Co-location of manufacturing & producer services – a simultaneous equations approach

by

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Abstract

This paper investigates the tendencies of co-location between the producer service sector and the manufacturing sector across Swedish functional regions. The employment in these sectors is modeled as being determined simultaneously, i.e. the location of the producer service sector is a function of the location of the manufacturing sector and vice versa. The rationale for the simultaneous approach comes from an assumption of an input-output schedule between the two sectors. Accessibility based on time distances is incorporated into the analysis to allow for inter-regional effects. The findings in this paper suggest that self-organized cluster formations of advanced manufacturing and knowledge intensive producer services can only be expected in urban regions. One important policy implication of the results is that a policy directed towards establishing a cluster of advanced manufacturing and knowledge intensive producer services in a non-urban region should focus on attracting the latter type of industries. The reason is that the results in this paper imply that advanced manufacturing respond to accessibility to knowledge intensive producer service industries while the opposite effect is not present in non-urban regions.

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1. Introduction

The intermediate sector of an economy, be it regional or national, has recently come into focus in the literature. This sector is, for instance, essential in numerous recent models dealing with what is sometimes called the economics of cities or the economics of agglomeration, (see e.g. Fujita & Thisse, 2002). The set-up in these types of models is usually such that the production function of the final sector exhibits increasing returns in the number of intermediate inputs. This is achieved by using the monopolistic competition model developed by Dixit & Stiglitz (1977) with a conventional CES aggregator over the varieties of the intermediate sector. In this manner, the performance of the final sector depends on the performance of the intermediate sector, (which operates under the monopolistic regime). One of the advantages of this structure is that it is possible to show in a neat fashion that the final sector, in the aggregate, experiences increasing returns in the labor force of a region[1]. Thus, it allows for an explanation of the relationship between "size" and productivity, which in itself is an explanation of why we observe cities. Furthermore, in the cluster literature the formation of a set of specialized input suppliers located in proximity to a localized industry is usually pointed out as one explanation for why firms localize in the first place. Specifically, this is one of Marshall's (1920) three famous reasons for co-location, the other two being a pooled labor market and information spillovers.

A typical input sector for the manufacturing sector is the producer service sector, which is emphasized in, among others, Rivera-Batiz (1998). Why manufacturing firms would purchase services such as marketing, finance, logistic etc., instead of producing them internally is usually explained by the standard argument in Stigler (1951)[2]. Specialized producer services firms achieve economies of scale, which makes it more productive for manufacturing firms to purchase the services externally. Specialization spurs efficiency and scale economies results in lower unit costs. In addition, Hansen (1993, p.256) maintain that the technological progress in general provides a greater potential for service specialization and that add-on services constitute an increasingly larger share of the value of new products; "…approximately two-thirds of the value-added in the computer market", he writes, "consists of software and maintenance services-add-ons that tend to be provided by firms in the service sector rather than in manufacturing"[3]. Surveying the literature on services, Glasmeier & Howland (1994) conclude that a vast amount of research suggests that services, as inputs to other industries, enhances productivity as well as that their presence in a region stimulate the competitiveness of other industries in the region. Producer services may, for example, facilitate for manufacturing firms to adapt skills, products and processes to changes in the market as well as help to reduce organizational, managerial and informational barriers to adjustment, (Marshall *et al*, 1987).

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[1] The reason is that the number of intermediate suppliers increases with size, which in turn allows for a higher degree of specialization.

[2] The great increase in producer service employment in advanced economies caused by the externalization can also be coupled to the rise of the flexible system of production, see for instance Coffey & Bailly (1991).

[3] As an example, only about 10-15 % of the purchase price of an IBM computer can be derived to the cost of manufacturing, (Reich, 1991). The rest is due to various services.

To a great extent it is often presupposed that proximity between the manufacturer and the producer service provider is important. Hansen (1990), for example, notes that the relationship between producer services and regional productivity differences assumes tight geographical closeness between producer services and the manufacturing sector. Also, in the aforementioned type of modeling, such as in Klaesson (2001), it is frequently assumed that the intermediate sector produces in proximity to the final sector, i.e. the presence of localization economies is often taken for granted. The intermediate sector is in principle only a necessary element in order to explain concentration of the final sector. The typical raison d'être for the role of proximity between the manufacturer and the service provider is that the cost to the former for obtaining the services from the latter rises with distance. Examples of such costs are travel time to meetings and frequency of contacts, etc., (c.f. O'Farrell & Hitchens, 1990a). Coffey & Bailly (1991, p.109) emphasize the role of frequency of contacts and mark; "…it is the cost of maintaining face-to-face contacts between the producer on the one hand, and their inputs and markets, on the other hand, that is potentially the most expensive element of intermediate-demand service production".

The reasoning above implies that manufacturing firms have much to benefit from being co-located with producer services. Notwithstanding the fact that many producer services is produced for other industries in the service sector, as shown by *inter alia* Goe (1990), producer service firms also have much to benefit from co-location with manufacturing firms since the latter sector constitutes a market for the former sector. The purpose of the present paper is to investigate the tendencies of co-location between the producer service sector and the manufacturing sector in Swedish functional regions. The employment in these sectors is modeled as being determined simultaneously, i.e. the location of the producer service sector is a function of the location of the manufacturing sector and vice versa. The rationale for the simultaneous approach comes from the assumption of an input-output schedule between the two sectors. A model developed by Venables (1996) is used to derive the linkages between the two sectors, which in turn leads to the result that the location of the two sectors is interdependent. Furthermore, previous empirical research has indicated simultaneous elements. Marshall (1982), for instance, confirms a bi-directional relationship between manufacturing and producer services. More precisely, the author finds that the organizational structure of the producer service industry affects manufacturing demand for such services at the same time as the organization of the manufacturing sector influences the supply of producer services[4]. To account for the described interdependency a simultaneous-equations model is employed for estimation. That is, how the size of the manufacturing sector affects the size of the producer service sector (and vice versa) is investigated. The study is based on Swedish employment data in 2000 and is a static cross-section investigation. Thus, the study looks for a static picture of co-located sectors, which can be interpreted as an equilibrium outcome, (c.f. Johansson, 2001). A distinction is made between knowledge-intensive advanced manufacturing and traditional manufacturing on the one hand, and knowledge-intensive and non knowledge-intensive producer services on the other. Accessibility based on time distances is incorporated into the analysis to allow for inter-regional

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[4] Marhall's (1982) study is based on a postal survey in the British city regions of Birmingham, Leeds and Manchester and, hence, is based on a limited sample of manufacturing establishments.

effects, i.e. manufacturing employment in a functional region is not restricted to be a function of the producer service employment in the same region only.

There are several justifications for performing a study of this type. First and foremost, the paper will reveal which synergy effects are likely to take place as a result of increased employment in one of the industries. This is important from a policy perspective, especially when it comes to policies aimed at attracting firms in the sectors considered in the paper. For example, the estimates will indicate what effects, in terms of manufacturing employment, policy makers can expect from attracting producer service providers. Second, since one of the conventional theoretical explanations for why firms would cluster is the existence of specialized input suppliers, the findings in the paper can be seen as a an indication of the validity of such explanations. The same applies to the type of modeling previously mentioned, in which it is often assumed that the intermediate sector operates in proximity to the final sector.

