INTERMEDIATE PRODUCER SERVICES: CENTRIPETAL OR CENTRIFUGAL FORCE FOR MANUFACTURING LOCATION?

Luis Lanaspa, Fernando Sanz-Gracia and María Vera-Cabello

January 2013

ABSTRACT

This work develops a theoretical model based on the Footloose Entrepreneur Model of New Economic Geography, in which producer services, differentiated and with increasing returns, which act as intermediate inputs for manufacturing production, play an essential role in characterising the industrial landscape. To summarise, the concentration of manufacturing is favoured when the service sector has high price elasticity for any variety; is a very efficient sector in production; and employs a high percentage of skilled workers in the region, thus behaving like centripetal forces.

KEYWORDS: producer services, manufacturing location

JEL: F12, R12

1. INTRODUCTION

In modern economies, especially in developed countries, the services sector is essential, not only quantitatively but also qualitatively. And its importance increases over time. A few points are enough to illustrate the two previous statements. In 2010, according to data from the World Bank, the service industry contributed 70.8% of world GDP, while in the early 70s it was scarcely above 50%. The global importance of the sector is accentuated if we focus on the most developed economies, where in 2010 it represented 78.82% in the United States of America (USA) and 72.98% in the European Union, reaching 86.88% in the GDP of Luxembourg. Indeed, the relative importance of services in GDP can be considered an indirect but useful indicator of the degree of a country's development and quality of life.

Why have these economies gradually become more tertiary in recent decades? Or, to put it another way, what is so special about services that makes them special goods? It is not our priority to deal with these questions, which would lead to a different paper, but we can sketch out a few answers.
First, by definition services have special characteristics which most goods do not share. Thus, among other characteristics, services are labour intensive; they are intangible goods to a degree, as they do not usually represent a transferable acquisition, but rather modify the characteristics of persons or goods; and, finally, they tend to be luxury goods, or at least present an income elasticity higher than that of a standard good. All this makes services sensitive goods.

Second, and this argument is much more closely related to the content of this work than the above, some services (producer services) can generate gains in productivity in the manufacturing sector and are closely related to the logistical base defining the functions of industrial companies. Therefore strong complementarities are produced between the secondary and tertiary sectors, which undoubtedly influence the localisation of both.

Finally, and also very much relating to the theoretical model we propose, in recent decades manufacturers have gradually changed their organisation strategies from vertically integrated activities to outsourcing, acquiring in the

2

marketplace the components or tasks which are now less efficient to produce internally. This externalisation has especially affected services. The producers of services outside the companies may be able to exploit scale economies, supplying these services in a specific and particularised way to a range of different industrial companies (differentiated producer services). This possibility of generating greater returns to take advantage of scale economies and variety is especially present in the production of knowledge-intensive services.

In this context, Hansen (1990) points out that the production of goods and services is increasingly integrated and those services play a fundamental role in the expansion of the division of labour, productivity and per capita income. Meanwhile, Camacho-Ballesta and Rodríguez-Molina (2009) show that every day more industries require more services in order to perform their activities, using different input–output tables of the Spanish economy. There are also several recent works showing that services to companies generate a positive impact on the industries using them as intermediate inputs in their production processes, and in particular on their productivity (Antonelli, 2000; Léo and Philippe, 2005; Baker, 2007; Kox and Rubalcaba, 2007; Cuadrado-Roura and Maroto-Sánchez, 2010).

Against this background, from a purely theoretical perspective, we incorporate the services sector into a standard New Economic Geography model, the Footloose Entrepreneur Model of Forslid and Ottaviano (2003), with a special emphasis on its role as an intermediate input for the manufacturing sector. Specifically, it incorporates a final good of consumer services and a producer services sector, differentiated and with increasing returns which, as remarked above, acts as an intermediate input for the industrial sector. In a nutshell, it aims to explore and define how the incorporation of services affects the spatial configuration of manufacturing equilibrium. Everything seems to indicate – and the results obtained confirm this working hypothesis – that the inter-industrial linkages which emerge between services and manufacturing, and the characteristics of the services themselves, have a notable influence on the industrial economic landscape.

