PRODUCT INNOVATION, EXPORT AND LOCATION OF ENTREPRENEURSHIP

by

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Abstract

This paper introduces a model where new products are introduced by entrepreneurs or innovating firms in a quasi-temporal setting. Market conditions are characterized by monopolistic competition between varieties belonging to the same product group, where varieties can become obsolete over time and hence disappear from demand. Firms that innovate have to make an R&D investment, and a firm’s decision to export a variety to a given market is associated with a market channel investment. The model is used to predict export behavior by firms in different regional milieus, and these predictions are compared with observations from a rich data set describing export activities of Swedish firms. The data set contains firm level information about export flows, where the flow of each variety is associated with the exporting firm’s location, export value, price and destination. In the empirical analysis we examine how the arrival of innovation ideas varies across regions and how this variation depends on regional characteristics.
1. INTRODUCTION

1.1 Product Diversity and Monopolistic Competition

Export flows from OECD countries are characterized by a great diversity of varieties for each product group (industry) that is exported. This form of diversity indicates that export markets have features that resemble monopolistic competition. The idea of monopolistic competition in an industry was introduced by Chamberlin (1933), accompanied by the concept imperfect competition as phrased by Robinson’s (1933). About 50 years later Brakman and Heijdra (2004), observe a second monopolistic competition revolution – based on a seminal paper by Dixit and Stiglitz (1977).

Monopolistic-competition models have been applied to analyze international trade in quite new directions (Helpman, 1984), and with – in a certain sense – more “realistic” assumptions, such as the existence of scale economies, and more “realistic” outcomes, such as two-way flows of differentiated product varieties (Krugman, 1980). Similar models have also been developed to analyze interregional trade, the formation of multi-city systems (Fujita, Krugman and Venables, 1999), and urban and regional economics in general, providing arguments for cumulative economic growth and decline (Fujita and Thisse, 2002).

According to Brakman and Heijda (2004), the primary benefits afforded by the Dixit-Stiglitz model was that it provided (i) a definition of an industry supplying varieties that are symmetric and possible to aggregate, (ii) an overall utility measure featuring separability, and (iii) incorporating economies of scale on the firm level.

In the literature on international trade the Dixit-Stiglitz model (DS-model) came into frequent use, partly because it made it possible to elegantly formulate simple models that captured observed phenomena such as two-way trade and product diversity in trade flows (Grubel and Lloyd, 1975). Moreover, based on the inherent taste for variety, the applied models could explain why international trade has continued to grow faster than the world product in recent decades. In addition, this model structure could be adjusted to combine features from both monopolistic competition and factor proportions models (Krugman, 1990), although recent contributions indicate that productivity differentials between firms may alter important conclusions (Chaney, 2005). The model framework in this paper borrows the basic ideas from previous contributions but allows a single firm to supply more than one variety, and distinguishes between different export markets.

1.2 Scale and Scope Economies

The subsequent contribution tries to accommodate the basic elements of monopolistic-competition models to a global economy that hosts multi-product and multi-market firms, while carefully retaining the monopolistic competition feature of every single geographic market. Customers in each market purchase product varieties, where some are domestically produced and others imported.

The introduction of multi-product and multi-market firms in the model is motivated by observations from firm-level datasets which show that lion’s share of the exports of countries
originates from a limited set of large firms that export many products and to many destinations (see e.g. Andersson 2006, Baldwin & Ottaviano 2000 and Bernard, Jensen & Schott 2005).

In view of the above, the model is 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 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. These different fixed costs help to explain the existence of multi-variety firms as well as firms that export to many different foreign markets. At the same time all markets are characterized by an essential feature of monopolistic-competition models – the competition is between varieties and not between firms. We claim in the model that this feature is safeguarded by the CES preference structure combined with the existence of sufficiently many single-variety firms. Moreover, we do not consider the possibility of firm mergers.

1.3 Innovation and Location of Entrepreneurship

A basic observation is that new product varieties are introduced as a consequence of product innovations, carried out by entrepreneurs. These entrepreneurs may be new or already established. Innovations of entrepreneurs include both new product varieties and new geographical markets, (c.f. Schumpeter 1913).

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. Such ideas that can generate 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. The materialization of an idea in the form of a new product variety is associated with an R&D investment. 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.

In the context of the arrival of ideas to entrepreneurs, the paper adheres to the large literature devoted to how different regional characteristics are related to the preconditions for innovations. In particular, these characteristics pertain to various forms of place-specific external economies, (c.f. inter alia Fujita & Thisse 2002, Marshall 1920, Fujita et al 1999, Jacobs 1969, Ohlin 1933). External economies encompass distance-sensitive knowledge and information spillovers\(^1\). It is maintained in the paper that such spillovers are related to the frequency and potential as regards the arrival of ideas to entrepreneurs. Specifically, entrepreneurs located in regions with a high potential for knowledge and information spillovers are more likely to receive ideas that can generate innovations. In relation to our model, this suggests a relationship between external trade and internal geography.

