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Metropolitan Regions and Product Innovation

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Abstract

In smaller countries, the non-metropolitan regions are to a substantial degree linked together with the metropolitan regions through various networks. The national infrastructure and transport networks are often organised with the metropolitan region as the central hub. This creates a number of dependencies between the metropolitan region and the non-metropolitan regions in a small country. In this paper we focus on the role that metropolitan regions play for the renewal of the export base in the non-metropolitan regions in a small country. The analytical part can be divided into three main parts: i) the role of the Stockholm metropolitan region for the renewal of the export base in the rest of Sweden between 1997 and 2003; ii) which non-metropolitan regions gain renewal of their export base; and iii) what factors can explain the spatial distribution of these gains. The results show that distance has little to do with the potential success of an export products diffused from Stockholm. Instead, regional characteristics such as a large manufacturing sector, educational level, size of public and/or agricultural sector, and access to producer services have a larger influential potential.

Keywords: metropolitan regions, exports, product innovation, networks, diffusion
JEL classification codes: R10, R11, R12, D85, F10

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1 Introduction

Our model intertwines two standard ingredients. The first of these emphasizes the impact of urban agglomerations. Metropolitan regions are large urban agglomerations that act as breeding places for innovations. The production of these products involves a relatively high share of skilled labor which explains why they are high value products. The speed of the technological change slows down along the product cycle- why the value of being located in a metropolitan region declines. The second relationship stresses the role of rural areas in the product cycle. The non-metropolitan regions are biased towards process change rather than product innovation. The threat of entry by imitators raises incentives to relocate the production from metropolitan regions to non-metropolitan regions since the factor prices on land and labor are lower in these regions.

Sweden is a small country where only Stockholm can be considered a metropolitan region. Stockholm is small compared to other European regions such as Paris and London or American regions such as New York. However, Stockholm is an important region in Sweden and is the location for the majority of the governmental, financial, and bureaucratic headquarters. It is also Sweden's largest global trade market whit nearly 30 % of the total export value and 16% of the total import value. Also, Stockholm has a strategically good location in northern Europe at an important node for trade. This paper analyses the relocation of exports between metropolitan regions and non-metropolitan regions and this can be summarised in three main questions with respect to Sweden. What role does the Stockholm metropolitan region (henceforth Stockholm) play for the renewal of the export base in the non-metropolitan regions in Sweden during the period 1997-2003? Which non-metropolitan regions gain from the renewal of their export base? What factors can explain the spatial distribution of these gains? The empirical section can be divided into two lines of results. First, the largest portion of export products that are defined as highly specialised in Stockholm are also those products that diffuse to the rest of Sweden the following years. The second largest portion of highly specialised products in Stockholm includes the products that have experienced stagnation in the rest of Sweden the following years. The second part of the analysis focuses only on the products that are highly specialised in Stockholm and which the rest of Sweden has successfully imitated in the subsequent period. This diffusion is mainly affected by the location factors in the imitating region rather than geographical proximity to the metropolitan region.

1.1 Issues and background literature

In recent decades, the world has experienced a new wave of economic globalisation. Economic globalisation has in recent decades been facilitated by decreasing costs for transportation of goods, people, and information, deregulation, liberalisation, and lowered barriers for international trade and foreign direct investments. The major forces of economic globalisation are manifold: (i) rapid physical integration helped by, e.g. reduced costs of transportation, (ii) rapid information integration, in particular the internet and other media, (iii) increased institutional integration such as the EU and NAFTA, and (iv) increased import penetration, e.g. GATT, WTO, etc.

To a substantial extent globalisation has been orchestrated by the large multinational firms in the old industrialised countries, who have used the emerging new economic arena to on the one hand out-source and off-shore production to lower production costs, and on the other locate production close to customers. However, in a parallel process, it has been possible to observe the emergence of a large number of new economic actors in a number of countries in particular in Asia with ambitions to penetrate the traditional export markets of the old industrialised countries. These developments have changed the rules of the game on the global economic arena and many regions have had to witness how their traditional export products have been out-competed by the new sources of products and the new actors, while other regions with a more favourable export specialisation have been able to keep or even improve their export position.

This raises fundamental questions about how regions renew their export base over time. The analysis of such renewal processes falls within the field of spatial industrial dynamics, which focuses on processes such as the evolution of technologies, firms, and industries within functional regions as well as within the system of functional regions (Karlsson, 1999). During the last 50 years, much has been written within this field about the relationship in open economies between the economic milieu offered by different nations and functional regions and the location behaviour of firms and industries. It is generally assumed that for regions in richer countries to compete on the new global arena they must engage in product competition, i.e. specialise in products with unique characteristics that are difficult for the newer actors in the world economy to compete with. However, it is also generally assumed that the development of new products in the richer countries to a high extent is confined to the large metropolitan regions in these countries. The hypothesis that large urban agglomerations are particularly favourable breeding places for innovations is known as the urban hierarchy hypothesis[1] (Thompson, 1965).[2] If these assumptions are correct, it is a major research issue to find out how the export base in non-metropolitan functional regions is renewed.

Metropolitan regions in developed countries are characterised by a concentration of human capital, research universities, private R&D, head-offices of large multinational companies, technology import firms, specialised business services, advanced customers, national government administration, etc. With their high density of a large variety of economic actors in geographical proximity, they allow for intense face-to-face interaction, which stimulates knowledge exchange and knowledge creation (Saxenian, 1994).[3] They also normally host one or several international airport(s), which make them well connected internationally. The characteristics of metropolitan regions generate specific agglomeration advantages, which make them superior as breeding places for innovations and new products (Ewers and Wettman, 1980, Perrin, 1988, Suarrez-Villa and Karlsson, 1996). In particular, Glaeser (1999) emphasizes the role played by agglomeration economies for innovative activities by fostering localised learning processes. According to theory (Cantwell, 1995), there are three major reasons why innovative activities concentrate in metropolitan regions: i) there are economies of scale in the R&D function, and if they are strong enough, R&D will concentrate to a high extent in metropolitan regions, ii) there are location and urbanisation economies in R&D and innovation, and iii) innovation is seen as a demand-led process stimulated by the demand of high-income consumers and skill-intensive downstream production in metropolitan regions (Burenstam-Linder, 1961, Schmookler, 1966).

[1] This hypothesis has been criticised on theoretical grounds by, for example, Taylor (1986) and on empirical grounds by Howells (1983) and Kleinklencht and Poot (1992).
[2] The role of metropolitan regions for the development of new products was stressed already by Hoover and Vernon (1959).
[3] However, results for the London conurbation reported by Gordon and McCann (2005) indicate that the importance of specifically local informal information spillovers is much more limited than has been suggested.

The general shift of economic activities between nations and between regions has been analysed within the framework of the spatial product life cycle theory (Norton and Rees, 1979, Vernon, 1966).[4] The decentralisation of economic activities within countries has also been analysed within the framework of the "filtering-down" theory (Erickson, 1976, Thompson, 1965). These theories have inspired the development of the "lead-lag"-model, which has been successfully applied on data for Sweden and Norway (Forslund and Johansson, 1995). To the extent that new products survive long enough to mature, there will be a shift from product to process development and from product to price competition, which makes production less dependent upon the economic milieu in metropolitan regions and more sensitive to lower production costs.[5] In particular, Markusen (1985) has explored the spatial implications of qualitatively changed conditions of production and demand during the course of the product cycle, emphasizing the particular role of agglomeration economies during the innovative phases of an industry's product cycle. These factors will induce a diffusion of production from the metropolitan regions to the non-metropolitan regions, a pattern, which has been confirmed in several empirical studies (Brouwer et al., 1999, Erickson, 1976, Ewers and Wettman, 1980, Martin, 1979, Oakey et al., 1980). Thus, we can understand how metropolitan regions play a critical role for the renewal of the export base in the rest of the country.

While larger countries such as the US, Japan and Great Britain have several metropolitan regions, smaller countries like Sweden, Denmark and Austria are dependent upon a single metropolitan region, i.e. Stockholm, Copenhagen and Vienna. In the latter case, it is reasonable to assume that the renewal of the export base in the remaining non-metropolitan regions to a substantial degree is dependent , on the one hand, on the characteristics and dynamics of the metropolitan region and, on the other hand, on the non-metropolitan regions' accessibility to the metropolitan region.