Before summarizing the contribution, it should be emphasized that, although we highlight the importance of services in general terms, from the beginning, we emphasize their role as an intermediate input for different

reasons. There is a vast literature, both theoretical and empirical, that finds that producer services play important roles in regional economic development (O'Farrell and Hitchens, 1990; Hansen, 1990; Moyart, 2005). Firstly, it is recognized that producer services can increase growth, see, for example, Oulton (2001). Greenhalg and Gregory (2001) point out that the reallocation of factors, through the outsourcing of services by productive firms, increases overall output and aggregate productivity. Secondly, producer services are the sector with the highest growth rate of the economy in terms of job creation (Coffey, 2000). Finally, some studies conclude that producer services are not only important for their direct contribution to the economy but also because they have an attraction capacity for other activities (Rubalcaba-Bermejo, 1999).

From our point of view, the exercise carried out is important for two reasons. On the one hand, from a theoretical approach, there is not much literature analysing the vertical linkages between services and manufacturing and their implications for the localisation of the latter, despite their importance in real life. Thus Van Marrewijk et al. (1997) combine factor proportions theory and monopolistic competition to explore, in a context of general equilibrium, the relationships between the trade in producer services, scale economies and factor markets; they find that the tradable level of services determines the results of the model. De Vaal and van den Berg (1999) point out that services linked to the production of goods promote the concentration of economic activity, although their conclusions are influenced by service costs and its tradability. Peeters and de Vaal (2003) extend this theoretical framework, distinguishing between the types of labour required for producing services and for manufacturing. Alonso-Villar and Chamorro-Rivas (2001) analyse how access to information affects localisation decisions; using simulations in a general equilibrium model, they deduce that, when regions are integrated, specialisation occurs, so that services are located in the centre and manufacturing in the periphery.

On the other hand, as far as we know, our results are novel and define perfectly when intermediate producer services act as a centripetal force encouraging the concentration of manufacturing. Specifically, three new effects appear: one, a very productive services sector; two, a differentiated services sector with high brand price elasticity; and three, a services sector which uses a

high percentage of skilled labour. These are characteristics of the tertiary sector which tend to favour a more concentrated industrial landscape.

The rest of the paper is structured as follows. The second section defines the basic model. The third section is the core of the work, and includes a comparative static analysis from which we deduce the three effects summarising how the services sector affects industrial localisation. The fourth section studies the number and stability of the resulting equilibria. Finally, the paper ends with our conclusions.

2. THE MODEL

The basic structure of the model is built on the analytically solvable model developed by Forslid and Ottaviano (2003) (FO hereafter) with the incorporation a final good of consumer services and a producer services sector.

The economy is composed of two regions (1 and 2), three final consumer goods (X: manufactured goods; A: agricultural goods or food; and Z: services) and three factors of production, two primary (L: unskilled labour and H: skilled labour) and an intermediate production factor, producer services (S). Obviously, $L_1 + L_2 = L$ and $H_1 + H_2 = H$; each of these workers inelastically supplies one unit of their type of labour. For the sake of simplicity, and because this supposition does not affect the qualitative results, we will consider that $L_i = L/2$.

Most of the literature on immigration considers that the level of education is an important variable to explain migration decisions. Specifically, they show that there is a direct correlation between the workers' level of qualification and their international mobility (Antolin and Bover, 1997; Chiswick, 1999; Chiquiar and Hanson, 2005; Docquier et al., 2007). As in the original model of FO, it follows from this that unskilled labour is only mobile between sectors, while skilled labour is mobile between sectors and regions. Therefore the latter can be understood to be self-employed entrepreneurs who move freely between countries, hence the name of this model in the literature: the Footloose Entrepreneur Model (FE).

