Agglomeration, Economies of Scale and Dynamic Specialisation in a Central-Place-System

by

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1. Introduction

It is a well-known fact that both production and households are not spread evenly across space, but tend to concentrate in cities and regions of various sizes and densities. This clustering is generally beneficial for both producers and households. The concentration of households gives the firms a better opportunity to find an appropriate workforce and at the same time find a market that is large enough for their products. The concentration of firms also gives households a better chance in finding suitable jobs. The concentration of firms may even become self-reinforcing. Firms want to locate their business in regions with access to a large market, and access to the market tends to be good in regions where a lot of firms locate their business (Krugman, 1998).

The major driving forces behind industrial/household concentration in regions are the dynamic interaction between factors such as trapped resources e.g. raw-material sources, market size, transportation and transaction costs, different kinds of amenities and economies of scale. Economies of scale can in turn be divided into external economies of scale and internal economies of scale. Internal economies of scale are primarily reaped by individual producers and arise when the production demands fixed costs. That is, costs that are not related to the volume of production, e.g. fixed set up costs. External economies of scale, on the other hand, arise due to the concentration of mutually related firms in the same location. Firms in such clusters are able to reduce costs through the proximity to each other. When the cluster consists of plants within the same industry, we talk about localisation economies, and when the cluster consists of plants from many different industries we talk about urbanisation economies (Marshall, 1920; Hoover, 1971 and Mulligan, 1984). However, at some point these agglomeration economies can be offset by diseconomies due to higher land rents, pollution and traffic congestion (Richardson, 1995).

In this paper we use the concept of functional urban regions to describe the distribution of central-place industries. A functional urban region can be defined as an economically coherent region with one or more urban centres, surrounded by its (their) hinterland. A functional region is characterised by a substantial amount of intra-regional contacts (Johansson, 1998). The main reason behind this is that the functional urban regions are aggregated so that the majority of people live and work in the same region. Thus, a functional region has a much higher degree of intra-regional commuting and contacts than interregional commuting and contacts. The reason for this is that the spatial interaction costs usually are considerably lower within a functional region than between functional regions. The spatial interaction costs is the sum of the transportation costs and the transaction costs.

When analysing why firms locate in a specific functional region two approaches are frequently used (Karlsson, 1999). On the one hand there is the central-place-system

(CPS) approach and on the other hand there is the location advantage (LA) approach.

According to the CPS-approach, location of firms in a specific industry within a functional region is basically determined by the size of market. If we assume that all production is associated with fixed set-up costs, a certain minimum demand must exist before any firm can start up a production that is profitable. The necessary demand needed in order to make production profitable is referred to as the threshold demand (Christaller, 1966). The total number of firms within an industry within a specific functional region will amongst other things depend upon the size of the actual product market and the size of the fixed set-up costs.

The CPS-approach generally states that the larger the market in a functional region is the larger will the number of different Central-Place (CP) industries in the region be (Christaller, 1966; Tinbergen, 1967; Beckmann, 1958). The reason for this is that due to the existence of fixed set-up costs firms will find the market for many types of products too limited in smaller regions to make production profitable. For products where the spatial interaction costs between regions are substantial, production will only take place in those regions where the market is large enough to make production profitable. This statement is, in particular true for industries with high spatial interaction costs between regions compared to the spatial interaction costs within a region.

This far we have only considered the effects of internal economies of scale. If we now also acknowledge the effects of external economies of scale and, in particular, to urbanisation economies, we have a second explanation to why the number of different industries should be expected to grow as the size of the functional regions increases.

According to the other type of theoretical framework, namely the location advantage approach, the location of firms is basically determined by the fact that some functional regions have some comparative advantages over other functional regions. One such advantage could be that a functional region hosts large and easily extractable natural resources. Firms and industries that are engaged in this type of production are characterised by that they do not only supply their products to the functional region where they are located but also, through exports, to other functional regions. Another feature is that these firms usually rely heavily upon economies of scale, in the form of either internal or external economies of scale. One typical example is industries belonging to so called industrial districts.

In the sequel, we will concentrate our discussion to CP-industries. That is, industries whose localisation first and foremost are determined by the market size. To qualify as a CP-industry, according to the strict definition, an industry must be present at all ranks in the CP-hierarchy above the lowest rank where it is

represented. That is, if an industry is present in a functional region of size X, it should also be present in all functional regions larger than X.

Industries with no or very small fixed costs only need a small market in order for production to be profitable. But the larger fixed costs needed in production the larger must the market be. Industries with no fixed costs will therefore be present in every functional region. Industries with a certain amount of fixed costs will not be present in the smallest functional regions, but in all functional regions larger than a particular size. And finally industries that demand very large fixed costs will only find it profitable to locate in the largest regions. Hence, the CP-industries will be distributed over the system of functional regions in a hierarchical way.

However, the distribution of CP-industries, in the system of functional regions does change over time. Important driving forces behind these changes are changes in the size of regional markets and demand, in the costs for setting up production, in the technologies used in various industries. As regional markets grow in terms of purchasing power and/or as set-up costs go down a general process of decentralisation of CP-industries might take place. Such a decentralisation is known as a filtering-down process. However, the factors might work in the opposite direction, which give rise to a filtering-up process.

From this background a number of questions emerge. What does the distribution of CP-industries over the functional urban system look like? At what rate does the number of CP-industries grow when the size of functional regions increase? What role do CP-industries play for employment in functional regions of different sizes? How do these relationships change over time? Are CP-industries becoming more or less important for regional employment over time? And are there variations for regions in various size classes?

The purpose of this paper is twofold. Firstly, to present a theoretical framework capable of explaining the distribution of CP-industries in the system of functional urban regions and its dynamics. Secondly, to empirically analyse the distribution of CP-industries in the Swedish system of functional urban regions and the changes over time in this distribution.

