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PRODUCT INNOVATION, EXPORT ENTREPRENEURSHIP AND REGIONAL CHARACTERISTICS

- an analysis of innovation ideas in regions

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- an analysis of innovation ideas across regions

by

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Abstract

This paper focuses on how characteristics of regions pertaining to local information about product varieties and markets as well as networks for the transmission of information about innovation opportunities influence the arrival of innovation ideas to existing and potential entrepreneurs. We formulate a model where entrepreneurs or innovating firms introduce new products in a quasi-temporal setting. Market conditions are characterized by monopolistic competition between varieties belonging to the same product group, in which there is entry and exit of varieties. Firms innovate in response to the arrival of innovation ideas. To realize these ideas firms have to make an R&D investment and a firm's decision to export a variety to a new market is associated with a market channel investment. The theoretical model is used as a reference when formulating two regression models, with which we estimate factors that can explain the introduction of new export varieties by firms in different regional milieus. In one model we examine the emergence of new export firms, and in the second model we investigate the appearance of new export varieties. Results are consistent with the assumption that knowledge and information flows have a positive influence on the frequency of arrival of innovation ideas to firms.

JEL: R11, R12, O31

1. INTRODUCTION

What governs the arrival rate of ideas to entrepreneurs? The major concern of this paper is how regional characteristics influence the rate at which innovation ideas arrive to potential and established firms in different regions. By focusing on regional characteristics that influence knowledge flows, this paper adheres to the large literature devoted to how different regional characteristics are related to the preconditions for innovations. Regional characteristics pertain to various forms of place-specific external economies (c.f. Marshall 1920, Ohlin 1933, Jacobs 1969, Fujita *et al* 1999, Fujita and Thisse 2002). External economies encompass distance-sensitive knowledge and information spillovers.[1] The same idea is expressed in Behrens et al. (2006), who examine how local density economies influence international trading conditions and thus location. It is maintained through the paper that such knowledge flows are related to the arrival frequency of innovation ideas to entrepreneurs (Glaeser and Saiz 2003, Glaeser 1994). Specifically, entrepreneurs located in regions with a high potential for knowledge and information spillovers are more likely to receive ideas that can generate innovations.

The current paper investigates how certain regional characteristics influence the generation of export innovations. In this endeavor, we make use of the model developed by Dixit and Stiglitz (1977) in which firms supply product varieties under conditions of monopolistic competition. We illustrate how a set of geographical markets and another set of variety producers define a system that can develop in the neighborhood of monopolistic-competition equilibrium. The analysis is quasi temporal by considering history as given at each point in time, in such a way that path dependence can be illuminated. In addition we show how firms with a single variety and a single geographic market can co-exist with firms supplying many varieties to many markets.

Each variety in this framework belongs to a specific product group, for which all customers in each geographical market have identical CES preferences (cf. Krugman 1980). Innovation is then a matter of developing new varieties and establishing links to new destination markets. This process is governed by the stochastic arrival of innovation ideas to individual existing or potential firms (entrepreneurs). The basic assumption is that the arrival rate is influenced by characteristics of the region hosting each innovating firm.

The theoretical model is used as a reference for an empirical analysis of how the arrival rate of innovation ideas is related to regional characteristics. In the empirical analysis we study exports of product varieties and exporting firms across Swedish functional regions at two different points in time. In this way we can observe for each region the emergence of new varieties and new exporting firms. Such events are used as indicators of innovation events across regions. The frequency of these innovation events are matched against characteristics of regions that reflect (i) a region's local information about varieties and markets, (ii) its networks for transmission of information about innovation opportunities, and (iii) the absorption capacity of entrepreneurs in the region. Each functional region is considered to be a place of origin for product and market ideas (Andersson and Karlsson 2004). The regions are called functional to express that the time distances between different places in a region are small enough to allow for frequent face-to-face

[1] See Audretsch (2003) and Feldman (1999) for reviews of empirical studies that investigate the role of such spillovers for innovations.

contacts. In this context, our principle task is to describe how the arrival of ideas is different in each region, and how these differences depend on the described regional characteristics.

The remainder of the paper is organized in the following fashion: Section 2 presents the theoretical model displaying how innovation ideas are generated, how such ideas materialize through innovation investments and how product varieties compete with each other in every specific geographic market. Section 3 outlines the concept of a functional region and the regional characteristics that affect the flow of innovation ideas to firms in a region, model as a Poisson process. Section four introduces the regression equations and presents the results of the empirical analysis, while Section 5 interprets the results and concludes.

2. INNOVATIONS AND VARIETY COMPETITION

The model introduced here depicts an economy with many separated destination markets for a given product group. In this economy each firm supplies varieties from a subgroup of the given product group. A stochastic process is assumed to generate new innovation ideas as time goes by, and at each date every individual geographic (destination) market is in the neighborhood of an MCE (monopolistic competition equilibrium).

The sequential structure of the model recognizes that new product varieties are introduced as a consequence of innovation ideas to entrepreneurs who carry out innovation investments. These entrepreneurs may be new or already established. Innovations of entrepreneurs include both new product varieties and new geographical markets (cf. Schumpeter 1934). The model recognizes that an innovation idea can arrive to a potential firm as well as to an already established firm. A new firm has to make a startup, an R&D and a market-channel investment. All firms have to make an R&D investment when introducing a new variety. Due to these investments, each firm will have fixed costs. Similar assumptions can be found in Brambilla (2006), who examines how firms can grow when expanding their range of product varieties in a model where the product development induces fixed costs. The innovation investments also constitute barriers to entry that reduce the crowding in the variety space (Hummels and Lugovsky 2005).

In view of the above, our model focuses on a specific product group that potentially includes many varieties. Entrepreneurs introduce new product varieties based on product ideas. These ideas become available to entrepreneurs through a sequence of periods, such that in each period there is a given set of varieties and export markets. The materialization of an idea in the form of a new product variety is associated with an R&D investment (cf. Andersson and Ejermo 2007). The competition structure ascertains that in each market two different firms will never supply the same variety, because any potential imitator would also have to make a similar investment. In an analogous way firms get ideas over time about export-market opportunities and can start to export after having made a trade-link investment. In this way the number of varieties – and hence the proximity to a monopolistic competition equilibrium (MCE) – in each respective market depends on entrepreneurs materialization of ideas in the past.