Before continuing with the description of the model, it is important to emphasize the advantages of using the FE model. First, we conserve all the

5

qualitative properties of the original Krugman model which can only be solved by means of numerical simulations but, given its tractability, the FO model is able to analytically deal with asymmetric regions and explicit expressions of wages can be derived (See Futjita et al. 1999; Baldwin et al., 2003; Robert-Nicoud, 2005). Wa also make the assumption that the factor intensity of fixed costs differs from the factor intensity of variable costs which is the most important introduction to achieve solvability in FO. In addition, the characteristic of tractability made it more useful to analyze public policy issues (see, for example, Anderson and Forslid, 2003; Baldwin et al., 2003; Baldwin and Krugman, 2004; on tax competition and economic integration and van Marrewijk, 2005; on the effects of pollution).

2.1. Demand

The Cobb-Douglas preferences of a representative consumer from region i are articulated around three goods: X is horizontally differentiated and tradable, A is homogeneous and freely traded, and Z is homogeneous and not tradable. In short, the utility function is given by:

$$U_i = X_i^{\mu} A_i^{\delta} Z_i^{1-\delta-\mu} \tag{1}$$

where μ and $\delta \in (0,1)$ and $(\mu + \delta) < 1$.

Manufacturing is a differentiated good defined according to the following CES type aggregate, where $\sigma > 1$ is the elasticity of demand for any variety and the elasticity of substitution between any two varieties.

$$X_i = \left(\int_{S \in N} d_i(s)^{\frac{\sigma-1}{\sigma}} d_s \right)^{\frac{\sigma}{1-\sigma}} \tag{2}$$

where $d_i(s)$ is consumption of the s-th variety and N is the total number of varieties ($N^x = n_1^x + n_2^x$, with obvious notation). From the maximization problem, the demand by residents in location i for a manufactured variety produced in j is:

$$d_{ji}(s) = \frac{P_{ji}(s)^{-\sigma}}{P_i^{1-\sigma}} \mu Y_i \quad \text{i,j = \{1,2\}} \tag{3}$$

where P_{ji} is the consumption price of a variety produced in j and sold in i, and P_i is the local price index in i, CES type, associated with the expression (2). In

turn, the local income in i, Y_i, is determined by the sum of the wage rents of the primary inputs:

$$Y_i = W_i H_i + W_i^L L_i \qquad (4)$$

where W_i (W_i^L) is the wages of the skilled workers (unskilled workers).

2.2. Supply

The firms in agricultural sector A produce under constant returns to scale and perfect competition, and employ unskilled labour as the only productive factor. Without loss of generality, we will suppose that one unit of output requires one unit of labour. At the same time, as mentioned above, it is a homogeneous good which is freely traded between regions and which we take as a numeraire. All the above allows us to conclude that $P_i^A = W_i^L = 1$, where P_i^A is the price of the agricultural good in the i-th region (i =1, 2)[1].

Two types of firms are distinguished in the services sector: on the one hand, companies producing services for final consumption, and on the other, companies producing services for intermediate consumption by companies in the manufacturing sector. In the first case, companies produce a homogeneous good and employ only unskilled labour for its production, with constant returns in a perfectly competitive environment. Also, this good presents two characteristics of its own: first, these are services where a face-to-face relationship between users and producers is needed for the transaction, making them non-tradable; second, they are labour-intensive (produced only with L), with limited possibilities for economies of scale. Catering, hairdressing, looking after children or the elderly, all of which are consumer services, can fall in this category of services. Perfect competition implies marginal cost pricing so that, with obvious notation, $P_i^Z = W_i^L = 1$.

In the second case we have the firms that produce horizontally differentiated services used as inputs by the industrial sector. It is important for us to characterise in detail the types of vertical links between companies (a services company and a manufacturer) that we are going to define. First, we

---

[1] Wage equalisation holds as long as the agricultural good is produced in both regions. For this, we introduce the non-full-specialisation condition, which establishes that overall consumption of the agricultural good in the economy is greater than the maximum production which can be reached if the sector is concentrated in only one of the regions.

need to define whether the services intermediate input is tradable. Indeed, some services to firms, thanks to recent improvements in telecommunications and, in general, in information and communication technology (ICT) can take place between a user and a producer in different countries if, for example, all that is required is an email or a phone call to make contact and provide the service. However, this is not always the case, and trading the service requires cross-border movements by the service producers, the consumers, or both. Thus the costs associated with consumption of the service (including time costs) are very high in situations where the two parties involved need to hold very frequent meetings, in the same language and knowing the same codes; in this case, the services sector companies must be located in the same region where the services are consumed. In this model, we will consider ourselves to be in the last case, so that intermediate services will be incorporated in the production processes of the manufacturing companies of the region where they are produced.

