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Agglomeration forces: A study of Swedish cities and municipalities since 1800

DRAFT VERSION

Abstract

Rapid globalization has recently led to a more international economy with global supply chains. Nevertheless, at the national level one can observe that economic production is increasingly concentrated. We focus on the Swedish economy to study these agglomeration forces. Stockholm county increased its population share from 10% to more than 20% during the last century. Based on the Swedish census records, we have detailed population data for all Swedish municipalities and cities from 1800 to 2010 on a decennial basis. Using Zipf's law and Gibrat's law as a benchmark, we study the evolution of regional population dynamics from the pre-industrial period until today. We also augment the analysis with geographic variables to analyze the relative importance of first- and second nature geography. Sweden is an interesting case study because it was an extremely poor and rural economy at Europe's periphery in 1800. It also was a latecomer to the Industrial Revolution. As a result of its low population density, Swedish industrialization was rural in nature, leading to the formation of small and isolated cities. The number of cities more than doubled between 1800 and 2010. A resource boom at the turn of the 19th century and the adoption of electricity a couple of decades later pushed out the frontier. Municipalities in the uninhabited North experienced higher population growth in the late 19th and early 20th century and the Swedish population became more dispersed. Only during the last decades with the so-called new economy did large agglomerations become a strong force of attraction.

Key words:

Agglomeration effects, urbanization, Zipf's law, Gibrat's law, first-nature geography, second-nature geogrpahy, house prices

Introduction:

The recent wave of globalization has led to a paradox when it comes to the location of economic production. In his book “The world is flat” Thomas Friedman (2005) describes how distance does not seem to play such an important role anymore. Production chains are increasingly global and information flows are instantaneous thanks to the modern ICT sector (information and communications technologies). On the other hand, some economists like Leamer (2007) points out that agglomeration effects have never been as important before as they are today. A big share of today’s Internet technologies is generated in one particular location, Silicon Valley, despite the fact that these high-tech companies could technically operate from anywhere in the U.S., or even from outside the country. Positive spillover effects between firms, linkages between different industries (Marshall, 1890), thick labor markets, and the positive amenities associated with living in large metropolitan areas seem to outweigh the negative effects that arise from increasing congestion, high wages, and high house prices (Carlsen & Leknes, 2015).

It has always been clear that a large fraction of economic activity is geographically highly concentrated in economic clusters, also known as cities. Moreover, increasing urbanization around the world has meant that these clusters have been gaining in importance in recent decades as globalization proceeded at a more rapid pace. The agglomeration forces seem to be particularly strong in developed economies, such as the U.S., where just a few extremely large metropolitan areas have generated the majority of American economic growth over the last two decades. A study by the McKinsey Global Institute shows that the top 600 urban centers account for about 60 percent of global GDP in 2010, generated by about a fifth of the global population. The top 100 cities will contribute about 35 percent of global growth in between 2010 and 2025 (Dobbs et al., 2011). While most of the recent surge in global urbanization can be accounted for by the rise of large metropolitan areas in South East Asia, one should note that economic activity also seems to become even more concentrated in advanced economies. This trend is happening despite the fact that urbanization rates in advanced economies were already quite high by the middle of the 20th century.

This study focuses on the Swedish economy where a similar phenomenon can be observed. Sweden is divided into 21 counties (figure 1). Figure 2 shows the growing importance of the Stockholm region over time in the Swedish national economy. Stockholm län is one of the smaller counties in Sweden. It comprises the country’s capital and had a total population share and GDP share of 10% and 13% in 1900, respectively. In 2010, Stockholm län accounted for more than 22% of Sweden’s population and 30% of the country’s GDP (Enflo, 2014). The inhabitants of Stockholm län are thus more productive than the average Swede, pointing towards a clear correlation between population density and productivity. The ten largest municipalities in Sweden produced about 40 percent of national GDP while accommodating 27 percent of the population in 2012, showing that average incomes in those urban centers are significantly higher than the national average. However, our also analysis shows that a simple narrative of increasing agglomeration forces risks oversimplifying the population dynamics that actually took place over the last two centuries. The country was still quite poor and overwhelmingly rural in the first half of the 19th century, even though the population grew at double-digit rates on a decennial basis. The urbanization rate was only at 9% in 1810 and increased to 13% by 1870. Today's value is slightly above 85% and it is projected to be around 90% in 2050 (van der Woude, 1995). Sweden was a relative latecomer to the Industrial Revolution, which reached the country at the end of the 19th century. Moreover, early industrialization was to some extent rural. Sweden is quite unique in that more than a third of its cities today did not exist as such 200 years ago.

The aim of this paper is twofold. First, we use Swedish population statistics for all Swedish cities and municipalities going back to 1800 to provide a detailed account of regional population growth in Sweden over the course of the last two centuries. We use Zipf's law (Gabaix, 1999a) and Gibrat's law (Gabaix, 1999b) as benchmark models for population growth dynamics. The idea is to evaluate the strengths of agglomeration forces in the economy and how they evolved over time. More importantly, it is of enormous interest to see to what extent Sweden's population dynamics followed that of other countries and deviated from the benchmark. Second, we augment the analysis with variables that proxy economic geography. Following the literature from the field of economic geography, we distinguish between first- and second-nature geography (Krugman, 1993). In the spirit of de Vries (2006), we use an index of urban potential to measure the impact of second-nature geography on agglomeration effects. The working hypothesis of this paper is that first-nature geography, natural landscapes, played a more important role in the past. However, especially over the last couple of decades agglomeration forces have become stronger. Second-nature geography, that is man-made constructions like infrastructure, supposedly dominates now and is the underlying source of the agglomeration forces at work.

While the literature on Zipf's law is extremely extensive, most studies focus on more contemporary data. Klein and Leunig (2013) are the notable exception as they study Gibrat's law during the British Industrial Revolution. This paper can contribute to the debate by studying Swedish population dynamics over a time frame of more than two centuries.

<u>Overview of results:</u>

The data shows that Sweden started to urbanize rapidly during the second half of the 19th century. Sweden's urban population was initially more concentrated to Stockholm and other large agglomerations than what Zipf's law predict. However, cities expanded rapidly and grew by more than 20% during the Industrial Revolution as well as after World War II. The number of cities in Sweden increased from about 60 in 1810 to about 90 in the 1930s. New cities were founded and small cities grew rapidly. Urbanization proceeded rapidly, but initally Sweden's urban population became more dispersed. The Industrial Revolution led to the rise of many small isolated cities in the sparsely settled country. With electrification, the economic frontier pushed further North. Municipalities in the North of the country had statistically higher growth rates during the first half of the 20th century. Economic life became feasible despite the proximity to the polar circle and modern technologies allowed for resource extraction even under harsh climatic and topographical conditions.

We restrict the analysis to Swedish cities with a certain population size (more than 10.000 inhabitans in 2010). Zipf's law coefficent for Swedish cities was slightly above one in absolute values in the early 1800s and increased to a maximum of 1.15 in 1900, meaning that the Swedish urban population initially became more concentrated over the course of the 19th century. The coefficent then decreased to a minimum of 0.89 in 2010, implying that the Swedish urban population became more dispersed than what Zipf's law predict. This is due to the rise of small cities in the more sparsely settled rural regions of Sweden. Industrialization thus led to the formation of small urban centers in the North of the country during the first half of the 20th century.

Using the municipality as a geographic unit of analysis, we can observe a similar phenomenon. Municipalities in the North experienced faster population growth rates in the aftermath of the second Industrial Revolution and it is only during the latter half of the 20th century when this growth pattern started to reverse. The new economy seems to favor the South of the country, including the large agglomerations of Stockholm, Gothenbourg and Malmö. We also see a similar reversal when it comes to agglomeration effects. Low-population municipalities were growing just as fast or even faster than high-population muncipalities during the 19th century. This pattern, however, changed after World War II. High-population municpalities have grown consistently faster ever since and this effect has become even stronger in recent decades. Accordingly, the Zipf's law coefficient has increased over time during the 20th century. It was relatively close to one in 2010 compared to a low of 0.76 in the 1920. The Swedish population has thus become much more concentrated over the last 90 years. Municipalities close to the large Swedish agglomerations have also increasingly outperformed their peers in terms of population growth. That is because there was a spillover effect from city centers to adjacent municipalities. While high-population concentration municipalities still growed faster in the beginning of the 20th century, this pattern has reversed as well as population density increasingly becomes an issue. City centers are growing slower because zoning laws and other regulations prevent additional housing construction. Nevertheless, large agglomerations still exercise a strong force of attraction and it is increasingly the outskirts that benefit from this gravitational pull. Our analysis thus shows that second-nature geography trumps first-nature geography in recent decades. While natural landscapes still seemed to matter more during the 19th century, it is infrastructure and economic activity that nowadays exercises the greatest force of attraction.

Literature overview:

Economists have long understood the various benefits that arise from economic concentration and deep markets. Adam Smith (1796) points out that a larger market leads to an increase in the specialization of labor and thus a more efficient allocation of resources. Marshall (1890) discusses the importance of externalities for the localization of firms. Myrdal (1957) foresees that increasing returns to scale will play a crucial in explaining agglomeration effects. It is not until the 1990s, however, that economists were able to formalize these ideas with rigorous mathematical models. New economic geography is to a great extent built upon the ideas of Krugman who can be seen as the founding father of the subfield (Prize Committee of the Royal Swedish Academy of Sciences, 2008). Krugman shows that increasing returns to scale lead to the concentration of manufacturing firms in one region under monopolistic competition (Krugman, 1990). Krugman also presents a simplistic model in which the interaction of scale economies and transportation costs explain the location and number of cities (Krugman, 1993b). Most importantly, Krugman (1996) offers a simple, yet plausible explanation for one of the well-known regularities that describe the size distribution of metropolitan areas. There are many different economic phenomena in economics that can be described by power laws. Indeed, Gabaix (2008) describes how the firm size distribution as measured by the number of employees follows such a power law with a slope very close to one in absolute values. Daily stock market fluctuations, the relationship between the pay of the CEO and firm size and many other examples can be added to the list.

For the field of economic geography, economists have found that the city size distribution tends to follow a specific power law where the exponent is equal to one. This phenomenon, commonly called Zipf's law, seems to describe city size in terms of population reasonably well for many countries (Gabaix, 1999a). It is important to note though that the geographic unit of analysis plays an important role here. Zipf's law has been found to be true for the U.S., but not for the EU (Venables, 2005). On the other hand, it seems to hold for many countries within the EU, but not necessarily for individual states within the U.S. (Cristelli et al., 2012). Giesen and Südekum (2010) find that Zipf's law holds both for Germany as a whole as well as for various subregions within Germany. Zipf's law can also be applied to different geographic units, such as municipalities instead of cities, for example (Hlabi and Plessis, 2013).

Various explanations have been offered to explain this specific geographic distribution. A random growth model, for example, ultimately leads to a distribution that follows such a power law. In this particular case, city growth and city size should be independent of each other, a proposition that is sometimes referred to as Gibrat's law (Gabaix, 1999b). While the proposition put forward by Gabaix (2008) that city growth follows a random growth process might hold in many instances, it is not entirely satisfactory as it suggests that geography does not play a crucial role in the determination of where economic activity is concentrated and how it develops over time. Krugman (1996), on the other hand, presents a model where the random distribution of first-nature geography, the natural landscape like as rivers and mountains, produces a city size distribution in accordance with Zipf's law. Naturally, the idea that geography instead of simple random growth process drives urban development is more appealing to economists. Indeed, there is growing evidence that both first-nature geography as well as second-nature geography, access to consumer markets, both play an important role in the formation and spatial distribution of urban centers. Furthermore, it seems that second-nature geography is becoming increasingly important (Bosker and Buringh, 2015).

Krugman (1993a) also discusses the importance of second-nature geography. City location rarely changes over time. The initial location of a settlement might just have been chosen more or less randomly, a historical accident, so to speak. The various externalities and interdependencies that arise from economic concentration make the location a self-fulfilling prophecy. It is even conceivable that some cities are locked-in at suboptimal geographic locations because of path dependency, i.e. second-nature geography overshadows first nature-geography. Michaels and Rauch (2016), for example, explain how French cities in the Medieval Ages have for historical reasons remained relatively close to a location where Romans had set up settlements during the Antiquity, which were predominantly located inland. In Great Britain, on the other hand, medieval towns were relocated and in most cases founded along rivers or along the coastline. As water transportation became increasingly more important over time thanks to technological progress, British cities enjoyed a locational advantage and prospered as measured by faster population growth. French cities, on the other hand, remained trapped in bad geographic locations. Booker and Boringh (2015) use an innovative approach to disentangle the effects of first and second-nature geography. Using actual and potential city location for the European city system for the period from 800 to 1800, they find that the geographic landscape, first-nature geography, played a crucial role in the initial determination of city location. Over the centuries, however, market access and the relative position to other cities, i.e. second-nature geography, became increasingly more important. This finding is line with Moretti (2012) who shows that theres is increasing economic concentration in the US. A few major technology hubs like San Francisco and Seattle have gained at the expense of the rest country. More specifically, many small to medium-sized towns have stagnated over the last decades while major urban centers have prospered and increased in importance.

Data and methodology:

For the purpose of the paper, we primarily rely on the Folknet database from Umea University. The database has detailed population statistics for all Swedish cities and all Swedish municipalities from 1800 to 1990 on a decennial basis. We have also incorporated the years 2000 and 2010 in the study using data from the Swedish Statistics Office SCB. The population data gathered by the Folknet database originates from parish data collected by the church and data from the Swedish census. It is quite unique to have such detailed and accurate population data on the municipality level going back in time for two centuries, which makes Sweden an interesting case study. It allows us to analyze the agglomeration forces and how they evolved over a long period of time, including decades from the pre-industrial era, the Industrial Revolution, and what is known as the "new economy" today. As a first step, we simply use the population data to analyze population growth over time on the city and municipality level. It is of interest here to study the long-term trends as well as deviations from Zipf's and Gibrats's law, insofar as they occur. We augment our analysis by including a number of variables reflecting both first- and second-nature geography into the population growth model.

Rapid population growth and Sweden's transition into a modern economy in the late 19th century:

Compared to other European countries Sweden was still extremely rural in 1800 with an urbanization rate below 10%. Per capita income was also much lower, less than half of the industrial leader Great Britain (Maddison, 2007), and the agricultural sector was the largest part of the economy with more than three quarters of the population employed in the sector (Schön, 2007). Sweden was a relative latecomer to the Industrial Revolution. Economic growth took off after 1870 and was higher in the decades thereafter than in many other Western European economies. This was partly a story of catch-up growth as the Swedish economy finally managed its transition from a mostly rural economy to a modern economy based on manufacturing. The end of the 19th century is thus the period of strong economic convergence during which the country caught up to other European nations in terms of per capita income. It is now accepted that the financial revolution of the mid-19th century played a substantial part in this story of modernization. Deposit growth and growth in the broad money supply accelerated substantially after 1830 (Ögren, 2010). This increase in liquidity as a result of fast deposit growth, the so-called deposit revolution, as well as large inflows of foreign capital were the basis of industrialization and high economic growth in the latter part of the 19th century. Ögren (2009) argues that financialization preceded the takeoff in economic growth. The financial revolution was thus a prerequisite to the structural transformation that changed Sweden from a largely agrarian economy into a modern industrialized nation within just a few decades after 1870. The construction of the railroad during the latter part of the 19th century helped to develop rural areas that were previously disconnected from the larger agglomerations (Berger and Enflo, 2015). It is noteworthy that Swedish industrialization during the 19th century was quite rural in nature and took place in small cities that became a regional industrial center in sparsely populated parts of the country.