In smaller countries, the non-metropolitan regions to a substantial degree are linked up with the metropolitan region through various networks. The national infrastructure and transport networks are often organised with the metropolitan region as the central hub. The metropolitan region also plays a central role in many business networks. The large multinational companies normally have both their head offices and major R&D facilities in the metropolitan region, while their production and distribution facilities are located in many different non-metropolitan regions. Most of the firms that are specialised in the import of new technologies as well as many of the specialised business service firms are located in the metropolitan region. This obviously creates a number of dependencies between the metropolitan region and the non-metropolitan regions in a small country.

2 Spatial product shifts and metropolitan regions

The main point for our theoretical analysis is that metropolitan regions have special advantages in developing and exporting new export products. Their monopoly in such products generates a monopoly rent, which explains their higher wages. In Krugman (1979) trade between metropolitan and non-metropolitan regions can be explained by how the production of products diffuses from metropolitan to non-metropolitan regions and also how

[4] The product life cycle theory can be seen as an extension of spatial theories of industrial dynamics developed by Marshall (1890), Kuznets (1929, 1930), Burns (1934), Schumpeter (1939), Clark (1940), and others.
[5] Duranton & Puga (2001) present a model where new products are developed in diversified cities, and relocated to specialised cities, when firms have found their ideal production process.

the analytical results are influenced by the mobility of skilled labour[6]. In such a model, the trade between a metropolitan region and a non-metropolitan region can be explained with a number of constraints. First, there is only one production factor – labour, which is immobile between the two regions. Second, all products are produced with the same production function. Third, the labour productivity for all products produced in both regions is the same. Finally, there are no transport costs between the two regions and there are only two types of products: old products and new products. Old products have been developed earlier and can be produced in both regions and one needs one unit of labour to produce one unit of old as well as new products. New products are recently developed and can only be produced in the metropolitan region.

The two-region system presented in Krugman (1979) tends to move toward a steady state where relative wages are constant and where the metropolitan region has a fixed mark-up to its advantage, which is an increasing function of the rate of new product development and a decreasing function of the speed with which new products become old products. The metropolitan region develops and exports new products and the non-metropolitan region exports old products. The non-metropolitan region increases its number of export products by imitating new products developed in the metropolitan region or if producers in the metropolitan region relocate their production to the non-metropolitan region when their products become old. This is in line with the product cycle theory as presented by Vernon (1966) and Norton & Rees (1979). The metropolitan region can improve its relative situation by increasing the rate or new product development, while the non-metropolitan region can improve its situation by speeding up imitation of new products so that they age rapidly.

2.1 Urban Agglomeration

Metropolitan and non-metropolitan regions differ in many respects. The advantages of urban specialisation can be traced back to Marshall's (1890) type of localisation economies and Jacob's (1969) urbanisation economies. The congestion costs of being located in a highly diversified metropolitan region are outweighed by the reduced search costs for the ideal production process. The localisation economies are only created by those firms that are involved in the same type of production. Duranton and Puga (2001) suggest that these diversified cities with internal localisation economies act as nursery cities. The diversified regions are more suitable for the early innovative stages of the product cycle. When the best production process found in the diversified environment becomes less important. The production is relocated to a specialised region where mass production is profitable.

One significant difference between metropolitan and non-metropolitan regions is that the former have a higher concentration of skilled labour than the latter. We now assume that there are two types of labour: skilled labour and unskilled labour. Skilled labour is characterised by being more mobile than unskilled, so we make the extreme assumption that skilled labour of which the total supply is fixed can move without frictions between the two regions, while unskilled labour is totally immobile. All products will be produced with unskilled and skilled labour based upon a constant-returns-to-scale production function. In other respects, the same assumptions prevail, i.e. new and old products enter demand symmetrically, and the metropolitan region specialises in new products. The same is true for the processes determining the rate of new product development and of product ageing.

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[6] The full model is presented in Appendix 1.

In the given setting new and old products as product groups can be looked upon as composite commodities since the relative prices within the groups are given. The relative prices on new and old products will determine the relative demand of the two commodities. To investigate the short-run equilibrium one now must observe that the relative supply of the two commodities no longer is fixed, since the fixed total supply of skilled labour can be relocated between the two regions. A rise in the relative price of new products, which increases the value of the marginal product of skilled labour, will induce skilled labour to move from the non-metropolitan to the metropolitan region until they earn the same wage in both regions. As a result, the output of new products will increase and that of old products decrease.

New product development in the metropolitan region, which increases the number of new products, increases the demand for new products, i.e. metropolitan products, at any given relative price. This will induce a rise in the price of new products, which will induce skilled labour to move to the metropolitan region. As a result, the wages of unskilled labour in the non-metropolitan region will decline. On the other hand, if the non-metropolitan region can speed up the imitation of new products and transform them into old products, production of old products will increase, skilled workers will start to move to the non-metropolitan region and the wages of unskilled workers in this region will increase. Interpreting the results, we can say that it is the region, which most rapidly can increase its product portfolio that will experience an inflow of skilled labour. It is important to notice the direction of the causation. It runs from new product development and product imitation, respectively, to skilled labour mobility, and not the other way around.

2.2 Mobility and imitating regions

The link between urban agglomeration and the mobility across locations can take many forms. If we assume that metropolitan regions are particularly good breeding places for innovations the imitation/diffusion of products from these regions to non-metropolitan regions can vary in the procedures (Johansson and Karlsson, 2003):

(1) Firms in the metropolitan region decentralise part or all of their activities, either to lower their production costs or because they are growing or because they intend to grow
(2) Firms can change their internal division of labour when they have production units in several different regions.
(3) Firms in the metropolitan region outsource part or all of their production to independent firms (suppliers) in non-metropolitan regions
(4) Firms in the metropolitan region make it possible for firms in non-metropolitan region to use their business concept via licensing, franchising, etc
(5) Firms in non-metropolitan regions imitate products produced by firms in the metropolitan region
(6) Firms in the metropolitan region, which has developed new products based upon new knowledge and/or imitation of imported products, locate the production of these products to non-metropolitan regions.

Skilled labour not only plays a role in the production of new and old products but also in the development of new products and in the imitation of new products. Here we are, in particular, interested in the imitation process, i.e. in the factors, which determine the rate of diffusion of aging products from the metropolitan region to non-metropolitan regions. An inherent assumption in the product cycle theory is that products as they age demand less and less skilled labour for their production. An implication of this assumption is that it is those non-metropolitan regions with the largest accessible supply of skilled labour that will adopt aging products early, while non-metropolitan regions less well supplied with skilled labour have to wait until a later stage.

Johansson & Karlsson (1991) highlight three factors, which are resource and system conditions for both innovation and imitation activities: (i) relevant competence for development work, (ii) information about customer preferences and willingness to pay for various product characteristics and (iii) information about new technical solutions.

From the perspective of the non-metropolitan regions, their competence for development work is determined on the one hand by their accessible supply of skilled labour and on the other hand by their accessible supply of company R&D, university R&D and specialised R&D institutes and firms. Information about customers is a function of a region's accessibility to different markets and presence of firms with information and knowledge about different markets. Information about new technical solutions in non-metropolitan regions is a function among other things of their accessibility to the metropolitan region, since that region is the major hub for the import of new ideas, new knowledge, new innovations, new technologies, etc. from abroad as well as a major hub for knowledge creation due to a strong concentration of company and university R&D. To summarize, we expect non-metropolitan regions to differ in their capabilities to absorb export products from the metropolitan region and to transform them to their own export products depending on the institutional infrastructure, education, geography, and resources devoted to R&D (c.f.,Maurseth and Verspagen, 1999).

Johansson & Karlsson (2001) present a framework within which a non-metropolitan region's capacity to absorb new export products from a metropolitan region is dependent on technology and scale effects together with influences from durable regional characteristics. The technology and scale effects are dependent on the potential to realise internal economies of scale in firms and the extent of external economies of scale in terms of location and urbanisation economies. The potential to realise internal economies of scale are among things depending on the production technology in existing plants in the region and their degree of flexibility to produce varieties of existing products as well as products that are totally new to the region.