Second, as will be seen in the total cost functions of the manufacturing companies, services act as a fixed input. We understand that these are costs which industrial companies have to bear, regardless of the level of production they bring to market. In short, these are typical producer services like those associated with consultants of different kinds: legal services, specialist logistics services, financial services, advertising costs, costs relating to the design and marketing of industrial products, and so forth[2].

Third, due to their special characteristics, services use skilled labour as their only production factor; we may think of highly qualified people (economists, engineers, lawyers, advertising and marketing experts, actuaries, insurance brokers, etc.).

Concretely, the productive process of these companies is carried out with increasing returns to scale and monopolistic competition (services are differentiated horizontally) with free entry. Specifically, a service firm incurs a requirement of λS_i units of skilled labour to produce S_i units of output services.

---

[2] Related with these first two characteristic, Francois and Woerz (2008) find that, while manufactures dominate direct trade data, services are often the most important activities contributing to final export flows, given the importance of non-traded services inputs in the production of traded goods.

In this way, a typical service company located in region i and producing variety r maximizes the following profit function:

$$\pi_i(r) = P^s{}_i(r)S_i(r) - \lambda W_i\, S_i \tag{5}$$

where $P^s{}_i$ is the sale price of the services produced in region i and S_i is the level of output of the service company at issue. The first order condition for maximization profits gives the price of services as a mark-up on the wages of the skilled workers:

$$P_i^s = \lambda\left(\frac{\rho}{\rho-1}\right)W_i \tag{6}$$

where $\rho>1$ is the elasticity of demand for any service variety and the constant elasticity of substitution between any two varieties.

Meanwhile, the firms of manufacturing sector X produce under monopolistic competition and increasing returns to scale, using both skilled and unskilled labour and services. Specifically, to produce X(s) units of variety s, a company incurs of βX_i units marginal costs associated to unskilled labour and fixed costs involving the employment of α units of skilled labour and γ units of services. Now, a vertical linkage is introduced in to the equation of total costs so that services are a fixed cost for manufacturing firms. Thus the total cost equation is given by the following expression:

$$TC_i(s) = \beta W_i^L X_i(s) + \alpha W_i + \gamma P_i^s \tag{7}$$

In equilibrium, the total number of firms in region i is determined by:

$$n_i = \frac{\varepsilon_i H_i}{\alpha} + \frac{(1-\varepsilon_i)H_i}{\lambda\gamma} \tag{8}$$

where the first addend is the number of manufacturing firms and the second is the number of service firms[3], and ε_i (($1-\varepsilon_i$)) is the percentage, on a per-unit basis, of the skilled labour in region i dedicated to producing manufactured goods (producer services). Logically, the number of active companies in an area is proportional to the number of its skilled residents.

As in the case of the agricultural good, manufactured goods are traded between regions, but unlike the former, they are subject to an iceberg-type transport cost, so that for one unit of manufactured goods to reach the other

---

[3] We only consider the companies producing services for consumption by the manufacturing industry, as they employ skilled labour as their only production factor.

region, $\tau > 1$ units must be shipped. Obviously, if $\tau = 1$ there are no transport costs; or, to put it another way, there are no barriers to trade.