1.1 Outline

The remainder of the paper is organized in the following fashion: Section 2 presents part of a model developed by Venables (1996). This model is used because it shows how the location of the producer service sector depends on the location of the manufacturing sector and vice versa. In Section 3, the producer service sector and the manufacturing sector are defined. Also, a general description of the spatial distribution of the sectors analyzed in the paper is presented. Section 4 presents the results of the empirical investigation. Section 5, the final section, concludes the paper and makes suggestions for further research.

2. Modeling location dependence between producer services & manufacturing

In this section, the basic structure of a model developed by Venables (1996) is presented. The model is based on the following theme: vertical linkages between sectors imply that the location of the sectors is interdependent. Since the downstream sector creates a market for the upstream sector, the latter is attracted to locations where there are relatively many upstream firms. (The author denotes this as the demand linkage). At the same time, the downstream sector experiences lower costs if it operates in a location in which there are relatively many upstream firms. (The author denotes this linkage the cost linkage). This model is of relevance in the present context because it shows how and why the locations of two vertically linked sectors are simultaneously determined. Here, downstream will be interpreted as manufacturing and upstream as producer services. This may be conceived as a very *ad hoc* assumption, but in a world where product attributes, such as design, technological refinement, branding and so forth, constitute an important part of the product value, manufacturing firms have inevitably to rely upon various producer service providers to sustain their market shares and competitiveness, (see for instance Reich, 1991 and Hansen, 1993 earlier referred to). Hence, producer services can be seen as an important input in the production function for manufacturing firms.

In Venable's (1996) model, there are two regions and three sectors; (i) a perfectly competitive sector, whose product is used as numeraire, (ii) a monopolistically competitive sector, which produces for final consumption and (iii) a monopolistically competitive intermediate sector, here the producer service sector, which supplies inputs to the final manufacturing sector. The two latter sectors are modeled using the common monopolistic competition model in Dixit & Stiglitz (1977)[5]. The presentation of the model follows the original presentation in Venables (1996). It starts by describing the manufacturing sector and then goes on to describe its linkages to the producer service sector.

2.1 Manufacturing – the final sector

1 and 2 denote the two regions in the economy. All manufacturing firms in the industry supply both locations. Consumers in region 1 (2) can consume varieties produced in the same region, z_{11} (z_{22}), or varieties produced in the other region, z_{21} (z_{12}). For varieties transported from the other region, the consumer price is the price of the variety at the origin multiplied by an *ad valorem* transport cost of $t > 1$. All consumers in both locations have a love-of-variety and their preferences are identical. The latter makes it possible to treat each region as one representative consumer. The problem for region 1, then, can be expressed as in Equation 1.

$$(1) \qquad \max_{\{z_{i11}, z_{i21} \geq 0\}} U_1 = \left(\sum_{i=1}^{n_1} z_{i11}^{\frac{s-1}{s}} + \sum_{i=1}^{n_2} z_{i21}^{\frac{s-1}{s}} \right)^{\frac{s}{s-1}} \qquad \text{s.t.} \quad m_1 = \sum_{i=1}^{n_1} p_{i1} z_{i11} + \sum_{i=1}^{n_2} p_{i2} t z_{i21}$$

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[5] For a comprehensive and pedagogical presentation of the monopolistic competition model with extensions see Matsuyama (1995).

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Given that the consumers in both regions have the same preferences, the (marshallian) demands can be expressed as in Equation (2) and (3). Since all varieties enter the utility function in a symmetric fashion, the subscript for variety ($i=1,......,n$) is ignored.

$$(2) \qquad z_{11} = m_1 p_1^{-s} P_1^{s-1}, \qquad P_1^{s-1} = \frac{p_1^{s-1}}{n_1} + \frac{(p_2 t)^{s-1}}{n_2}$$

$$(3) \qquad z_{12} = m_2 (p_1 t)^{-s} P_2^{s-1}, \qquad P_2^{s-1} = \frac{(p_1 t)^{s-1}}{n_1} + \frac{p_2^{s-1}}{n_2}$$

z_{11} is the demand for a particular variety produced in region 1 and sold in region 1 and z_{21} is the demand for a particular variety produced in region 2, but sold in region 1. P_1 and P_2 are the price indexes in the respective regions. n_1 is the total number of manufacturing firms producing in region 1 and n_2 is the total number of manufacturing firms producing in region 2. $s > 1$ is the price elasticity of demand for an individual variety, ($\partial \ln z / \partial \ln p = s$).

The profits of a firm located in region 1, $\boldsymbol{p}_1$, is given by,

$$(4) \qquad \boldsymbol{p}_1 = (p_1 - c_1)(z_{11} + z_{12}) - c_1 f$$

where c_1 is marginal cost and $c_1 f$ is fixed costs. The condition for profit maximization, i.e. $p_1(1 - s^{-1}) = c_1$, together with the zero profit condition implies that firm scale is independent of costs.

$$(5) \qquad z_{11} + z_{12} = f(s - 1)$$

In order to explore how the industry is located between the two regions the relative production value, relative cost and relative expenditure is used.

$$(6) \qquad l \equiv \frac{n_2 p_2 (z_{22} + z_{21})}{n_1 p_1 (z_{11} + z_{12})}, \qquad \boldsymbol{r} \equiv \frac{c_2}{c_1} = \frac{p_2}{p_1}, \qquad \boldsymbol{h} \equiv \frac{m_2}{m_1}$$

In Equation (6), l is the relative production value. $\boldsymbol{r}$ is the relative cost (and also relative price[6]) and $\boldsymbol{h}$ is the relative expenditure. Expressing the ratio of the price indexes in terms of $\boldsymbol{r}$ and l leads to Equation (7).

$$(7) \qquad \left(\frac{P_2}{P_1} \right)^{s-1} = \frac{1 + t^{1-s} \boldsymbol{r}^{-s} l}{t^{1-s} + \boldsymbol{r}^{-s} l}$$

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[6] This follows from the fact that $p_1(1 - s^{-1}) = c_1$ under profit maximization, i.e. marginal revenue equals marginal cost.

Since Equation (5) implies that $(z_{22} + z_{21})/(z_{11} + z_{12}) = 1$, l can be expressed as a function of $\boldsymbol{r}$ and $\boldsymbol{h}$ using (7).

$$(8) \qquad l = \frac{\left(t^{2s}\,\boldsymbol{r}^s - t^s\,\boldsymbol{r}^{2s}\right)\boldsymbol{h} - t^{1+s}\,\boldsymbol{r}^{2s} + t\boldsymbol{r}^s}{\left(t\boldsymbol{r}^s - t^{1+s}\right)\boldsymbol{h} + t^{2s}\,\boldsymbol{r}^s - t^s} \equiv f(\boldsymbol{r},\boldsymbol{h},t)$$

Equation (8) gives the distribution of production between the two regions as a function of transport costs, relative costs and relative consumer expenditure. The relationship in Equation (8) is dependent on the assumption that n_1, $n_2 > 0$[7].

