



Socio-economic Segregation in European Cities
A Comparative Study of Brussels, Copenhagen,
Amsterdam, Oslo and Stockholm

Karen Haandrikman, Rafael Costa, Bo Malmberg, Adrian Farner Rogne and Bart
Sleutjes

ResSegr Working Paper 2019:1

© Copyright is held by the author(s). ResSegr Working Papers receive only limited review. Views and opinions expressed in ResSegr Working Papers are attributable to the authors and do not necessarily reflect those held at the institutions the authors are affiliated with.

Socio-economic Segregation in European Cities
A Comparative Study of Brussels, Copenhagen, Amsterdam, Oslo and Stockholm

Karen Haandrikman

Stockholm University, Department of Human Geography

Rafael Costa

Vrije Universiteit Brussel, Interface Demography

Bo Malmberg

Stockholm University, Department of Human Geography

Adrian Farner Rogne

University of Oslo, Department of Sociology and Human Geography

Bart Sleutjes

Netherlands Interdisciplinary Demographic Institute (currently Municipality of Amsterdam)

Abstract: The purpose of this study is to compare socioeconomic segregation patterns and levels in Brussels, Copenhagen, Amsterdam, Oslo, and Stockholm with uniform measurements. Socioeconomic segregation is a persistent reality in European cities that may have negative effects on social cohesion and individual outcomes. Previous research has been hampered by conceptual and methodological shortcomings, preventing comparable studies of segregation. We use harmonized datasets from 2011 containing geocoded indicators based on a nearest-neighbors approach, allowing for comparable measures of socio-economic segregation at multiple scales. Our analyses offer an unprecedented comparison of patterns and levels of socio-spatial inequalities in European capitals. Using maps, segregation indices and percentile plots, we find that for all cities, the level of segregation by affluence is much larger than that of poverty. Macro-scale poverty segregation is most prominent in Stockholm and Brussels, and quite low in Amsterdam. At micro-scales, Brussels and Stockholm stand out with very high concentrations of poverty at the local level. In such poor neighborhoods, there are hardly any non-poor, indicating high levels of polarization. Macro-scale segregation by affluence is most pronounced in Oslo. Differences in levels and patterns are interpreted in the light of their particular welfare regimes, housing systems, area-based policies and migration dynamics.

Keywords: socio-economic segregation; comparative studies; European capitals; nearest-neighbor approach.

1. Introduction

Socio-economic segregation is a long-lasting phenomenon in European cities (Musterd 2005; Cassiers and Kesteloot 2012; Tammaru et al. 2015) and a subject of concern in urban policy (Kleinhans 2004; Galster 2007; Bolt 2009;). An extensive literature has shown that the concentration of deprived populations in specific neighborhoods can represent a threat to social cohesion (Cassiers and Kesteloot 2012), hindering citizen participation (Kühn 2015), access to the labor market (Andersson 2004; Dujardin, Selod, and Thomas 2008), educational attainment (Andersson and Malmberg 2015) and even lead to urban unrest and riots (Olzak, Shanahan, and McEneaney 1996; Malmberg, Andersson, and Bergsten 2014).

International comparative studies on socio-economic segregation are rare, and this is mainly due to the difficulty in producing and obtaining comparable data across countries. Spatial data are typically available for predefined areal units, such as municipalities, wards, census tracts, etc.; these units differ greatly in size, function and distribution from one country to the other. These differences in spatial units severely hamper international studies, making it hard to compare segregation levels and patterns in an accurate way.

The few studies that have investigated socio-economic segregation from an international comparative perspective (Musterd 2005; Tammaru et al. 2015), despite the methodological and conceptual difficulties, have generated interesting insights. They suggested that socio-economic segregation in European cities is modest compared to the levels observed in the U.S. (Musterd 2005) and in other cities in Asian and American countries (Marciniczak et al. 2015). Still, segregation levels and patterns vary greatly among European cities, which is commonly attributed to differences in welfare states regimes, housing systems and income distribution (Musterd 2005; Arbaci 2007; Tammaru et al. 2015). Furthermore, the studies suggest that higher social classes tend to live more segregated than the lower classes (Musterd 2005; Tammaru et al. 2015) and that socio-spatial inequalities have increased in Europe over the last decade (Marciniczak et al. 2015; Musterd et al. 2017). Such findings are crucial to understand and to address socio-economic segregation. However, they are founded on serious methodological limitations of data comparability across countries. Therefore, as even the authors of these studies emphasize, they need to be interpreted with caution and may be seen only as being indicative (Musterd 2005; Tammaru et al. 2015).

For the present study, we benefitted from newly available data from Belgium, Denmark, the Netherlands, Norway and Sweden, which allowed us to construct comparable datasets for their five

capitals in 2011. Our main purpose is to investigate socio-economic segregation patterns and levels in Brussels, Copenhagen, Amsterdam, Oslo, and Stockholm in a comparative setting.

Our research is based on harmonized geocoded indicators of poverty and affluence. Using a nearest-neighbors approach, we produced comparable measures of socio-economic segregation with a fine level of geographic detail and at multiple scales. Our analyses offer an unprecedented comparison of patterns and levels of socio-spatial inequalities in five European capitals, each with its particular housing system, housing policies and territorial, cultural and migration history.

2. Background

Previous Comparative Studies on Socio-economic Segregation

Until now, comparative studies on socio-economic segregation in Europe have been unable to use a standard for spatial variation in socio-economic inequality (Musterd 2005). Indicators of poverty and affluence have varied a great deal across studies, as did the type of areal units and the methods to measure segregation levels.

In the last decades, two strands of research have attempted to compare socio-economic segregation among European cities. The first one is synthesized by Musterd (2005) in a paper that gathers results from a series of international projects carried out around the year 2000, and which compares segregation levels in 16 European cities. An important obstacle is that poverty and affluence are measured by different indicators depending on the country. Moreover, these indicators refer to small spatial units when available (for instance ward or neighborhood), but in some cases larger units had to be used. With such differences of measurement, segregation levels (based on the dissimilarity index) are hardly comparable among the 16 cities. Even so, bearing in mind the data limitations, the results suggest that socio-economic segregation is low in European cities compared to American cities. One notable exception is Antwerp, where the segregation of poor households is strikingly high compared to the other cities¹. Oslo appears as having relatively high segregation based on the concentration of social assistance receivers, whereas Copenhagen was found to have the lowest levels of segregation of low-income households. Amsterdam lies somewhere in the middle of the ranking. In all cases, Musterd (2005, p. 339) stresses that affluent households live much more segregated than low-income households do: whereas the former are able to dissociate from the rest of the population, the latter tend to remain spatially attached to the middle classes.

More recently, a second research project examined socio-economic segregation in 13 European cities (Tammaru et al. 2015), among which were Amsterdam, Oslo and Stockholm. Although there was an effort to make segregation measures as comparable as possible, the intercity comparison was affected by data and measurement issues. Socio-economic status was based on occupation, income or education, depending on data availability in each city. Analyses focused on small spatial units; still these varied a great deal from one city to the other. The studies did not employ a single definition of cities' geographical size: some included the metropolitan area while others were limited to the inner city. On this basis, the authors draw strong conclusions. In line with Musterd's intercity comparison (2005), the authors argued that segregation is relatively low in Europe compared to other parts of the world (Marcinićzak et al. 2015), although segregation levels had been on the rise since 2000, except for Amsterdam (Musterd et al. 2017). Again, they also found that the affluent classes live much more segregated than the lower classes in all cities. Their main findings related to the cities in the present study are that Stockholm had the highest segregation of the poor and the lowest segregation of the rich among all cities in 2011 (based on the dissimilarity index). Segregation of the rich was the second lowest in Oslo, while it was the second highest in Amsterdam. Both cities have middle positions in the ranking of segregation of the lower classes (fourth and sixth).

Differences in segregation levels among cities are commonly ascribed to the impact of structural factors, namely different welfare regimes, the organization of housing systems, the level of income distribution, and how the city is connected globally (Arbaci 2007; Musterd et al. 2017). What these studies find, however, is that these factors only partly account for the intercity differences: there is also "a significant effect of 'space' and historically developed morphological, social, and cultural structures" (Musterd et al. 2017, 1077), such as legacies of local housing and planning regulations.

Despite methodological issues, these studies undeniably show the interest of intercity comparisons in order to understand socio-economic segregation.

Methodological Challenges in Comparative Studies

There are at least three major methodological challenges in international comparisons of socio-economic segregation: differences in spatial units, lack of standard segregation measures, and issues related to the scale of segregation.

Most studies use data that are aggregated for fixed administrative subdivisions. Analyses based on administrative boundaries are hampered by a range of issues (Clark et al. 2015), namely the Modifiable Unit Problem (MAUP) (Openshaw 1984; Nielsen and Hennerdal 2014) that states that outcomes highly depend on the way geographical units are defined. With inter-country comparisons, the problem is aggravated, as spatial units that represent data tend to differ structurally between countries and regions and over time. Research on the MAUP suggests that segregation research will not be able to progress until this problem is addressed in a credible way (Openshaw 1984). In addition, differences in population data systems between countries — with dissimilar types of data and output geographies — add to the difficulties of international comparisons (Shuttleworth and Lloyd 2009).

Another factor that further complicates comparison of levels of socio-economic segregation across cities and countries is that there is no standard of segregation measurement. Some of the most used indices are the dissimilarity index and the exposure index (Clark 2015), with a number of indices especially suitable for geographical studies (Brown and Chung 2006).

A third methodological issue that studies increasingly give notice to is that segregation processes occur at different scales. American segregation researchers have started to make a distinction along geographical levels, and between micro and macro scale segregation (Fisher et al. 2004; Reardon et al. 2008; Lichter, Parisi, and Taquino 2015). Others have modified segregation and isolation indices by introducing spatially weighted matrices to reflect the extent of contact between spatial units (e.g. Wong 2004). Andersson et al. (2018) describe the recent surge in studies advocating a multiscale measurement of segregation. Instead of focusing on either large neighborhood scales or small-scale predefined administrative areas, as most previous studies have done, a multiscale design examines segregation levels depending on the size of the neighborhood (Fisher et al. 2004; Reardon et al. 2008; Lichter, Parisi, and Taquino 2015; Hennerdal and Nielsen 2017). As Fowler (2016) argues, there is no correct scale for measuring segregation; instead, segregation should be measured continuously at different scales to capture both large-scale divisions and segregated “pockets”. A multiscale approach is also able to take into account varying local levels of segregation, which may be hidden when only considering single measures of segregation levels for a whole city.

In the last few years, increasing attention has been given to an innovative multiscale approach that uses individualized neighborhoods instead of predefined administrative units (MacAllister et

al. 2001; Chaix et al. 2005; Lee et al. 2008; Reardon et al. 2008, 2009; Chaix et al. 2009; Östh, Malmberg, and Andersson 2014; Östh, Clark, and Malmberg 2015; Clark et al. 2015; Fowler 2016; Andersson, Lyngstad, and Sleutjes 2018; Andersson et al. 2018; Costa and De Valk 2018; Malmberg et al. 2018; Sleutjes, De Valk, and Ooijevaar 2018). Individualized neighborhoods are defined as neighborhoods based on a pre-determined number of nearest neighbors, independently of administrative borders. Alternatively, individualized neighborhoods can be based on a fixed distance radius. A main advantage of the approach is that it can be applied in the same way in different national contexts, resulting in measures of segregation that are exactly comparable and that offer a solution to the MAUP. By using different sizes of neighborhoods, measured as different numbers of nearest neighbors, several scales can be included in the analysis.

There may be disadvantages using multiscale individualized neighborhoods as well. Depending on the research question, the use of administrative areas might be useful. An example of such a case could be when one is interested in the effect of policy measures on certain geographical levels. Second, a consequence of the method is that the geographical size of the individualized neighborhoods varies substantially depending on population density. Andersson et al. (2018) show that notwithstanding this variation in the five countries under study, people live in local neighborhoods that are similarly structured.