In section 2 we outline our theoretical framework, i.e. the Central-Place theory and its dynamic counterpart, i.e. the theory of the filtering-down and filtering-up processes. The section ends with some hypothesis, which we will test, in the empirical part. In section 3 we describe the data material as well as the empirical analyses. The paper ends with section 4, in which we present our conclusions and give some suggestions for further research.

2. Dynamic specialisation in a Central Place System

In the first part of the section we outline the theory of central-places in a more formal way. We are interested in analysing what type of factors that determine the urban system and how changes in these factors affect the CP-system. We are also interested in finding out what industries can be classified as CP-industries. In the second part of the section we outline the theories of the filtering-down and filtering-up processes which are the dynamic framework of the central-place theory. Here we analyse how changes in technology and demand may affect the industrial distribution in the urban system over time. To do so we introduce a vintage index, which describes a product's degree of standardisation. We assume that as time lapses, production will become more and more standardised, which in turn foster changes to the distribution of CP-industries.

2.1 Industrial location in a Central Place System

An urban system consists of a large number of small regions, a substantially smaller number of medium sized regions and only a very limited number of large regions. The market size in a large region is usually considerably larger than the market size in a medium sized region. Which in turn usually is substantially larger than the market size in the smallest regions (Christaller, 1966; Tinbergen, 1967; Beckmann, 1958). Given this, we should expect to find industries with large internal economies of scale to find it favourable to locate to larger functional region with a large home market. This is especially true for products where the inter-regional transaction costs are much higher than the intra-regional transaction costs.

According to the theory of central-places, the urban system of regions can be ranked according to the market size in the following way $M_1 > M_2 ...> M_{m-1} > M_m$. M_1 is the market size in region(s) of rank 1 and M_m is the market size of regions of rank m. In a similar fashion we are also able to rank the goods produced in the urban system. Products denoted as 1 are those that due to for instance large fixed costs only will be produced in regions of rank 1. Products of rank 1 are thus only produced in the largest regions and exported to regions of lower rank. These types of products are referred to as high-order products. Products of rank m are produced in regions of ranks larger and equal to rank m. Assuming that rank m is the lowest rank in the urban system these products will be produced in every region in the urban system. Products that are produced in every region are referred to as low-order products (Christaller, 1966).

Hence, a central-place system can be interpreted as a hierarchical system of functional regions, where the industrial composition in a region varies with its position in the hierarchy of the urban system. When one is analysing the industrial composition within the CP-system it is natural to begin with the following question:

What activities will the smallest functional regions of rank m, i.e. the regions at the lowest level in the hierarchy contain? This will be determined by three factors:

- the fixed costs associated with setting-up production
- the size of the market in regions of rank m
- the presence of agglomeration economies, that here are assumed to be a function of the number of industries (n) located in regions of rank m.

An industry will be located in a region of rank m with at least one establishment if the following condition holds:

$$\Pi_m = \left[p - AVC*A(n_m) \right] * f(p)M_m - FC \geq 0 \qquad (2.1)$$
$$0 < A(n_m) \leq 1$$

where Π_m is the profit made by an establishment, in a given industry, in regions of rank m. p is the price of the product. AVC is the average variable costs and FC the total amount of fixed set-up costs, f(p) is the individual demand, M_m is the market size in regions of rank m. $A(n_m)$ is a variable describing the agglomeration economies, in the shape of urbanisation economies, in regions of rank m. It is assumed that the larger the number of industries, n, in a region the larger will the agglomeration effect usually be and the lower will $A(n_m)$ be. It is assumed that firms through the economies of agglomeration are able to reduce their variable costs. This is done, for instance, through spill-over effects from R&D made by firms from related industries and cheaper/better inputs from downstream companies and lower transportation costs etc. From equation (2.1) we also see that, given constant prices and variable costs, the larger fixed costs needed in production, the larger market size is needed in order to make production profitable.

Industries that fulfil criteria (2.1) will be represented in all functional regions at all levels in the CP-system. The industries that produce these low-order products are thus usually characterised by small internal as well as small urbanisation economies and/or facing a large individual demand. That is, products that everybody need and demand on regular basis.

For regions of rank (m-1), i.e. the second smallest regional rank, we get a similar condition:

$$\Pi_{m-1} = \left[p - AVC*A(n_{m-1}) \right] * f(p)M_{m-1} - FC \geq 0 \qquad (2.2)$$

Following the reasoning above, we have that regions of rank (m-1) will contain all industries present in regions of rank m. But, due to the larger market size they will also contain a number of additional industries. Since regions of rank m-1 will contain more industries than regions of rank m we also have that $A(n_{m-1}) < A(n_m)$. M_{m-1} is larger than M_m since it not only contains the demand from the home region

but also from the surrounding regions of rank m that it services. A larger market size in combination with larger agglomeration economies will thus make it possible for a number of industries that could not operate with profit in regions of rank m to do so in regions of rank m-1. Industries that fulfil condition (2.2) will be represented in all functional regions of rank m-1 and higher in the CP-system. The criteria for profitable production in regions of rank larger than (m-1) follows analogous to equation (2.2).

Another observation can be made from (2.2), namely that through the effects of the urbanisation economies the variable costs of production will be smaller in a regions of rank m-1 compared to regions of regions of rank m. This is consistent with the law of market areas (LMA) (Parr, 1995). The LMA states that, the lower price in regions of rank m-1 will lead to a larger market area for the products produced in regions of rank m-1. If the price differentials are sufficiently large, the market area of the larger region can in fact cover the whole market area of the smaller region. In this case production of product m, will not take place in the smaller region. In reality this can give rise to gaps in the urban system. The discussion above is of course not only confined to regions of rank m-1 and rank m, but to all regions in all ranks. The only condition needed is price differentials between regions of different ranks. The effect is even further strengthened if the accessibility to regions of higher ranks is good, and if we introduce the possibility that consumers from smaller regions also are able to buy products that can not be produced in low rank regions (Parr, 1995). For example, a consumer from a small region is able to buy low-order products while going to the larger region for high-order products.

