Scandinavian Economic History Review

ISSN: 0358-5522 (Print) 1750-2837 (Online) Journal homepage: https://www.tandfonline.com/loi/sehr20

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To cite this article: Jakob Molinder & Martin Söderhäll (2020) Did industrialisation lead to segregation in cities of the nineteenth century? The case of Uppsala 1880–1900, Scandinavian Economic History Review, 68:1, 23-44, DOI: 10.1080/03585522.2019.1640787

To link to this article: https://doi.org/10.1080/03585522.2019.1640787

Published online: 21 Jul 2019.

SCANDINAVIAN ECONOMIC HISTORY REVIEW
2020, VOL. 68, NO. 1, 23–44
https://doi.org/10.1080/03585522.2019.1640787

Routledge
Taylor & Francis Group

Did industrialisation lead to segregation in cities of the nineteenth century? The case of Uppsala 1880–1900

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ABSTRACT

How did industrialisation affect land use and residential patterns in cities of the nineteenth century? We use census data and GIS mapping techniques to analyse class segregation and changes to the spatial structure using the case of Uppsala, Sweden between 1880 and 1900. We find that there was a clear concentration of business activity in the central district and in proximity to the transportation hubs. Since these activities became more numerous but remained concentrated, they likely increased land values in the central areas of the city, inducing the lowest social classes to locate away from the centre. However, while these households were pushed out, it did not result in the type of class segregation we observe in many twentieth-century cities. Before the widespread use of transport technologies allowing populations to sprawl, city expansion in the type of middle-sized city that we study led instead to increased density and mixed uses in the central areas.

ARTICLE HISTORY
Received 13 March 2018
Accepted 24 June 2019

KEYWORDS
Land use; residential patterns; segregation; geographical information systems; spatial structure

1. Introduction

The fact that industrialisation and the takeoff to modern economic growth were concurrent with the growth of cities and of increased urbanisation is well known. In Sweden, this process intensified in the 1870s. Before this, cities had remained small and urban growth had been modest. Between 1880 and 1900 city populations grew by 58% and the urbanisation rate rose from below 20 to over 30% (Nilsson, 1989). This experience of urbanisation during economic takeoff was shared across the now developed world (Bairoch, 1988). Increasing levels of residential segregation have long since been associated with the industrialisation of the nineteenth century, particularly in the larger cities of Victorian era Britain (Carter & Wheatley, 1980; Pooley, 1984). However, others such as Ward (1975) have suggested that many Victorian cities, in fact, consisted of integrated and diverse communities and also points to the arrival of cheaper mass transportation as an important cause of increased segregation in the latter part of the nineteenth century.

Though there exists a literature on the effects of nineteenth-century industrialisation on residential segregation of British and American, and in particular, large cities, much less is known about the cities of the European periphery and especially the smaller ones, many of which saw unprecedented population growth in relative terms during this period, and who are in many cases more representative for the urban experience than the larger cities.[1]

At this time, urban structure in most smaller cities was shaped by the ability to walk between places, mainly due to the lack transport infrastructure such as trams and commuter railways,

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Supplemental data for this article can be accessed at https://doi.org/10.1080/03585522.2019.1640787.
[1]More than half of the Swedish urban population were living in cities with fewer than 50,000 inhabitants in both 1880 (64%) and 1900 (55%). Calculation based on Nilsson (1989).

which had been constructed in many larger cities.[2] When lacking internal rail bound transport infrastructure, the dominating system of transport between cities was by railroad as well as by water, leading to clustering of industries in proximity to these transportation hubs. In this paper, we aim to examine the dynamic between residential patterns, industrialisation and urbanisation in the small and growing city of Uppsala during the late nineteenth century.

We take advantage of new data sources and geographic information system (GIS) mapping techniques to analyse residential patterns and changes to the spatial structure of a growing and industrialising city in the late nineteenth century by using the case of Uppsala, Sweden. It is clear from previous work that spatial social differentiation was present also in smaller Nordic cities in the nineteenth century (Jutikkala, 1968; Nummela, 1990), but the process through which this happened has not been studied to a great extent.

There are several features of the city that makes it a good case for the overall experience of smaller-sized Nordic cities at the time.[3] Uppsala had a diversified economy, and while industrialisation drove population growth, no single employer or industry dominated the local economy. In addition, there was no sea or lakeshore, mountain or other geographical feature that restricted land use. There were no major changes in the internal transport infrastructure during the period. Most cities in the Nordic countries were small and very ethnically homogenous.[4] In addition, only a few cities were strongly focused on a particular industry, so the results for Uppsala should apply to the majority of Nordic towns at this time.

We find that that there was a clear concentration of manufacturing, services and high-order artisans and retailers in the central district and in proximity of the two transportation hubs: the railway station and the harbour.[5] While we cannot measure land values directly, the fact that these activities became more numerous but remained concentrated likely led to an increase in housing costs in the central parts of the city. Interestingly, this process did not appear to have led to increased class segregation, which we analyse by mapping households by social class and by calculating a set of segregation indices common to the literature. While there was no upsurge in spatial clustering of social classes, there was, however, a de-concentration of the lowest social classes away from the central city, and in the newly built-up areas in the periphery the working class strongly dominated. We argue that this was likely the result of increased competition for land in the central district, driven by retailers and industries desire to be located at the centre of the market and close to transportation hubs in the absence of transport infrastructure that allowed them to be located further away.

The rest of the article is organised in the following way. In the next section, we review the relevant literature on urban geography and the fairly recent attempts to use GIS mapping techniques on nineteenth-century census data. Section 3 presents the research design, data material and the process of georeferencing the census data. In section 4, we present the case of Uppsala in more detail. Finally, section 5 presents the results before we conclude in section 6.

2. Theory and previous literature

2.1. Determinants of localisation

In the dense walking city of the nineteenth century, production and consumption, as well as residency had to take place within the confines of a fairly limited geographical area. Before the advent

[2]Stockholm had its first tramway constructed in 1877, Gothenburg in 1879, Copenhagen in 1862, Helsinki in 1891 and Oslo in 1875.
[3]It is important to note that in some countries, such as the United Kingdom, urbanization had reached high levels much earlier. The experience of Uppsala is therefore more comparable to smaller cities in countries of the second wave of industrialisation such as those in the Nordics. The Nordic countries were also very homogenous, so the results for social class segregation are much more likely to apply to cities in these countries.
[4]Only 8 Nordic cities had a population above 50,000 in 1900: Aarhus, Bergen, Copenhagen, Gothenburg, Helsinki, Malmö, Oslo, and Stockholm (Chandler, 1987).
[5]According to Westlund (1992) Uppsala had the second highest railway-connectivity amongst mid-sized cities in Sweden in the late nineteenth century.

of streetcars and the widespread use of telephones the cost of transportation of goods and the sending of information between cities was relatively cheaper than within cities (Anas, Arnott, & Small, 1997). Therefore, the location pattern of economic activities is expected to differ if the final product is consumed within the city or if it is shipped away, the weight-to-value ratio and whether the good and service sold is of a lower or higher order.[6] Industries with low value-to-weight inputs and outputs are expected to be transport-oriented, seeking to minimise the cost of moving materials and products within the city (Glaeser & Kohlhase, 2003; Weber, 1929)

In the case of manufacturing, some industries such as food processing mainly produce for the local market, but are still dependent on bulky inputs from other places. Other manufacturing industries such as engineering and metal manufacturing are dependent both on bulky inputs and the ability to transport their final goods to other places. In both types of industries there is reason to be located close to transportation hubs. In the former case, the city was the main source of demand for products, while in the latter case it was mainly a source of labour. Industries using weight-losing materials that were available locally, such as brickworks and tile factories, would instead be located close to the raw material (Fales & Moses, 1972). In the case of retail and services the main dividing line is between higher order (and durable) goods and services that had reason to be located close to the city centre while lower order day-to-day goods and service providers had reason to spread out close to places where people lived (Christaller, 1966).

The location patterns for manufacturing and services determined by these forces in a second step have consequences for residential patterns. According to bid-rent theory firms compete for land in the central district and push parts of the population away from the central city (Alonso, 1960). In addition, population growth in itself reinforces this tendency since the increased demand for goods and services results in an increased concentration of firms offering higher order goods and services in the central business district (Berry & Garrison, 1958).

From theory, we therefore expect to observe the following broad patterns for Uppsala in the late nineteenth century. First, a concentration of manufacturing plants to areas close to the two available places for long-range transport: The railway station and the harbour. Second, a concentration of higher order (durable) services and retailers close to the city centre while lower order day-to-day goods and service providers should be more spread out to residential areas. Second, we expect high- to lower-skilled workers to be relatively concentrated in the central district while unskilled workers were forced to live in the periphery. Third and finally, as manufacturing and services expanded and bid up land values in the centre, the group of unskilled workers should be pushed further out while we do not expect the same patterns for high to lower-skilled workers.

2.2. Previous studies

Many studies have looked at some aspect of within-city spatial structures and the existing literature can be divided into two strands. The first consists of older studies using mapping techniques to understand the process of urbanisation and firm location, while the second and newer literature is interested in similar questions but leveraging the power of GIS to calculate segregation indices and other measures non-randomness in residential patterns.