According to the above, a manufacturing company in region i maximizes the following profit equation:

$$\pi_i(s) = P_{ii}(s)d_{ii}(s) + P_{ij}(s)d_{ij}(s) - \beta[d_{ii}(s) + \tau d_{ij}(s)] - \alpha W_i - \gamma P_i^s \qquad (9)$$

where it has already been taken into account that the wage of the unskilled workers is the unit, and $\tau d_{ij}(s)$, represents the total supply to location j, which includes the fraction of output lost due to transport costs. Consequently, maximizing (9) and replacing the price of the services with its expression in (6) gives us:

$$P_{ii}(s) = \frac{\beta\sigma}{\sigma - 1} \qquad P_{ij}(s) = \frac{\tau\beta\sigma}{\sigma - 1} \qquad (10)$$

for every i and j. Thus, as in the original model, the equilibrium prices are equalised across regions and independent of the agents' localisation decisions. Introducing (10) in the price index we obtain:

$$P_i = \frac{\beta\sigma}{\sigma - 1}\left[n_i^x + \phi n_j^x\right]^{\frac{1}{1-\sigma}} \qquad (11)$$

where $\phi = \tau^{1-\sigma}$ is the freeness of trade parameter, which is limited between zero and one; the bigger it is, the freer trade is.

Due to the free entry and exit of firms in the manufacturing sector no company obtains extraordinary profits, meaning that their scale of production is such that operating profits equal fixed costs – in this particular case, skilled labour and services:

$$W_i + P_i^s = P_{ii}(s)d_{ii}(s) + P_{ij}(s)d_{ij}(s) - \beta\big(d_{ii}(s) + \tau d_{ij}(s)\big) \qquad (12)$$

so that, by (6) and (10) the wage per worker is:

$$W_i = \frac{\rho - 1}{(1 + \lambda)\rho - 1} x \frac{\beta X_i}{\alpha(\sigma - 1)} \qquad (13)$$

where $X_i = d_{ii}(s) + \tau d_{ij}(s)$ is the total production by a firm located in i. This last expression, together with (3), (10) and (11) lets us obtain the output of a typical company in region i:

$$X_i = \frac{\sigma - 1}{\beta\sigma}\left(\frac{\mu Y_i}{n_i^x + \phi n_j^x} + \frac{\phi\mu Y_j}{\phi n_i^x + n_j^x}\right) \qquad (14)$$

Using (14) and (8), the wages of a skilled worker, equation (13), can be written as:

$$W_i = \frac{\rho - 1}{(1+\lambda)\rho - 1} \frac{\mu}{\sigma} \left(\frac{Y_i}{\varepsilon_i H_i + \phi \varepsilon_j H_j} + \frac{\phi Y_j}{\phi \varepsilon_i H_i + \varepsilon_j H_j} \right) \tag{15}$$

In turn, local income is given by:

$$Y_i = W_i H_i + \frac{L}{2} \tag{16}$$

For i = 1,2 the system consisting of equations (8), (10), (13), (14) and (16) determines the endogenous variables n_i, P_i, W_i, X_i and Y_i for a given allocation of skilled workers H between the regions and the sectors ($\varepsilon_i, \varepsilon_j$). In particular, plugging (15) into (14), similarly to FO we generate a two-equation system which lets us obtain individual expressions for the wages according to the number of skilled workers in each region:

$$W_i = \frac{(\rho - 1/(1+\lambda)\rho - 1)(\mu/\sigma)(L/2)\left(2\phi\varepsilon_i H_i + H_j\left(\varepsilon_j - (\rho - 1/(1+\lambda)\rho - 1)\mu/\sigma + \left(\varepsilon_j + (\rho - 1/(1+\lambda)\rho - 1)\mu/\sigma\right)\phi^2\right)\right)}{\phi\left[\varepsilon_i H_i^2\left(\varepsilon_i - (\rho - 1/(1+\lambda)\rho - 1)\mu/\sigma\right) + \varepsilon_j H_j^2\left(\varepsilon_j - (\rho - 1/(1+\lambda)\rho - 1)\mu/\sigma\right)\right] + H_i H_j \Gamma} \tag{17}$$

where

$$\Gamma = \varepsilon_i \varepsilon_j - (\rho - 1/(1+\lambda)\rho - 1)(\mu/\sigma)(\varepsilon_i + \varepsilon_j) + (\rho - 1/(1+\lambda)\rho - 1)^2 (\mu/\sigma)^2$$
$$+ \phi^2\left(\varepsilon_i \varepsilon_j - (\rho - 1/(1+\lambda)\rho - 1)\mu/\sigma\right) + \phi^2 (\rho - 1/(1+\lambda)\rho - 1)\mu/\sigma\left(1 - (\rho - 1/(1+\lambda)\rho - 1)\mu/\sigma\right) \tag{18}$$