The durable regional characteristics consist of on the one hand accessibility to local and external market potentials for different types of products and on the other hand of the supply of durable capacities. The durable capacities represent regionally trapped resources, such as material and non-material infrastructure, the sector composition of the economy, i.e. its specialisation, and the labour force with its skill-distribution, which at least in the short-run is a trapped resource. The material infrastructure of regions is important in several respects. The intra-regional transport infrastructure determines the accessibility of economic actors within a region and thus the conditions for face-to-face interaction, which are critical for knowledge generation and knowledge diffusion and exchange (Lucas, 1993).[7] In particular, we assume that the accessibility to human capital to be a critical factor for the capacity of non-metropolitan regions to adopt new export products from the metropolitan region (Andersson et al., 2007, Gråsjö, 2006).

[7] Ciccone & Hall (1996) emphasize the importance of density for productivity.

2.3 Hypotheses formulations

New products appear in the Stockholm metropolitan region and are thereafter diffused to the non-metropolitan regions in Sweden. These are more favourable locations when the products have reached a mature phase. We build the hypotheses on the main arguments in Johansson and Karlsson (2001, 2003) and three hypotheses are formulated below for the present paper:

Hypothesis 1 *If highly specialised export products in Stockholm relocate they will have a strong export value growth in those regions they are relocated to.*

This follows the product cycle theory and urban hierarchy/filtering down type of arguments. Products follow a cycle of development and it is not the same location that is most advantageous in the phase of product innovation as it is in the phase of product standardisation. An export product emerges in the metropolitan region as a new innovation or a new import good. It is thereafter relocated to a location outside the metropolitan region in order to achieve, e.g. lower factor costs or a sector specific business milieu.

Hypothesis 2 *The non-metropolitan accessibility to the metropolitan region facilitates the rate of relocated products.*

Links between the metropolitan region and the non-metropolitan region may facilitate the number of relocated export products but also the growth of the export value in the regions where they relocate to. These links may be of physical infrastructural character but may also be industry specific such as knowledge networks. The built up competence and externalities in the innovative metropolitan region is advantageous for the non metropolitan region in order to strengthen the export position of the relocated product.

Hypothesis 3 *Export value enhancing characteristics in the non-metropolitan region are not only important for the frequency of relocated export products but also the subsequent export value growth.*

Two general hypotheses could be launched as regards which regional conditions, which are most conducive for the adoption of new export products. The first hypotheses is in line with the diversity characteristics such as those presented by Jacobs (1969). Here the idea would be that regional diversity of economic activities would stimulate the adoption of new export products in non-metropolitan regions. The underlying motivation would be that new export products to be produced are dependent upon a rich and varied supply of production factors for successful and profitable production in non-metropolitan regions.

The alternative hypothesis could be developed along the lines of Marshall (1890), Arrow (1962) and Romer (1986), who contend that knowledge is largely sector-specific. This would imply that export products, which diffuse from the metropolitan region, mainly will be produced in non-metropolitan regions with a specialisation in the sector to which the product belongs, i.e. there would be a clear pattern of path-dependence.

If we assume ex ante that the export product has been relocated from the metropolitan region and adopted in a non-metropolitan region the success rate is most comparatively calculated as the export growth in the subsequent period. A high export value growth region has to possess advantageous factors such as compatible labour force, natural resources, educated labour, etc.

3 Analysis

The data on exported products is provided by Statistics Sweden and covers the years between 1997 and 2003 and uses the 8-digit CN classification of products[8]. The data set is constructed in such a way that the export value, export volume and the number of firms, can be calculated for every combination of municipality, 8-digit product and the firm identification. Hence, the raw material consists of more than 600 000 observations[9]. The export specialisation of the metropolitan region of Stockholm (henceforth, Stockholm) in 1997 is calculated as location quotients. The export value growth is thereafter calculated for the remaining 80 functional regions in Sweden.

3.1 Descriptives

In Sweden, there are 81 functional regions based on commuting patterns where the Stockholm region is numbered as 1. All functional regions consist of one and in most cases several municipalities. In total, there are 289 municipalities in Sweden and 30 of these are within Stockholm. Consequently, 259 municipalities belong to any of the functional regions numbered 2 to 81. One municipality in each functional region can be considered the central municipality that has a large inflow of commuters to work. This municipality often hosts the local government offices. That implies that the other municipalities in a functional region can be considered peripheral to varying degree. Clearly, this is not true for those functional regions with only one municipality.

In this paper, we are only interested in the products that are exported from Stockholm that also are represented in at least one of the other functional regions. The absolute export value difference between 1997 and 2003 is calculated for all regions but Stockholm. Those products that did not exist in any of the regions but Stockholm in 2003 were deleted. Keeping them would cause bias in the results.

Table 1 is the contingency table of the split sample. Rows represent the degree of export product specialisation of different products in Stockholm in 1997[10]. The 8-digit products are then divided according to their respective degree of specialisation. The specialisation, calculated as the location quotient has been divided into four groups: high, medium high, medium low and low export specialisation. Columns represent the export value growth between 1997 and 2003 of these products in the functional regions 2 to 81. This has been divided into five groups: high, medium high, medium low, low and negative export value growth.

The table has a skewed distribution, and the χ^2 value shows that this distribution significantly deviates from an equal distribution over the cells. There are 580 export products with a high export specialisation in Stockholm in 1997 that also have had a high export value

[8] CN = Combined Nomenclature based on the Harmonized Commodity Description and Codifying System. Exports of services are not included and the agriculture, fishery and forestry are excluded when the sample is extracted.

[10] Specialisation is calculated with a location quotient:
$\sigma = \left[\left(EV^{k}_{Sthlm}\right)/\left(\Sigma_{SthlmEV}\right)\right]/\left[\left(EV^{k}_{Sweden}\right)/\left(\Sigma_{SwedenEV}\right)\right]$, where EV is the export value, k is the 8-digit product. $\sigma > 1$: The product's share of Stockholm's export is larger than the product's share of Sweden's total export, i.e. the product is over represented. $\sigma < 1$: The product's share of Stockholm's exports is smaller than the product's share of Sweden's total exports, i.e. the product is under represented.

growth in the following 6-year period in the rest of Sweden. This group of products will be used as the sample in the analysis because we are interested to learn what regions benefit and what characteristics make regions able to absorb these highly specialised products in Stockholm[11]. These 580 export products indicate a high specialisation in the Stockholm region in one period and a rapid export value growth in the rest of Sweden in subsequent periods. Henceforth, this group of exports is called H^{++}[12]. The analysis that follows will be performed on the level of municipalities. That is, those municipalities in functional regions 2 to 81, i.e. 258 municipalities.

As an example, assume that we have an export product such as *"card with an inbuilt magnet strip"* with product code *85246000*. Also imagine that this export product has a high location quotient in the Stockholm metropolitan area in 1997. Also imagine that the export value of this exact product code grows rapidly between 1997 and 2003 in the other functional regions. Then, this export product belongs to the cell in the upper left corner of Table 1. If only the products in the upper left corner are extracted, the municipalities in the functional regions 2 to 81 may be able to export these products to a varying extent. Hence, the export value for these particular products serves as observations for each municipality respectively.

Table 1 Contingency table: export specialization (location quotient) in Stockholm in 1997 and export value growth in the remaining regions between 1997 and 2003.

	The number of export products in each export value category (absolute difference between 1997 and 2003) in all regions but Stockholm					
Export specialisation in Stockholm *	High	Medium High	Medium Low	Low	Neg**	Total
High (>2.34)	**580**	244	161	127	366	1478
Medium High (>0.58)	212	249	220	238	561	1480
Medium Low (0.08)	158	205	256	225	634	1478
Low (<0.08)	94	161	221	262	741	1479
Total	1044	859	858	852	2302	5915

Pearson Chi-Square 771,7 (*sig. 0.000*)
Likelihood Ratio 726,3 (*sig. 0.000*)
Linear-by-linear Association 531.2 (*sig. 0.000*)

*Divided into quartiles of export specialization in Stockholm (LA 1) in 1997.
**Those products which had a negative absolute difference in all regions but Stockholm (LA 2-81).

As many as 78 out of the 80 functional regions outside Stockholm had some export in the group called H^{++} in 1997. In 2003 the representation had decreased to 76. For those municipalities within these functional regions, 237 were represented as exporters of H^{++} in 1997. This increased to 246 by 2003, indicating that there also has been diffusion in this respect.

Table 2 presents the export value growth (in percent) in all the categories in Table 1. The highest export value growth appears for the product group H^{++} in the upper left corner.