\(^1\) See Audretsch (2003) and Feldman (1999) for reviews of empirical studies that investigate the role of such spillovers for innovations.
In the empirical part of the paper, the model is used as a reference for analyses of the introduction of new export varieties and new exporting firms across Swedish functional regions. This part of the analysis makes use of regional export data, obtained from information on the location of exporting firms across 81 functional regions. Each such region is considered to be a place of origin for product and market ideas. 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 regional characteristics. 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 contacts. A basic question is about the arrival of new product-variety ideas. Does the generation of new ideas differ between regions and does it differ between similar firms in different regions? Does regional concentration of a particular product group imply that that the birth of new varieties is more frequent in such a region?

1.3 Outline
The remainder of the paper is organized in the following fashion: Section 2 presents the model and introduces economies of scope into the general monopolistic-competition framework. Section 3 presents the data. Section 4 presents the results of the empirical analysis and Section 5 concludes.
2. THEORETICAL FRAMEWORK

2.1 Geography, Market Demand and Pricing

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:

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

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 \( U \) such that:

\[
\sum_{i=1}^{N} \ln a_i = \ln a_1 + \ln a_2 + \cdots + \ln a_N = \ln \left( \sum_{i=1}^{N} a_i \right) = \ln M, \quad \sum_{i=1}^{N} a_i = 1 \quad (2)
\]

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 market 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, 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, 2004), the following demand function applies:

\[
x_k = a p_k^{-\phi} M \quad (3)
\]
where the parameter $\theta = 1/(1-\phi) > 1$ represents the price elasticity and where $\alpha$ applies for all product varieties in the product group. The derivation of (3) and the nature of $\alpha$ are described in Appendix 1. The value of $\alpha$ reflects the market structure and shrinks as the number of varieties increases. In monopolistic-competition we get $\alpha = P^{\theta-1}$, where $P \equiv (\sum_k p_k^{-\theta})^{1/\theta}$ is the ideal price index satisfying $U_k = M/P$, as described in Appendix 1. 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 $n$? The equilibrium value of $n$ obtains when firms 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.\textsuperscript{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 Market Solution with Single-Variety Firms

Consider a firm that supplies only one variety to one market. The production conditions of this firm are given by the cost function:

$$ C = F + G + H + vx $$ \hfill (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:

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

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

\textsuperscript{2} One may compare this approach to the product cycle model of Krugman (1979), where new product ideas arrive according to a deterministic process.
\[ x^o = (\theta - 1)(F + G + H) / v \]  

(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, \( \bar{x} \), 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.

2.3 Innovation Processes, Technology Relatedness and Scope Economies

We will assume that certain varieties in a given product group are technology related, whereas other varieties may lack such relatedness. In view of this, consider an existing firm that supplies a variety \( i \). Associated with this variety is a set \( N(i) \) of varieties that are mutually technology related, where \( i \in N(i) \) and where \( i \) may be the only element of \( N(i) \). Technology-related varieties can share fixed costs in the operation of a firm as expressed by assumption 1:

**Assumption 1:** Two varieties that are technology related can (i) share the same firm-specific fixed cost, \( F \), and (ii) the same trade-link fixed cost, \( H \).

Technology relatedness strictly refers to the production technology. The preference structure in (1) implies that the marginal rate of substitution (MRS) between two technology related varieties is always the same as the MRS between two non-technology related varieties.

In our model framework, new varieties become available through an innovation process with two steps. The first part has to do with the arrival of new ideas, which may arrive to not yet active entrepreneurs (potential firms) and existing firms. Once an idea has arrived the potential innovator has to decide about the associated innovation investments:

**Assumption 2:** Ideas about new product varieties and new trade links arrive according to some random process to either a potential or an existing firm. (a) For a new entrepreneur, a new idea can be transformed to an innovation when the firm makes a firm-specific (\( F \)), a variety-specific (\( G \)), and a trade-link specific (\( H \)) investment. (b) For an existing firm that supplies variety \( i \), a variety idea can be realized by a \( G \)-investment, while the firm relies on already made investments in \( F \)-capital and \( H \)-capital. (c) For an existing firm, an idea about a new trade link can be realized by means of an \( H \)-investment, while the firm relies on already made investments in \( F \)-capital and \( G \)-capital.

Note that our framework implies that entrepreneurs can potentially exploit economies of scope on the production side. However, materializing this potential requires that an entrepreneur receives multiple product ideas \( j, l \in N(i) \) and decides to transform these ideas into innovations, i.e. introduce the varieties associated with the ideas \( j, l \in N(i) \) on the market. Moreover, it may be observed that there are no incentives to consider pure imitations of previous innovations,
because an imitation also gives rise to fixed costs $G$ for a new variety and $H$ for a new trade link. However, observations of already materialized innovations may trigger new ideas.

The above implies a sequence over time in which ideas for new product varieties and trade links are gradually received by existing and new entrepreneurs. Whether or not such ideas will be materialized depends on existing firms’ and potential entrepreneurs’ incentives to do so. The subsequent subsections analyze these respective incentives.