2.1 Demand in a Destination Market

Consider an economy with *N* different product groups. In the model presentation we focus on one particular product group, say *K*, where a product group at a given point in time consists of *n* product varieties, and where *n* may change over time. The typical customer is assumed to have a taste for variety, expressed by a CES function such that the customer prefers to buy equal amounts of each variety. This means that a product group is characterized by the following preference function of a representative customer:

$$U_K = \left(\sum_{k \in N} q_k^{\phi} \right)^{\frac{1}{\phi}}, \ 0 < \phi < 1, \quad (1)$$

In the case when all customers are consumers, formula (1) would represent a so-called sub-utility function of the representative consumer. The focus on one single product-group market may for example be based on a separability assumption such that the overall preferences are described by a function *U*:

$$\ln U = a_1 \ln U_1 + ... + a_K \ln U_K + ... + a_N \ln U_N, \quad \sum_i a_i = 1 \quad (2)$$

When (2) applies the market for the varieties in a product group is a separated market. However, if (1) applies to all product groups, we may without loss of generality focus on a single product group *K*. Note that the emergence of a new product group in (2) entails a new industry which correspond to a radical product innovation. On the other hand, an expansion of the set of varieties within a product group corresponds to a non-radical innovation. In this paper we constrain the analysis to cover only the latter type.

The formulation in (1)-(2) implies that for customers who maximize U with a given total budget $\hat{m}$, the budget share allocated to product group *K* is constant and equal to a_K. Hence, we can write $m = a_K \hat{m}$ to express the budget that a typical customer allocates to buy varieties in group *K*. With a given number of customers the corresponding aggregate budget for the selected market is *M*. In all of the subsequent analysis, one may think of the representative customer as a fictitious agent as long as formula (3) below applies.

We shall now examine the market solution at a point in time where the number of varieties, *n*, is given. Let us assume that all customers optimize their preference function in (1), subject to the budget constraint $m - \sum_k p_k q_k \geq 0$, where p_k denotes the price of product variety *k*. Assuming that there are sufficiently many varieties to make income effects negligible (Dixit and Stiglitz 1977), the following demand function applies:

$$x_k = \alpha p_k^{-\theta} M \quad (3)$$

where the parameter $\theta = 1/(1-\phi) > 1$ represents the price elasticity and where α applies for all product varieties in the product group. The value of α reflects the market structure and shrinks as the number of varieties increases. In monopolistic-competition we get $\alpha = P^{\theta-1}$, where $P \equiv \left(\sum_k p_k^{1-\theta}\right)^{\frac{1}{1-\theta}}$ is the ideal price index satisfying $U_k = M/P$. In the subsequent analyses each firm is assumed to perceive P as given, which implies that each individual firm perceives a demand schedule that depends only on its own pricing decision.

At any point in time, n varieties are supplied, and $\sum_{k=1}^{n} p_k x_k = M$. But how large is n? In the next subsection we conclude that an equilibrium value of n obtains when firms with only one variety and one market make zero profit and is denoted by n^e. This value is determined by M and the production technology. However, how the actual n compares to n^e in a given point in time is historically given and depends on entrepreneurs' past introduction of varieties. Over time n may grow but the change is limited by entrepreneurs' activity to introduce new varieties. In view of this, we shall assume that every new variety has to be introduced by entrepreneurs (an existing firm or a potential firm). In order to introduce a variety the entrepreneurial firm must have a viable product idea.[2]

The above presentation refers to one particular geographical market. Consider now that there is a set of potential markets to which a firm can sell its output. One of these markets is the firm's home market and the others are export markets. To simplify arguments we assume that all markets are similar in the sense that a firm perceives the same demand schedule in each market.

2.2 Supply Conditions of Firms

The supply conditions of each firm are based on three types of fixed costs associated with the supply of a product. These are caused by (i) a firm-specific investment, (ii) product-specific development investments and (iii) trade-link investments that are market specific. We assume that certain varieties (TR-varieties) in a product group are technology-related, which brings about synergies such that these varieties can share the same firm-specific investment as well as the same trade-link investment. The latter occurs when two related varieties are being exported to the same export destination.

Our first assumption is that a product group consists of several subgroups, each containing a set of TR-varieties, forming a TR-group. We assume:

(A.1) Varieties in the same TR-group of a firm can share the same startup capital and the same trade-link capital.

An implication of (A.1) is that if an existing firm receives a variety idea which does not belong to its TR-group, the idea can only lead to the formation of a new firm. Thus, a firm will always supply varieties belonging to a given TR-group. Our second assumption is about a firm's cost:

(A.2) Every firm has three types of capital: (i) F-capital for firm startup, (ii) G-capital representing R&D efforts for each variety, and (iii) H-capital for developing a trade-link to a market. The variable cost of each firm is v per unit output.

[2] One may compare this approach to the product cycle model of Krugman (1979), where new product ideas arrive according to a deterministic process.

Given assumptions (A.1) and (A.2), we can identify four archetypes of firms: one variety and one market, many varieties and one market, one variety and many markets, and many varieties and many markets. To understand their co-existence we first have to characterize the supply conditions of the first type of firm, which we call SVSM-firm (single-variety and single-market). Therefore, consider a firm that supplies only one variety to one market. The production conditions of this firm are given by the cost function:

$$C = F + G + H + vx \qquad (4)$$

where F denotes firm-specific fixed costs, G denotes the fixed costs related to product development, H denotes the fixed costs related to investment in a market channel (trade link to the particular market), v denotes variable costs, and x denotes total output. Assume that the firm maximizes its profit $V = px - vx - F - G - H$, given the perceived demand schedule in (3). The profit-maximizing price is given by:

$$p = v\sigma \qquad (5)$$

where $\sigma = \theta/(\theta - 1)$. The price given in (5) is viable only if $V = v(\sigma - 1)x - F - G - H$ is non-negative when the quantity x is supplied. If the number of varieties supplied is sufficiently large, the profit of the SVSM-firm is driven towards zero, which implies that the output in the market becomes:

$$x^o = (\theta - 1)(F + G + H)/v \qquad (6)$$

By assuming that every geographical market contains single-variety firms as described above, we can assert that in every market the sales of a variety is charged the price $p = v\sigma$, and that in equilibrium the amount sold equals x^o, where equilibrium refers to a situation when the number of varieties is large enough to make the profit of single-variety firms equal to zero. The number of varieties in such a situation is hereafter denoted by n^e.

A geographical market for which (5) and (6) apply is characterized by monopolistic-competition equilibrium (MCE). A market solution is in the proximity of an MCE when (5) applies. In such a solution the sales of individual varieties, $\tilde{x}$, may exceed x^o, and then this reflects a gap in the market, $n < n^e$. As a consequence, all supplying firms make positive profits.