Among the older set of studies is the book by Ekstedt, Löfberg, and Rudberg (1944) who used data for 1938 to study Uppsala. This investigation was ordered by the city, likely as a consequence of the rising interest in urban planning in Sweden during the 1930s. It followed in the spirit of William-Olsson (1937), who studied the economic geography of Stockholm. While relating to a later time period than ours, Ekstedt, Löfberg and Rudberg's results for 1938 make a convenient reference for what was to come in terms of the urban development of Uppsala. They found that higher-

[6]The concepts higher- and lower-order goods (and services) are related to the range of the good. According to Christaller (1966) the range of a higher order good is greater than the range of a lower order good. Thus providers of higher order goods tend to cluster at the centre of consumer demand (i.e. in central business districts), providers of lower order goods on the other hand tend to cluster around residential districts.

order economic activity was concentrated to the central parts of the city. However, the population increase between 1928 and 1938 did not take place through increased densities in already populated areas. Instead new residential areas were created to house the growing population. By this time, Uppsala had a tram network (opened in 1906) and several bus lines. Thus, the ability to live outside the city centre had grown while business appears to have remained dependent on central locations.

Studies of other Nordic cities include the work by Jutikkala (1968), Nummela (1990) as well as Åström (1957). The focus of these studies is to large extent concerned with the effects of urban planning. However, they all point out that spatial social differentiation was present in almost all of the cities studied in the nineteenth and early twentieth centuries. Nummela's (1990) results for Kuopio in the 1875–1914 period is especially interesting as he finds that market forces were the main factor behind land values and land use.

The second group of studies is the fairly recent literature that uses the tools of GIS and historical census and other materials to analyse residential segregation, urban spatial structure and growth. The Urban Transition project led by John R. Logan has used census micro data for 1880 from the North Atlantic Population Project to map individuals to addresses in several U.S cities. Gilliland and Olson (2010) used data from the Canadian census to study the social geography of Montreal in 1881 and pioneered the combination of mapping of historic data at the micro level with the use of statistical measures to track levels of segregation. They also explored the problem that can arise if administrative boundaries of potentially different sizes are used to calculate segregation, and how measured segregation varies with spatial scale. This was made possible by the use of very detailed spatial coding of the census data, allowing for different aggregations. They conclude that the city was strongly segregated along social dimensions such as ethnicity and class but that segregation declined with the size of spatial units. The main interest for these research projects and others like it such as Shertzer, Walsh, and Logan (2016), Logan and Bellman (2016) and Gilliland, Olson, and Gauvreau (2011) is on ethnic and religious residential segregation combined with class, a topic that has a long tradition in the US (Cutler, Glaeser, & Vigdor, 1999; Spear, 1967).[7]

Our Swedish and Nordic context differs from these North American studies in two ways. The first difference has to do with the social context and the second has to do with data availability and quality. In Sweden and the Nordics in the late nineteenth century, religious and other ethnic differences were almost non-existent. This is important when studying economic-spatial processes and how they affected residential patterns for different social classes. In the North American context, ethnic and religious differences interacted with economic factors to generate segregation. We are interested in the effect of industrialisation and commercialisation on land use and in the Swedish case it is much more likely that 'pure' economic forces were the deciding factor for residential patterns.

The quality of data in the Swedish case is also better. The census was not, as in North American and in most other European countries, carried out by census takers moving from door to door. Instead, the decennial census consisted of the local clergy sending in excerpts from the continuous parish registers to the central statistical agency, Statistics Sweden (SCB). This is potentially important since the risk of undercounting individuals is smaller given that the local clergy is more likely to keep track of their subjects than temporary census takers.

To analyse the impact of industrialisation and commercialisation on land use and residential patterns in Uppsala between 1880 and 1900, we will proceed in three steps. First, we use GIS maps to analyse residential patterns by social class across the city and how it changed as the city expanded. Complementing this analysis, we also calculate a set of segregation indices common to the literature. These indices provide a summary measure for different aspects of non-randomness in residential patterns. Second, we use information from address calendars to analyse the location of firms in economic categories. Finally, we use the framework of bid-rent and land-use theory to look at the location

[7]The last few decades have seen a rising interest in these questions in Sweden. See for example Molina (1997) who studied ethnic residential segregation in Uppsala in the late twentieth century.

of population and social groups at different distances from the central square. In the following section, we present the research design.

3. Research design

3.1. Research questions

The aim of this study is to examine the dynamic between residential patterns, industrialisation and urbanisation in a small and growing Nordic city during the late nineteenth century. The historical case makes it possible to discuss the spatial consequences of population growth in a setting without major changes in transport infrastructure or government-led investment in public housing. In our view this experience was the norm for many small and mid-size Nordic cities during this period, and to some extent this is still the norm in many urbanising areas in the world.[8]

This paper centres around three research questions. (1) Did the spatial distribution of different social groups change in Uppsala between 1880 and 1900, and if so how? (2) How did the localisation of business activity change in Uppsala between 1880 and 1900? and (3) How did these forces interact to produce the spatial patterns of the city?

3.2. Data sources

This study uses micro census data from the North Atlantic Population Project (NAPP) for 1880 and 1900. Our choice of time period has been guided by the availability of the NAPP data. The source consists of the Swedish full count census and has been coded according to the standard of NAPP. In our case, this is especially important for the classification of occupations, which has been coded by the NAPP-project according to the HISCO scheme (Historical International Classification of Occupations). This makes it possible to analyse segregation by social class since it allows us to link occupations to the hisclass occupational status scheme (van Leeuwen & Maas, 2011). A summary of the data is given in Table 1.

To go from the NAPP-data to the georeferenced maps we have proceeded in two steps. First, we have handcoded the address of every individual in the NAPP-data living in Uppsala domkyrko parish using the original census manuscripts available at the website of the Swedish National Archives. Second, we have used georeferenced historical maps of Uppsala available as WMS-layers on the homepage of Uppsala municipality.[9] Using these historical maps we have constructed a spatial dataset consisting of all blocks in Uppsala with every individual linked to the polygons representing the blocks where the individuals are registered in the census. The process of geocoding locations is explained in more detail in Appendix 2.

The data on business localisation has been collected from address calendars and business registries, the method is similar to the one used by Shaw and Wild (1979) in their study of retail patterns in Victorian Britain.[10] The data has been geocoded at the address level using the WMS-layers of Uppsala mentioned above (further details available in Appendix 2). While the number of firms is an admittedly crude measure of overall business activity and land use, it is the only available material for this time period.

We have divided the firms into four categories: Manufacturing, Services, Artisans and Retail and wholesale. The last two categories have also been separated, following Christaller (1966), into a subcategory indicating if the firm provides goods or service of a higher or lower order. The majority of businesses we categorised as services can be characterised as higher order, such as physicians, bookkeepers and lawyers. This is the main reason why we have chosen not to group services into two

[8]As discussed by Fay and Opal (1999) and more recently by Jedwab and Vollrath (2015).
[9]The maps can be found on the website http://kartan.uppsala.se/cbkort?&profile=allman (retrieved 2017-02-14).
[10]*Kalender för Upsala stad år 1880* for 1880 and *Kalender för Upsala stad år 1900* for 1900. Since the calendar from 1880 did not list firms by sector, each post was cross-checked with info from the national business registry *Sveriges handelskalender 1879–1880*.

Table 1. Description of data.

Year	Variable	Number	Mean	Median	SD
	Individuals	15,680	91.7	64.0	86.8
	Household heads	4557	26.6	15.0	27.0
1880 (172 populated blocks)	HC HIGH	179	1.0	0.0	1.5
	HC LOW	262	1.5	1.0	2.0
	HC UNS	1069	6.3	2.0	9.7
	Individuals	22,877	113.3	79.5	111.8
	Household heads	6282	31.1	21.0	31.2
1900 (204 populated blocks)	HC HIGH	277	1.4	0.0	2.2
	HC LOW	414	2.0	1.0	2.8
	HC UNS	1654	8.2	4.0	10.9

Sources: Swedish Census of 1880 and 1900 from the North Atlantic Population Project (NAPP). The reader should note that not all HISCLASS categories are covered in our three groups, which is why the total for the three classes does not sum to the total number of household heads. In addition, the total number includes household heads without an occupation due to retirement or other reasons.

subcategories. However, this does not mean that Uppsala lacked a supply of lower order services in the late nineteenth century, instead of many of the businesses offering those services where artisans, such as cobblers. Other examples of lower order artisans include bakers and seamstresses while bookbinders and gilders are examples of higher order artisans. For retail and wholesale, grocery stores and butchers are considered as lower order while glass and porcelain dealers and furniture retailers are coded as higher order. Table 2 gives the number of firms belonging to each category in 1880 and 1900.

A first thing to notice is the general growth in the number of firms over the period, from 611 to 1037; an increase of about 70%. The growth was shared among most categories, with lower order artisans showing the smallest increase, growing by only 25%.