[11] 741 of the export products with a low export specialization in Stockholm in 1997 also had a negative growth in all other regions in Sweden between 1997 and 2003.
[12] It should be mentioned that no distinction is made with respect to novelty. That is, this group also comprises products that where not exported in 1997 but are exported in 2003.

Table 2 Growth of export value between 1997 and 2003 in LA regions 2-81

	Percentage change in export value per category				
Export specialisation in LA 1	**High**	**Medium High**	**Medium Low**	**Low**	**Neg**
High (>2.34)	25.5	1.83	0.84	0.34	-0.75
Medium High (>0.58)	20.21	1.7	0.77	0.27	-0.45
Medium Low (0.08)	8.26	2.1	0.7	0.22	-0.76
Low (<0.08)	9.52	1.99	0.6	0.21	-0.45

Table A6 in Appendix 2 provides the rank of the export value growth in H^{++} for all functional regions except Stockholm. Also, the share of employees within manufacturing (and density), share of highly educated labour (and density), and distance to Stockholm are presented. The first ten regions w.r.t export value growth in H^{++} has a relatively high share of employees within the manufacturing industry. This also holds for the share of highly educated labour. Figure A1-3 in Appendix 2 shows the geographical distribution of the export value in H^{++} in 1997 and 2003, the unit value for H^{++} for both years respectively, and the export value growth during this time period. A darker shade in the maps indicates a higher value. An ocular inspection signifies a similar geographical distribution in export value in 1997 as in 2003. The map of absolute export value growth differs significantly since it has had a wider spread into regions further away from Stockholm. It is interesting to note that unit value for the sum of all products in H^{++} is lower in 2003 (19.31) compared to 1997 (31.24). This follows the arguments in product life cycle theories of urban agglomeration and filtering down. The products have a higher unit value in an earlier stage of the product cycle. They spread geographically along the phase of maturation and standardisation.

3.2 Estimation results

The following model has been used in the estimations:

$$\ln EV_i^t = \ln EV_i^{t-1} + \ln Dist_{iS}^{t-1} + \ln Manuf_i^{t-1} + \ln Edu_i^{t-1} + \ln AccServ_i^{t-1} + \ln Wage_i^{t-1} + D_i^{t-1} \quad \textbf{Eq. 1}$$

, where $\ln EV_i^t$ is the natural logarithm of the export value product group H^{++} in region i in 2003. In order to see whether this follows a pattern of path dependency, $\ln EV_i^{t-1}$ is inserted as a right hand side variable. All other independent variables aim at reflecting regional characteristics in 1997, i.e. $t-1$. Furthermore, $\ln Dist_{iS}$ is the logarithm value of the distance between the center of region i and the center of Stockholm in kilometers, $\ln Manuf_i^{t-1}$ is the employment share of the manufacturing sector in region i, $\ln Edu_i^{t-1}$ is the natural logarithm of the regional share of employees with at least 3 years of university education and, $\ln AccServ_i^{t-1}$ is the natural logarithm of the regional accessibility to producer services. Producer services can act as complements to manufacture and are sensitive to distance (Gaspar and Glaeser, 1998). Hence, producer services are largely dependent on the potential for face-to-face interactions and can be expressed as an exponentially decreasing function of distance. The full model is given in Appendix 3.

The variable $\ln Wage_i^{t-1}$ is the natural logarithm of the annual wage per employee in the manufacturing sector in each municipality. Product cycle theories and the Dixit Stiglitz type of modelling suggest that the metropolitan regions, being the driving force of product and process development also have higher wages than the regions where the products are relocated into *per se*. Products tend to exist at locations with low labour costs and favourable business milieus when they reach the stage of maturity (Norton and Rees, 1979).

Four alternative Dummy variables D_i^{97} are used in the analysis. For simplicity they are estimated separately in models II to V [13]. First, $D_{i,PubSect}$ indicates whether region i has a high employment share within the public sector. It takes the value one if region i belongs to the top quartile of regional employment shares for the public sector and zero otherwise. Second, $D_{i,AgricSect}$ indicates whether region i has a high employment share for the agricultural sector. It takes the value one if region i belongs to the top quartile of regional employment shares in the agricultural sector and zero otherwise. Third, $D_{i,Central}$ takes the value one if municipality i is a central municipality in the local labour market and zero otherwise. Finally, $D_{i,Periph}$ takes the value one if municipality i is a peripheral in a large functional region and zero otherwise. The descriptive statistics for all variables as well as their natural log are presented in Table 3 [14]. Only 13 (22) of the 258 municipalities outside Stockholm had no exports in 2003 (1997) in the product group H^{++}. A Breusch-Pagan/Cook-Weisberg test indicates that the linear regression (without the dummy variables) may suffer from heteroscedasticity.

[13] The regression has been run with all dummy variables simultaneously with very similar results.
[14] A dummy indicating the second and third largest municipalities Gothenburg and Malmö has been inserted into the analysis without a significant result.

Table 3 Descriptive statistics non transformed variables and ln (variable)*, municipalities

Variable[a]	Variable Explanation	Mean	Median	Std. dev	Min	Max
EV_i^{03}	Export value (2003) in H^{++} (million SEK)	80.15	3.72	340.97	0.00	3863.18
	Ln	14.34	15.12	4.28	0.00	22.07
EV_i^{97}	Export value (1997) in H^{++} (million SEK)	3.01	0.20	16.60	0.00	249.21
	Ln	11.33	12.23	4.25	0.00	19.33
$Dist_i^{97}$ (-/+)	Distance to Stockholm (km) (1997)	417.84	401.10	206.47	71.94	1227.02
	Ln	5.91	5.99	0.52	4.28	7.11
$Manuf_i^{97}$ (+)	Share of employees in manufacturing (1997)	0.26	0.25	0.12	0.03	0.69
	Ln	-1.45	-1.39	0.50	-3.44	-0.38
Edu_i^{97} (+)	Share of highly Educated labor (1997)	0.13	0.12	0.04	0.07	0.38
	Ln	-2.09	-2.14	0.28	-2.61	-0.97
$AccServ_i^{97}$ (+)	Access to producer services (1997)	1.10e5	1.17e5	6.49e4	2.50e3	3.46e5
	Ln	11.31	11.67	0.95	7.83	12.75
$Wage_i^{98}$ (-)**	Wage per employee (1998) (thousand SEK)	209.61	207.15	23.04	156.43	287.71
	Ln	12.25	12.24	0.11	11.96	12.57
$D_{i,PubSect}^{97}$ (-)	D_1 : 1= Large public sector 1997; 0 Otherwise	0.11	0.00	0.31	0.00	1.00
$D_{i,AgriSect}^{97}$ (-)	D_2 : 1=Large agricultural sector 1997; 0 Otherwise	0.33	0.00	0.47	0.00	1.00
$D_{i,Central}^{97}$ (+)	D_3 : 1=Central municipality 1997; 0 Otherwise	0.31	0.00	0.46	0.00	1.00
$D_{i,Periph}^{97}$ (-)	D_4 : 1=Peripheral municipality 1997 in large functional region; 0 Otherwise	0.68	1.00	0.47	0.00	1.00

* N is 258 and no missing values for all variables, ** 13 municipalities have no export value in H^{++} 2003, [a] expected sign in brackets. ** The per employee wage is calculated for year 1998 due to data restrictions

The expected sign of the variables presented in Table 3 are in brackets in the first column. The dummy variables indicating a large public sector, a large agricultural sector and peripheral regions in large functional regions are expected to have a negative impact on the export value growth in H^{++}. The dummy indicating a municipality to be central in a functional region should exert an opposite effect. The regional share of employees within the manufacturing sector should have a positive impact from a product cycle perspective. Also, the regional share of highly educated labour may also impact positively from an export product renewal perspective. Also, this holds for total access to producer services. The distance from region i to Stockholm does not necessarily have to be of major importance. Reduced costs of transportation also reduce the importance of a near location to the metropolitan regions. So, for certain products to diffuse from the Stockholm metropolitan region the location may be of more importance than the distance per se.

The bivariate correlations are presented in Table A7 in Appendix 2. The highest positive correlation appears between the export value in H^{++} in 2003 and in 1997 respectively which indicates path dependency. Regions with a high export value in this specific export category have a tendency to attract the same type of products during the subsequent years. The correlation between the distance to Stockholm and accessibility to producer services has the largest negative value. Hence, the further away you are from Stockholm the lower your potential reach producer services.