2.1 Linkages between manufacturing and producer services

In order to illustrate the location dependence between the two sectors, it is assumed that the structure of the producer service sector is the same as in the previous section. The manufacturing sector is denoted by d and the producer service sector by u. (Henceforth, superscripts will denote sector). The demand for the final products comes from the consumption expenditure at each location. On the other hand, the demand for the producer service sector's output comes from manufacturing since it uses the producer service sector's output as inputs. Also, the cost of the manufacturing sector depends on the producer services sector. These cost and demand linkages imply that the relative cost of the manufacturing sector ($\boldsymbol{r}^d$) and the relative expenditure on the output of the producer services sector ($\boldsymbol{h}^u$) are endogenous. The cost of the producer service sector and the demand for the final product ($\boldsymbol{r}^u$, $\boldsymbol{h}^d$), though, are exogenous.

Venables (1996) assumes that both industries use labor in production and that the relative wage between the two locations, $\boldsymbol{w} \equiv w_2/w_1$, is exogenous. The producer service sector uses only labor, implying that it's relative cost and relative price is $\boldsymbol{w}$. As in Either (1982), Rivera-Batiz (1988) and others, the producer services sector's output enters the manufacturing sector's production function through a CES aggregator. Specifically, the production function of the manufacturing sector is a Cobb-Douglas over labor and producer services, with a CES sub-production function for the producer services sector's composite output. Since the cost function of the CES sub-production function is given by the price index, it has already been provided in equation (2) and (3), (see Appendix A). Due the assumption of a Cobb-Douglas technology, the relative cost of the producer services industry can be expressed as,

$$(9) \qquad \boldsymbol{r}^d = \left(\frac{c_2^d}{c_1^d}\right) = \boldsymbol{w}^{1-g}\left(\frac{P_2^u}{P_1^u}\right)^{\boldsymbol{g}}$$

, where $\boldsymbol{g}$ is the share of the producer service sector's output used in production.

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[7] Venables (1996) shows that a necessary condition for this to be so is that $t > \boldsymbol{r} > 1/t$.

From (7) it follows that,

$$(10) \qquad \boldsymbol{r}^d = \boldsymbol{w}^{1-g} \left(\frac{1 + t^{1-s} \boldsymbol{w}^{-s} l^u}{t^{1-s} + \boldsymbol{w}^{-s} l^u} \right)^{\frac{g}{s-1}} \equiv g\left(\boldsymbol{w}, l^u, t\right)$$

This function says that the cost of the manufacturing sector is a function of the location of the producer service sector. In particular, the relative cost of manufacturing decreasing in the relative location of producer services, l^u. Hence, the larger the producer services sector, the lower are the costs of the manufacturing sector.

Next, since consumer expenditure is the only source of demand for the manufacturing industry's output, we have that $\boldsymbol{h}^d = m_2^d / m_1^d$, which is exogenous. The expenditure on the output of the producer service sector comes from the manufacturing industry alone. This implies that the producer service sector's share of the manufacturing sector's total expenditure (total cost), $\boldsymbol{g}$, determines the demand for the output of the producer service sector.

$$(11) \qquad m_1^u = \boldsymbol{g} \; n_1^d c_1^d \left(z_{11}^d + z_{12}^d + f \right) \quad \Rightarrow \quad \boldsymbol{h}^u = \frac{n_2^d p_2^d \left(z_{22}^d + z_{21}^d \right)}{n_1^d p_1^d \left(z_{11}^d + z_{12}^d \right)} \equiv l^d$$

Using Equations (8), (10), (11) as well as keeping in mind that the relative cost and the relative prices for the producer service sector is $\boldsymbol{w}$, l^u and l^d can be expressed as in Equation (12) and (13).

$$(12a) \qquad l^u = f^u\left(\boldsymbol{r}^u, \boldsymbol{h}^u, t\right) = f^u\left(\boldsymbol{w}, l^d, t\right)$$

$$(12b) \qquad l^d = f^d\left(\boldsymbol{r}^d, \boldsymbol{h}^d, t\right) = f^d\left(g(\boldsymbol{w}, l^u, t), \boldsymbol{h}^d, t\right)$$

These equations can be solved for the endogenous variables, l^u and l^d. Equation (12a) shows the dependence of the producer service sector's location on the demand from the manufacturing industry and gives l^u as an increasing function of l^d. Equation (12b) captures the dependence of the manufacturing sector's location on supply from the producer service sector and gives l^d as an increasing function of l^u. Hence, the model shows that the locations of the sectors are simultaneously determined.

3. Definition of the sectors & their spatial distribution across the Swedish economy.

In the sequel, the relationship above will be tested across Swedish functional regions. Equation (12a) and (12b) will serve as basis for the specification of the econometric model. Before turning to the econometric results, however, the present section presents the definition of the producer service sector and the manufacturing sector applied in the paper. Also, it provides a general description of the spatial distribution of the manufacturing and the producer service sector in Sweden.

3.1 Defining manufacturing and producer services[8]

O'Farrell & Hitchens (1990) maintain that one distinctive feature of service research in general is the lack of consensus on both the boundary and classification of services. Due to that services traditionally have been viewed as something tertiary, they have been defined by means of exclusion, e.g. they are not manufacturing nor agriculture. However, as Glasmeier & Howland (1994, p.199) rightly comment; "…the problem with this scheme is that it does not reveal what services are, only what they are not".

A standard way of classifying services is to use the Standard Industrial Classification (SIC) system of the relevant country. However, since the SIC is a classification primarily based on activity, (i.e. production units are classified according to their main activity)[9], and not on the type of job, some problems are associated with the use of it. For instance, such a scheme implies that a marketing manager working in a manufacturing firm will be classified into the manufacturing sector whilst a marketing manager in a marketing firm, which provides the same service as the former, will be classified into the service sector. Hence, employment data based on SIC codes will not provide "true" figures of those engaged in services and those engaged in production.

Ideally for the purpose of this paper, producer service industries should be chosen based on recent disaggregated input-output tables. This would make it possible to ascertain which services the manufacturing firms are linked to and vice versa. Unfortunately, such information is presently not available for Sweden. The latest regional input-output table available for Sweden is from 1996 and is an aggregated one. Therefore, in spite of the abovementioned deficiencies, the definition of producer services is captive to the SIC classification scheme. In Appendix B, a list and description of the SIC codes at the 5-digit level which are defined as producer services in this paper is provided. The choice of industries to be classified as producer services was made by studying the main activities of the industries, i.e. the description of the SIC-code. Hence, the definition of the producer service sector in this paper is very wide, but it will nevertheless provide the broad picture of the tendency of co-location with the manufacturing sector.

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[8] For a comprehensive review of various methods to classify services with discussions of pros and cons, see Glasmeier & Howland (1994) and O'Farrell & Hitchens (1990).
[9] For a description of the Swedish SIC (SNI, *Svensk Näringslivsindelning*), see the homepage of Statistic Sweden, www.scb.se.

In contrast to the producer service sector, the manufacturing sector is easily identified. A list of these will not be provided. The industries classified into the manufacturing sector are those with a SIC code within the interval 15-37 at the 2-digit level.