The same outcome is obtained using a slightly different approach, namely the law of retail gravitation (LRG). In the LRG approach it is assumed that neighbouring regions of different rank can reshape the market areas in favour of the larger region. If the regional size differentials are large enough, the whole market area of the smaller region can be absorbed for certain products. Again, this effect is strengthened if the intra-regional costs due to good accessibility are relatively small (Parr, 1995). The standard model of central-place theory thus shows some weaknesses.

But, even from the standard central-place theory we can draw the rather obvious conclusion that the number of CP-industries represented in a region will grow with the size of the region. But, what type of industries can we expect to belong to the category of CP-industries?

To answer this question it is fruitful to separate between manufacturing industries and service industries. The service sector can in turn be divided into two sectors, namely the household service sector and the business service sector.

Services usually have one common feature compared to manufactured goods, namely that the ”production” and the ”consumption” usually is carried out at the

same place. However, due to the increasing use of telecommunications there exist exceptions to this statement. For instance, some services can nowadays be provided via the Internet. In these cases the producer of the service and the consumer of the service could be located in separate parts of the world. But for most services the production/consumption include a certain amount of physical interaction between the producer and the consumer, usually in the form of face-to-face contacts. Hence, many services are not as easily transported over a long distance as manufactured goods are, which give rise to considerable spatial interaction costs between functional regions. Compared to the manufacturing industry, the service industry, and perhaps especially the household service sector, is more likely to be categorised as CP-industries (Keeble and Tyler, 1995).

What determines whether an industry is a low- or a high-order industry is the amount of fixed costs needed to set-up production in combination with the size of the market. Low-order industries will thus have no or very small fixed costs and/or consist of industries that supply products that are demanded frequently. High-order industries usually supply non-standardised products or products that are demanded seldom by consumers and/or products that demand a large amount of fixed costs, which induce large internal economies of scale. High-order industries are often also able to take advantage of the proximity to other industries, i.e. they are able to capitalise from urbanisation economies.

Thus, the CP-system will in its standard form, form a hierarchical pattern where every industry present in a certain regional rank will also be present in all functional region above this rank. However, the distribution of CP-industries in the urban system is not static over time. How changes in technology and demand affect the distribution over time will be analysed in the next section.

2.2 Filtering processes in a Central Place System

The dynamic framework associated with the central-place theory is the filtering-down and filtering-up process. In the filtering process the major driving forces to the changes in the industrial distribution in the urban system are technological change and changes in the demand (Camagni, Diappi and Leonardo, 1986). In the filtering-down process industries gradually decentralise to regions of successively lower rank. The filtering-up process works in the opposite way.

The dynamics of the filtering process is closely related to the product life cycle (Erickson, 1976). The product life cycle consists of three phases. The first stage is referred to as the innovation phase, the second one is the growth phase and the third phase is the mature phase (Hirch, 1967).

In the innovation phase the product is introduced to the market. This stage is characterised by the product going through continuously improvements and development. Hence, firms do not compete with prices as much as over the

attributes of the product itself. This phase is usually associated with a high degree of R&D, which in turn demand a highly skilled workforce. In combination with a relatively limited demand for the product, production in this stage is usually concentrated to the largest functional regions.

In the growth phase knowledge of the new product increases to consumers in a wider area, which induce that the demand for the product increases rapidly. Another reason for the increased market demand is that the product gradually becomes more standardised and that the production process becomes continuously more routinised.

During the mature phase the market demand for the product usually increases, but at a decreasing rate. The main reason for the slower growth rate is the introduction of newer and better products, which in accordance to the product life cycle enter the economy in the largest regions.

Given the product life cycle, we should expect the products and their industries to spread, or filter-down in the urban system over time. According to the filtering-down process this is a gradual process in which the products first spread from the largest functional regions to the medium sized regions and finally to the smallest functional regions over time.

We are interested in analysing how the standardisation process of products affects the industrial distribution in the urban system. In order to do so we introduce a vintage index, τ, which assumes the value of 0 when a new product is introduced to the market, and increases towards 1 the more standardised the product and the more routinised the production process becomes.

Rewriting equation (2.1), taking the vintage index into account and changing the subscript from rank m to rank k gives. (Note: rank k refers to an arbitrary rank in the urban system.)

$$\Pi_k(\tau) = \left[p - AVC(\tau)*A(n_k)\right]* f(p)M_k - FC(\tau) \geq 0 \qquad (2.3)$$

The regional size level k is here assumed to be the lowest regional rank in which production is profitable. Over time the product will become more and more standardised, i.e. the vintage index will increase from τ to $\tau+\mu$. If we assume that the technological change process results in decreasing fixed costs. That is, $FC(\tau+\mu) < FC(\tau)$, but it does not affect the variable costs (at least not positively), i.e. $AVC(\tau+\mu) \leq AVC(\tau)$. As the product becomes more standardised, production becomes profitable in regions of successively lower rank. Given these assumptions industries will filter-down to gradually smaller functional regions over time. This process can, at least partially, be offset if the industry rely heavily on the economies arising from proximity to other industries.