### 2.3.1 Incentives for Product Innovations

We initially focus on the innovation incentives in a single geographic market. What are the incentives for a new entrepreneur and an existing firm, respectively, to introduce a new variety? If there is a gap in the market, such that $n < n'$, it implies that $x > x'$. As a consequence, all firms in the market make positive profits, $V > 0$.

**Remark 1:** Suppose that $n < n'$: Then a new entrepreneur has an incentive to pay $F + G + H$ and introduce a new variety on the market. Moreover, an existing firm supplying variety $i$ has an incentive to pay $G$ and introduce an additional variety $j \in N(i)$ on the market.

In relation to Remark 1, we observe that if an idea $s \notin N(i)$ arrives to an existing firm, the result is the establishment of a new firm, stressed by the fact that a firm-specific investment in $F$-capital is necessary.

Given that multi-variety firms have a cost advantage compared to single-variety firms, can the entry process approach an MCE in which single-variety firms make zero profits? Evidently, this hinges on how the pricing strategy of multi-variety firms compares to that of single-variety firms.

The demand for any variety is independent of the production technology. All varieties consequently face the demand schedule in (3). The corresponding pricing strategy of single product firms is given by (5). To determine the pricing strategy of multi-variety firms we note that the cross-price elasticity of demand is equal across all varieties. Provided that the number of varieties supplied by a multi-variety firm is always a small subset of the total number of varieties, a consequence of this is that multi-variety firms cannot control competition between the varieties they supply themselves. A reduction in the price of one variety has the same effect on all varieties on the market. Therefore, just as single-variety firms, multi-variety firms take the price index $P$ in (3) as given and price its respective varieties according to (5).

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3 Recall that $n'$ refers to an MCE where the number of varieties is large enough to make the profit of single-variety firms equal to zero.

4 This is a corollary of the CES preference structure in (2.1): consumers perceive all varieties as equally close substitutes. This is indeed a convenient property and keeps the analysis simple. Analyses of the pricing strategies of multi-product are otherwise complicated due to that firms can control competition within its product line and engage in e.g. cross-subsidisation, (see e.g. Brander & Eaton, 1984 and Katz, 1984). This is so because multi-product firms internalize “spillovers” in the form of demand interdependencies across related products.
Remark 2: Since all varieties face the same demand schedule (3) and are priced according the same pricing strategy (5), the supply of each and every variety at an MCE is $x^o$, as given by (6). This means that $V = 0$ for single-variety firms, while $V$ can be positive for multi-variety firms.

Remark 2 tells us that a single-market firm with $g$ varieties has always an incentive to introduce an additional variety if there is a gap in the market. In addition to this we can also show that when $g$ is sufficiently smaller than $n^e$, there is still an incentive to introduce a new technology-related variety. The argument is as follows. A firm that supplies $g$ technology-related varieties to only one geographical market has the following profit

$$V_{(g)} = (p - v)x^o g - F - H - gG$$

This profit is always positive when single-variety firms are present, since $(p - v)x^o - F - G - H = 0$ for single-variety firms in MCE. If the depicted firm introduces one more technology-related variety the sales of all varieties in that market will shrink from $x^o$ to $\tilde{x} = x^o n^e / (n^e + 1)$.

Remark 3: In a market with many varieties, $n$ will be much larger than $g$ and then $V_{(g+1)} > V_{(g)}$ holds whenever $F + H > G$. On the other hand, when $g$ becomes a large share of $n$ the incentive to introduce additional products disappears.

Remark 3 implies that an MCE solution can be perturbed, since $\tilde{x} < x^o$ implies that single-variety firms have negative profits. Observing that $(F + G)$ represents sunk costs, we conclude that the single-variety firms can only return to non-negative profits if the market budget $M$ grows over time or if existing varieties disappear from the index set $N$ of the representative buyer’s preference function in (1), by analogy with radioactive decay or some similar process.

2.3.2 Incentives for Trade-Link Innovations

The theoretical framework allows two types of innovations to occur. The previous subsection describes the introduction of new product varieties, and here we consider the introduction of new trade links. The model framework is employed to describe the conditions of a single-variety firms with $h > 1$ trade links. For such a firm the following total profit applies:

$$V_{(1,h)} = (p - v)hx^o - F - G - hH$$

$^5$ To see this, observe that the preference structure implies that each consumer will always buy that same amount of each variety. With constant prices, then, we have $\tilde{x} = x^o n^e + 1 = \tilde{m} = x^o n^e$, where $\tilde{m}$ denotes the expenditure per variety, i.e. total budget divided by the price of a variety.
Let us now assume that there exist single-variety firms in each of the $h$ different markets. Since this implies that $(p - v) \bar{x} \geq F + G + H$, we may conclude:

**Remark 4:** Assume that markets 1, 2, ..., $h$ host single-variety firms, where each firm supplies the amount $\bar{x} \geq x^0$ of its variety. Then a single variety firm can increase its profit by adding a new export market from $h$ to $h+1 \geq 2$. In other words, $V_{(1,h+1)} > V_{(1,h)}$ and $V_{(1,1)} \geq 0$. Suppose instead that for market $h+1$ we have that $n = n^e$ before introduction of an additional variety. The introduction remains profitable as long as $F > H/n^e$ (see Appendix 2).