Aims and Research Questions

The increase in availability of geocoded individual register data opens up possibilities for multiscale studies of segregation patterns within and across countries. The current paper on residential segregation in five European countries uses such data for Belgium, Denmark, the Netherlands, Norway and Sweden, and constructs individualized scalable neighborhoods to examine patterns of segregation. Using these unique data and methods, this paper aims at overcoming the typical methodological limitations in international comparisons and accurately compare segregation levels and patterns of poverty and affluence in the five countries' capitals. We address the following research questions:

1. To what extent do socio-economic segregation patterns vary across European capitals and at different scales?

2. How can these segregation patterns be interpreted in the light of inter-country structural differences such as welfare regimes, housing systems, income distribution and migration dynamics?

3. Data and Methods

Data and Indicators

We use geocoded register data provided by the statistical offices of the five countries for 2011. The unit of analysis is the grid obtained by x and y coordinates. In Belgium, Denmark, Norway and the Netherlands, indicators were computed for each 100m*100m grid cell. For Sweden, coordinates are aggregated into 250m*250m grids in urban areas and 1000m*1000m grids outside urban areas. Details are provided in Nielsen et al. (2017).

For each grid cell, indicators of poverty and affluence were computed based on income data from national registers maintained by the tax authorities. For the poverty indicator we used disposable income after social transfers. For the affluence indicator we used taxable earned income from wages and net-earnings from self-employment. There are differences in what is included in the income measured (see Nielsen et al. (2017))². In Belgium, for example, it is not possible to distinguish disposable income and taxable earned income, and the latter was used in both indicators. In addition, we had to exclude all null incomes in Belgium – mostly from international workers – to avoid bias³. Income data in the Netherlands do not include rent subsidies and income from capital. Some countries include certain grants in the data, while others do not. Therefore, income data are not strictly comparable among countries. But, as argued below, our analyses are still able to provide insights into segregation patterns despite these issues. Moreover, we use measures of relative income rank, that are likely to be less sensitive to different definitions compared to direct measures of income.

The poverty indicator is based on the Eurostat definition of the ‘at-risk-of-poverty rate’, defined as the share of people with an equivalised disposable income below the at-risk-of-poverty threshold, which is set at 60 percent of the national median equivalised disposable income after social transfers. Due to difficulties in finding a common definition of households with data from the five countries, our measure is defined for individuals who are aged 25 or above.

The affluence indicator is based on taxable earned income for those aged 25 to 64 years old. People are ranked according to their income and grouped into deciles. Persons in the highest income decile at the national level are defined as high-income earners.

In sum, the indicators used in the paper are the following:

- poverty: the share of persons aged 25 or above with a personal disposable income below 60 percent of the median level;
- affluence: the share of persons aged 25 to 64 whose taxable earned income is in the highest decile.

Definition of Study Space and Multiscalar Individualized Neighborhoods

For comparability purposes across the five cities, we demarcated metropolitan areas of equal area. These extend over a 25 km radius around each city's central train station. The central stations were chosen as a central point because they are a common reference as the city center, especially for commuters. Using this definition, we attempted to encompass all the neighborhoods that are linked to the cities' labor market and commuting zones – that is, where the cities' inhabitants reside, even if it is outside of their administrative boundaries.

In each of the five metropolitan areas, we constructed individualized neighborhoods at multiple scales. First, the territory was divided into small-scale grids (250m*250m in Stockholm; 100m*100m elsewhere). Next, we used individual geocoded register data to identify the population residing inside each grid. The individualized neighborhoods were constructed by expanding a geographic buffer around each grid cell using the EquiPop software (Östh, Clark, and Malmberg 2015) until the 200; 1,600; 12,800; and 51,200 nearest neighbors were obtained. In this way, we constructed strictly comparable units across the five cities at four different scales, varying from individuals' immediate surroundings to urban areas, with a high level of geographic detail and independent of administrative borders.

In the end, we obtain five datasets (one per city) with two indicators (affluence and poverty) calculated for individualized neighborhoods at four scale-levels (k= 200; 1,600; 12,800; 51,200).

Methods

We use methods that focus on the spatial representation of poor and affluent, as opposed to spatial concentration (see Andersson et al. 2018). In other words, we do not compare the proportion

of poor (affluent) inhabitants with respect to the neighbourhood population; instead, we relate these proportions to each city’s overall levels of poverty and affluence. The question we are looking at is how much of the city’s poor (affluent) population live in each neighbourhood and to what extent they are over/ underrepresented in certain neighborhoods. We believe this strategy minimizes the risk of bias that may arise from the slight differences in definitions in income data in the five countries.

We use three tools to examine segregation patterns and levels: representation of poor (affluent) in neighborhood percentiles, dissimilarity index (DI), and the mapping of location quotients.

For the first tool we started by ordering all individuals in each city by the proportion of poor (affluent) people in their individualized neighborhood at a given scale⁴. Next, we divided them in percentiles, or bins, containing 1 percent of the population each (see Andersson et al. 2018b). The representation of poor (affluent) persons with feature F in a given bin i is obtained by the number of poor (affluent) individuals in the bin divided by the total number of poor (affluent) individuals in the metropolitan area:

$$\frac{F_i}{F_{metro}}$$

If poor (affluent) residents were equally distributed across the metropolitan area, each bin would contain 1 percent of the total poor (affluent) population; that is, a value of 1 percent means equal representation. Values lower than 1 percent denote under-representation whereas values higher than 1 percent signify over-representation. As shown below, this tool allows us to examine how much of the cities’ population live in neighborhoods where the poor (affluent) are over- and under-represented.

The second tool is the DI, the most widely used aggregate measure of segregation (Duncan and Duncan 1955; Massey and Denton 1988). Here, DIs can be easily derived from the bins (Andersson et al. 2018):

$$DI = \frac{1}{2} \sum_{i=0}^{99} \left| \frac{F_i}{F_{metro}} - \frac{non F_i}{non F_{metro}} \right|$$

The way the DIs are calculated for individualized neighborhoods are slightly different from the typical formulas used in the case of fixed geographical units (Malmberg et al. 2018). They are obtained by taking the sum of the absolute differences between the representation of poor (affluent) and the representation of non-poor (non-affluent) in each bin (Andersson et al. 2018); the DI can

thus be considered as a synthetic measure of representation at the level of metropolitan areas. Its values vary between 0 and 100; 0 denoting that poor and non-poor (affluent and non-affluent) are equally represented in all neighborhoods; and 100 signifying that the poor (affluent) are not present at all in neighborhoods with non-poor (non-affluent).

Third, as we are interested in the location and extension of poor and affluent areas, we map the representation of poor and affluent residents in neighborhoods. To this end, we computed and mapped the location quotients (LQ) of poverty and affluence at the four scales in each metropolitan area. The location quotient compares the share of the subgroup in question (here poor/affluent) in a neighborhood to the share of the subgroup in the total area (here the metropolitan area). It is a measure of the relative density or area concentration, and has the advantage of being simple and straightforward (Brown and Chung 2006). It may be seen as a spatial variant of the percentile plots. Spatial patterns, including spatial outliers, can be identified using the LQ. If the LQ is one, it means that there is a match between the neighborhood's share of poor (affluent) and the total area's share of poor (affluent); values lower than 1 indicate that poor (affluent) residents are under-represented in the neighborhoods; values higher than one indicate that poor (affluent) residents are over-represented in the neighborhoods relative to a perfectly even distribution in the metropolitan area⁵.

4. Findings

Table 1 presents the total population in the five metropolitan areas delimited in the study and the overall shares of the population at risk of poverty and with high income. These overall shares may not be strictly comparable among cities due to the differences in income definitions mentioned above. Still, bearing in mind that levels of poverty and affluence are indicative, it is interesting to note that the three Scandinavian capitals cities have somewhat lower shares of residents at risk of poverty compared to Brussels and Amsterdam. Overall levels of socio-economic inequality may suggest higher levels of socio-economic segregation (Reardon and Bischoff 2011), although the relation is far from linear. On the other hand, the share of persons with high income is higher in the Scandinavian cities. Brussels and Amsterdam are the most populated metropolitan areas: population density is knowingly higher in Belgium and The Netherlands and, furthermore, the three Scandinavian areas encompass significant extents of water.

Table 1. Total population and overall levels of poverty and affluence in the five metropolitan areas

	Total population	At risk of poverty (percent)	High income (percent)
Brussels	2,349,631	22.6	12.7
Copenhagen	1,398,650	16.0	14.2
Amsterdam	2,159,410	18.0	9.2
Stockholm	1,897,982	14.5	17.4
Oslo	989,569	12.8	14.5

Table 2 reports the dissimilarity indices for the five capital cities, calculated based on individualized neighborhoods using four different scale levels. As could be expected, DI values decrease as the scale increases: under- and overrepresentation tend to be lower as we consider an increasing number of nearest neighbors.

Brussels and Stockholm have the highest dissimilarity indices for poverty at every scale, while Amsterdam shows the lowest segregation of the poor at higher scales. In Brussels, segregation of the poor changes relatively little as the scale increases. Brussels is the only city with substantial large-scale poverty segregation: the DI for poverty is still 29 at the level of 51,200 nearest neighbors, which is double that of Oslo and Copenhagen and more than triple that of Amsterdam.

The second part of Table 2 shows the DI for high income. Compared to the concentration of poverty in capital cities, segregation by high income is much more severe. At the smallest scale levels, about 55 to 71 percent of the population would have to move to create an equal distribution of high income across metropolitan areas. Segregation by high income at small scale levels is nearly double that of the level of poverty segregation in most capitals. Stockholm stands out as the most segregated at lower scales, while large-scale segregation is lowest in Amsterdam. In Oslo, high-income groups to the highest extent live in segregated neighborhoods with relatively few other income groups at the highest k-level.

Table 2. Dissimilarity index (percent) of poverty and affluence in the five metropolitan areas

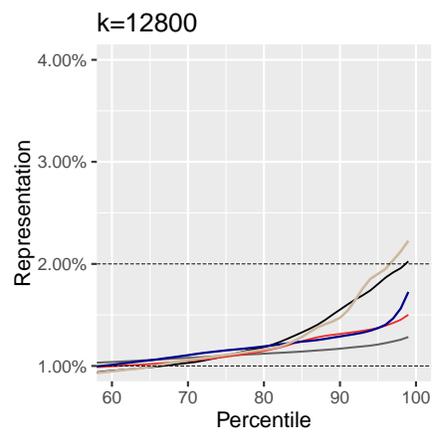
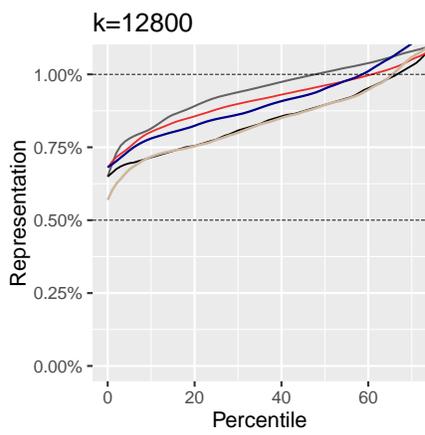
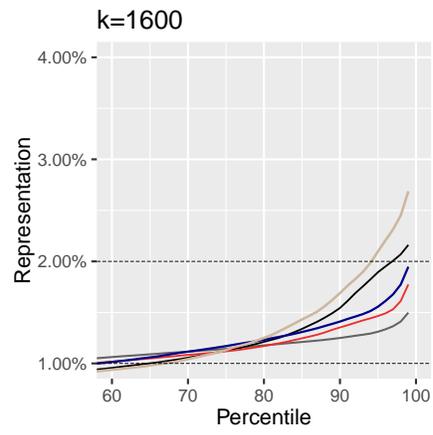
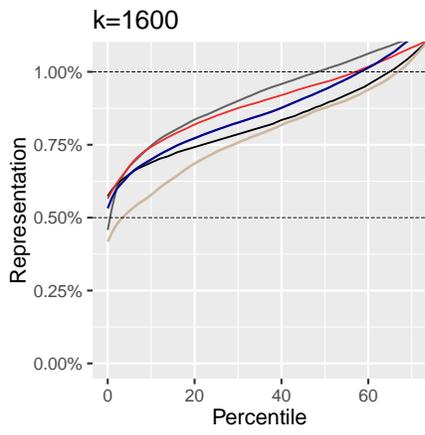
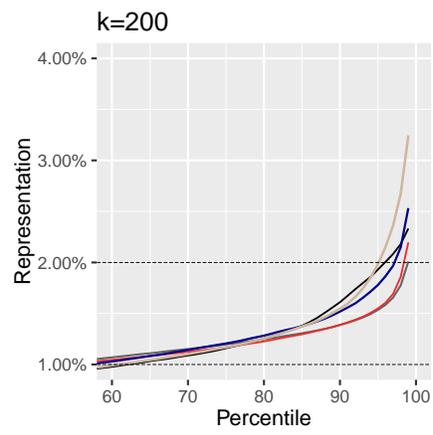
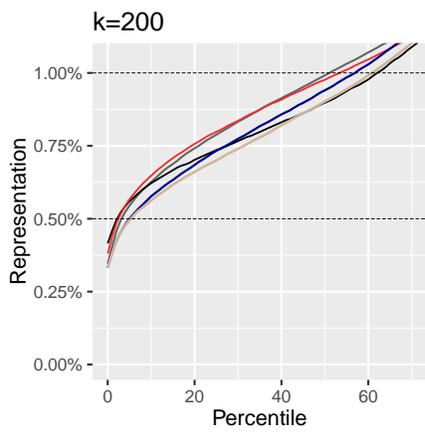
	Brussels	Copenhagen	Amsterdam	Oslo	Stockholm
<u>At risk of poverty</u>					
$k = 200$	37.9	27.1	29.2	33.9	38.0
$k = 1,600$	33.5	21.1	19.4	25.3	39.2
$k = 12,800$	30.6	16.8	13.0	19.1	29.7
$k = 51,200$	29.0	15.5	9.2	14.0	22.0
<u>High income</u>					
$k = 200$	55.6	66.9	62.5	61.9	71.4
$k = 1,600$	46.9	56.7	47.9	53.7	62.3
$k = 12,800$	41.7	46.0	35.4	45.0	45.9
$k = 51,200$	35.8	35.6	26.6	40.8	32.7

