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Location of New Industries – The ICT-Sector 1990-2000[1]

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Abstract

The overall purpose of this work is to study the location pattern of new industries and how it changes over time. With this objective as motivation, a set of 27 industries are classified as belonging to the ICT-sector (information and communication technology). The goods and services supplied by these industries were to a large extent new at the end of the 1980s. The paper outlines two interrelated models of vertical externalities to explain the location pattern of the industries in 1990 and 2000. The two externalities concern a firm's input demand and its output demand. These models are introduced to illustrate how these externalities favour location in the largest functional urban regions. The same models predict that location in smaller regions is facilitated as demand grows, when internal scale economies (start-up costs) are not too strong. The empirical analyses apply a logit model to estimate location probabilities, which depend on the size and the diversity of a region's economy.

Keywords: Location externalities, new industries, location dynamics, product cycles.
JEL Classification: 012, 018, L14

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1. INTRODUCTION

1.1 Location of Firms and Establishments in New Industries

The study of how economic activities are located has a long tradition, and in retrospect one can conclude that the development path of ideas is indeed dwindling. A milestone along this path is the theory of resource-based comparative advantages that springs from Ricardo’s suggestion that the available technology differs between regions (countries). This idea was transformed by Ohlin (1933) into a theory of how resource abundance in a region provides the region with comparative advantages that affect location. The resource abundance argument has been further exploited in models that focus on localised knowledge as a production factor (e.g. Andersson and Mantsinen, 1980; Romer, 1990).

In Weber (1909) the perspective is shifted completely to consider the interaction costs between supplier and customer as the factor influencing where firms locate. In this context an individual firm may consider how its location affects the costs of inputs to its production (supply) activity, and it may also consider how its delivery price is influenced by the accessibility to customers buying its output. Thus, in a Weber type of model we may consider how increasing distance to input suppliers raises input costs, and (ii) how increasing distance to customers reduces net returns from sales. From these two phenomena one can derive two location externalities.

In the von Thünen (1826) class of models the distance between seller and buyer plays an equally important role. In this case the major idea is that the distance sensitivity varies across types of products, and this generates a location equilibrium with differentiated land values. The ideas of von Thünen and Weber are integrated in the seminal work by Beckmann and Puu (1985).

The analysis in this paper derives from ideas present in the Weber and von Thünen contributions. The analysis makes use of two basic externalities that affect the location process in functional urban regions. The externalities are referred to as input-demand and output-demand externality. When the former operates, input costs fall as input demand grows. When the latter is active, unit cost falls as output demand grows. The two externalities are activated when internal scale economies are present.

The input-demand externality is based on co-location of a firm and its input suppliers. The phenomenon arises because a firm can reduce its costs by locating itself in the proximity of its major input suppliers, given that these inputs are distance sensitive. This type of externality was emphasised early by Marshall (1920) and is elaborated in a recent contribution by Fujita and Thisse (2002). The externality obtains when the input suppliers are characterised by internal scale economies.

The second externality phenomenon is the output-demand externality, which has been emphasised in a series of contributions by Krugman (1990) in models in which the production features internal scale economies (Fujita, Krugman and Venables, 1999). In this case a firm that supplies distance-sensitive products benefits from a location where there are sufficiently many customers present in the proximity. When this is the case, demand will be large enough to cover the fixed cost of the firm. In the following presentation this idea is exploited for market conditions ranging from monopoly to monopolistic competition.

The empirical analysis in this chapter deals with new industries. Product cycle models in the tradition of Vernon (1966) include specific assumptions about our two externalities. In the early stages of a product cycle a firm's success depends critically on its accessibility to both input suppliers and customers. The first assumption is that in early stages of a novel industry's product cycle the share of distance sensitive inputs is large. Some of these inputs are delivered by so-called knowledge providers. As a consequence, the introduction of new products can be expected to be more frequent in large urban regions where the likelihood of finding appropriate local input suppliers is larger then elsewhere. Thus, the input-demand externality predicts that the location probability of industries supplying novel products is comparatively high in large urban regions (Jacobs, 1984; Johansson and Andersson; 1998; Forslund, 1998). Moreover, its also assumed that the inputs become less distance sensitive as the product cycle evolves.

Product cycle models also assume that output-demand externalities affect where the supply of novel products are successfully located (Hirsch, 1967; Forslund, 1998). During the product innovation phase of a product cycle, each supplier is assumed to communicate intensively with its customers and this is a distance sensitive activity. In addition, it is assumed that for a novel product only a small fraction of all potential customers are willing to test and experiment with the new product (Vernon. 1966; Jacobs, 1984; Johansson and Andersson, 1998). As a consequence, this small fraction will represent a sufficiently large demand only in large urban regions. This location feature is accentuated for products that (i) are distance sensitive and (ii) are supplied by firms characterised by internal scale economies

The major assumption in the paper is about the location externalities described above. These externalities are basic factors in the theory agglomeration economies as presented in Fujita and Thisse (2002). This paper stresses that the externalities are of particular importance for novel industries that supply goods and services with new attributes. In addition the paper presents a framework for understanding why and how the focused externalities may become weaker over time. In this way the contribution share ideas that have earlier been associated with product cycle models.

1.2 Calculating Location Probabilities in a Temporal Setting

It is reasonable to assume that in the individual case a location decision is influenced by idiosyncratic factors. However, inspecting the overall pattern of how new industries and industries with intense product development are located across regions, it becomes evident that location probabilities vary across regions in a systematic way (Forslund, 1998; Karlsson, 1997).

The notion of a region refers to the idea of a functional urban region, which is assumed to have low transaction costs for interaction between actors inside a given region, whereas transaction costs are much higher for exchange between actors that are located in different regions (Cheshire and Gordon, 1998, Fujita, Krugman and Venables, 1999). In the subsequent analysis transaction costs include both the costs of physical movement of goods and person mobility costs that arise due to face-to-face interaction and other communication associated with transaction activities (Johansson and Karlsson, 2001). In the Swedish context such regions can be approximated by the statistical concept LA-region (labour-market region), an approach applied in this study.

The theoretical analysis employs a simple model structure of a semblant type as the one popularised by Krugman (1990). The model is meant to represent a typical firm of an industry, where a firm may have a monopoly-like position in a region. However, the model also accommodates situations where different firms in a region supply differentiated product varieties belonging to the same industry (product group). The analysis aims at making precise the mechanisms that generate input-demand externalities and output-demand externalities. From this analysis two conclusions are derived about location probabilities of a region, with reference to a region's economic size and diversity. Two associated conclusions are derived with regard to how such probabilities should be expected to change over time.

In the empirical analyses the basic ideas of the four conclusions are associated with testable hypotheses, and these are tested by means of regression analysis and comparisons of estimated parameters for two different years, 1990 and 2000. The empirical analysis is based on observations of 27 ICT industries, which are assumed to represent novel industries at the beginning of the 1990s. The observations are based on information about individual establishments in each of 81 LA-regions.

The set of all establishments in each industry is divided into two groups. The first group contains establishments with less than 5 employees, called micro firms. The second group contains all other establishments, referred to as ordinary firms. Its is assumed that micro firms produce a different type of output than ordinary firms, and the empirical analysis concentrates entirely on the latter.