3.3. Segregation measures and spatial scales

To facilitate distance calculations and comparisons of residential patterns over time, we have converted the blocks to a grid layer with 100-meter wide hexagonal grids covering the area of Uppsala domkyrko parish, in total 1112 grids. Hexagons are preferred over squares since hexagonal grids result in more connections between areas (See Gilliland & Olson, 2010 for a similar procedure). To map the blocks to the grids we have used the centroids of the blocks and of the grids and linked the individuals in each block to the grid with the closest centroid. Using grids in this way allows us to calculate densities as well as distances between each grid and every other grid. It also makes possible a comparison between 1880 and 1900 since the location of the grids are the same in both years.

In the maps showing residential patterns for different social classes and in calculating spatial indices we will group households in the following way. For each household, we assign a hisclass value according to the HISCO coded occupation of the household head. We will classify three such groups.

The first group, that we will refer to as hisclass high, contains household with hisclass '1. Higher managers' and '2. Higher Professionals'. This group includes occupations such as professors and

Table 2. Number of firms by economic activity in Uppsala, 1880 and 1900.

Firms by sector	Type	1880	1900
Manufacturing		19	49
Services		146	195
Artisans	Lower order	36	45
	Higher order	209	402
Retail and wholesale	Lower order	20	84
	Higher order	181	262
Total		611	1037

Note: Based on businesses listed in the address calendars.
Sources: *Kalender för Upsala stad år 1880, Kalender för Upsala stad år 1900.*

engineers. The second group, called hisclass low, contains hisclass groups '9. Lower-skilled workers' and '10. Lower-skilled farm workers' and includes blue-collar occupations such as dressmakers, tile workers and painters. The final group, that we call hisclass unskilled, with the lowest social status, includes hisclass groups '11. Unskilled workers' and '12. Unskilled farm workers'. Example of occupations belonging to this group is general workers, house workers, packers and charworkers. The reason that we focus on household heads is to eliminate the effect of servants living in other people's home. Table 1 shows the number of households belonging to each group. While there was similar percentage increase (around 50%) in the number of households in each group, the unskilled group was by far the largest.

In the maps, we will group the value of the variable, in most cases the share of household heads in the respective hisclass category, into four colours. Each of the four colours represents the first, second, third and fourth quartile of the value of the respective variable. In this way, the maps showcase the distribution of each HICLASS group relative to itself each year across space. From the legend in the maps, which shows the range of values for each colour, it is also easy to see the difference across the maps and between each HICLASS group. In some cases when the number of grids where no household belonging to the social class lives is large, the first and the second quartile both include zero. In this case, the map only gives three colour categories.

Apart from showing maps highlighting the residential patterns in 1880 and 1900, we will use four measures to complement the visual analysis. The dissimilarity index D (Duncan & Duncan, 1955) is a standard measure in the literature, which is calculated using the following formula:

$$D = \frac{1}{2}\sum_{i=1}^{N}\left|\frac{g_{i,j}}{G_j} - \frac{p_i - g_{i,j}}{P - G_j}\right| \tag{1}$$

where in our case, $g_{i,j}$ is the number of household heads in the jth hisclass-group in areal unit i, G_j is the total number of household heads in the jth group in our area, p_i is the total population in areal unit i and P is the total population in our area. The index can take values between 0 and 1, where 0 indicates no segregation, and 1 indicates complete segregation. The index will be calculated with both blocks (D_{adress}) and grids (D_{grid}) as the areal unit of analysis.

D shows the incidence of segregation but ignores the spatial pattern of segregation. We address this shortcoming in two ways. Firstly we calculate the boundary modified dissimilarity index *D(adj)* (Morril, 1991),[11] and secondly we use absolute and relative centralisation indices (*ACE* and *RCE)* to analyse differences in the degree of centralisation of each hisclass-group. The boundary adjusted dissimilarity index accounts for spatial contiguity among groups and is calculated using the following formula:

$$D(adj) = D - \left(\sum_{i=1}\sum_{j=1}\frac{|c_{i,j}(z_i - z_j)|}{\sum_{i=1}\sum_{j=1} c_{i,j}}\right) \tag{2}$$

where D is the dissimilarity index as in Equation (1), $c_{i,j}$ is the value of the cell in the ith row and jth column of a binary connectivity matrix, where 1 indicates connectivity and 0 no connectivity, z_i is the proportion of g_j in grid i; i.e. $g_{j,i}/p_i$. The values of *D(adj)* can be interpreted in the same way as D.[12]

The absolute centralisation index measures a group's spatial distribution compared to the distribution of land around the central part of a city (Massey & Denton, 1988). In our case all of the grids surrounding the grid where Uppsala main square is located. The index is calculated using the

[11] Since the original dissimilarity index does not account for possible interactions outside of the observation unit, a high value of the index does not automatically mean that one group is spatially segregated and unable to interact with other groups within a wider area. To account for this problem, the boundary modified index of dissimilarity in our case adjusts for the proportion of individuals from jth hisclass-group in adjacent areas (i.e. areas contiguous to i).

[12] Since we were unable to get any information on the block numbers location in their respective block from our sources, we can only calculate $D_{(adj)}$ with grids as the areal unit of analysis.

following formula:

$$ACE = \left(\sum_{i=1}^{n} X_{i-1}A_i\right) - \left(\sum_{i=n}^{n} X_i A_{i-1}\right) \tag{3}$$

where X_i is the cumulative proportion of group X (i.e. G_j) in grid i and A_i is the cumulative share of land area through grid i. The index varies between −1 and +1, where positive values indicate that members of group G_j are living close to the city centre while negative values indicate that members of a group reside farther away from the city centre. A value of 0 indicates that a group has a uniform distribution throughout the area.

The relative centralisation index RCE (Duncan & Duncan, 1955; Massey & Denton, 1988), measures the proportion of a group that have to change its residential location to achieve the same level of centralisation as another group, and is calculated using the following formula.

$$\text{RCE} = \left(\sum_{i=1}^{n} X_{i-1}Y_i\right) - \left(\sum_{i=n}^{n} X_i Y_{i-1}\right) \tag{4}$$

where the n grids are ordered by increasing distance from the central grid, and X_i and Y_i are the corresponding cumulative proportions of group X and Y in grid i. In our case, the comparison group Y is always all other household heads than those belonging to group X. The index varies between −1 and +1, where positive values indicate that members of group X are distributed closer to the centre than members of group Y, and negative values that members of group X are located farther away from the centre than members of group Y.

The aggregated indices give a summary of the overall pattern within the city but could mask some of the heterogeneity across different neighbourhoods. To complement the aggregated analysis, we will additionally calculate and map class-diversity within each grid using Simpson's Diversity Index. In the version of the index we use it measures the probability that two individuals randomly sampled from a grid belong to different groups. The index is calculated using the following formula:

$$\text{Simpson Diveristy Index} = \frac{\sum_{j=1}^{n} g_j(g_j - 1)}{G(G-1)} \tag{5}$$

where in this case, g_j is the number of household heads in the jth hisclass-group in the grid, and G is the total number of household heads in the included hisclass-groups living in the grid. We calculate the index for each grid and map the results. This allows us to observe how exposure of social classes varied across neighbourhoods in the city, and whether there were any discernable changes in these patterns over time.

4. Swedish cities in the late nineteenth century and the case of Uppsala

In this section, we present our study area. But before we go into the development in Uppsala, some general notes on the evolution of cities in Sweden should be made. The general living conditions in Swedish cities improved substantially during the late nineteenth century. Molitoris and Dribe (2016) show, in the case of Stockholm, that while differences between social classes in mortality remained fairly constant; there was a dramatic absolute decline, especially for children, across all social groups. In tandem with the absolute decline in infant mortality in the whole country of about 8%, mortality in towns also declined relative to rural districts from 145% to 135% in the period between 1881 and 1890 compared to 1891–1900 (Historisk statistik, Del 1, Tab. 4, p. 115). There was also substantial real wage growth while nominal urban-to-rural wage differences remained roughly constant (Bagge, Lundberg, & Svennilson, 1933; Ericsson & Molinder, 2018; Lundh & Prado, 2014). Reflecting the growth in manufacturing and services, there was also substantial in-migration from the countryside

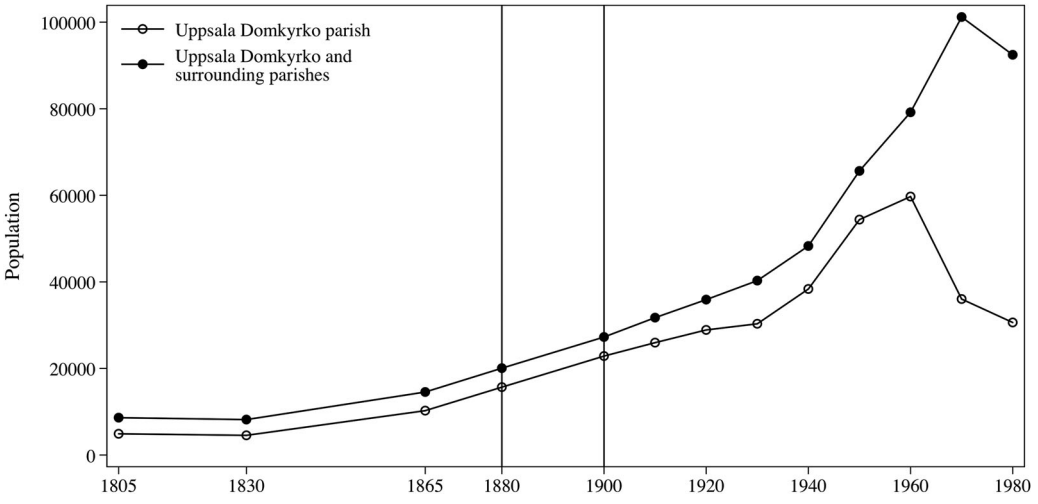

Figure 1. Population in Uppsala Domkyrko parish and Surrounding Parishes, 1805–1980. Note: The figure shows the population of Uppsala Domkyrko parish and of Uppsala Domkyrko and the surrounding parishes of Helga Trefaldighet, Danmark, Vaksala and Gamla Uppsala between 1805 and 1980. Source: Authors calculation from Andersson-Palm (2000) for the period 1805–1900, the Swedish Census (Folkräkningen) of 1910, 1920, 1930, 1940 and the Swedish Population and Housing Census (Folk-och bostadsräkningen) of 1950, 1960, 1970, 1970, 1980 and 1990.

to the cities in this period such that in 1900, 16% of the Swedish population lived outside their county of birth (Bengtsson, 1990). In Uppsala, the same figure in 1900 was 35%.