Overall, we can conclude that socio-economic segregation is much more severe for high income than for poverty⁶. Furthermore, Brussels and Stockholm have the highest large-scale poverty segregation, followed by Oslo, Copenhagen, and Amsterdam, but this varies according to scale level. Oslo has the highest large-scale high-income segregation, closely followed by Brussels and Copenhagen, Stockholm, and finally Amsterdam. At smaller scale levels, Stockholm stands out with a very high level of segregation by both poverty and affluence.

Figures 1 and 2 contain the percentile plots of poverty and affluence respectively in the five capitals, at four different scales. These plots depict the representation of poor and affluent residents in neighborhood bins. The left plot shows percentiles 0-60 while the right plot shows percentiles 60-100. This is done to facilitate the visualization of values at both ends of the distribution (note that the two plots have different scales on the y-axis). Taking the two upper plots in Figure 1 as an example, these can be interpreted as follows. Each percentile contains 1 percent of a city's population; hence, if poor residents were equally represented in neighborhoods, each percentile

would contain 1 percent of poor. In the absence of segregation, the curves in the plots would therefore be horizontal at 1 percent. Points below this threshold mean that poor residents are under-represented in neighborhoods, whereas points above this threshold reflect over-representation of the poor. The left plot shows the neighborhoods, formed by the 200 nearest neighbors, with lower representation of poor residents. At the 10th percentile, Stockholm has a value below 0.55: this means that 10 percent of Stockholm's population live in neighborhoods that have less than 55 percent poor residents than would be expected if these were evenly distributed in the city. The curve for Stockholm and Brussels are the lowest of all capitals, which means that these cities stand out with the lowest shares of poor people in the neighborhoods that have the largest shares of non-poor groups. In the plot on the right, the line for Stockholm is the highest on the far right side, meaning that in the poorest neighborhoods formed by the 200 nearest neighbors, representation of poor people is higher than in the other capitals. Both cases — under- and over-representation — indicate high levels of polarization.

Globally, the percentile plots for poverty (Figure 1) suggest that Copenhagen, Amsterdam and Oslo have rather similar profiles, while Stockholm and Brussels stand out as the most segregated of cities. At the lowest scale ($k=200$), around 25 percent of the cities' populations live in neighborhoods in which the poor are equally represented in respect to the metropolitan average (within 0.9 to 1.1 percent). In the case of affluence (Figure 2), profiles are more homogeneous among the five capital cities compared to that of poverty. The plots confirm once again that segregation of the affluent is much higher than the segregation of the poor: the cities' slopes are much steeper and farther away from the 1 percent threshold. At the lowest scales ($k=200$ and $k=1600$), only 10 percent of the cities' populations live in neighborhoods where affluent residents are equally represented in respect to the metropolitan average (within 0.9 to 1.1 percent).



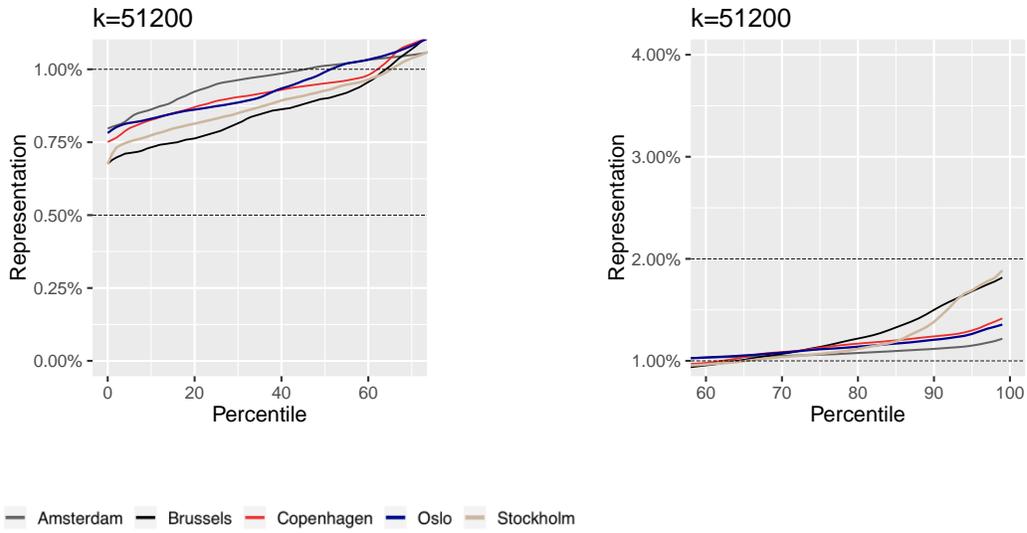
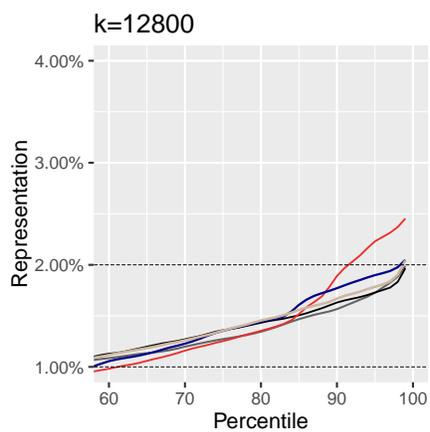
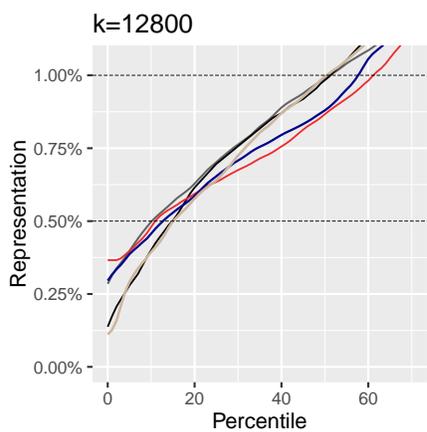
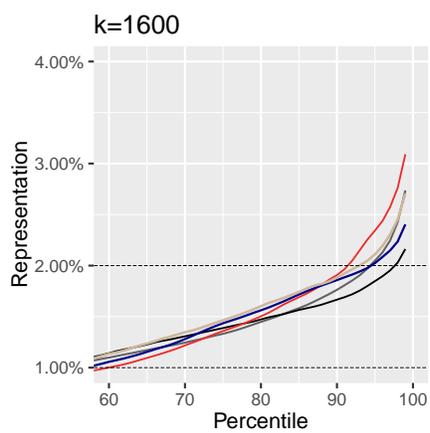
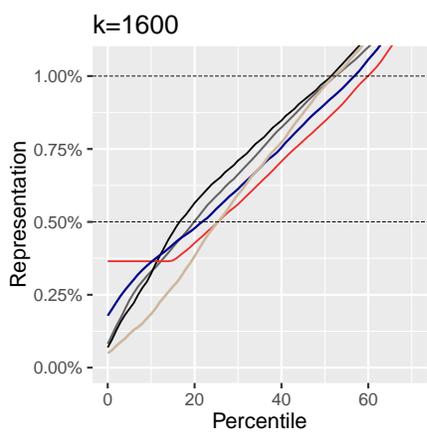
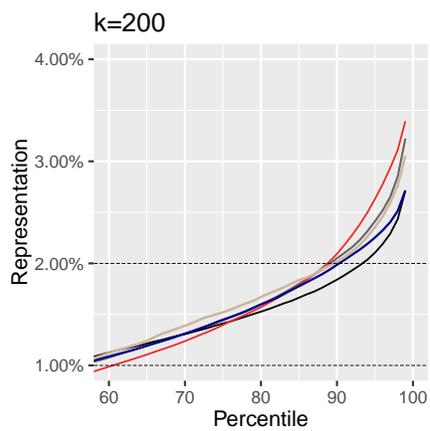
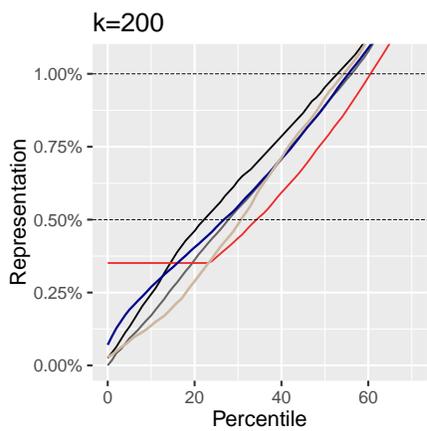


Figure 1: Representation of persons at risk of poverty in percentiles



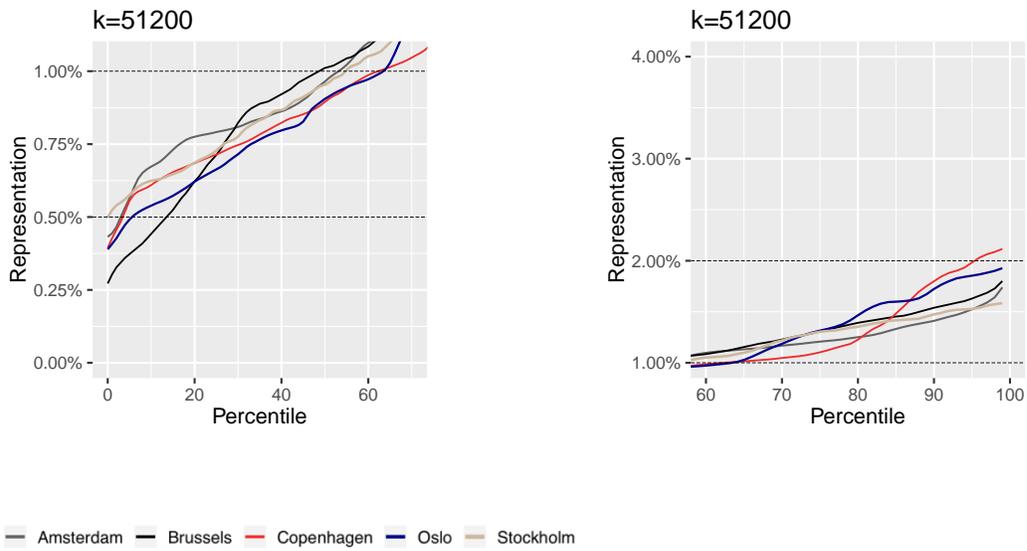


Figure 2: Representation of persons with high income in percentiles*

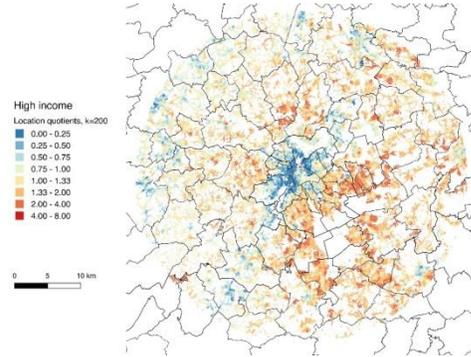
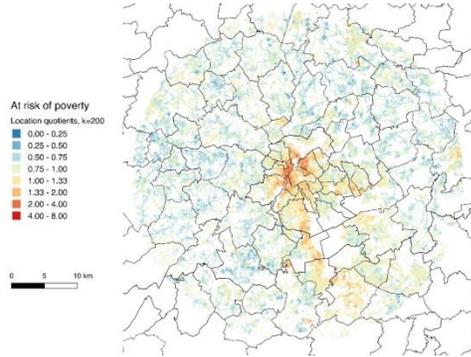
* Copenhagen's curves are flat on the low end because of data capping; low concentrations of high income were set at 5 percent for privacy considerations.