The ordinary least square estimations are presented in Table 4. The dummy variables are inserted one at a time to see why five alternative models are estimated. The export value in 2003 is positively affected by the export value in 1997. It is all over significant and stable across the five estimations. Distance is positive but only significant when introducing the dummy variables characterizing the type of region. The regional share of employees within the manufacturing sector $\ln Manuf_i$ is positive and stable across the alternative models. Though, this variable too is only significant when testing for central and peripheral municipality respectively. The employment share of highly educated labour $\ln Edu_i$ is positive, significant and stable across models. The same is true for the regional accessibility to producer services, $\ln AccServ_i$[15]. As already mentioned, the bivariate correlation is negative and significant between regional access to producer services and the distance to Stockholm. So, the non-significant impact of distance to the metropolitan region may be incorporated into the access to producer services. That is, if a majority of the relevant producer services are located in the metropolitan region, then access to them also measures closeness to Stockholm. The annual wage per employee $\ln Wage_i^{98}$ is positive through all models but never significant. In case the wage in $t-1$ would have a positive impact on the export value in product group H^{++} it may signify an attractive business milieu in those regions absorbing these specific products rather than low labour costs.

Neither coefficients nor significance are largely affected by the introduction of the dummy variables. First, a large public sector $D_{i,PubSect}$ has a positive but insignificant coefficient. This could be a result of accessibility to producer services and the employment share within the manufacturing sector. A region with a large public sector could per se have a low share of employees within the manufacturing sector and thereby lower access to producer services. The negative relation between distance and access built into the accessibility measure could overlap with a large public sector. Very few producer services within one municipality may per se correspond to a large public sector[16]. Second, in a region with a large agricultural sector, $D_{i,AgricSect}$ the export value in H^{++} tends to be lower than if not. Hence, the coefficient is negative and significant. Third, in regions that can be defined as central municipality, $D_{i,Central}$ is positive and significant. On the other hand, regions that are defined as peripheral in a large functional region $D_{i,Periph}$ seem to have less potential to enhance the export value in H^{++}. This can be a result of the structure of the functional regions. Central municipalities often function as nodes of infrastructure and local government offices. Their central location with easy access from the peripheral municipalities is likely to be attractive for location of

[15] Total accessibility to harbors has been tested for but the variable did not turn out as significant.
[16] The bivariate correlation between total accessibility to producer services and the number of employees within the public sector has a significant coefficient as high as 0.91 which is in line with this interpretation.

new export products. This structure may be more lucid in the large functional regions than in small ones. Also, it is likely to believe that infrastructural links to the metropolitan region of Stockholm increase with the population size of the functional region (Johansson, 1993).

Table 4 Regression results, estimation method: OLS, Dependent variable = $\ln EV_i^{03}$ i.e. export value in H++ in 2003 in municipalities, inclusion of independent variable $\ln EV_i^{97}$

	Models				
Variable	**I**	**II**	**III**	**IV**	**V**
$\ln EV_i^{97}$	0.42 *(7.85)* **	0.42 *(7.82)* **	0.40 *(7.51)* **	0.39 *(7.29)* **	0.39 *(7.09)* **
$\ln Dist_{iS}^{97}$	0.88 *(1.75)* *	0.90 *(1.78)* *	0.84 *(1.68)* *	1.06 *(2.08)* **	1.22 *(2.27)* *
$\ln Manuf_i^{97}$	0.42 *(0.67)*	0.43 *(0.69)*	0.22 *(0.36)*	0.48 *(0.77)*	0.40 *(0.63)* **
$\ln Edu_i^{97}$	2.52 *(2.24)* **	2.27 *(1.96)* *	2.19 *(1.94)* *	2.19 *(1.95)* *	2.54 *(2.23)* **
$\ln AccServ_i^{97}$	1.35 *(4.21)* **	1.40 *(4.23)* **	1.40 *(4.36)* **	1.57 *(4.69)* **	1.65 *(4.64)* **
$\ln Wage_i^{98}$	3.55 *(1.39)*	3.61 *(1.41)*	2.55 *(0.99)*	3.49 *(1.38)*	3.75 *(1.46)*
$D_{i,PubSect}^{97}$		0.64 *(0.93)*			
$D_{i,AgricSect}^{97}$			-0.97 *(-2.08)* **		
$D_{i,Central}^{97}$				1.02 *(2.17)* **	
$D_{i,Periph}^{97}$					-0.92 *(-2.18)* **
N	258	258	258	258	258
Adj R^2	0.46	0.46	0.46	0.47	0.47

**Significant at the 0.01 level, *Significant at the 0.1 level

3.3 Spatial autocorrelation

In addition to the OLS estimations we test for spatial autocorrelation. Table A 8 in the Appendix 2 presents the Morans I's test under $H_0 : independent\ observations$, for spatial dependence in export value in H++ across regions in Sweden. The tests are based on the spatial weight matrix with travel time distance by car measured in minutes. The weight matrix is standardized and all time distances w_{ij} exceeding 180 minutes are removed[17]. The null hypothesis of independent observations can be rejected and the sample suffers from spatial autocorrelation. OLS estimations rest on the assumption that observations are independent of one another. In the presence of spatial dependence, estimates are inefficient with incorrect standard errors and may create biased results. Table 5 presents the alternative model with a spatial dependence, spatial lag model, i.e. the spatial autoregressive model[18].

[17] For a discussion on distance friction parameters (Hugosson and Johansson, 2001).

[18] The number of observations is 257. That is, without the island Gotland that creates bias in the distance matrix. An OLS estimation has been executed when excluding Gotland but the results do not differ appreciably from the results in Table 4. For obvious reasons the variable measuring distance from region i to Stockholm is removed when testing for spatial dependence.

The estimations have also been performed with the spatial error model and the results are, without exception, highly robust[19]. A comparison between the results from the OLS estimations in Table 4 and the estimations correcting for spatial autocorrelation in Table 5 indicates robustness in parameters and significance levels.

Table 5 Spatial lag model, estimations with spatial autocorrelation**:** Dependent variable, EV_i^{03}

	Models- Spatial lag *(z-value)*				
	I	**II**	**III**	**IV**	**V**
$\ln EV_i^{97}$	0.42 *(7.98)* **	0.42 *(7.97)* **	0.40 *(7.58)* **	0.40 *(7.44)* **	0.40 *(7.46)* **
$\ln Manuf_{ii}^{97}$	0.47 *(0.74)*	0.49 *(0.77)*	0.17 *(0.27)*	0.50 *(0.79)*	0.52 *(0.83)*
$\ln Edu_i^{97}$	2.77 *(2.43)* **	2.50 *(2.15)* **	2.23 *(1.95)* *	2.33 *(2.02)* **	2.78 *(2.44)* **
$\ln AccServ_i^{97}$	1.00 *(3.38)* **	1.03 *(3.41)* **	1.07 *(3.52)* **	1.11 *(3.52)* **	1.07 *(3.41)* **
$\ln Wage_i^{98}$	3.50 *(1.28)*	3.62 *(1.34)*	2.80 *(1.04)*	3.79 *(1.42)*	3.57 *(1.33)*
$D_{i,PubSect}^{97}$		0.67 *(0.96)*			
$D_{i,AgricSect}^{97}$			-1.10 *(-2.36)* **		
$D_{i,Central}^{97}$				1.02 *(2.17)* **	
$D_{i,Periph}^{97}$					-0.80 *(-1.86)* *
N	258	258	258	258	258

** Significant on 0.05 level, * Significance on 0.1 level

4 Conclusions and discussions

It is well recognized that many new products arise in metropolitan regions. Depending on the type of products and the phase of product development, products change location, i.e. diffusion or relocation. The purpose of this paper is to analyse the role of Stockholm for the renewal of the export base in the non-metropolitan regions in Sweden during the period 1997-2003. That is, what products have had a high export specialisation in Stockholm and thereafter a high export value growth in the rest of Sweden (H^{++}). Are there any non-metropolitan regions in particular that have experienced a renewal of their export base? The current paper has mainly two important parts of results. First, the largest group of products that have been defined as highly specialised in Stockholm in 1997 have also had a high export value growth in the remaining part of Sweden the following years. The second largest group of the highly specialised export products in Stockholm are those that have had a decreased growth in the rest of Sweden. This result suggests that the successful export products in Stockholm are grouped in two polar parts. The existence of these products in other parts of Sweden could either be strengthened or highly diluted. The latter does not

[19] The spatial error model considers the error process and not the model itself. The spatial lag model affects the dependent variables by values of the variables in nearby locations (Anselin, 1990).

necessarily imply a continued strong export in Stockholm but could be caused by possible product exits or diffusion across national borders. Though, the important insight is the low level of diffusion to the rest of Sweden.