The exclusion of micro firms is consistent with our assumption about scale economies. Obviously, the demarcation value of 5 employees is arbitrary. However, the group of micro firms are different, and this is reflected by the fact that the average size of a micro firm is smaller than one employee. In the concluding section we comment further on the effect of excluding micro firms.

1.3 Outline of the Contribution

Section 2 introduces a model where a novel industry is associated with a new product group. Any firm supplying a product variety inside such a group is assumed to feature internal scale economies. For such a firm the input-demand and the output-demand externalities are described. Based on the analysis of the model four conclusions are derived with regard to location decisions of firms. Section 3 presents the ICT-sector industries that will be analysed empirically as examples of novel industries. Moreover, measures of location patterns and concentration are described. The section also characterises the regression models to be estimated in Section 4.

Section 4 presents estimation results that are interpreted in view of the theoretical conclusions in Section 2. The regressions relate the location pattern of each industry to the size and diversity of each region's economy. The regressions are also used to evaluate the hypothesis that the industries become less size dependent over time. Section 5 provides a final assessment of how the empirical models manage to reflect the theoretical conclusions, and presents new questions that arise from the regression results.

2. LOCATION OF NEW INDUSTRIES

Section 2 introduces a model in which individual firms feature internal scale economies and sell their output in a market that is separated in two aspects. First, all customers are located in the same functional region as the supplying firm. Second, all firms supply product varieties that belong to a given product group. In this context, the analysis generates conclusions about firm location, based on the existence of an input-demand externality and an output-demand externality.

2.1 Internal and external scale economies

In this sub section we consider a specific product group that may contain several differentiated product variants, where each product is distance sensitive to the extent that a firm in a functional region only will sell its output in the same region. Moreover, we assume that internal scale economies prevail for each product type. As a consequence, each firm supplies only one product type. With this formulation a demand pattern is introduced, such that the size of the region's economy, M , affects how many firms and hence types of products that the region can host. In this sense the model reflects conditions, which affect the possibility to establish firms that supply new products. Admittedly, this is a very simple and restrictive model but it will help us to make the externality mechanisms precise. The basic features of these mechanisms can be generalised for less restrictive cases.

In the sequel we use one basic model to illustrate the production conditions of a typical firm for each given ICT-industry. The basic model assumes that every firm has internal scale economies. Every firm's production is reflected by a region-specific cost function with the following specification:

$$C(x) = vx + F \qquad (2.1)$$

where x denotes output, and where vx represents variable costs and F fixed costs. The corresponding unit cost function is

$$c = v + F / x \qquad (2.2)$$

This unit cost function reflects internal scale economies, based on the existence of fixed costs. We may interpret this in the following way: F is associated with a given product, which in turn is associated with one and only one firm. In the rest of the paper we maintain the assumption that all firms exhibit this property, which is accentuated when F is large relative to the size of accessible demand. Given this assumption, it is also reasonable to assume that every firm faces a negatively sloping demand curve. The focus is on distance-sensitive products, and for these we assume that demand is influenced by the size of the local economy, i.e., the economy of the functional region in which a firm is located. A demand function that satisfies this condition is

$$x = \alpha p^{-\theta} kM \qquad (2.3$$

where α and k are parameters, x represents sales and p the price of the product, where αkM reflects how the size of the economy, M, affects the total demand budget for the product group, and where $\theta > 1$. It should be observed that for $\theta = 1$, one obtains that $px / M = \alpha k$, which means that αk resembles a constant budget share for the separated market, when *M* is interpreted as the total demand budget of the region (Appendix 1). In the following sub sections the parameter *k* is called demand intensity. A basic assumption is that for a new market (new product group) *k* initially has a low value that may grow over time.

Obviously, (2.2) is compatible with a monopoly situation. As shown in many contributions by Krugman (1990), another solution obtains if there is a set of differentiated products, *i* = 1,…, n, each with the same unit cost function, $c_i = v + F / x_i$, and each with the same demand expression, $x_i = \alpha p_i^{-\theta} kM$. In this latter case monopolistic competition obtains, and with free entry the price of each product approaches the condition $p_i = c_i = c$. This also implies that $v + F / x_i = \alpha kM / n$, which in turn means that the larger the size of the economy, *M*, the larger the number of products, *n* (See Appendix 2).

The example above shows that for a new product group with a separated regional market, reflected by (2.3), the entry of new firms is influenced by (i) the size of the regional economy, (ii) the size of the fixed cost, and (iii) the demand intensity, as given by *k*. Without exception, F is assumed to be positive for every firm, but may vary between industries and possibly also across regions. In this context it should be observed that *F* may be interpreted as a start-up cost or cost of introducing a new firm with a new differentiated product.

2.2 Input Demand Externality

The previous sub section provides an overview picture of entry conditions for firms supplying local, distance-sensitive products. However, when firms enter a regional market they also generate demand for inputs. Some of these inputs are also distance sensitive and supplied by firms that are characterised by internal scale economies. This generates an externality that operates via the market. This simply means that when local input suppliers of distance-sensitive products are present in the region they can offer the inputs at a lower price than suppliers outside the region can, given that the demand for these inputs is sufficiently large to allow local suppliers to have non-negative profits.

Externalities are frequently considered as a proximity phenomenon, where accessibility to input suppliers or to customers is the source of the externality. In the subsequent analyses all interest is concentrated on proximity-related externalities. Sub section 2.2 deals with input externalities, which are referred to as input demand externalities in the following presentation. This phenomenon may also be described as an upstream externality (Johansson, 2004).

In recent years a variety of input demand externalities have been elaborated. Two major classes can be identified. The first includes externalities that operate via the market, which means that the price and quality of traded inputs are affected by the externality. The second class contains externality mechanisms that work outside the market. These may also be classified as spillover externalities (Johansson, 2004).

Consider now the unit cost function in (2.2), which can be expressed as $c = v + F / x$ for a given region. Our concern is the variable cost coefficient, v, the size of which is affected by the share, β, of inputs bought from local suppliers and the share $(1-\beta)$ of inputs purchased from suppliers outside the region. For distance-sensitive inputs we assume that the local price

ρ is lower than the external price $\hat{\rho}$. In other words, the transaction costs are higher for inputs that are delivered by suppliers far away and as a consequence $\hat{\rho} > \rho$.

Assume now that all inputs are distance sensitive and that there is an input coefficient, *s*, such that *sx* represents the total amount of inputs. The input cost per unit output can then be written as

$$v = [\beta\rho + (1-\beta)\hat{\rho}]s \qquad (2.4)$$

From (2.4) we conclude that a firm will have lower costs in a region where β is large than in a region with a small β. Moreover, there is a cumulative effect: when firms locate in a region the size of β will increase. The basic assumption here is that the size of β is likely to be larger when the size of the region, *M*, is larger. Thus, we can draw the following conclusion:

> *Conclusion 1a*: The input-demand externality can cause a reduction of the variable cost component, *v*, as specified in (2.2) and (2.4). As a consequence *v* is assumed to be smaller in regions where *M* is large.

Besides the pecuniary input-demand externality described above, the literature also identifies non-pecuniary externalities, where Gordon and McCann (2000) provides an overview of the interface between pecuniary and non-pecuniary externalities. The latter are here referred to as a spillover phenomenon. In our model information spillovers might influence the parameter *v* to be reduced as a consequence of a regional clustering of semblant firms. However, it seems more interesting in our context to assume that when similar firms in the same industry cluster together, this circumstance brings about a reduction of the start-up cost, represented by *F* in the cost function.