The results in Remark 3 and Remark 4 can be combined for firms with both many varieties and many destination markets. It is obvious that firms can obtain a profit advantage. When a firm already has many trade links, each such link can be used for all the technology-related varieties a firm has. However, we leave the issue with that observation. Instead we can conclude that in general the benefits from finding a new destination market are greater than those from introducing more varieties to one and the same markets. When examining this conclusion for empirical observations, however, we have to observe that the trade-link fixed cost $H$ is not the same for all destination markets. Instead, we should assume that for a firm with a given location, the markets, 1, 2, ..., $h$ can be ordered such that $H_1 < H_2 < \ldots < H_h$, and for some $h + k$, the value $H_{h+k}$ is high enough to be an export barrier, that is, we obtain $F < H_{h+k}/n^e$.

### 2.4 Ideas, Innovations and Characteristics of Regional Milieus

The model presented in the preceding sections builds on a random arrival process for product and trade link ideas. We shall here focus on the arrival rate of such ideas and describe how the rate of arrival can be related to characteristics of different regional milieus.

In order to make the assumption about the arrival of ideas – as expressed in Assumption 2 – formally precise, we may assume that the process by which product ideas about new varieties and trade links arrive to firms can be described by a Poisson process. The probability that a firm receives $n \in \{0,1,2,3,\ldots\}$ product ideas during the interval $[t, t + \tau]$ is then given by:

$$\Pr[(N_{t+\tau} - N_t) = n] = f(n, \lambda \tau) = \frac{e^{-\lambda \tau} (\lambda \tau)^n}{n!}$$  \quad (9)$$

where $\lambda \in \{0, \infty\}$ is the rate of arrival of product ideas, i.e. the expected number of ideas per time unit. An analogous arrival process for ideas about trade links implies that ideas that can generate 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.

We will now consider the parameter $\lambda$, which determines the arrival rate of product and trade link ideas, and describe how this parameter is related to attributes of regions.

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6 As shown the previous sections, this means that markets may temporarily be in a state of ’out-of-equilibrium’.
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 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). Secondly, several market transactions pertinent for market-mediated knowledge and information spillovers 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 that changing of job and settlement. External economies in the form of knowledge and information spillovers are thus place-specific.

Knowledge and information spillovers refer to flows outside the market that benefit individual firms. That they take place outside the market means that they are not priced, though they may be mediated through market transactions. Examples include transactions on the labor market where an agreed salary may not fully reflect the knowledge and ideas of an employee. By definition, such spillovers are outside the control of the individual firm, which motivates modeling the arrival of ideas in a random process.

Agglomeration economies have two general sources: (i) localization economies and (ii) urbanization economies. Both types of economies are place-specific, but differ in terms of their scope. Localization economies refer to economies that are external to the individual firms but internal to the industry in a region. On the other hand, urbanization economies are external to the individual firms but internal to the region. The benefits from urbanization economies can thus be reaped by firms in different industries.

Localization economies, ascribed to Marshall (1920), refer to external economies that arise from the co-location of firms in a similar industry. Localization economies thus relate to regional specialization and concentration in a specific industry. As maintained in Marshall, (1920), such industry-specific cluster environments offer a higher potential for knowledge and information spillover among firms in a given industry.

Urbanization economies develop in large city regions and bare a natural relation to regional diversity. Jacobs (1969) described how diversified cities constitute a favorable environment for innovations. Central to this argument is that diversity stimulates the generation of ideas and innovations. Similar theoretical arguments can be found in spatial product cycle models in the spirit of Vernon (1966) and Hirsch (1967), where new product cycles are initiated in large and diversified city regions. Recent theoretical and empirical contributions in this vein include Dumais, Ellison & Glaeser (1997), Duranton & Puga (2002) and Feldman & Audretsch (1999), which find that most innovations and new plants are created in large and diversified regions.

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7 Compare Polyani (1966)
There is vast literature on which of the two forms of economies is the main source of the generation of innovation ideas. This literature consists primarily of empirical tests of how specialization and diversity across regions relate to some innovation-related output measure, (c.f. Ejermo 2004). However, it is intrinsically difficult to separate between the two. In a general sense, both urbanization and localization economies are related to the size of a region. Urbanization economies develop in large and diversified city regions. Such diverse environments arise from the fact that large city regions have wide array of specializations (or clusters). Therefore, localization and urbanization economies co-exist in larger city regions. Moreover, the potential for knowledge and information spillovers is larger in large and dense regions than in small regions. Concentrations of people and firms bring about a large potential for contacts.

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:

**Assumption 3:** The arrival rate of ideas for product varieties and trade links, \( \lambda \), 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 \( \lambda \)'s in (9) are specific for each region, such that:

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

(10)

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, and is such a feature based on regional characteristics or on attributes of firms that are located in the region?