Having reached this stage we may conclude that as soon as a market contains sufficiently many varieties, all firms will charge the price given in (5) in their ambition to maximize profits. As n approaches n^e and $\tilde{x}$ approaches x^o, the profit of SVSM-firms approaches zero. This result is contrasted by the solution for multi-variety-multi-market firms (MVMM-firms), which supply TR-varieties to several markets. These firms will make positive profits also in equilibrium as long as they co-exist with SVSM-firms. To see this, we introduce the following innovation matrix, Ω, that describes a particular firm's combination of markets and varieties. $\Omega = \{\omega_{ij}\}$, where the typical element satisfies the following condition:

$$\omega_{ij} = \begin{cases} 1 \text{ if variety } i \text{ is sold on market } j \\ 0 \text{ otherwise} \end{cases}$$

where i = 1, 2, …, N enumerates the set of all possible varieties, and where j = 1, 2, …, M enumerates the set of potential markets. With this notation we can express the total profit of an MVMM-firm as follows:

$$V_{MVMM} = (p - v)\sum_i \sum_j \omega_{ij}\tilde{x}_{ij} - hH - gG - F \qquad (7)$$

where $p = v\sigma$, $\tilde{x}_{ij}$ is the supply of variety i to market j, h is the number of trade links and g the number of varieties. Now, assume that there is supply from an SVSM-firm with non-negative profits in each destination market j. Then our MVMM- firm must have non-negative profit in every market where it is active as supplier. The quantity supplied of each variety in market j is $\tilde{x}_j$ Moreover, in market j the firm's total revenue is $(p - v)\sum_i \omega_{ij}\tilde{x}_j$ and its fixed cost are smaller than or equal to $H + gG + F$, where $g = \sum_i \omega_{ij}$. Thus, the profit from market j for the two firms satisfy

$$V_{SVSM} = (p - v)\tilde{x}_j - H - G - F \geq 0 \qquad (8a)$$

$$V_{MVMM} \geq (p - v)g\tilde{x}_j - H - gG - F > gV_{SVSM} \qquad (8b)$$

In a similar way we may take into account that the MVMM-firm can supply its varieties to other markets, given that such market-destination innovations have occurred. Although simple, the result is clear-cut. A sufficient amount of varieties in a market j ascertains that all suppliers in that market supply the same quantity $\tilde{x}_j$ for all varieties and the same price $p = v\sigma$ is charged for each variety[3]. Because of this a MVMM-firm can make positive profits in that market.

2.3 Innovation Process: Entry and Exit of Varieties

In the preceding subsection we considered both SVSM and MVMM-firms. The first type of firm is the result of a single innovation, whereas the MVMM-firm is the result of a sequence of innovation events. In our theoretical framework we assume that an innovation event is preceded by an innovation idea that is received by an entrepreneur. More specifically we assume:

[3] This is a corollary of the CES preference structure in (2.1): consumers perceive all varieties as equally close substitutes. This is a convenient property which keeps the analysis simple.

(A.3) A stochastic process governs the arrival of innovation ideas to entrepreneurs, and such an entrepreneur may be associated with a potential (brand new) firm as well as with an already established firm.[4] We assume that there are four types of innovation ideas as described in Table 1.

Table 1. *Innovation events and associated investments*

Type of innovation event	Character of the innovation idea	Innovation investments
I	A potential firm receives an idea about a variety and a market	$F + G + H$
II	An established firm receives a TR-idea about a new variety and a new market	$G + H$
III	An established firm receives a TR-idea about a new market for an already established variety	H
IV	An established firm receives a TR-idea about a new variety for an already established market	G

Table 1 shows that an innovation idea that reaches a potential firm requires a larger total investment than an innovation idea to an already established firm. As specified in the table, established firms only adopt ideas associated with TR-varieties. There are no economic motives for a firm to host varieties that are not technologically related. If another idea arrives, that will formally result in a new firm.

Consider now that the arrival of ideas over time brings about a solution in a geographic market, such that the number of varieties is $n = n^e$ and the quantity sold of each variety is $\tilde{x} = x^o$. In this equilibrium the profit of an SVSM firm satisfies:

$$V = (p - v)x^o - F - G - H = 0 \qquad (9)$$

Suppose that we in the same market can find a single-market firm with g TR-related varieties. Than this firm has a positive profit equal to $V_g = (g - 1)(F + H)$. Consider now that this multi-product firm manages to make an additional innovation, resulting in the supply of (g + 1) varieties from the firm. The consequences of this introduction of an additional variety would be as described in Table 2.

[4] In the empirical analysis we assume that a Poisson process generates new ideas, and this process may differ for the four types of innovation events.

Table 2. *Consequences of an innovation that distorts equilibrium.*

(i) Profit of SVSM-firms	$V_{SVSM} < 0$
(ii) Number of varieties in the market	$\tilde{n} = n^e + 1$
(iii) Supply quantity of each variety	$\tilde{x} = x^o \left(n^e /(n^e + 1)\right)$
(iv) Profit of the innovating firm	$V_{g+1} = (g-1)(F+H) - \dfrac{(p-v)(g+1)x^o}{(n^e+1)}$

The first part of (iv) is the amount of profit before the innovation event. The second part is the reduction in revenue of each variety in the market that is caused by the fact that $n^e + 1$ varieties have to share the equilibrium purchasing budget $pn^e x^o$. This means that a little bit less is sold of each variety as described in (iii) of Table 2.

It is obvious from (iv) that the innovator's profit, V_{g+1}, will remain positive as soon as $n^e + 1)$ is sufficiently large compared to (g + 1). The result presented in Table 2 is just one example of how multi-variety firms can disturb equilibrium. It also shows that the model framework needs an additional assumption. We need to determine what happens with firms that experience negative profits.

(A.4) A stochastic process governs the shut down of firms with a negative profit.

> *Remark 1*: Assumptions (A.1)-(A.3) allow geographic markets with sufficiently many varieties to develop in a sequential process towards states where the number of varieties is equal to n^e. Assumption (A.4) ascertains that a geographic market can return to equilibrium after a distortion caused by innovations made by a multi-variety firm.
>
> *Remark 2*: The profit expression (iv) in Table 2 shows that the incentives to introduce new varieties declines as a firms number of varieties, g, expands. At the same time, growth in the product-group budget M, increases the equilibrium value of n^e. Such growth allows entry of new varieties both by single-variety and multi-variety firms.

2.4 Stochastic Processes and Regional Characteristics

The model presented in the preceding sections assumes that innovation ideas and shut-down decisions are generated by random processes. In this subsection we assume that these processes are of Poisson type and focus on the arrival rate of the four types of ideas described in Table 1. In particular, we discuss how the rate of arrival can be related to characteristics of different regional milieus.

In order to make the assumption (A.3) formally precise, we will assume that the process by which innovation ideas about new varieties and trade links arrive to firms can be described by a Poisson process. The probability that a firm receives $n \in \{0,1,2,3,...\}$ innovation ideas during the interval $[t, t+\tau]$ is then given by:

$$\Pr\left[\left(N_{t+\tau} - N_t\right) = n\right] = f(n,\lambda) = \frac{e^{-\lambda}(\lambda)^n}{n!} \qquad (10)$$

where $\lambda \in \{0,\infty\}$ is the rate of arrival of product ideas, i.e. the expected number of ideas per time unit. The essential parameter, λ, may be specific for each type of innovation idea, and its value may also be a function of the characteristics of each region. In such a process, innovations become available to entrepreneurs through a sequence of periods, such that in each period there is a given set of varieties and export markets[5].

The decisions to shut down firms with a negative profit may also be modeled as a Poisson process, according to (9). However, the subsequent analyses concentrate on the arrival of ideas and the associated innovation events, and the entire interest is directed towards the parameter λ, which determines the arrival rate of ideas. The mission is to describe and estimate how this parameter is related to the characteristics of individual regions.