At risk of poverty

High income

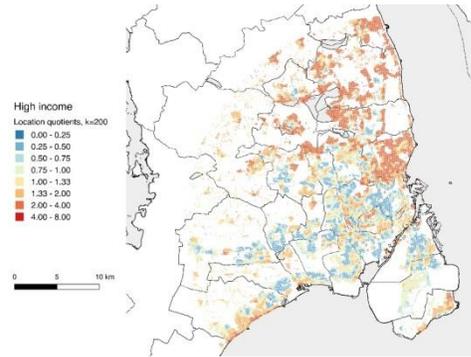
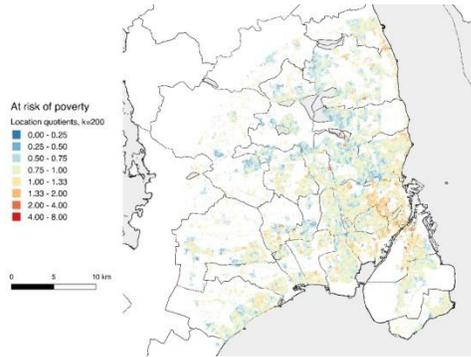
a. Brussels

f. Brussels



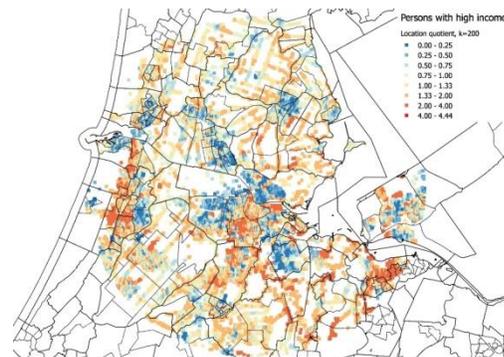
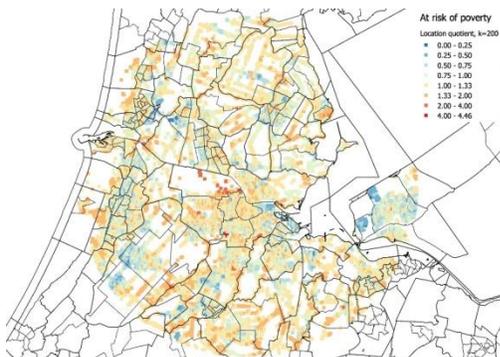
b. Copenhagen

g. Copenhagen

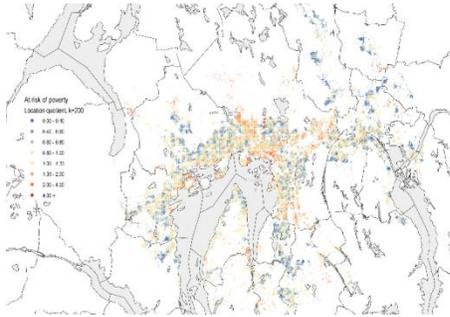


c. Amsterdam

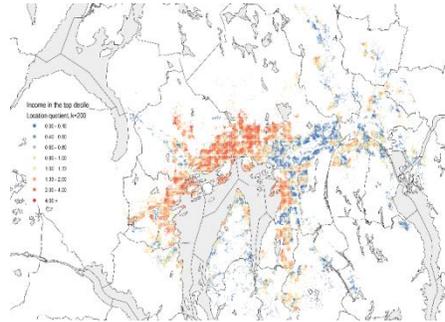
h. Amsterdam



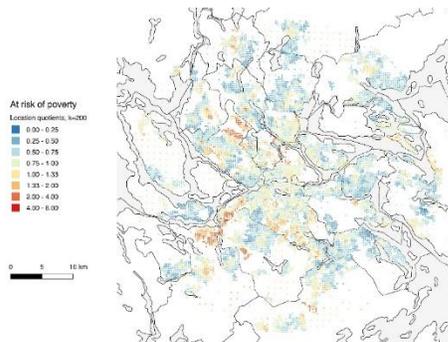
d. Oslo



i. Oslo



e. Stockholm



j. Stockholm

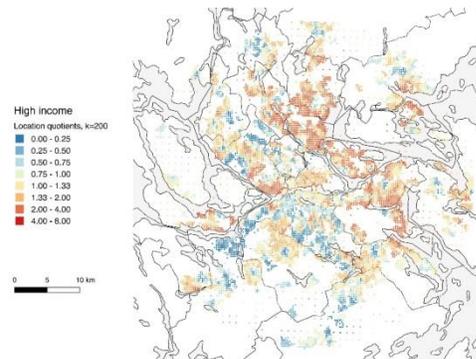
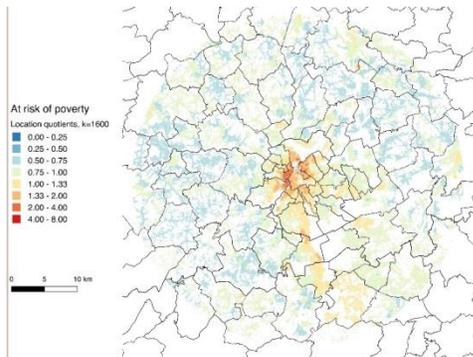


Figure 3: Location quotients at $k=200$

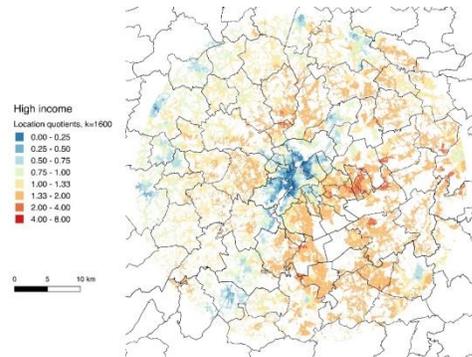
At risk of poverty

a. Brussels

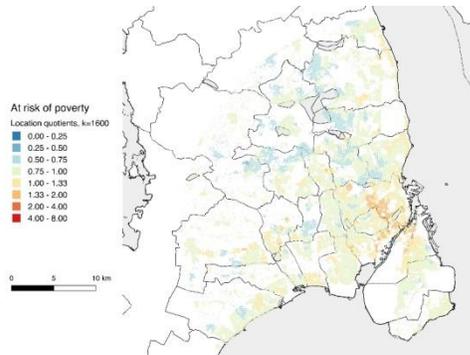


High income

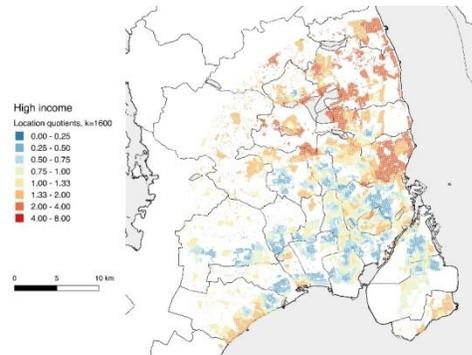
f. Brussels



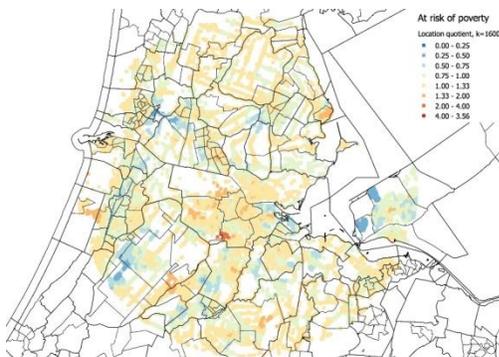
b. Copenhagen



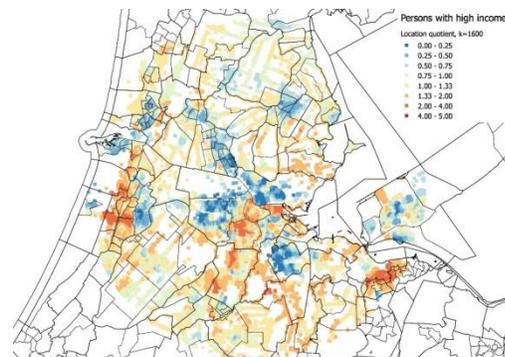
g. Copenhagen



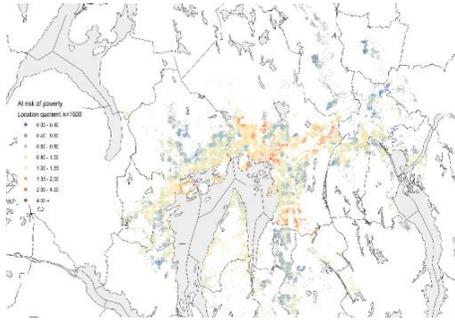
c. Amsterdam



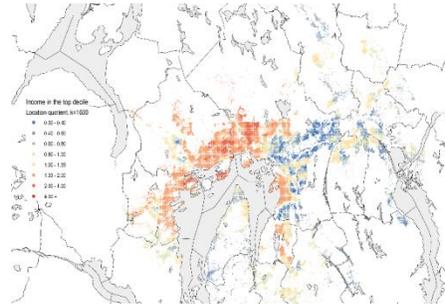
h. Amsterdam



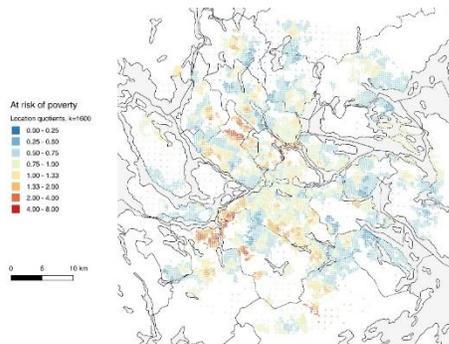
d. Oslo



i. Oslo



e. Stockholm



j. Stockholm

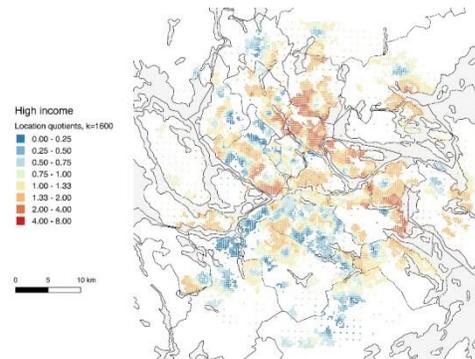


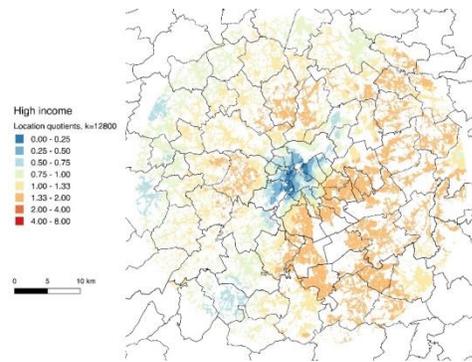
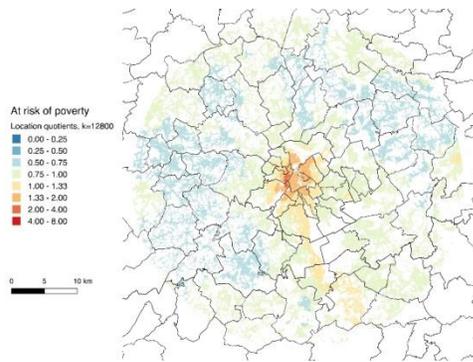
Figure 4: Location quotients at $k=1600$