Suppose now that spatial clustering of firms in the same industry is more likely in a region where *M* is large. Then we might conjecture that *F* may in fact be lower in larger than in smaller regions.

There is also a temporal question associated with Conclusion 1a. What happens with the externality mechanism when the production and supply of a new product becomes routinised and the input supply becomes more standardised? Such a change is assumed to imply that inputs become less distance sensitive. Given this assumption one may conclude:

> *Conclusion 1b*: As the inputs to a gradually maturing industry become less distance sensitive the difference between ρ and $\hat{\rho}$ will reduce in formula (2.4). As a consequence, the location decision of a firm becomes less dependent on having a large β-value, and hence less dependent on the size of a region's economy.

2.3 Output Demand Externality

In the preceding sub sections the variable M plays an important role by representing the size of the economy of a region. Hence, M will affect how large the demand in the region may become. The demand function $x = \alpha p^{-\theta} kM$ reflects that *x* increases as *p* is reduced and increases as *M* is augmented. The parameters satisfy $0 < \alpha < 1$, $0 < k < 1$, and $\theta > 1$. In order to depict the behaviour of a profit maximising firm, the following profit expression is formulated:

$$V = \alpha p^{1-\theta} kM - v\alpha p^{-\theta} kM - F \qquad (2.5)$$

By differentiating (2.5) and setting the derivate equal to zero we can determine the profit-maximising price as

$$p = v\sigma \qquad (2.6)$$

where $\sigma = \theta/(\theta-1)$. Imagine now that the price in (2.6) is a local price of a supplier in a region. This price will be viable only if the profit as specified in (2.5) is non-negative, which requires that

$$\alpha kMv^{1-\theta}\sigma^{-\theta}(\sigma-1) \geq F \qquad (2.7)$$

If the condition in (2.7) is not satisfied, the supply in the region will be zero and the customers have to satisfy their demand with the help of imports from other regions, where the import price may be high because of interregional transaction costs. From this we conclude:

Conclusion 2a: For a novel product the demand intensity, *k*, may be low, and then this novel product can be supplied with a non-negative profit only in regions with a sufficently large demand, as represented by the size variable *M*.

It is now important to observe that the parameter *k* can be interpreted as a demand-intensity coefficient. For a new product (and hence new industry) the value of *k* can be assumed to be low initially. This is compatible with numerous empirical observations and this assumption is essential in a broad set of product-cycle models (e.g. Vernon, 1966; Johansson and Andersson, 1998). These models also assume that the value of *k* increases over time as the potential customers are gradually informed about the existence of the product and of its attributes. A well-known empirical study of growing demand intensity is Törnquist (1967). This leads to the following temporal conclusion:

Conclusion 2b: For a region where condition (2.7) is not satisfied from the start, the growth of *k* can lead to a shift such that profits are no longer negative, and this will then make it feasible to establish a firm in the region at this later stage.

Consider now a region with a large *M* and assume that there is a large set of potential product variants, each with the same demand function as given by (2.3). Assume also that there is free entry and that the start-up cost, *F*, is the same for each differentiated product and hence each firm. With these additional assumptions, the specifications in (2.1)-(2.3) together with (2.5)-(2.6) provide a framework for monopolistic competition (Brakman and Heijdra, 2004). As the number of firms grows in this setting, the output of each individual firm approaches the value $x = (F/v)(\theta-1)$, as described in Appendix 1.

2.4 Location Decisions

In the three preceding sub sections the size of a region's economy is denoted by *M*. In the subsequent empirical analysis the size of region's economy will be measured by two alternative variables, denoted by $\hat{S}_{jr}$ and $\hat{A}_{jr}$ for industry *j* and region *r*. In order to make the definitions clear we first introduce the following variables:

S_{jr} = Number of persons employed in industry *j* and region *r*
A_{jr} = Number of establishments in industry *j* and region *r*.

The total number of person employed in region *r* is denoted by S_r, while the total number of establishments (firms) is denoted by A_r. Given this we define our size variables as follows:

$$\hat{S}_{jr} = S_r - S_{jr} \tag{2.8}$$

$$\hat{A}_{jr} = A_r - A_{jr} \tag{2.9}$$

The variable in (2.8) informs us about the number of persons employed in region *r*, except for those employed in the industry that we examine, i.e., industry *j*. In an analogous way formula (2.9) presents the number of establishments in region *r*, except for establishments in industry *j*. Hence, both size variables are defined specifically for each industry. The specifications in (2.8) and (2.9) are motivated by statistical arguments. The location of a certain industry should not be regressed against a variable that includes numbers that reflect the location of the very same industry.

Having introduced the definitions in (2.8) and (2.9) we can drop the index *j*, remembering that in each case that we analyse $\hat{S}_r$ and $\hat{A}_r$ are specified for a given industry. Moreover, we observe that $\hat{S}_r$ is a direct measure of the size of the economy in *r*, whereas $\hat{A}_r$ reflects the diversity of the same economy.

Let us first consider the size of the economy. Following Conclusion 1a and Conclusion 2a in Section 2, we assume that a certain industry's probability of locating in region *r* increases with the size of $\hat{S}_r$. Next, we introduce z as a binary variable that takes on the value z = 1 when the industry is located in region *r* and the value z = 0 otherwise. Given this, we assume that the probability that z = 1, P_r, is given by the following logit expression:

$$P_r = P_r(z=1) = \left[1 + \exp\left\{\mu - \tau\hat{S}_r\right)\right\}\right]^{-1} \tag{2.10a}$$

In order to clearly express the idea, (2.10a) is reformulated as an odds ratio in (2.10b), which shows that P_r increases as $\hat{S}_r$ increases. Moreover, when $\tau\hat{S}_r = \mu$ the odds ratio equals 1, and hence $P_r = 0.5$.

$$P_r/(1-P_r) = \exp\left\{-\mu + \tau\hat{S}_r\right\} \tag{2.10b}$$

Next we turn to Conclusion 1b and Conclusion 2b, which indirectly state that as time goes by the probability P_r is expected to increase for a given value of $\hat{S}_r$. Technically, this means that over time μ will decrease and/or τ will increase. The relation between size and location probability is illustrated in Figure 2.1

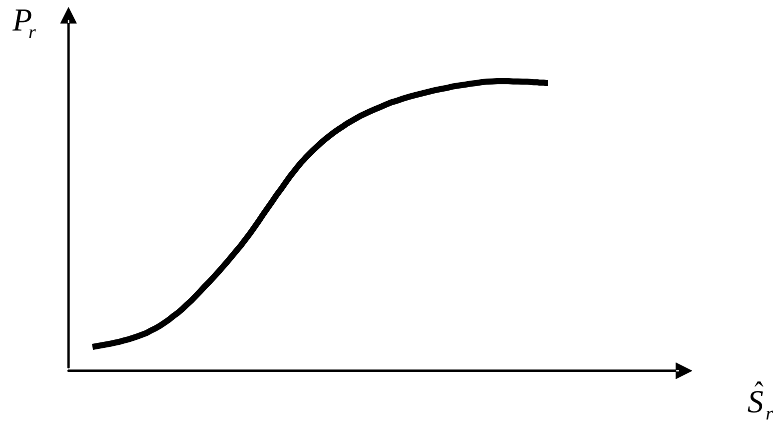

Figure 2.1: The location probability as a function of the size variable

The model given in (2.10a) will subsequently be called the "size model", whereas the following model in (2.11) will be called the "diversity model". The latter is based on similar assumptions as the size model, but uses $\hat{A}_r$ as the explanatory variable, which represents the total number of establishments in region *r*. This leads to the following probability formulation:

$$P_r = P_r(z=1) = \left[1 + \exp\{\mu - \tau\hat{A}_r)\}\right]^{-1} \tag{2.11}$$

Expressing (2.11) in terms of an odds ratio yields $P_r/(1-P_r) = \exp\{-\mu + \tau\hat{A}_r\}$. The diversity model implies for Conclusion 1a that it is rather the diversity of input suppliers that affects the location probability. With regard to Conclusion 2a the diversity model implies that the demand for the industry output is primarily influenced by the diversity of firms that are customers of the industry.