3.2 The spatial distribution of manufacturing & producer services across Swedish functional regions

Figure 3.1. shows how the spatial distribution of the employment in manufacturing and producer service sector across Swedish functional regions in 2000. It is evident that the manufacturing sector is less concentrated to large urban regions than the producer service sector. The three largest regions[10], in population terms, had approximately 58 % of the total employment in the producer service sector while the same regions accounted for about 30 % of the total manufacturing employment.
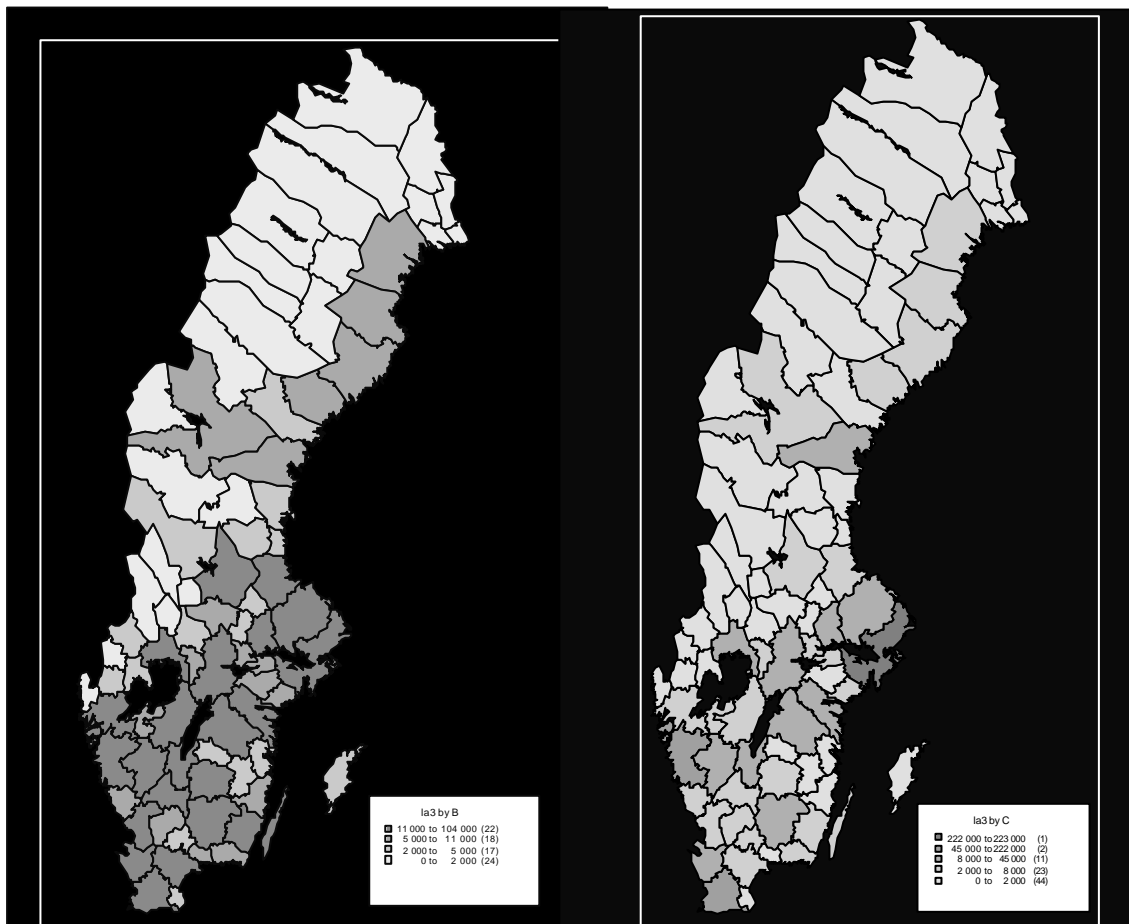

Figure 3.1. The geographical distribution of manufacturing (*left*) and producer service (*right*) employment across the 81 functional regions in Sweden 2000.

The Stockholm region stands out when it comes to the producer service sector. By itself, it accounted for no less than 37 % of the total employment in this sector. The same figure for manufacturing amounted to 14 %. This can be seen as an indication of that

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[10] These are, in descending order, Stockholm, Gothenbourg and Malmoe.

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producer services thrive in urban regions. By this token, they seem to be attracted to economic milieus in which urbanization economies are present. In addition, it may be noted that only 14 out of the 81 functional regions had a larger share of the employment in the producer service sector than in the manufacturing sector.

In Table 3.1. the correlation coefficient between (i) producer service and manufacturing employment and (ii) producer service employment per employed in manufacturing. Also, the mean producer service employment per employed in the manufacturing is presented. All figures are across the 81 functional regions.

Table 3.1. Correlation coefficients and mean producer service employment per employed in manufacturing in 2000.

Correlation coefficient between producer service and manufacturing employment.	0.899*
Correlation coefficient between producer service employment per employed in manufacturing and total manufacturing employment.	0.387*
Mean producer service employment per employed in manufacturing.	0.54 (0.40)

*) Denotes significance at the 0.01 level.

**) Standard deviation of the mean presented within brackets.

As should be expected from an inspection of Figure 3.1., there is a high correlation between producer service employment and manufacturing employment. Thus, a high employment in manufacturing implies a high employment in producer services. It is also evident that the higher the employment in manufacturing in a region, the more producer service provision per employed in manufacturing. Since both producer service and manufacturing employment increase with population, this reflects that producer services employment rise disproportionably with respect to manufacturing employment as the population rises. From the mean figure, it can be seen that there are on average twice as many employed in manufacturing compared to producer services. However, the figure varies greatly across the regions. The minimum value is 0.11 while the maximum value is 2.34. The size of the standard deviation is also large compared to the mean. The overall pattern is that there are more employed in manufacturing than in producer services. 9 out of the 81 regions have a higher producer service employment than manufacturing employment.

4. Tendencies of co-location across functional regions – a simultaneous approach

4.1 Model specification & description of variables

Since the employment in the manufacturing and producer service sectors will be modeled simultaneously, a system of equations is subject to estimation. The equation system is based on Equation (12a) and (12b) in Section 2.1 and is presented in Equation (13a) and (13b). Here, the employment in manufacturing in region R, is a function of the accessibility to producer service employment (and vice versa) along with some exogenous variables, which will be specified below.

(13a) $$M_R = a + f_1 P_R^a + f_2 w_R + f_3 D^{urban} + f_4 \left(D^{urban} * P_R^a \right) + e_R$$

(13b) $$P_R = d + g_1 M_R^a + g_2 K_R + g_3 D^{urban} + g_4 \left(D^{urban} * M_R^a \right) + m_R$$

In Table 4.1., the variables appearing in the equation system above is explained[11]. Manufacturing employment is a function of the accessibility to producer services and wage-sum per inhabitant. The latter variable is used as proxy for consumer expenditure. Likewise, producer service employment is a function of the accessibility to manufacturing employment and the average knowledge intensity of the workforce. Both manufacturing and producer service employment as well as the accessibility to these variables are expressed in units per square kilometer, i.e. they are expressed in density terms.

Table 4.1. Description of variables, superscripts and symbols.