We will consider three categories of regional characteristics for each product group (industry):

(i) Information and knowledge sources in the region
(ii) Absorption capacity in the region
(iii) Special localization and urbanization phenomena

The first category of characteristics can be reflected for each product group by the number of export firms, export varieties and trade links in each region. The second category may be identified as the knowledge intensity of firms associated with a product group. The localization phenomenon is primarily reflected by regional specialization for each product group, whereas urbanization is reflected by total employment in a region.

It has long been recognized that the conditions for innovations in a region are related to durable characteristics of the region's economic milieu. The general concept of agglomeration economies encompasses the flow and generation of ideas in a region in the form of distance-sensitive spillovers of knowledge and information. The proximity in an agglomeration brings about potentials that pertain to the frequency of such spillovers (see e.g. Audretsch 2003 and Feldman 1999 for reviews). There are two general reasons for this. Firstly, knowledge is complex and has 'tacit' elements wherefore the transmission is facilitated by face-to-face contacts (c.f. von Hippel 1994 and Polyani 1966). Secondly, several market transactions pertinent for market-mediated knowledge and information flows are more recurrent in geographically limited areas. For instance, in an integrated labor market region – delineated by commuting distances – employees can typically change job without changing settlement. This is a more frequent phenomenon than

[5] As shown the previous sections, this means that markets may temporarily be in a state of 'out-of-equilibrium'.

changing both job and settlement. External economies in the form of knowledge and information spillovers can thus be described as place-specific.

Place-specific external economies and the potential for knowledge and information spillovers in particular, suggest that the arrival of ideas to existing and potential entrepreneurs can be related to the characteristics of the region in which they are located:

> *Arrival rate assumption*: The arrival rate of ideas for product varieties and trade links, λ, vary across regions with different characteristics. Existing firms and potential entrepreneurs located in regions with high density of characteristics pertinent for external economies in the form of knowledge and information spillovers have a higher probability of receiving ideas about new product varieties and new trade links.

This implies that the λ's in (10) are specific for each region, such that:

$$\lambda_r > \lambda_s \quad \Rightarrow \quad \Pr\left[\left(N_{t+\tau,r} - N_{t,r}\right) = n\right] > \Pr\left[\left(N_{t+\tau,s} - N_{t,s}\right) = n\right] \tag{11}$$

where *r* and *s* denote two different locations. This formulation stimulates to a series of questions related to the outline above. Does the generation of new ideas differ between regions and does it differ between similar firms in different regions? Does the diversity of a region in terms of number of firms or number of varieties supplied have any affect on the frequency of introduction of new varieties or new firms? Does regional concentration of a particular product group imply that that the birth of new varieties is more frequent in such a region?

3. DATA AND EMPIRICAL ISSUES

This section presents the empirical counterpart to the arrival of innovation ideas in the form of (i) new export varieties and the cumulated number of exported varieties and (ii) new exporting firms and the cumulated number of exporting firms. Although our model give predictions about ideas for new trade links, we focus on product ideas in the empirical part and observe that a new exporting firm combines a product and a trade-link idea. The section starts by defining the unit of analysis and goes on to describe the data used in the empirical analysis.

3.1 Functional Regions and Innovation Ideas

The unit of analysis in the subsequent empirical analysis is 81 functional regions in Sweden. These are equivalent to Local Labor Market (LLM) regions, comprising a distinct integrated labor market (NUTEK 1998).

Each LLM provides the firms in the region short time distances for travel between different locations, in most cases less than 50 minutes. The average time distance is 20-30 minutes (Johansson, Klaesson and Olsson 2002). LLMs are delineated based on the intensity of intra-regional commuting flows and are in this sense characterized by a high frequency of intra-regional interaction. The borders of a LLM are distinguished by a sharp decline in the intensity of such flows. Hence, a LLM can be conceived as an arena for face-to-face interaction and a milieu for the generation and diffusion of innovation ideas (Andersson and Karlsson 2006).

3.2 Innovations and Ideas - number of varieties, firms and destinations

As an empirical counterpart to the model formulated in Section 2 we make use of a rich dataset on the export activities by firms in different regions at different points in time. These data allow us to measure (i) number of exporters, (ii) number of export varieties and (iii) number of destinations (destination countries) and (iv) export value in each LLM in different time periods. The data material is provided by Statistics Sweden (SCB) and is based on information of the location of exporting firms across Swedish functional regions. In these data a firms is defined as a legal entity, whose exports are classified into product categories according to the CN[6] classification system, which is common for EU-member countries. An export product (or variety) is referred to as a distinct classification code at the 8-digit level in the CN classification scheme. The data cover the manufacturing industry, which is comprised by the sectors listed in Appendix. 38 manufacturing sectors define the manufacturing industry in the data material.

The data described above allow us to provide a coherent description of the variety of different regions' export activities, which is related to urbanization economies and Jacob's (1969) diversity hypothesis as regards the potential for knowledge and information spillovers. Moreover, the data also allow for an analysis of the concentration and specialization of regions' exports across sectors, which can be related to localization economies.

Our main focus is on how characteristics of regions influence the innovation potential in terms of the generation of innovation ideas. Any measure of ideas has to be indirect in the sense that we do not observe the idea but rather the outcome of ideas, as registered in (economic) data records. The data used in this paper allow us to measure, for each region, the number of exporters and the number of varieties that are exported over a sequence of years. Thus, we can observe how the number of exporters and number of varieties that are exported change over time.

The model outlined in Section 2 focuses on (i) new varieties by existing firms and (ii) new firms as manifestations of innovation ideas. The empirical counterpart applied here measures the number of new exporters and the number of new export varieties across LLMs in Sweden between 1997 and 2003. Each new exported variety and each new exporting firm that enters to the data during the period is assumed to be based on an innovation idea.

To make these measures formally precise, let $v_i^r(t)$ denote the export value of export product *i* in period *t* in region *r*. If N^r denotes the set of new export products in region *r* between period (*t*) and period ($t+\tau$), all elements *i* in this set satisfy:

$$N^r = \{i : v_i^r(t) = 0 \wedge v_i^r(t+\tau) > 0\} \qquad (12)$$

In a similar fashion, each element *f* in the set F^r of all new export firms in region *r* between period (*t*) and ($t+\tau$) satisfy:

$$F^r = \{f : v_f^r(t) = 0 \wedge v_f^r(t+\tau) > 0\} \qquad (13)$$

[6] CN = combined nomenclature.

In the subsequent analysis we have (t) = 1997 and ($t+\tau$) = 2003. Thus, we use the introduction of new export varieties and new export firms across regions between these two periods as empirical counterparts to innovations in the model, where each innovation – following the model – is assumed to be based on a product idea. Note that the formulation in (12) and (13) implies that we measure export varieties and export firms that are new to each region[7]. If N^r and F^r for certain regions contain many elements, this is assumed to reflect that the characteristics of the milieu in these regions are favourable for the generation of product ideas and thus innovations.

