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The spatial concentration of Swedish manufacturing industries between 1920 and 1950
- an analysis of innovativeness and clustering

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Abstract: This thesis looks into the spatial concentration of Swedish manufacturing industries between 1920 and 1950, particularly focusing on whether the tendency to do so was more prominent among innovative industries then their less innovative counterparts. The spatial concentration of the most, the average and the least innovative industries in Sweden at the time is presented and the findings are compared to cluster theories that emerged later on. Several economists have over the last decades claimed that innovative industries benefit more from clustering as proximity enhances the ability of economic activities to exchange ideas and be cognizant of important incipient knowledge. The scope of the thesis is to find out whether this pattern was prevailing at a time when scientific knowledge was starting to become an important part of the industry. The findings points to an industrial de-agglomeration phase taking place at the time, and give no evidence to the idea that innovative industries clustered more than other industries. There appear to have been a spread-out phase taking place which largely meant that industries located in many new areas – particularly cities. This development can largely be ascribed to the rapid overall industrial and urban growth taking place in Sweden between 1920 and 1950 – not only did many industries locate in the new and growing cities, cities grew around the locations of new industries as well. De-agglomerating factors such as cheap labor and land in peripheral areas and a limited number of local markets that was able to support the economies of agglomeration appears to have been contributing to this development.

Key words: Manufacturing industry, early 20th century, spatial concentration, innovation, agglomeration economies.

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Table of content

Table of figures

Table of tables

1. Introduction

The issue of industrial location, its effect on the economy and its role in regional development has long attracted the interest of researchers, planners and, in recent decades, politicians as well as media. To establish where industries locate and understand why they locate in certain areas have been of primary interest to researchers. The focus has had a tendency to be on clusters of economic activities in general and on high-tech clusters in particular. These high-tech clusters, also referred to as innovative or knowledge-intensive, traditionally consists of "company headquarters, company R&D divisions, other advanced industries, research universities, university hospitals or R&D institutes" according to contemporary theory.[1] This thesis aims to look into how the localization of Swedish manufacturing industries changed between 1920 and 1950, a time when knowledge started to shape the industry to an increasing extent, and whether there were any distinguishable differences between less and more innovative industries. A newly compiled database forms the basis for the thesis and the analysis stems from the location quotients (LQ) of different industries during this period, ultimately making up the empirical core of the thesis.

1.1 Contribution

The primary goal of this paper is to address whether the innovative industries of the early 1900's, largely forming the basis for the second industrial revolution, saw a greater spatial concentration than the less innovative industries did overall in Sweden. There have been many studies conducted on the localization patterns of the Swedish manufacturing industry during the last couple of decades. The localization changes of the Swedish manufacturing industry up until 1950 has on the other hand been covered to a limited extent, especially the focus on agglomeration of innovative industries that is presented here. What we today define as innovative industries naturally differs from how people have defined it in the past - a consequence of the fact that many innovative industries of today have gone through major changes since or did not yet exist. However, there were of course industries that were new and innovative by the standards of the early 1900's. As the second industrial revolution emerged during the late 1800's scientific evidence started to become systematically applied in many industrial activities. While the first industrial revolution had meant that skilled craftsmen were replaced by machines (i.e. capital) and

[1] Karlsson, 2008, p.2

unskilled workers, the second industrial revolution had other characteristics – skilled labour and capital became complementary production resources rather than substitutable.[2] Increased knowledge of the preparation and processing of metals changed the conditions for industrial activities. New sources of power, electricity and oil, was used to an increasing extent and eventually created new industries and in the longer term some new opportunities for production and transportation. The geography of innovation and production were affected by this as the conditions for input factors, markets, transport costs and internal as well as external economies of scale had begun to change. The emergence of new infrastructure, such as telecommunication systems, roads and electricity, not only affected knowledge spillovers – it changed the availability of production factors and opened up for possibilities on new markets.

This period of industrial growth was also characterized by rising living standards and increasing urbanization which put new demands on housing, water, drainage, lighting and transport. Not only did innovations in the form of new products emerge - organizational innovations took place as well: formal training became far more important for would-be inventors; institutions external to the firm became important for such formal training; bodies of scientific knowledge became powerful engines for expansion and diversification; and firm structure changed as large-scale enterprises emerged that began to incorporate specialized research and development departments.[3] Knowledge became increasingly important as the Swedish industry grew more advanced and if the ability to receive knowledge spillovers is influenced by distance, as implied by several studies on agglomeration economies, it would lead to an increased spatial concentration of industries in general and of innovative industries in particular.[4] Both the agglomerating and de-agglomerating forces of the economy (explained further in the theory-section) had changed forever as time and space had shrunk. Relatively little is known about whether innovative industries concentrated more geographically than others during these early years of increasingly advanced products and production methods. This thesis will ultimately shed some light on the localization trends of the Swedish manufacturing industry during this transformative period.

[2] Nilsson, 2005, Yrkesutbildningen I Sverige 1850-1920, p.18
[3] Fagerberg et al, 2005,p.359
[4] Feldman et al, 1996, p.630

1.2 Scope and limitations

From an empirical perspective, the best way to identify a cluster and how it develops is to analyze the complex interdependence of producers, sub-suppliers along a territorially identified value chain through an in-depth case study. Having noted that, it is important to underline that this thesis isn't analyzing the dynamics of clustering industries, but merely their spatial concentration and its potential causes. Also, the historical nature of the data I use means that there is none or a very limited amount of alternative data sources. This does in turn mean that if there are any errors or flaws when it comes to the data it would be hard to uncover – there are simply very few, if any, sources that would give evidence to conflicting results. Data from every tenth year between 1920 and 1950, described further in chapter 4, is included in the analysis in order to be able to establish potential long-term patterns and at the same time discover whether particular industries diverges from the general trend at certain points during the period.

When making spatial analyses it is important to make an appropriate choice of spatial division. As the theoretical framework is that of localization externalities, the regional unit of analysis should be defined such that externalities are likely to occur within the regional unit. The chosen regional unit of analysis to identify clusters is cities as they are defined in the dataset (see chapter 4). Clusters are in other words assumed to be localized in cities. This also means that clustering is not assumed to take place in areas outside the city-borders. The data from *Statistics Sweden* were only available at county and city level which excluded the possibility of using local labor markets as the area of analysis. Local labor markets are perhaps the preferable regional unit to be used in a study like this since the spatial division is based on the level of strong internal links within areas (e.g. commuting patterns). However, it should be noted that these links were much more limited in the first half of the 20^{th} century than in it later would be as the motorization and the related infrastructure was still by 1950 relatively limited compared to today's standards. Similarly it could be argued that both the urban-to-rural and rural-to-rural links were limited as transportation costs is depending on the existing infrastructure, further supporting the use of cities as areas to analyze clustering patterns.

The number of workers per industry is used as a measurement of how the manufacturing industries concentrated spatially and this can be questioned as well. The share of the value added produced in an area could also be a way of measuring location changes, but the variable is excluded as this thesis is mainly focusing on the aspects of local externalities rather than on where each industry is more profitable. The number of factories or firms is other examples of measurements that could be used in order to analyze how the localization pattern of urban industries changed. Some scholars would possibly even argue that these measurements would be preferable due to the simple fact that the mere word *clusters*, refers to a group of similar elements occurring closely together. This variable, however, does not take into account any existing difference in firms' sizes and a calculation based on the number of work sites can thus overestimate small firms at the expense of larger ones. Another noteworthy issue is the classification of industries – it partly include activities of rather different type (e.g. *manufacture of leather, hair and rubber products)*. This may affect the spatial concentration of the industries as cluster dynamics can get lost.

1.3 Outline

First the Introduction has provided the contribution, aim, justification, scope and limitations of the thesis. The paper is then broken down into five main sections: Theory, Methodology, Data, Results and Discussion. The theoretical section provides an introduction to the established cluster theories of economic activities in general and of manufacturing industries in particular. Criticism of these theories is also included in this section. The methodology that is used in order to establish which industries that was more and less innovative as well as their level of spatial concentration is described in the following section. The data originally comes from Statistics Sweden, but some alterations were made in the dataset that forms the basis of the thesis – the changes being made with regard to the raw data is presented and explained here. The findings of a previous study on the localization of Swedish manufacturing industry are also presented here. The answers to how the geography of industries changed depending on their innovation level is presented in the Results part. The results are elaborated further upon in the Discussion section – which industries agglomerated, which industries didn't, what conclusions can be drawn etc. Suggestions for future studies are also discussed here. An overview of the data that forms the basis for the thesis is presented in the appendix.