At risk of poverty

High income

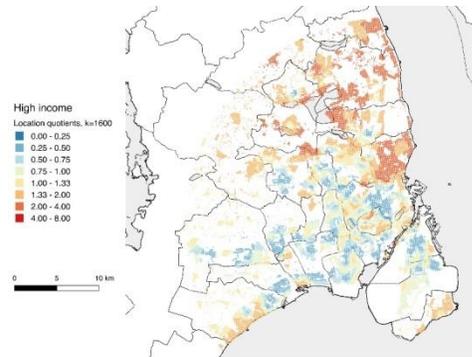
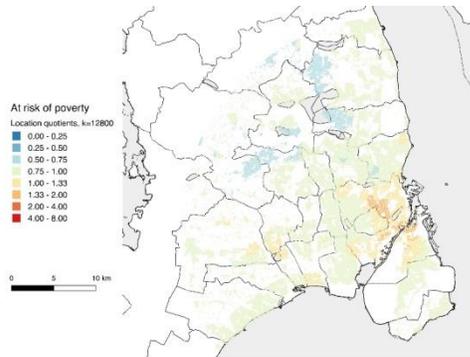
a. Brussels

f. Brussels



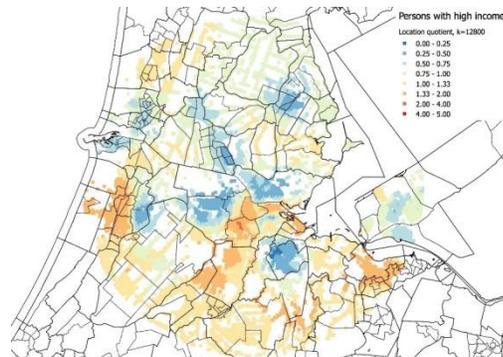
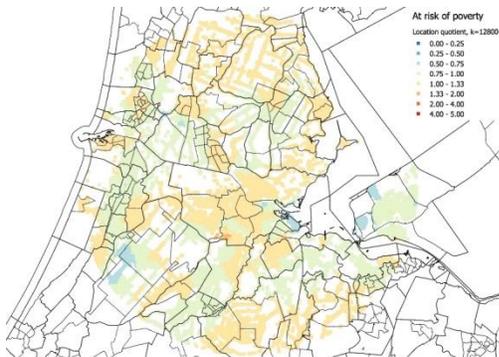
b. Copenhagen

g. Copenhagen

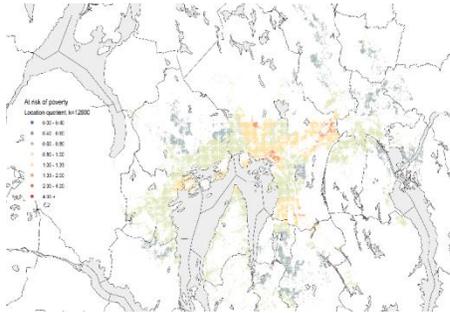


c. Amsterdam

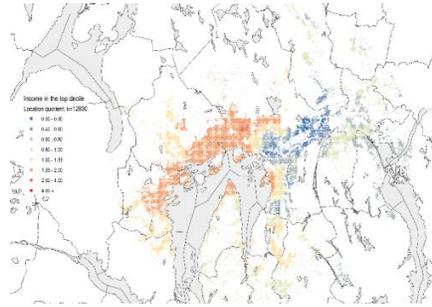
h. Amsterdam



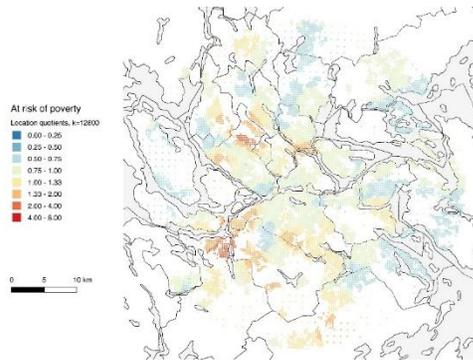
d. Oslo



i. Oslo



e. Stockholm



j. Stockholm

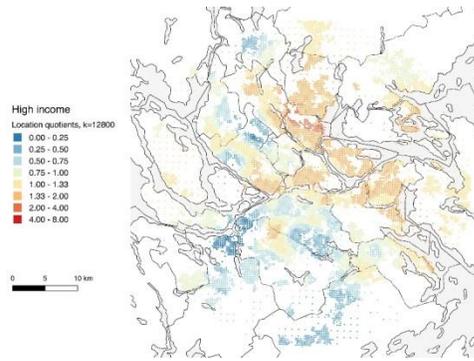


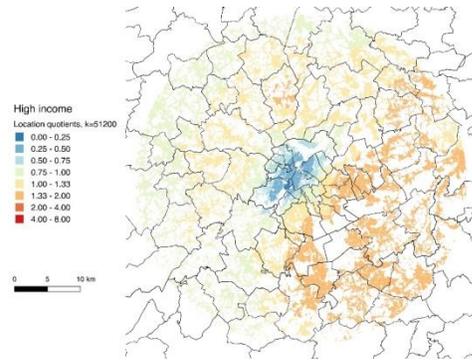
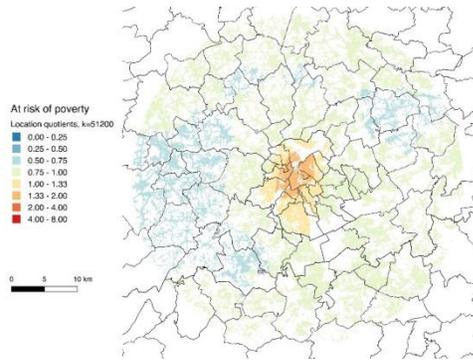
Figure 5: Location quotients at $k=12800$

At risk of poverty

High income

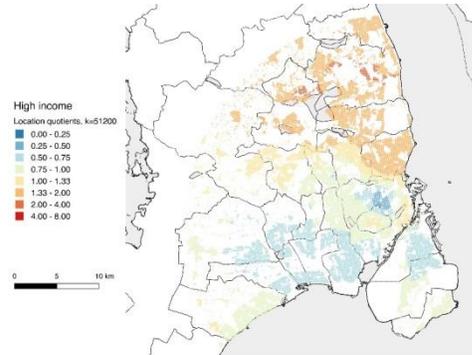
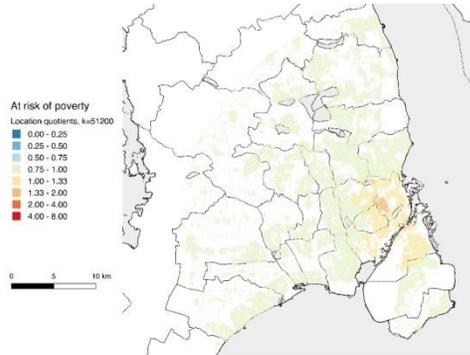
a. Brussels

f. Brussels



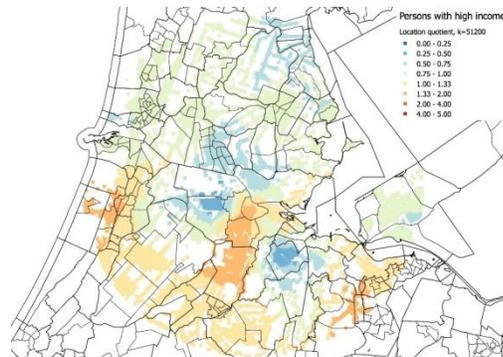
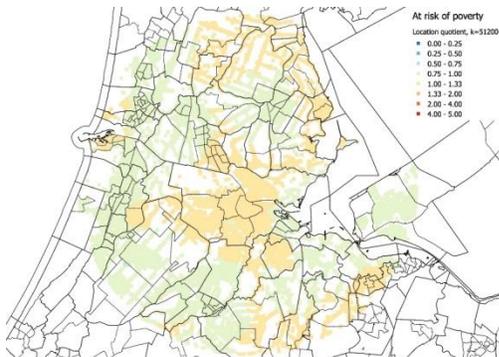
b. Copenhagen

g. Copenhagen

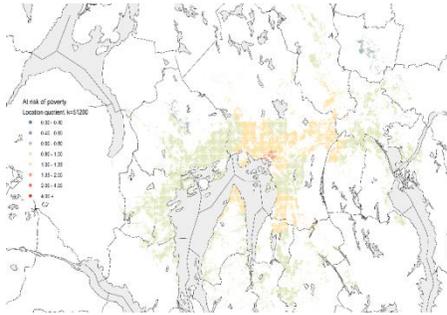


c. Amsterdam

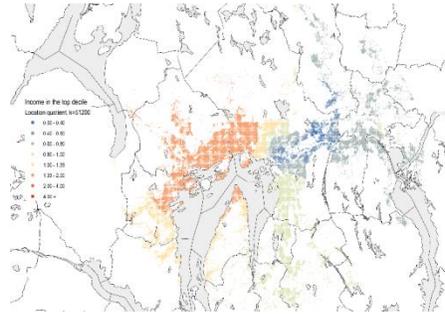
h. Amsterdam



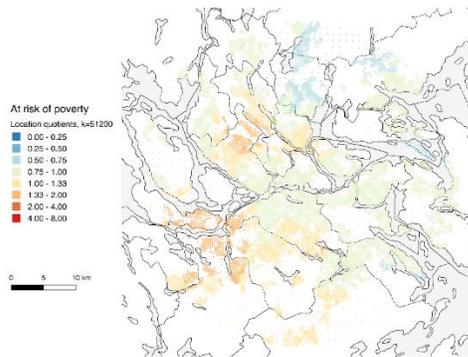
d. Oslo



i. Oslo



e. Stockholm



j. Stockholm

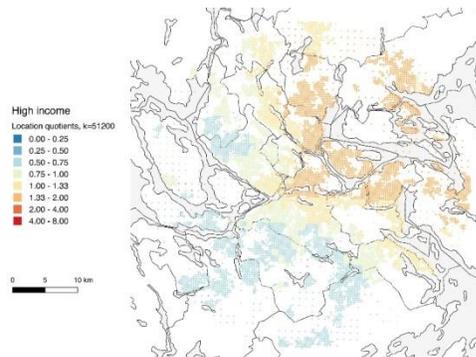


Figure 6: Location quotients at $k=51200$

The maps in Figures 3 to 6 depict the location quotients of poverty and affluence in the five capitals. They allow us to locate the highest and lowest concentrations of poor and affluent residents in the cities and to compare spatial patterns of segregation. In particular, the maps show a clear socio-economic east-west divide in Oslo, a center-periphery divide in Brussels, a north-south division in Copenhagen while spatial patterns are more complex in Stockholm (for higher scale levels there is north-east / south-west divide) and Amsterdam. In most cases, the highest concentrations of poor residents are scattered in ‘poverty pockets’ around the cities, whereas the highest concentrations of rich residents extend over larger homogeneous areas, often in the outer cities. It is also interesting to notice that some of the highest concentrations of poverty in Brussels, Copenhagen and Oslo are located in central neighborhoods, whereas the poor are much less represented in central Stockholm and Amsterdam.