However, in reality it is perhaps more likely to assume that when a product becomes more standardised and routinised the fixed costs will in fact increase and the variable costs will decrease as μ increases. This is especially the case for manufacturing industries. The reason for this is that firms are able to engage in large scale production as the product gets standardised and the production processes becomes routinised. From equation 2.4 it is clear that the resulting dynamic process is ambiguous. If

$$\left[p - AVC(\tau+\mu)*A(n_k)\right] * f(p)M_k > FC(\tau+\mu) \qquad (2.4)$$

the industry will filter-down through the urban system. But if the inequality sign in equation 2.4 is reversed the industry will filter-up through the urban system, i.e. due to the relatively larger impact of the increasing fixed costs compared to the decreasing variable costs the industry will need a successively larger market to make production profitable. Given these assumptions, increasing importance of economies of scale can lead to both a decentralisation and a concentration of industries. Hence, technological changes may induce a process of gradual filtering-down, but it is also possible to give rise to a filtering-up process (Camagni, Diappi and Leonardo, 1986). However, it is reasonable to assume that the standardisation process in combination with increased competition will reduce prices, which will induce an increase in the individual demand that is large enough to offset the filtering-up process.

Standardisation of products often has an other property, namely that the degree of face-to-face contacts, which is an important feature for non-standardised products, is greatly reduced. As a consequence, the spatial interaction costs will decrease, which in turn increases the range of the product. This will lead to an enlargement of the market size, M_k, that according to equation 2.4 should strengthen the filtering-down process.

From equation 2.4, we also see that an increase in demand for a product will foster a trend of filtering down. The increase on demand could either be an effect of increased purchasing power or changes in preferences or a combination of the two.

2.3 Hypotheses

In this section we put forward a few hypothesis, which will be tested in the empirical section.

H1: The number of CP-industries will increase with the rank of the functional region.

H2: The CP-industries share of total employment will increase with the rank of the functional region.

H3: The average size of a CP-industry establishment will increase with the rank of the functional region. That is, the average size of a CP-industry establishment will be highest in the largest functional regions.

H4: The average size of an establishment will increase as the order of the industry increases, i.e. high-order industries should consist of larger establishments than medium-order industries etc, on average.

H5: The number of establishments will decrease when we move upward in the CP-system, i.e. high-order industries will have fewer establishments compared to the low-order industries.

3. Empirical analyses

3.1 The data

The definition of functional region used in this paper do not only take commuting patterns into consideration, but also other factors, such as distance between cities/municipalities and other variables that link cities/municipalities to each other. This means that one city/municipality that formerly, due to a low degree of outcommuting, has been defined as an independent functional region according to this definition can be treated as a part of a larger functional region, due to its geographical proximity to that functional region.

From a historical perspective we can observe that the number of functional regions in Sweden has decreased, which of course is the same as to say that the average area of functional regions has increased over time. In 1970 Sweden consisted of 187 functional regions, in 1980 the figure was 139, and in 1991 it was 108 (NUTEK, 1997). According to the latest division, which is the one used in this paper, Sweden in, 1998 consisted of 81 functional regions (NUTEK, 1998).

The database used in this paper is collected by Statistics Sweden and consists of employment and establishment data on a 5-digit level for 738 industries in 1993 and 742 industries in 1996. Comparable data for years before 1993 does not exist because of changes in the industrial classification.

3.2 Classification of CP-industries

The first task is to determine what type of industries that follows the CP-system according to the strict definition. That is, industries that are present in every region larger than the smallest one in which they are present. In order to study this we rank the functional regions according to size, measured as total population. The industries are ranked according to the number of functional regions in which they are present by at least one establishment. In appendix 1 and 2 the results for the years 1993 and 1996 are shown. Although the plots are very hard to analyse in detail, we see that the number of industries that follow the strict definition of central-places is very low. In both years they only add up to 42 industries, see appendix 3 and 4. What can be said about the type of industries? We see that most of the industries are related to utilities, building activities, standardised private services, public services and retail sale. One common feature for many of these industries is that they supply products that are demanded frequently by the public. That is, products that can be classified as necessities. Another feature is that most products got substantial spatial interaction costs, i.e. they are not transported easily or cheaply over a longer distance. This fact is not surprising since almost all of the CP-industries are so called low-order industries. Another observation that can be made, is that the distribution of CP-industries is quite constant over time, i.e. out of the 42 CP-industries in 1993, 35 are present also in 1996.

However, according to appendix 1 and 2 we clearly see that regional size matters for location. The correlation between number of industries and population in a region is 0.62 in 1996.There are several reasons to why we get the above result. One is that regional size measured as population is an unsatisfactory proxy for market size. Other studies have used income as a proxy for market demand (Burns & Healy, 1978). Harris (1954) suggested a technique for calculation of the market potential as the sum of retail sales for each county divided by the distance (Krugman, 1998). Other possible explanations for the gaps in the CP-system is that the market area for some industries in some regions is reduced due to price differentials between regions and/or proximity to denser and larger regions as described in section 2.1. One indication that this might be the case is that some regions with easy access to the two largest metropolitan regions have fewer industries than other regions of the same size. Other possibilities include regional differences regarding the demographic composition. Furthermore, the gaps can to some extent be explained by the fact that some industries locate in clusters to capitalise from localisation economies.

As the strict approach did not generate so very interesting results we now slightly change our approach in which we classify all the functional regions into size classes. The regional classification can be made in several ways (Gunnarsson, 1976). The regional classification used in this paper is based upon the classification made by NUTEK (NUTEK, 1998). The result of the classification is presented in table 3.1.

Table 3.1: Description of the regional classification

Rank	Number of regions	Description	Max size	Min size	Median size
1	3	Metropolitan regions	1.750.793 1.809.813	601.828 618.348	856.067 881.181
2	26	Regional centres	294.619 299.301	81.059 79.720	152.452 152.128
3	52	Small regions	71.057 71.442	3.480 3.337	29.225 28.697

Note: Top figure represents population in 1993, and bottom figure shows population in 1996.

Despite the short time period, we are able identify some of the effects of the ongoing trend of urbanisation. In rank 1, all three functional regions show increasing population. Out of the 29 largest functional regions, 22 increase their population from the year 1993 to 1996. And only 4 out of the 52 functional regions in rank 3, exhibit population growth.