2. Theoretical framework

Ever since the early 19th century there have been theories trying to explain the localization of economic activities. Land use, cities, rural areas, communications, trade and human interaction are all examples of phenomena that both have been analyzed through established localization theories and spurring the creation of new ones. The German economist von Thünen was a pioneer in this field when he in 1826 established a theoretical framework revolving the production location of agricultural activities and their relation to a city in his theory of *The Isolated state*.[5] He started out from Adam Smith's idea of the *economic man* (in von Thünen's case it meant that a farmer is expected to maximize the profit from his farmland) and concluded that the production of a crop is only worthwhile within certain distances from the market (i.e. the city). Beyond a certain distance from the city the production of a crop becomes unprofitable, either because the cost of land becomes too high, due to increased transport costs, or the profits earned by other crops are higher. This did in other words mean that for each product there is a given distance from the city where its production would be worthwhile.

A number of other economists have further developed von Thünen's work since – in the late 19th century Marshall suggested that firms in different industries may benefit from locating near to one another, through localized inter-industry spillovers. He identified three channels through which these benefits could flow: input-output linkages, labor market pooling, or technology spillovers.[6] According to his theories these local external effects help raise the return to particular firms located in a region as a result of the location of other firms in the same region. Later Weber also suggested that industries benefit from locating close to other industries, but distinguished transport costs, labor, and agglomeration as three determinants of the location of manufacturing production. In Weber's view, the reasons for agglomeration were based on a cost-minimization decision by the firms and only occur if the savings exceed the costs.[7] The spatial location of industries was, in other words, largely decided by agglomeration economies and transport costs. While Weber acknowledged the complexity of industry location he did not go as far as looking in to industry-specific similarities or differences.

In the late 20th century new theories emerged that sprung from these ideas, such as Porter who suggested that clusters are a geographically concentrated group of companies of related

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[5] von Thünen, 1826
[6] Marshall, 1890
[7] Weber, 1909

branches often forming linkages and alliances. Porter emphasizes the role of clusters in regional competition and he shows in which way clusters can positively affect competition by increasing productivity and innovation.[8] Because of the linkage between growth and innovation, R&D intensive industries play a crucial role in cluster development strategies. A few years prior Krugman had, by invoking Marshall, focused on external increasing returns arising from spillovers from; a pooled labor market, economic externalities enabling the provision of non-traded inputs to an industry in a greater variety and at lower cost, and information or technological spillovers.[9]

Later research pointed to how location mitigates the inherent uncertainty of innovative activity. According to Audretsch and Feldman "*proximity enhances the ability of firms to exchange ideas and be cognizant of important incipient knowledge*" - hence reducing uncertainty for firms that work in new fields.[10] A previous study by Jaffe had also found that investment in R&D by private corporations and universities spills over for a third-party to exploit - the distance from a knowledge source can affect the ability to receive these knowledge spillovers.[11] Innovation consequently clusters in areas where knowledge externalities reduce the costs of scientific discovery and commercialization. In addition, Audretsch and Feldman suggest that firms producing innovations tend to be located in areas where there are necessary resources: resources that have accumulated due to a region's past success with innovation.[12] Spatial proximity advances cooperative relationships as well as the building of shared resources and institutions.

The findings in this thesis will first and foremost be of descriptive character and the analysis will depart from the empirical findings and how it compares to Audretsch and Feldman's conclusion. This leads to the following research questions:

How did the spatial concentration of industries in Sweden change with regard to their innovation-level between 1920 and 1950?

Do the findings support that "proximity enhances the ability of firms to exchange ideas and be cognizant of important incipient knowledge"?

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[8] Porter, 1998
[9] Krugman, 1991
[10] Audretsch et al, 2003, p.7
[11] Jaffe, 1989
[12] Audretsch et al, 1996

2.1 Critique on cluster theories

Whether industries concentrate spatially and the importance of agglomeration economies has been questioned by both economists and geographers over the years.[13] This springs from many different factors, but one important issue that has spurred the critique is how the clustering of industries eventually would create and sustain regional differences. Theoretically the cumulative self-reinforcing growth process created in clusters contribute to a fast growth in some regions, but it also hinder other regions from catching up as their resources would be attracted to the clusters. The industrial clustering would in other words sustain regional differences in terms of economic growth and structure. Weber actually pointed to the existence of forces that counteracts this process – the de-agglomerating factors.[14] De-agglomeration occurs when firms relocate or is put out of business because of industries' excessive concentration. After reaching an optimal size the initial advantages of clustering may be offset as rents, services or taxes are likely to be affected and eventually contribute to increasing production costs. Studies made on industrial localization during the 1970's and 1980's indicated that these counter-forces was present in several countries (e.g. USA, Great Britain and Germany) as the industry largely was relocating from large urban areas and industrial core areas to small cities and other peripheral areas.[15]

The dynamics of clusters have also been criticized for mainly being applicable to small, specialized firms, particularly because of the level of trust and cooperation required for a successful cluster. Studies have showed that small establishments have a larger effect on the attractiveness of a location than do larger establishments.[16] In reality, critics claim, large multi-national companies dominate the economy, and these companies will "undermine the trust that is required for a cluster to be effective".[17] Another criticism, perhaps more applicable in today's economy due to the technological changes taking place since 1950, is that improvements in physical infrastructure and especially in ICT is replacing the need for spatial clustering as firms no longer receive the competitive advantage from close geographic proximity.

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[13] Lundmark et al, 1988, p.8
[14] Weber, 1909
[15] Lundmark et al, 1988, p.10
[16] Rosenthal et al, 2001, p.204
[17] Bergman et al, 1999,p.24

3. Methodology

The spatial concentration of the manufacturing industries is based on information coming from a dataset, described further in chapter four, and is calculated according to their location quotients (LQ, henceforth). The LQ is a way of quantifying how concentrated an industry is in a region as compared to a larger geographic area and it can reveal what makes a particular region stand out in comparison to the national average. This is an effect of the formula, in which the share of an asset in a given area is divided by the equivalent number on a larger reference area. Here an industry's share of workers employed in cities (relative to the total number of workers employed in all manufacturing industries in this area) is measured against its national share of the entire manufacturing industry. The formula is presented below. Suppose X is the amount of some asset in a local economy (e.g. chemical industries), and Y is the total amount of assets of comparable types in the same area (e.g. all industries). X divided by Y is then the local "concentration" of that asset in the local economy. If X' and Y' are similar data points for some larger reference region (like a nation), then the LQ or *relative* concentration of that asset in the region compared to the nation is calculated accordingly:

$$LQ = \left(\frac{X}{Y}\right) / \left(\frac{X'}{Y'}\right)$$

If an industry has the same share of employment in the local area as it does in the reference area its LQ is equal to 1. A LQ exceeding 1 indicates that an industry has a greater share of the local area employment than is the case in the reference area, and if exceeding 1.25 it is usually taken as initial evidence of a regional specialization in a given sector.[18] The basic uses of industries' LQ's include: to determine which industries make the local economy unique; to identify established and emerging import- and export-oriented industries in the region; and to identify endangered export industries that could erode the region's economic base. Industries with high LQ are typically (but not always) export-oriented industries, which are important because they bring money into the region, rather than simply circulating money that is already in the region. Industries which have both high LQ and relatively high total job numbers typically form a region's economic base. Industries with high LQ are not only important for the jobs they provide, but also for their multiplier effect - the jobs they create in other dependent industries.

[18] Bergman et al, 1999

The concept of innovation, elaborated further upon in chapter six, has a broad definition and the process of classifying industries according to their level of innovativeness demands an explanation. The manufacturing industry consisted of 79 industries according to the database, slightly modified from the divisions made in the raw data. In order to create a better overview a total of nine industries is divided into three groups consisting of three industries each – the lowest, medium and highest level of innovation. The measurement used to calculate industries' innovativeness is the share that technically and scientifically skilled personnel made up of the industry's total workforce in 1930. The year (i.e. 1930) was chosen because it occurs near the middle of the analyzed period and should consequently represent which industries that was more and less innovative between 1920 and 1950 relatively well. These numbers doesn't come from the database, but is nevertheless of use as the two divisions of industries largely are the same. To use the share of technically and scientifically educated personnel as an indicator of an industry's innovativeness is not necessarily the best measurement as it doesn't provide information on issues directly related to innovation, such as R&D expenditures. However, to use figures on R&D expenditures is ruled out due to the lack of data.

Lastly it must be noted that "LQ, as with any other relative measure of specialization, are not substitutes for absolute indexes, for the two give complementary information".[19] The relative index (i.e. LQ) is what the main focus of the thesis will be, but absolute figures will also be included as the two give complementary information. Clusters are in many ways best identified with relation to other comparable types of activities, as it is no absolute concept, but these spatial phenomenons can be identified in other ways given that the presence of other industries affects the LQ. Not only do the spatial division (i.e. the city borders) and the industrial aggregates affect the results, it is also important to remember that the LQ's of the different industries is measured in relation to the industry in the country as a whole.

[19] Karlsson, 2008, p.56

4. Data

The data that forms the basis for this thesis is taken from a dataset that was constructed as a part of a research project where I assisted.[20] Information about the raw data that formed the basis for the dataset and the modifications being made in the dataset is presented below.