Population growth quickly accelerated after 1800. It has been argued that the introduction of the potato played a quite significant role here (Berger, 2016) as it led to large increases in agricultural output and thus pushed the Swedish economy out of the Malthusian equilibrium where a substantial fraction of the population lived at subsistence level. Population growth averaged out at a little less than 10% per decade in between 1820 and 1880 (figure 4). Sweden's population increased from about 2.3 million in 1800 to 5.1 million in 1900 and about 9.4 million in 2010. The population in my sample of cities increased from a bare 200.000 in 1800 to 1 million in 1900 and 5.6 million in 2010, which is 9%, 21%, and 60% of the total population, respectively. However, the true urbanization rate in 2010 is a little larger than 80%. Small cities with a population of less than 10.000 inhabitants in 2010 are excluded from the sample. Furthermore, while Stockholm city has a population of about 1.3 million in 2010, the greater area of Stockholm contains about 2 million inhabitants. For larger metropolitan areas it is thus a matter of debate where one should draw the line and whether suburbs like Södertälje should be included as belonging to Stockholm or counted as separate entities. For the purpose of our analysis we have decided to resort to the second option. The number of cities in the sample increases from less than 60 in 1800 to about 80 in 1900 and a little less than 120 in 2010. Sweden is thus special within the European context insofar as various urban localities were formed over the last 200 years that did not exist previously. While the country was not quite a frontier economy like the U.S. or Canada, certain regions of Sweden might be classified as such. Our analysis below shows how the very far North grew at a much faster rate than the rest of the country in terms of population growth and thus economic activity at the turn of the 19th century. This was related to the expansion of certain industries in remote areas of the country, such as mining and the wood and paper industry. The exploitation of hydroelectric power also played a role in the economic development of the remote North where dams and power stations were built. Large transmission lines bring the electricity to the more populated regions in the South of the country that contains the largest fraction of economic activity.

City population growth accelerated in the second part of the 20th century and exceeded total population growth by a substantial margin, thus leading to a higher urbanization rate. The average growth rate of Swedish cities exceeded 15% for several decades between 1870 and 1970. One should note, however, that this is a simple geometric average, which takes every city as one data point. The growth rate of Stockholm thus counts just as much as the growth rate of Lund, for example, even though the latter is a much smaller city. Depending on the objective, a population-weighted average might be a more meaningful measure of the rate of urbanization. Furthermore, it should be noted that part of the growth can be attributed to changes in administrative boundaries as large agglomerations expanded and incorporated the suburbs into the city.

Zipf's law and Gibrat's law for Swedish cities:

Zipf's law posits a simple linear relationship between the logarithm of city size in terms of population and the logarithm of city rank by population across regions. As summarized above, this empirical relationship has been found for many countries and regions around the world across different time periods. The law is usually expressed by the following equation:

$$(1) \quad \ln(population) = \beta_1 + \beta_2 \ln(rank) + \varepsilon$$

Table 1 shows the population for the largest agglomerations in Sweden in 2010 with Stockholm at about 1.3 million inhabitants followed by Gothenburg and Malmö with about half a million and a quarter million inhabitants, respectively. The tenth largest city in Sweden is Norrköping with close to 90.000 inhabitants. All 118 cities in the sample have a population of more than 10.000 inhabitants in 2010. One should note that the geographic size varies quite considerably by a factor of about 100 with Stockholm covering more than 300 km^2 whereas a small city like Lomma with no more than 10.000 inhabitants only covers a few km^2. As a comparison to today, Stockholm's population was only about 75.000 in 1800. Moreover, many of the so-called cities in the database had less than a thousand inhabitants 200 years ago.

Graph 4 shows how the number of cities in my sample increases over time from less than 60 in 1800 to more than 120 in 2010. We run the Zipf's law regression for every single decade. The coefficient increases from less than 1.03 in 1800 to a record high of 1.15 in 1900, meaning that the Swedish urban population became increasingly more concentrated over time. Quite surprisingly, however, the coefficient has dropped ever since 1900. It reached a low of 0.88 in 1990 has stayed relatively stable since then (graph 5). This indicates that the Swedish urban population actually became more dispersed over the last century, contrary to our hypothesis. One should bear in mind though that every city represents one data point and has an equal weight in the regression independent of its population size. Plotting the graphs for Zipf's law, we can see that the three largest agglomerations Stockholm, Gothenburg, and Malmö have indeed been consistently above the line since the 1930s. This is equally true for all small Swedish cities in the sample. Both the large agglomerations as well as the small cities are thus too large compared to the benchmark whereas the cities in the middle of distribution have consistently been smaller than predicted by the law.

In order to avoid bias by including more and more small cities into the sample over time, we also estimate Zipf's law just for the 50 largest cities in Sweden for each decade. We can see that a similar pattern emerges even though the fluctuations of the coefficient are not quite as large (graph 6). The coefficient increases from a low of 0.9 in the beginning of the 19^{th} century to close to 1 in 1940. Subsequently, it drops in the decades thereafter, reaching a value of 0.89 in

2010.

According to Gibrat's law, city size and growth rate should be independent of each other, meaning that small and large cities should have the same population growth rate in the long-run. We test this prediction by running the following regression for each decade from 1800 to 2010.

$$(2) \quad population\ growth\ rate = \beta_1 + \beta_2\ rank + \varepsilon$$

The results are summarized in table 3. One can see that the coefficient for city rank is insignificant for almost all decades, meaning that population growth is indeed independent of city rank. There are two decades in the end of the 19th century during which large cities experienced statistically higher growth rates and the size of the effect is quite large. Increasing city rank by 50 leads to a decline in growth rate by about 9% during the 1860s, for example. However, during the 1910th and 1920s we can observe precisely the opposite pattern. Small cities are now growing at a significantly faster pace. The same holds for the 1970s and 1980s whereas the pattern reverses again for the 1990s. On average, it is thus fair to say that city growth and city rank is independent of each other over a longer time frame. Gibrat's law, that is random city population growth, thus seems to hold in the long-run. However, a word of caution is in order. By expanding the sample size over time, our analysis includes an increasing number of small but fast growing localities that became cities over the course of the 2 centuries under consideration, which can lead to bias in the estimation. Consequently, we also estimate the relationship for the sample that includes only the 50 largest cities. Again, we find that there is no systematic relationship between city population growth rate and city rank over time.

The results of our analysis thus show no systematic long-run relationship between city growth rate and city rank. Gibrat's law seems to hold. However, when it comes to Zipf's law, we find some unexpected findings. First, the coefficient for Sweden is very rarely equal to the magical number one, which has been found so often in the empirical literature. This might be due to the particularities of the Swedish economy, a very sparsely settled country with a small number of cities, most of them being extremely small in size. Second, the Zipf's law coefficient shows significant variation over time. Surprisingly, the recent decline indicates that the Swedish urban population has become somewhat more dispersed on the city level. However, one must bear in mind that each city just represents one data point. The three largest agglomerations in Sweden are larger than predicted by the law whereas cities in the middle of the distribution are smaller than the benchmark implies.

Glaeser et al. (2016) note that the European city network is distinct from that in North America, for example, particularly if one considers the West Coast of the United States. Urbanization on the European continent occurred when transport costs where still relatively high. As a result, Europe has an abundance of smaller cities that it does not wish to abandon. In order to further analyze changes in the city network over time, we have calculated two primacy ratios for the Swedish urban population in the spirit of Rosen and Resnick (1980) where Primacy I is defined as the ratio of the largest city to the sum of the top five cities and primacy II is defined as the ratio of the largest city to the top 50 cities (table 4). The test shows a clear dominance of Stockholm in the beginning of the 19^{th} century with primacy I at 67% and primacy II being at 37% in 1800. Over the next 100 years, however, the other large cities increasingly gained ground on Stockholm. As a result, primacy I falls to a record low of 50% in 1920 while primacy II falls to a low of 27% in the same decade. Stockholm thus became much less dominant as the Swedish city network developed with increasing urbanization over the course of the 19^{th} century. In recent decades we can see that there has been a slight reversal. Primacy I increased from 51% in 1970 to 0.56 in 2010, meaning that Stockholm grew at a faster rate than the other large agglomerations in Sweden. Primacy II, on the other hand, has barely edged upwards, indicating that smaller towns in Sweden have in general managed to keep up with Stockholm in terms of population growth rates. These two measures confirm that there has not been a dramatic change in the urban network in favor of large cities in recent decades.

<u>Zipf's law and Gibrat's law for Swedish municipalities:</u>

We now turn to Zipf's law and Gibrat's law from 1810 to 2010 using municipalities as a geographic unit of analysis. One should note that Sweden's municipalities are extremely different in terms of geographic size, ranging from a mere 8.8 km^2 with a population density of about 5300 for Sundbyberg (belonging to the agglomeration of Stockholm) to more than 20.500 km^2 with a population density of only 1.2 for Kiruna municipality. Furthermore, some Swedish municipalities are even more sparsely settled and have a population density of less than 1 person per km^2. A priori, there is no fundamental reason to believe why Zipf's law should hold at the municipality level as the largest municipality is more than 3000 times larger than the smallest in terms of geographic size. Nevertheless, analyzing Swedish municipalities in terms of Zipf's law is meaningful because it can tell us something about the population distribution during the time period under consideration.

The results are somewhat surprising. Graph 7 displays the Zipf's law coefficient over time while figure 3 displays the Zipf's law distribution for all Swedish municipalities for each decade, respectively. The analysis shows that the Zipf's law coefficient actually slightly decreased after 1820, then stayed relatively stable at around 0.79 for about 80 years until 1900, only to decrease even further to a record-low of 0.76 in 1930. A decrease in the coefficient means that the Swedish population actually became more dispersed using the municipality as a geographic unit of analysis. This is due to the fact that Sweden experienced rapid growth in the remote North at the turn of the 19th century as certain sectors expanded in these areas, such as mining, the pulp industry and hydroelectric power generation. After 1930, we see a rapid reversal of this trend as the Zipf's law coefficient increases continuously to hit a record-high of 0.95 in 2010. This means that the Swedish population started to become much more concentrated on the municipality level after 1930. This evolution can thus be interpreted as a sharp acceleration in agglomeration effects. It is interesting to note that the coefficient seems to approach unity even though there is, a priori, no fundamental reason why such a relationship should hold at the municipality level.

Using Gibrat's law as a benchmark, we can see that at the municipality level population growth was somewhat random at the beginning of the 19th century, meaning that municipality population size and population growth rate were independent of each other. However, we can observe a strong pattern after 1870. For the following 50 years there was a statistically significant positive relationship between municipality rank and population growth. Increasing municipality rank by 100 leads to an increase in the growth rate by about 2%, 1.5%, 2.1%, 3.5%, and 1.8%, respectively, during the five decades after 1870. Low population municipalities thus grew at a significant faster rate, which explains the decrease in the Zipf's law coefficient one can observe during that time period. The Swedish population thus became more dispersed at the municipality level.

The pattern completely reverses after 1940 when we start to observe a statistically significant negative relationship between municipality rank and municipality population growth rates. Furthermore, this relationship becomes stronger over time. Increasing municipality rank by 100 decreases population growth by about 2.4% in the 1940s, 2.8% in the 1980s, and an astonishing 6.9% in the 2000s, which explains the significant increase in the Zipf's law coefficient over the last 70 years. Consequently, the Swedish population became much more concentrated on the municipality level and this tendency has increased in recent decades, thus suggesting an increase in agglomeration effects.

We also estimate an alternative specification of Gibrat's law based on the following specification:

$$population\ growth\ rate = \beta_1 + \beta_2 \ln population + \varepsilon$$

While the interpretation of the coefficient is slightly different, the results are very much in line with expectations (table 7). The coefficient is negative and statistically significant from 1870 to 1920, indicating population dispersion. At its peak, doubling the population level leads to a decrease of population growth by more than 3% in the decade after 1900, for example. After 1940, the coefficient is positive and statistically significant. Furthermore, it increases over time. Doubling population leads to an increase in population growth by about 5.8% in the 2000s.

Tables 8 to 10 in the appendix show some descriptive statistics for municipality growth rates per decade. Analyzing municipalities per quartile (table 9) is interesting insofar as it tells us something about the distribution of the growth rate. Low population municipalities have consistently higher standard deviations for population growth over the last 200 years. Municipality population growth rates were obviously much higher during the early 19th century when the Swedish population expanded rapidly. At that time municipalities in different quartiles grew roughly at the same rate, on average. The pattern changes at the turn of the 19th century. Low population municipalities now grow at a much faster rate during the two decades prior 1900 as well as the during the two decades thereafter. However, municipalities in the first quartile are also growing faster than those in the second and third quartile during that time, suggesting that some agglomeration effects were already at play. It is thus the municipalities in the middle of the distribution that have lower growth rates.

Starting in the middle of the 20th century, the pattern changes again. Population growth decelerates for the country as a whole. High population municipalities now start to grow significantly faster and this effect becomes stronger over time. For the two decades prior to 2010 one can observe for the first time in history that a majority of Swedish municipalities are actually experiencing population losses. Only municipalities in the first quartile are growing at a rapid pace whereas the average growth rate for the second, third and fourth quartiles are now negative with the smallest population municipalities experiencing the highest relative population losses, which again points to a strong increase in agglomeration forces in recent decades.

<u>Stability of the city network albeit increasing agglomeration effects:</u>

Table 11 shows four transition matrices we have computed for all Swedish municipalities. Based on these matrices, we can see to what extent municipalities transitioned in between the different quartiles of the population distribution on 50-year intervals. This computation can be interpreted as an indicator of structural change in the economy. The results are somewhat surprising. We can see that in the first period from 1810 to 1860 only a tiny fraction of municipalities (38 out of 275) actually changed their quartile. Furthermore, not a single municipality transitioned by more than one quartile upwards or downwards. The municipality distribution thus stayed relatively stable during this first period. During the second period from 1860 to 1910 a few municipalities transitioned two quartiles up: two from the third to the first quartile, and three from the fourth to the second quartile, respectively. Finally, in the last two periods there are a few municipalities that even managed to transition from the fourth to the first quartile. Furthermore, the total number of municipalities that transitioned increased significantly from the first to the last period, leading us to conclude that structural change increased over time as the municipality population distribution became increasingly unstable.

Table 12 is a list of municipalities, which showed the largest transitions. Again, we can see a very clear pattern. During the period from 1860 to 1910 five municipalities transitioned two quartiles upwards. Four of them are located in the sparsely populated North and Northeast of the country. Clearly, during that time this part of the country can be regarded as the economic frontier. The expansion of economic activity was related to mining activities, the pulp and paper industry, and the buildup of hydroelectric power stations. The population in Northern Sweden increased from about 450.000 in 1850 to 750.000 in 1890. This corresponds to an annual growth rate of about 1.6%, twice the size of that for the country as a whole (Schön, 2010).

While the Swedish city network shows relatively little sign of structural change in favor of large cities in recent decades, the picture is completely different on the municipality level. There has been a complete reversal of fortunes over the last century. While the resource-abundant grew significantly faster until the 1920s, the growth pattern completely changes thereafter. In the third and fourth period, all municipalities that transitioned from the fourth to the first quartile are located in Stockholm län. One can clearly see the effect of Stockholm city as a force of attraction for surrounding municipalities. Population and economic activity expanded rapidly in the periphery of the capital. Stockholm county's population share thus increased from 10% in 1900 to more than 22% in 2010. As we will see below, the agglomeration effects can thus be best understood by growth in the periphery of the large cities, thus potentially indicating increasing congestion effects in the already densely populated city centers where the supply of housing is relatively inelastic.

Market potential:

In order to examine the effects of agglomeration economies more closely, we construct a measure of market potential for all Swedish municipalities. We use this variable as a proxy for agglomeration effects. It also allows us to more formally identify when second-nature geography has become more important over the course of the last 2 centuries. Our measure is based on De Vries (2006) who created a variable called urban potential, which is constructed as follows:

$$U_i = \sum_{j=1}^{n} \frac{Pop_j}{D_{ij}}$$

The urban potential of a particular city i is thus the sum of all city populations in the urban network divided by their respective distance to that city. In other words, a city’s urban potential is high if there are many other high-population cities nearby. The basic idea is, of course, that your own market potential is a function of economic activity in close proximity. Economic literature supports the theory that market access is crucial for economic development. Specialization of labor is only possible if the market is large enough. Industrialization and modern economic growth required a critical population mass and market size so that large-scale production of manufacturing goods made actually became feasible and indeed profitable, i.e. it hade to made sense from an economic point of view (Schön, 2010).

Instead of using city data, we apply the same concept to municipalities. We measure the market potential for each municipality for all decades from 1810 to 2010.

The shortfall of the index, however, is that it cannot capture non-linearities. It is possible to imagine a scenario where the proximity to a large market might actually be growth-inhibiting in certain cases. A small city in very close proximity to a big agglomeration, for example, might actually lose out because of a competition effect. In that way a large agglomeration might actually stifle areas nearby. Such a negative effect, however, cannot be captured by the simple measure constructed above.