In this approach we want to analyse; what type of industries are present in all three regional ranks? That is, industries that can be classified as low-order industries. What type of industries is present in every functional region apart from the functional regions in rank 3? That is, industries that can be classified as medium-order industries. And, what type of industries is present in the three metropolitan

regions but not in rank 2 or rank 3? That is, industries that can be classified as high-order industries. In order for an industry to be present in a rank it have to have at least one establishment in every region in the rank.

If we apply this classification we get the following result for 1993:
Number of low-order industries: 37
Number of medium order industries: 158
Number of high-order industries: 346

From the above result, we see a clear indication of the existence of a kind of CP-hierarchy.

As expected, the type of industries present varies between the different orders. The low-order industries consist mainly of building activities, utilities, standardised private services, transportation and communication, education and health activities and retail sale. Thus, low-order industries can be characterised by the fact that they consist of industries with relatively small internal economies of scale and/or by that they produce commodities that are demanded on a frequent and regular basis, i.e. necessities such as petrol. Another characteristic is that they usually demand a certain amount of face-of-face in the exchange, e.g. restaurants.

The medium-order industries consist mainly of wholesale and retail sale. An interesting fact regarding the retail sale industry of medium-order is that they include industries dealing with products that are demanded less frequently, e.g. jewellery, music instruments, computers and art. Other medium-order industries include business services, education and health activities and private and public services. It should however be pointed out that most industries classified as a medium order industry, also is present by at least one establishment in at least one region from rank 3.

The high-order industries, i.e. the additional CP-industries in rank 1, consist mainly of manufacturing and processing industry, wholesale and retail sale. The additional retail sale industry in rank 1 consists of more specialised items, e.g. coins and stamps. Other high-order industries include activities related to transportation and the computer industry. Again, we have to point out that most of the additional industries in rank 1, are present in regions belonging to rank 2 as well as rank 3 by at least one establishment. This fact induces us to constrain the definition somewhat.

The criteria chosen here is that in order to be classified as a medium-order industry an industry have to be present by at least one establishment in all regions of rank 2 and rank 1. And in addition each industry also have to have an employment ratio in regions 1 and 2 that is larger than the population ratio. The criteria will thus discard industries whose main employment exists in regions of rank 3. For the high-order industries an analogue constraint is used. In order to be classified as a high-order

industry, the industry has to be present in all regions of rank 1. And in addition the employment ratio in rank 1 have to be larger than the population ratio in rank 1. Thus, we here discard industries that have its main employment base in regions of rank 2 and/or 3.

3.3 Analysis of the Swedish CP-system in 1993 and 1996

Given the above method to classify CP-industries in different orders, we obtain the following results:

Table 3.2 Number of CP-industries with respect to their order in 1993 and 1996.

	1993	1996	Number of industries that stay in the same order from 1993 to 1996
Number of low-order industries	37 (37)	37 (37)	33
Number of medium-order industries	100 (137)	117 (154)	80
Number of high-order industries	209 (346)	206 (360)	175

Note: Numbers in brackets show the total number of CP-industries in rank 3,2 and 1.

In hypothesis 1 we stated that the number of CP-industries would increase when we move upward in the CP-system. From table 3.2 we clearly see that this is case. One of the reasons for this is that the market in regions of rank 3 is to thin to host industries with for instance large fixed set up costs and/or industries producing other things but necessities. We can also see that the number of CP-industries is increasing but at a decreasing rate, as we move upward in the CP-system.

As can be seen from table 3.2 the total number of CP-industries increases, in rank 1 and rank 2, during the studied time-period. This is possibly a reflection of the increased population in those regions, which thus makes it possible for regions to host more industries.

As stated above, industries classified as low-order industries are basically related to production of necessities. But what can be said regarding medium-order and high-order industries?

Table 3.3: Medium- and high-order industries in 1993 and 1996

type of industry	number in medium-order		number in high-order	
	1993	1996	1993	1996
various manufacturing	7	7	55	51
wholesale and retail sale	40	45	51	52

business services	22	24	29	27
public administration/services	6	5	10	12
education & health services	7	8	10	8
private/household services	8	13	17	17

Almost two-thirds of the medium-order industries belong to wholesale, retail sale and business services. Furthermore, it seems that these two types of industries are related to each other. Without a sufficient number of industries engaged in wholesale and retail sale the demand for business services will be too low to make production profitable. Thus, when the market for wholesale and retail sale increases, the threshold demand is not only exceeded for those industries but also for related service industries, e.g. security activities and cleaning of premises. Many of the business activities are of course present in low-order but then they are usually done in house. This process of specialisation through division of labour (Stigler, 1951) becomes even more obvious if we study the industrial composition of high-order industries. Here, we see a substantial increase of industries in the manufacturing sector as well as the wholesale and retail sales industry. The demand for services from these industries, are reflected by the increase in specialised business services, such as consultancy activities. We also see that the number of household services is increasing, due to the larger demand in the largest regions.

In hypothesis 2 we stated that the share of employment in CP-industries will increase when we move upward in the CP-system.

Table 3.4: Employment in CP-industries with respect to rank

	1993	1996
Employment in regions of rank 3	220.384 547.511 0.4025	208.038 562.814 0.3696
Employment in regions of rank 2	982.429 1.544.173 0.6362	947.963 1.584.940 0.5981
Employment in regions of rank 1	1.150.780 1.318.287 0.8229	1.197.664 1.412.376 0.8480

Note: Top figure shows total employment in CP-industries in each rank. Middle figure shows total employment in each rank. Bottom figure shows the share of employment employed in CP-industries.

The share of employment increases substantially as we move upward in the CP-system. For instance, the share of employment in CP-industries more than doubles between rank 3 and rank 1.