4.1 The raw data

The raw data that was used to create the dataset originally comes from Statistics Sweden – the government agency responsible for producing official statistics regarding Sweden. Statistics Sweden has produced statistics within a wide range of fields from the 19th century until today; the statistics is divided into many different set of volumes and spans over a wide range of areas that covers everything from domestic trade to healthcare. The data used in this thesis is originally from the volume *Industry* [Industri] and contains information on the number of factories, workers and gross value of output for each industry at county- and city-level. Workers are the average number of workers during a given year. The factories are classified according to their main lines of production. The manufacturing industry is divided into twelve different sectors during the analyzed years. Each sector is in turn divided into industries on a more detailed level – together they make up more than 100 industries. During the period analyzed in this paper the industries within each sector changes, partly an effect of activities being included in the data gradually as new industries have emerged and partly a result of industry classifications changing over time. The data that covers the number of technically and scientifically educated personnel per industry (used in order to make a distinction between the less and more innovative industries) also come from statistics Sweden - *The 1931 census of production, distribution and services* [*1931 års företagsräkning*].

4.2 The dataset

The industries in the raw data have been divided into aggregated industry groups in the dataset in order to allow for studies to be made over time more easily. The pharmaceutical industry can

[20] The project resulted in the *Swedish Manufacturing Industry Database* (SMID) and was led by Kerstin Enflo, at the Department of Economic History, and Martin Henning, at the Department of Human Geography, both at Lund University.

serve as an example - prior to 1940 it was defined as *other chemical industries* in the raw data but from 1940 and onwards it was classified as an industry of its own. In the dataset the pharmaceutical industry was defined as *other chemical industries* throughout the entire period – which results in making industry-wise comparisons possible over longer time frames. Together the industries make up nine main groups which in turn consist of seventy-nine subgroups (the divisions are presented in the appendix). Only factories with 10 workers or more have been included in the dataset in order to avoid confusion over the changing restrictions regarding the minimum amount of workers a factory need to have to be included in the raw data. The data does not provide answers as to the cause or form of agglomeration changes (e.g. mergers or relocations). Consequently it will be difficult to make any definite conclusions regarding the reasons for the localization changes.

The number of workers per industry is presented per city- and county-level in the dataset, which is due to the data only being available according to these divisions in the raw data. The city-definitions are the same in the dataset and the raw data in most cases. However, there are two cases where divisions have been made according to a more aggregated level in the dataset; urban areas listed as *köping* (i.e. administrative units made up of towns that were too small to achieve city status) were not consistently regarded as cities in the raw data and thus defined as rural areas, and cities situated close to a larger city were included as a part of the city (i.e. in the form of a suburb). In the dataset this is mostly prominent in Stockholm, where several suburbs (e.g. Solna) have been regarded as being a part of Stockholm rather than being cities of their own. The total number of cities in the dataset each year is listed in table 1 and it shows a marked growth between 1920 and 1950 – despite the inclusion of suburbs as parts of nearby cities.

Table 1. The total number of cities in Sweden every tenth year between 1920 and 1950.

Year	**1920**	**1930**	**1940**	**1950**
Number of cities	102	102	133	152

5. Historical background

The Swedish population was relatively well spread out across much of the country during the 19th century. The land reforms and reclamation of land that took place in Sweden during this century led to more evenly distributed settlements in Sweden than in many other comparable countries. The 1870's are looked upon as the starting decade of the Swedish industrialization because of the industrial breakthrough of the sawmill industry and an increased foreign demand for wood and iron.[21] Initially this process was slow but Sweden started to become industrialized on a larger scale by the final decades of the century and the development led to an increasing concentration of settlements and population. By 1920 Sweden's population was close to 6 million out of which almost 30% lived in cities (see figure 1). Most cities were still very small at the time; Stockholm was by far the largest city with more than 420 000 inhabitants. Beside Stockholm there were still only three cities with more than 50 000 inhabitants.[22] The urbanization had started and Swedish cities experienced a massive population growth in the following decades.

The urban population had almost doubled by 1950 (increasing from roughly 1,7 to 3,3 million people) compared to a less than 20 percent increase for the total population. The urban population exceeded the rural for the first time a few years later.[23] The growth rate and distribution of industrial workers during the same period was similar to the overall population

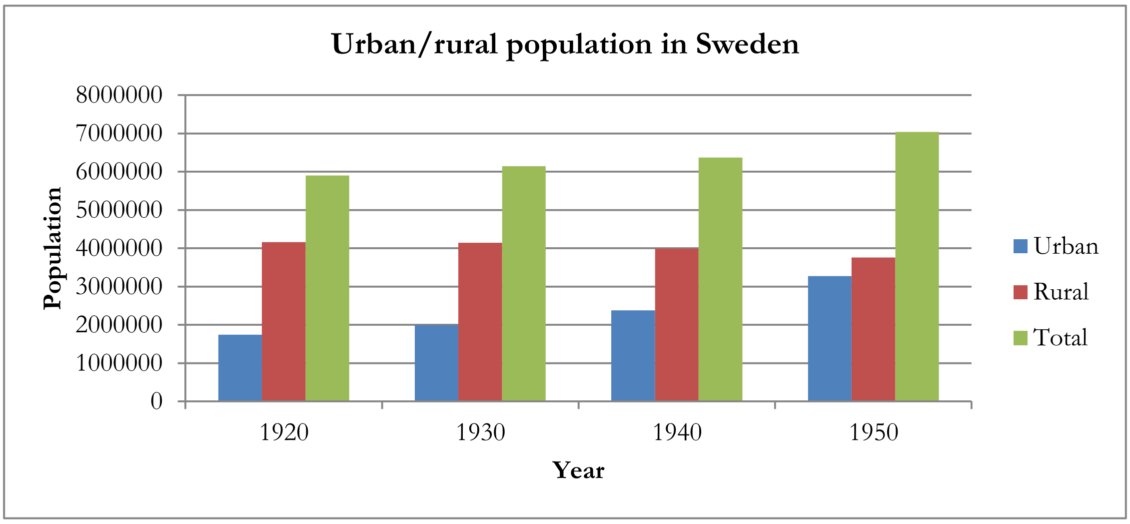

Figure 1. The total number of people living in urban and rural areas in Sweden every tenth year from 1920 to 1950.[24]

[21] Karlström, 1985, p.25.
[22] Ylander, 1993, p.86.
[23] Ylander, 1993, p.83.
[24] Statistiska Centralbyrån, 1969, p.47.

changes, albeit with smaller differences between urban and rural areas; while the workers more than doubled in urban areas, increasing from roughly 200 000 to over 400 000 people, the overall increase was less than 40 percent during the same period (see figure 2). However, it is worth stressing that the occupation of people living in cities remained more or less unchanged in relative terms throughout the entire period. Around half of the urban population worked in occupations related to industry and crafts, around a third worked in occupations related to trade and traveling, around fifteen percent worked in public services and a few percent worked in agriculture.[25] The level of urban concentration varied greatly between industries. While some industries were almost exclusively situated in cities, others were largely based in rural areas. This were perhaps most prominent in industries such as mining, where the localization heavily depends on the access to natural resources. One specific feature of Swedish industrialization is important to notice here. Industry, to a great extent, was located in rural areas early on and city-based industrial workers did not form a majority until the 1920's. In particular the wood and mining industries, sectors that largely initiated the Swedish industrial era, were mainly rural based. The increasing numbers of urban industrial workers points to a typical feature of the Swedish urbanization process – the creation of new and larger cities, albeit relatively small in an international perspective, through population agglomerations around rural industries. After some

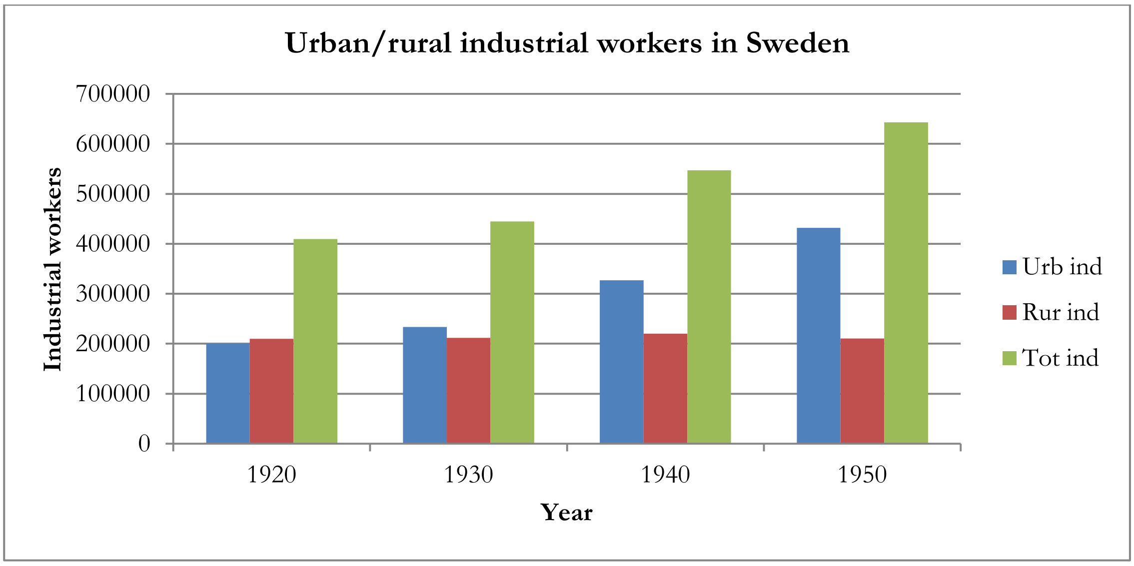

Figure 2. The total number of industrial workers employed in urban and rural areas in Sweden every tenth year from 1920 to 1950.[26]

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[25] Ylander, 1993, p.77.