During the time period from 1880 to 1900 the city of Uppsala was synonymous with Uppsala domkyrko parish, it was only later that the urban area would stretch out beyond the parish borders (See Figure 1). During this period, the population of the city grew by 46%, from 14,756–21,614. Figure 2 shows the georeferenced map of populated blocks in our data for 1880 and 1900, respectively. In addition to the blocks, the map shows the border of Uppsala domkyrko parish as well as of the surrounding parishes, and of the present-day urban area. It is important to note that the few scattered blocks located physically outside of the parish borders still belonged administratively to Uppsala domkyrko.

Uppsala city was given town charters in 1497, approximately 60 years after the inauguration of the Uppsala cathedral. The built-up area grew around the Fyris River (blue in the map) that connected the city to markets in Stockholm and the Mälardalen region. Historically, Uppsala has been a market town for the surrounding region consisting of highly fertile agricultural plains. It is also the administrative centre of Uppsala County and alongside Lund in the south it is one of Sweden's two historical university towns. The university was founded in 1477 and in the 1906–1910 period the number of students was 1976 and the number of professors 63 (William-Olsson, 1937).

In the historical literature, Uppsala is often depicted as a segregated town with the academic and bourgeois dominated area west of the river and a working-class area to the east of the river (see for example Franzén, 1996). However, there has been no calculation of residential segregation indices that could substantiate this claim. We will return to this question in section 5, where we calculate a set of such segregation indices.

Figure 1 also gives some context to the period that we study in this paper. It gives the population of Uppsala domkyrko parish and of Uppsala domkyrko together with the four surrounding parishes of Heliga Trefaldighet, Gamla Uppsala, Danmark and Vaksala that makes up what is today the urbanised area of Uppsala. Population growth took off in the mid-nineteenth century. Before 1950, however, almost all growth took place within the borders of Uppsala domkyrko parish, and population and density peaked in this year. After this, the urban area continued to grow as a whole but mostly in

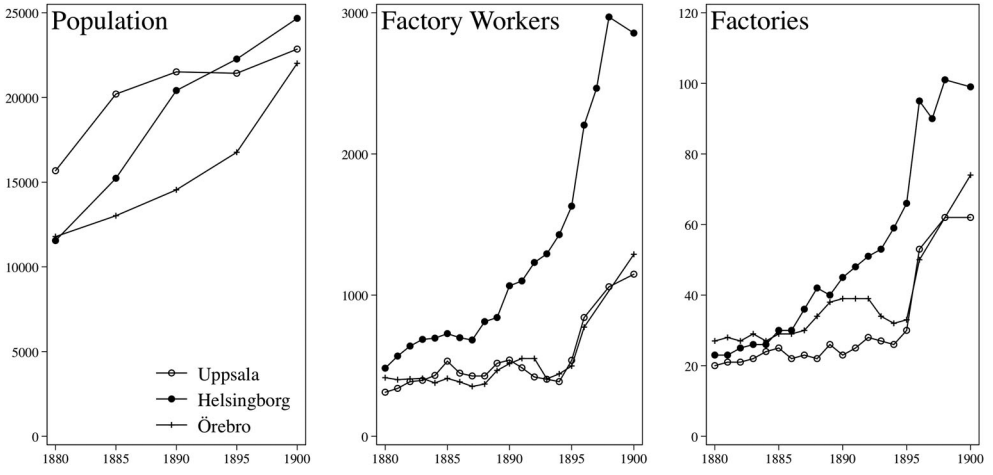

Figure 2. Population, number of factory workers and factories in Uppsala, Helsingborg and Örebro 1880–1900. Note: The figure shows population, the number of factory workers and the number of factories in Uppsala, Helsingborg and Örebro between 1880 and 1900. Source: Population from Nilsson (1989), factory workers and factories from Official Manufacturing Statistics (Fabriker och manufacturer BiSOS D) published by Statistics Sweden (SCB).

the surrounding parishes. During the 1960s and 1970s the population of Uppsala domkyrko parish even declined.

The Uppsala pattern fits well with the general trend of sprawl in the postwar period described in the case of the U.S, by Glaeser and Kahn (2001). The advent of widespread car ownership and the construction of new suburban neighbourhoods centred on car use drove this change. The arrival of truck freight also led to a spreading out of especially land-intensive manufacturing plants. In the case of Uppsala, in 1980 the population in the central parish was no larger than it had been in 1930, while total city population was almost three times as large. Most importantly, during the period studied in this paper, from 1880 to 1900, population growth was almost entirely concentrated to Uppsala domkyrko parish.

The economy of Uppsala was not dependent on any one dominant manufacturing sector. The largest private employer in 1910 was LE Larssons shoe factory with 206 employees. Another major industrial employer, Nymans mechanical workshops, had 91 workers employed in 1900 (Ullenhag, 1984). The Swedish historian Gregor Paulsson (1950) has compared the development of two cites: Helsingborg and Örebro, similar in size to Uppsala during the period of early industrialisation. Paulson's tentative finding from visual analysis was that residential segregation by social class was higher in Helsingborg than in Örebro partly due to the clustering of larger industrial enterprises on newly developed land in the areas of the city closest to the harbour in Helsingborg.

To give some context to the experience of Uppsala in this period, Figure 2 plots the evolution of population, the number of factory workers and the number of factories in Uppsala in comparison to the two cities of Örebro and Helsingbrog studied by Paulsson (1950).

The first panel, displaying the growth of population, shows that Uppsala started out slightly larger in 1880, but that Örebro and especially Helsingborg grew faster until 1900. This is also reflected in the rapid increase in the number of factory workers in Helsingborg, while Örebro and Uppsala saw a very similar development of the industrial workforce that was concentrated to the latter part of the 1890s. Interestingly the difference between Uppsala and Örebro on the one hand and Helsingborg on the other, was smaller when it comes to the expansion in the number of factory plants, suggesting that they were less reliant on large manufacturing employers.

Taken together this suggests that the experience of Uppsala was similar to that of Örebro but different from Helsingborg, as the latter displays a more rapid population increase driven by the

growth of large industrial employers. This is important for the land use patterns that we can expect in Uppsala. Since the business sector consisted of a mix of services and small and relatively light manufacturing plants, the experience of the city is likely to be more relevant for cities with a similar economic structure, than to large-company towns dependent on heavy industry.

5. Results

In this section, we present the results that we are able produce after georeferencing the population and firms of Uppsala in 1880 and 1900. To give a general picture of the spatial distribution of population in the two years, Figure 3 maps the population by block.

In 1880, the most populated places were located in the central district between the river and the railway. The blocks west of the river, the academic and bourgeois area, was generally more sparsely populated. By contrast, the working-class area of Svartbäcken to the north-east was relatively densely populated.

By 1900 this pattern had changed somewhat. While population density remained high in the central district some areas west of the river had become more populated, and the newly built up area of Luthagen in the northwest also hosted a large population.

5.1. Residential patterns and segregation

What were the patterns of class segregation in the city? In the maps in Figures 6–8, we have plotted the spatial distribution of the three hisclass groups in each of the two years. The colour of each grid represents the share of all households in the grid that belonged to the respective hisclass group.

Figure 4, presenting the residential patterns for the high-status households, showcase a visible concentration of elites and professionals in the academic areas west of the river. This is, as noted before, in line with other characterisations of the residential patterns in Uppsala during the period (Franzén, 1996). The opposite pattern can be noted for the newly built-up areas to the east and northeast. Interestingly, however, in the central district between the river and the railway, with a concentration of population and business, the group appears to have been present as well in both years.