The second important outcome is the results of the analysis. This part of the paper only focuses on those products that belong to H^{++}. The theoretical part of the paper lays out some specific regional characteristics in $t-1$ that can be expected to influence the export value in t and these are tested for. First, the distance from a region to Stockholm appears not to be overall significant for the size of the export value in H^{++}. The important implication of this could be that the location characteristics are more important than the distance per se. The diffused export products are not affected by the distance to the metropolitan region. This is line with other empirical studies on transport costs in the manufacturing sector. Furthermore, the size of the manufacturing sector and regional educational level are both characteristics that positively affect the export value outside Stockholm. This also holds for regional access to producer services.

A large public sector seems to enhance the diffusion of export products from Stockholm. A large share of employees in the public sector has a positive (though not significant) impact on the export value in H^{++}. A large public sector can be the opposite of a large manufacturing sector and the rationale behind a low diffusion rate is plausible a result of a lack of absorption possibilities. Regions with a large agricultural sector have a lower degree of absorption of these products. Hence, the coefficient is negative as well as significant and the rationale is presumably similar to regions with a large public sector.

The non significance of distance and the high significance of the two last dummy variables cause some interesting implications. Municipalities that are counted as central in a functional region have a larger potential to capture those export products coming from Stockholm. The opposite holds for those in the peripheral areas in large functional regions. The functional regions are defined with respect to commuting patterns this could hold as a motivation. Peripheral areas serve as regions of living where people commute into the central municipalities. The most strategic location where to export from seems to be highly influenced by these nodes of infrastructure. Since the distance parameter is insignificant, it appears to be of little importance if the export product diffuses to a location far away from Stockholm as long as it locates in a central place.

Also, the detection of spatial dependence emphasizes the matter of location. A large agricultural sector may be spatially dependent due to specific natural resource characteristics. Some regional characteristics seem to spill over beyond the regional borders. However, correcting for spatial dependency does not affect the results.

Much of the analysis in the present paper can be elaborated upon in future studies. First, it would be of major interest to distinguish industrial differences in the diffusion process between the metropolitan area and the remaining regions. Second, despite the robust estimations, the spatial dependence could be further analysed since the sample suffers from spatial autocorrelation. Finally, the results present the relationship between specialisation degree in the Stockholm metropolitan region and the export growth in the other Swedish regions. This leaves us with an unanswered question which could be proposed for future research. In terms of export growth, do Sweden’s growing regions exhibit the same export attributes as the shrinking ones?

References

ANDERSSON, M., GRÅSJÖ, U. & KARLSSON, C. (2007) Human Capital and Productivity in a Spatial Economic System-Relating the Extent of Spatial Dependence to a Localities' Position. *Annales d'economie et de statistique,* (forthcoming).

ANDERSSON, Å. E. & JOHANSSON, B. (1995) Förnyelse av Västsveriges Regioner: Borås en Framtida Marknadsplats i Norden. Swedish Institute for Regional Research

ANSELIN, L. (1990) SPATIAL DEPENDENCE AND SPATIAL STRUCTURAL INSTABILITY IN APPLIED REGRESSION ANALYSIS. *Journal of Regional Science,* 30**,** 185.

ARROW, K. J. (1962) The Economic Implications of Learning by Doing. *Review of Economic Studies***,** 155-173.

BROUWER, E., BUDIL-NADVORNIKOVA, H. & KLEINKNECHT, A. (1999) Are Urban Agglomerations a Better Breeding Place for Product Innovation? An Analysis of New Product Announcements. *Regional Studies,* 33**,** 541 - 549.

BURENSTAM-LINDER, S. (1961) *An essay on Trade and Transformation,* New York.

BURNS, A. F. (1934) *Production trends in the United States since 1870,* New York, National Bureau of Economic Research.

CANTWELL, J. (1995) The globalisation of technology: what remains of the product cycle model? *Camb. J. Econ.,* 19**,** 155-174.

CICCONE, A. & HALL, R. E. (1996) Productivity and the Density of Economic Activity. *National Bureau of Economic Research Working Paper Series,* No. 4313.

CLARK, C. (1940) *The Conditions of Economic Progress,* London, Macmillan.

DURANTON, G. & PUGA, D. (2001) Nursery Cities: Urban Diversity, Process Innovation, and the Life Cycle of Products. *The American Economic Review,* 91**,** 1454-1477.

ERICKSON, R. A. (1976) THE FILTERING-DOWN PROCESS: INDUSTRIAL LOCATION IN A NONMETROPOLITAN AREA*. *The Professional Geographer,* 28**,** 254-260.

EWERS, H.-J. & WETTMAN, R. W. (1980) Innovation-oriented regional policy. *Regional Studies,* 14**,** 161-179.

FORSLUND, U. & JOHANSSON, B. (1995) The Mälardalen: A Leading Region in Scandinavia. IN CHESHIRE, L. P. & GORDON, T. I. (Eds.) *Territorial Competition in an Integrating Europe.* Avebury, Aldershot.

GASPAR, J. & GLAESER, E. L. (1998) Information Technology and the Future of Cities. *Journal of Urban Economics,* 43**,** 136-156.

GLAESER, E. (1999) Learning in Cities. *Journal of Urban Economics*
254-277.

GORDON, I. R. & MCCANN, P. (2005) Innovation, agglomeration, and regional development. *J Econ Geogr,* 5**,** 523-543.

GRILICHES, Z. (1979) Issues in Assessing the Contribution of Research and Development to Productivity Growth. *The Bell Journal of Economics,* 10**,** 92-116.

GRÅSJÖ, U. (2005a) Accessibility to R&D and Patent Production. *Working Paper Series in Economics and Institutions of Innovation.* Royal Institute of Technology, CESIS-Center of Excellence for Science and Innovation Studies.

GRÅSJÖ, U. (2005b) *The importance of accessibility to R&D on patent production in Swedish municipalities*.

GRÅSJÖ, U. (2006) *Spatial Spillovers of Knowledge Production : An Accessibility Approach,* Jönköping, Jönköping International Business School [Internationella handelshögsk. i Jönköping].