[26] The figure is based on the numbers in the dataset and, due to the exclusion of work sites that had less than ten workers; does not reflect the exact numbers.

time these settlements either received town charters or were incorporated into neighboring cities.[27] According to the dataset there were 102 areas regarded as cities in 1920, and by 1950 the number of cities had increased considerably to 152, as shown in table 1. This was not exclusively an effect of cities growing up around rural industries, but it played an important part in the formation and development of new cities in Sweden at the time. The increasing urbanization of industries in Sweden was also an effect of industries actually locating in cities; a development mainly spurred by the metal- and engineering industries.[28]

The first half of the 20th century in Sweden can largely be associated with this rapid urbanization and industrialization. Although the Swedish economy went through several turbulent phases between 1920 and 1950, largely a consequence of external shocks such as two major economic depressions and World War II. The development of the Swedish manufacturing industry has largely been affected by changes taking place in the outside world, an effect of the fact that Sweden's share of the global economy always has been very small and yet relatively export-oriented. For a small country like Sweden, international market integration was (and still is) important for economic growth, due to the home market being limited. While there were economic ups- and downs globally that affected the employment and output of the manufacturing industry in the short term, the general trend in Sweden during this period was very positive - both for the industry and the overall economic development. The period between 1945 and 1975 often is referred to as the golden age of economic growth in Sweden, but the Swedish economy actually grew faster relative to other industrializing countries between 1920 and 1950.[29]

Sweden went from being a capital importer to a become a capital exporter during the course of World War I.[30] This was largely an effect of; Sweden never entering the war while at the same time going through a revolutionizing industrial development (at the outbreak of the World War I, about one third of Sweden's exports consisted of goods that 25 years earlier had not existed in Swedish export statistics).[31] The ending of World War I in 1918 meant that international trade was going back to normal. The replacement industries that had been established during the war, due to the international trade being limited, became affected by the competition that was coming from economies recovering after the war. Sweden was struck by a crisis in 1921 and it was accompanied by a dramatic deflation, which lead to a rapid decrease in the number of industrial

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[27] Karlström, 1985, p.33.
[28] Lundmark, 1988, p.61.
[29] Krantz i Ekonomisk debatt, 2000, p.11
[30] Edvinsson, 2005, p.208
[31] Karlström, 1985, p.25.

workers and a deep downturn in the overall economy. The crisis of the early 1920's was caused by excessive mal-investment and speculation during the First World War, which was further aggravated by tight monetary policies.[32]

The Swedish industry recovered fast from the downturn of the early 1920's and a growth phase continued up until 1930 as the industry still was not affected by the global financial crisis of the previous year. The Swedish economy felt the effects of the financial crisis during the following two years, resulting in a decreasing number of industrial workers. Scholars argue that the new innovative forces in the Swedish industry had been firmly established and permeated the whole economy by 1930 and thus largely ascribe the depression to external factors.[33] The multilateral trade system broke down in 1931 as a result of the financial crisis and it led to an increased level of self-sufficiency in Sweden with more focus on the home market.[34] By 1940 the effects of World War II was being felt, both export- and import markets disappeared or became more difficult to reach, but it wasn't as pronounced as it would be during the years that followed. The manufacturing industry was affected, but industries related to the military defense and the import substituting industries did initially counteract a lot of the negative effects on productivity and employment. Sweden registered record low unemployment numbers and saw labor shortages during and especially after World War II – a development that would continue in the following decades. The share of people working in the manufacturing industry reached its peak around 1950 when it employed a third of the total Swedish workforce.

5.1 Previous findings

Many studies have been made on clustering and innovative industries, but few of these cover the period in question. However, a previous study have been made by economic geographers Lundmark and Malmberg on the spatial concentration of the Swedish manufacturing industry spanning from 1968 to 1984. They found that there was a de-agglomeration and de-urbanization phase taking place in many industries during this period.[35] In order to establish whether that development was part of a long-term trend the study also looks into how the location of industries in Sweden changed, based on the number of employees, on county-level between 1870 and 1980. The authors uses studies on municipality-level as complementary information from

[32] Edvisson, 2005, p.242
[33] Edvinsson, 2005, p.243
[34] Johansson, 1985, p.97
[35] Lundmark et al, 1988

1940 and onwards, noting that counties often covers too large areas to represent a cluster. According to the study, the industries was concentrating in urban counties during the 1920's (the counties in which the three largest cities were situated), a move to areas labeled as "industrial counties" ensued during the 1930's (counties in which industrial workers made up a larger share of the total workforce than the national average), and the 1940's was largely characterized by a move towards rural/peripheral counties.[36] These findings were in line with Dahméns' analysis of the industries in Sweden during the interwar years in *Entrepreneurial activity in Swedish Industry in the period 1919-1939*, according to the authors. In his study he had found that more industries emerged in rural areas and smaller cities than in large and medium-sized cities between 1919 and 1939 – in absolute as well as relative terms.[37] Lundmark and Malmberg emphasize the following central elements in a structural approach to their analysis of industrial location:

- *"The optimal location cannot be defined separately from the characteristics of the product, the production process and the market"* – benefits of agglomeration economies differ with regard to this.
- *"The overall strategy of the firm is constricted by the macroeconomic structures that form the economic environment of the firm"* – these structures constantly change due changes in production.
- *"Different elements in physical and social structures become resources if and when a demand for them is created by some economic activity"* – they cease to be resources when that demand disappears.
- *Industries "may increase the attractiveness of the area to other firms, the concept of agglomeration economies, but the structures which are formed around firms may also hamper subsequent industrial growth".*[38]

The general trend both prior to 1920 and after 1950 was a move to rural and other peripheral counties, according to the study. Beside from using a different spatial division (i.e. counties), the study conducted by Lundmark and Malmberg differed from this thesis in that it analyzed the entire industry and its location rather than the inter-industrial differences during this period. Their classifications have been made according to how large share all industrial workers make up relative to the total workforce, rather than to the share that industrial workers of an industry make up relative to the manufacturing industry. This complicates making direct comparisons between the two studies.

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36 Ibid, p.57
37 Ibid, p.62
38 Ibid, p.261-262 (include all four quotes).

6. Results

This section is divided into two parts; in the first part the industry classes are divided into groups according to their level of innovativeness (representing the least, the average and the most innovative industries), and the spatial concentration of each industry (based on the LQ's) are presented in the second part.

6.1 Identifying innovative industries

In order to determine whether innovative industries had a tendency to cluster in cities to a larger extent than other industries it is first and foremost important to establish which activities that was innovative at the time. Almost all industries has some innovative elements to it, but in order to create a better overview a total of nine industries is divided into three groups consisting of three industries each – lowest, medium and highest level of innovation. Audretsch and Feldman notes that "the greater the extent to which industry workforce is composed of skilled workers, the more important knowledge spillovers are likely to be".[39] The industries are classified into groups according to the share that technically and scientifically educated personnel makes up of each industry's total workforce – making it possible to identify the industries in which new economic knowledge plays a more important role. This group of skilled workers still made out a small share of the total workforce at the time – averaging 2.9%. The three industries that had the largest share of skilled workers at the time, and consequently were the most innovative, was *other metal product manufacturing* (technically and scientifically educated personnel constituted 12.5% of the industry's total workforce)*; manufacture of electrical machinery (10.9%);* and *shipyards and boatbuilding (7.8%).*[40] The former of the three include activities such as metal goods manufacturing and lamp manufacturing. These innovative industries were all are all part of the metal sector.