3.3 Hypotheses and Outline of the Empirical Analysis

The outline in Section 2.4 suggests a set of hypotheses about how characteristics in regions affect the generation of ideas and innovations. The empirical analysis focuses on whether observations from the data on LLMs are consistent with the predictions of the model, as given by reference to place-specific external economies and knowledge and information spillovers.

The first basic hypothesis is that the arrival rate of ideas differs across regions, i.e. that the λ's are region-specific as formulated in (11). That leaves us with variation across regions to be explained. The second basic hypothesis is that the variations in λ across regions can be explained by characteristics in regions that pertain to the potential for knowledge and information spillovers. As maintained in Section 2.4, such a potential is related to agglomeration economies.

We empirically examine a set of relationships consistent with such a general hypothesis. Specifically, the following sets of relationships are empirically examined:

1) New export varieties and the size of functional regions.
2) New exporting firms and the size of functional regions.
3) New export varieties as a function of (i) existing number of varieties and (ii) existing number of destinations.
4) New exporting firms as a function of (i) existing number of exporting firms and (ii) existing number of destinations.

The relationships expressed above relate to urbanization economies in the sense that new varieties and new exporting firms are related to the regional size and the scale of the existing regional export variety. They pertain to the general diversity hypothesis and that the size of a region is an important characteristic for the generation of ideas and innovations.

In order to empirically examine (i)-(iv) we make use of the Poisson and the Negative Binomial regression techniques. These models are appropriate for analyses of count data (Cameron and Trivedi 1998). The number of new export varieties and new export firms are clearly count data and take discrete vales 0,1,2…,n. The Poisson regression model assumes that the number of events – i.e. new export varieties or new exporting firms – in each region r, n_r, is drawn from a

[7] This way of constructing an empirical measure is similar to what is used in the literature on entry and exit of firms (c.f. Nyström 2006). In such studies, entry (exit) is measured as the (dis)appearance of a legal entity (or an identity code in a firm-level dataset) in a region or country. In this sense, the exporting firms and new export varieties is the 'entry' of an export firm and an export variety in a region.

Possion distribution with parameter λ_r. Our hypothesis is that this parameter depends on characteristics x_r in region r:

$$\Pr\left[N_r = n_r \left| x_r \right.\right] = \frac{e^{-\lambda_r} \lambda_r^{n_r}}{n_r\,!}, \quad \text{where} \quad \ln \lambda_r = x_r' \beta \tag{13}$$

A drawback with the Poisson model is that the variance and mean are assumed to be equal. If this not the case, we have overdispersion and the Negative Binomial model is a valid alternative (Greene 2003). This model does not require that mean and variance are equal. The Negative Binomial model includes unobserved effects, such that (Greene 2003):

$$\ln \mu_r = \ln \lambda_r + u_r = x_r' \beta + u_r \tag{14}$$

where u_r represents specification error or cross-sectional heterogeneity. Like Poisson model the Negative Binomial model assumes a Possion distribution:

$$\Pr\left[N_r = n_r \left| x_r, u_r \right.\right] = \frac{e^{-e^{x_r'\beta} e^{u_r}} (e^{x_r'\beta} e^{u_r})^{n_r}}{n_r\,!} \tag{15}$$

4. EXPORTS, IDEAS AND INNOVATIONS ACROSS REGIONS

4.1 Size and Export Variety – stylized relationships across regions

This section describes the relationship between the size of a region and the variety of its export flows. In doing so, it shows the scale of the potential for knowledge and information spillovers about innovation ideas.

Figures 1-3 plot the relationship between the size of regions (in terms of employment) and a) the number of export varieties, b) the number of export firms and c) the number of destination countries.

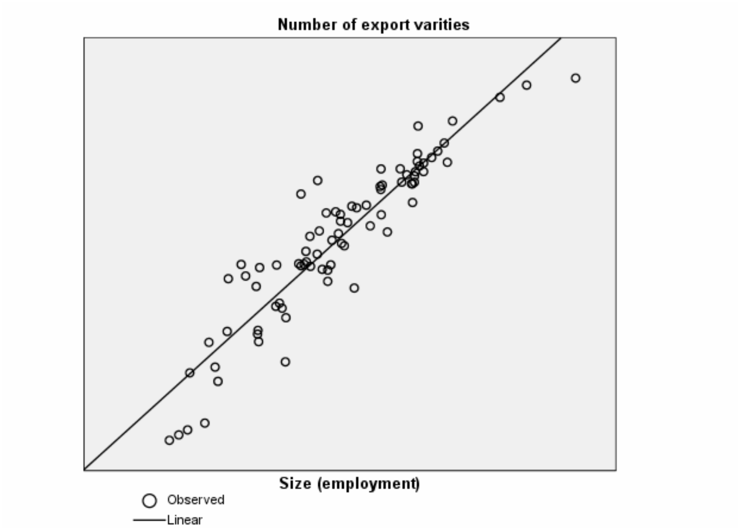

Figure 1. *The relationship between regional size and number of export varieties,(in logs).*

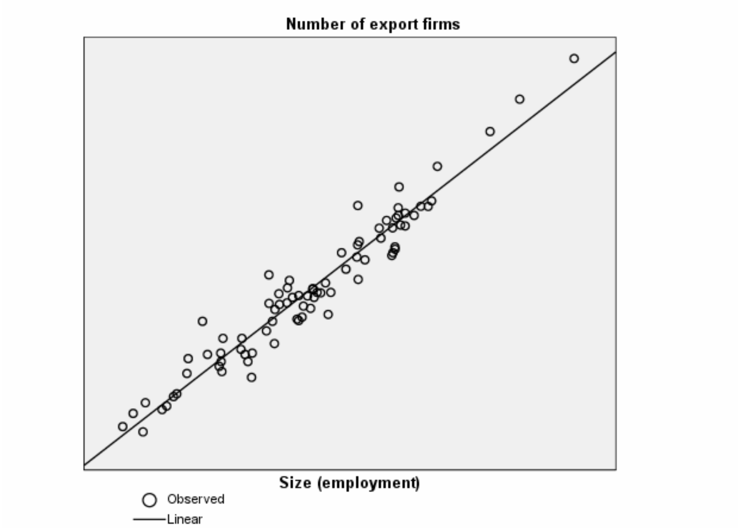

Figure 2. *The relationship between regional size and number of export firms,(in logs).*