Based on our findings – DIs, percentile plots, and location quotients maps – we describe the specific segregation patterns of each of the five capital cities below.

Brussels

Brussels has high segregation by poverty relative to the other capitals but relatively similar to Stockholm, especially at higher scale levels. DI values for Brussels are comparatively higher in general, but more interestingly, they decrease very little as we increase neighborhood size (Table 1). The high-scale segregation of the poor is also illustrated in the percentile plots in Figure 1: the higher the scale level, the more the Brussels curves become steeper and detach from those of Copenhagen, Amsterdam and Oslo. The 10 percent poorest neighborhoods have a significant over-representation of poor (>1.5 percent), independently of scale. As shown by the maps (Figure 3 to 6), high concentrations of poverty are not scattered around the Brussels metropolitan area as is the case for the other capitals; instead, they are located in a vast and contiguous area in the inner city. The highest clusters of poverty (the red zones in the left-hand map) extend over the nineteenth century industrial belt around the historical core — known as the ‘poor croissant’. These are also the zones where poverty overlaps with the segregation of migrants (Costa and de Valk 2018). Affluent residents are virtually absent in these neighborhoods, as depicted by their blue tone in the affluence maps (note that Brussels is the only city in which the affluence map is a quasi-negative image of the poverty map). Like in all cities, affluent residents in Brussels live more segregated than poor residents (see DIs in Table 1). In the percentile plots for affluence (Figure 2), Brussel’s

profile is similar to the other capitals, except again at the highest scale level ($k=51200$) in which the rich are significantly under-represented in the poorest neighborhoods located in the city center. Similar to the poverty patterns, the highest concentration of affluence extends over a vast contiguous zone, located south-east from the center (Uccle, Watermael-Boitsfort, Auderghem Woluwe) towards the suburban green areas to the east and south. Other clusters of affluence are found all around Brussels in peripheral municipalities. The clear duality between densely populated poor zones in the center and vast affluent zones in the periphery is what explains why segregation in Brussels is a particularly large-scale phenomenon.

Copenhagen

The residential area around Copenhagen's central station extends over a much smaller area compared to the other capitals, as the center is very close to the sea. Segregation by poverty is relatively low, especially compared to Stockholm and to Brussels (Table 2). Copenhagen has a similar representation profile to Oslo and Amsterdam with flat curves that do not deviate much from the equal-representation threshold of 1 percent (Figure 1). Areas with the highest levels of poverty segregation are located (south)west of the city center, around the Frederiksberg area. On the other hand, affluent households live fairly segregated in Copenhagen relative to the other capitals. Its affluence curves (Figure 2) detach from that of the others cities' after the 90th percentile, which means that the richest neighborhoods have a strong over-representation of affluent residents. Furthermore, segregation of the affluent residents persists in Copenhagen at higher scales, contrary to most of the other cities (Figure 2). The 8 percent of Copenhagen's wealthiest residents live in neighborhoods with double the number of affluent people as would be expected without segregation (i.e., >2 percent representation; by comparison, no other city surpasses this threshold). This strong and large-scale segregation by affluence is probably due to the fact that many of the rich neighborhoods are located in an extensive homogeneous area north of the city, on and parallel to the coast (Figures 3 to 6).

Amsterdam

Amsterdam stands out with the lowest levels of socio-economic segregation, regarding both poverty and affluence, at nearly all scale levels. At medium- and large-scale ($k=12,800$ and $k=51,200$), levels of poverty segregation are quite low, with relatively equal distributions of

poverty in a majority of neighborhoods. In fact, at $k=51,200$, 68 percent of Amsterdam's population live in neighborhoods where the poor are equally represented (0.9 to 1.1 percent), a much higher proportion compared to Brussels (20 percent), and also to Oslo and Stockholm (around 30 percent). This is in line with Amsterdam's low DI value at the highest scale (Table 2). At the smallest scale, we see a few very small concentrations of poverty in sparsely populated (non-residential) areas near the circular motorway. For the rest, there are no significant concentrations of poverty, at least according to this definition, in the Amsterdam region. An underrepresentation of poor is visible in the area east of central Amsterdam (eastern Docklands), and more suburban zones such as the area around Almere in Flevoland. Segregation by affluence is much stronger in Amsterdam compared to segregation by poverty. Overall, affluence is concentrated in the area from the inner-city including the Canal Belt to the south (Oud-Zuid and the suburb of Amstelveen), further south towards the so-called "Green Heart" of the Randstad. Other notable concentrations of higher income groups are the dune area east of Haarlem (to the west of Amsterdam) and the suburban municipalities of Het Gooi (to the southeast of Amsterdam). The strong presence of affluent residents in the city center is a particularity of Amsterdam compared to the other capitals.

Oslo

Segregation by poverty in Oslo is slightly higher than in Copenhagen and Amsterdam — as shown by DI values (Table 1) and steeper representation curves (Figure 1) — but it remains modest compared to Stockholm and Brussels. Many of the areas with higher than average densities of poverty are located in the eastern valley of Groruddalen, in the city center, and around the southeastern parts of the city, near Holmlia and Søndre Nordstrand. Oslo has the highest large-scale segregation by affluence of the five capitals (DI=40 for $k=51,200$). At the largest scale, 20 percent of the population live in neighborhoods with a significant over-representation of affluent residents (>1.5 percent). The major division in the city is between the affluent west (including a fjord-facing strip to the south) and the poorer east (see Wessel 2015, 2017). Socio-spatial polarization has grown since the 1990s, with an increase in the segregation of poor households, but especially in the segregation of the most affluent groups (Wessel 2015; Toft 2018). These are highly concentrated in the west and along the fjord to the south, a residential pattern sometimes referred to as "golden ghettos" (Ljunggren 2017). The 'poorer east/ richer west' pattern is visible on Oslo's maps at all

scale levels (Figures 3 to 6). Eastern deprived areas are also where the majority of non-western migrants have settled (Wessel 2017).

Stockholm

Compared to the other capitals, Stockholm has many small-scale neighborhoods with few poor people. At the lowest scale level ($k=200$), 14 percent of Stockholm's population live in neighborhoods with half the share of poor residents than expected with equal representation (against 3 to 6 percent in the other cities). This is illustrated by the various blue spots on Stockholm's poverty maps (Figures 3 to 6). Neighborhoods with high concentrations of poverty are present at all scales in Stockholm. These are most prevalent in the northwest (for instance Rinkeby and Tensta) and southwest of the city (for instance Botkyrka), with a few spatial outliers, such as Fisksätra in the east. With increasing scale levels, the Stockholm and the Brussels maps show relatively many red spots — i.e., high poverty areas — compared to the other capitals; this is also reflected in the much higher dissimilarity index (Table 1) as well as in the deviation from the curves for Copenhagen, Amsterdam and Oslo in the percentile plots (Figure 1). Micro-scale poverty segregation is thus most prominent in Stockholm. Macro-scale poverty segregation is also high, though lower than in Brussels. Segregation by affluence is also high in Stockholm relative to the other cities, especially at lower scale-levels (Table 1). It is mostly the northeast of the city that accommodates the rich: areas such as Lidingö, Danderyd and Täby show the highest shares of affluent people. In the west, it is mostly the area around Bromma, and in the east, some areas in Nacka such as Saltsjöbaden stand out.

5. A Discussion of Mechanisms behind Spatial Patterns of Socio-Economic Segregation

In the preceding parts, we examined and compared socio-economic segregation in Brussels, Copenhagen, Amsterdam, Oslo Stockholm at different scales. In this section, we discuss the main factors that may drive the patterns we observe. A number of factors have been identified in the literature as driving socio-economic inequality across space: welfare regimes, housing market systems, area-based policies, neighborhood preferences and migration dynamics. Below, we make an attempt to see our findings in the light of these factors.

First, higher levels of wealth distribution, especially in social-democratic welfare states, are generally linked to lower levels of socioeconomic inequality, and to lower levels of socio-economic

segregation (Musterd 2005; Arbaci 2007; Tammaru et al. 2015). There are many exceptions to this association, which is also confirmed by our results. Denmark, Norway and Sweden are similar universalistic welfare states, but Stockholm really stands out among these with much higher levels of segregation of the poor, while Oslo stands out with high segregation of the affluent. The Netherlands may be seen as a corporatist or a hybrid welfare state that since the 1990s moves into a more liberal model (Musterd and Van Gent, 2015), however, our results show that socio-economic segregation levels are by far the lowest for Amsterdam. Belgium has been characterized as a conservative-corporatist welfare state type, with Arbaci (2007) adding that the housing system makes Belgium a hybrid case. Musterd (2005) describes Belgium as a strong welfare state with a high extent of redistribution and low levels of income inequality, which does not correspond to relatively high segregation levels in Brussels.

The links between overall levels of income inequality, as illustrated by the metropolitan level of poverty and affluence, is also not directly linked to the observed spatial levels of socio-economic segregation. Amsterdam has a relatively high share of poor people in its population, but levels of socio-economic segregation are the lowest among the metropolitan areas. According to Musterd and Van Gent (2015), this might be due to a long tradition of relatively equal income distribution. Levels of socioeconomic inequality as measured by the GINI coefficient (2011 data from Eurostat) show that Norway had the lowest coefficient (22.7), while Belgium, Denmark, the Netherlands and Sweden had quite similar levels of around 25-26. Even if these levels are national instead of local, they do not translate into the observed levels of socio-economic segregation, especially not for Oslo, which has the highest large-scale segregation of affluent people. This is in line with Arbaci's (2007) conclusion that a low GINI coefficient is not a sufficient condition for low levels of segregation in a European context.

Second, housing systems have been found to drive segregation patterns. The housing systems in the capitals in this study have all been de-regulated over time. Liberalization of the housing market has in most places led to an increase of market influences, for instance by an increasing share of home ownership and a decreasing share of available rentals. Studies have shown that the liberalization of urban housing markets tends to influence mobility of especially the more affluent groups. General trends in European housing markets over the last few decades are retrenchments of welfare states, cuts in universal housing subsidies, partial privatization of the social housing stock and promotion of owner-occupied housing (Arbaci 2007). Especially the role of the social

rented sector is seen as a significant factor behind (changing) patterns of segregation. A relatively small share of social housing tends to be associated with higher levels of socio-economic segregation (Musterd 2005). Examining our results, this relationship is not straightforward. In Amsterdam, the share of public housing is 67 percent (Statistics Netherlands, 2011), and indeed, Amsterdam also has the lowest levels of socio-economic segregation. The Dutch social rented sector, and even more so in Amsterdam, is characterized by a relatively mixed population in terms of income, compared to other countries. Nevertheless, as a result of the sale of social rented dwellings and stricter regulations, Musterd and Van Gent (2015) found that social housing in Amsterdam is increasingly inhabited by the lowest income groups, affecting the overall pattern of poverty segregation. The Belgian housing system has long been exceptionally liberal (De Decker 2008), and social housing accounts for only 8 percent of the total housing stock in Brussels (Dessouroux et al. 2016); and indeed, we found high levels of segregation by poverty in Brussels. But the relationship between the housing system in Norway, Sweden and Denmark and their levels of socio-economic segregation seems more complicated. Norway stands out among the Nordic countries with a very high share of home-ownership, and a very low share of public housing, after the housing market was deregulated in the 1980s, and has lower levels of socio-economic segregation of the poor compared to Stockholm. The latter has a very constrained housing market, with very long queues for rental housing that especially affects newcomers and youth. Property prices in both Stockholm and Oslo have increased substantially over the last decade, and an increasing share of rentals are transferred to owner-occupied apartments in Stockholm. Andersson and Kährrik (2015) show that in Stockholm in the period 1990-2010, the share of public rentals went down from 19 to 7 percent in the inner city, and from 31 to 17 percent in the inner suburbs. As a result, low-income groups are forced into multifamily housing estates in suburbs much further away from the city center. It is most likely that these developments have affected the patterns we find in this paper, namely that poverty segregation is very high in the Stockholm area. The Danish situation is characterized by a substantial social housing sector in a strongly regulated housing market (Skifter Andersen, Andersen, and Ærø 2000), which may correspond to the relatively low levels of socio-economic segregation in Copenhagen.