Somewhat unexpected is that the share of employment, in both regions of rank 2 and rank 3, decreases over time, despite increasing overall employment. For rank 3,

a possible explanation is the fall in overall population. For rank 2 the decrease in the share of employment in CP-industries is explained by the fact that industries that are classified as CP-industries in 1993, but not in 1996, have more employed than the industries appearing as CP-industries in 1996. If we only study the CP-industries present in both years we find that the share is constant over time.

Hypothesis 3,4 and 5 are related to the presence of economies of scale and its role in the CP-system. The presence of economies can be analysed from the production function of the firm, but since our data do not contain output nor inputs from capital our analyse will be somewhat unorthodox. To analyse whether economies of scale are a crucial factor in the distribution of CP-industries we first study the average size of establishments, with respect to whether the industry is a low-, medium- or a high-order industry. If economies of scale is an important factor we would expect the average size of an establishment to increase when we move upward in the CP-system. It should however be pointed out that even very small firms might have substantial economies of scale, but on average we should expect to find a correlation between size of an establishment and economies of scale.

Table 3.5: Average size in employment of establishments with respect to their order, in 1993 and 1996

	1993	1996
Low-order industries	6.06	5.96
Medium-order industries	9.89	8.32
High-order industries	16.53	17.08

We see that the average size of establishments in high-order industries are almost twice as large as establishments belonging to the medium-order industries, which in turn is around 50 percent larger than low-order establishments. This is at least an indication that economies of scale are more prominent in high-order industries compared to either medium-order or low-order industries.

The importance of economies of scale may also be highlighted by studying the average size of establishments with respect the regional rank. This is done in table 3.6 below. If the economies of scale are importance we should expect to find the average size of establishment to increase when we move from smaller regions to larger regions.

Table 3.6: Average size in employment of establishments with respect to the rank in 1993 and 1996

	1993	1996
CP-industries in regions of rank 3	5.12	5.08
CP-industries in regions of rank 2	7.20	6.76

CP-industries in regions of rank 1	9.11	8.62

Comparing table 3.6 and 3.5 we see that the average size in the low-order industries are larger in regions of rank 1 and 2 than in rank 3, reflecting that some economies of scale are present even amongst the low-order industries.

If economies of scale are an important determinant of the industrial distribution we should also expect to find that the number of establishments would be lower amongst the high-order industries compared to the medium- and low-order industries.

Table 3.7: Number of establishments with respect to order

	Establishments	Min	Max	Median
Low-order 1993	205.748	389	30.012	3.341
Medium-order 1993	96.111	101	8.040	606
High-order 1993	34.327	8	772	125
Low-order 1996	196.073	366	34.903	3.389
Medium-order 1996	121.605	151	9.842	566
High-order 1996	33.054	5	1.068	112

Note: Establishments refers to the total amount of establishments in each order. Min refers to the minimum amount of establishment in an industry in each order. Max refers to the maximum amount of establishment in an industry in each order. Median refers to the number of establishments at the 50^{th} percentile in each order.

Although some industries belonging to the medium-order and high-order in some cases have a substantial amount of establishments, we clearly see that the number of establishments is declining from low-order to high-order industries.

The tables above at least indicate that economies of scale are an important determinant to the industrial distribution in the CP-system.

In order to separate the effects from the urbanisation economies from the internal economies of scale we would need to have an input-output table describing the links between the industries. Since we do not have this, the analysis is done from studying the industries in the different orders.

In table 3.3, we saw that when demand for certain industries exceeded its threshold, the threshold demand for other industries was exceeded as well. This was especially the case in the largest regions but we were also able to identify some of these tendencies in regions of rank 2. In order to do a more thorough test regarding the role of urbanisation economies we need more information about the linkages between different industries.

Turning to the changes over time we saw from table 3.2 that a number of industries are not present in the same order 1993 and 1996. To get some knowledge of what have happened to the CP-industries during the time period we present the following table:

Table 3.8: Description of industrial movement between orders in 1993 to 1996

1993		1996				
		LOI	MOI	HOI	Other	∑
	Low-order industries	33	2	0	2	37
	Medium-order industries	1	80	**9**	10	100
	High-order industries	0	**24**	175	10	209
	Other	3	11	22	356	392
	∑	37	117	206	378	738*

* The table excludes the four new industries. LOI, MOI and HOI are abbreviations for Low-order, Medium-order and High-order industries.

Due to the short time period we find that the system is rather stable over time. The most interesting is the potential filtering-down of the 24 industries and the potential filtering-up of the 9 industries.

Regarding the 9 industries that were classified as medium-order industries in 1993 and became high-order industries in 1996 none showed any greater tendencies to filter-up. The industry that showed the largest tendency only lost its position in three medium-order industries. In order to study whether these industries really do tend to filter-up or if the gaps are due to other causes we would need a longer time period.

When it comes to the 24 industries that show tendencies to filter-down, 8 industries enter more than three regions of rank 2. 3 industries enter more than 25 percent of the rank 2 regions. These are retail sale in telecommunication equipment, courier services and educational services. Reasons for the filtering-down concerning these industries are probably more induced by changes in demand than changes in technology.

4. Conclusions and suggestions for further research

In this paper we analyse the Swedish CP-system and its determinants. This is done for the static case as well as for the dynamic case. In the static case we argue that the major determinants to the industrial distribution of the CP-system are the market size in combination with internal economies of scale and economies of agglomeration, in the form of urbanisation economies. The internal economies of scale reflect the amount of fixed set-up costs needed in order produce and the urbanisation economies reflects the fact that when related industries are located in proximity to each other they are able to reduce some costs.

The CP-industries will thus be distributed in the CP-system in hierarchical way, in which some industries will be present in all functional regions. Other industries will be present in all functional regions but the smallest, and finally some industries will only be present in largest functional regions.