In the sequel, a set of the questions above are analyzed empirically across Swedish regions.
3. DATA AND EMPIRICAL ISSUES

This section discusses how we can empirically examine the arrival of innovation ideas and their implementation in the form of (i) new export varieties and the number of exported varieties and (ii) new exporting firms and the number of exporting firms. Although our model gives 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. However, as will be explained below, trade link ideas are implicitly addressed by examining the export value per new export variety and new exporting firm. 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 functional regions. These are equivalent to Local Labor Market (LLM) regions which individually comprises a distinct integrated labor market.

In Sweden there are 81 LLMs, where 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, and LLM can be conceived as an arena for face-to-face interaction and a milieu for the generation and diffusion of innovation ideas.

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

In this paper, a rich dataset on the export activities of individual firms are used as an empirical counterpart to the generation of ideas and innovations across functional regions described in the model.

These data allows 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 on a yearly basis 1997-2003. 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\textsuperscript{8} 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 Table1. Thus, these 38 manufacturing sectors define the manufacturing industry in the data material.

\textsuperscript{8} CN = combined nomenclature.
The data described above allows us to measure (i) – (iv) across LLMs in a given time period. This provides 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 allows for an analysis of the concentration and specialization of regions’ exports across sectors, which can be related to localization economies.

Our main focus, however, is on how characteristics of regions – such as those described above – influence the innovation potential in terms of the generation of 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 allows us to measure the

### Table 1. Sectors in the manufacturing industry.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wood products</td>
</tr>
<tr>
<td>2</td>
<td>Paper</td>
</tr>
<tr>
<td>3</td>
<td>Publishing, printing</td>
</tr>
<tr>
<td>4</td>
<td>Petroleum products, nuclear fuel</td>
</tr>
<tr>
<td>5</td>
<td>Basic chemical</td>
</tr>
<tr>
<td>6</td>
<td>Pesticides, agro-chemical products</td>
</tr>
<tr>
<td>7</td>
<td>Paints, varnishes</td>
</tr>
<tr>
<td>8</td>
<td>Pharmaceuticals</td>
</tr>
<tr>
<td>9</td>
<td>Soaps, detergents, toilet preparations</td>
</tr>
<tr>
<td>10</td>
<td>Other chemicals</td>
</tr>
<tr>
<td>11</td>
<td>Man-made fibres</td>
</tr>
<tr>
<td>12</td>
<td>Rubber and plastics products</td>
</tr>
<tr>
<td>13</td>
<td>Non-metallic mineral products</td>
</tr>
<tr>
<td>14</td>
<td>Basic metals</td>
</tr>
<tr>
<td>15</td>
<td>Fabricated metal products</td>
</tr>
<tr>
<td>16</td>
<td>Energy machinery</td>
</tr>
<tr>
<td>17</td>
<td>Non-specific purpose machinery</td>
</tr>
<tr>
<td>18</td>
<td>Agricultural and forestry machinery</td>
</tr>
<tr>
<td>19</td>
<td>Machine-tools</td>
</tr>
<tr>
<td>20</td>
<td>Special purpose machinery</td>
</tr>
<tr>
<td>21</td>
<td>Weapons and ammunition</td>
</tr>
<tr>
<td>22</td>
<td>Domestic appliances</td>
</tr>
<tr>
<td>23</td>
<td>Office machinery and computers</td>
</tr>
<tr>
<td>24</td>
<td>Electric motors, generators, transformers</td>
</tr>
<tr>
<td>25</td>
<td>Electric distribution, control, wire, cable</td>
</tr>
<tr>
<td>26</td>
<td>Accumulators, battery</td>
</tr>
<tr>
<td>27</td>
<td>Lightening equipment</td>
</tr>
<tr>
<td>28</td>
<td>Other electrical equipment</td>
</tr>
<tr>
<td>29</td>
<td>Electronic components</td>
</tr>
<tr>
<td>30</td>
<td>Signal transmission, telecommunications</td>
</tr>
<tr>
<td>31</td>
<td>Television and radio receivers, audiovisual electronics</td>
</tr>
<tr>
<td>32</td>
<td>Medical equipment</td>
</tr>
<tr>
<td>33</td>
<td>Measuring instruments</td>
</tr>
<tr>
<td>34</td>
<td>Optical instruments</td>
</tr>
<tr>
<td>35</td>
<td>Watches, clocks</td>
</tr>
<tr>
<td>36</td>
<td>Motor vehicles</td>
</tr>
<tr>
<td>37</td>
<td>Other transport equipment</td>
</tr>
<tr>
<td>38</td>
<td>Furniture, consumer goods</td>
</tr>
</tbody>
</table>
number of exporters and the number of varieties that are exported across regions over a sequence of periods. 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 focused on (i) new varieties by existing firms and (ii) new firms as manifestations of product ideas. The empirical counterpart applied here measures the number of new exporters and 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 a product idea.

To make these measures formally precise, let $v'_i(t)$ denote the export value of export product $i$ in period $t$ in region $r$. If $N(t)$ denotes the set of new export products in region $r$ between period $(t)$ and period $(t + \tau)$, all elements $i$ in this set satisfy:

$$N(t) = \{i : v'_i(t) = 0 \land v'_i(t + \tau) > 0\}$$

(11)

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

$$F(t) = \{f : v'_f(t) = 0 \land v'_f(t + \tau) > 0\}$$

(12)

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 (11) and (12) implies that we measure export varieties and export firms that are new to each region$^9$. If $N$ and $F$ are large, i.e. contain many elements, in certain regions, it is interpreted as an indication of 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 as regards what 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, in particular.