As discussed in the theory section, the group that we expect to have been most concentrated to the central district is the hisclass low group. It consists of household heads with occupations such as dressmakers, tile workers and painters. These groups were likely to be tied to their place of work

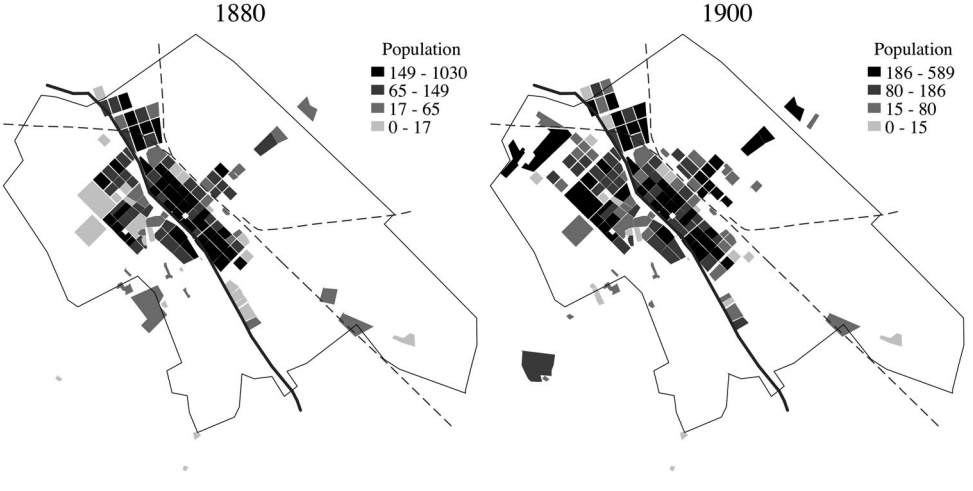

Figure 3. Population by block, 1880 and 1900. Source: Swedish Census of 1880 and 1900 from the North Atlantic Population Project (NAPP).

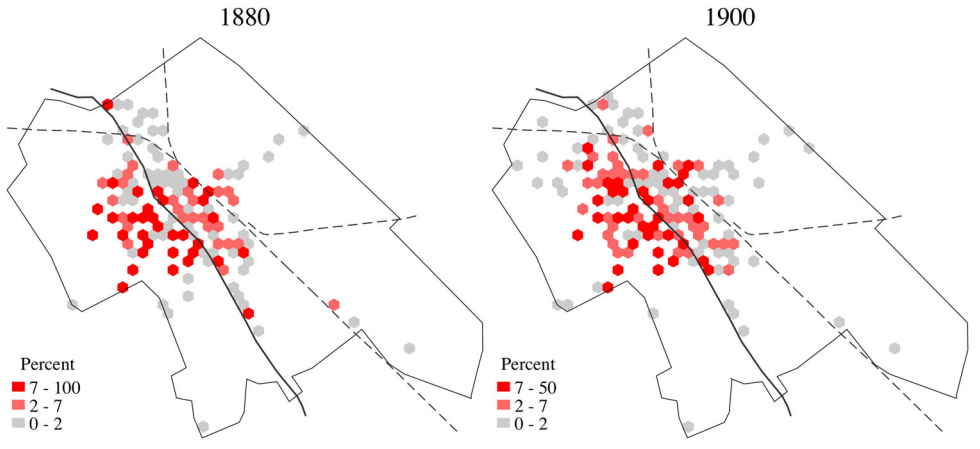

Figure 4. Share of hisclass high-households by grid, 1880 and 1900. Note: The maps show the share of all households in each populated grid that belonged to the HC HIGH group in 1880 and 1900. HC HIGH includes the two hisclass categories '1. Higher managers' and '2. Higher Professionals'. Each colour represents a quartile of the share of HC HICH by grid. Since the first and the second quartile both include grids with 0% there are only three colours in the map. Source: Swedish Census of 1880 and 1900 from the North Atlantic Population Project (NAPP).

and this workplace was prone to have a central location. This is also the basic pattern revealed by the maps in Figure 5. The highest concentrations can be found close to the railway-station and in proximity to the industries by the harbour. However, the hisclass low group likewise made up a large portion in some of the grids west of the river.

On the other side of the class spectrum the hisclass unskilled group, while the largest group in almost all parts of the city, were disproportionally living in the areas that where newly built up as shown in Figure 6. In the outright periphery of the city, this group clearly dominated, and this was especially true for the area east of the railway. That being said, however, the unskilled group also made up a large part of the households in the grids in the central district and there were even swatches of grids dominated by unskilled households in the bourgeois area west of the river, especially in 1900.

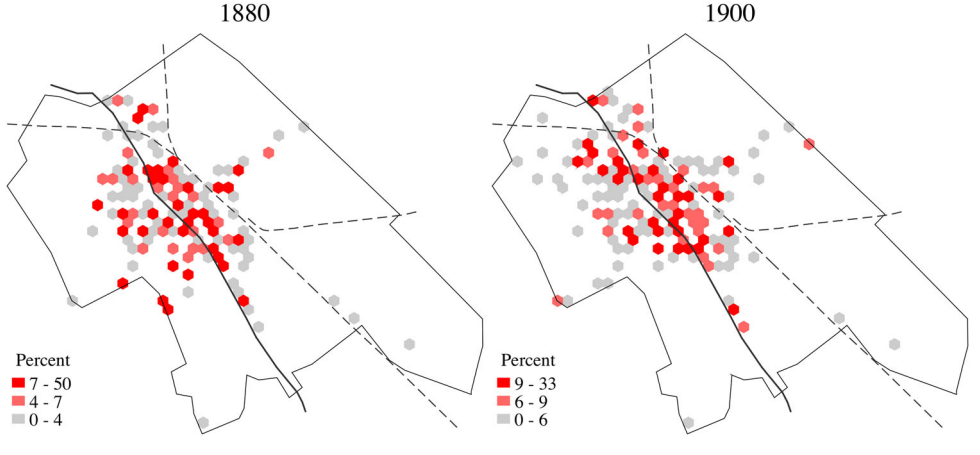

Figure 5. Share of hisclass low-households by grid, 1880 and 1900. Note: The maps show the share of all households in each populated grid that belonged to the HC LOW group in 1880 and 1900. HC LOW includes the two hisclass categories groups '9. Lower-skilled workers' and '10. Lower-skilled farm workers'. Each colour represents a quartile of the share of HC LOW by grid. Since the first and the second quartile both include grids with 0% there are only three colours in the map. Source: Swedish Census of 1880 and 1900 from the North Atlantic Population Project (NAPP).

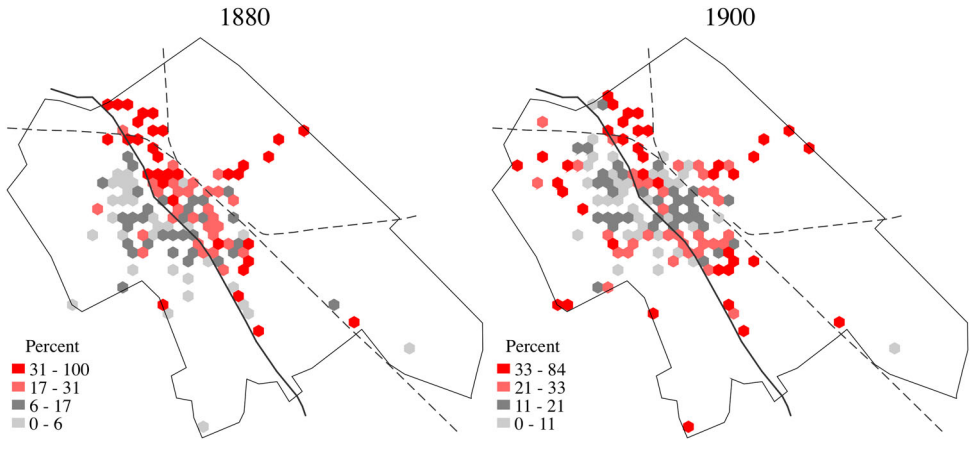

Figure 6. Share of hisclass unskilled-households by grid, 1880 and 1900. Note: The maps show the share of all households in each populated grid that belonged to the HC UNS group in 1880 and 1900. HC UNS includes the two hisclass categories groups '11. Unskilled workers' and '12. Unskilled farm workers'. Each colour represents a quartile of the share of HC UNS by grid. Source: Swedish Census of 1880 and 1900 from the North Atlantic Population Project (NAPP).

Over the period from 1880 to 1900, when the population grew by 45% and there was an expansion of manufacturing and business activity, the most significant shift in the spatial distribution of the three groups can be observed for unskilled hisclass households, which were pushed out from the central areas between the river and the railway. High hisclass households continued to be disproportionally located west of the river while the opposite was true for low hisclass households.

To highlight the shift of the unskilled group, Figure 8 includes a map that displays the percentage point shift in the share of households in each grid that was made up by unskilled hisclass households. The map exhibits the drop in the share of unskilled households in the centre between the river and the railway. At the same time, there was a strong increase in the share of unskilled households in the working class dominated Svartbäcken area in the northeast. Otherwise the areas with the most significant growth in the unskilled group were the peripheral areas in the outskirt of the city.