Referring to Conclusion 1b and Conclusion 2b, formula (2.11) implies that the location probability increases over time for a given diversity level. In other words, diversity becomes a less critical decision factor as time goes by, along a development path where a firm's contacts with input suppliers and customers become less distance sensitive, i.e., generate smaller geographic transaction costs.

Indeed, one might argue that both $\hat{A}_r$ and $\hat{S}_r$ should be used as combined location factors. However, although these variables reflect different things, they are too correlated to be inserted in the same regression model. As a consequence, we instead estimate each of the two models and then compare them.

The subsequent exercise is about the location of establishments belonging to different ICT industries. The study excludes so-called micro firms that are defined as establishments with less than five employees. The remaining establishments are referred to as “ordinary firms”. This approach may be considered as somewhat arbitrary. However, we argue that what matters here is that we use the selected criterion in a systematic way.

3. AGGLOMERATION ECONOMIES AND ICT INDUSTRIES

3.1 Characteristics of the ICT Industries

In sub section 3.1 the various ICT industries are described in terms of persons employed in the years 1990 and 2000. In this presentation we only include observations of so-called ordinary firms. The industries are separated into three groups, consisting of (i) manufacturing industries, (ii) wholesale and network industries, and (iii) service industries.

There are eight manufacturing industries. Six of these had increasing employment figures during the period. The two industries with reduced employment are Office machinery and Computers and information processing equipment. In the eight industries in Table 3.1, the total employment expanded by almost 20 percent.

The average size of an establishment in Table 3.1 is much larger than for other ICT industries. All industries in the table had in 1990 on average more than 67 employees per establishment. This is more than double the average size of firms belonging to the wholesale, network and service industries that are presented in tables 3.2 and 3.3.

Table 3.1: ICT Manufacturing Industries 1990 and 2000

	Industry	Total employment 1990	Total employment 2000
30010	Office machinery	1556	1467
30020	Computers, information processing equipment	10432	3323
31300	Insulate wire and cable	4961	6149
32100	Electronic valves, tubes and components	4386	7186
32200	Television and radio transmitters & apparatus	25608	30666
32300	Television and radio receivers & recording apparatus	1125	5764
33200	Equipment for measurement, control & testing	8719	13461
33300	Equipment for control of industrial processes	1729	2087
	Total	58516	70103

Remark: The employment figures exclude micro firms and hence refer to establishments which 5 employees or more.

Table 3.2 provides an overview of industries classified as wholesale of ICT products and ICT network industries. For this group, total employment fell by around 10 percent. The largest reduction occurred for the industry Telecommunications network operation that fell from more than 40 000 employees to just above 25 000. In all, seven industries out of eleven experienced growing employment.

Table 3.2: Wholesale of ICT Products and Network Industries 1990 and 2000

	Industry	Total employment 1990	Total employment 2000
51431	Household machinery and apparatus	1197	1426
51432	Radio and TV receivers	2082	1173
51433	Phonograms and video cassettes	568	1024
51434	Electric equipment	5770	6347
51640	Office machinery and equipment, including computers	18274	20564
51651	Measurement and precision instruments	1983	1949
51653	Electronic components and telecommunication products	5466	7438
51659	Other machinery for industry and transport	13582	14083
64201	Telecommunications network operation	40317	25645
64202	Telecommunications radiation	0	793
64203	Cable TV	710	466
	Total	89949	80908

Remark: The employment figures refer only to establishments which 5 employees or more.

The ICT service industries are presented in Table 3.3. As a group these industries increased the number of person employed by 170 percent, with just above 29 000 persons in 1990 to almost 80 000 ten years later. In spite of this, three industries had a slightly falling employment. Two of the industries feature comparatively large establishments and hence displayed in 1990 signs of pronounced internal scale economies. These industries are (i) Hardware consultancy and (ii) Data base activities. However, during the ten years period the average establishment size fell considerably in these two industries.

Table 3.3: ICT Service Industries 1990 and 200

SNI-code	Industry	Total employment 1990	Total employment 2000
71330	Renting of office machinery, equipment and computers	1000	297
72100	Hardware consultancy	842	3132
72201	Software consultancy	15916	52684
72202	Software production and supply	3128	13696
72300	Data processing	4926	6345
72400	Data base activities	810	1240
72500	Maintenance/repair of office and computing equipment	1603	1523
72600	Other computer-related services	988	837
	Total	29213	79754

Remark: The employment figures refer only to establishments which 5 employees or more.

We may now ask: what happened during the period 1990-2000 with the number of ordinary firms across the 27 industries? This number increased from 5003 to 7037. Moreover, the number of firms increased for 19 of the industries. We may finally observe that in 2000 there were 11 industries with a large number of firms. These are:

- 32100: Electronic valves, tubes and components (108)
- 33200. Equipment for measurement, control and testing (159)

- 51434: Wholesale of electric equipment (296)
- 51640: Wholesale of office machinery and equipment, including computers (872)
- 51651: Wholesale of measurement and precision instruments (137)
- 51653: Wholesale of electronic components and telecommunication products (368)
- 51659: Wholesale of other machinery for industry and transport (886)
- 64201: Telecommunications network operation (704)
- 72201: Software consultancy (1982)
- 72202: Software production and supply (483)
- 72300: Data processing (167)
- 72500: Maintenance and repair of office and computing equipment (102)

3.2 Measures of Concentration

Our set of industries contains 27 distinct SNI-codes (industry classification). For most of these industries, the location pattern is selective, meaning that only a limited number of functional regions host a particular industry. This observation can be made both 1990 and 2000. Obviously, the fewer the host regions are, the greater the spatial concentration is. With this type of measure some industries experience a reduced and others an increased concentration between 1990 and 2000.

An alternative measure of concentration would be the location quotient (LQ). This latter measure could be used to demonstrate the dominating position that the largest region (Stockholm) has had through the 1990s. Calculating the location quotient for employment gives the following values for the Stockholm region in 1999:

- Manufacturing (30010-33300) = 1.3
- Wholesale (51431-51659) =1.9
- Telecommunication (64201-64203) = 1.5
- Renting ICT equipment (71330) = 2.5
- Consultancy (72100-72600) = 1.8

The above figures represent ratios of the following type: LQ = $(L_{ir} / L_r)/(L_i / L)$, where L_{ir} denotes the employment in industry *i* and L_r denotes total employment in the Stockholm region, whereas L_i and L refer to employment in industry *i* and total employment for Sweden as a whole.