Variable	Description
M_R	Employment in manufacturing per square kilometer in region R in 2000.
P_R	Employment in producer services per square kilometer in region R in 2000.
w_R	Average wage-sum per inhabitant in region R in 2000.
K_R	Average knowledge-intensity of the workforce in region R in 2000[12].
D^{urban}	Dummy for urban regions (population>100 000: 23 in Sweden in 2000);
	D=1 if urban, D=0 otherwise
Superscripts	
a	Accessibility

The average knowledge-intensity of the workforce is incorporated in the equation for producer services. In view of the fact that the producer service sector is a knowledge-intensive sector, this is a justified set-up. It can at least be expected that a large pool of skilled workers imply low search costs[13]. Furthermore, a dummy for urban regions and an

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[11] The instrumental variables are not listed in the table. The instrumental variables are the exogenous variables in the system plus predetermined values of the endogenous ones.

[12] The average knowledge intensity is defined as the total number of employed with a university education of 3 years or longer divided by the total employment.

[13] Also, a large supply of potential employees implies that a firm has a strong position in the wage negotiations.

interaction variable based on this dummy are incorporated into the model. These are used in order to reveal if regional size-effects are present, i.e. is it so that the relationship between the employment in the sectors are different between urban and non-urban regions?

As mentioned in the introduction, accessibility is used to allow for inter-regional effects. Thus, manufacturing employment in a functional region is not restricted to be a function of the producer service employment in the same region only (and vice versa). The superscript *a* refers to the *total* accessibility of a region. That is, it is a region's accessibility to itself plus the accessibility to everything outside the region. Letting $W=\{1,\dots,n\}$ be a set containing all n municipalities in the economy and letting R denote a functional region constituted by some of the municipalities in W, so that $R \subset W$, the total accessibility to manufacturing employment of functional region R is in this paper defined as in Equation (14)[14].

$$(14) \qquad M_R^a = \sum_{i \in R} \sum_{j \in W} M_j \exp\{-\mathit{l}\, t_{ij}\} \mathbf{q}_i \qquad \Rightarrow \mathbf{q}_{i \in R} = \frac{M_{i \in R}}{\sum_{i \in R} M_i}$$

The total accessibility of region R is consequently constructed as a weighted average of the total accessibility of all the municipalities belonging to that functional region. $\mathbf{q}_i$ refers to municipality i's share of the total manufacturing employment in region R. t_{ij} is the time distance between municipality i and j[15]. $\mathit{?}$ is a distance-decay (or distance-friction) parameter. In the construction of the accessibility variable, a value of l has to be used. Here, $\mathit{?}$ was set to 0.017. This is the value found by Hugosson & Johansson (2001), when studying inter-regional business trips in across regions in Sweden. The accessibility to producer services was constructed in an analogous manner.

At this point, some clarification is needed before moving on to the actual estimation of the equation system. The system of equations might not appear as being simultaneous, meaning that the L.H.S variable in one equation does not explicitly emerge on the R.H.S in the other equation. For instance, in Equation (13a) the accessibility to producer service employment is treated as endogenous while the dependent variable in Equation (13b) is the regional producer service employment. As in Deitz (1998, p.205), this type of modeling can be motivated by the fact that the accessibility to, say, manufacturing employment in region i from region j is likely to be determined by the same factors as producer services in region j. Thus, the accessibility variables will be treated as endogenous even if they technically do not give the impression of being so.

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[14] Observe that in Equation (14), j can be equal to i, so that the intra-municipal accessibility is incorporated into the total accessibility.

[15] Specifically, the time distance refers to the travel time by car between two municipalities 1998. The Swedish National Road Administration (SNRA) provided this data.

4.2 Results from the estimations

In order to complete the estimations two estimators were considered: (i) the 2SLS estimator and (ii) the 3SLS estimator. To determine which to choose, the Hausman (1978) specification test was performed[16]. In the context of comparing the 2SLS estimator with the 3SLS estimator, the strategy is to see if 3SLS improves over 2SLS, (see e.g. Doan, 1996 or Greene, 1994). The 3SLS estimator is more efficient only in the presence of correlation between the disturbances in the structural equations. Otherwise, 3SLS reduces to 2SLS. Thus, the estimates of the 2SLS should be identical to the 3SLS if a hypothesis that no correlation between the disturbances in the structural equations is true. This is H_0 in the test and a rejection of it, hence, implies that we should use 3SLS. It will be evident from the subsequent tables that H_0 could be rejected in all cases.

Table 4.2. 3SLS estimations of Equations 13a and 13b, total employment in manufacturing and producer services in 2000.

Variable	Parameter	Estimates (manufacturing)	Estimates (producer services)
Intercept	a, d	-3.67 (-2.9)*	-4.86 (-4.32)*
Acc. producer services	f_1	0.06 (5.66)*	-
Acc. manufacturing	g_1	-	0.01 (0.66)
Wage-sum	f_2	0.00005 (3.45)*	-
Knowledge intensity	g_2	-	52.98 (5.20)*
Dummy urban regions	f_3, g_3	0.85 (1.14)	-2.14 (-1.55)
Interaction variable ($D*P^a$)	f_4	0.12 (3.01)*	-
Interaction variable ($D*M^a$)	g_4	-	0.15 (2.8)*
Adj. R^2	-	0.64	0.43
No. of observations	-	81	81
Hausman Specification test	-	51.00 (12.59)	

*)denotes significance at the 0.05 level.

**)denotes significance at the 0.1 level.

***) t-values are presented within brackets. For the Hausman specification test, the figure within brackets is the critical value at the 0.05 level.

Table 4.2 presents the results from a 3SLS estimation of the equation system in Equation (13a) and (13b) over the total employment in manufacturing and the total employment in producer services. It is evident that all the estimates have the expected signs. Wage-sum has a positive impact on manufacturing employment and the average knowledge intensity of the workforce has a positive impact on the producer service employment. Since the interaction variables are significant and positive in both equations, regional size-effects are present in both equations. More precisely, this implies that the manufacturing sector respond more to the accessibility to producer services in urban regions compared to non-urban regions. Likewise, the relationship between the

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[16] The test was performed in the *RATS* package and follows the standard procedure suggested in the accompanying manual by Doan (1996).

employment in the producer service sector and the accessibility to manufacturing is stronger in urban than in non-urban regions. Such type of disproportionality indicates that both sectors flourish in the presence of urbanization economies. Another interesting result is that non-urban regions' accessibility to producer services has an effect on the manufacturing employment in those regions, while the opposite effect cannot be confirmed. The accessibility to manufacturing does not add nor subtracts anything to the employment in producer services in non-urban regions. The lower goodness of fit (adj. R^2) for the producer services compared to manufacturing, indicates that this might be due to that the employment in producer services in these regions are there because of factors not accounted for in the model

In order to investigate if there are structural differences at a more disaggregated level, a distinction is made between knowledge intensive and non-knowledge intensive producer service industries within the sector[17]. Also, knowledge intensive (advanced) manufacturing industries are distinguished from non-knowledge intensive (traditional) manufacturing industries within the manufacturing sector. Here, it is hypothesized that advanced manufacturing, such as *Manufacture of industrial process and control equipment* and *Manufacture of computers and other information processing equipment*, is essentially more dependent upon knowledge intensive producer service industries such as *Technical testing and analysis* and *R&D on engineering and technology* than on non-knowledge intensive producer service industries and vice versa. Thus, it is assumed that the input coefficients between knowledge intensive producer service and manufacturing sectors on the one hand, and between non-knowledge intensive producer service and manufacturing industries on the other are significantly larger relative to each other.
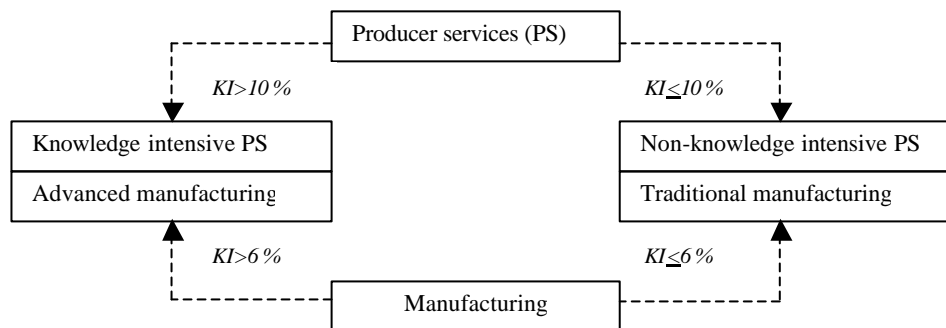

Figure 4.1. Division of producer services and manufacturing.