It is also worth noting that the economic crisis hit the Dutch housing market much harder compared to the other countries. During economic crises, people tend to move much less, which may result in decreasing segregation, as was found for Amsterdam (Musterd and Van Gent 2015).

However, after the economic crisis, because of increased mobility and rising house prices, socio-economic segregation may increase again.

A third major factor influencing patterns of socio-economic segregation are area-based interventions. Especially, interventions directed towards an increasing social mix have been implemented in all cities of the study, with the aim of decreasing deprivation and increasing social cohesion. Musterd (2005) speculates that Dutch policies might have been more efficient in intervening in deprived areas compared to for instance Sweden.

Fourth, the interrelations between migration dynamics and segregation patterns is an important research topic that deserves some attention as well. All capitals in this study have seen large increases in migration flows during the last decades, but absolute and relative numbers have by far been largest for Sweden. Ethnic segregation in the countries in this study is highest for the Netherlands and Belgium on a macro scale, and lowest for Denmark and Norway. On the smallest scale level, ethnic segregation is quite similar across countries, but highest for Belgium and lowest for Norway (Andersson et al. 2018; Rogne et al. 2018), though local urban segregation patterns may be quite different from those at the national scale. There are studies evidencing the link between deprived areas and high densities of immigrants: for example, Costa and De Valk (2018) found that ethnic and socio-economic segregation clearly overlap in Brussels, in a process of large-scale isolation of deprived migrants in central neighborhoods. But the relationship is by no means universal (Wessel 2015).

The link between migration and segregation may be also related to the cities' global connectedness. The more connected a city is, the more it attracts affluent workers for high-profile jobs and in companies and international institutions, and also low-skilled workers in the consumer service sector (Sassen 2001; Musterd et al. 2017). According to the GaWK's 2012 city classification, Brussels and Amsterdam are the most globally connected of the five cities (Alpha), followed by Stockholm (Alpha-), Copenhagen (Beta+) and Oslo (Beta) (Globalization and World Cities Research Network 2012). Brussels' connectedness may influence its high segregation levels, with high- and low-skilled migrants fueling the existing socio-spatial divisions in the city (Costa and de Valk 2018). But this relationship does not seem to hold for the other cities.

Migration flows to, from and within metropolitan areas may also impact on levels of socio-economic segregation. The theory of spatial assimilation states that with increasing socio-economic status, migrants tend to move from deprived areas and to more affluent areas. However, the

evidence for the theory in the cities under examination is mixed. Rogne (2018) finds that descendants of non-western migrants that are economically successful more often move to neighborhoods that are more affluent and contain lower shares of non-western migrants. However, he also finds that the contribution of descendants of non-western migrants to both ethnic and socio-economic segregation is insignificant. Vogiazides (2018) finds that it is mostly recently arrived migrants in Stockholm that move away from distressed areas, while other migrants stay put; while Kenji Chihaya and Vogiazides (2017) find that being employed and highly educated increases the probability for migrants to move to more affluent neighborhoods. Settlement patterns are also caused by ethnic preference among migrants, to move to co-ethnics in certain parts of urban areas (Van Ham and Manley 2009). In addition, natives' avoidance of deprived or immigrant-dense areas also influences segregation patterns (Bråmås 2006; Zorlu and Latten 2009). In Denmark and Sweden, natives have been found to be more likely to leave immigrant-dense neighborhoods (Skifter Andersen et al. 2016).

In the same vein, preferences for high-quality housing, good neighborhoods and affluent neighbors may drive patterns of affluence, as houses in such neighborhoods are more expensive and thus only available to affluent residents. Thus, purchasing power and socioeconomic homophily may contribute to the segregation of the most affluent. Additionally, the segregation patterns in each city have been shaped by a number of factors not accounted for here, such as specific historical developments like industrialization processes and urban expansions, and local geographical features (Myhre 2017). Further attempts at explaining the differences in segregation patterns between cities should also account for such idiosyncrasies

6. Conclusions

This paper has presented unique data on socio-economic segregation in North-Western European capital cities in 2011. The data and methods used in the paper allow for truly comparable dissimilarity indices, maps and percentile plots. For the first time, we are able to draw conclusions on the levels and patterns of socio-economic segregation in Brussels, Copenhagen, Amsterdam, Oslo and Stockholm in a comparative perspective.

The unique geocoded register data in combination with a multiscalar approach solves the previous problems that have prevented good comparative segregation studies. In addition, conceptual issues could largely be solved as well, by adapting joint definitions of indicators of

poverty and affluence. The resulting measures of socioeconomic segregation at multiple scales offer a first-time comparison of patterns and levels of socio-spatial inequalities in five European capitals.

Our main conclusions are that for all cities, the level of segregation by affluence is much larger than that of segregation by poverty. Macro-scale poverty segregation is most prominent in Stockholm and Brussels, and quite low in Amsterdam. At micro scales, Brussels and Stockholm stand out with a presence of local pockets of poverty. In such poor neighborhoods, there are few non-poor, indicating high levels of polarization. Macro-scale affluence segregation is most pronounced in Oslo (which is very different from the results from Tammaru et al. 2015), followed by Brussels, Copenhagen, Stockholm and Amsterdam.

What these results clearly show is that differences in segregation patterns can be subtle and not possible to explain by a simplified model. In our view this implies that progress in understanding segregation processes cannot be made without measures that capture differences between urban areas in a reliable way. As long as there is uncertainty about the extent to which segregation measures reflect real differences between cities, it is not meaningful to develop models that try to explain differences. We would, however, argue that the approach presented in this paper provides secure descriptive results that can serve as an inspiration for both theory building and for testing of hypotheses. The paper has used three different methods to study the spatial distribution of socio-economic segregation, namely dissimilarity indices, percentile plots and location quotients. The latter are seldom used in segregation studies, but as they are suitable for comparisons across time and contexts, they are a promising method to spatial segregation studies. The simultaneous use of different methods can also be very helpful in segregation studies.

We have discussed that a combination of welfare regimes, housing market systems, area-based policies, migration dynamics and preferences all influence patterns of socio-economic segregation, and that the country- and city-specific histories and circumstances matter in explaining spatial patterns of poverty and affluence.

Further research will hopefully be able to use these data to re-examine the theories that explain segregation patterns, to study neighborhood effects on individual outcomes in a comparative perspective, and to assess effects of different policy interventions.

Notes

1. Although Brussels did not figure in the comparison, it is plausible to assume that segregation levels of poor households based on similar data would have been high as well, as Belgian cities have very similar segregation patterns (see Costa and de Valk 2018)
2. In contrast to the technical report (Nielsen et al. 2017), the Swedish data used to construct the poverty indicator is measured at individual and not household level.
3. Tax returns in Belgium include all null income declarations. These produce a bias in income data because international workers do not pay taxes in Belgium, and falsely appear as being poor. In order to address this bias, we excluded null incomes from the data. The change mostly leaves out wealthy international workers and non-working spouses, and not poor households. This is because most households without a revenue have unemployment grants or other types of social assistance, and do not appear as having null income in tax returns. The exclusion of international workers is not ideal because they obviously participate in the spatial distribution of poverty and affluence in Brussels. However, our tests have shown that the data is consistent and suitable for our purposes in this article. Furthermore, we can assume that neighborhoods that cluster on wealthy international workers also cluster wealthy domestic workers. More details on this issue are available upon request.
4. As explained, neighborhoods were constructed by expanding geographical buffers around grids; however, we can consider that each inhabitant of a grid has their own individualized neighbourhood.
5. Thresholds based on a difference of one standard deviation, namely 1.2 for a significant concentration/segregation of subgroups and 0.85 for a significant under-representation, are used in the literature (Brown, Lobao, and Verheyen 1996; Brown and Chung 2006), but depend on specific distributions.
6. The age groups for measuring segregation of the poor and the affluent are slightly different, which may mean the indices are not strictly comparable.

References

- Andersson, Eva (2004). From valley of sadness to hill of happiness: The significance of surroundings for socioeconomic career. *Urban Studies* 41(3), 641–659. Doi: 10.1080/0042098042000178726.
- Andersson, Roger and Kährrik, Anneli (2015). Widening gaps. Segregation dynamics during two decades of economic and institutional change in Stockholm. In T. Tammaru, S. Marcinczak, M. van Ham, and S. Musterd (Eds.), *Socio-economic segregation in European capital cities: East meets west* (pp. 112–128). London: Routledge.
- Andersson, Eva K., Lyngstad, Torkild H. and Sleutjes, Bart (2018). Comparing patterns of segregation in North-Western Europe: A multiscalar approach. *European Journal of Population* 34(2), 151–168. Doi: 10.1007/s10680-018-9477-1.
- Andersson, Eva K. and Malmberg, Bo (2015). Contextual effects on educational attainment in individualised, scalable neighbourhoods: Differences across gender and social class. *Urban Studies* 52(12), 2117–2133. Doi: 10.1177/0042098014542487.
- Andersson, Eva K., Malmberg, Bo, Costa, Rafael, Sleutjes, Bart, Stonawski, Marcin J. and De Valk, Helga A.G. (2018). A comparative study of segregation patterns in Belgium, Denmark, the Netherlands and Sweden: Neighbourhood concentration and representation of non-European migrants. *European Journal of Population* 34(2), 251–275. Doi: 10.1007/s10680-018-9481-5.
- Arbaci, Sonia (2007). Ethnic segregation, housing systems and welfare regimes in Europe. *International Journal of Housing Policy* 7(4), 401–433. Doi: 10.1080/14616710701650443.
- Bolt, Gideon (2009). Combating residential segregation of ethnic minorities in European cities. *Journal of Housing and the Built Environment* 24: 397–405. Doi: 10.1007/s10901-009-9163-z.
- Bråmås, Åsa (2006). White flight? The production and reproduction of immigrant concentration areas in Swedish cities. *Urban Studies* 43(7), 1127–1146. Doi: 10.1080/00420980500406736.
- Brown, Lawrence A. and Chung, Su–Yeul (2006). Spatial segregation, segregation indices and the geographical perspective. *Population, Space and Place* 12, 125–143. Doi: 10.1002/psp.403.
- Brown, Lawrence A., Lobao, Linda M. and Verheyen, Anthony L. (1996). Continuity and change in an old industrial region. *Growth and Change* 27, 175–205. Doi: 10.1111/j.1468-2257.1996.tb00902.x.

- Cassiers, Tim, and Kesteloot, Christian (2012). Socio-spatial inequalities and social cohesion in European cities. *Urban Studies* 49(9), 1909–1924. Doi: 10.1177/0042098012444888.
- Chaix, Basile, Merlo, Juan, Subramanian, S.V., Lynch, John and Chauvin, Pierre (2005). Comparison of a spatial perspective with the multilevel analytical approach in neighbourhood studies: The case of mental and behavioural disorders due to psychoactive substance use in Malmö, Sweden, 2001. *American Journal of Epidemiology* 162(2), 171–182. Doi: 10.1093/aje/kwi175.
- Chaix, Basile, Merlo, Juan, Evans, David, Leal, Cinira and Havard, Sabrina (2009). Neighbourhoods in eco-epidemiologic research: Delimiting personal exposure areas. A response to Riva, Gauvin, Apparicio and Brodeur. *Social Science & Medicine* 69(9), 1306–1310. doi: 10.1016/j.socscimed.2009.07.018.
- Clark, William A.V. (2015). Residential segregation: Recent trends. *International Encyclopedia of the Social and Behavioral Sciences* 20: 549–554. Doi: 10.1016/B978-0-08-097086-8.72134-9.
- Clark, William, Andersson, Eva, Östh, John and Malmberg, Bo (2015). A multi-scalar analysis of neighbourhood composition in Los Angeles 2000–2010: A location based approach to segregation and diversity. *Annals of the Association of American Geographers* 105(6), 1260–1284. Doi: 10.1080/00045608.2015.1072790.
- Costa, Rafael and De Valk, Helga A.G. (2018). Ethnic and socioeconomic segregation in Belgium: A multiscalar approach using individualised neighbourhoods. *European Journal of Population* 34(2), 225–250. Doi: 10.1007/s10680-018-9480-6.
- De Decker, Pascal (2008). Facets of housing and housing policies in Belgium. *Journal of Housing and the Built Environment* 23(3), 155–171. Doi: 10.1007/S10901.
- Dessouroux, Christian, Bensliman, Rachida, Bernard, Nicolas, De Laet, Sarah, Demonty, Francois, Marissal, Pierre and Surkyn, Johan (2016). Housing in Brussels: diagnosis and challenges. BSI synopsis. *Brussels Studies* 99. doi: 10.4000/brussels.1353.
- Dujardin, Claire, Selod, Harris and Thomas, Isabelle (2008). Residential segregation and unemployment: The case of Brussels. *Urban Studies* 45(1), 89–113. Doi: 10.1177/0042098007085103.
- Duncan, Otis D. and Duncan, Beverly (1955). A methodological analysis of segregation indexes. *American Sociological Review* 20(2), 210–217.