The three industries whose share of technically and scientifically educated personnel were closest to the average share of the Swedish manufacturing industry at the time, the "medium innovative industries", was *malting and breweries (2.7%); manufacture of china, pottery and earthenware (2.8%);* and *cordage, rope and twine industries (3%).*[41] Contrary to the most innovative group, the industries of the medium group were all part of different sectors – the quarrying, the food and the textile industry respectively. The least innovative industries were *bakeries (0.5%); manufacture of*

[39] Audretsch et al, 1996, p.635
[40] Kommerskollegium, 1931, p.51-55
[41] Kommerskollegium, 1931, p.51-55

furniture (0.9%); and manufacture of other leather, hair and rubber products (0.9%).[42] The latter of the three include activities such as brush-making, saddlery and horse hair weaving. The least innovative industries were, just like the medium industries, all part of different sectors – the food, the wood, and the rubber industry respectively.

The number of workers and the share of workers employed in urban areas per industry between 1920 and 1950 are presented in table 2. The table shows how the size of the industries differed over time as well as relative to each other. The analyzed industries generally employed a couple of thousand workers during this period, but a couple of industries deviate somewhat from this trend. M*anufacture of electrical machinery; shipyards and boatbuilding* and *manufacture of furniture* employed more than 10 000 workers each in 1920. *Shipyards and boatbuilding* was the largest industry at the start of the period, but *manufacture of electrical machinery* soon grew larger as the number of workers increased faster than in any of the other industries. *Cordage, rope and twine industries* is on the other side of the spectrum – less than 1000 workers were employed throughout most of the period. Not only was it the smallest industry by far, apart from *malting and breweries* it was the industry that grew the least in relative terms between 1920 and 1950.

More than half of the workers employed in industry still worked in rural areas in 1920, but there were many industries whose manufacturing was located almost exclusively in urban areas – both among the most and the least innovative firms. Industries in all of the three groups had a high share of urban workers by 1920 – close to 90 percent of the workers already worked in cities in several industries at the time. The most innovative industries were all mainly located in urban areas, but much more so in the case of *manufacture of electrical machinery* and *boatbuilding* than of *other metal product manufacturing*. The former two saw slow increases in their urban share and by 1950 there were only a few percent that didn't work in cities, while the latter saw fluctuating shares around 60 percent.

The average industry group also saw varying urban shares – *malting and breweries* and *cordage, twine and rope industries* both employed around 90 percent of their workers in cities by 1920, while the equivalent share for *manufacture of china, pottery and earthenware* was less than 70 percent. The urbanization rate of the three medium innovative industries varied as well; *malting and breweries* saw a slight urban increase, *cordage and rope* saw their urban share decrease throughout most of the period, and *china and pottery* initially went through a rapid decrease but between 1940 and 1950 the urban share increased rapidly from 43 to 73 percent. This sudden rise was partly an effect of the

[42] Kommerskollegium, 1931, p.51-55

Table 2. The total number of workers per industry (and the share of urban workers in paranthesis) every tenth year between 1920 and 1950.

Classification	Industries	1920	1930	1940	1950
The most innovative industries	Other metal product manufacturing	6200 (0.62)	7268 (0.57)	9130 (0.64)	12709 (0.62)
	Manufacture of electrical machinery	12838 (0.84)	18227 (0.95)	20156 (0.95)	32563 (0.94)
	Shipyards and boatbuilding	14685 (0.87)	13902 (0.91)	17627 (0.92)	22306 (0.95)
The medium innovative industries	Cordage, rope and twine industries	756 (0.90)	681 (0.81)	757 (0.73)	1135 (0.75)
	Manufacture of china, pottery and earthenware	2790 (0.69)	2594 (0.58)	3540 (0.43)	4918 (0.73)
	Malting and breweries	5200 (0.89)	4872 (0.99)	4586 (0.99)	5041 (0.94)
The least innovative industries	Manufacture of other leather, hair and rubber products	1666 (0.83)	1700 (0.72)	4688 (0.75)	5072 (0.77)
	Manufacture of furniture	12547 (0.47)	14735 (0.39)	19792 (0.36)	26008 (0.38)
	Bakeries	3804 (0.89)	6092 (0.94)	7362 (0.92)	9040 (0.96)
Total manufacturing industry	Include all 79 industries	197769 (0.49)	233347 (0.52)	327315 (0.60)	432222 (0.67)

industry actually urbanizing (as new cities emerged etc.), but also of new economic activities being regarded as *manufacture of china, pottery and earthenware* in the dataset.

The urban share of the least innovative industries were also varying – while *bakeries* were among the most urban industries throughout the entire analyzed period, the urban share of workers in *manufacture of other leather, hair and rubber products* remained relatively constant around 80 percent. Among the nine industry classes selected here, it was in fact only *manufacture of furniture* that was mainly an activity taking place in rural areas. Not only was *manufacture of furniture* the least urban industry in 1920 - the share of workers employed in urban areas did in fact decrease throughout most of the analyzed period. Still in 1950 only 38 percent of the workers in *manufacture of furniture* were working in cities.

6.1.1. The most innovative industries

Table 3. The location quotients of the most innovative industries every tenth year between 1920 and 1950.

Industries	**1920**	**1930**	**1940**	**1950**
Other metal	1.92	1.77	1.85	1.37
Electrical machinery	3.07	2.72	2.43	2.02
Boatbuilding	2.80	2.81	3.10	2.68
Average	2.60	2.43	2.46	2.02

All three of the most innovative industries had an LQ above 1 throughout the entire period, which is in line with Feldman's theories; however, the development over time does nothing to confirm the ideas. *Manufacture of electrical machinery* had the highest LQ in 1920 – its proportional role in cities on average was approximately three times greater than the industry's national mean. The level of agglomeration was in other words high, a result of the fact that more than 80 percent of the industry's workers were located in only 15 cities at the time (see table 4). *Shipyards and boatbuilding* saw a similar agglomeration level – due to an even larger share of the industry's workers (close to 90 percent) being spread out in 24 cities. The two industries had several things in common – both were capital intensive activities and both were, relative to other industries, made up by large work sites to a great extent (see table 5). To manufacture electronic machinery and even more so to manufacture ships are activities that depend on large pools of labor being available as benefits from internal scale economies are important when capital intensive goods make up a large part of the input into the industries. Consequently the production of goods such as electrical machinery and ships benefited more from being in cities where, compared to rural areas, a larger pool of labor was available. Also, the cities did not only supply a large pool of labor to the industry in general, the urbanization meant that the supply of skilled labor was increasingly concentrated to the urban areas as well – something the most innovative industries at the time could benefit from.

Other metal product manufacturing, the most innovative of all industries at the time, had a markedly lower LQ than the other two. This was a result of the industry having a low share of workers employed in urban areas; around 60 percent worked in 24 cities in total (rendering in a LQ below two). This still means that the industry had a high level of concentration, but reasons behind the deviation are nevertheless of interest here. One thing that stands out with regard to the other two innovative industries are the fact that *other metal product manufacturing* largely took place in smaller work sites (see table 5). A small establishment does not necessarily indicate that

Table 4. The number of cities in which the most innovative industries were located every tenth year between 1920 and 1950.

Industries	**1920**	**1930**	**1940**	**1950**
Other metal	24	21	27	43
Electrical machinery	15	16	22	43
Boatbuilding	24	17	17	26

it is located in rural areas, large establishments, however, does exclude the possibility of an industry being located in rural areas to a certain degree due to the pool of workers being more limited in the local area.

By 1930 the agglomeration of the most innovative industries had decreased or remained more or less unchanged. The LQ of *shipyards and boatbuilding* remained unchanged; while the number of cities in which the industry was located did decrease from 24 to 17. The industry's proportion of all manufacturing industries remained unchanged in these cities – counteracting the effects that a decrease in the industry's total number of workers would have on the LQ. *Other metal product manufacturing* was also located in fewer cities in 1930 than it had been ten years prior. However, unlike *shipyards and boatbuilding*, the number of workers in cities increased at a considerably slower rate than the overall workforce did. This industry, whose city-based share of workers was already low in relation to most other metal industries, consequently saw a decreasing LQ. *Manufacture of electrical machinery* also saw a lower LQ than in 1920. The industry, whose LQ was at a high level, grew fast (especially in Stockholm where the number of workers had doubled in ten years), but not in all of the urban areas. This highlights how the LQ here reflects an average of the entire industry rather than of each city.

Ten years later, in 1940, the overall LQ of the three most innovative industries remained steady. Both *shipyards and boatbuilding* and *other metal product manufacturing* saw an increased spatial concentration. While the workers of the former industry increased at a similar rate in urban and rural areas, the workers of the latter increased faster in urban areas (albeit starting from a much lower share to begin with). The urban increase of workers in *other metal product manufacturing* was, above all, a result of the fact that the industry had spread to new cities. The LQ of electrical machinery industries continued to decrease as work sites were established in several new cities and the share of workers employed in cities remained unchanged. In 1950 all three industries saw their lowest LQ during the analyzed period. While each industry's share of urban workers was more or less the same as it was ten years before the number of cities in which they were established had grown rapidly. *Manufacture of electrical machinery* had almost doubled the amount of

Table 5. The average number of workers per work site and industry in urban and rural areas every tenth year between 1920 and 1950. The urban average is at the top, and the rural average is at the bottom (in parenthesis).