How the division described above was performed is illustrated in Figure 4.1. The classification of knowledge intensive industries vs. non-knowledge intensive industries was constructed relative to the own sector[18]. Therefore, the cut-values are different between the two sectors, as can be seen in the figure. Since the producer service sector is in general more knowledge intensive than the manufacturing sector, knowledge intensive

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[17] The right column in the table in Appendix B indicates which industries within the producer service sector that are knowledge intensive.
[18] The knowledge intensity is defined as the total number of employed with a university education of 3 years or longer divided by the total employment in the industry.

producer service industries have on average a higher knowledge intensity than knowledge intensive manufacturing industries, according to this classification.

In Table 4.3, the results from a 3SLS estimation of the system of equations in Equation (13a) and (13b) over the total employment in advanced (knowledge intensive) manufacturing and the total employment in knowledge intensive producer services are presented. In terms of which estimates that are significant, the results mirror those obtained in Table 4.2. The only difference is that the dummy for urban regions is significant in the equation for the producer service sector. However, that the dummy is significantly negative should not be interpreted as that those municipalities have a lower employment in producer services overall. Instead, the dummy is negative due to the steeper relationship for these municipalities, which presses down the intercept. A striking result, though, is that the size of the estimate for the interaction variable in the producer service equation is much larger in this case compared to the estimate based on the aggregate data. This implies that the knowledge intensive industries within the producer service sector in urban regions are more dependent on the accessibility to knowledge intensive manufacturing compared to the overall pattern in the same type of regions. This amounts to say that the hypothesis of a stronger input coefficient between these types of industries within the two sectors seems to be correct, but only for urban regions.

Table 4.3. 3SLS estimations of Equations 13a and 13b, *knowledge intensive manufacturing and producer services*.

Variable	Parameter	Estimates (manufacturing)	Estimates (producer services)
Intercept,	a, d	-1.20 (-1.50)	-2.26 (-2.90)*
Acc. producer services	f_1	0.02 (2.26)*	-
Acc. manufacturing	g_1	-	0.001 (0.07)
Wage-sum	f_2	0.00002 (1.85)**	-
Knowledge intensity	g_2	-	25.60 (3.66)*
Dummy urban regions	f_3, g_3	0.23 (0.51)	-1.76 (-2.13)*
Interaction variable ($D*P^a$)	f_4	0.16 (4.11)*	-
Interaction variable ($D*M^a$)	g_4	-	0.30 (4.51)*
adj. R^2	-	0.50	0.42
No. of observations	-	81	81
Hausman Specification test	-	33.95 (9.49)	

*)denotes significance at the 0.05 level.

**)denotes significance at the 0.1 level.

***) t-values are presented within brackets. For the Hausman specification test, the figure within brackets is the critical value at the 0.05 level.

Turning to the estimation of the dependency between the non-knowledge intensive industries within the two sectors, the results are presented in Table 4.4. As before, the estimates have the expected signs. It can immediately be seen that the major difference is that the estimate for the accessibility to manufacturing employment in the producer service equation is now significant. In other words, there is a significant relationship

between the employment in producer services and accessibility to manufacturing also for non-urban regions. This holds only, though, for the non-knowledge intensive industries within the two sectors. Moreover, the estimate for the interaction variable in the producer service equation is substantially smaller than in Table 4.3. Thus, regional size-effects are present also for non-knowledge intensive industries, but the effects are smaller.

Table 4.4. 3SLS estimations of Equations 13a and 13b, *non knowledge-intensive manufacturing and producer services.*

Variable	Parameter	Estimates (manufacturing)	Estimates (producer services)
Intercept,	a, d	-2.27 (-3.55)*	-1.60 (-4.70)*
Acc. producer services	f_1	0.15 (9.36)*	-
Acc. manufacturing	g_1	-	0.02 (2.92)*
Wage-sum	f_2	0.00003 (4.03)*	-
Knowledge intensity	g_2	-	16.60 (5.23)*
Dummy urban regions	f_3, g_3	0.13 (0.35)	-0.29 (-0.70)
Interaction variable ($D*P^a$)	f_4	0.17 (3.07)*	-
Interaction variable ($D*M^a$)	g_4	-	0.07 (2.46)*
adj. R^2	-	0.73	0.50
No. of observations	-	81	81
Hausman Specification test	-	42.64 (12.59)	

*)denotes significance at the 0.05 level.

**)denotes significance at the 0.1 level.

***) t-values are presented within brackets. For the Hausman specification test, the figure within brackets is the critical value at the 0.05 level.

Point elasticity calculations are useful in order to be more precise about the relative impact values of the variables. The point elasticity of manufacturing with respect to (w.r.t) accessibility to producer services is calculated according to Equation (15).

$$(15) \qquad e_{M,P^a} = \frac{\partial M}{\partial P^a} * \frac{\overline{P^a}}{\overline{M}}$$

In the above equation, e_{M,P^a} expresses the point elasticity of manufacturing w.r.t accessibility to producer services. $\partial M / \partial P^a$ is the parameter estimate of accessibility to producer services. $\overline{P^a}$ is the mean value for the accessibility producer services and $\overline{M}$ is the mean value for manufacturing employment. The point elasticity for producer service employment w.r.t accessibility to manufacturing employment is calculated in an equivalent fashion. Due to the presence of the dummy for urban regions together with an interaction variable in the estimated equations, one elasticity value will be calculated for urban regions and one for non-urban regions.

Table 4.5, presents the point elasticities based on the parameter estimates in Table 4.2-4.4. Evidently, the elasticity values differ heavily both between urban and non-urban

regions and between knowledge intensive industries and non-knowledge intensive industries within the two sectors.

Table 4.5. Point elasticities based on estimations of Equation (13a) and (13b)[19].

	Elasticity of M w.r.t P^a	Elasticity of P w.r.t M^a
Aggregated data		
Urban regions	0.50	0.63
Non-urban regions	0.54	0.00
Knowledge intensive		
Urban regions	0.67	0.92
Non-urban regions	0.39	0.00
Non-knowledge intensive		
Urban regions	0.61	0.56
Non-urban regions	0.70	0.79

*) Elasticity values are based on the estimates in Table 4.2-4.4 and are calculated according to Equation (15).