---

$^9$ 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.
The first basic hypothesis is that the arrival rate of ideas differs across regions, i.e. that the $\lambda$’s are region-specific as formulated in (10). That leaves us with variation across regions to be explained.

The second basic hypothesis is that the variations in $\lambda$ 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 that, if significant and positive, are 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. If the above relationships are significant and positive, it provides support for 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 the abovementioned relationships we make use of Poisson and Negative Binomial regression techniques. These models are commonly used for analyses of count data, (see e.g. Cameron & Trivedi 1998). The number of new export varieties and new exporting firms are clearly count data and take discrete values 0,1,2,…, etc. 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 Possion distribution with parameter $\lambda_r$:

$$\Pr[n_r = n] = \frac{e^{-\lambda_r} \lambda_r^n}{n_r!}, \quad \text{where} \quad \ln \lambda_r = x'_r \beta$$

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):

$$\ln \mu_r = x'_r \beta + \varepsilon_r = \ln \lambda_r + \ln u_r$$

where $\varepsilon_r$ represents specification error or cross-sectional heterogeneity. As the Poisson model, however, the Negative Binomial model assumes a Possion distribution:
Both the Poisson and the Negative Binomial model thus allow us to examine how the $\lambda$-parameter varies with regional characteristics, as regards new export varieties and new exporting firms.

4. EXPORTS, IDEAS AND INNOVATIONS ACROSS REGIONS

This section presents empirical analyses of the hypotheses and relationships stated in Section 3.3. In order to provide the reader with a feel for the structure of the data, the section starts by presenting some stylized relationship between the size of a region and the diversity of the export flows of the firms located in the region.

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 how the scale of potential knowledge and information spillovers as regards product ideas and ideas for trade links.

Figures 1-3 plots the relationship between the size of regions (in terms of employment) and a) the number of exports products (varieties), b) the number of export firms and c) number of destinations (countries), respectively.

![Figure 1](Image)

*Figure 1. The relationship between regional size and number of export varieties, (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 (i) number of export varieties, (ii) number of export firms and (iii) number of destination markets.

In addition, we also examined the above relationships across the 38 manufacturing sectors described in Table 1. 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 product and trade-link ideas 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 products exported. With reference to the model in 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.

The subsequent subsections examine how the characteristics described above of regions is related to the introduction of new export varieties and new export firms across regions over a sequence of periods.

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 3.2 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.

Table 2 presents descriptive for total figures for the 38 manufacturing sectors, i.e. the manufacturing industry, across the 81 functional regions in Sweden.

<table>
<thead>
<tr>
<th>Table 2. Descriptives for new export varieties and new exporting firms across functional regions in Sweden based on a comparison between 1997 and 2003.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of new export varieties</strong></td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>Std.dev</td>
</tr>
<tr>
<td>Max.</td>
</tr>
<tr>
<td>Min.</td>
</tr>
<tr>
<td>No. of obs</td>
</tr>
</tbody>
</table>

Evidently, each variable is skewed to the right which can be seen form the difference between the mean and the median and how the standard deviation compares to the mean. Moreover, the table shows that there are differences across regions in terms of the entry of new export varieties and the entry of new exporting firms during the period time under study.

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. The baseline empirical model is given by:

\[
\ln \lambda_{r,s} = \alpha + \beta x_{r,s} + \phi k_{r,s} +\text{Size}_{r,s} + \sum_{\sigma=1}^{S} D_{\sigma} + \sum_{\delta=1}^{R} D_{\delta} + \varepsilon_{r,s}
\]

(16)

where \( \lambda_{r,s} \) denotes the arrival rate of new export firms and new export varieties, respectively, in sector \( s \) in region \( r \) between period \( t \) and \( t + \tau \). \( x_{r,s} \) denotes export characteristic of region \( r \) in

---

\[10\] In the negative binomial model, the left hand side of (16) is given by \( \ln \lambda_{r,s} + \ln u_{r,s} \), (14) and (15) in the previous section.
sector \( s \) in period \((t)\) and is either, number of export varieties, export firms, export destinations or export specialization in region \( s \) in period \((t)\). \( k'_{r,s}\) denotes the knowledge intensity of the workforce in sector \( s \) in region \( r \) in the same time period. Size denotes the size of region \( r \) (in terms of employment). \( D_\sigma \) is a sector-specific dummy with \( D_\sigma = 1 \) when \( \sigma = s \) and \( D_\sigma = 0 \) otherwise. Similarly, \( D_\delta \) is a region-specific dummy with \( D_\delta = 1 \) when \( \delta = r \) and \( D_\delta = 0 \) otherwise.