Industries	**1920**	**1930**	**1940**	**1950**
Other metal	32.71 (53.18)	27.24 (54.39)	28.23 (32.87)	30.78 (31.79)
Electrical machinery	160.93 (146.86)	103.34 (121.50)	126.15 (79.07)	129.66 (65.50)
Boatbuilding	206.27 (33.26)	222.79 (35.38)	311.42 (23.88)	336.87 (15.47)
All manuf. industry	52.48 (50.87)	45.91 (48.93)	48.38 (41.74)	52.27 (70.35)

cities in which it was located in ten years (22 in 1940 against 43 in 1950). The industries grew in the "old" cities but as the spreading out to new cities increased at an even faster rate the agglomeration trend was counteracted. Meanwhile differences in both intra- and inter-industry factory sizes were more pronounced than ever before during the analyzed period. *Shipyards and boatbuilding* was the most spatially concentrated industry, but the number of workers per work site in urban areas was on average more than twenty times larger than the industry's rural-based work sites. This contributes to an increasing LQ as the value is based on the number of workers and not the number of work sites. *Other metal product manufacturing,* the least spatially concentrated industry in the group, saw a different trend. By 1950 the industry almost had the same average factory size in urban as in rural areas, and up until the 1930's it was actually larger in rural than in urban areas – ultimately having the opposite effect on the industry's LQ than on that of shipyards and boatbuilding. Although *other metal product manufacturing* differs somewhat from the other two, the findings are largely in line with Audretsch and Feldman's theory that more innovative industries would tend to locate in urban areas since these regions offers good conditions for firms developing new products on both the demand- and supply-side. How this group compares to the medium and least innovative industries will be presented in the following chapters.

6.1.2 The medium innovative industries

Table 6. The location quotients of the medium innovative industries every tenth year between 1920 and 1950.

Industries	**1920**	**1930**	**1940**	**1950**
Cordage and rope	6.30	5.25	4.84	4.78
China and pottery	2.78	5.21	4.47	4.54
Breweries	1.97	2.08	1.92	1.57
Average	3.69	4.18	3.74	3.63

The LQ of all three medium innovative industries were above 1 in 1920, but they were differing widely. *Cordage, rope and twine industries* had an LQ over 6, the highest LQ value of all industries throughout the entire period, and 90 percent of the industry's workforce was located in 8 cities (see table 6). A factor that comes into play here is the absolute number of workers – *cordage, rope and twine industries* was the smallest industry of all nine and that increases the possibility of a certain level of anomalies. The industry even employed all industrial workers in one of the smallest cities. As *cordage, rope and twine industries* was rather small in relation to the manufacturing industry as a whole, the few cities in which the industry was located generally had a very high relative share of workers. The LQ of *manufacture of china, pottery and earthenware* and *malting and breweries* were more in line with the most innovative industries; around 2 and 3. However, as illustrated in table 7 and 8, there were considerable differences between the two industries. The former was relatively small and its urban workers were only spread out in 15 cities. The latter was almost twice as big in terms of workers and its urban workers were spread out in 66 cities – more than any of the other industries at the time. This was largely an effect of there being many smaller breweries at the time, largely supplying local markets.

The total number of workers had decreased in all three industries by 1930. The number of cities in which *cordage, rope and twine industries* and *manufacture of china, pottery and earthenware* was located had almost been halved as a result. The LQ of *manufacture of china, pottery and earthenware* did, however, grew rapidly as the number of cities where it was located were fewer than ten years prior, ultimately resulting in an increase in its relative share of industrial workers in cities. *Malting and breweries,* on the other hand, saw an increase in its share of urban workers that led to an almost exclusively urban-based workforce (99 percent were employed in cities, making it the most urban industry of all). The large differences between the industries only became further established by the development in the next ten years. In absolute numbers *cordage, rope and twine industries* grew to the employment level of 1920, but its urban share had shrunk considerably since

Table 7. The number of cities in which the medium innovative industries were located every tenth year between 1920 and 1950.

Industries	**1920**	**1930**	**1940**	**1950**
Cordage and rope	8	5	5	4
China and pottery	15	8	6	12
Breweries	66	65	69	86

(having gone from 90 to 73 percent). *Manufacture of china, pottery and earthenware* saw a similar development – an increase in the total number of industrial workers, but a major drop in its urban share. The LQ for each of the two industries was still high, but decreased below 5. *Malting and breweries*, on the other hand, still almost had a completely urban workforce but the total number of workers decreased as taxes and sales restrictions was affecting the producers – an effect of the increasing state influence.[43] The regulations would eventually lead to the industry becoming dominated by larger actors whose production methods were less labor-intensive.

Ten years later, in 1950, the LQ's of *cordage, rope and twine industries* and *china, pottery and earthenware* remained more or less unchanged, while it decreased for *malting and breweries*. *Malting and breweries'* urban share of workers decreased by a few percentages, but none of the other industries were located in as many cities (86) as *malting and breweries* were in 1950. Only being located in 4 cities *cordage, rope and twine industries* were on the other side of the spectrum – none of the other industries were located in as few cities during any of the investigated years. The average number of workers per factory indicates that industries with few workers per factory have a high urban presence and vice versa – contrary to the industries of the most innovative group (see table

Table 8. The average number of workers per work site and industry in urban and rural areas every tenth year between 1920 and 1950. The urban average is at the top, and the rural average is at the bottom (in parenthesis).

Industries	**1920**	**1930**	**1940**	**1950**
Cordage and rope	56.42 (39.50)	68.88 (65.00)	79.43 (100.50)	211.50 (144.5)
China and pottery	100.95 (290.67)	149.70 (548.50)	138.73 (201.40)	212.47 (118.73)
Breweries	33.59 (27.18)	27.54 (13.00)	26.58 (10.25)	32.65 (8.77)
All manuf. industry	52.48 (50.87)	45.91 (48.93)	48.38 (41.74)	52.27 (70.35)

[43] Sandberg, 2006, p.12

3). There is no uniform trend for all three medium innovative industries in terms of their spatial distribution. The fact that the industries all were from different sectors can partly serve as an explanation to this – the industries go through different phases of growth during different periods as both micro- and macro-level effects are being felt separately for each of the industry. Ultimately, as the medium innovative industries had a higher LQ than their more innovative counterparts, these results do not support the theory of Feldman and Audretsch.

6.1.3 The least innovative industries

Table 9. The location quotients of the least innovative industries every tenth year between 1920 and 1950.

Industries	**1920**	**1930**	**1940**	**1950**
Other leather	2,55	3,92	2,18	2,09
Furniture	1,18	1,30	1,86	1,05
Bakeries	2,82	2,17	2,06	2,18
Average	2,19	2,46	2,03	1,77

The least innovative industries differed widely in the number of workers, the number of cities in which they were located and how they developed throughout the analyzed period – much like the medium innovative industries. *Manufacture of other leather, hair and rubber products* and *bakeries* had similar LQ by 1920; below 3. *Manufacture of furniture* had a much lower LQ; at 1,18 it was lower than any of the other eight industries. While the workers of the former two industries were much more city-based, they were distributed in a lot fewer cities and this ultimately contributed to the large LQ differences. The wood working industry has always been an important contributor to the Swedish economy and few industries have been as widespread spatially. This was largely an effect of the fact that wood was an abundant good and available throughout most of Sweden. The average factory sizes of the least innovative industries were substantially smaller than for the manufacturing industry as a whole, allowing a large presence in areas with a limited supply of labor (see table 11).

The LQ for *manufacture of other leather, hair and rubber products* in 1930 had risen substantially compared to ten years prior. The number of cities in which the industry was located decreased and did consequently increase the LQ. The LQ for the bakery industry decreased as a result of it being located in more cities. The industry had grown fast over the past ten years and the growth

Table 10. The number of cities in which the least innovative industries were located every tenth year between 1920 and 1950.

Industries	**1920**	**1930**	**1940**	**1950**
Other leather	21	16	25	29
Furniture	57	47	62	85
Bakeries	28	34	41	40

was evenly distributed across the country. The LQ for *manufacture of furniture* remained more or less unchanged. In 1940 all three least innovative industries saw a similar level of concentration in urban areas - each industry had a LQ around 2. *Manufacture of other leather, hair and rubber products* saw a faster relative increase in its number of workers than any other industry did over any other ten year period. The urban share of the industry's total number of workers largely remained on a similar level as in 1930, but the LQ dropped significantly as it had spread to several new locations. The LQ of *bakeries* remained more or less static – indicating that its share of workers in urban areas remained the same in relation to the whole manufacturing industry. *Manufacture of furniture* deviated from the other two industries in that it saw a clustering trend – largely due to growth taking place in cities where the industry made up a large share of the local manufacturing industry.