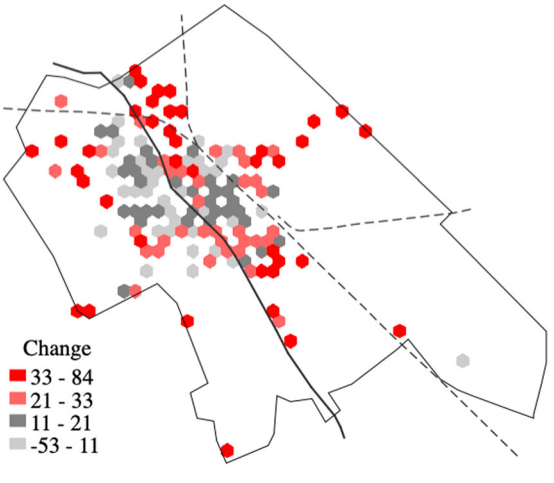

Figure 7. Percentage point change in the share of hisclass unskilled-households by grid, 1880 to 1900. Note: The maps show the percentage point change between 1880 and 1900 in the share of all households in each populated grid that belonged to the HC UNS group. HC UNS includes the two hisclass categories groups '11. Unskilled workers' and '12. Unskilled farm workers'. Each colour represents a quartile of the percentage point change of HC UNS by grid. Source: Swedish Census of 1880 and 1900 from the North Atlantic Population Project (NAPP).

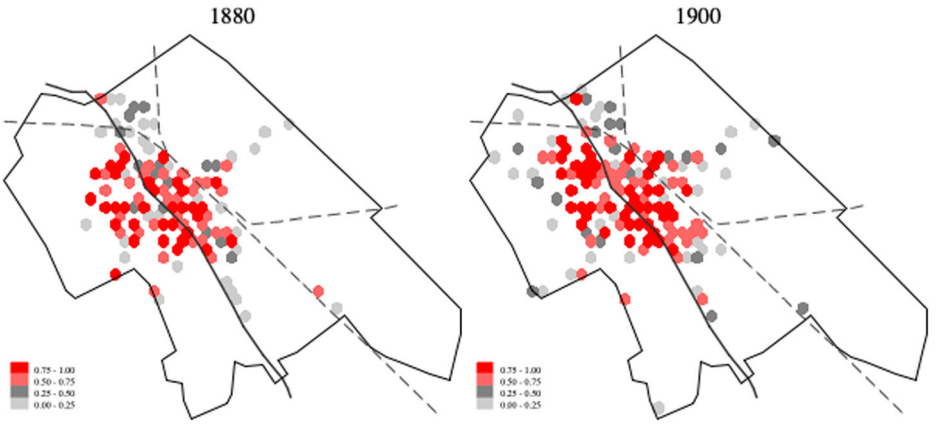

Figure 8. Simpson-index by grid, 1880 and 1900. Source: Swedish Census of 1880 and 1900 from the North Atlantic Population Project (NAPP).

While the maps give visualisation, in order to understand class segregation patterns, we need to look at some more refined metrics to get a better understanding of any changes in the residential structure during the period.

Table 3 shows the five different segregation indices outlined previously. The difference between the D_{adress} and the D_{grid} indices is especially interesting in relation to what the maps showed. The fact that the D_{adress} is higher than the D_{grid} index for all groups and for both years suggests that segregation was stronger when looking at specific addresses, while for the larger neighbourhood that the grid represents, segregation, was not as powerful. Our interpretation of this is that the neighbourhoods with a relatively high proportion of individuals of higher socioeconomic status were in fact quite mixed, but that different socioeconomic groups seldom occupied the same buildings within a neighbourhood. The fact that the scores for *D(adj)* is smaller than D_{grid} further strengthens this idea since the *D(adj)* accounts for spatial contiguity among groups in a larger neighbourhood.

As mentioned above, Uppsala has often been depicted as a socioeconomically divided city. Our findings indicate that this picture is not exactly accurate, since households headed by both low- and unskilled household heads were not excluded from the neighbourhoods with high concentrations of bourgeois households, and this holds for both 1880 and 1900. The division is found instead when comparing the newly built-up areas north and east of the railway to the older parts of the city. These areas were clearly class-segregated, something the dissimilarity indices fail to capture this since the city as a whole was mixed. Our interpretation is strengthened by the scores of the centralisation indices. The absolute centralisation index (ACE) shows that the hisclass unskilled-group is located farther away from the city centre than the hisclass low- and hisclass high groups in both 1880 and 1900. The same can be said about the relative concentration index, where the hisclass unskilled-group is the only of the groups with a negative score. The large change in the RCE-score for the hisclass low- and hisclass unskilled-groups between 1880 and 1900 is also

Table 3. Segregation indices for each hisclass group, 1880 and 1900.

Year	Group	D_{adress}	D_{grid}	$D(adj)_{grid}$	ACE_{grid}	RCE_{grid}
1880	HC HIGH	0.760	0.488	0.485	0.798	0.054
	HC LOW	0.547	0.285	0.282	0.783	0.011
	HC UNS	0.508	0.374	0.368	0.673	−0.148
1900	HC HIGH	0.731	0.460	0.456	0.762	0.060
	HC LOW	0.551	0.269	0.265	0.707	0.062
	HC UNS	0.419	0.280	0.274	0.533	−0.059

Sources: Swedish Census of 1880 and 1900 from the North Atlantic Population Project (NAPP).

worth noting as they indicate that both groups became relatively more centralised in 1900 than in 1880.

The RCE-score for the hisclass high group is almost unchanged between 1880 and 1900 and the same can be said for the group's ACE-score. It seems as the hisclass high group were neither pulled nor pushed out from their residential areas during the last twenty years of the nineteenth century. Major residential projects directed to the well-off households were in fact not started until the 1910s when garden suburbs where constructed at the fringes of the Uppsala domkyrko parish. One of these developments was constructed in the former working-class area of Svartbäcken, which since the early 1900s were connected to the city centre through tramway; the same can be said of the Eriksdal located in the north west. It is clear that the upscaling of these areas was in part driven by the tramway network, which made the location attractive for higher-skilled workers and officials, something that has been pointed out by Bergold (1985) in his study of housing in Uppsala between 1900-1950. Another 'garden suburb', Kåbo in the south west, had no direct tramway connection to the city centre but the location was close to major workplaces for academic and bourgeois individuals, such as the hospital, the university and the regiment (Bergold, 1985).

As noted earlier, the aggregate indices discussed previously mask some of the heterogeneity across the city in the exposure of different social groups. To explore how levels of segregation varied across neighbourhoods, Figure 8 plots Simpson's Diversity Index for each grid in the map using the three hisclass groups as the basis. The index measures the probability that two randomly sampled individuals in a grid will belong to different social groups. The map in Figure 8 shows a clear contrast between the central city and the more peripheral, newly built-up areas. In the centre, class exposure is high, above 50% for most of the grids along the river. In the new working-class areas to the west, northeast, and east of the central city, to the contrary, the integration of social classes was much less significant. Consequently, there appear to have been a bifurcated pattern over time in that integration in the central city increased, which was also reflected in the aggregate indices presented previously. At the same time, many new working-class neighbourhoods appeared on the outskirts of the city where other social classes were almost absent.

Summing up, the picture that develops is one was class segregation by address was quite high in 1880, especially for the hisclass high group. However, when looking at the neighbourhood level represented by the 100-meter wide grids, segregation was less strong. What is more, as the city industrialised and grew there is no evidence that this led to increased segregation overall. In fact, the dissimilarity index fell for all groups between 1880 and 1900. However, for the hisclass unskilled group there was clear drop in absolute centralisation, suggesting that this group was pushed out to the fringes of the city. The Simpson Index also revealed a pronounced pattern of class segregation across different neighbourhoods, where the new areas on the outskirts of the city were almost completely dominated by the working class. In the following section, we will look in more detail at how the spatial structure changed over this time.

5.2. Spatial change in the growing city

In this section, we take a closer look at the location of the three hisclass categories by distance from the central square in Uppsala. The information provided in the graphs is similar to the ACE-index but while the ACE-index provides one single summary measure of absolute concentration, the graphs make it possible to see how each respective group resided at different distances from the city centre, painting a more nuanced picture.

Before we go into the pattern for each hisclass group, we look at the change in the spatial distribution of the city as a whole. As noted earlier, the population grew by 6657 persons from 14,756 in 1880–21,614 in 1900, an increase by 45%. Where in the city did this growth take place? Figure 9 plots the population by distance from the central square in 1880 and 1900 respectively.

As the figure highlights, the overall spatial pattern remained unchanged. A large share of the population lived within half a kilometer of the central square and after this distance, population

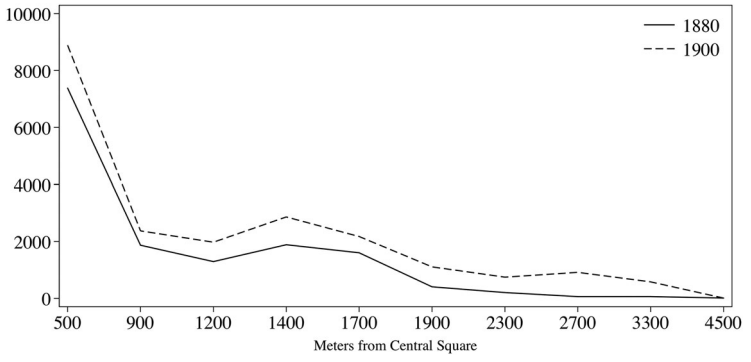

Figure 9. Population by distance from the central square. Note: The figure shows the total population by distances from the central square of Uppsala in 1880 and 1900. Each distance on the *x*-axis contains the same number of grids. Source: Swedish Census of 1880 and 1900 from the North Atlantic Population Project (NAPP).

densities fall rapidly. The growth in population also appears to have taken place at all distances, even though the increase was slightly larger at distances further away from the square, suggesting that the city as a whole became somewhat more spread out. This should be contrasted, however, to the pattern for the postwar period highlighted in Figure 1, when sprawl was the main tendency and the population of Uppsala domkyrko parish even declined. Comparatively, population growth in the late nineteenth century only led to small changes in the spatial structure.