Given our theoretical model, our primary interest is whether the null hypothesis as regards the parameter associated with \( \chi'_{r,s} \), i.e. \( \beta = 0 \), can be rejected. The dummy variables control for heterogeneity across sectors and regions. The knowledge intensity of a region is a further control-variable, which is expected to have a positive impact on the likelihood of new export varieties and new export firms, respectively. Size controls for the overall impact of regional size. The hypothesis that mean equals the variance could be rejected for all estimations. Therefore, we estimated (16) with the Negative Binomial model. Tables 3 and 4 present the parameter estimates of the variables in (16), excluding the dummies, obtained with the latter model. Table 3 presents the results for new export varieties whereas Table 4 presents the results for new exporting firms. McFadden’s \( R^2 \) is the likelihood-ratio index, which compares the likelihood of an ‘intercept only’ model to the likelihood of the ‘full’ model with the independent variables included.

The three estimations in Table 3 are equivalent in terms of their fit. McFadden’s \( R^2 \) amounts to about 0.23 in each model. Controlling for size, knowledge intensity and sector as well as region heterogeneity, the likelihood of new export varieties between period \((t)\) and \((t + \tau)\) is larger in regions with a larger number of export varieties in period \((t)\). In a similar manner, the likelihood is larger in regions with higher specialization index. As expected, size and knowledge intensity have a positive impact on the likelihood of new export varieties. However, the parameter estimate for the number of destinations is insignificant. All the independent variables are state variables that describes the characteristics of a region in a given time period. As the results show, these state variables have a significant impact in the likelihood of new export varieties in subsequent periods.

As seen in Table 4, the fit of the model in (15) for new export firms is larger than for new export varieties. McFadden’s \( R^2 \) is around 0.37. The parameter estimates show that the likelihood of new export is increasing in the number of export firms, number of destinations and the export specialization index. Thus, whereas the parameter estimate associated with number of destination is insignificant for new export varieties, it is significant for new export firms. Moreover, both size and knowledge intensity has a positive impact on the likelihood of new export firms.

<table>
<thead>
<tr>
<th>Table 3. Estimates of the impact of regional characteristics on the likelihood of new export varieties across sectors and regions according to the Negative Binomial estimator (estimated with sector and region dummies).</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x'_{r,s} ), i.e. ( \beta = 0 ), can be rejected. The dummy variables control for heterogeneity across sectors and regions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The knowledge intensity of a region is a further control-variable, which is expected to have a positive impact on the likelihood of new export varieties and new export firms, respectively. Size controls for the overall impact of regional size.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The conclusion from the empirical investigation is that the pattern described by the data is consistent with the model presented in Section 2. The hypothesis that characteristics of regions which pertain to the potential for knowledge and information spillovers have an impact on the likelihood of product ideas cannot be rejected. In accordance with the general concept of agglomeration economies, the likelihood of new export varieties and new exporting firms is larger in regions with a higher potential for such spillovers.

### Table 4. Estimates of the impact of regional characteristics on the likelihood of new export firms across sectors and regions according to the Negative Binomial estimator (estimated with sector and region dummies).\textsuperscript{a,b,c}

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export firms in sector ( s ) ((t))</td>
<td>0.0002*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(2.78)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Destinations in sector ( s ) ((t))</td>
<td>-</td>
<td>0.004*</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(9.08)</td>
<td></td>
</tr>
<tr>
<td>Export specialization in sector ( s ) ((t))</td>
<td>-</td>
<td>-</td>
<td>0.015*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(6.95)</td>
</tr>
<tr>
<td>Knowledge intensity in sector ( s ) ((t))</td>
<td>0.52*</td>
<td>0.42*</td>
<td>0.47*</td>
</tr>
<tr>
<td></td>
<td>(5.16)</td>
<td>(4.22)</td>
<td>(4.63)</td>
</tr>
<tr>
<td>Size of region ( r ) ((t))</td>
<td>7.4e-06*</td>
<td>6.9e-06*</td>
<td>7.6e06*</td>
</tr>
<tr>
<td></td>
<td>(22.65)</td>
<td>(21.26)</td>
<td>(23.48)</td>
</tr>
</tbody>
</table>

\textsuperscript{a)} \((t)=1997\) and \((t+\tau)=2003.\)
\textsuperscript{b)} Estimates of constant and sector and region dummies not shown.
\textsuperscript{c)} \(t\)-values presented within brackets (*-denotes significance at the 0.05-level).
<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Log likelihood</td>
<td>-6603.17</td>
<td>-6567.29</td>
<td>-6587.91</td>
</tr>
<tr>
<td>McFadden’s $R^2$</td>
<td>0.37</td>
<td>0.38</td>
<td>0.37</td>
</tr>
<tr>
<td># of observations</td>
<td>3 078</td>
<td>3 078</td>
<td>3 078</td>
</tr>
</tbody>
</table>

a) $t=1997$ and $(t+\tau)=2003$.
b) Estimates of constant and sector and region dummies not shown.
c) $t$-values presented within brackets (* and ** denotes significance at the 0.05 and 0.10-level, respectively).
5. SUMMARY AND CONCLUSIONS

This paper presented a model where new products are introduced by entrepreneurs or innovating firms. 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. With reference to the concept of agglomeration economies and its relation to the potential for knowledge and information spillovers, it was hypothesized that different regional milieus provide different opportunities as regards the generation such ideas. The theoretical model predicted that in regions with a high density of characteristics that pertain to the potential for knowledge and information spillovers, existing and potential entrepreneurs have a higher likelihood of receiving and materializing innovation ideas. The predictions were compared with observations from a rich data set describing export activities of Swedish firms across functional regions.