<u>First vs. second-nature geography:</u>

There is a large academic literature that geography matters for economic growth. Sachs (2003) shows how variables like distance from the coast and distance from the equator are statistically significant in explaining the level of economic development. The African continent is more than three times as big as the United States. Some countries are thousands of miles away from the coastline and cannot access world markets as easily as Western Europe where every country is located in close proximity to the sea. Geography also mattered for the location of cities. Most Roman cities were seaports or located next to large rivers, as trade was far easier by ship than by other means of transportation during the Antiquity. There is no doubt that first-nature geography, the distribution of natural landscapes like rivers, mountains, and the ocean, has important consequences for the spatial distribution of economic activity. The most direct effect comes via trade costs and lower market integration. In recent decades, however, second-nature geography has become increasingly important. Market access, the size of the market, and proximity to infrastructure, customers, suppliers, and even competitors is crucial despite the fact that transportation costs are now a fraction of what they were a few decades ago. Externalities seem to be especially prevalent in the so-called knowledge economy. High-tech firms still locate in Silicon Valley despite the fact that both housing prices as well as wages are among the highest in the world.

In what follows, we estimate a random effects Generalized Least Squares (GLS) regression for municipality population growth that includes time dummy variables for each decade. The index of market potential for each municipality calculated above is used as a measure for second-nature geography. The distance to the closest large agglomeration in Sweden (Stockholm, Gothenburg, and Malmö) as well as population concentration are two additional measures for second-nature geography. We also include several proxy variables for first-nature geography, which are longitude, latitude, land mass, an ocean dummy, and a variable for lake mass.

We interact the variables with a time dummy variable (d_t) for each decade in order to trace out the effects over time. The working hypothesis is that second-nature geography has become more important in recent decades and first-nature geography less so.

The GLS model thus has the following form:

$$Municipality\ population\ growth_t = \alpha + d_t * \ ln(rank) \ + d_t * ln(Market\ Potential) + d_t * ln(distance\ agglomeration) \ + d_t * ln(pop.concentration) + \ d_t * ln(latitude) + d_t * ln(longitude) + d_t * ln(land\ mass) + d_t * ln(lake\ mass) + ocean\ dummy$$

<u>Results:</u>

Table 14a shows the results for the main variables of interest for specification I of my main regression. One of the most important proxy variables for second-nature geography is market potential. The variable is mostly insignificant during most of the 19th century, but significant for most decades during the 20th century. Moreover, the economic effect increases over time. As of the early 2000s, an increase in market potential by a factor of two leads to a more than 10% increase in municipality population growth.

The logarithm of distance to one of the three large agglomerations is statistically insignificant for most of the 19th century, but significant for every single decade during the 20th century. Similar to the variable market potential, we can see that the economic effect increases over time. Proximity to one of Sweden's large agglomerations becomes more important by the end of the 20th century. Doubling the distance from one of the large agglomerations leads to 6% decline in population municipality growth in the 2000s.

One should note that this first specification excludes the three large agglomerations Stockholm municipality, Gothenburg municipality, and Malmö municipality because the logarithm of a zero distance does not exist. This is an important omission with which we deal later on by using alternative specifications.

Population density is positively correlated with municipality population growth, but only in the decades following World War II. The effect disappears by the end of the 20th century. This might suggest that congestion effects are now counterbalancing agglomeration effects in the most densely populated areas. It is especially in the old city centers where the stock of housing is relatively fixed in the short to medium run. The growth thus occurs in the periphery of the agglomerations instead.

The latitude variable is statistically significant for several decades around the turn of the 19th century. This reflects the economic expansion in the North of the country tied to resource industries, such as mining, timber, and hydroelectric power.

Surprisingly, longitude is also statistically significant during most of the 20th century, thus indicating that the Western part of the country is growing at a slower pace. Only in the very South does Sweden have a coastline adjacent to Denmark while in the North it shares more than 1600km of border inland in extremely rugged and mountainous terrain. The Eastern part of the country, on the other hand, has more than 2000km of coastline. The municipalities located there have much easier access to the Baltic Sea and are thus more integrated into the Baltic economic region and international markets. One should note, however, that the ocean dummy is for the most part statistically insignificant during the time period under consideration.

We also run an alternative specification of the same regression where we simply replace the logarithm of distance with distance itself (table 14b). In between 1880 and 1950, municipalities that are far away from the large agglomerations have a significantly higher growth rate. Increasing the distance by 100km leads to a 9.5% lower growth rate in 1900. By the end of the 20th century, the distance coefficient reverses sign, but remains statistically insignificant. Comparing specification I and specification II leads us to conclude that agglomeration forces display a non-linear effect because the logarithm of distance is statistically significant while the distance coefficient itself is not. This suggests that agglomeration forces only occur in very close proximity to the agglomeration itself, but that the effect peters out as distances increases.

We test this hypothesis by using an alternative specification where we replace the distance to agglomeration variable with two dummy variables instead (table 14c). The first dummy takes a value of one if a municipality is located within 50km of the next agglomeration. The second dummy variable takes a value of one if a municipality is located within 50km and 100km from the next agglomeration.

The results show that the first dummy is statistically significant at the 1% level for every decade after 1900. Moreover, the economic effect increases over time. Being located within 50km of one of the three agglomerations increases municipality population growth rate by more than 10% in every decade after 1970. The second dummy variable, on the other hand, is statistically insignificant for almost every decade. This result confirms our previous hypothesis that it is only close proximity to the agglomeration that matters a lot.

<u>Robustness checks:</u>

As a robustness check, we also calculate an alternative measure for market potential where we include the municipality's own population. The new measure of market potential is a weighted average of the old index and the municipality's own population with a weight of 70% and 30%, respectively. These weights are chosen relatively arbitrarily. However, intuitively it makes sense that the municipality's own population should not be totally dominant in measuring market potential, i.e. the weight should not be close to 100%. Changing the relative weights to some degree does not substantially alter the results. Furthermore, this new measure of market potential remains statistically significant at the 1% level for every decade after 1870.

As a robustness check for my distance results, we run a fourth specification where the two distance dummy variables are changed. We now use 40km and 40km to 80km instead (table 14d). The second dummy variable is now also statistically significant for most decades after 1960, but the economic effect is smaller. A comparison of specification III and specification IV thus suggests that the agglomeration effects peter out at about 80km or slightly above. This might correspond nowadays to about one hour of train ride or car ride at normal travel speed, which still seems reasonable as commuting time.

Economic convergence and divergence on a regional level:

Graph 9 and table 12 show the forces of regional convergence and divergence in terms of income per capita in Sweden over time. One can see that the 19th century and the beginning of the 20th century were mostly about convergence as markets became more integrated over time. New technologies like the railroad and later on the introduction of the automobile obviously played the most important role. GDP per capita was more than twice the national average in Stockholm during the 1860s and reached an all time low of 1.1 in 1980. All other regions in Sweden were thus rapidly catching up to the leader and the distribution narrowed substantially: The standard deviation of GDP per capita between the 24 counties in Sweden decreased from 0.33 in 1860 to a low of 0.07 in 1980. During the three decades thereafter, however, we can observe a reversal as the income distribution widened again. In 2010, almost every county in Sweden has an income per capita level that is lower than the national average. This is obviously because of the substantial weight of Stockholm län in terms of population size where per capita income is substantially higher than the national average (by a factor of 1.37 in 2010), pointing towards a positive correlation between concentration of economic activity and productivity. Stockholm län thus has increasingly become more important as a percentage of total Swedish GDP because of two effects: The increase in its population as well as the divergence in terms of per capita income relative to the rest of the country.

Redistributive policies and "highways to nowhere":

Regional GDP statistics thus show that regional inequalities have increased again over the last few decades. Incomes are significantly higher in Greater Stockholm than in the rest of the country. As a consequence, politicians have increasingly asked for redistributive policies that would inhibit regional divergence. However, this begs the question to what extent such policies are working and whether they are actually desirable. Italy is maybe the prime example of how such policies can actually fail. Per capita income in the South of the country was only about 60% of the income level of the rich North after World War II. After many decades of fiscal transfers this income gap is now roughly the same as it was 70 years ago (Iuzzolino et al., 2011).

With increasing agglomeration effects it does not seem desirable to increase the stock of infrastructure in regions that actually experience population decline, "highways to nowhere", if you will. Instead, policy makers should expand infrastructure in the places where it is most needed: The large metropolitan areas. Hsieh and Moretti (2015) estimate that the U.S. economy could increase its potential output by a few percentage points if workers would relocate from low-productivity to high-productivity regions. The most important bottleneck that prevents such relocation is the housing market.

Agglomeration effects and housing: A case for government intervention

Rising agglomeration effects have huge impacts for the housing market as well as large distributional consequences. Rising demand in the big cities is facing a supply of housing, which is relatively fixed in the short to medium run. As a consequence, housing prices in the big agglomerations have exploded. This is pretty much a global phenomenon, which can also be observed in Sweden. Graph 8 shows how real house prices in Stockholm and Gothenburg have outpaced price increases in the rest of the country. Furthermore, these asset price booms have also outrun increases in the national CPI and disposable income. Correspondingly, rents have risen a lot as well, albeit at a smaller pace because of housing policies like rent caps. Those, however, also come at an economic cost, mostly in the form of overly long queues for apartments with a desirable location. Location-specific housing thus has become much more expensive relative to other goods and services in recent decades. This is undesirable insofar as it also represents a huge wealth transfer from the non-owners of real estate to the owners, potentially exacerbating the rise in inequality. There is thus some room for government involvement to counteract this pecuniary externality of increasing house prices in large agglomerations: Facilitating and subsidizing housing construction in desirable locations being the most obvious solution.

During the 1960s, the Swedish government implemented the so-called *Miljonprogrammet* ("Million Program"). The aim of this ambitious housing program was to dramatically increase the stock of dwellings in urban areas, by one million units to be precise, over the course of one decade. The urban population increased significantly as a result within just a few years. Given Sweden's geography, many small cities also benefited from government subsidies. A similar government program could be set up today, but with a particular focus on the three large agglomerations Stockholm, Gothenburg, and Malmö, where housing demand is high and productivity is above the national average.

Suboptimal equilibria, path dependence, and sunk costs in infrastructure investment:

Especially in the beginning of the 20th century, Sweden's population became increasingly dispersed as a result of population growth in the remote North of the country. Furthermore, Sweden experienced what might be characterized as a "rural industrialization" with growth in small urban centers. Berger and Enflo (2015) use the expansion of the railroad network as a natural experiment. They show that this infrastructure investment has long-term economic effects on the population trajectory of cities in Sweden. A transitory shock in the 19th century led to path dependence in the location of economic activity.

We show that agglomeration effects have increased over time and have increasingly dominated first-nature geography. Productivity in Stockholm county is much higher than in the rest of the country, a result of economies of scale and positive externalities. While past infrastructure investments in small and remote areas represent a sunk cost, it is possible to imagine a scenario where this past population growth as a result of infrastructure investments now comes at the expanse of future economic growth. More specifically, Michaels and Rauch (2016) show that French cities are stuck in suboptimal locations. Many of them are located inland as a result of Roman settlement. Similarly, railroad expansion in Sweden connected many small cities in the middle of the country as the railroad stayed clear of the coast because of military considerations (Berger and Enflo, 2015). As a result, Sweden experienced a sort of rural industrialization with urbanization occurring in many small and remote cities far away from the coastline. While a population reshuffling has started over the last decades with most of the growth occurring in the three large agglomerations, it is possible that part of the workforce remains trapped in low-productivity areas as a result of past infrastructure investments. Past population growth in remote areas might thus come at the expanse of present and future economic growth because small economies of scale and positive externalities are less prevalent in small urban areas. This lock-in effect provides another argument against regional infrastructure investment to alleviate regional inequalities. It is not in the national interest to trap workers in low-productivity areas since such policies could be a drag on economic growth.

Avenues for further research:

Desmet et al. (2015) suggest that it is not market size per se that determines economic development, but rather spatial competition between cities. China's internal market was very large, but so was the relative distance between Chinese cities. In England, on the other hand, distance between different urban centers was much smaller, meaning that the degree of spatial competition between them was much higher. Craft guilds acted as local monopolies and successfully prevented the introduction of labor-saving technologies during the Renaissance period. This, however, was not feasible anymore once the degree of spatial competition exceeded a certain threshold (Desmet et al, 2015). Their model can account for the diverging path of industrialization between the UK and China. Sweden is an interesting case study insofar as the county is much more sparsely populated than the UK and continental Europe. Sweden urbanized relatively late in comparison to other European economies. Furthermore, the country experienced rapid growth of small urban centers in remote areas. The Swedish city network must thus be an intermediate case between that of the UK and China when it comes to relative distance between cities. It would thus be of interest to test the spatial competition model against the Swedish data to find out whether this might account for the relative late outset of the Industrial Revolution in Sweden.

Conclusion:

Sweden was a latecomer to the Industrial Revolution. The country was relatively poor compared to continental Europe and overwhelmingly rural. Urban growth accelerated only by the end of the 19th century. The country saw urban growth in small cities, which became regional centers in the vast countryside. Using Zipf's law as a benchmark, we show that Sweden does not quite confirm the usual pattern. The three large agglomerations Stockholm, Gothenburg, and Malmö are consistently larger than predicted by the benchmark and the same also holds for small cities. It is cities in the middle of the distribution, on the other hand, that are consistently too small. On the municipality level, we see that the Swedish population actually became more dispersed around the turn of the 19th century as a result of economic expansion in the resource-abundant North of the country. The country was to some extent a frontier economy in the sense that mining, timber, and hydroelectric power generation expanded in the first half of the 20th century. Agglomeration effects started to become of increasing importance during the last few decades. Distance to one of the three agglomerations and market potential are a good predictor of municipality population growth. By the end of the 20th century, only municipalities in the first quartile of the distribution (ranked by population) experienced further population growth whereas the rest either stagnated, on average, or actually experienced decline. Recent decades have also seen an increase in regional divergence. Large agglomerations have experienced a significant house price boom. After more than a century of convergence, regional income statistics have shown increasing divergence again since the 1980s. Redistributive policies, such as fiscal transfers and infrastructure projects, for regions in decline might be misguided. Instead, the economy's potential output could increase significantly if policy makers focus on expanding infrastructure where demand is highest. Relocating workers from low-productivity to high-productivity regions could provide a significant long-term boost to the economy after more than a decade of disappointing productivity growth following the Great Recession of 2008/2009.