However, over time technological change processes and/or changes in demand will induce changes in the CP-system. The technological change process, giving rise to large-scale production can induce both a filtering-down as well as filtering-up process depending on the relative changes in fixed costs and average variable costs.

Our conclusions from the empirical part are that the number of CP-industries increases as we move upward in the CP-system, but at a decreasing rate. Since the number of CP-industries is increasing with regional size, we should also expect to find that the CP-industries will be more important for larger than for smaller regions when it comes to employment. We show that this is the case and that the share of employment in CP-industries amounts to over 80 percent in the metropolitan regions. In these regions, it even seems to be the case that employment in CP-industries is increasing over time, but at a very slow rate. The most probable reason for the increasing share of employment is the increasing population in the metropolitan regions. Furthermore, economies of scale in combination with urbanisation economies seem to be important determinants of the industrial distribution in the CP-system.

Due to the short time period, the CP-system is rather stable over time. However, we find indications of both filtering-up and filtering-down processes. From our study it seems that the filtering-down process are the dominating one. The results here are unfortunately very uncertain.

However, the results of the paper are to some extent dependent upon the used classification. The paper should certainly benefit from an objective classification, such as principal component analysis, to the more subjective method used here. Analysing how changes in different variables, such as population, economies of scale etc, affects the CP-system can also make further improvements to the paper.

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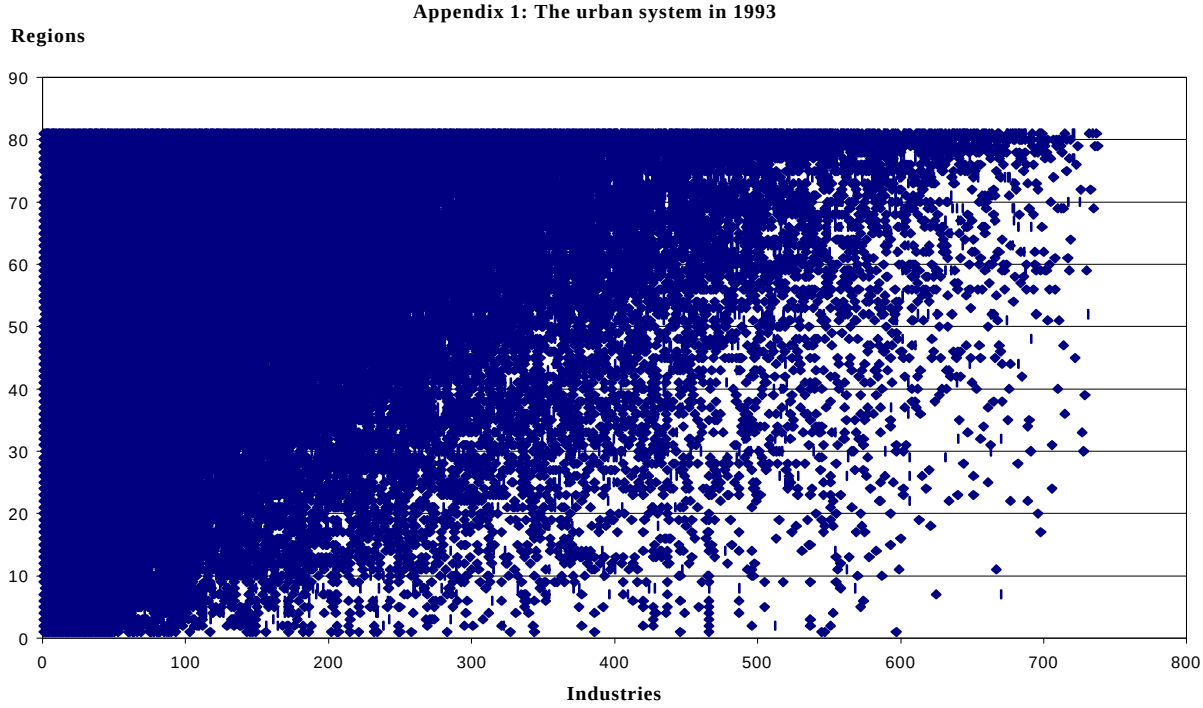
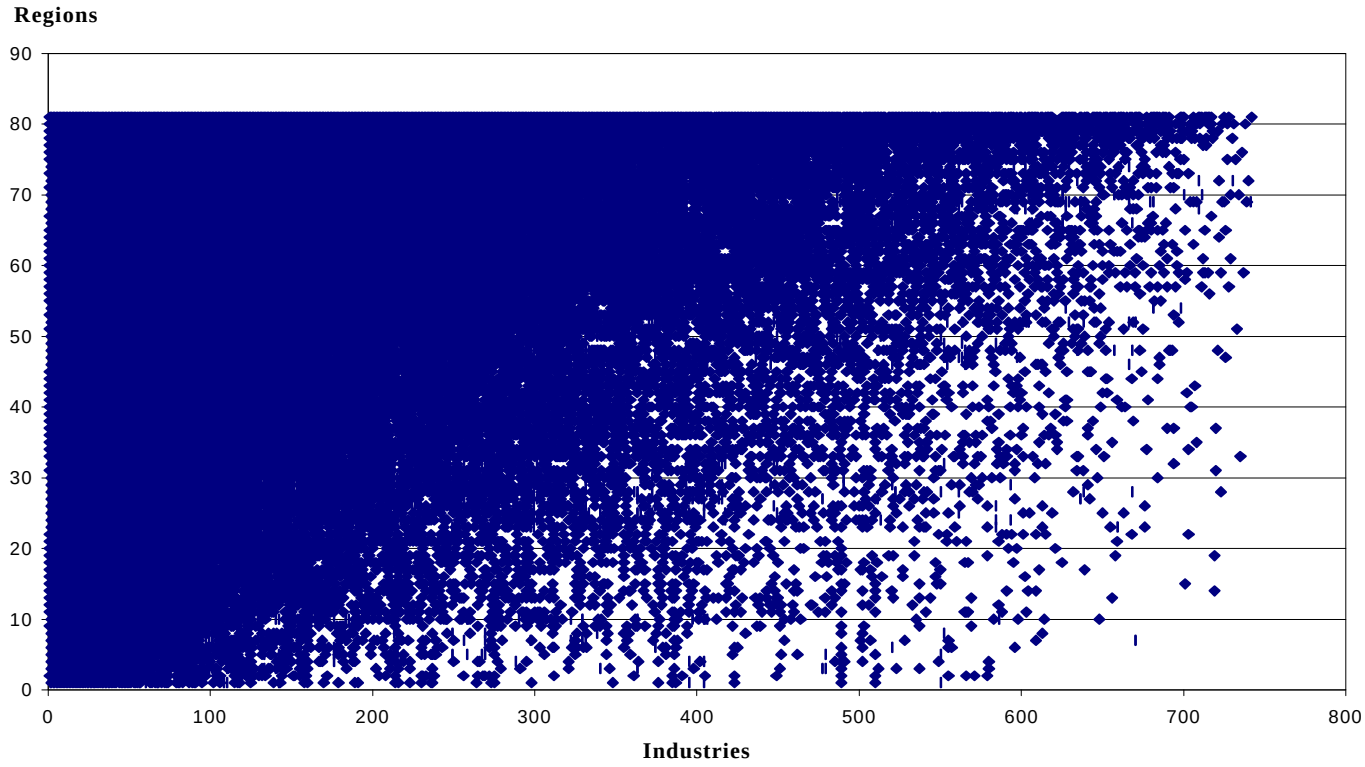
Appendix 1: The urban system in 1993