After examining the spatial distribution of the city as a whole, we now take a closer look at the distribution of each hisclass group. Figure 10 shows the allocation of the hisclass high group relative to the central square. Just as the population as a whole, almost half of all households in this group lived within half a kilometer from the centre. After the 500-meter mark, the share of the population drops rapidly. Just as the ACE index indicated, the distribution of the hisclass HIGH group remained mostly unchanged as the city grew.

The pattern for the hisclass low group, shown in Figure 11, mirrors in many ways that of hisclass high. However, a slightly larger share lived within the 500-meter ring, just as expected. There is also some indication that hisclass low households became moderately redistributed to distances of more than 2300 meters from the square. All in all, however, there was no profound change in the distribution of the hisclass low group.

Was the pattern for unskilled households different? Figure 12 plots their distribution. Interestingly, in 1880 just as for the hisclass high group, about 50% of the households lived within 500 meters

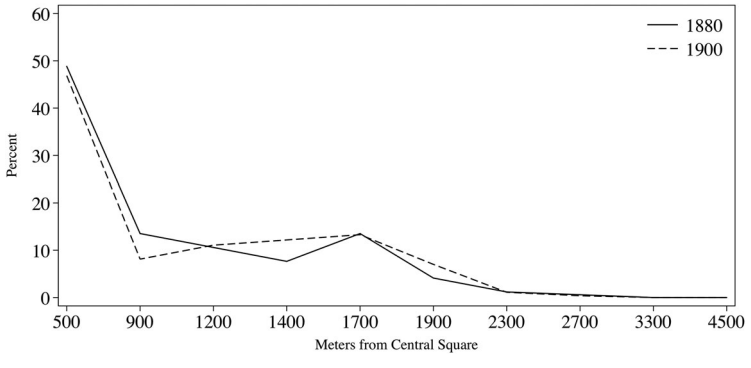

Figure 10. Share of hisclass high-households by distance from the central square. Note: The figure shows the share of all HC HIGH households by distances from the central square of Uppsala in 1880 and 1900. Each distance on the *x*-axis contains the same number of grids. Source: Swedish Census of 1880 and 1900 from the North Atlantic Population Project (NAPP).

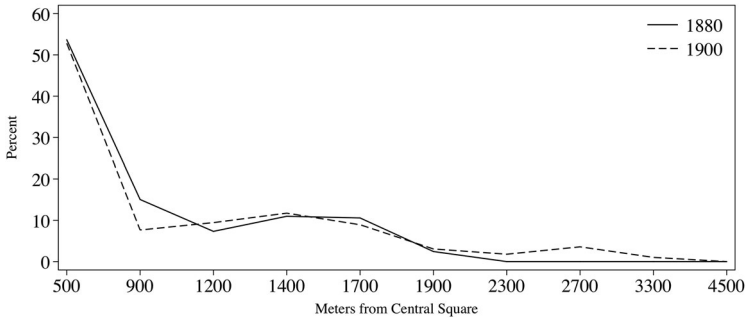

Figure 11. Share of hisclass low-households by distance from the central square. Note: The figure shows the share of all HC LOW households by distances from the central square of Uppsala in 1880 and 1900. Each distance on the *x*-axis contains the same number of grids. Source: Swedish Census of 1880 and 1900 from the North Atlantic Population Project (NAPP).

from the central square. The share of households also falls rapidly after half a kilometer. However, for the hisclass unskilled group there was a clear change in the spatial distribution between 1880 and 1900. The ACE index for this group fell from 0.673–0.533, suggesting a substantial decrease in absolute centrality. Figure 11 shows in more detail the process that produces these aggregated numbers. The hisclass unskilled group was pushed out of the central city; at distances within 1.4 kilometers of the central square the share fell quite substantially. This was mirrored by an increased percentage of the group living further away; the change was especially strong at distances of 2.7 kilometers or more, which could be viewed as places in the outright periphery.

Keeping the changes in the distribution of the population in mind, we now turn to the location of different business activities within the city. To what extent did it follow the distribution of the population and what role did their expansion play in the residential patterns we have observed so far?

5.3. Location of economic activity

Online Appendix Figure 2 plots all businesses in the address calendars divided across four categories of economic activities: factories, service providers, higher-order artisans and retailers as well as lower-order artisans and retailers.

As expected, the location of manufacturing plants was the most concentrated of the four categories; practically no factories were located in northern part of the city. Instead they were concentrated in areas closer to the transportation hubs. Services show an interesting but likewise expected location pattern. Many services such as banking, legal services and insurance agents were used only

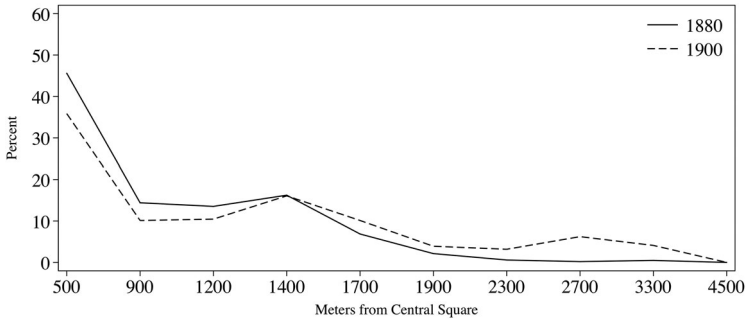

Figure 12. Share of hisclass unskilled-households by distance from the central square. Note: The figure shows the share of all HC UNS households by distances from the central square of Uppsala in 1880 and 1900. Each distance on the *x*-axis contains the same number of grids. Source: Swedish Census of 1880 and 1900 from the North Atlantic Population Project (NAPP).

at specific occasions and were located in the central district, where visitors to the city centre had easy access. In addition, there was a concentration of more day-to-day services in the more affluent district west of the river. In the working-class area of Svartbäcken, to the northeast, there were almost no higher-order service providers but the growth in the absolute number of lower-order services in the area between 1880 and 1900 is striking.

The most marked difference between 1880 and 1900 in terms of the localisation of businesses is the growth in lower-order retail and artisanal activities in almost the entire city, especially when compared to higher-order retail and services. This observation is in line with the central place theory (Christaller, 1966) which suggests that the spatial distribution of lower order retail (and artisanal) activities correlates with the spatial distribution of people, whereas higher-order activities tend to cluster in the central business district. However, it is interesting to note that a many of the non-central areas that saw a rise in the number of lower-order commercial establishments between 1880 and 1900 were in no way non-populated in 1880, this is an indication that the competition among firms for central land was less intensive in 1880 than in 1900. The localisation patterns of different economic activities in Uppsala in 1900 are also similar to the pattern observed for 1938 by Ekstedt et al. (1944). The fact that the structure changed so little between 1900 and 1938 suggests that the new transport technologies introduced in the early twentieth century (such as the tramway), while important for residency, had a limited impact on the localisation decisions for firms.

5.4. Determinants of the location of economic activities

To consider more formally the factors affecting firm localisation, we estimate a simple regression model with observations at the level of the individual grid. The model is influenced by Alonso's (1964) bid rent-theory where business localisation (in its most simple form) is determined by rent and distance from the central city. In a single-centre city one can expect a negative relationship between land values and distance from the central city. A relationship that, in the case of Uppsala, likely strengthened during the period between 1880 and 1900 due to a growing population and economy. We also except population to matter in particular for lower order goods providers.

The model includes two set of variables: One tallying the number of people living in the grid and another measuring the distance of the grid from the central square. The model allows us to see how the number of firms in a specific category (manufacturing, services, lower- and higher-order goods), located within a specific grid, depended on the distance from the centre and on population density. We can also assess if there were any changes in this pattern between 1880 and 1900. In the model, we allow the effect of distance from the centre to change exponentially. The model and the full regression results are given in Appendix 1.

The coefficients for log(*Population*), shown in Online Appendix Figure 3, gives the effect of population density on firm localisation, and indicate that there was no statistically significant relationship for manufacturing firms, while the relationship is positive and statistically significant for the other firm categories. It is also worth noting that the effect is almost twice as high for firms categorised as lower-order retail than for higher-order retail, which is in line with theory as well as the patterns evident in the map. There were only small changes over time in the importance of population for firm localisation.

When it comes to the effect of distance from the central square, given in Online Appendix Figure 4, the coefficients show an effect across all firm categories. The figure plots for each firm category, the relationship between distance from the centre and the number of firms, in each of the two years respectively.

