inequalities reduce intergenerational social mobility (Krueger, 2012). Nieuwenhuis et al. (2017) argue that high levels of segregation (spatial inequality) reduces upward socio spatial mobility.

Figure 6.3. Vicious circles of segregation at the urban region level



The idea of the vicious circles of segregation combines sorting mechanisms into poverty concentrations in neighbourhoods and other domains, with mechanisms of contextual effects on individual outcomes. Some of these processes run between generations. Sorting mechanisms sort low income groups in deprived neighbourhoods, which also affects exposure to poverty in schools and leisure activities. Contextual effects of these domains have an effect on individual outcomes, including income, work and health. And these outcomes influence the sorting processes of individuals and households into poverty concentration neighbourhoods. On the aggregate level these vicious circles of exposure to poverty concentrations lead to segregation. When there are high levels of inequality and segregation in an urban region, this reduces the probability of socio-economic and socio-spatial mobility, reinforcing existing spatial patterns of inequality.

Policy implications: breaking the circles

Before developing some directions for policy to reduce levels of segregation it is important to repeat that segregation by socio-economic status is not necessarily a bad thing. Many groups live together in neighbourhoods because they choose to live there with people who are similar to them. For individuals and households, in fact, segregation can have advantages for a variety of reasons as mentioned before. However, it is also clear from the literature that there are negative side effects of segregation, and especially of living in poverty concentration neighbourhoods, and particularly for children (see Hedman et al., 2015; Chetty et al., 2016). In the end, the question whether policy should fight segregation is partially a political and possibly also a moral question (Buitelaar et al., 2018).

The multi-level model of vicious circles of exposure to poverty concentrations and the resulting patterns of segregation leads to several ideas of how to break these vicious circles and how to improve cities as places of opportunities by investing in places, people, and transport, if there is a political wish to do so. Generally speaking there are three types of policy responses to segregation by socio-economic status: place-based policies, people based policies and connectivity based policies (see also van Ham et al. 2012; van Ham et al., 2016).

The place-based policies, as conceptualised here, mainly focus on the physical upgrading of deprived neighbourhoods. By demolishing low cost (social) housing and rebuilding more expensive rental and owner-occupied housing the socio-economic mix of households can be influenced. Often these policies are referred to as social mix policies (Atkinson and Kintrea, 2002; Musterd, 2002). Place-based policies require huge investments, but within a relatively short period of time a neighbourhood can be upgraded by replacing buildings and people. Such policies can only be successful if middle class households can be attracted to deprived neighbourhoods, which is not an easy task to accomplish (Lelévrier and Melic, forthcoming).

Place-based policies were popular up to the start of the financial crisis in 2008, and since then most of the larger initiatives in Europe have ended or have been stopped due to financial constraints (Zwiers et al., 2016). There have been warnings that policy should not strive to upgrade all neighbourhoods (in terms of their socio-economic status) in a city as this might lead to displacement of low income households to outside the metropolitan region. Expanding the supply of "good" neighbourhoods will only be beneficial for low income groups if in parallel also investments are made in education and social mobility for those groups. Also, every city needs low cost neighbourhoods to house new arrivals, low income workers and students. If such neighbourhoods are not available this might lead to a spatial mismatch between locations of employment and residential locations for low income workers.

There is a strong belief that social mix policies also have a positive effect on the original residents of deprived neighbourhoods. The idea is that introducing middle income households in such neighbourhoods will create positive role models and job finding networks. There is no solid evidence that this is actually the case. Recently, many European media evaluated the current situation in the Paris suburbs which were the stage of the 2005 riots. Ten years after the riots, and despite many billions in investments in these suburbs, little seems to have changed. Newspapers headlined "10 years after the riots, nothing changed" (Chrisafis, 2015) and "it goes better with the stones, but not with the people" (Giesen, 2015). Also in the Netherlands evaluation of large scale urban restructuring comes to similar conclusions: place-based investments have been successful in upgrading buildings and infrastructure, but the people have not benefitted in terms of jobs and income.

Place-based policies have the ability to reduce levels of segregation, but will only have limited effects on breaking some of the vicious circles that lead to segregation as described in this chapter. By reducing poverty concentrations in cities and by mixing socio-economic groups, people might also meet others from different socio-economic groups in different domains, such as workplaces, schools and during leisure activities. Diluting poverty concentrations might also reduce intergenerational transmissions of living in deprived neighbourhoods, and it might positively affect social mobility. However, it is unlikely that place-based policies alone will have long lasting effects on reducing levels of segregation; in the end place based policies only reduce concentrations of low income groups, without affecting the underlying mechanisms that lead to persistent poverty. To break some of the vicious circles of segregation it is needed to invest in people and opportunities.

People-based policies focus on reducing poverty and creating opportunities for people in the areas of education and employment. People-based policies require a very long term perspective as it might take a generation or longer to reduce (intergenerational) poverty. The success of people-based policies are not always visible in local communities as success might leak away. If people-based policies are successful, then children do well in school and move to higher education, and people might get jobs, more income, and hence a larger choice set on the housing market, and as a result move to a better neighbourhood. The success of such policies might therefore end up in other parts of the urban region, and the people who leave might be replaced by other low income households.

People-based policies and investing in education might break some of the vicious circles leading to segregation. Education introduces people into new networks which is likely to result in more diverse networks also in other domains of life, such as schools, workplaces and leisure. More diverse networks will affect partner choice, job matching, and education, and can have a positive effect on income and therefore affect residential choices. Obtaining a higher level of education will also help to severe intergenerational transmission of living in deprived neighbourhoods. Those who are born in a low income neighbourhood and who get a higher education degree are increasing their chances of living in a better neighbourhood as adults (De Vuijst et al., 2017).

Moving households from high poverty neighbourhoods to low poverty neighbourhoods, like in the Moving to Opportunity programme, is also a type of people-based policy. But one that also affects places as well. Moving people affects both the composition of neighbourhoods, and the spatial opportunity structure of the households who move. The research by Chetty et al. (2016) shows that in the US "moving to opportunity" can have positive effects on the incomes of children as they grow up, but only in the long run. It is not simple to translate these results to other national contexts and policies. One could argue that based on the work by Chetty et al. it is beneficial to create more socio-economically mixed neighbourhoods. But this mixing probably only works when low income households are re-located to higher income neighbourhoods, but not the other way around.

Finally, connectivity based policies are focused on physically linking deprived neighbourhoods with places of opportunity in the larger urban region. If public transport would be for free, there would be less barriers for people living in low income neighbourhoods to travel to jobs or schools in other parts of the city (Hess et al., 2018). This is especially relevant for those living in large, often high rise, housing estates which are often located at the edge of cities, and physically separated from places with job opportunities.

In conclusion, place-based policies do not necessarily reduce poverty and inequality, and people-based policies might not have the desired local effect. In the end, segregation of the poor is often a symptom of inequality and poverty. Segregation exists because there is inequality and because housing is spatially organised by socio-economic status. Reducing levels of segregation by socially mixing neighbourhoods will have some effects on inequality and social mobility, but in the end directly reducing poverty through education seems to be the most efficient way forward. A better transport accessibility can also help to break some of the vicious circles that lead to segregation by bringing people to places of opportunity. So the best strategy seems to be a mix of policies, tailored at specific neighbourhoods and cities, where neighbourhoods should not be viewed in isolation, but how they function within the larger urban housing and labour markets. Such an urban wide view should also include policies which stimulate intra-urban mobility through public transport, aiming at improving access to jobs and services.

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