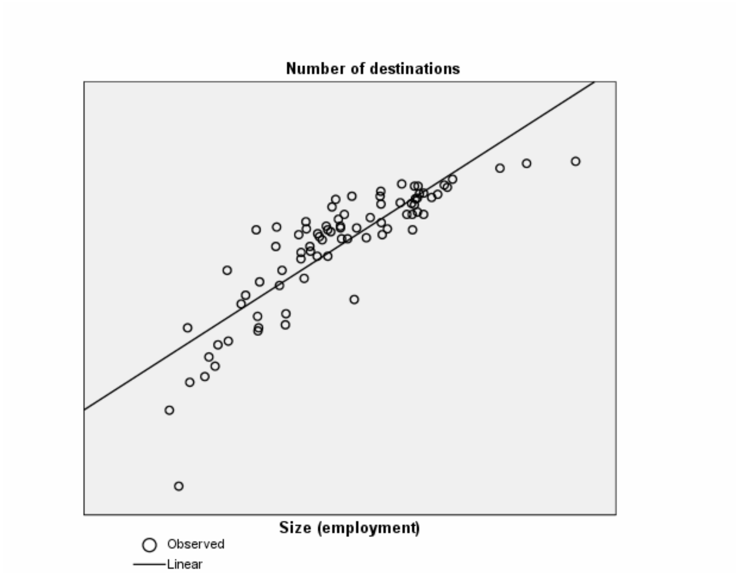

Figure 3. *The relationship between regional size and number of export firms,(in logs).*

As can be seen from the figures, there is a palpable relationship between the size of a region and the variety of the export flows, as measured by the number of export varieties, the number of export firms and the number of export destinations. In addition, we also examined the above relationships across the 38 manufacturing sectors described in the Appendix. For each of the sectors the aggregate relationships above were confirmed.

What are the implications of the stylized relationships described above? The clear-cut implication is that the potential and scale of knowledge and information spillovers as regards new varieties are greater in large regions. In such regions, there is a larger set of export firms, a larger set of opened trade links and a larger set of exported varieties. With reference to the model outlined in Section 2, we may thus expect that the arrival rate of ideas for products and trade-links is higher per unit of time. This, evidently, has an obvious parallel to agglomeration economies.

4.2 New Export Varieties, New Exporting Firms and Regional Characteristics

How are new export varieties and new export firms across regions related to characteristics of the regional economic milieu? In accordance with the description in Section 3 we measure new export varieties between 1997-2003 as those varieties that were exported from a given region in 2003 but not exported in 1997. New exporting firms are measured in an equivalent manner. Figures 4 and 5 present the estimated Kernel density for new export varieties and new export firms across Swedish functional regions, respectively.

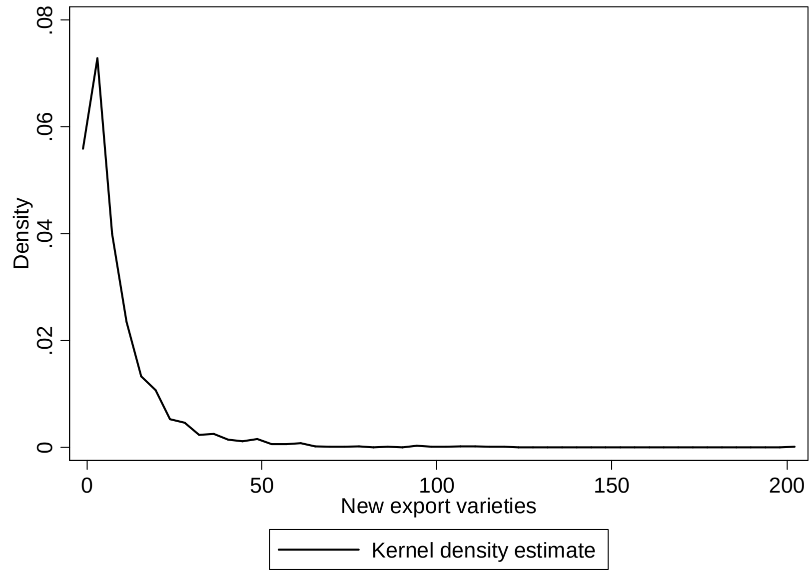

Figure 4. *Kernel density estimate new export varieties across sectors and regions 1997-2003.*

The figures show that the distribution is highly skewed. New export firms and new export varieties are infrequent phenomena in most regions. There are differences across regions and sectors in terms of the entry of new export varieties and the entry of new exporting firms during the period time under study.

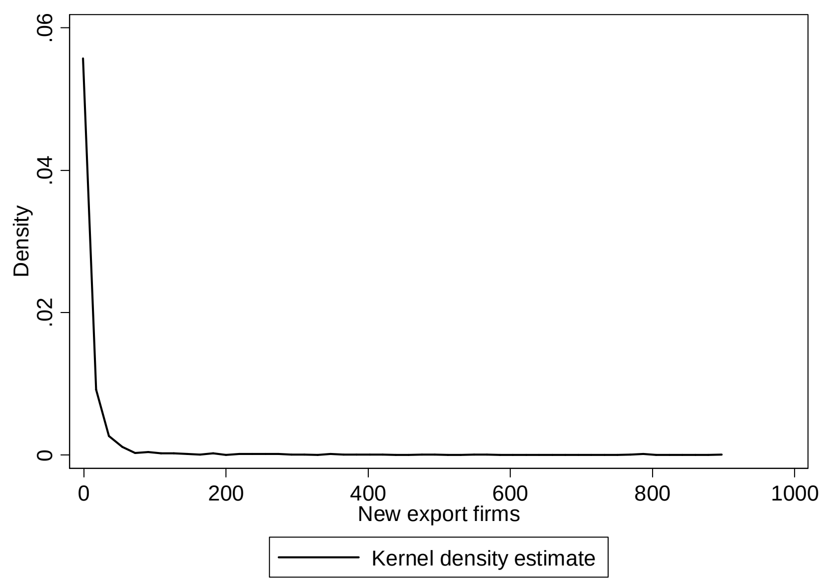

Figure 5. *Kernel density estimate of new export firms across sectors and regions 1997-2003.*

In order to examine how the likelihood of new export varieties and new export firms, we make use of a two-dimensional cross-section dataset, in which an observation pertains to a specific sector in a region. There are 38 sectors and 81 regions, so there are 3 078 observations in the data material. We conduct estimations for the number of new export varieties and new export firms, respectively. Table 3 presents the independent variables in the regression analyses (summary statistics can be found in the Appendix). The motivation for each independent variable is presented in the right column.

Table 3. *Independent variables reflecting regional characteristics in the regression analysis (initial conditions)*

Variable	Description	Motivation
Export varieties in sector *s* (*t*)	Number of exported products in 1997 in sector *s* in the region	Cumulated knowledge about export varieties in each sector and region
Export firms in sector *s* (*t*)	Number of exporting firms in 1997 in sector *s* in the region	Cumulated experience of export initiation in each sector and region
Number of destinations in sector *s* (*t*)	Number of exporting firms in 1997 in sector *s* in the region	Experience about trade links and export conditions in each sector and region
Export specialization in sector *s* (*t*)	Revealed comparative advantage index of sector *s* in the region 1997. Sectors' share of the region's total export value in relation to the sector's share of Sweden's total export value[8].	Specialization phenomena in each sector and region
Knowledge intensity in sector *s* (*t*)	Share of workforce in sector *s* with a long university education in the region in 1997.	Knowledge and absorptive capacity of the workforce in each sector and region
Size of region (*t*)	Total employment in the region in 1997.	Agglomeration and urbanization phenomena in each region
Export dummy sector *s* (*t*)	Dummy which equals 1 if the region has no exports in sector *s* 1997, 0 otherwise.	Indicate lack of trade-link and general export experience in each sector in the region
Sector dummy	Dummy which equals 1 if observation pertains to sector *s*, 0 otherwise.	Control for heterogeneity across sectors.
Region dummy	Dummy which equals 1 if observation pertains to region *r*, 0 otherwise.	Control for heterogeneity across regions.