The results suggest that centrality was almost equally important for firms in services as for higher- and lower-order retail, but less important for manufacturing. However, the evidence also displays that central locations became slightly more attractive for manufacturing firms over time. From theory, we expect manufacturing to locate close to the two transportation hubs: the harbour and the railway station, rather than the central square. However, in the context of Uppsala, these two hubs were located

very close to the square and both within the central business district. For that reason, we believe that the distance to the central square can serve as a reasonable proxy for locating within the central area in general. We have also run the regression for the location of manufacturing using the distance to the harbour and the railway as alternative locational variables and the results look very similar.

Summing up the regression results, it appears that being located near the local population was important for services and for lower- and higher-order retail. Manufacturing was less dependent on those factors, which is in line with the theoretical predictions. Interestingly, however, despite a rapid expansion of around 70% in the number of firms across all firm categories, there was no change in the locational profile of firms in services and retail while manufacturing became slightly more centralised.

As a consequence, there is no evidence that business location reacted to the increased number of firms and people in the centre by locating further away, suggesting that the benefits from locating near the centre overweighed the increase in costs.

6. Conclusion

In this article, we have used GIS mapping techniques and historical Swedish census data from the North Atlantic Population Project (NAPP) to analyse the spatial structure of an industrialising and growing city in the late nineteenth century. We have looked at the case of Uppsala, which we have argued is representative for the experience of other Nordic cities of similar size.

In addition to providing high quality census data that is especially useful for georeferencing populations, the case of Uppsala has allowed us to analyse a context where ethnic and religious differences were almost non-existent, which sets it aside from studies of North American cities where such differences interacted with economic forces to produce segregation. Our context allows us to look at the 'pure' effect of economic forces on residential patterns.

To analyse the spatial structure of Uppsala we have proceeded in three steps. First, we looked at the spatial distribution of three groups of households: hisclass high, hisclass low and hisclass unskilled. Neither the maps nor the segregation indices indicated any strong increase in class segregation as the city grew. If anything, class segregation measured in this way declined. However, there was increased absolute spatial dispersion of the unskilled hisclass group, which was also reflected in an increase for the group in the ACE index.

As a second step, we therefore looked in more detail at the distribution of total population and of the three groups by different distances from the central square. The distribution of population showed a pattern familiar to the dense walking city of the nineteenth century; about half of the population lived within 500 meters from the central square and after this distance densities fell rapidly. As the city grew there was only a small tendency of dispersion, a pattern very different from what we see in the postwar period when the construction of residential areas centred on car use led to sprawl.

When looking at the distribution of the different social groups we found clear evidence that the unskilled group was pushed away from the central district towards the periphery. This was likely the result of the increased competition for land in the central district that drove these households to locate further away from the centre. Consequently, economic processes as envisioned by the bid-rent framework were consequential for the residential changes that we see. This was very different from the processes producing segregation in many cities during the twentieth century. The pervasive class segregation in postwar cities was often the result of the construction of whole residential areas, a process that was amplified when widespread car use made it possible to construct satellite residential neighbourhoods with single-use zoning and only few connections to the wider city.

Third, we analysed the location of firms by economic activity to see in what parts of the city the expansion of economic activity took place. This mapping showed that there was a clear concentration of manufacturing, services and high-order artisans and retailers in the central district. This was also confirmed by our simple regression analysis. Services, as well as both lower- and higher-order goods providers increased with proximity to the central square. While manufacturing

was less dependent on central locations, it became slightly more centralised over the period. Since all four types of economic activities became more numerous but remained concentrated, they likely led to an increase in land values and housing costs in the central parts of the city.

The main results of our study can therefore be summarised as follows: the increase in population in Uppsala during the late nineteenth century did not result in general dispersion of the population, nor any increase in class segregation. Despite this overall pattern, some households in the unskilled hisclass group got pushed out from the central areas of the city. The push was primarily driven by an increasing competition for land in the central areas of the city, in part because of retailer's desire to locate at the centre of the market

The application of GIS mapping techniques on historical Swedish census data shows great potential. The analysis presented here can be extended to more years and cities in future work. The former will allow us to look in detail at the spatial effect of streetcars and later of automobiles on population and business location as well as segregation. The availability in Sweden of high-quality census material and other sources that can be geocoded makes it especially well-suited for these types of studies.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendices

Appendix 1. Regression results

In this appendix, we present the regression model we use in Section 5 to discuss the determinants of firm location. The model we estimate is the following:

$$\log(Nr\ of\ firms) = \beta_1\ Year + \beta_2\ \log(Population) + \beta_3\ Year{*}\log(Population) + \beta_4\ \log(Distance\ to\ cs) + \beta_5\ \log(Distance\ to\ cs)^2 + \beta_6\ Year{*}\log(Distance\ to\ cs) + \beta_7\ Year{*}\log(Distance\ to\ cs)^2,$$

where log (*Nr of firms*) is the log of the number of firms located in the grid. We estimate the regression separately for each of the four categories of firms: manufacturing, services, lower-order and higher-order. Year is a dummy taking the value of 0 if the year is 1880 and 1 if it is 1900. This allows us to capture the general increase in the number of firms in

each category in the city as a whole. log(*Population*) is the log of the number of residents in each grid, and this term capture to what extent firms tended to cluster close to where people resided or if localisation was determined by other factors. *log*(*Distance to cs*) is the log of the distance from the central square. This gives an estimate of how dependent firms were on having a central location. The ensuing interaction terms allow us to capture if the relationship between *log*(*Distance to cs*) and log (*Nr of firms*) was exponential rather than linear and if the effect of distance from the central square changed between 1880 and 1900. Since we are using variables that can be calculated also for grids without any population, we use the full set of 2224 grids in the regression. Table A1 gives the regression results.

Table A1. Regression of Locational Determinants of Firms by Economic Activity, 1880 and 1900.

Dependent variable:	log (*Nr of firms*) (1) *Manufacturing*	log (*Nr of firms*) (2) *Services*	log (*Nr of firms*) (3) *Higher-order retail*	log (*Nr of firms*) (4) *Lower-order retail*
Year = 1880	0	0	0	0
Year = 1900	0.146***	0.200**	0.196*	0.259**
	(4.20)	(2.89)	(1.99)	(2.83)
log(*Population*)	0.00188	0.0579***	0.0817***	0.0487***
	(0.67)	(10.40)	(10.31)	(6.61)
Year = 1880∗log(*Population*)	0	0	0	0
Year = 1900∗log(*Population*)	0.00876*	−0.0162*	0.0157	0.00817
	(2.37)	(−2.20)	(1.50)	(0.84)
log (*Distance to cs*)	−0.230***	−1.248***	−1.353***	−1.219***
	(−4.94)	(−13.44)	(−10.24)	(−9.93)
log (*Distance to cs*)^2	0.0892***	0.498***	0.533***	0.482***
	(4.21)	(11.80)	(8.88)	(8.64)
Year = 1880∗ log (*Distance to cs*)	0	0	0	0
Year = 1900∗ log (*Distance to cs*)	−0.235***	−0.323*	−0.196	−0.381*
	(−3.59)	(−2.48)	(−1.05)	(−2.21)
Year = 1880∗*log*(*Distance to cs*)^2	0	0	0	0
Year = 1900∗*log*(*Distance to cs*)^2	0.0900**	0.123*	0.0481	0.142
	(3.01)	(2.07)	(0.57)	(1.80)
Constant	0.141***	0.730***	0.808***	0.723***
	(5.70)	(14.83)	(11.53)	(11.10)
Observations	2224	2224	2224	2224
R^2 adj	0.110	0.347	0.327	0.251

Note: *t* statistics in parentheses.
*$p < .05$.
**$p < .01$.
***$p < .001$.

Appendix 2. The process for geocoding locations

To go from the NAPP-data to the georeferenced maps we have proceeded in two steps. First, we have handcoded the address of every individual in the NAPP-data living in Uppsala domkyrko parish using the original census manuscripts available at the website of the Swedish National Archives (*Riksarkivet*). While still a tedious task, the fact that the original census manuscripts where organised by address and the individuals in the NAPP-data appears in the same order as on the original manuscripts greatly facilitated this task. From this coding, we know the address and block of residence for every individual living in Uppsala in 1880 and 1900, respectively. This allows us to construct a large number of variables at the block and address level, since we are not restricted by any pre-processing of the data.

In a second stage, we have used georeferenced historical maps of Uppsala available as WMS-layers on the homepage of Uppsala municipality.[13] Using these historical maps we have constructed a spatial dataset consisting of all blocks in Uppsala with every individual linked to the polygons representing the blocks where the individuals are registered in the census. Unfortunately, the historical maps are shorter on information for specific addresses, which is why we focus on blocks. Locations were linked manually using the block names available in the maps and in the census.

The data on business localisation have been collected from address calendars and business registries, the method is similar to the one used by Shaw and Wild (1979) in their study of retail patterns in Victorian Britain.[14] The data has been geocoded at the address level using the WMS-layers of Uppsala mentioned above. To determine the location of different addresses, a combination of the historical and contemporary maps, as well as historical address registers for Uppsala was used.

[13]The maps can be found on the website http://kartan.uppsala.se/cbkort?&profile=allman (retrieved 2017-02-14).
[14]*Kalender för Upsala stad år 1880* for 1880 and *Kalender för Upsala stad år 1900* for 1900. Since the calendar from 1880 did not list firms by sector, each post were cross-checked with info from the national business registry *Sveriges handelskalender 1879–1880*.