**) Urban regions are defined as regions with more than 100 000 inhabitants (non-urban regions as regions with less than 100 000 inhabitants).

The elasticity values reveal that the accessibility to manufacturing employment has a greater impact on the manufacturing employment in urban regions, than the accessibility to producer services on the manufacturing employment in the same type of regions. This holds for the aggregated data and for the knowledge intensive industries within the two sectors. On the other hand, the reverse is true for the non-knowledge intensive industries. Here, the impact of accessibility to manufacturing on producer service employment is less than that of the accessibility to producer services on the manufacturing employment in urban regions. However, the opposite pattern holds for these industries in non-urban regions.

The main findings in this section can be summarized in the following way: (i) Co-location tendencies of manufacturing and producer services can be found in urban regions for the aggregated employment in the sectors and for the knowledge intensive as well as non-knowledge intensive industries in the same type of regions. Thus, the employment in one sector depends on the accessibility to the other sector. (ii) Except for non-knowledge intensive producer services, producer service industries locate in non-urban regions because of reasons other than high accessibility to manufacturing. However, the manufacturing employment can be coupled to the existence of good accessibility to producer services. (iii) In urban regions, except for non-knowledge intensive industries in the sectors, accessibility to manufacturing has a greater impact on producer service employment than the other way around.

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[19] To clarify, the non-significant parameter-estimates in Table 4.2-4.4 were treated as being equal to zero in the construction of the elasticities.

5. Conclusions

Starting with the observation that co-location between the intermediate sector and the final sector is usually assumed in the recent type of modeling within the field of the so-called economics of agglomeration (or cities) and that the cluster literature emphasize proximity to input suppliers, the endeavor in this paper has been to investigate the tendencies of co-location between manufacturing and producer services. Indeed, producer services constitute an important input sector for manufacturing industries. A simultaneous equations approach, motivated by an assumed input-output relation between the two sectors, was applied in order to test the co-location tendencies between manufacturing and producer services.

Using employment data for Swedish functional regions in 2000, the paper has shown that manufacturing and producer services are indeed co-located in urban regions, i.e. the size of one sector explains the size of the other sector in those regions. In non-urban regions, bi-directional location dependency between the sectors could only be found for non-knowledge intensive traditional industries within the sectors. Additionally, in urban regions (except for non-knowledge intensive industries), manufacturing was shown to have a greater impact on producer service employment than the other way around.

The findings in this paper suggest that self-organized cluster formations of advanced manufacturing and knowledge intensive producer services can only be expected in urban regions. In this respect, the cumulative mechanism behind such a process is probably urbanization economies. On the other hand, clusters of traditional manufacturing and non-knowledge intensive producer services may be found in both urban and non-urban regions. Hence, their locations seem to be less dependent on regional economic milieu factors.

One important policy implication of the results presented in the present paper is that a policy directed towards establishing a cluster of advanced manufacturing and knowledge intensive producer services in a non-urban region should focus on attracting the latter type of industries. The reason is that the results in this paper imply that advanced manufacturing respond to accessibility to knowledge intensive producer service industries while the opposite effect is not present in such regions.

Since the investigation was made in a static manner, an obvious suggestion for future research is to perform a dynamic study. This could, for instance, be made by employing a model of the type presented in Mills & Carlino (1989). With such a set-up, not only equilibrium employment levels in the two sectors can be obtained, but also long run effects of changes in the exogenous variables.

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Appendix A.   *Derivation of the cost function for manufacturing*

The production function for the manufacturing firm is given by:

(1) $X = L^{1-g} Z^{g}$

Z is a sub-production function over the producer service sector's composite output of and is of the CES-type:

(2) $Z = \left(\sum_{i=1}^{n_1} x_{i11}^{1-\frac{1}{s}} + \sum_{i=1}^{n_2} x_{i21}^{1-\frac{1}{s}} \right)^{\frac{s}{s-1}}$

The *Lagrangean* associated with the problem of minimizing $\sum_{i=1}^{n_1} p_{i1} x_{i11} + \sum_{i=1}^{n_2} p_{i2} t x_{i21}$

subject to the constraint that the production level is constant at Z is:

(3) $\ell = \sum_{i=1}^{n_1} p_{i1} x_{i11} + \sum_{i=1}^{n_2} p_{i2} t x_{i21} + \textbf{\textit{l}} \left(Z - \left(\sum_{i=1}^{n_1} x_{i11}^{1-\frac{1}{s}} + \sum_{i=1}^{n_2} x_{i21}^{1-\frac{1}{s}} \right)^{\frac{s}{s-1}} \right)$

The 1st order conditions are:

(4) $\dfrac{\partial \ell}{\partial x_{i11}} = p_{i1} - \textbf{\textit{l}} \ \dfrac{s}{s-1} \left(\sum_{i=1}^{n_1} x_{i11}^{1-\frac{1}{s}} + \sum_{i=1}^{n_2} x_{i21}^{1-\frac{1}{s}} \right)^{\frac{s}{s-1}-1} \left(1 - \dfrac{1}{s} \right) x_{i11}^{-\frac{1}{s}} = 0, \ \forall \ i,j....n_1$

(5) $\dfrac{\partial \ell}{\partial x_{i21}} = p_{i2} t - \textbf{\textit{l}} \ \dfrac{s}{s-1} \left(\sum_{i=1}^{n_1} x_{i11}^{1-\frac{1}{s}} + \sum_{i=1}^{n_2} x_{i21}^{1-\frac{1}{s}} \right)^{\frac{s}{s-1}-1} \left(1 - \dfrac{1}{s} \right) x_{i21}^{-\frac{1}{s}} = 0 \ \forall \ i,j....n_2$

(6) $\dfrac{\partial \ell}{\partial \textbf{\textit{l}}} = Z - \left(\sum_{i=1}^{n_1} x_{i11}^{1-\frac{1}{s}} + \sum_{i=1}^{n_2} x_{i21}^{1-\frac{1}{s}} \right)^{\frac{s}{s-1}} = 0$

Dividing (4) with $\partial \ell / \partial x_{j11}$ and (5) respectively, leads (after some manipulation) to

(7) $x_{j11} = \left(\dfrac{p_{i1}}{p_{j1}} \right)^{s} x_{i11}$

(8) $x_{i21} = \left(\dfrac{p_{i1}}{p_{i2} t} \right)^{s} x_{i11}$

From (6) we see that:

$$(9) \qquad Z = \left(\sum_{i=1}^{n_1} x_{i11}^{1-\frac{1}{s}} + \sum_{i=1}^{n_2} x_{i21}^{1-\frac{1}{s}} \right)^{\frac{s}{s-1}}$$

Making a substitution of (7) and (8) into (9) leaves us with:

$$(10) \qquad Z = \left(x_{i11}^{1-\frac{1}{s}} \sum_{j} \left(\frac{p_{i1}}{p_{j1}} \right)^{s\left(1-\frac{1}{s}\right)} + x_{i11}^{1-\frac{1}{s}} \sum_{j} \left(\frac{p_{i1}}{p_{j2}t} \right)^{s\left(1-\frac{1}{s}\right)} \right)^{\frac{s}{s-1}}$$