By 1950 the slow clustering trend that *manufacture of furniture* had been going through was ended abruptly as the industry not only reached its own lowest LQ, but the lowest LQ of all industries throughout the entire analyzed period. With an LQ of 1,05 it roughly meant that a city with *manufacture of furniture* on average had as large share of the local manufacturing industry's workers as the industry had in the country overall. The *manufacture of furniture* grew fast between

Table 11. The average number of workers per work site and industry in urban and rural areas every tenth year between 1920 and 1950. The urban average is at the top and the rural average is at the bottom (in parenthesis).

Industries	**1920**	**1930**	**1940**	**1950**
Other leather	24.40 (27.50)	30.73 (21.41)	41.54 (18.97)	35.35 (16.68)
Furniture	21.70 (19.11)	19.63 (17.19)	22.60 (16.30)	23.92 (16.90)
Bakeries	26.85 (28.07)	21.05 (15.29)	22.16 (12.91)	20.98 (17.00)
All manuf. industry	52.48 (50.87)	45.91 (48.93)	48.38 (41.74)	52.27 (70.35)

1920 and 1950, but the growth of the industry was spread across much of the country. The low share of urban workers (38 percent) was distributed in 85 cities – a spatial distribution made possible by the dispersed and large supply of raw material. The long tradition of wood-related industries in Sweden, the benefits of being close to the raw material, the small establishments and the low level of sophistication (making relocations or new establishment less risky) were other contributing factors behind this development. This underlines how "optimal location cannot be defined separately from the characteristics of the product, the production process and the market" - manufacture of furniture did benefit more from being close to the resources being used (i.e. wood) than from being close to the market (i.e. the cities).[44] The LQ of the other two least innovative industries almost stayed on the same level as it had ten years earlier. Both industries grew in absolute numbers and saw minor changes in the urban/rural distribution of workers. There was no distinct uniform trend for the least innovative industries between 1920 and 1950, but it is worth noticing that the group had the lowest LQ on average of all three groups and reached a low point by the end of the analyzed period. The fact that the least innovative industries had the lowest LQ supports the ideas of Audretsch and Feldman, as it indicates that these industries benefits less from clustering than their more innovative counterparts.

[44] Lundmark et al, 1988, p.261

7. Discussion

Both theories and studies made on clustering and innovative industries have been contradicting throughout the last couple of decades; while scholars like Audretsch and Feldman have argued that innovative industries tend to cluster more than other industries, others have been less prone to put an equal sign between the two.[45] When considering this it seems fitting that this study shows conflicting results. The members of the most, the average and the least innovative groups each had varying LQ's, with inter-industrial as well as intra-industrial differences over time. When looking at the result it becomes obvious that the characteristics of the product, the production process and the market together affect the spatial distribution of industries. It is for instance unambiguous that there were differences between the industries as far as their innovativeness was concerned, but it is more difficult to grasp exactly how big these differences were. The data on technically and scientifically educated personnel indicate that the level of innovativeness still was relatively low in 1930 (the group made up 12,5 % of the workforce in the most innovative industry - in comparison around a third of all Swedes between the age of 25 and 64 have a post secondary education today). Some industries were more innovative than others but the low level of innovativeness in absolute terms indicate that the benefits that innovative firms could gain from clustering possibly were more limited than today, as it did not allow technology spillovers and skilled labor market pooling to the same extent.

The number and the size of the cities in which each industry was located had an effect on the LQ of the industries. This is obvious as the industries that consistently had the highest LQ throughout the period (*cordage, twine and rope industries* and *manufacture of china, pottery and earthenware)* also were located in the fewest, and mainly the smallest, cities. This can be explained by the fact that LQ is an index that takes the size of the local economy into account, a high LQ is consequently more likely to result if industries are located in a few small cities. Contrary to this the opposite trend could be identified as well - industries located in many cities generally had the lowest LQ throughout the period (i.e. *malting and breweries* and *manufacture of furniture).* However, the correlation between being located in many cities and having a low LQ is far from perfect - this much can be established when comparing *other metal product manufacturing* to *bakeries.* The former had a lower LQ throughout the entire period in spite of the latter being present in more cities in three of the four studied years. This fact also gives an indication as to whether the findings of the thesis support Feldman's ideas on innovative industries and clustering. *Other metal*

[45] Lundmark et al, 1988

product manufacturing and *bakeries* had similar characteristics, such as employing roughly the same number of workers and being located in roughly the same number of cities. If Feldman's thoughts were applied one would assume that the LQ should be quite different considering how the industries were two extremes in terms of innovativeness. This is only further underlined when all nine industries are taken into consideration. The least innovative industries did indeed have the lowest LQ of the three industry groups, but the difference between the most and the least innovative industries was small and it was the average innovative industries that had the highest LQ during the entire period. Industries tend to be less geographically concentrated when scale economies play a more important role, but based on the average number of workers per work site there are no uniform pattern here either.[46] The spatial concentration of the industries show no indication of being related to the average size of the work site; industries made up of small work sites also had relatively low LQ's (e.g. *malting and breweries* and *manufacture of furniture*) and vice versa (e.g. *china, earthenware and pottery*).

The changes of the LQ over time did nothing to further confirm Feldman's ideas. Most industries saw declining LQ during the entire period - only one industry (*china, pottery and earthenware*) saw an increase between the start and end of the period. If emerging from Feldman's ideas on innovative firms and clustering, the expected development during this period would be a faster clustering for the innovative industries than for the other groups as these industries should benefit more from factors such as closeness to; other advanced industries, concentrations of demanding customers etc. A majority of the industries became increasingly urban between 1920 and 1950, but their average urbanization rate was not as fast as that of the manufacturing industry overall and judging from the results, urbanization wasn't synonymous with agglomeration. The move to urban areas was, it seem, more of a spread out effect than a clustering effect. The number of cities in which each industry was located at the start and end of the period rose in seven of the nine investigated industries - clearly illustrating this spread out effect. Many new industries and firms developed during this period and new establishments occurred throughout the country as the industry as a whole grew rapidly. Both the industrialization and the urbanization were rapid in Sweden at the time and the growth did not just take place in a few cities – most cities grew, new urban areas emerged and many cities developed around these establishments. Thus, the emergence of industries in new cities continuously counteracted the

[46] Audretsch et al, 1996, p.636

growth taking place in the "established" cities. The industries' spatial concentration does in other words seem to be more in line with the findings of Lundmark and Malmberg.

They identified a concentration of industries in the three most populous counties during the 1920's, in industrial core counties during the 1930's and in peripheral areas during the 1940's. However, as this thesis uses a different approach (i.e. analyzes the spatial distribution of specific industries rather than the industrial life of specific regions) the concentration of industries during these specific periods was mostly counteracted by the de-agglomeration taking place simultaneously in all the other regions. If anything the findings of Lundmark and Malmberg seem to point to there being a regional pattern (industries first concentrating in urban areas, then in industry-intense areas and lastly in peripheral area) in the same vein of more recent studies that look into the relationship between major technology shifts, growth cycles and regional development (known as *the geographical reference cycle*).[47] Having noted that, it is nevertheless important to call attention to the fact that agglomeration could have taken place in many areas during any of the years; it is merely the average development for each industry that is considered here. This highlights the relativity of the agglomeration-concept (an industry can grow locally but still be considered to diffuse if the local growth is slower than in the larger reference area) and consequently also illustrates the difficulty of verifying alt. refuting Audretsch and Feldman's cluster theory entirely.

Many different factors influence where industries locate and if they cluster – it can be initiated by a variety of incidents stretching from pure chance to conscious public planning. Cities (or regions) in which industries locate and eventually cluster would continue to grow stronger according to the ideas of Audretsch and Feldman, while lagging areas are doomed to remain underdeveloped. All industries would strive to locate in cities according to this center/periphery-view of clustering, but the findings in this thesis seem to indicate that a different development was taking place. There was a tendency among the most innovative industries to be located in urban areas. However, based on the findings in the thesis it is also obvious that less innovative industries cannot be excluded from the group that were the most prone to locate in urban areas. One case in point is how the least innovative industry (*bakeries*) was more urban than the most innovative industry (*other metal product manufacturing*). These findings seem to indicate that dynamics other than the agglomerating were at work. The result provide no exact answer to which these factors were, but the possibility of de-agglomerating factors counteracting the

[47] More about these cycles can be read in Lundquist et al, 2007, 2009, 2010.

agglomerating ones cannot be ruled out. Going back to Lundmark and Malmberg's study, causes are attributed to the Swedish industry largely being made up of raw materials-based activities (e.g. *manufacture of furniture*) and to the lower costs of labor and land in peripheral areas.