Appendix 2: The urban system in 1996



Appendix 3: CP-industries according to strict definition, 1993

SIC-code	Description	Order
1300	Growing of crops combined with farming of animals (mixed farming)	Low
2010	Sawmilling and planing of wood, impregnation of wood	Low
17230	Worsted-type weaving	High
24410	Manufacture of basic pharmaceutical products	High
24640	Manufacture of photographic chemical material	High
40100	Production and distribution of electricity	Low
45110	Demolition and wrecking of buildings; earth moving	Low
45211	General construction of buildings	Low
45230	Construction of highways, roads, airfields and sport facilities	Low
45310	Installation of electrical wiring and fittings	Low
45331	Installation of heating and sanitary equipment	Low
45441	Painting	Low
50201	Non-specialized maintenance and repair of motor vehicles	Low
50500	Retail sale of automotive fuel	Low
52112	Retail sale in other non-specialized stores with food, beverages and tobacco predominating	Low
52250	Retail sale of alcoholic and other beverages	Low
52310	Dispensing chemists	Low
52452	Retail sale of radio and television sets	Low
55111	Hotels with restaurant, except conference centres	Low
55300	Restaurants	Low
55521	Catering for the transport sector	High
60220	Taxi operation	Low
60240	Freight transport by road	Low
64110	National post activities	Low
64201	Network operation	Low
65120	Other monetary intermediation	Low
70201	Letting of dwellings	Low
74120	Accounting, book-keeping and auditing activities; tax consultancy	Low
74500	Labour recruitment and provision of personnel	Low
75211	Administration of foreign affairs	High
75300	Compulsory social security activities	Low
80100	Primary education	Low
80424	Activities of adult education associations	Low
85120	Medical practice activities	Low
85130	Dental practice activities	Low
85311	Care for residents in service homes and homes for the aged	Low
85321	Pre-primary school activities	Low
91310	Activities of religious organizations	Low
91330	Activities of other membership organizations n.e.c.	Low
92621	Sportsmen's and sports clubs activities	Low

92729	Various other recreational activities	Low
93021	Hairdressing	Low

Appendix 4: CP-industries according to strict definition, 1996

SIC-code	Description	Order
1300	Growing of crops combined with farming of animals (mixed farming)	Low
2011	Growing of standing forest and standing timber	Low
2013	Logging	Low
40100	Production and distribution of electricity	Low
45110	Demolition and wrecking of buildings; earth moving	Low
45211	General construction of buildings	Low
45230	Construction of highways, roads, airfields and sport facilities	Low
45310	Installation of electrical wiring and fittings	Low
45331	Installation of heating and sanitary equipment	Low
45441	Painting	Low
50201	Non-specialized maintenance and repair of motor vehicles	Low
50500	Retail sale of automotive fuel	Low
51530	Wholesale of wood, construction materials and sanitary equipment	Low
52112	Retail sale in other non-specialized stores with food, beverages and tobacco predominating	Low
52250	Retail sale of alcoholic and other beverages	Low
52310	Dispensing chemists	Low
52410	Retail sale of textiles	Low
52452	Retail sale of radio and television sets	Low
52487	Retail sale of flowers and other plants	Low
55111	Hotels with restaurant, except conference centres	Low
55300	Restaurants	Low
55521	Catering for the transport sector	High
60220	Taxi operation	Low
60240	Freight transport by road	Low
64110	National post activities	Low
64201	Network operation	Low
65120	Other monetary intermediation	Low
70201	Letting of dwellings	Low
74120	Accounting, book-keeping and auditing activities; tax consultancy	Low
74500	Labour recruitment and provision of personnel	Low
75300	Compulsory social security activities	Low
80100	Primary education	Low
80424	Activities of adult education associations	Low
85120	Medical practice activities	Low
85130	Dental practice activities	Low
85311	Care for residents in service homes and homes for the aged	Low
85321	Pre-primary school activities	Low
85323	Day care activities for the aged and handicapped	Low
91310	Activities of religious organizations	Low

92511	Public library activities	Low
92621	Sportsmen's and sports clubs activities	Low
93021	Hairdressing	Low