In the sequel we focus on how many regions that are hosts for a given industry. With this focus Table 3.4 can be constructed. It shows that between 1990 and 2000 the location of ordinary establishments were extended to a larger number of regions for 19 industries, whereas the number of host regions decreased for 8 industries. The growth column in the table shows that the number of host regions summed over industires increased by 62 between 1990 and 2000.

Table 3.4: The number of regions hosting an ordinary establishment for each industry

		Number of regions 1990	Number of regions 2000	Growth
30010	Office machinery	11	14	3
30020	Computers, information processing equipment	38	25	-13
31300	Insulate wire and cable	24	33	9
32100	Electronic valves, tubes and components	22	34	12
32200	Television and radio transmitters & apparatus	20	25	5
32300	Television 6 radio receivers & recording app.	15	26	11
33200	Equipment for measurement, control & testing	30	35	5
33300	Equipment for control of industrial processes	9	21	12
51431	Household machinery and apparatus	27	26	-1
51432	Radio and TV receivers	20	17	-3
51433	Phonograms and video cassettes	6	12	6
51434	Electric equipment	36	45	9
51640	Office equipment, including computers	54	53	-1
51651	Measurement and precision instruments	21	23	2
52653	Electronic components and telecom. products	37	38	1
51659	Other machinery for industry and transport	55	62	7
64201	Telecommunications network operation	81	55	-26
64202	Telecommunications radiation	0	12	12
64203	Cable TV	22	8	-14
71330	Renting of office equipment and computers	19	6	-13
72100	Hardware consultancy	12	19	7
72201	Software consultancy	55	62	7
72202	Software production and supply	29	47	18
72300	Data processing	32	37	5
72400	Data base activities	7	10	3
72500	Maintenance/repair of office and computing eq.	30	32	2
72600	Other computer-related services	14	11	-3
	Sum	726	788	62

Table 3.4 contains a last row that presents the sum of industries that are hosted across all regions. If all industries could be found in each region, the sum would be 2187. Still in year 2000 the sum was not larger than 36 percent of this maximal value. This reveals that the ICT industries have retained a selective location pattern. As many as 19 of the industries were each located in 36 regions or less. Thus, on average 2/3 of the industries were missing in a typical region.

3.3 Estimation and Interpretation of the Location Models

From sub section 3.2 we know that in 1990 only one industry was located in every region, and in 2000 all industries were missing in several regions. Given these observations we return to the issues in sub section 2.4. This first question is to what extent the location pattern reflects the size of regions, and we examine if the probability of finding an industry in a region depends on the size of the region's economy. In parallel we examine if the location probability of each industry depends on a region's economic diversity.

In (2.10a) the size model is introduced as a logit model, specified as $P_r = \left[1 + \exp\left\{\mu - \tau\hat{S}_r\right\}\right]^{-1}$. To get an intuitive understanding of this model it can be reformulated as an odds ratio formula, as described in (2.10b). Doing that and taking the natural logarithms of both sides of the equation yields

$$\ln[P_r/(1-P_r)] = -\mu + \tau\hat{S}_r \qquad (3.1)$$

The function in (3.1) is illustrated in Figure 3.1, which shows that the parameter μ can be interpreted as a threshold that reduces the location probability. The parameter τ on the other hand refers to the steepness of the straight line in the figure, and expresses how sensitive the probability is to changes in economic size.

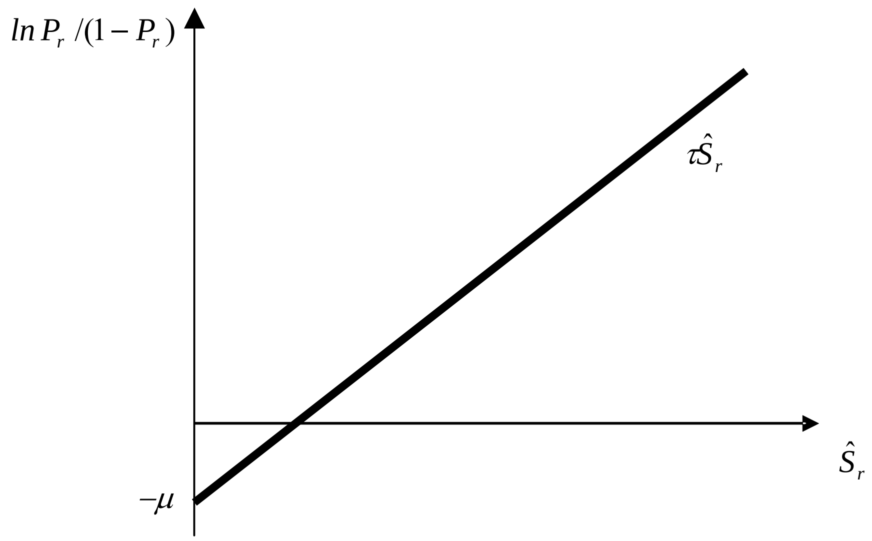

Figure 3.1: Illustration of the odds-ratio version of the logit model

The parameter μ can be interpreted as a threshold coefficient such that the larger this coefficient is, the more important is the size effect as a compensating factor. The parameter τ expresses the strength of the size effect and shows how much an increment in $\hat{S}_r$ increases the odds ratio, $P_r/(1-P_r)$. When this parameter is large even modest increases in size will improve the location probability considerably.

Can μ and τ inform us of the strength of scale economies, i.e., the effect of fixed costs? Together they provide information. If μ is large in size and τ is small, the internal scale-economies are strong.

All considerations above are of course applicable also with regard to the diversity model, which has the odds-ratio form described in formula (3.2).

$$\ln[P_r/(1-P_r)] = -\mu + \tau\hat{A}_r \qquad (3.2)$$

Although the independent variable $\hat{A}_r$ is referred to as a diversity measure, it also reflects indirectly the size of the regional economy, since diversity tends to increase with the size of the economy.

4. ESTIMATION OF LOCATION PROBABILITIES

4.1 Location and the Size of the Regional Economy

The exercise to estimate the size model has several motives. First, we want to ascertain that both the threshold parameter μ and the size-effect parameter τ have the right signs and are statistically different from zero. Second, we want to assess the model performance, which is done with the help of three measures. The first of these is the McFadden pseudo R-square, the second the chi-square measure and the third the number of correct predictions made by the model in percent of a perfect prediction outcome.

The estimation is done for the years 1990 and 2000 separately. This also allows us to discuss if there are any general changes in the threshold values and in the size-effect values. The two estimations are presented in tables 4.1 and 4.2, and we start with the first table that refers to 1990.