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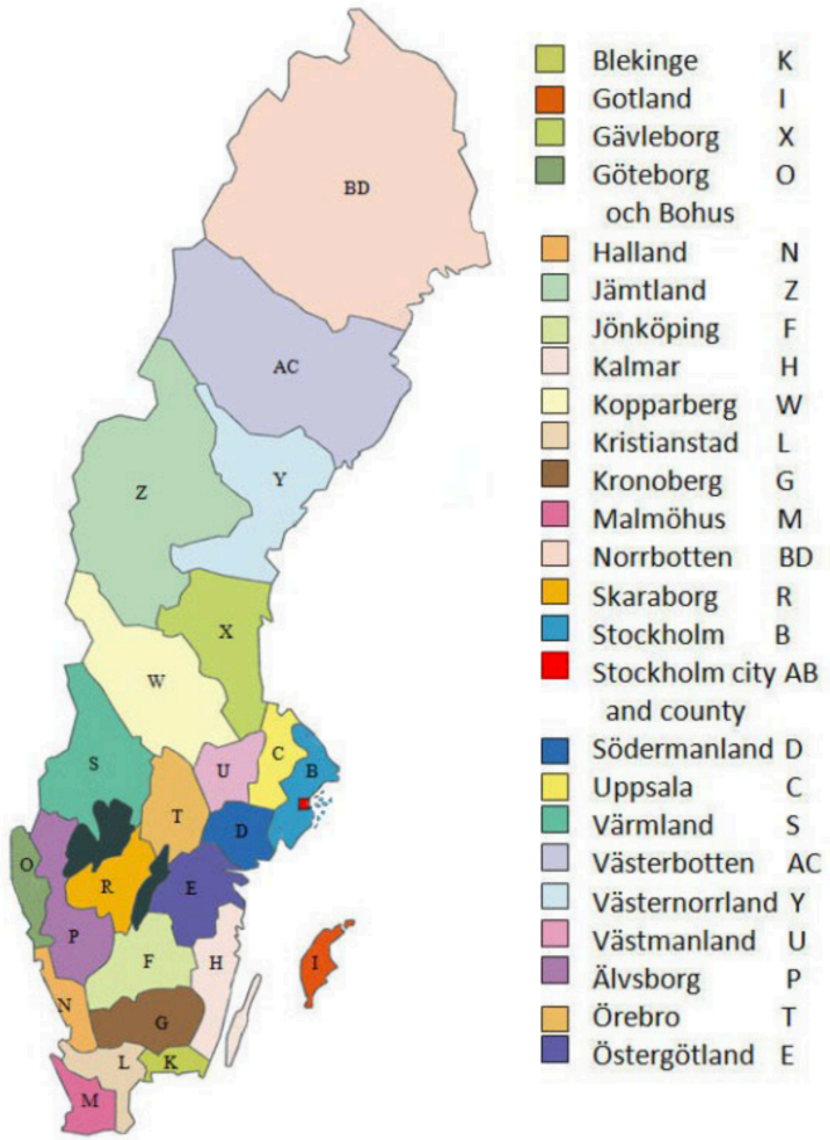
Data:

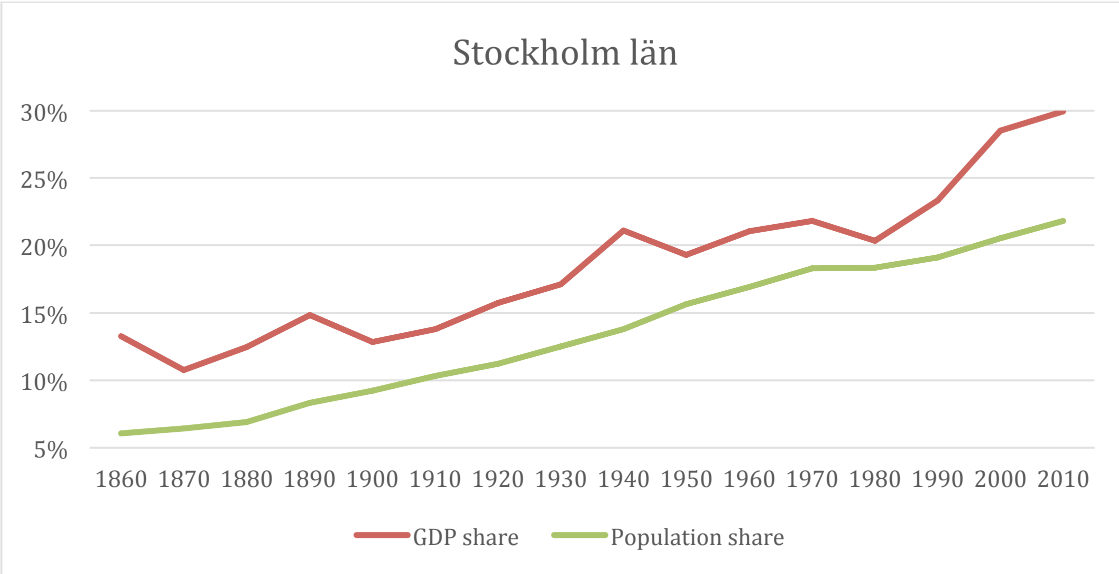
- Folknet database, Umeå University: http://www.cedar.umu.se/english/ddb/databases/folknet/
- Statistics Sweden: http://www.scb.se/en_/
- Swedish Historical Regional accounts, Lund University: http://www.ekh.lu.se/en/research/economic-history-data/shra1860-2010

Appendix:

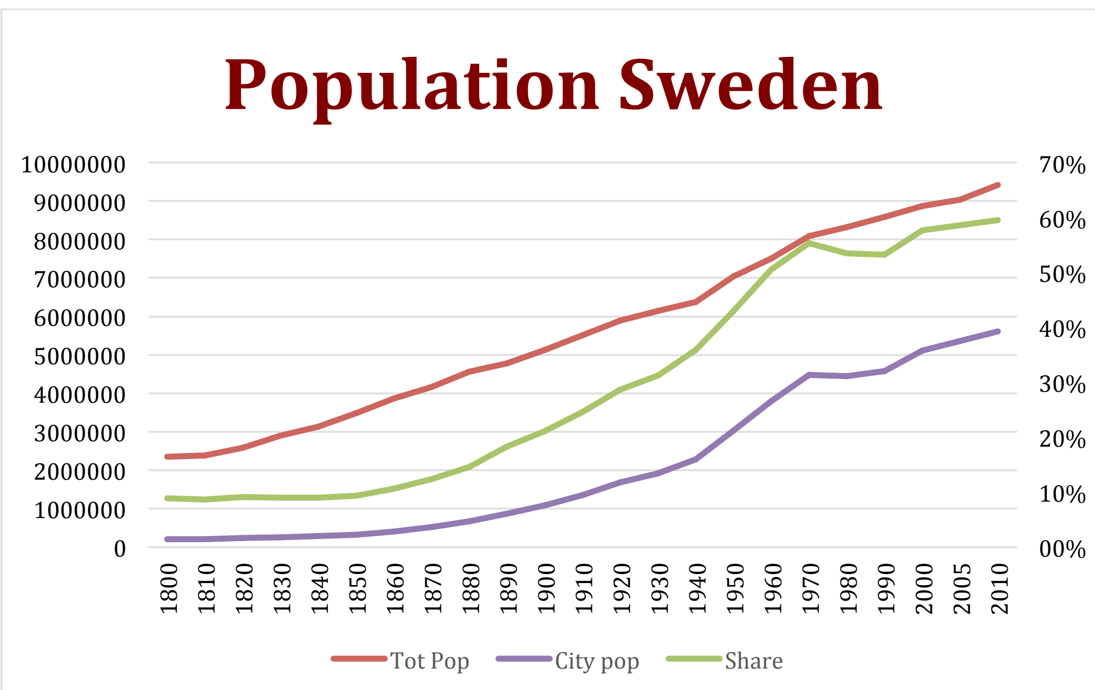
Figure 1: Sweden's counties



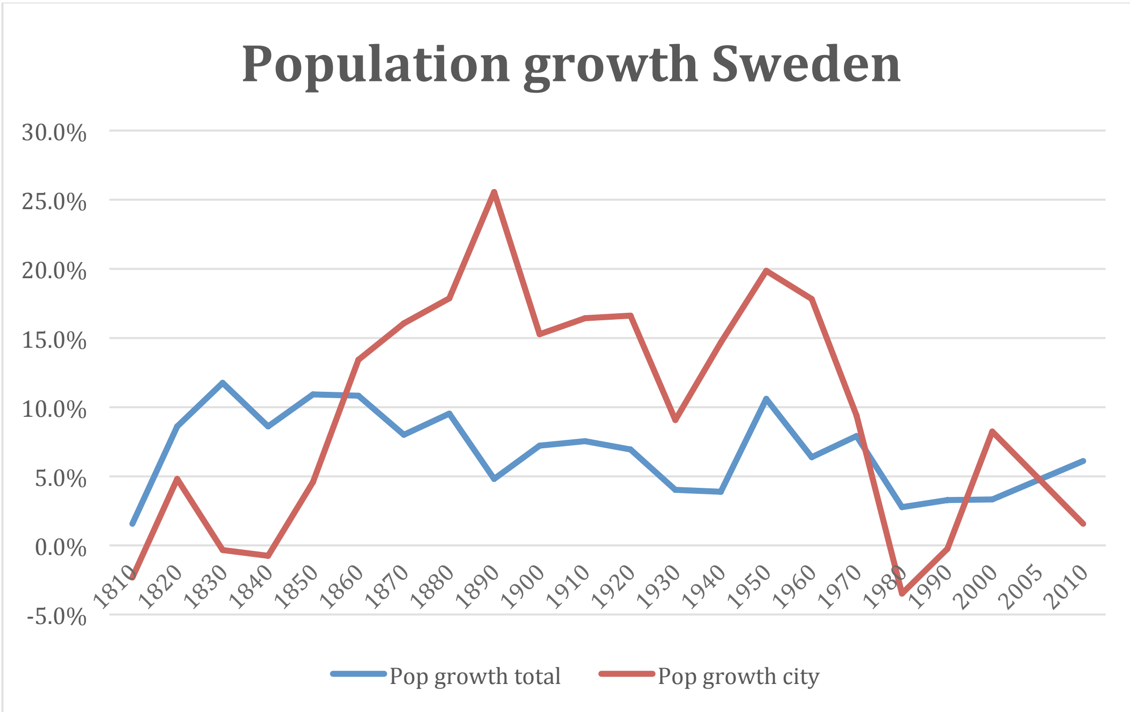
Graph 1: Stockholm county



Graph 2: Sweden's population



Graph 3: Population growth



Graph 4: City sample

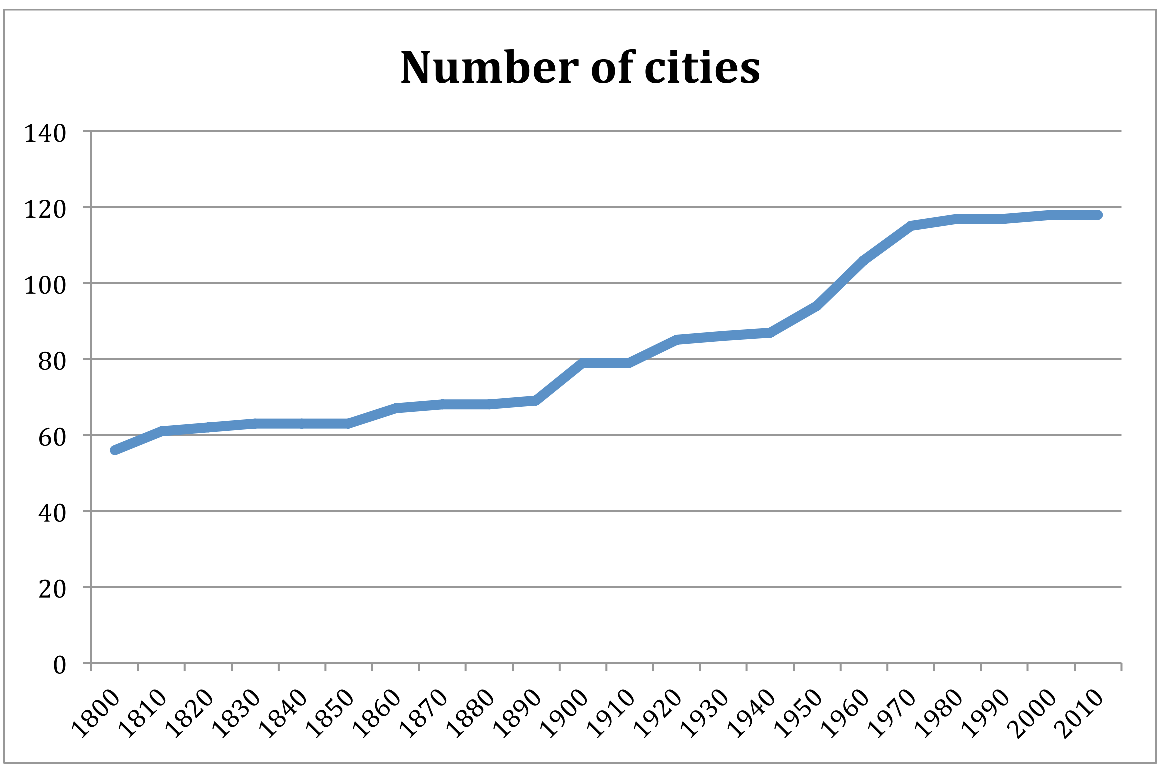


Table 1: Top 11 Swedish cities in 2010:

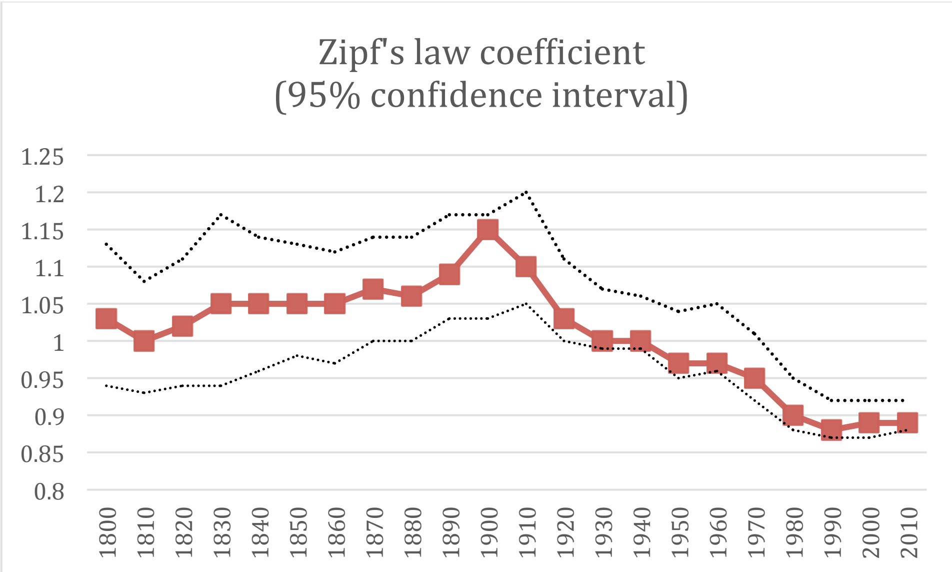
Stockholm	1.372.565
Gothenburg	549.839
Malmö	248.520
Uppsala	140.454
Västaras	110.877
Örebro	107.038
Linköping	104.232
Helsingborg	97.122
Jönköping	89.396
Norrköping	87.247
Lund	82.800

Table 2: Zipf's law Swedish cities

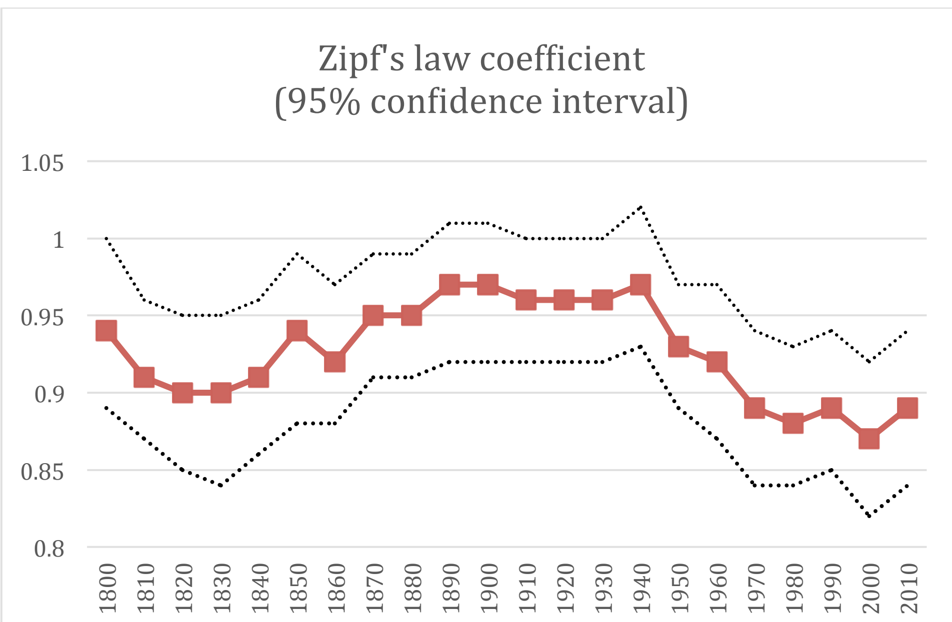
Regression: $\ln(\text{population}) = \beta_1 + \beta_2 \ln(\text{city rank}) + \varepsilon$