In particular, the paper investigated empirically how the likelihood of new product varieties and new exporting firms across regions is influenced by regional characteristics. The paper focused on regional characteristics that relate to the potential and scale of knowledge and information spillovers. In this context it was acknowledge and shown that regional size is an important characteristic: in such regions, there is a larger set of export firms, a larger set of opened trade links and a larger set of products exported. This, evidently, has an obvious parallel to agglomeration economies.

The result of the undertaking is that the hypothesis that characteristics of regions that pertain to the potential for knowledge and information spillovers have an impact on the likelihood of product ideas cannot be rejected. In accordance with the general concept of agglomeration economies, the data described 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. These results were confirmed at aggregate and the sectoral level.
REFERENCES

Chaney T (2005), Distorted Gravity: Heterogeneous Firms, Market Structure and the Geography of International Trade, mimeo, MIT.
Appendices

Appendix 1

Consider the solution to an individual customer’s optimization problem, related to the preference function in (2.1). This solution should satisfy \( q_j^{\theta-1} / q_i^{\theta-1} = p_j / p_i \), which implies that \( q_i = p_i^{-\theta} P^{\theta-1} m \), where \( m \) is the budget of an individual buyer and where \( P = \left[ \sum_j p_j^{-\theta} \right]^{(1-\theta)} \). Summing over all identical buyers yields \( x_i = \alpha p^{-\theta} M \), where \( M \) is the sum of all individual budgets, and \( \alpha = P^{\theta-1} \).

A firm that supplies a variety perceives the following demand schedule \( x = \alpha p^{-\theta} M \), where \( \alpha \) is conceived given. Assuming that each firm maximizes the profit associated with a variety, each firm will select the price

\[ p = \nu \sigma \quad \text{for} \quad \sigma = \theta / (\theta - 1) \quad (A.1.1) \]

Our next concern is that profits should be non-negative, i.e., that \((p - \nu)x - F - G - H \geq 0\). Free entry in a monopolistic-competition setting drives profits of the individual firm to zero, which yields \( x^o = F / (p - \nu) \), which means that \( x^o = ((F + G + H) / \nu)(\theta - 1) \). Since \( px^o = \nu x^o + F + G + H \), we can calculate the number of varieties, \( n^e \), in a MCE solution as

\[ n^e = \frac{M}{(F + G + H)\theta} \quad (A.1.2) \]

Thus, the number of differentiated products increases as \( M \) gets larger. We may also observe that as \( \theta \) reduces towards unity the number of products, \( n^e \), increases. The condition \( px^o = \nu x^o + F + G + H \) is valid for single-variety firms and obtains as the result of a gradual introduction of new varieties. As long as there are sufficiently many single-variety firms with zero profits, multi-product firms are assumed to perceive \( P \) as given, and hence supply the same amount \( x^o \) at the price \( p = \nu \sigma \).

Appendix 2

Remark 5: In an MCE-solution the number of varieties is \( n = n^e \). For such a market solution, let the profit of a \( g \)-variety firm be \( V_{(g)} = (p - \nu)x^o g - F - H - gG \). This profit is always positive when single-variety firms are present, since \((p - \nu)x^o - F - G = 0\) for single-variety firms in
MCE. If the depicted firm introduces one more technology-related variety the sales of all varieties in that market will shrink from $x^o$ to $\tilde{x} = x^o n^e / (n^e + 1)$. As a consequence the $g$-variety firm has an incentive to introduce an additional variety when $V_{(g+1)} = (p-v)\tilde{x}(g+1) - F - H - (g+1)G > V_{(g)}$, and that is satisfied if $F + H > G[(g+1)/(n-g)]$, a result which obtains from calculating $V_{(g+1)} - V_{(g)}$.

Remark 6: The profit of a single-variety firm with $h$ trade links (destinations) equals $V_{(1,h)} = (p-v)hx^o - F - G - hH$, when each destination market is characterized by $n \leq n^e$. Suppose that this condition also applies for still another destination market. When there exists single-variety, single-market firms’ incentive to enter this additional market follows from the fact that $V_{(1,h+1)} - V_{(1,h)} > 0$, since $V_{(1,h+1)} - V_{(1,h)} = (p-v)x^o - H$ and $(p-v)x^o - F - H - G = 0$ for a single-variety, single-market firm.

Suppose instead that in there is no gap in the new market, $h+1$, which means that $n = n^e$. The profit obtained from this market then becomes $(p-v)x^o [n^e / (n^e + 1)]$ and we have that the total profit becomes $\hat{V}_{(1,h+1)} = V_{(1,h)} + (p-v)x^o [n^e / (n^e + 1)] - H$, and $\hat{V}_{(1,h+1)} > V_{(1,h)}$ as $F > H / n^e$. 

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