Table 4.1: Estimated parameters of the size model for year 1990

	Constant (μ)	Size (τ)	McFadden	Chi-square	Predict %
30010	3.93 (0.00)	0.056 (0.00)	0.379	24.39	90.1
30020	1.22 (0.00)	0.049 (0.00)	0.176	19.72	71.6
31300	1.41 (0.00)	0.018 (0.05)	0.089	8.74	72.8
32100	2.66 (0.00)	0.059 (0.00)	0.293	27.79	81.5
32200	2.74 (0.00)	0.056 (0.00)	0.285	25.79	87.7
32300	2.86 (0.00)	0.042 (0.01)	0.253	19.66	87.7
33200	2.77 (0.00)	0.095 (0.00)	0.415	44.29	82.7
33300	3.18 (0.00)	0.027 (0.03)	0.263	14.84	92.6
51431	2.11 (0.00)	0.055 (0.00)	0.245	25.26	75.3
51432	2.68 (0.00)	0.053 (0.00)	0.274	24.81	81.5
51433	4.00 (0.00)	0.030 (0.02)	0.392	16.78	93.8
51434	3.30 (0.00)	0.164 (0.00)	0.548	61.03	86.4
51640	2.49 (0.00)	0.291 (0.00)	0.508	52.42	87.7
51651	2.53 (0.00)	0.051 (0.00)	0.258	23.88	84.0
52653	2.81 (0.00)	0.140 (0.00)	0.486	54.24	85.2
51659	1.67 (0.00)	0.202 (0.00)	0.406	41.23	77.8
64201	**	**	**	**	**
64202	**	**	**	**	**
64203	1.39 (0.00)	0.013 (0.09)	0.069	6.50	74.1
71330	5.28 (0.00)	0.127 (0.00)	0.623	54.94	90.1
72100	4.34 (0.00)	0.071 (0.00)	0.438	29.77	87.7
72201	1.35 (0.01)	0.164 (0.00)	0.358	36.38	80.2
72202	4.82 (0.00)	0.185 (0.00)	0.677	71.53	88.9
72300	2.10 (0.00)	0.072 (0.00)	0.303	32.93	80.2
72400	3.16 (0.00)	0.017 (0.00)	0.222	10.59	93.8
72500	3.05 (0.00)	0.108 (0.00)	0.466	49.72	86.4
72600	3.10 (0.00)	0.046 (0.00)	0.282	21.03	86.4

Remark. The sign ** indicates that there is no regression to report, due to lack of observations in one case and lack of variation in the second. . Significance levels are given in parenthesis.

For each parameter in Table 4.1 the significance level is given within parenthesis. All estimated parameters have a significance level at one percent or below, except three. For these three two have a significance level below 5 percent and one below 10 percent. These results indicate that the size variable has the capacity to predict the location probability. As the regards the capability of the model of the model to make correct predictions, the table shows that 20 out of 25 equations has more than 80 percent correct predictions.

How can the model for 1990 be evaluated by means of the McFadden measure? As an overall observation, the measure tells us that the model performance can be accepted as good for at least 22 out of the 25 estimated equations. Only two industries have McFadden measures that are clearly too low. These two industries are the only for which the chi-square measure signals unreliability. These industries are (i) Manufacturing of insulate wire and cable, and (ii) Cable-TV operation.

Table 4.2: Estimated parameters of the size model for year 2000

	Constant (μ)	Size (τ)	McFadden	Chi-square	Predict %
30010	2.90 (0.00)	0.045 (0.00)	0.260	19.39	87.7
30020	1.45 (0.00)	0.026 (0.03)	0.107	10.70	72.8
31300	1.11 (0.02)	0.034 (0.01)	0.114	12.46	70.4
32100	1.40 (0.00)	0.053 (0.00)	0.183	20.12	70.4
32200	2.14 (0.00)	0.057 (0.00)	0.237	23.72	77.8
32300	2.19 (0.00)	0.063 (0.01)	0.260	26.47	77.8
33200	1.89 (0.00)	0.086 (0.00)	0.306	33.86	76.5
33300	2.34 (0.00)	0.051 (0.03)	0.233	21.57	80.2
51431	2.96 (0.00)	0.098 (0.00)	0.418	42.50	86.4
51432	3.42 (0.00)	0.075 (0.00)	0.379	31.54	85.2
51433	6.57 (0.00)	0.138 (0.00)	0.644	43.77	93.8
51434	3.84 (0.00)	0.378 (0.00)	0.632	70.35	86.4
51640	3.51 (0.00)	0.500 (0.00)	0.621	64.81	91.4
51651	3.11 (0.00)	0.090 (0.00)	0.406	39.20	84.0
52653	1.93 (0.00)	0.106 (0.00)	0.351	39.29	79.0
51659	1.66 (0.01)	0.395 (0.00)	0.462	40.74	88.9
64201	1.19 (0.01)	0.180 (0.00)	0.345	35.12	77.8
64202	3.40 (0.01)	0.053 (0.00)	0.321	21.82	87.7
64203	4.33 (0.00)	0.057 (0.01)	0.430	22.46	95.1
71330	5.24 (0.00)	0.064 (0.02)	0.545	23.30	96.3
72100	2.83 (0.00)	0.062 (0.00)	0.302	26.62	82.7
72201	0.94 (0.08)	0.248 (0.08)	0.353	31.15	82.7
72202	1.53 (0.00)	0.138 (0.00)	0.351	38.72	76.5
72300	1.99 (0.00)	0.103 (0.00)	0.352	39.29	76.5
72400	3.56 (0.00)	0.047 (0.01)	0.332	20.10	92.6
72500	4.14 (0.00)	0.211 (0.00)	0.648	70.40	90-1
72600	4.41 (0.00)	0.076 (0.00)	0.452	29.11	92.6

Remark. Ordinary establishments (at least 5 4mployees) are observables. Significance levels are given in parenthesis.

To what extent do the conclusions for 1990 hold also for the estimations referring to year 2000? To answer this we turn to Table 4.2, which shows again that almost all parameter estimates have a significance level of one percent or lower. The number of industries for which the prediction is correct in more than 80 percent of the cases is 17 in Table 4.2. However, both for 1990 and 2000 the predictions are correct in more than 70 percent of the cases for all industries.

Moreover, in Table 4.1 chi-square values are in most cases clearly above 20 and never below 10. The McFadden measure indicates that the model performance is at least as good for year 2000 as for 1990. For some industries the chi-square values are very high (above 50), indicating that in these cases size seems to be "the only thing that matters". Other industries may be influenced by other factors not included in the model, although the size effect remains significant.

In summary, the hypothesis expressed indirectly by Conclusion 1a and Conclusion 2a are not rejected by the observation in tables 4.1 and 4.2. What about Conclusions 1b and 2b? To assess that conclusion against empirical observations one has to control for changes in both μ and τ, and this assessment is made in sub section 4.3. At this instance we may just observe that the τ-value is augmented between 1990 and 2000 for 17 out of 25 industries. And a higher size-effect coefficient implies that the size-requirement for location is reduced.

4.2 Location and Diversity

The subsequent exercise has the ambition to examine if the diversity of each region's economy has anything to add in comparison with the results in the preceding sub section. We apply the model in (2.11) and interpret the results with the help of the odds-ratio formulation in (3.2). Regressions are carried out for year 1990 and 2000 in the same way as with the size model.

The results from the estimations for the two years are presented in Table 4.3, with regard the estimated values of μ and τ together with the significance levels. For year 2000 all parameters are significantly different from zero at the 5 percent level, and all except two parameters are significant at the 1 percent level or lower. The results for year 1990 display almost the same satisfying results. Taken together, this means that we cannot reject the diversity model in association with Conclusion 1a and Conclusion 2a.

It then remains to ask if the diversity model estimates the location probabilities as well as the size model or better. A simple answer is that the performance is quite similar for the two models. This statement is based on the information in Appendix 3, where the two models are compared industry by industry for year 2000 with regard to (i) the chi-square measure, (ii) the McFadden measure, and (iii) the number of correct predictions. The two first measures are more or less the same across the industries. Considering the last type of measure, the two models have the same correct prediction-rate in 10 cases, the size model is slightly better in 10 cases and the diversity model is slightly better in 7 cases. Thus, on the basis of this type of comparisons we cannot discriminate between the two formulations.