Collecting the terms in (10) that relate to input x_{i11} and simplifying leads to:

$$(11) \qquad Z = x_{i11} p_{i1}^{s} \left(\sum_{j} p_{j1}^{1-s} \right)^{\frac{s}{s-1}} + x_{i11} p_{i1}^{s} \left(\sum_{j} (p_{j2}t)^{1-s} \right)^{\frac{s}{s-1}}$$

This can be written as:

$$(12) \qquad Z = x_{i11} p_{i1}^{s} P^{-s}$$

, where $P = \left(\sum_{i=1}^{n_1} p_{i1}^{1-s} + \sum_{i=1}^{n_2} (p_{j2}t)^{1-s} \right)^{\frac{1}{1-s}}$. Due to the symmetric fashion in which the producer service varieties enter the sub-production function of the manufacturing firm, this expression of P can be simplified to read:

$$(13) \qquad P = \left(n_1 p_1^{1-s} + n_2 (p_2 t)^{1-s} \right)^{\frac{1}{1-s}}$$

, which the same as Equation (2). To see that P is the cost function, we solve for input demand:

$$(14) \qquad x_{i11} = Z p_{i1}^{-s} P^{s}$$

Letting the cost function be evaluated at a production of Z=1 leads to:

$$(15) \quad c = \sum_{i} p_{i1}^{1-s} P^{s} + \sum_{i} (p_{i2}t)^{1-s} P^{s} = P^{s} \left(n_1 p_1^{1-s} + n_2 (p_2 t)^{1-s} \right)^{\frac{1-s}{1-s}} = P^{s} P^{1-s} = P$$

Appendix B. *Industries within the producer service sector*

SIC code (5-digit level)	Description	Knowledge-intensive (1=yes, 0=no)
74 849	Various other business activities	1
74 844	Exhibition, trade fair, congress and day conference activities	1
74 843	Debt collecting and credit rating activities	1
74 842	Other design activities	1
74 841	Graphical design	1
74 830	Secretarial and translation activities	1
74 820	Packaging activities	0
74 814	Photographic laboratory activities	0
74 813	Press and other photography	1
74 812	Advertising photography	0
74 811	Portrait photography	0
74 409	Other advertising activities	1
74 403	Delivery of advertising material	0
74 402	Advertisment placement activities	1
74 401	Advertising agency activities	1
74 300	Technical testing and analysis	1
74 202	Construction and other engineering activities	1
74 201	Architectural activities	1
74 150	Management activities of holding companies	1
74 140	Business and management consultancy activities	1
74 130	Market research and public opinion polling	1
74 120	Accounting, book-keeping and auditing activities; tax consultancy	1
74 112	Advisory activities concerning patents and copyrights	1
73 203	Interdisciplinary research and development, predominantly on social sciences and humanities	1
73 202	Research and development on humanities	1
73 201	Research and development on social sciences	1
73 105	Interdisciplinary research and development, predominantly on natural sciences and engineering	1
73 104	Research and development on agricultural sciences	1
73 103	Research and development on medical sciences	1
73 102	Research and development on engineering and technology	1
73 101	Research and development on natural sciences	1
72 600	Other computer related activities	1
72 500	Maintenance and repair of office, accounting and computing machinery	0
72 400	Data base activities	1
72 300	Data processing	1
72 202	Software supply	1
72 201	Software consultancy	1
72 100	Hardware consultancy	1
71 340	Renting of other machinery and equipment n.e.c.	0
71 330	Renting of office machinery and equipment including computers	1
71 320	Renting of construction and civil engineering machinery and equipment	0
71 310	Renting of agricultural machinery and equipment	0
71 230	Renting of air transport equipment	0
71 210	Renting of other land transport equipment	0
63 210	Other supporting land transport activities	0
63 120	Storage and warehousing	0
63 110	Cargo handling	0
60 300	Transport via pipelines	0
60 240	Freight transport by road	0
51 700	Other wholesale	0
51 660	Wholesale of agricultural machinery and accessories and implements, including tractors	0
51 659	Wholesale of machinery for industry, trade and navigation n.e.c.	0
51 653	Wholesale of telecommunication equipment and electronic components	1
51 652	Wholesale of computerized materials handling equipment	1
51 651	Wholesale of measuring and precision instruments	1
51 640	Wholesale of office machinery and equipment	1
51 630	Wholesale of machinery for the textile industry, and of sewing and knitting machines	0
51 620	Wholesale of construction machinery	0

51 610	Wholesale of machine tools	0
51 570	Wholesale of waste and scrap	0
51 569	Wholesale of intermediate products n.e.c.	0
51 562	Wholesale of packaging materials	0
51 561	Wholesale of industry supplies	0
51 550	Wholesale of chemical products	1
51 542	Wholesale of plum bing and heating equipment	0
51 541	Wholesale of hardware	0
51 530	Wholesale of wood, construction materials and sanitary equipment	0
51 520	Wholesale of metals and metal ores	0
51 510	Wholesale of solid, liquid and gaseous fuels and related products	1
51 479	Wholesale of household goods n.e.c.	1
51 473	Wholesale of stationery and other office supplies	0
51 472	Wholesale of sports and leisure goods	0
51 471	Wholesale of furniture and interior fittings	0
51 460	Wholesale of pharmaceutical goods	1
51 450	Wholesale of perfume and cosmetics	0
51 440	Wholesale of china and glassware, wallpaper and cleaning materials	0
51 434	Wholesale of electrical and lighting equipment	0
51 433	Wholesale of gramophone records, tapes, CDs and video tapes	0
51 432	Wholesale of radio and television goods	0
51 431	Wholesale of household appliances	0
51 420	Wholesale of clothing and footwear	0
51 410	Wholesale of textiles	0
51 390	Non-specialized wholesale of food, beverages and tobacco	0
51 380	Wholesale of other food including fish, crustaceans and molluscs	0
51 370	Wholesale of coffee, tea, cocoa and spices	0
51 360	Wholesale of sugar and chocolate and sugar confectionery	0
51 350	Wholesale of tobacco products	0
51 340	Wholesale of alcoholic and other beverages	1
51 330	Wholesale of dairy produce, eggs and edible oils and fats	0
51 320	Wholesale of meat and meat products	0
51 310	Wholesale of fruit and vegetables	0
51 240	Wholesale of hides, skins and leather	0
51 230	Wholesale of live animals	0
51 220	Wholesale of flowers and plants	0
51 210	Wholesale of grain, seeds and animal feeds	0
51 190	Agents involved in the sale of a variety of goods	1
51 180	Agents specializing in the sale of particular products or ranges of products	0
51 170	Agents involved in the sale of food, beverages and tobacco	0
51 160	Agents involved in the sale of textiles, clothing, footwear and leather goods	0
51 150	Agents involved in the sale of furniture, household goods, hardware and ironmongery	1
51 142	Agents involved in the sale of office machinery and computer equipment	1
51 141	Agents involved in the sale of machinery, industrial equipment, ships and aircraft, except office machinery and computer equipment	1
51 130	Agents involved in the sale of timber and building materials	1
51 120	Agents involved in the sale of fuels, ores, metals and industrial chemicals	1
51 110	Agents involved in the sale of agricultural raw materials, live animals, textile raw materials and semi-finished goods	0
37 200	Recycling of non-metal waste and scrap	0
37 100	Recycling of metal waste and scrap	0