HOOVER, E. M. & VERNON, R. (1959) *Anatomy of a Metropolis,* Cambridge, MA, Harvard University Press.
HOWELLS, J. R. L. (1983) Filter-Down Theory: Location and technology in the UK Pharmaceutical Industry. *Environment and Planning*, 147-164.
HUGOSSON, P. & JOHANSSON, B. (2001) Business trips between functional regions. IN HUGOSSON, P. (Ed.) *Interregional business travel and the economics of Business interaction.* Jönköping., Jönköping International Business School, .
JACOBS, J. (1969) *The Economy of Cities,* New York, Random House.
JOHANSSON, B. (1993) *Ekonomisk dynamik i Europa : nätverk för handel, kunskapsimport och innovationer,* Malmö, Liber-Hermod i samarbete med Institutet för framtidsstudier.
JOHANSSON, B. & KARLSSON, C. (1991) *Från brukssamhällets exportnät till kunskapssamhällets importnät,* Karlstad.
JOHANSSON, B. & KARLSSON, C. (2001) Geographic Transaction Costs and Specialisation Opportunities of Small and Medium-Sized Regions. IN JOHANSSON, B., KARLSSON, C. & STOUGH, R. R. (Eds.) *Theories of Endogenous Regional Growth. Lessons for Regional Policies.* Berlin, Springer.
JOHANSSON, B. & KARLSSON, C. (2003) *Växande branscher-om Stockholmsregionens samspel med övriga landet,* Stockholms läns landsting, Stockholm, Regionplane och trafikkontoret.
JOHANSSON, B., KLAESSON, J. & OLSSON, M. (2003) Commuters non-linear response to time distance. *Journal of Geographical Systems,* 5**,** 315-329.
KARLSSON, C. (1999) Spatial Industrial Dynamics in Sweden: Urban Growth Industries. *Growth and Change,* 30**,** 184-212.
KLEINKNECHT, A. & POOT, T. (1992) Do Regions Matter for R&D? *Regional Studies: The Journal of the Regional Studies Association,* 26**,** 221-232.
KRUGMAN, P. R. (1979) Increasing returns, monopolistic competition, and international trade. *Journal of International Economics,* 9**,** 469-479.
KUZNETS, S. S. (1929) Retardation in Economic Growth. *Journal of economic and Business History***,** 534-560.
KUZNETS, S. S. (1930) *Secular movements in production and prices : their nature and their bearing upon cyclical fluctuations,* Boston, Houghton Mifflin.
LUCAS, R. E., JR. (1993) Making a Miracle. *Econometrica***,** 251-272.
MARKUSEN, J. R. (1985) *Profit Cycles, Oligopoly and Regional Development,* Cambridge, MA, The MIT Press.
MARSHALL, A. (1890) *Principles of economics,* London, Macmillan.
MARTIN, F. E. A. (1979) The Interregional Diffusion of Innovations in Canada. Ottawa.
MAURSETH, P. B. & VERSPAGEN, B. (1999) Europe: One or Several Systems of Innovation? An Analysis Based upon Patent Citations. IN FAGERBERG, J., GUERRIERI, P. & VERSPAGEN, B. (Eds.) *The Economic Challange for Europe.* Cheltenham, Edward Elgar.
NORTON, R. D. & REES, J. (1979) The product cycle and the spatial decentralization of American manufacturing. *Regional Studies,* 13**,** 141-151.
OAKEY, R. P., THWAITES, A. T. & NASH, P. A. (1980) The regional distribution of innovative manufacturing establishments in Britain. *Regional Studies: The Journal of the Regional Studies Association,* 14**,** 235-253.
PERRIN, J.-C. (1988) New Technologies, Local Synergies and Regional Policies in Europe. IN AYDALOT, P. & KEEBLE, D. (Eds.) *High Technology Industry and Innovative Environments: The European Experience* London, Routledge.

ROMER, P. M. (1986) Increasing Returns and Long-Rung Growth *Journal of Political Economy*, 1002-1037.

SAXENIAN, A. (1994) *Regional Advantage: Culture and Competition in Silicon Vaelley and Route 128,* Cambridge, MA, Harvard University Press.

SCHMOOKLER, J. (1966) *Invention and Economic Growth* Cambridge, MA, Harvard University Press.

SCHUMPETER, J. (1939) *Business Cycles,* New York, McGraw Hill.

SUARREZ-VILLA, L. & KARLSSON, C. (1996) The Development of Sweden's R&D-intensive Electronics Industries: Exports, Outsourcing and Territorial Dispersion. *Environment & Planning A*, 783-817.

TAYLOR, M. (1986) The Product Cycle Model: A Critique. *environment & Planning A*, 751-761.

THOMPSON, W. R. (1965) *A Preface to Urban Economics,* Baltimore, MD, The John Hopkins University Press.

WEIBULL, J. W. (1976) An axiomatic approach to the measurement of accessibility. *Regional Science and Urban Economics,* 6, 357-379.

VERNON, R. (1966) International Investment and International Trade in the Product Cycle. *The Quarterly Journal of Economics,* 80, 190-207.

Appendix 1

Old and new products enter demand symmetrically. All individuals have the same utility function:

$$U = \left\{ \sum_{i=1}^{n} c(i)^{\theta} \right\}^{1/\theta} \quad , 0 < \theta < 1$$

Eq. 2

where $c(i)$ is the consumption of the i^{th} product and n is the total number of old and new products. Furthermore, there is a latent demand for not yet developed new products. If Δn new products are developed the consumers will now maximize

$$U = \left\{ \sum_{i=1}^{n+\Delta n} c(i)^{\theta} \right\}^{1/\theta}$$

Eq. 3

under their budget restriction. This implies that utility increases with an increased variety of available products for given incomes and prices.

On the production side, all products are assumed to be produced under perfect competition with zero profits:

$$P_M = w_M$$

Eq. 4

$$P_{NM} = w_{NM}$$

Eq. 5

Where w_M and w_{NM} are the wage rates and P_M and P_{NM} are the prices of any product produced in the metropolitan or the non-metropolitan region, respectively. All new products will be produced in the metropolitan region and whether the metropolitan will produce any old products at all depend on the relative wages. If $w_M / w_{NM} > 1$, the metropolitan region will specialise totally in new products.

Now consider what happens if some new products mature and become old products, so that they also can be produced in the non-metropolitan region. We study the relative demand for a product produced in the metropolitan region and one produced in the non-metropolitan region. The relative demand will according to Equation (1) only depend on the relative prices:

$$\frac{c_M}{c_{NM}} = \left(\frac{P_M}{P_{NM}}\right)^{-(1/1-\theta)} = \left(\frac{w_M}{w_{NM}}\right)^{-(1/1-\theta)}$$

Eq. 6

where c_M is the consumption of the metropolitan product and c_{NM} is the consumption of the non-metropolitan product. Labour demand in each region will be equal to the demand for each product times the number of products. This implies that the relative demand for labour can be expressed as

$$\frac{L_M}{L_{NM}} = \frac{n_M c_M}{n_{NM} c_{NM}} = \left(\frac{n_M}{n_{NM}}\right)\left(\frac{w_M}{w_{NM}}\right)^{-(1/1-\theta)}$$

Eq. 7

Equation (6) can be rearranged expressing relative wages as a function of the ration of new products to old products and relative labour forces:

$$\frac{w_M}{w_{NM}} = \left(\frac{n_M}{n_{NM}}\right)^{1-\theta}\left(\frac{L_M}{L_{NM}}\right)^{-(1-\theta)}$$

Eq. 8

i.e. the relative wage rate in the metropolitan region is dependent on the relative importance of new products. An increase in the rate of new product development in the metropolitan region will increase its relative wage rate. What determines then the rate of new product development in metropolitan regions? In line with Krugman (1979) we assume that the number of new products developed is proportional to the number of existing products, i.e.

$$\dot{n} = in$$

Eq. 9

However, over time new products become old products, which in the same tradition can be expressed as

$$\dot{n}_{NM} = tn_M$$

Eq. 10

which implies that new products will become old products and can be produced in non-metropolitan regions with a time lag equal to $1/t$. The rate of change of the number of new products is equal to the difference between Equation (8) and Equation (9), i.e.

$$\dot{n}_M = in - tn_M$$

Eq. 11

The system described by Equations (8)-(10) is not stable. However, the stock of products will tend toward a stable mix. Defining the share of new products as $\sigma = n_M / n$ we have

$$\dot{\sigma} = \frac{\dot{n}_M}{n} - \frac{\sigma \dot{n}}{n} = i - (i+t)\sigma$$

Eq. 12

Hence, the system described will tend towards equilibrium at $\sigma = i/(i+t)$. The ratio of new to old products determines relative wages, implying that we in equilibrium have

$$\frac{n_M}{n_{NM}} = \frac{\sigma}{1-\sigma} = \frac{i}{t}$$

Eq. 13

Appendix 2

Table A6 Absolute value growth of products in H^{++} in functional regions 2 to 81, share of highly educated labor, distance to Stockholm, share of employees within the manufacturing (In ascending order w.r.t export value growth in H^{++}).