Year	β_1	β_2	F-test $\beta_2 = 1$	Observations
1800	10.69	-1.03*** (0.05)	0.49	56
1810	10.64	-1.00*** (0.03)	0.94	61
1820	10.82	-1.02*** (0.04)	0.56	62
1830	11.00	-1.05*** (0.05)	0.34	63
1840	11.07	-1.05*** (0.04)	0.26	63
1850	11.24	-1.05*** (0.04)	0.14	63
1860	11.45	-1.05*** (0.04)	0.22	67
1870	11.73	-1.07*** (0.03)	0.04	68
1880	11.97	-1.06*** (0.03)	0.07	68
1890	12.28	-1.09*** (0.03)	0.01	69
1900	12.65	-1.15*** (0.04)	0	71
1910	12.5	-1.10*** (0.04)	0.01	79
1920	12.79	-1.03*** (0.03)	0.20	85
1930	12.79	-1.00*** (0.02)	0.83	86
1940	12.97	-1.00*** (0.02)	0.83	87
1950	13.19	-0.97*** (0.02)	0.19	94
1960	13.43	-0.97*** (0.02)	0.55	106
1970	13.54	-0.95*** (0.02)	0.06	115
1980	13.37	-0.90*** (0.02)	0	117
1990	13.34	-0.88*** (0.01)	0	117
2000	13.43	-0.89*** (0.01)	0	118
2010	13.52	-0.89*** (0.01)	0	118

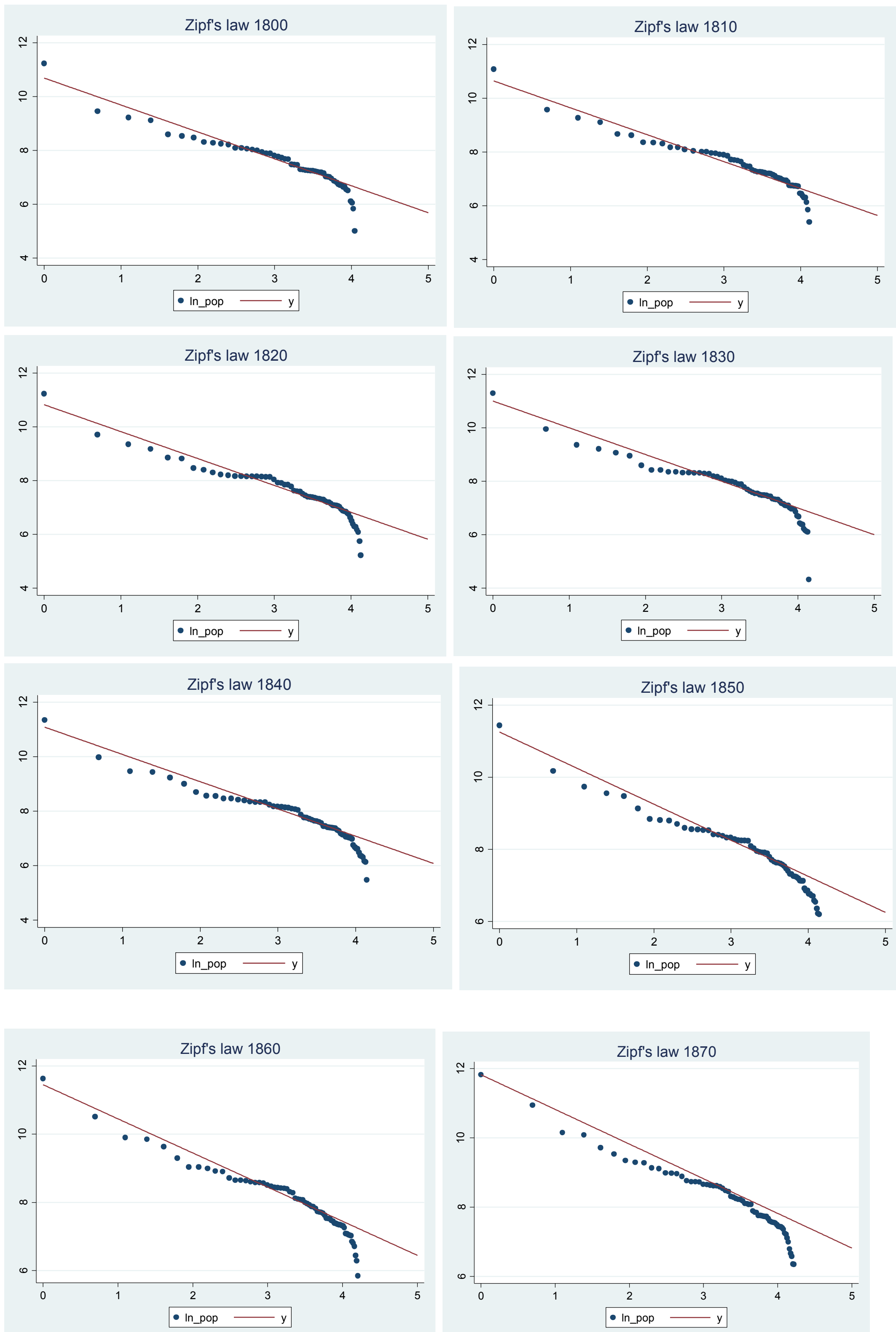
Graph 5: Zipf's law Swedish cities

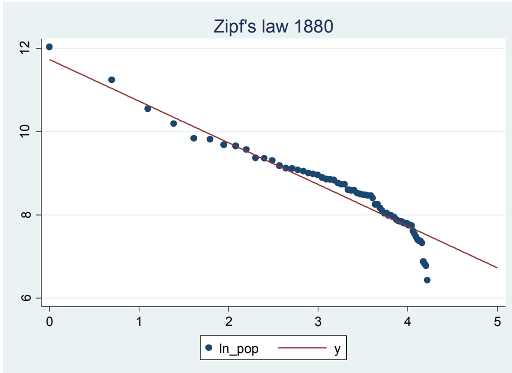


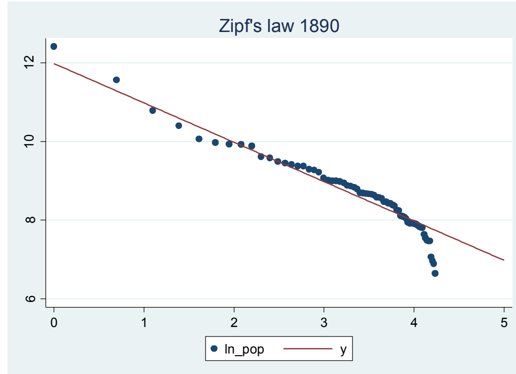
Graph 6: Zipf's law Swedish cities top 50

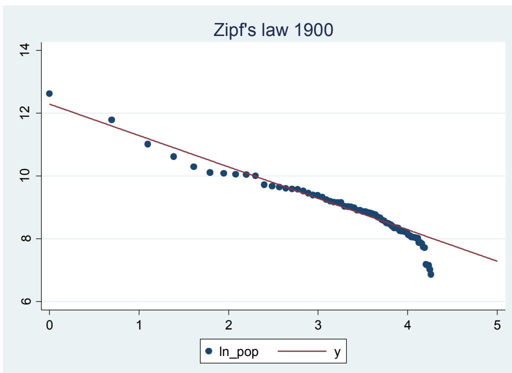


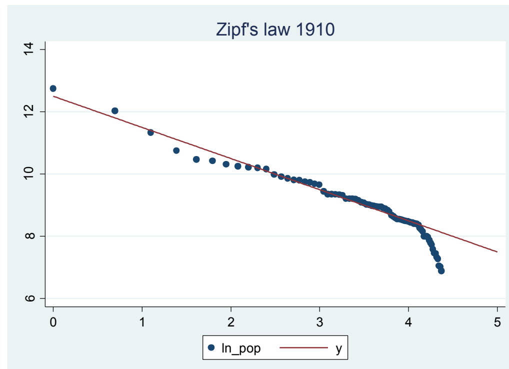
<u>Figure 2: Zipf’s law Swedish cities 1800-2010:</u>




Zipf's law 1880
ln_pop
y


Zipf's law 1890
ln_pop
y


Zipf's law 1900
ln_pop
y


Zipf's law 1910
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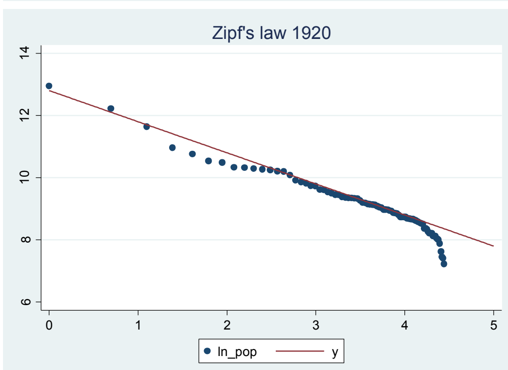
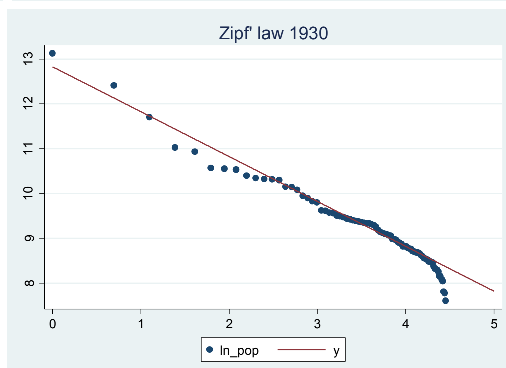

Zipf's law 1920
ln_pop
y


Zipf' law 1930
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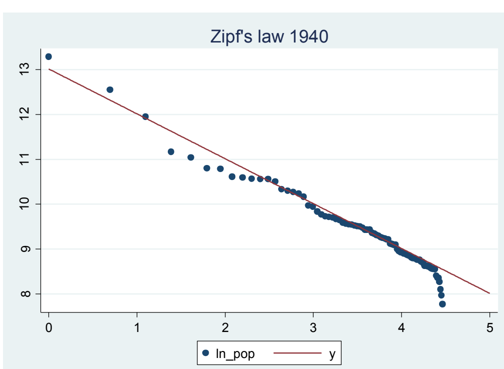
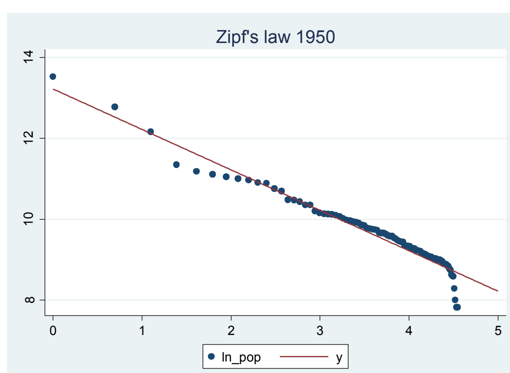

Zipf's law 1940
ln_pop
y


Zipf's law 1950
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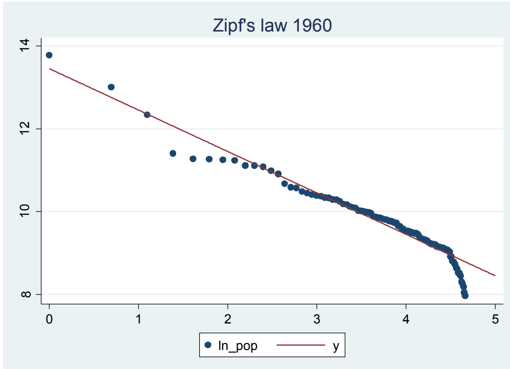
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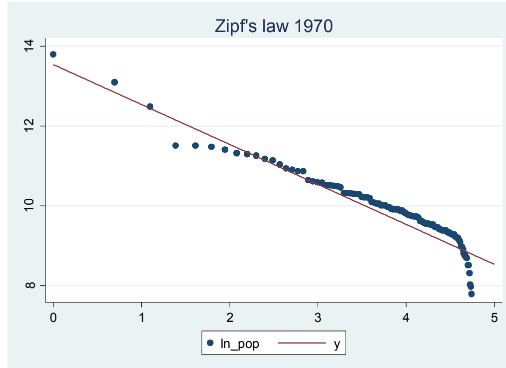
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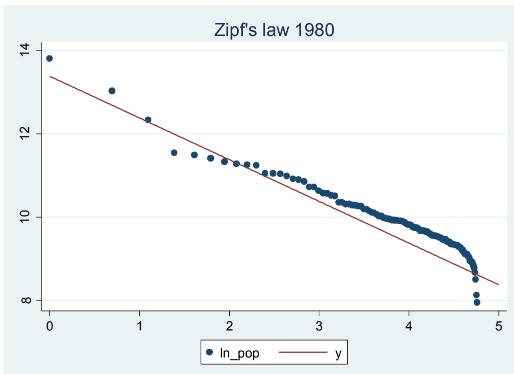
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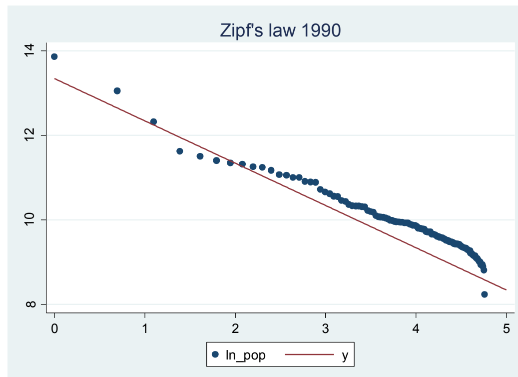
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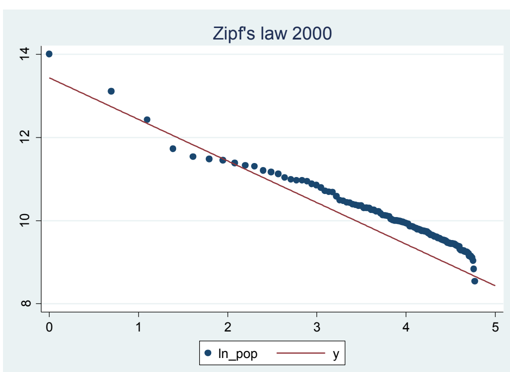
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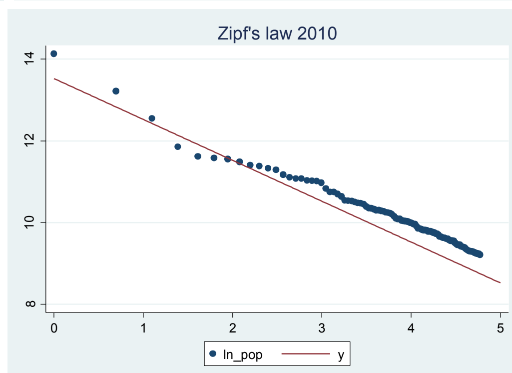
Zipf's law 2010
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ln_pop
y

Table 3: Gibrat's law Swedish cities

Regression: population growth $= \beta_1 + \beta_2(\text{city rank}) + \varepsilon$

Decade	β_1	β_2	P-value of β_2	Observations
1800 - 1810	0.09	0.0049	0.44	56
1810 - 1820	0.14	-0.00047	0.58	61
1820 - 1830	0.1	-0.001	0.27	62
1830 - 1840	0.08	0.00036	0.74	63
1840 - 1850	0.16	-0.00004	0.96	63
1850 - 1860	0.2	0.00061	0.53	63
1860 - 1870	0.25	-0.0018**	0.05	67
1870 - 1880	0.28	-0.00032	0.72	68
1880 - 1890	0.26	-0.0014*	0.07	68
1890 - 1900	0.22	-0.00002	0.98	69
1900 - 1910	0.24	0.0002	0.85	79
1910 - 1920	0.14	0.0023**	0.05	79
1920 – 1930	0.05	0.0013**	0.04	85
1930 - 1940	0.16	-0.00008	0.87	86
1940 - 1950	0.36	-0.0009	0.39	87
1950 - 1960	0.17	0.0012*	0.09	94
1960 - 1970	0.2	0.0015	0.12	106
1970 - 1980	-0.07	0.00196***	0.00	115
1980 - 1990	-0.01	0.0008**	0.02	117
1990-2000	0.19	-0.0014**	0.04	117
2000-2010	0.07	0.00001	0.96	118