While the result seem to prove that there was no agglomerating trend in the Swedish industry between 1920 and 1950, it is important to keep in mind that this does not necessarily reflect the ensuing development. This is especially true considering how politicians, urban planners and researchers have gained interest in the creation of clusters since, groups of people that have been able to shape the locating patterns of economic activities accordingly. The time period is also a factor that contributes to the possibility of changes taking place in the creation of clusters. According to both Weber and Feldman, high-tech entrepreneurs and firms can benefit from locating in large urban regions since physical infrastructure such as highways and airports leads to better accessibility to suppliers and customers located in other regions or abroad. While this is most certainly true for innovative firms in cities of today, the benefits to be made from physical infrastructure were not as pronounced in Sweden before 1950. This relates to Weber's cluster theories, in which agglomeration was conceived as a trade-off between agglomeration economies and transport costs. In other words, the possibility of benefiting from agglomeration economies were not as pronounced as it is today due to the limitations in terms of physical infrastructure. In addition to this yet another externality-hindering aspect of the selected time period is the lack of benefits to be made from accessibility to arenas for diffusion and exchange of knowledge (e.g. R&D institutes and universities). A couple of research institutes were founded at the time and a few already existed, but neither the physical nor the organizational infrastructure for R&D was as developed as it is today. The possible gains to be made from this were in other words restricted to a rather limited number of urban areas.

The issue of whether industries at the time could benefit from the externalities generally linked to clustering also highlights the problems associated with the inclusion of all cities in the analysis. The positive externalities that comes from clustering is often linked to large urban areas, but Sweden had (and still have) a relatively small population, having between six and seven million inhabitants at the time, and most cities were too small to develop many of the positive demand- and supply-side factors. These cities could for instance be too small to function as: a testing ground for new products (as spatial concentrations of demanding customers with strong willingness to pay were limited), a creator of local competition (as limited local markets can restrict the number of local competitors), a hub of knowledge creation (as limited population bases can restrict the number of education and research institutions being present across the country) or a reducer of transaction costs (as search costs for customers, suppliers, services and knowledge can only be marginally improved in small urban regions). The fact that these and other local externalities were limited or absent altogether in many of the cities do restrict the gains that according to Audretsch and Feldman can be made from spatial concentration of economic activities.

7.1 Future studies

The dataset that forms the basis for this thesis has been of great help as it has allowed for quantitative inter- and intra-industrial comparisons to be made uniformly over time. However, as previously mentioned, the lack of information regarding the cause or form of agglomeration does of course lead to some limitations in the analysis. These limitations could be said to highlight alternatives as to how studies could have been conducted had it used other sources and/or methodologies. It does for instance point to one area of research of which little is known – the interactivity taking place between actors across and within clusters at the time. This matter revolve around issues such as: Which firms or industries were linked (in terms of business-to-business activities)? What kind of links existed among innovative firms or industries at the time (in terms of both tacit- and non-tacit knowledge spillovers)? Also, how did these links differ between firms, industries and/or clusters? The methodology would be of a more quantitative kind, and the focus of the study would be to understand more about why specific industries have located in certain areas and particularly of the dynamics in innovative clusters. A study of this kind would naturally differ a lot from this thesis, but it could help shed some light on many of the issues that we know little of today. These issues include whether the dynamics of industrial clusters in Sweden have changed over time, the extent of these possible differences, and what role the different economies of agglomeration have played in the development of clusters.

The general trend during the analyzed period was for industries to spread out and locate in cities, often emerging cities in peripheral areas. The causes have been attributed to factors such as state policies and lower costs of production outside cities. However, the knowledge about what part these de-agglomerating factors played is limited. Weber stated that the spatial concentration of industries depends on labor, transport costs and agglomeration economies. An inclusion of measures on costs of labor and transport on urban/rural-level would help clarify more about what part these factors played in the spatial location of industries. The issue at stake here, regardless of the area concerned, is partly whether any data exists and partly if the data is uniform over time.

7.2 Conclusions

This thesis examines the geography of innovation and manufacturing. In particular, by examining the spatial concentration of industries in Sweden between 1920 and 1950, the focus is on past development rather than present. From the results it is clear that the number of industrial workers in Sweden grew rapidly during this period, all this growth took place in urban areas whilst the size of the workforce in rural areas remained unchanged. The industrial growth in cities was connected to the urbanization – new local markets emerged as cities grew and as towns grew into cities. According to Audretsch and Feldman, geographic concentration should be observed in industries where knowledge play an important role as the ability to receive knowledge spillovers is influenced by distance from the knowledge source. Cities generally hold many of the necessary characteristics (supply of labor, demand for products, limited distances - lowering transport costs etc) that spur agglomeration. However, the result, using location quotients, showed little support for their findings. Of the three groups of industries it was the least innovative industries that saw the lowest spatial concentration throughout the entire period, ultimately verifying the theory of knowledge spillovers. However, the findings showed another pattern as well - the average innovative industries saw a considerably higher spatial concentration than the most innovative industries. The development taking place from 1920 to 1950 indicated that there was no spatial concentration taking place over time either – eight out of nine industries saw a decreasing location quotient. So, overall it seems like the industrialization in cities was a diffusion of activities rather than a clustering. The causes behind this development were many, but some of the explanations to why this was are attributed to de-agglomerating forces. These forces were related to: the Swedish industry largely being made up of raw materials-based activities (thus leading to a substantial presence in rural areas), lower costs of labor and land in peripheral areas (causing firms to locate in areas where rents and wages are low, i.e. outside large urban centers), and the fact that few Swedish cities were large enough to support clusters and create economies of agglomeration. I argue that the possibility of benefiting from agglomeration economies were not as pronounced as it is today, which for instance was due to the limited transport infrastructure of the time and the lack of benefits to be made from accessibility to arenas of knowledge (e.g. R&D institutes and universities). The possible gains to be made from these factors were restricted to a rather limited number of urban areas. Related to this is the low level of absolute innovativeness prevailing at the time - even the most innovative industries of the time had a low share of knowledge-intensity (i.e. scientifically educated personnel) by today's standards. The benefits that innovative firms could gain from clustering were consequently imperfect as both the demand and supply of knowledge was limited.

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Appendix

The aggregated division of industries according to the database (the analyzed industries are marked in italics). The 9 main sectors consist of between 3 and 16 industries each.

Sector	Industries
Ore mining and metal industries	Iron ore mines and processing plants; other ore mines and processing plants; Iron and steel mills, ferrous alloy mills; Other basic metal plants; Manufacture of tinware, tinners and coppersmith; Manufacture of hardware; *Other metal product manufacturing*; Manufacture of gold and silver- and nickelsilverware; Galvanizing, plating and enameling mills; Engineering work and foundries; *Shipyards and boatbuilding*; *Manufacture of electrical machinery;* Manufacture of instruments, watches and clocks.
Stone, clay and glass industries	Coal mines; Peat industry; Sand, gravel and clay pitts, Stone quarrying and manufacturing; Chalk and lime mills; Manufacture of cement; Manufacture of concrete products; Manufacture of bricks and tiles; *Manufacture of china, pottery and earthenware;* Manufacture of glass and glass products; Manufacture of non-metallic mineral products not elsewhere classified.
Wood product industries	Sawmills and planing mills; Manufacture of boxes and veneer; Flatboat building, *Manufacture of furniture*; Other wood industries.
Paper, pulp and printing industries	Wood pulp mills; Paper and cardboard mills; Manufacture of cardboard and paper products; Wallpaper products; Printing and allied industries not elsewhere classified; Printing and binding of books and newspapers.
Food product industries	Flour mills; Starch industries; Manufacture of yeast; *Bakeries*; Sugar factories; Sugar refineries; Manufacture of chocolate and sugar confectionary; Manufacture of spirits; Distilleries; *Malting and breweries*; Manufacture of other beverages; Tobacco manufacture; Manufacture of dairy products; Manufacture of margarine; Slaughtering and manufacture of meat products; Canning and preserving fish; Other food manufacturing industries.
Textile and wearing apparel industries	Wool industry; Cotton industry; Linen, hemp and jute industries; Manufacture of synthetic fibres and silk; Knitting mills; *Cordage, rope and twine industries*; Manufacture of cords, laces, ribbons and curtains; Manufacture of schoddy, wadding, waste and tow; Dyeing, bleaching and impregnating; Manufacture of wearing apparel; Manufacture of hats and caps; Other manufacture of textile goods.
Leather, hair and rubber industries	Tanneries; Manufacture of fur goods; leather and skin clothing; Manufacture of footware; Manufacture of rubber products; Rubber repair work shops; *Manufacture of other leather, hair and rubber products.*
Chemical industries	Manufacture of paints and varnishes; Manufacture of oils, soaps and candles; Manufacture of fertilizers; Charcoal ovens and wood processing plants; Manufacture of explosives; Manufacture of matches; Other chemical industry.
Electricity, gas and water works	Electriucity works; Gas works; Water works.