Table 4.3: Estimated parameters of the diversity model for the years 1990 and 2000

	Constant (μ) ,1990	Diversity (τ) , 1990	Constant (μ) , 2000	Diversity (τ) , 2000
30010	3.93 (0.00)	0.496 (0.00)	2.76 (0.00)	0.307 (0.00)
30020	1.16 (0.00)	0.396 (0.00)	1.40 (0.00)	0.177 (0.04)
31300	1.48 (0.00)	0.183 (0.04)	1.44 (0.00)	0.266 (0.00)
32100	2.67 (0.00)	0.523 (0.00)	1.41 (0.00)	0.401 (0.00)
32200	2.88 (0.00)	0.527 (0.00)	2.11 (0.00)	0.424 (0.00)
32300	2.75 (0.00)	0.340 (0.01)	2.22 (0.00)	0.487 (0.00)
33200	2.83 (0.00)	0.854 (0.00)	1.95 (0.00)	0.670 (0.00)
33300	3.13 (0.00)	0.223 (0.03)	2.24 (0.00)	0.357 (0.00)
51431	2.15 (0.00)	0.491 (0.00)	3.13 (0.00)	0.806 (0.00)
51432	2.73 (0.00)	0.481 (0.00)	3.54 (0.00)	0.608 (0.00)
51433	4.02 (0.00)	0.265(0.02)	7.58 (0.00)	1.252 (0.01)
51434	3.36 (0.00)	1.448 (0.00)	4.15 (0.00)	2.960 (0.00)
51640	3.00 (0.00)	2.805 (0.00)	4.00 (0.00)	3.908 (0.00)
51651	2.54 (0.00)	0.454 (0.00)	3.12 (0.00)	0.691 (0.00)
52653	3.23 (0.00)	1.442 (0.00)	1.93 (0.00)	0.784 (0.00)
51659	1.99 (0.00)	1.931 (0.00)	1.84 (0.00)	2.816 (0.00)
64201	**	**	1.58 (0.00)	1.637 (0.00)
64202	**	**	3.42 (0.00)	0.406 (0.00)
64203	1.36 (0.00)	0.100 (0.10)	4.59 (0.00)	0.487 (0.01)
71330	5.24 (0.00)	1.115 (0.00)	4.98 (0.00)	0.438 (0.02)
72100	4.22 (0.00)	0.600 (0.00)	2.84 (0.00)	0.482(0.00)
72201	1.38 (0.01)	1.351 (0.00)	1.65 (0.00)	2.553 (0.00)
72202	4.67 (0.00)	1.565 (0.00)	1.80 (0.00)	1.198 (0.00)
72300	2.24 (0.00)	0.682 (0.00)	2.11 (0.00)	0.836 (0.00)
72400	3.14 (0.00)	0.141 (0.00)	3.71 (0.00)	0.397 (0.00)
72500	3.26 (0.00)	1.032 (0.00)	4.48 (0.00)	1.750 (0.00)
72600	3.11 (0.00)	0.407 (0.00)	4.39 (0.00)	0.586 (0.00)

Remark. Ordinary establishments (at least 5 4mployees) are observables. Significance levels are given in parenthesis.

4.3 Changing Critical Values for the Size and Diversity Effects

In Section 2 Conclusion 4 is formulated as follows. For a region where the size of *M* initially is too low, the growth of the demand intensity can improve profit conditions, making it feasible to establish a firm in the region at a later stage when the demand intensity has increased enough. With the size model introduced in (2.10a) the variable *M* is represented by $\hat{S}_r$, and with the diversity model in (2.11) *M* is represented by $\hat{A}_r$. The statement in Conclusion 1b means that an industry's probability of location increases for each particular region as the demand intensity grows over time. The statement in Conclusion 2b means that as input deliveries become more standardised and routine-based, the location decision of an individual firm becomes less sensitive to the size of a region's economy.

In order to make the formulation above precise, let $P_r(90)$ denote the location probability of region *r* in year 1990, and let $\mu(90)$ and $\tau(90)$ be the corresponding parameters of equation (2.10a). For year 2000 the variable $P_r(00)$, $\mu(00)$ and $\tau(00)$ can be introduced in an analogous way. Then an increasing demand intensity is assumed to bring about a shift from the pair [$\mu(90), \tau(90)$] to [$\mu(00), \tau(00)$] such that condition (4.1) is satisfied for the size model and condition (4.2) is satisfied for the diversity model:

$$-\mu(00)+\tau(00)\hat{S}_r > -\mu(90)+\tau(90)\hat{S}_r \quad (4.1)$$

$$-\mu(00)+\tau(00)\hat{A}_r > -\mu(90)+\tau(90)\hat{A}_r \quad (4.2)$$

Conclusion 1b in Section 2 states that the variable cost variable can be assumed to be lower as *M* gets larger. Conclusion 2b considers the effects of a change process such that inputs to a novel industry become less distance sensitive as the industry gradually matures and its activities get routinised. In view of this, Conclusion 1b implies that over time the input-demand externality weakens, and this should then bring about a shift from the pair [$\mu(90)$, $\tau(90)$] to [$\mu(00)$, $\tau(00)$] such that the conditions in formulas (4.1) and (4.2) are satisfied.

In order to assess the conditions expressed by formula (4.1) and (4.2) we use the two formulas in (2.10a) and (2.11) to calculate for each industry the values of $\hat{S}_r$ and $\hat{A}_r$ that correspond to a probability of 0.5 (50 percent). This calculation is carried out for the years 1990 and 2000 separately and presented in Table 4.4 as critical values for an 0.5 location probability.

Table 4.4: Critical values for 50 percent location probability

	Size level 1990	Size level 2000	Diff %	Diversity 1990	Diversity 2000	Diff
30010	69 849	64 115	- 8.2	7 913	8 999	13.7
30020	24 803	56 562	128.0	2 924	7 898	170.2
31300	77 055	32 978	- 57.2	8 084	4 302	- 46.8
32100	44 963	26 629	- 40.8	5 111	3 525	- 31.0
32200	49 279	37 340	- 24.2	5 466	4 986	- 8.8
32300	67 765	34 830	- 48.6	8 075	4 549	- 43.7
33200	29 067	21 996	- 24.3	3 318	2 908	- 12.4
33300	117 922	45 853	- 61.1	14 037	6 266	- 55.4
51431	38 584	30 172	-21.8	4 373	3 884	- 11.2
51432	50 422	45 609	- 9.5	5 666	5 818	2.7
51433	133 603	48 266	- 63.9	15 158	6 049	- 60.1
51434	20 113	10 174	- 49.4	2 320	1 400	- 39.7
51640	8 582	7 006	- 18.4	1 071	1 022	- 4.6
51651	49 368	34 535	- 30.0	5 600	4 510	- 19.5
51653	20 092	18 304	- 8.9	2 238	2 466	10.2
51659	8 251	4 196	- 49.1	1 033	655	- 36.6
64201	**	6 617	**	**	963	**
64202	**	64 670	**	**	8 409	**
64203	111 103	75727	- 31.8	13 600	9 425	- 30.7
71330	41 596	82 044	97.2	4 702	11 380	142.0
72100	61 405	45 310	-26.2	7 031	5 896	- 16.1
72201	8 229	3 767	- 54.2	1 019	645	-36.7
72202	25 977	11 152	- 57.1	2 985	1 504	- 49.6
72300	29 150	19 212	-34.1	3 277	2 530	- 22.8
72400	190 856	74 876	- 60.8	22 227	9 349	- 57.9
72500	28 136	19 619	- 30.3	3 160	2 561	- 19.0
72600	67 777	57 727	- 14.8	7 651	7 495	- 2.0

Let us first consider the size model. According to Table 4.4 the critical *S*-value is reduced for 23 industries between the two years. This result is consistent with the hypotheses that follow from Conclusion 1b and Conclusion 2b. What can be said about the two deviating industries?