Table 4: Urban primacy

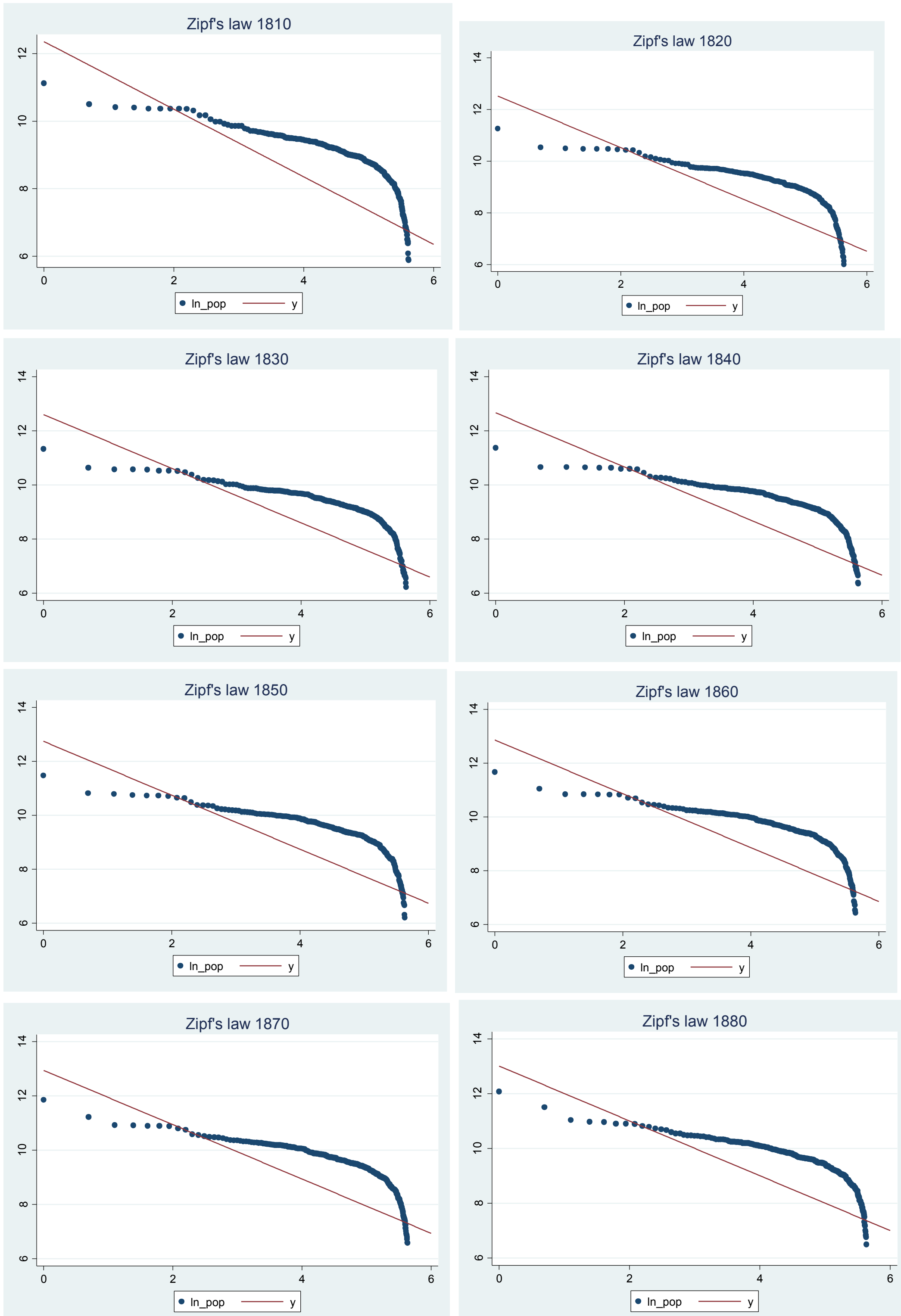
	Primacy I 1/5	Primacy II 1/50
1800	0,67	0,36
1810	0,62	0,32
1820	0,63	0,33
1830	0,61	0,32
1840	0,60	0,31
1850	0,57	0,29
1860	0,55	0,29
1870	0,53	0,28
1880	0,51	0,27
1890	0,54	0,29
1900	0,53	0,29
1910	0,51	0,27
1920	0,50	0,27
1930	0,51	0,29
1940	0,51	0,28
1950	0,51	0,28
1960	0,53	0,29
1970	0,51	0,26
1980	0,53	0,27
1990	0,54	0,28
2000	0,56	0,29
2010	0,56	0,30

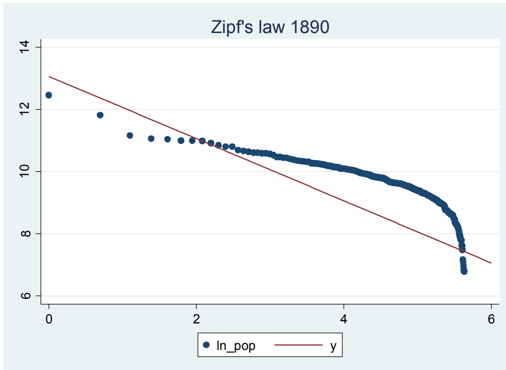
Table 5: Zipf's law Swedish municipalities

Regression: $\ln(\text{population}) = \beta_1 + \beta_2 \ln(\text{municipality rank}) + \varepsilon$

Year	β_1	β_2	F-test $\beta_2 = 1$	Observations
1810	12.35	-0.78*** (0.03)	0	275
1820	12.52	-0.81*** (0.03)	0	279
1830	12.60	-0.8*** (0.03)	0	280
1840	12.66	-0.79*** (0.03)	0	280
1850	12.74	-0.78*** (0.03)	0	280
1860	12.86	-0.79*** (0.03)	0	281
1870	12.94	-0.79*** (0.03)	0	281
1880	13.01	-0.79*** (0.03)	0	281
1890	12.82	-0.79*** (0.03)	0	281
1900	13.1	-0.79*** (0.02)	0	281
1910	13.12	-0.77*** (0.02)	0	282
1920	13.14	-0.76*** (0.02)	0	282
1930	13.15	-0.76*** (0.02)	0	282
1940	13.2	-0.77*** (0.01)	0	282
1950	13.36	-0.79*** (0.01)	0	282
1960	13.5	-0.81*** (0.01)	0	282
1970	13.72	-0.85*** (0.01)	0	282
1980	13.76	-0.84*** (0.01)	0	282
1990	13.86	-0.86*** (0.01)	0	282
2000	14.05	-0.9*** (0.01)	0	282
2010	14.28	-0.95*** (0.02)	0	282

Figure 3: Zipf’s law Swedish municipalities 1810-2010:




Zipf's law 1890
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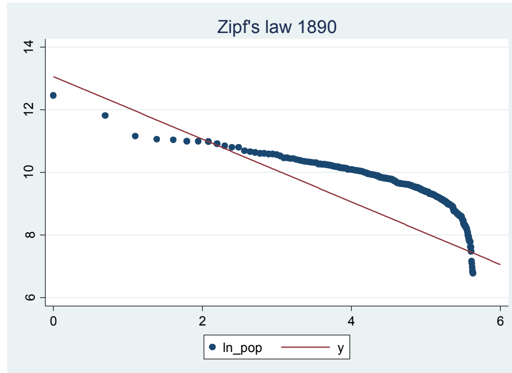
ln_pop
y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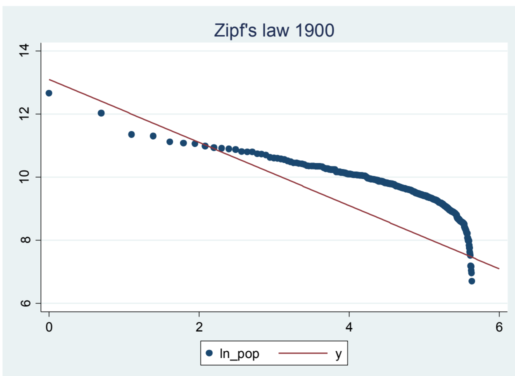
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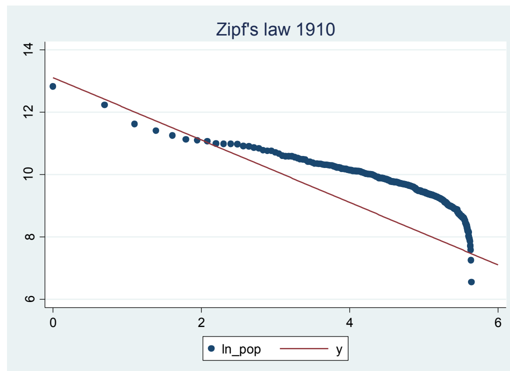
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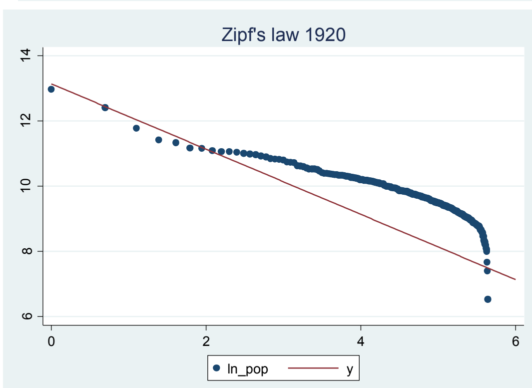
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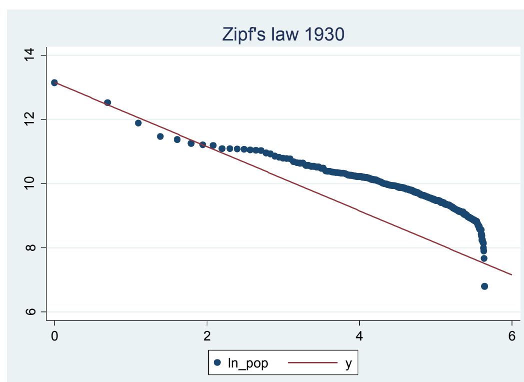
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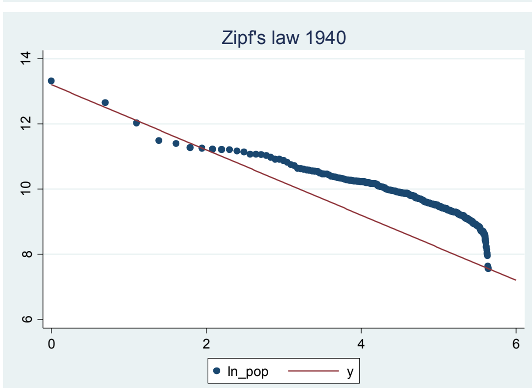
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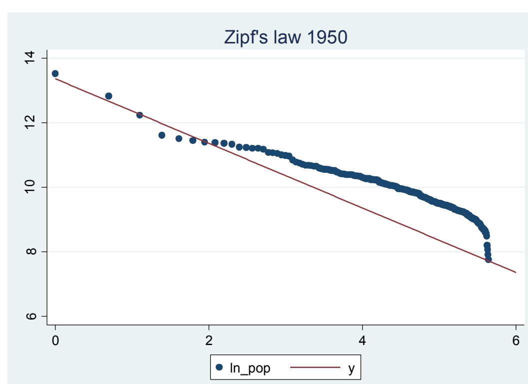
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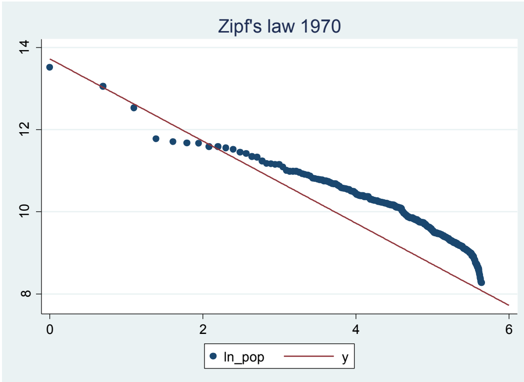
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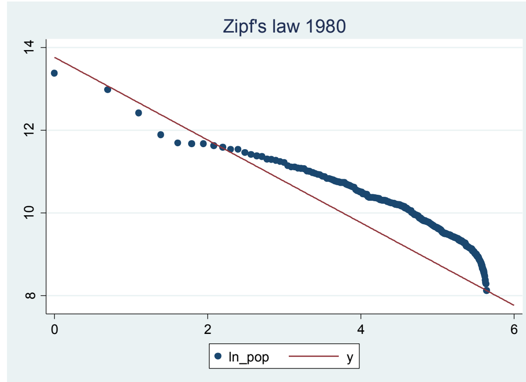
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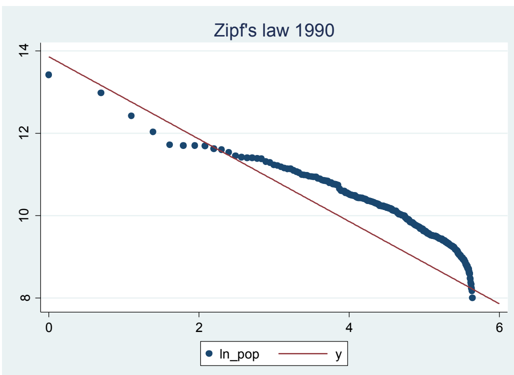
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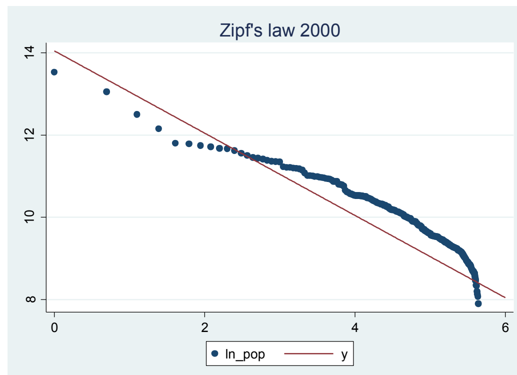
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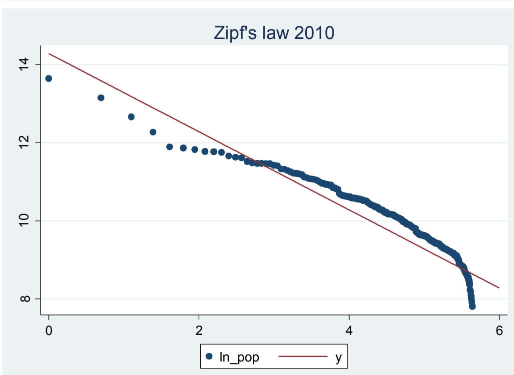
Zipf's law 2010
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ln_pop
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Graph 7: Zipf's law Swedish municipalities

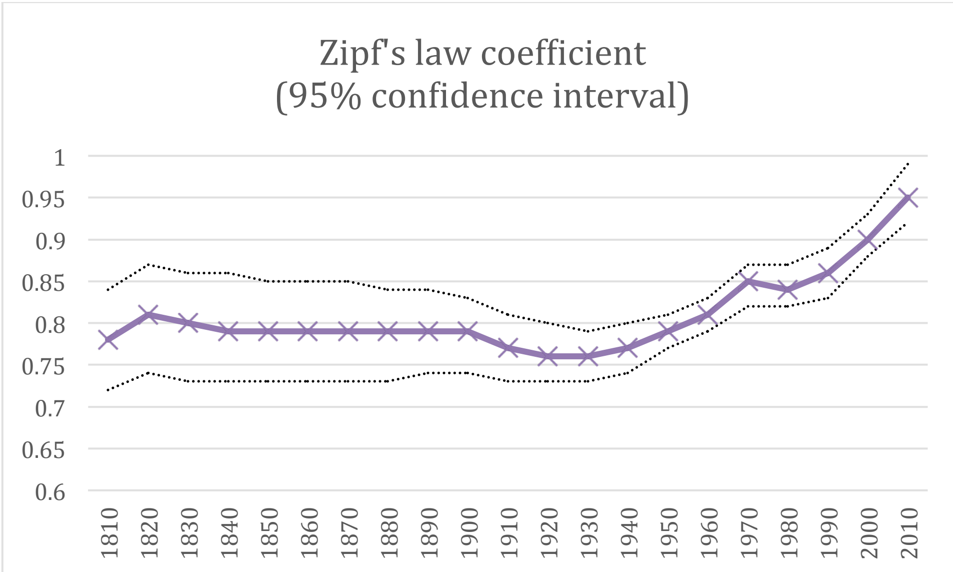


Table 6: Gibrat's law Swedish municipalities

Regression: $\text{population growth} = \beta_1 + \beta_2(\text{municipality rank}) + \varepsilon$