[8] To be precise, the export specialization of region *r* in sector *s* is given by $(x_{s,r}/x_r)/(X_s/X)$, where x_r denotes regions *r*'s total exports, *X* Sweden's total exports and *s* denotes sector.

All independent variables are measured in 1997, which is the base year for the analysis. The variables in the table thus describe in initial regional characteristics. In the regression analysis these initial conditions explain changes in a subsequent time interval, i.e. new export varieties and new export firms, respectively, between 1997 and 2003.

The main objective of the empirical exercise is to demonstrate that the arrival of innovation ideas differs between regions and the variables in Table 3 characterize a region's capacity to stimulate the emergence of innovation ideas. The theoretical framework claims that the number of new export varieties grows as the frequency of new ideas increases.

Tables 4 and 5 presents estimated parameters of the variables listed in Table 1 for new export varieties and new export firms between 1997 and 2003, respectively, across sectors and regions. In all cases we could reject the null hypothesis that the mean equals the variance could be rejected for all estimations. Because of this, we present the estimated parameters obtained with the Negative Binomial model.

Table 4. *Estimates of the impact of regional characteristics on the likelihood of new export varieties across sectors and regions, (Negative Binomial model with sector and region dummies).*[a,b]

	I	**II**
Export varieties in sector *s* (*t*)	0.003* (0.0004)	-
Destinations in sector *s* (*t*)	-	0.0008 (0.0008)
Export specialization in sector *s* (*t*)	0.007* (0.0026)	0.008* (0.0030)
Knowledge intensity in sector *s* (*t*)	0.67* (0.1371)	0.65* (0.1406)
Size of region *r* (*t*) (log)	0.35* (0.0393)	0.42* (0.0403)
Export dummy (*t*)	-0.59* (0.0475)	-0.55* (0.0478)
Cragg-Uhler(Nagelkerke) R^2	*0.77*	*0.76*
McFadden R^2	*0.24*	*0.22*
# of observations	*3 078*	*3 078*

a) Estimates of constant and sector and region dummies not shown.

b) Standard errors presented within brackets (* denotes significance at the 0.05 level).

Table 4 presents the results for new export varieties whereas Table 5 presents the results for new exporting firms. All independent variables are as in Table 1, except that the size of each region is measured in logs (a correlation matrix is presented in Appendix). The two reported measures of fit – McFadden and Cragg-Uhler R^2 – are satisfactory. MacFadden R^2 is around 0.22 in Table 4 and 0.38 in Table 5, whereas Cragg-Uhler R^2 ranges from about 0.77 to over 0.90. The models have in general better fit for new export firms compared to new export varieties.

It is evident from the tables that the selected regional characteristics have a similar impact on the likelihood of new export varieties and the likelihood of completely new export firms. However, in the latter case the impacts tend to be stronger.

The basic regional characteristic is the presence of agglomeration economies, which is simply reflected by the size of the region. Two other regional characteristics indicate the potential information about variety options. The first of these describe for each sector (product group) the number of already introduced varieties in a region. The second measures for each industry the export specialisation in a region, and this reflects the presence of localization economies. All these three characteristics have clearly significant parameter values.

For each industry, the regression results show that the absorption capacity has a significant influence on the generation of innovation ideas. The absorption capacity is reflected by the knowledge intensity of each sector in a region. However, the number of destination links for each industry in a region has a significant impact only on the emergence of new export firms.

The results from the regression analyses are consistent with the theoretical framework. Regional characteristics reflecting the potential for knowledge and information flows have a positive influence on the arrival of innovation ideas to firms, as measured by new export varieties and new export firms.

Table 5. *Estimates of the impact of regional characteristics on the likelihood of new export firms across sectors and regions, (Negative Binomial model with sector and region dummies).*[a,b]

	I	II
Export firms in sector *s* (*t*)	0.0002* (0.0001)	-
Destinations in sector *s* (*t*)	-	0.0045* (0.0005)
Export specialization in sector *s* (*t*)	0.014* (0.0022)	0.007 (0.0026)
Knowledge intensity in sector *s* (*t*)	0.47* (0.1007)	0.38* (0.0999)
Size of region *r* (*t*) (log)	1.03* (0.0480)	0.98* (0.0483)
Export dummy (*t*)	-0.26* (0.0451)	-0.29* (0.0450)
Cragg-Uhler(Nagelkerke) R^2	*0.92*	*0.91*
McFadden R^2	*0.38*	*0.37*
# of observations	*3 078*	*3 078*

a) Estimates of constant and sector and region dummies not shown.

b) Standard errors presented within brackets (* denotes significance at the 0.05 level).

5. SUMMARY AND CONCLUSIONS

This paper presented a model where entrepreneurs or innovating firms introduce new products. The model incorporated a fixed R&D investment associated with each product and a fixed market channel investment.

In the model, new products are introduced over a sequence of periods based on product and trade-link ideas. Innovations are in this context a matter of realizing such ideas in the form of developing new varieties and establishing links to new destination markets. The basic assumption was that the arrival rate of ideas is influenced by characteristics of the region hosting each innovating firm.

The theoretical model was used as a reference for an assessment of how the arrival rate of innovation ideas is related to regional characteristics. In the empirical analysis we studied the emergence of new varieties and new exporting firms. The frequency of these innovation events were matched against characteristics of regions that reflect (i) a region's local information about varieties and markets, (ii) its networks for transmission of information about innovation opportunities and (iii) the absorption capacity of entrepreneurs in the region.

The results of the empirical analysis are consistent with the assumption that knowledge and information flows have a positive influence on the frequency of arrival of innovation ideas to firms. The data describe a pattern in which the likelihood of new export varieties and new exporting firms is larger in regions with a higher potential for knowledge and information spillovers about export varieties and export opportunities. It was further shown that new export firms and new export varieties are more frequent phenomena in regions in which the workforce has higher absorptive capacity (as measured by education intensity).

The empirical results are in concordance with empirical results in many other studies. The novelty in the contribution is two-fold. First, we have introduced a framework focusing on the emergence of new product varieties. Second, we use a new type of data set, which allows direct observations of entry of new export varieties and new export firms. Hence, regional characteristics associated with knowledge sources and knowledge flows are coupled in a straightforward way with observations of new export varieties and export firms across a set of regions.