They are (i) Manufacturing of computers and information processing equipment and (ii) Renting of office machinery, information processing equipment and computers. Both these industries experienced a considerable loss of employment between 1990 and 2000. They both reduced to about 1/3 of their initial size.

The diversity model generates a similar result as the size model. However, with the diversity model there are 5 out of 25 industries for which the change in critical value contradicts the prediction based on Conclusion 1b and Conclusion 2b. From this we may conjecture that the size model better reflects the expected change process of a novel industry's gradual maturing process. The two deviating industries in the size model are deviating also in the diversity model.

5. CONCLUDING REMARKS

The results from the estimation exercises in this chapter are compatible with the assumption that the likelihood of a successful start of a novel industry increases as the size and diversity of the host region increases. This feature is close to universal in the sense that it can be observed both for manufacturing and service industries. What would the alternative assumption be? One recurrent assumption is that novel industries, like the ICT industries, have a tendency to be attracted by each other. In estimations not presented here, this hypothesis has also been tested. Indeed the empirical observations do not exclude such an interpretation, where the location of each individual ICT industries is stimulated by the location of all other ICT industries. However, the estimation results in such a setting are less convincing, with lower Chi-square and McFadden values and with less significant parameter estimates. In other words, size and diversity remain first options in the explanation of location probabilities.

The chapter also presents a temporal hypothesis, which in particular says that the size dependence should be expected to fall over time – especially for those industries that experience a growing demand. The study shows that for a majority of the industries this form of change process was present in the period 1990-2000.

Consider now that we accept the findings as valid. In what ways could the empirical analysis bee enlarged and improved in order to sharpen results? We suggest that three such extensions should be made. In all cases the idea is to categorise industries further. The first option is to distinguish between industries with growing and not growing demand. The second alternative is t distinguish between industries with growing and not growing employment. A third possibility is to distinguish between industries with high and low knowledge intensity.

We should also comment on the separation of micro firms from ordinary firms. In order to check the location pattern of micro firms, the authors have repeated all the regressions in section 4 for micro firms. The same type of regression results apply also in this case, although the regression properties are weaker and less sharp. Micro firms are more often found in smaller regions. At the same time, there is a larger number of micro firms in large regions.

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APPENDIX 1

The demand function in (2.3) $x = \alpha p^{-\theta} kM$, with $\theta > 1$, implies that the profit of the firm, *V*, can be written as $V = \alpha p^{1-\theta} kM - v\alpha p^{-\theta} kM - F$. The first-order condition for profit maximisation can be expressed as $dV / dp = \alpha(1-\theta) p^{-\theta} kM + \theta\alpha v p^{-\theta-1} kM = 0$. Rearranging leads to $p(\theta - 1) = v\theta \Rightarrow p = v\theta /(\theta - 1)$, which yields

$$p = v\sigma \text{ for } \sigma = \theta /(\theta - 1)$$

We have assume that *k* is a fraction of the budget *M*, which implies that $px / M = k$. Is this consistent with the solution that has been derived? To answer this, consider first that the demand expression implies that $px = \alpha p^{1-\theta} kM$. Inserting $p = v\sigma$ into the expression above yields $px / M = \alpha k[v\sigma]^{1-\theta}$. Obviously, $px / M = k$ can be true only if $\alpha = [v\sigma]^{\theta-1}$. Hence, this is the value of α that makes the demand specification consistent. Of course, this implies that $x = kMp^{-1}$.

Consider now that $\alpha > 0$ does not satisfy the above condition. Also in this case we can ascertain that $\partial x / \partial k > 0$, which means that an increasing *k* still reflects an increasing budget share. Moreover, as θ approaches unity, the budget share, px / M , approaches αk .

Our next concern is that profits should be non-negative, i.e., that $px - vx - F \geq 0$. If free entry in a monopolistic-competition setting drives profits of the individual firm to zero, we obtain that $x = F /(p - v)$, which means that $x = (F / v)(\theta - 1)$.

APPENDIX 2

Let $x_i = \alpha p_i^{-\theta} kM$ for each product variant *i* in a monopolistic competition market, where free entry makes the price of each product approache the condition $p_i = c_i = c$. This implies that $v + F / x_i = \alpha kM / n$. We may now use the result $x_i = (F / v)(\theta - 1)$ to calculate the value of *n* by writing: $v + F /[F(\theta - 1) / v] = v + v /(\theta - 1) = \alpha kM / n$. This yields $n = \alpha kM (\theta - 1) / v\theta$, and we then obtain $n = \alpha kM / v\sigma$. Thus, the number of differentiated products increases as *M* gets larger. We may also observe that a large $\sigma = \theta /(\theta - 1)$ makes *n* smaller, and σ gets large as θ is being reduced towards unity.

APPENDIX 3

Table A3.1: Performance measures for the size and diversity models with regard to 2000

	Chi-square size model	Chi-square Diversity model	McFadden size model	McFadden diversity model	Prediction size model, %	Prediction diversity model, %
30010	19.39	17.64	0.260	0.237	87.7	86.4
30020	10.70	9.90	0.107	0.099	72.8	70.4
31300	12.46	12.63	0.114	0.115	70.4	70.4
32100	20.12	19.37	0.183	0.176	70.4	71.6
32200	23.72	22.53	0.237	0.225	77.8	76.5
32300	26.47	25.98	0.260	0.256	77.8	77.8
33200	33.86	33.38	0.306	0.301	76.5	79.0
33300	21.57	19.37	0.233	0.209	80.2	79.0
51431	42.50	43.76	0.418	0.430	86.4	86.4
51432	31.54	32.27	0.379	0.388	85.2	87.7
51433	43.77	45.61	0.644	0.671	93.8	96.3
51434	70.35	68.40	0.632	0.615	86.4	85.2
51640	64.81	63.56	0.621	0.609	91.4	87.7
51651	39.20	37.68	0.406	0.390	84.0	84.0
52653	39.29	36.97	0.351	0.330	79.0	79.0
51659	40.74	38.50	0.462	0.436	88.9	88.9
64201	35.12	37.84	0.345	0.372	77.8	77.8
64202	21.82	22.09	0.321	0.325	87.7	86.4
64203	22.46	24.50	0.430	0.469	95.1	86.3
71330	23.30	22.75	0.545	0.532	96.3	95.1
72100	26.62	26.13	0.302	0.296	82.7	81.5
72201	31.15	36.3§	0.353	0.411	82.7	82.7
72202	38.72	41.10	0.351	0.373	76.5	81.5
72300	39.29	39.91	0.352	0.357	76.5	79.0
72400	20.10	21.64	0.332	0.357	92.6	93.8
72500	70.40	72.07	0.648	0.663	90.1	90.1
72600	29.11	29.01	0.452	0.451	92.6	92.6