Decade	$\boldsymbol{\beta_1}$	$\boldsymbol{\beta_2}$	P-value of $\boldsymbol{\beta_2}$	Observations
1810 - 1820	0.08	-0.00001	0.86	275
1820 - 1830	0.1	0.00013**	0.01	279
1830 - 1840	0.08	0.00007	0.17	280
1840 - 1850	0.1	0.0001*	0.06	280
1850 - 1860	0.1	0.00001	0.18	280
1860 - 1870	0.07	0.00004	0.25	281
1870 - 1880	0.06	0.00020***	0	281
1880 - 1890	0.01	0.00015*	0.08	281
1890 - 1900	0.04	0.0021**	0.05	281
1900 - 1910	0.02	0.00035***	0	281
1910 - 1920	0.04	0.00018**	0.02	282
1920 – 1930	0.01	0.0001	0.25	282
1930 - 1940	0.02	-0.00001	0.87	282
1940 - 1950	0.1	-0.00024**	0.01	282
1950 - 1960	0.09	-0.00036***	0	282
1960 - 1970	0.21	-0.00107***	0	282
1970 - 1980	0.09	-0.00025**	0.01	282
1980 - 1990	0.06	-0.00028***	0	282
1990 - 2000	0.07	-0.00059***	0	282
2000 - 2010	0.1	-0.00069***	0	282

Table 7: Gibrat's law Swedish municipalities, alternative specification

Regression: $\text{population growth} = \beta_1 + \beta_2(\log \textit{population}) + \varepsilon$

Decade	β_1	β_2	P-value of β_2	Observations
1810 - 1820	0.09	-0.0004	0.94	275
1820 - 1830	0.23	-0.0123***	0	279
1830 - 1840	0.18	-0.0103**	0.02	280
1840 - 1850	0.17	-0.0062	0.15	280
1850 - 1860	0.16	-0.006	0.15	280
1860 - 1870	0.12	-0.0050	0.2	281
1870 - 1880	0.27	-0.0187***	0	281
1880 - 1890	0.14	-0.0112***	0.15	281
1890 - 1900	0.22	-0.0162**	0.12	281
1900 - 1910	0.38	-0.0326**	0.01	281
1910 - 1920	0.2	-0.0144*	0.06	282
1920 – 1930	0.09	-0.0064	0.45	282
1930 - 1940	-0.04	0.0054	0.5	282
1940 - 1950	-0.21	0.0285***	0	282
1950 - 1960	-0.31	0.0359***	0	282
1960 - 1970	-0.82	0.0898***	0	282
1970 - 1980	-0.11	0.0169*	0.09	282
1980 - 1990	-0.22	0.0247***	0	282
1990 - 2000	-0.54	0.053***	0	282
2000 - 2010	-0.56	0.0575***	0	282

Table 8: Municipality population growth: Descriptive statistics

Decade	Mean	Std. Dev.	Min	Max	Observations
1810 - 1820	0.083	0.079	-0.299	0.71	275
1820 - 1830	0.122	0.066	-0.095	0.497	279
1830 - 1840	0.088	0.704	-0.089	0.744	280
1840 - 1850	0.11	0.065	-0.147	0.333	280
1850 - 1860	0.104	0.062	-0.086	0.389	280
1860 - 1870	0.076	0.059	-0.066	0.323	281
1870 - 1880	0.093	0.092	-0.093	0.651	281
1880 - 1890	0.031	0.113	-0.180	0.41	281
1890 - 1900	0.065	0.147	-0.54	1.06	281
1900 - 1910	0.074	0.158	-0.143	1.221	281
1910 - 1920	0.065	0.102	-0.161	0.746	282
1920 – 1930	0.027	0.111	-0.19	0.892	282
1930 - 1940	0.015	0.104	-0.171	0.764	282
1940 - 1950	0.065	0.131	-0.121	0.801	282
1950 - 1960	0.037	0.138	-0.168	0.971	282
1960 - 1970	0.059	0.263	-0.366	0.891	282
1970 - 1980	0.019	0.7	-0.137	0.335	282
1980 - 1990	0.019	0.07	-0.137	0.335	282
1990 - 2000	-0.016	0.079	-0.182	0.348	282
2000 - 2010	0.004	0.079	-0.176	0.215	282
1810 - 2010	0.059	0.122	-0.54	1.652	5619
1810 – 1920	0.083	0.101	-0.54	1.221	3081
1920 - 2010	0.029	0.138	-0.367	1.652	2538

Table 9: Municipality population growth: Descriptive statistics by quartile

Decade	Quartile	Mean	Std. Devi.	Min	Max	Observations
1810 - 1820	1	0.087	0.053	-0.014	0.218	68
	2	0.078	0.049	-0.006	0.246	69
	3	0.085	0.062	-0.101	0.209	69
	4	0.08	0.125	-0.299	0.705	69
1820 - 1830	1	0.11	0.052	-0.02	0.288	69
	2	0.118	0.042	-0.017	0.226	70
	3	0.126	0.046	0.049	0.284	70
	4	0.133	0.103	-0.095	0.497	70
1830 - 1840	1	0.09	0.032	0.02	0.164	70
	2	0.081	0.043	-0.089	0.148	70
	3	0.081	0.046	-0.059	0.233	70
	4	0.1	0.122	-0.08	0.744	70
1840 - 1850	1	0.107	0.044	-0.005	0.251	70
	2	0.101	0.043	0.006	0.187	70
	3	0.106	0.053	-0.005	0.32	70
	4	0.124	0.101	-0.147	0.333	70
1850 - 1860	1	0.101	0.049	0.013	0.247	70
	2	0.1	0.043	0.003	0.231	70
	3	0.094	0.051	0.004	0.218	70
	4	0.119	0.092	-0.086	0.389	70
1860 - 1870	1	0.079	0.049	-0.015	0.23	70
	2	0.68	0.046	-0.056	0.175	70
	3	0.061	0.058	-0.05	0.219	70
	4	0.095	0.075	-0.066	0.323	71
1870 - 1880	1	0.091	0.08	-0.028	0.341	70
	2	0.071	0.069	-0.093	0.244	70
	3	0.07	0.068	-0.072	0.225	70
	4	0.14	0.124	-0.077	0.651	71
1880 - 1890	1	0.04	0.112	-0.131	0.374	70
	2	-0.003	0.083	-0.138	0.237	70
	3	0.007	0.111	-0.125	0.35	70
	4	0.081	0.126	-0.18	0.408	71
1890 - 1900	1	0.064	0.087	-0.063	0.295	70
	2	0.03	0.088	-0.113	0.307	70
	3	0.059	0.203	-0.54	1.06	70
	4	0.107	0.166	-0.123	0.853	71
1900 - 1910	1	0.067	0.061	-0.052	0.273	70
	2	0.042	0.108	-0.123	0.697	70
	3	0.044	0.175	-0.136	1.082	70
	4	0.141	0.219	-0.143	1.221	71
1910 - 1920	1	0.063	0.06	-0.051	0.209	70
	2	0.044	0.084	-0.081	0.353	70
	3	0.048	0.111	-0.161	0.746	71
	4	0.103	0.13	-0.13	0.55	71
1920 - 1930	1	0.024	0.055	-0.082	0.191	70
	2	0.011	0.07	-0.11	0.298	70
	3	0.032	0.162	-0.098	0.892	71
	4	0.038	0.122	-0.19	0.512	71

1930 - 1940	1	0.037	0.089	-0.096	0.534	70
	2	-0.01	0.077	-0.145	0.37	70
	3	0.01	0.101	-0.171	0.38	71
	4	0.025	0.135	-0.161	0.764	71
1940 - 1950	1	0.109	0.095	-0.079	0.44	70
	2	0.061	0.15	-0.121	0.801	70
	3	0.035	0.109	-0.115	0.492	71
	4	0.065	0.152	-0.099	0.722	71
1950 - 1960	1	0.083	0.101	-0.13	0.348	70
	2	0.053	0.173	-0.15	0.971	70
	3	0	0.127	-0.168	0.62	71
	4	0.01	0.129	-0.164	0.64	71
1960 - 1970	1	0.151	0.206	-0.146	1.07	70
	2	0.105	0.283	-0.249	1.509	70
	3	0.068	0.309	-0.276	1.652	71
	4	-0.087	0.168	-0.366	0.78	71
1970 - 1980	1	0.062	0.145	-0.134	0.891	70
	2	0.075	0.151	-0.111	0.562	70
	3	0.07	0.14	-0.176	0.771	71
	4	0.002	0.113	-0.204	0.5	71
1980 - 1990	1	0.048	0.055	-0.084	0.219	70
	2	0.023	0.077	-0.128	0.231	70
	3	0.013	0.064	-0.095	0.174	71
	4	-0.01	0.071	-0.137	0.334	71
1990 - 2000	1	0.052	0.056	-0.106	0.18	70
	2	-0.005	0.08	-0.138	0.35	70
	3	-0.041	0.06	-0.182	0.098	71
	4	-0.071	0.062	-0.152	0.315	71
2000 - 2010	1	0.076	0.053	-0.033	0.215	70
	2	0.02	0.068	-0.123	0.178	70
	3	-0.008	0.061	-0.134	0.166	71
	4	-0.072	0.049	-0.176	0.046	71

Table 10: Municipality population growth: Descriptive statistics by century

Decade	Rank	Mean	Std. Dev.	Min	Max	Observations
1810 – 2010	[0;70]	0.077	0.091	-0.146	1.07	1400
	[71;140]	0.053	0.114	-0.249	1.509	1400
	[141;211]	0.048	0.13	-0.54	1.652	1420
	[211;282]	0.056	0.144	-0.367	1.221	1399
1810 – 1920	[0;70]	0.082	0.068	-0.131	0.374	770
	[71;140]	0.067	0.075	-0.138	0.697	770
	[141;211]	0.071	0.107	-0.54	1.082	781
	[211;282]	0.112	0.133	-0.299	1.221	760
1920 – 2010	[0;70]	0.071	0.112	-0.146	1.07	630
	[71;140]	0.037	0.146	-0.249	1.509	630
	[141;211]	0.02	0.149	-0.276	1.652	639
	[211;282]	-0.011	0.128	-0.367	0.783	639

Table 11: Transition matrices Swedish municipalities

1860 / 1810	1	2	3	4	Sum
1	62	8	0	0	70
2	6	52	11	0	69
3	0	8	52	10	70
4	0	0	6	59	65
Sum	69	69	69	69	274

1910 / 1860	1	2	3	4	Sum
1	54	14	2	0	70
2	16	39	12	3	70
3	0	17	44	9	70
4	0	0	12	59	71
Sum	70	70	70	71	281

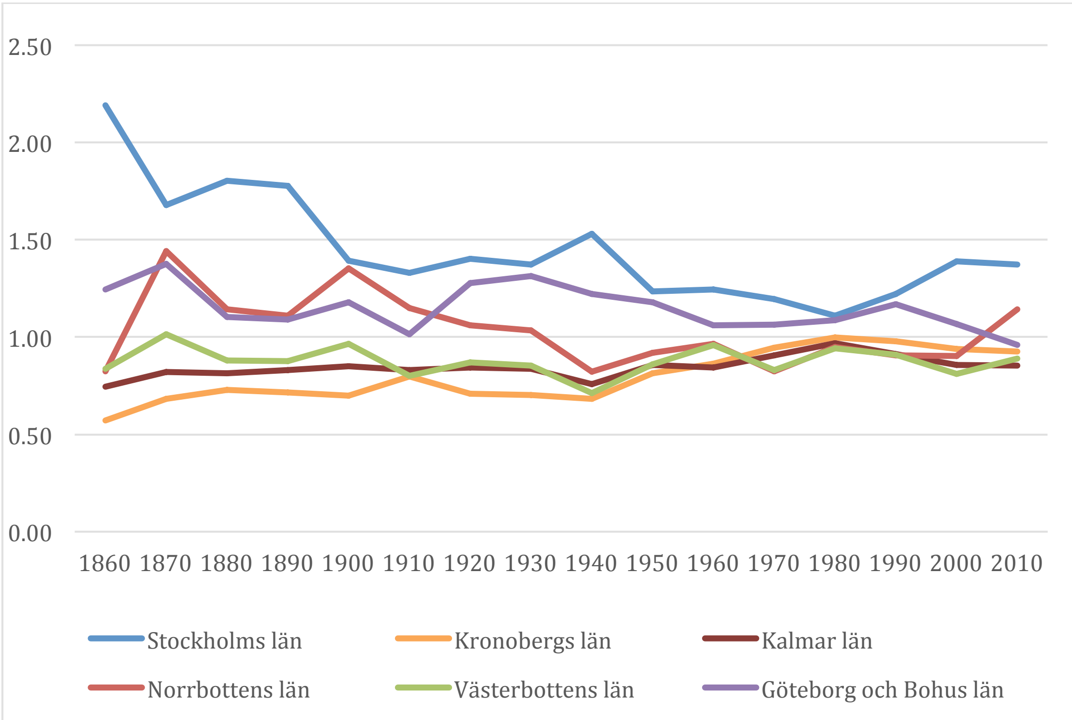
1960 / 1910	1	2	3	4	Sum
1	57	7	4	2	70
2	13	41	5	11	70
3	0	20	37	14	71
4	0	2	24	45	71
Sum	70	70	70	72	282

2010 / 1960	1	2	3	4	Sum
1	53	10	3	4	70
2	17	41	3	9	70
3	0	18	38	15	71
4	0	1	27	44	72
Sum	70	70	71	72	283

Table 12: Municipality transition:

	Transition	Municipality	County
Period 2 (1860-1910)	+2	Solna	Stockholm
	+2	Borlänge	Dalarna (Middle- East)
	+2	Bräcke	Jämtland (Northeast)
	+2	Stromsund	Jämtland (Northeast)
	+2	Gällivare	Norbotten (North)
Period 3 (1910-1960)	+3	Huddinge	Stockholm
	+3	Lidingö	Stockholm
	-2	Söderköping	Östegötland (Southwest)
	-2	Orust	Västra Götaland (Southwest)
Period 4 (1960-2010)	+3	Österaker	Stockholm
	+3	Värmdö	Stockholm
	+3	Tyresö	Stockholm
	+3	Upplands-Väsby	Stockholm
	-2	Hofors	Gävleborg County (Northwest)