Functional region	No.	ΔH^{++}	Rank of share 2003*	Education Share 1997	Distance Stockholm	Manuf.share 1997
Skövde	34	1302.17	3	0.13	327	0.25
Jönköping	9	1020.95	5	0.16	328	0.19
Örnsköldsvik	60	944.89	6	0.14	555	0.24
Hudiksvall	57	652.99	17	0.12	303	0.21
Haparanda	80	455.37	47	0.11	1022	0.14
Gällivare	78	353.45	68	0.11	1110	0.21
Fagersta	45	310.89	25	0.09	175	0.31
Ljungby	13	189.78	21	0.09	434	0.29
Arvika	40	178.1	39	0.1	376	0.29
Bengtsfors	31	164.66	52	0.08	407	0.19
Örebro	42	153.48	4	0.16	193	0.31
Nyköping	3	115.51	14	0.14	103	0.2
Lidköping	33	96.54	18	0.11	346	0.28
Hagfors	39	95.8	49	0.09	334	0.13
Malmö	25	86.86	1	0.22	602	0.24
Sundsvall	58	78.96	16	0.15	384	0.15
Gävle	53	72.04	23	0.14	177	0.23
Kalmar	16	53.71	15	0.14	388	0.22
Ljusdal	54	48.74	54	0.07	333	0.18
Norrköping	7	46.52	9	0.15	163	0.18
Vilhelmina	67	42.02	57	0.1	692	0.13
Uppsala	2	40.68	11	0.24	72	0.19
Växjö	14	36.39	22	0.15	411	0.15
Sunne	35	31.94	48	0.1	360	0.2
Eskilstuna	5	30.51	24	0.14	114	0.15
Västerås	44	30.05	13	0.17	110	0.18

Göteborg	28	29.01	2	0.21	469	0.2
Simrishamn	22	27.5	42	0.12	595	0.18
Hultsfred	15	26.43	19	0.08	306	0.29
Linköping	6	25.73	8	0.2	200	0.19
Falkenberg	27	20.62	31	0.12	491	0.2
Arvidsjaur	71	20.56	65	0.13	865	0.18
Storuman	65	20.49	75	0.1	760	0.12
Årjäng	37	20.19	51	0.07	401	0.17
Karlstad	36	18.65	38	0.17	302	0.2
Karlskrona	21	18.29	30	0.18	467	0.24
Eksjö	10	17.15	28	0.1	317	0.17
Malung	48	16.2	35	0.07	353	0.2
Halmstad	26	16	26	0.14	489	0.22
Uddevalla	29	15.92	10	0.14	430	0.17
Kristianstad	24	14.74	32	0.14	528	0.23
Ludvika	52	11.99	50	0.12	222	0.22
Borås	32	9.29	12	0.13	410	0.21
Avesta	51	8.84	72	0.1	157	0.2
Strömstad	30	8.1	37	0.1	497	0.28
Helsingborg	23	7.93	7	0.15	562	0.19
Östersund	64	7.82	33	0.17	542	0.13
Arboga	46	7.66	45	0.1	153	0.28
Tranås	11	6.4	43	0.1	269	0.27
Gnosjö	8	6.23	27	0.09	389	0.34
Karlskoga	43	5.84	34	0.13	243	0.18
Falun	50	5.68	36	0.15	224	0.24
Skellefteå	70	4.91	20	0.14	772	0.21
Vansbro	47	4.04	71	0.07	308	0.28
Luleå	79	2.74	53	0.18	905	0.16
Bollnäs	56	2.37	66	0.09	270	0.22
Åre	62	2.29	63	0.12	588	0.14
Älmhult	12	1.82	41	0.12	465	0.21
Kiruna	81	1.54	61	0.12	1227	0.22
Karlshamn	20	1.35	46	0.11	494	0.18
Kalix	75	1.26	73	0.14	972	0.28
Filipstad	38	1.22	44	0.08	284	0.31
Lycksele	69	0.98	64	0.13	713	0.18
Härjedalen	63	0.71	70	0.07	435	0.14
Strömsund	61	0.47	69	0.09	606	0.19
Sollefteå	59	0.11	40	0.12	500	0.2
Sorsele	66	0	79	0.1	830	0.14
Arjeplog	72	0	76	0.1	909	0.17
Jokkmokk	73	0	77	0.11	1022	0.27
Överkalix	74	0	80	0.09	997	0.22
Pajala	77	0	78	0.11	1109	0.15
Mora	49	-0.03	60	0.11	308	0.23
Gotland	19	-0.05	67	0.14	201	0.13
Oskarshamn	17	-0.1	55	0.1	318	0.24
Västervik	18	-0.16	59	0.12	263	0.2
Katrineholm	4	-0.7	29	0.11	141	0.17
Umeå	68	-0.7	56	0.25	643	0.13
Övertorneå	76	-0.83	74	0.11	1045	0.17

Åmål	41	-0.86	58	0.1	378	0.1
Söderhamn	55	-0.93	62	0.1	252	0.17

* The regional share H^{++} of the region's total export

Table A 7 Correlation matrix, 259 municipalities i.e. all but those belonging to the Stockholm functional region

	$\ln EV_i^{03}$	$\ln EV_i^{97}$	$\ln Dist_i^{97}$	$\ln Manuf_i^{97}$	$\ln Edu_i^{97}$	$\ln AccServ_i^{97}$	$\ln Wage_i^{98}$
$\ln EV_i^{03}$	1	0.593^{**}	-0.135^{*}	0.114	0.391^{**}	0.443^{**}	0.402^{**}
(Sig.2-tailed)		0.000	0.030	0.067	0.000	0.000	0.000
$\ln EV_i^{97}$		1	-0.068	0.008	0.396^{**}	0.309^{**}	0.319^{**}
(Sig.2-tailed)			0.273	0.899	0.000	0.000	0.000
$\ln Dist_i^{97}$			1	-0.308^{**}	0.071	-0.613^{**}	-0.291^{**}
(Sig.2-tailed)				0.000	0.256	0.000	0.000
$\ln Manuf_i^{97}$				1	-0.433^{**}	0.462^{**}	0.314^{**}
(Sig.2-tailed)					0.000	0.000	0.000
$\ln Edu_i^{97}$					1	0.125^{*}	0.417^{**}
(Sig.2-tailed)						0.045	0.000
$\ln AccServ_i^{97}$						1	0.423^{**}
(Sig.2-tailed)							0.000
$\ln Wage_i^{98}$							1
(Sig.2-tailed)							

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-taled)

Table A 8 Moran’s I test for Spatial dependence for all models in Table 4 for year 2003 model

Variable	**Moran’s I** *(p-value)*[a,b]				
$\ln EV_i^{03}$	0.078 *(0.00)*				
$\ln EV_i^{97}$	0.035 *(0.00)*				
$\ln Manuf_i^{97}$	0.094 *(0.00)*				
$\ln Edu_i^{97}$	0.062 *(0.00)*				
$\ln AccServ_i^{97}$	0.336 *(0.00)*				
$\ln Wage_i^{98}$	0.067 *(0.00)*				
Dummy (1997)	**I**	**II**	**III**	**IV**	**V**
$D_{i,PubSect}$		0.017 *(0.00)*			
$D_{i,AgricSect}$			0.017 *(0.00)*		
$D_{i,Central}$				0.021 *(0.00)*	
$D_{i,Periph}$					0.060 *(0.00)*

[a] Tests are based on 258*258 row-standardized symmetric weight matrix.
b “-tail test

Figure A 1 Export value in H^{++} in all Swedish municipalities 1997, Export unit value=31.24

Figure A 2 Export value in H^{++} in all Swedish municipalities 2003, Export unit value= 19.31

Figure A 3 Absolute growth of export value in H^{++} in all Swedish municipalities 1997-2003

Appendix 3

The conceptual framework for geographic spillovers is based on the knowledge production function of Griliches (1979). Also, a discussion of accessibility and the association to exponential distance decay is available in (Weibull, 1976) and the accessability concept is shown in detail in Gråsjö (2005a). A summary follows below.

The accessibility of municipality i to itself and the $n-1$ surrounding municipalities is defined as the sum of the internal accessibility to a given opportunity D and its accessibility to the same opportunity in the other municipalities,

$$A_i^D = D_1 f(c_{i1}) + ... + D_i f(c_{ii}) + ... + D_n f(c_{in})$$

Eq. 14

where A_i^D is the sum of accessibilities of municipality i. D_i is the measure of an opportunity to have a face-to-face contact which can be the opportunity to meet with R&D institutes, customers, producers, etc. $f(c)$ is the distance decay function that determines how the accessibility value is related to the costs of reaching this specific opportunity. A common approximation of this is to apply an exponential function such as,

$$f(c_{ij}) = \exp\{-\lambda t_{ij}\}$$

Eq. 15

, where λ is a time distance parameter and t_{ij} is the travel time distance between region i and region j. The number of people employed within industries of producer services in region i will be used as a proxy for the supply of producer services. Here, spatial interaction is emphasized as each industry's potential reach for producer services measured as accessibility[20]. So, total regional accessibility is a function of the sums of internal and external accessibility where the potential opportunities are negatively related to distance

$$A_i^D = \Sigma D_j \exp\{-\lambda t_{ij}\}$$

Eq. 16

[20] For further readings see (Andersson and Johansson, 1995, Gråsjö, 2005b, Johansson et al., 2003, Weibull, 1976).