- Fisher, Claude S., Stockmayer, Gretchen, Stiles, Jon and Hout, Michael (2004). Distinguishing the geographical levels and social dimensions of US metropolitan segregation, 1960-2000. *Demography* 41(1), 37–59.
- Fowler, Chris S. (2016). Segregation as a multiscale phenomenon and its implications for neighborhood-scale research: The case of South Seattle 1990-2010. *Urban Geography* 37(1), 1–25. Doi: 10.1080/02723638.2015.1043775.
- Galster, George (2007). Should policy makers strive for neighborhood social mix? An analysis of the Western European evidence base. *Housing Studies* 22(4), 523–545. Doi: 10.1080/02673030701387630.
- Globalization and World Cities Research Network (2012). The World According to GaWK 2012. Retrieved December 10, 2018, from <https://www.lboro.ac.uk/gawc/world2012.html>.
- Hennerdal, Pontus and Nielsen, Michael M. (2017). A multiscale approach for identifying clusters and segregation patterns that avoids the Modifiable Areal Unit Problem. *Annals of the American Association of Geographers* 107(3), 555–574. Doi: 10.1080/24694452.2016.1261685.
- Kleinmans, Reinout (2004). Social implications of housing diversification in urban renewal: A review of recent literature. *Journal of Housing and the Built Environment* 19(4), 367–390.
- Kühn, Manfred (2015). Peripheralization: Theoretical concepts explaining socio-spatial inequalities. *European Planning Studies* 23(2), 367–378. Doi: 10.1080/09654313.2013.862518.
- Lee, Barrett A., Firebaugh, Glen, Matthews, Stephen A., Reardon, Sean F., Farrell, Chad R. and O’Sullivan, David (2008). Beyond the census tract: Patterns and determinants of racial segregation at multiple geographic scales. *American Sociological Review* 73(5), 766–691.
- Lichter, Daniel T., Parisi, Domenico and Taquino, Michael C. (2015). Toward a new macro-segregation? Decomposing segregation within and between metropolitan cities and suburbs. *American Sociological Review* 80(4), 843–873. Doi: 10.1177/0003122415588558.
- Ljunggren, Jørn (2017). Oslo - Ulikhetenes By. Oslo: Cappelen Damm Akademisk.
- MacAllister, I., Johnston, R.J., Pattie, C.J., Tunstall, H., Dorling, D. F. L. and Rossiter, D.J. (2001). Class dealignment and the neighbourhood effect: Miller revisited. *British Journal of Political Science* 31(1), 41–59. Doi: 10.1017/S0007123401000035.

- Malmberg, Bo, Andersson, Eva K. and Bergsten, Zara (2014). Composite geographical context and school choice attitudes in Sweden: A study based on individually defined, scalable neighborhoods. *Annals of the Association of American Geographers* 104(4), 869–888. Doi: 10.1080/00045608.2014.912546.
- Malmberg, Bo, Andersson, Eva K., Nielsen, Michael M. and Haandrikman, Karen (2018). Residential segregation of European and non-European migrants in Sweden: 1990-2012. *European Journal of Population* 34(2), 169-193. Doi: <http://doi.org/10.1007/s10680-018-9478-0>.
- Marcińczak, Szymon, Musterd, Sako, Van Ham, Maarten and Tammaru, Tiit (2015). Inequality and rising levels of socio-economic segregation: Lessons from a pan-European comparative study. In T. Tammaru, S. Marcińczak, M. van Ham and S. Musterd (Eds.), *Socio-economic segregation in European capital cities: East meets west* (pp. 358–382). London: Routledge.
- Massey, Douglas S. and Denton, Nancy A. (1988). The dimensions of residential segregation. *Social Forces* 67(2), 281–315.
- Musterd, Sako (2005). Social and ethnic segregation in Europe: Levels, causes and effects. *Journal of Urban Affairs* 27(3), 331–348.
- Musterd, Sako and Van Gent, Wouter (2015). Changing welfare context and income segregation in Amsterdam and its metropolitan area. In T. Tammaru, S. Marcińczak, M. van Ham and S. Musterd (Eds.), *Socio-economic segregation in European capital cities: East meets west* (pp. 66–85). London: Routledge.
- Musterd, Sako, Marcińczak, Szymon, Van Ham, Maarten and Tammaru, Tiit (2017). Socioeconomic segregation in European capital cities. Increasing separation between poor and rich. *Urban Geography* 38(7), 1062–1083. Doi: 10.1080/02723638.2016.1228371.
- Myhre, Jan E. (2017). Oslos historie som delt by [Oslo's history as a shared city]. In J. Ljunggren (Ed.), *Oslo - ulikhetenes by* (pp. 31-56). Oslo: Cappelen Damm Akademisk.
- Nielsen, Michael M., Costa, Rafael, Sleutjes, Bart, Stonawski, Marcin J., Rogne, Adrian F. and Haandrikman, Karen (2017). Residential segregation in 5 European countries: Technical report. ResSegr Working Paper 2017:2. Stockholm: Stockholm University.
- Nielsen, Michael M. and Hennerdal, Pontus (2017). Changes in the residential segregation of immigrants in Sweden from 1990 to 2012: Using a multi-scalar segregation measure that

- accounts for the Modifiable Areal Unit Problem. *Applied Geography* 87, 73–84. Doi: 10.1016/j.apgeog.2017.08.004.
- Olzak, Susan, Shanahan, Suzanne and McEneaney, Elizabeth H. (1996). Poverty, segregation, and race riots: 1960 to 1993. *American Sociological Review* 61(4), 590–613.
- Openshaw, Stan (1984). The Modifiable Areal Unit Problem. Concepts and Techniques in Modern Geography. Vol. 38. Norwich: GeoBooks.
- Östh, John, Malmberg, Bo and Andersson, Eva (2014). Analysing segregation with individualized neighbourhoods defined by population size. In C.D. Lloyd, I. G. Shuttleworth and D.W. Wong (Eds.), *Social-spatial segregation: Concepts, processes and outcomes* (pp. 135–161). Bristol: Policy Press.
- Östh, John, Clark, William A. V. and Malmberg, Bo (2015). Measuring the scale of segregation using k-nearest neighbor aggregates. *Geographical Analysis* 47(1), 1–16. Doi: 10.1111/gean.12053.
- Reardon, Sean F. and Bischoff, Kendra (2011). Income inequality and income segregation. *American Journal of Sociology* 116(4), 1092–1153.
- Reardon, Sean F., Matthews, Stephen A., O’Sullivan, David, Lee, Barrett A., Firebaugh, Glen, Farrell, Chad R. and Bischoff, Kendra (2008). The geographic scale of metropolitan racial segregation. *Demography* 45(3), 489–514.
- Reardon, Sean F., Farrell, Chad R., Matthews, Stephen A., O’Sullivan, David, Bischoff, Kendra and Firebaugh, Glen (2009). Race and space in the 1990s: Changes in the geographic scale of racial residential segregation, 1990–2000. *Social Science Research* 38(1), 55–70. Doi: 10.1016/j.ssresearch.2008.10.002.
- Rogne, Adrian F. (2018). Ethnic segregation, economic segregation and the ‘second generation’. The moving patterns of the descendants of non-western immigrants in Oslo. ResSegr Working Paper 2018:1. Stockholm: Stockholm University.
- Rogne, Adrian F., Andersson, Eva K., Malmberg, Bo and Lyngstad, Torkild H. (2018). Neighbourhood concentration and representation of non-European migrants. New results from Norway. *European Journal of Population*, forthcoming.
- Sassen, Saskia (2001). *The Global City: New York, London, Tokyo*. 2nd edition. Princeton: Princeton University Press.

- Shuttleworth, Ian G. and Christopher D. Lloyd (2009). Are Northern Ireland's communities dividing? Evidence from geographically consistent population data 1971-2001. *Environment and Planning A* 41(1), 213–229. Doi:10.1068/a40163.
- Skifter Andersen, Hans, Andersen, Hans Thor and Ærø, Thorkild (2000). Social polarisation in a segmented housing market: Social segregation in Greater Copenhagen. *Geografisk Tidsskrift-Danish Journal of Geography* 100(1), 71–83. Doi: 10.1080/00167223.2000.10649440.
- Skifter Andersen, Hans, Andersson, Roger, Wessel, Terje and Vilkama, Katja (2016). The impact of housing policies and housing markets on ethnic spatial segregation: Comparing the capital cities of four Nordic welfare states. *International Journal of Housing Policy* 16(1), 1–30. Doi: 10.1080/14616718.2015.1110375.
- Sloutjes, Bart, De Valk, Helga A. G. and Ooijevaar, Jeroen (2018). The measurement of ethnic segregation in the Netherlands: Differences between administrative and individualized neighbourhoods. *European Journal of Population* 34(2), 195–224. Doi: 10.1007/s10680-018-9479-z.
- Statistics Netherlands. 2011. StatLine, statistical database. <http://statline.cbs.nl> (accessed 26 April 2016).
- Tammaru, Tiit, Marcińczak, Szymon, Van Ham, Maarten and Musterd, Sako (2015). Socio-economic segregation in European capital cities: East meets west. London: Routledge.
- Toft, Maren (2018). Enduring contexts: Segregation by affluence throughout the life course. *The Sociological Review* 66(3), 645–664. Doi: 10.1177/0038026117741051.
- Van Ham, Maarten and David Manley (2009). Social housing allocation, choice and neighbourhood ethnic mix in England. *Journal of Housing and the Built Environment* 24(4), 407–422.
- Vogiazides, Louisa (2018). Exiting distressed neighbourhoods: The timing of spatial assimilation among international migrants in Sweden. *Population, Space and Place* 24(8), e2169. Doi: 10.1002/psp.2169.
- Vogiazides, Louisa and Guilherme Kenji Chihaya (2017). Migrants' residential trajectories in Swedish metropolitan areas: An exploratory study. Paper presented at the Nordic Geographers Meeting, Stockholm, June 18–21.

- Wessel, Terje (2015). Economic segregation in Oslo. Polarisation as a contingent outcome. In T. Tammaru, S. Marcińczak, M. van Ham, and S. Musterd (Eds.), *Socio-Economic Segregation in European Capital Cities: East Meets West* (pp. 129–148). London: Routledge.
- Wessel, Terje (2017). Det todelte Oslo – Etniske minoriteter i øst og vest (Divided Oslo – Ethnic minorities in east and west). In J. Ljunggren (Ed.), *Oslo - Ulikhetenes By* (pp. 79-102). Oslo: Cappelen Damm Akademisk.
- Wong, David W.S. (2004). Comparing traditional and spatial segregation measures: A spatial scale perspective. *Urban Geography* 25(1), 66–82. doi: 10.2747/0272-3638.25.1.66.
- Zorlu, Aslan and Latten, Jan (2009). Ethnic sorting in the Netherlands. *Urban Studies* 46(9), 1899–1923. Doi: 10.1177/0042098009106023.