Graph 8: Regional GDP per capita compared to national average



Graph 9: Real house prices

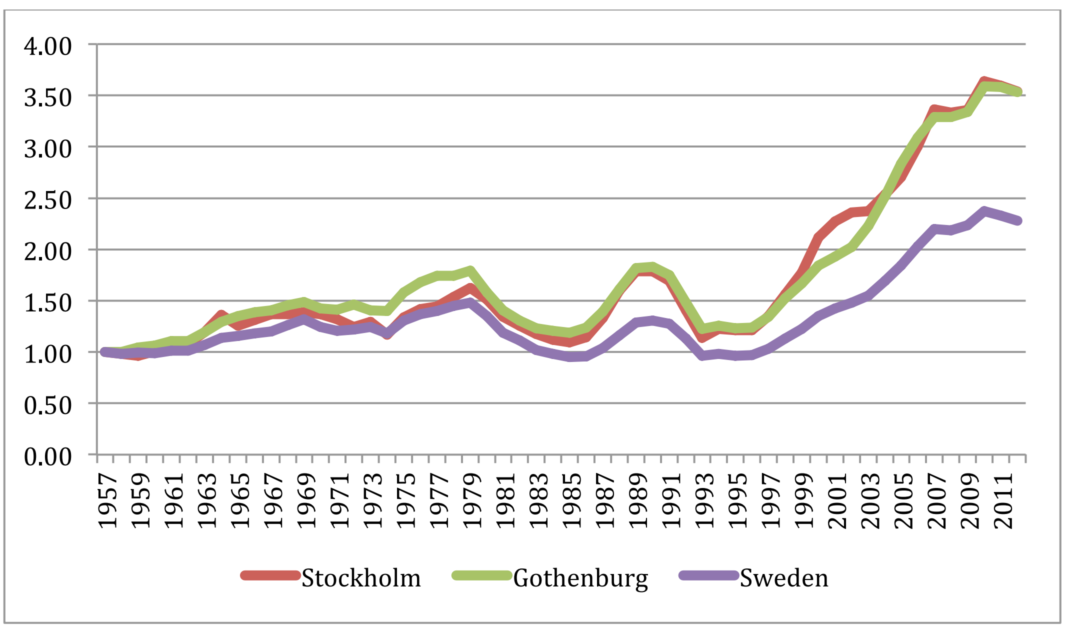


Table 13: GDP per county per person compared to national average

GDP per county per person, SEK, Current

	1860	1870	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
Stockholms län	2,19	1,68	1,80	1,78	1,39	1,33	1,40	1,37	1,53	1,23	1,24	1,19	1,11	1,22	1,39	1,37
Uppsala län	1,37	1,00	1,00	0,85	0,87	0,91	0,97	0,92	0,92	0,89	0,88	0,90	0,85	0,82	0,88	0,86
Södermanlands län	1,19	0,93	0,98	0,98	0,92	0,97	0,91	0,88	0,95	0,95	0,97	0,97	0,96	0,89	0,79	0,80
Östergötlands län	1,22	1,01	0,99	1,07	0,95	1,03	0,94	0,93	0,94	0,93	0,96	0,96	0,99	0,95	0,85	0,84
Jönköpings län	0,75	0,74	0,91	0,78	0,78	0,92	0,81	0,83	0,85	0,99	0,91	0,96	1,03	1,01	0,99	0,87
Kronobergs län	0,57	0,68	0,73	0,71	0,70	0,80	0,71	0,70	0,68	0,81	0,86	0,95	1,00	0,98	0,94	0,93
Kalmar län	0,74	0,82	0,81	0,83	0,85	0,83	0,84	0,84	0,76	0,86	0,84	0,90	0,97	0,91	0,86	0,85
Gotlands län	0,94	1,06	0,90	0,96	0,84	0,97	0,81	0,78	0,74	0,79	0,83	0,83	0,91	0,80	0,77	0,77
Blekinge län	0,83	0,86	0,86	0,83	0,85	1,01	0,92	0,91	0,89	0,83	0,93	0,95	0,99	0,91	0,92	0,82
Kristianstads län	0,98	0,79	0,79	0,83	0,84	0,97	0,86	0,83	0,80	0,85	0,86	0,94	0,90	0,86	0,89	0,85
Malmöhus län	0,89	1,10	1,19	1,20	1,16	1,27	1,16	1,15	1,11	1,07	1,00	1,04	1,02	1,00	0,92	0,88
Hallands län	0,85	0,96	0,78	0,63	0,81	0,87	0,86	0,84	0,79	0,92	0,85	0,96	0,89	0,87	0,78	0,88
Göteborg och Bohus län	1,25	1,37	1,10	1,09	1,18	1,01	1,28	1,31	1,22	1,18	1,06	1,06	1,09	1,17	1,07	0,96
Älvsborgs län	0,76	0,71	0,68	0,65	0,74	0,79	0,85	0,90	0,93	1,04	0,95	1,01	0,92	0,89	0,88	0,96
Skaraborgs län	0,74	0,77	0,82	0,75	0,76	0,84	0,74	0,72	0,76	0,88	0,85	0,90	0,95	0,90	0,89	0,96
Värmlands län	0,86	0,79	0,76	0,78	0,80	0,81	0,86	0,86	0,83	0,90	0,94	0,91	0,96	0,91	0,84	0,81
Örebro län	0,77	0,93	0,83	0,81	0,89	0,90	0,98	0,99	1,05	1,00	1,00	0,98	0,91	0,93	0,85	0,88
Västmanlands län	1,08	1,00	1,06	0,95	1,00	0,92	0,92	0,90	0,98	0,97	0,99	1,01	1,06	0,98	0,88	0,87
Kopparbergs län	0,73	0,95	0,91	0,97	0,92	1,03	0,90	0,90	0,89	0,95	0,94	0,91	0,97	0,90	0,88	0,88
Gävleborgs län	1,19	1,37	1,42	1,26	1,28	1,05	1,01	1,00	0,89	0,94	0,93	0,93	0,99	0,93	0,87	0,87
Västernorrlands län	1,14	1,17	1,15	1,18	1,17	0,95	0,99	0,98	0,84	0,89	1,00	0,88	0,96	0,94	0,95	0,96
Jämtlands län	1,14	1,15	1,17	1,10	1,20	0,88	0,88	0,82	0,83	0,83	0,95	0,79	0,85	0,83	0,82	0,98
Västerbottens län	0,84	1,02	0,88	0,88	0,96	0,80	0,87	0,85	0,71	0,86	0,96	0,83	0,94	0,91	0,81	0,89
Norrbottens län	0,82	1,44	1,14	1,11	1,35	1,15	1,06	1,04	0,82	0,92	0,97	0,82	0,95	0,90	0,90	1,14
Average	0,99	1,01	0,99	0,96	0,97	0,96	0,94	0,93	0,91	0,94	0,94	0,94	0,97	0,93	0,90	0,91
Standard deviation	0,33	0,25	0,25	0,25	0,20	0,14	0,16	0,16	0,18	0,11	0,09	0,09	0,07	0,10	0,12	0,12

Table 14a: Time-fixed effects model for municipality population growth

R^2 within:	0.425	Number of observations:	5559
R^2 between:	0.695	Number of groups:	279
R^2 overall:	0.468		

Time	ln (rank)	ln (Mark. Potential)	ln (dist. agglo.)	ln (pop. concentr.)	ln (latitude)	ln (longitude)	ln (land)
1820 - 1830	0.0095	0.073	0.0025	-0.0166	0.3865	-0.0222	0.0084
1830 - 1840	-0.0267	0.0519	0.0027	-0.0405	-0.2773	0.109	-0.0251
1840 - 1850	0.0089	-0.0064	0.004	-0.0079	-0.0677	0.0261	0.0051
1850 - 1860	0.0041	0.0712	0.005	-0.0152	0.6812	0.0861	0.0133
1860 - 1870	0.0042	0.1297**	-0.0088	0.0019	1.0916**	0.2963	0.0225
1870 - 1880	-0.001	0.1427***	-0.0143	-0.011	1.612***	0.3978	0.0107
1880 - 1890	-0.0507*	0.0841*	-0.0129	-0.0385*	2.2647***	0.1621	-0.0212
1890 - 1900	0.0015	0.1291**	-0.05***	0.0305	3.2814***	0.3286***	0.0374
1900 - 1910	-0.0129	0.1859***	-0.0662***	-0.0152	2.7793***	0.5578***	-0.0013
1910 - 1920	0.0147	0.1676***	-0.0496***	0.1399	2.0718***	0.4678***	0.0359
1920 - 1930	-0.0105	0.0812	-0.0659***	-0.0207	1.4471***	0.4421***	-0.0095
1930 - 1940	-0.0346	0.0974**	-0.0399**	-0.0353	1.2598***	0.5061***	-0.0410
1940 - 1950	0.0163	0.2042***	-0.0326**	0.0678*	1.912***	0.5508***	0.0412
1950 - 1960	0.0736**	0.1881***	-0.0497***	0.1317***	1.7997***	0.5641***	0.1076***
1960 - 1970	0.1129***	-0.0064	-0.2085***	0.0194***	0.4707	1.1189***	0.118***
1970 - 1980	0.0853**	0.029	-0.1268***	0.0807**	0.3772	0.3821***	0.088**
1980 - 1990	0.0331	0.1162**	-0.0661***	0.0242	0.6792	0.2240*	0.0537
1990 - 2000	0.0343	0.1115**	-0.0718***	0.02	0.5711	0.32433***	0.0508
2000 - 2010	0.0124	0.1039**	-0.058***	0.061	0.3985	0.3405***	0.0814**

Table 14b: Time-fixed effects model for municipality population growth

R^2 within:	0.41	Number of observations:	5619
R^2 between:	0.626	Number of groups:	282
R^2 overall:	0.445		

Time	ln (rank)	ln (Mark. Potential)	dist. agglo.*100	ln (pop. concentr.)	ln (latitude)	ln (longitude)	ln (land)
1820 - 1830	0.0127	0.0806	0.0033	-0.0148	0.3550	-0.0172	0.0106
1830 - 1840	-0.016	-0.0573	0.0011	-0.0379	-0.3371	0.1304	-0.0185
1840 - 1850	0.0095	0.0176	0.0074	-0.0052	-0.0426	0.0218	0.0076
1850 - 1860	-0.0097	0.0513	-0.0027	-0.014	0.6896	0.0843	0.0097
1860 - 1870	-0.0005	0.0742	-0.00146	-0.0011	1.0403**	0.3079**	0.0146
1870 - 1880	-0.0181	0.0972	-0.011	-0.0196	1.5853***	0.3799***	-0.0087
1880 - 1890	-0.063**	-0.0283	-0.0288*	-0.0483**	2.2551***	0.2133*	-0.041*
1890 - 1900	-0.323	0.3731***	0.0451***	0.0049	3.1844***	0.1181	0.0093
1900 - 1910	-0.0714***	0.6491***	0.0949***	-0.0621**	2.463***	0.124	-0.0417
1910 - 1920	-0.0269	0.4119***	0.0465***	-0.0251	1.8075***	0.2035	0.0004
1920 - 1930	-0.0551*	0.3784***	0.0536***	-0.0659**	1.0952***	0.1232	-0.0476
1930 - 1940	-0.0675**	0.321***	0.0486***	-0.0725**	0.7486*	0.2288*	-0.0688**
1940 - 1950	-0.013	0.4596***	0.0664***	0.0254	1.0231**	0.1904	0.0165
1950 - 1960	0.0764**	0.2964***	0.0122	0.1312***	1.5906***	0.4151***	0.1117***
1960 - 1970	0.1542***	0.2653***	-0.0208	0.2539***	1.2677***	0.7951***	0.1807***
1970 - 1980	0.0984**	0.1794***	-0.0167	0.1038***	0.8861**	0.2175	0.1109***
1980 - 1990	0.0357	0.1923***	-0.0064	0.0319	0.838*	0.1298	0.06
1990 - 2000	0.0146	0.2197***	-0.0035	0.0298	0.6249	0.1818	0.0603*
2000 - 2010	0.0363	0.1603**	-0.007	0.0681	0.5363	0.2543*	0.0867***

Table 14c: Time-fixed effects model for municipality population growth

R^2 within:	0.427	Number of observations:	5619
R^2 between:	0.678	Number of groups:	282
R^2 overall:	0.468		

Time	ln (rank)	ln (Mark. Potential)	dist.agglo. <50	dist.agglo. >50 & <100	ln (pop. concentr.)	ln (latitude)	ln (longitude)	ln (land)
1820 - 1830	0.0128	0.069	0.0021	-0.0083	-0.0148	0.358	-0.0234	0.012
1830 - 1840	-0.0178	0.0528	-0.0011	-0.0141	-0.0387	-0.3374	0.1116	-0.0181
1840 - 1850	0.0108	-0.0139	-0.0047	0.0044	-0.0067	-0.0878	0.0279	0.0058
1850 - 1860	-0.0111	0.0596	0.0027	-0.0073	-0.015	0.6888	0.0632	0.0098
1860 - 1870	-0.0007	0.1311***	0.0178	0.0001	0.0007	1.0771**	0.2785**	0.019
1870 - 1880	-0.0196	0.1419***	0.0139	-0.0175	-0.0189	1.6263***	0.3374***	-0.004
1880 - 1890	-0.0655**	0.0863*	0.0219	-0.0125	-0.0443*	2.2845***	0.1297	-0.032
1890 - 1900	-0.1186	0.1954***	0.0487*	0.0014	0.014	3.2997***	0.2629**	0.0229
1900 - 1910	-0.0215	0.2685***	0.0943***	0.0257	-0.0271	2.7689***	0.4977***	-0.0097
1910 - 1920	-0.0069	0.2277***	0.0737***	0.0181	0.0054	2.075***	0.4188***	0.0292
1920 - 1930	-0.0107	0.1639***	0.0972***	0.0197	-0.0214	1.4236***	0.3908***	-0.0067
1930 - 1940	-0.0307	0.1465***	0.0675***	0.0073	-0.0339	1.2106***	0.4698***	-0.0342
1940 - 1950	-0.0314	0.2472***	0.059***	-0.0018	0.0779**	1.8322***	0.517***	0.061*
1950 - 1960	0.0997***	0.2372***	0.095***	0.0328	0.1583***	1.6544***	0.5476***	0.139***
1960 - 1970	0.1488***	0.2062***	0.3538***	0.0941***	0.2196***	-0.0774	0.9637***	0.1654***
1970 - 1980	0.1054***	0.1671***	0.2115***	0.0678***	0.0925**	0.1036	0.318**	0.112***
1980 - 1990	0.0432	0.19***	0.1023***	0.0398	0.032	0.5874	0.197	0.0655*
1990 - 2000	0.0216	018667***	0.1127***	0.0327	0.0278	0.4504	0.295**	0.0631*
2000 - 2010	0.0448	0.1631***	0.0916***	0.0391	0.0708**	0.3098	0.3191**	0.0932***

Table 14d: Time-fixed effects model for municipality population growth

R^2 within:	0.428	Number of observations:	5619
R^2 between:	0.688	Number of groups:	282
R^2 overall:	0.47		

Time	**ln (rank)**	**ln (Mark. Potential)**	**dist.agglo. <40**	**dist.agglo. >40 & <80**	**ln (pop. concentr.)**	**ln (latitude)**	**ln (longitude)**	**ln (land)**
1820 - 1830	0.0140	0.068	0.0048	-0.0081	-0.014	0.3487	-0.0196	0.0129
1830 - 1840	-0.0153	0.0516	0.007	-0.0148	-0.0368	-0.3514	0.1177	-0.0154
1840 - 1850	0.0109	-0.0132	-0.0012	-0.0034	-0.006	-0.0818	0.0219	0.0077
1850 - 1860	-0.0094	0.0589	0.0096	-0.0077	-0.0134	0.6813	0.0659	0.0122
1860 - 1870	0.0008	0.1305***	0.0256	0.0033	0.0023	1.073**	0.2787**	0.0214
1870 - 1880	-0.0148	0.139***	0.0339	-0.0122	-0.0138	1.6018***	0.3475***	0.0026
1880 - 1890	-0.0628**	0.0835*	0.0312	0.0017	-0.0418*	2.269***	0.1415	-0.03
1890 - 1900	-0.0096	0.1913***	0.0647**	-0.0148	0.0183	3.2628***	0.2514**	0.029
1900 - 1910	-0.021	0.265***	0.1079***	0.0075	-0.0244	2.7311***	0.4705***	-0.0049
1910 - 1920	0.009	0.2223***	0.0908***	0.0114	0.0091	2.026***	0.4035***	0.0345
1920 - 1930	-0.01	0.1591***	0.1114***	0.0159	-0.0195	1.3785***	0.374***	-0.0036
1930 - 1940	-0.0301	0.1408***	0.0847***	-0.0092	-0.0322	1.1479***	0.4535***	-0.0303
1940 - 1950	-0.0327	0.2377***	0.0852***	-0.0129	0.0797**	1.738***	0.5114***	0.0651*
1950 - 1960	0.0962***	0.2341***	0.1098***	0.0111	0.1541***	1.5977***	0.5144***	0.1385***
1960 - 1970	0.1444***	0.2005***	0.3826***	0.093***	0.2126***	-0.1993	0.9012***	0.1628***
1970 - 1980	0.1087***	0.1703***	0.204***	0.0944***	0.0996***	0.1575	0.2838**	0.1172***
1980 - 1990	0.0437	0.1906***	0.1035***	0.0478*	0.0339	0.6017	0.1754	0.0674*
1990 - 2000	0.0238	01837***	0.1226***	0.0493*	0.0309	0.4333	0.2845**	0.0659*
2000 - 2010	0.0453*	0.1622***	0.0974***	0.0475*	0.072**	0.3067	0.301**	0.0949***