It has long been recognized that large city regions – sometimes referred to as gateway-cities (cf. Andersson and Andersson 2000) – often function as multi-hub nodes through which a variety of goods and information flows are channeled. The results of the analysis in the current paper are consistent with that such characteristics are conducive for innovations. Jacobs (1969) argued precisely that city-regions with diversified trading networks are birthplaces for new ideas and innovations. The results of the paper have also a bearing on the stability of these types of regions over time as they indicate path-dependent phenomena; the frequency of innovation ideas is larger in regions where many ideas already have been materialized. In such region there exists local information about varieties and markets as well as networks for transmission of information about innovation opportunities (trade networks), which are conducive for the arrival of innovation ideas to potential and existing entrepreneurs.

Further research in this field may attempt to capture the innovation process over a sequence of periods and a more detailed analysis of the time pattern of the process. Such efforts could also better clarify the path dependence of the process. Quite another approach would be to include not only characteristics of individual regions, but also attributes of the individual firms located in each region.

REFERENCES

Andersson, Å.E & D. Andersson (eds) (2000), *Gateways to the Global Economy*, Edward Elgar, Cheltenham

Andersson, M. and C. Karlsson (2004), "Regional Innovation Systems in Small and Medium-Sized Regions – a critical review and assessment", in Johansson, B. et al. (eds), *The Emerging Digital Economy: entrepreneurship, clusters and policy*, Springer-Verlag, Berlin: 55-82

Audretsch, D.B. (2003), "Innovation and Spatial Externalities", *International Regional Science Review*, 26: 167-174

Behrens, K., C. Gaigné., GIP Ottaviano and J-F. Thisse (2006), “How Density Economies in Transportation Link the Internal Geography of Trading Partners”, *Journal of Urban Economics*, 60: 248-263

Brambilla, I (2006), “Multinationals, Technology and the Introduction of Varieties of Goods”, *NBER Working Paper*, No.12217

Cameron, A. and P. Trivedi (1998), *The Analysis of Count Data*. Cambridge University Press, New York

Dixit, AK. and JE. Stiglitz (1977), “Monopolistic Competition and Optimum Product Diversity”, *American Economic Review*, 67: 297-308

Feldman, M. (1999), “The New Economics of Innovation, Spillovers and Agglomeration: a review of empirical studies”, *Economics of Innovation and New Technology*, 8: 5–25.

Fujita, M. and J-F. Thisse (2002), *Economics of Agglomeration: Cities, Industrial Location and Regional Growth*, Cambridge University Press, Cambridge.

Fujita M, P. Krugman and AJ. Venables (1999), *The Spatial Economy*, MIT Press, Boston.

Glaeser, E.L. and A. Saiz (2003), “The Rise of the Skilled City”, *Harvard Institute of Economic Research*, Discussion Paper 2025

Glaeser, E.L (1994), “Cities, Information and Economic Growth”, *Cityscape*, 1: 9-47

Greene, W. H. (2003), *Econometric Analysis*, Prentice-Hall, Upper Saddle River

Hummels D. and V. Lugovskyy (2005), “Trade in Ideal Varieties: theory and evidence”, Working Paper Krannert School of Management, Purdue University

Jacobs, J. (1969), *The Economy of Cities*, Random House Inc., New York

Johansson B, J. Klaesson and M. Olsson (2002), “Time Distances and Labor Market Integration”, *Papers in Regional Science*, 81:305-327.

Krugman, P. (1979), A Model of Innovation, Technology Transfer, and the World Distribution of Income, *Journal of Political Economy*, 87: 253-266.

Krugman, P. (1980), Scale Economies, Product Differentiation, and the Pattern of Trade, *American Economic Review*, 70: 950-959

Marshall, A. (1920), *Principles of Economics*, MacMillan, London

NUTEK (1998), *Små företag och Regioner i Sverige – med ett tillväxtperspektiv för hela landet*, Report 1998:10, Stockholm

Nyström, K. (2006), “Interdependencies in the Dynamics of Entry and Exit”, *Journal of Industry Competition and Trade*, 7:113-130

Ohlin, B. (1933), *Interregional and International Trade*, Harvard University Press, Cambridge

Polyani, M. (1966), *The Tacit Dimension*, London; Routledge & Kegan Paul Ltd

Schumpeter, J. A. (1934), *The Theory of Economic Development*, Harvard University Press, Cambridge

von Hippel, E. (1994), “Sticky Information and the Locus of Problem Solving: Implications for Innovation”, *Management Science*, 40: 429-439

Appendix

Sectors in the manufacturing industry.

Sector	Description
1	Wood products
2	Paper
3	Publishing, printing
4	Petroleum products, nuclear fuel
5	Basic chemical
6	Pesticides, agro-chemical products
7	Paints, varnishes
8	Pharmaceuticals
9	Soaps, detergents, toilet preparations
10	Other chemicals
11	Man-made fibres
12	Rubber and plastics products
13	Non-metallic mineral products
14	Basic metals
15	Fabricated metal products
16	Energy machinery
17	Non-specific purpose machinery
18	Agricultural and forestry machinery
19	Machine-tools
20	Special purpose machinery
21	Weapons and ammunition
22	Domestic appliances
23	Office machinery and computers
24	Electric motors, generators, transformers
25	Electric distribution, control, wire, cable
26	Accumulators, battery
27	Lightening equipment
28	Other electrical equipment
29	Electronic components
30	Signal transmission, telecommunications
31	Television and radio receivers, audiovisual electronics
32	Medical equipment
33	Measuring instruments
34	Optical instruments
35	Watches, clocks
36	Motor vehicles
37	Other transport equipment
38	Furniture, consumer goods

Summary statistics of independent variables in the regression analyses (excl. sector and region dummies)

	Export varieties	Export firms	Number of destinations	Export specialization	Knowledge Intensity	Size	Export dummy
Mean	19.86	27.45	20.01	1.06	0.04	44632.09	0.34
Std. dev	35.14	108.76	26.67	4.83	0.09	101899.01	0.47
Min	0.00	0.00	0.00	0.00	0.00	1160.00	0.00
Max	458.00	2674.00	160.00	138.18	0.72	832457.00	1.00
# obs	3078	3078	3078	3078	3078	3078	3078

Correlations between independent variables in the regression analyses (excl. sector and region dummies)

	Export varieties	Export firms	Number of destinations	Export specialization	Knowledge Intensity	Size (log)	Export dummy
Export varieties	1	-	-	-	-	-	-
Export firms	0.57	1	-	-	-	-	-
Number of destinations	0.73	0.58	1	-	-	-	-
Export specialization	0.06	0.02	0.15	1	-	-	-
Knowledge Intensity	0.17	0.17	0.25	0.02	1	-	-
Size (log)	0.52	0.42	0.62	-0.01	0.28	1	-
Export dummy	-0.38	-0.18	-0.49	-0.12	-0.17	-0.56	1