Based on (17), after some algebra, we can work out the quotient for skilled workers' wages according to the percentage of these workers in region 1: h = (H_1/H):

$$\frac{W_1}{W_2} = \frac{2\phi\varepsilon_1 H_1 + H_2\left(\varepsilon_2 - \frac{\rho - 1}{(1+\lambda)\rho - 1}\frac{\mu}{\sigma} + \left(\varepsilon_2 + \frac{\rho - 1}{(1+\lambda)\rho - 1}\frac{\mu}{\sigma}\right)\phi^2\right)}{2\phi\varepsilon_2 H_2 + H_1\left(\varepsilon_1 - \frac{\rho - 1}{(1+\lambda)\rho - 1}\frac{\mu}{\sigma} + \left(\varepsilon_1 + \frac{\rho - 1}{(1+\lambda)\rho - 1}\frac{\mu}{\sigma}\right)\phi^2\right)} \tag{19}$$

Equilibrium is reached when $(d(W_1/W_2)/dh) = 0$ so that, when skilled labour moves between regions, the relative wage does not change, and thus there is no incentive for such movements. This condition is fulfilled for a value of the freeness parameter such as the following:

$$\phi_W = \sqrt{\frac{\left(\varepsilon_1 - \dfrac{\rho-1}{(1+\lambda)\rho-1}\dfrac{\mu}{\sigma}\right)\left(\varepsilon_2 - \dfrac{\rho-1}{(1+\lambda)\rho-1}\dfrac{\mu}{\sigma}\right)}{\left(\varepsilon_1 + \dfrac{\rho-1}{(1+\lambda)\rho-1}\dfrac{\mu}{\sigma}\right)\left(\varepsilon_2 + \dfrac{\rho-1}{(1+\lambda)\rho-1}\dfrac{\mu}{\sigma}\right)}} \qquad (20)^4$$

On the other hand, if $(d(W_1/W_2)/dh)>0$ or, to put it another way, $\phi>\phi_w$, we are seeing a process of accumulation of skilled workers in region 1. Thus this parameter defines the interval in which dispersion ($\phi < \phi_w$) or concentration ($\phi>\phi_w$) dominates.

It will be straightforward to verify that the freeness parameter condition of FO is a special case of our extension when there are no vertical linkages between sectors, specifically, where the economy is only composed of the manufacturing and agricultural sectors or where the services sector is only introduced for final consumption. In this sense, expression (20) is a little more complicated in this model than in the FE, but it is still valid for deducing the three effects operating in both models: market crowding effect, market size effect and cost-of-living effect. The transmission mechanism of these three effects, which are now classics, is perfectly explained and described in the original work, so we will not comment on it here. It is more interesting to examine the new elements arising from the introduction of the services sector in the model, especially due to its input–output links with the manufacturer. So, for the value of ϕ_w to be always positive (and between zero and one), we need to impose the following restriction, which lets the model make sense:

$$\varepsilon_i > \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma} = M \quad \text{i,j = \{1,2\}} \qquad (21)$$

M being between zero and one. This condition defines the minimum threshold for the percentage of skilled labour in the manufacturing sector in both regions. As can be observed in light of the last expression, this threshold depends as much on the parameters of manufactures as it does on others associated with the services sector.

---

[4] A more detailed analysis of (20) shows that the model can also work if $\varepsilon_i < M$, i = 1, 2. But this condition, while it makes sense mathematically, does not do so economically, and therefore is not considered. First, the fulfilment of the restriction is compatible with null ε_i. Second, because it leads to the direction of the influences of the parameters σ and μ being the opposite of what is established and reasoned by the previous literature, which also makes no sense.

3. COMPARATIVE STATICS: EFFECTS

We can now carry out a simple comparative static analysis based on (20). What we will do is evaluate the sign of the derivative of ϕ_w in relation to each of the relevant parameters. Thus, as reasoned above, if the derivative is positive, an increase in the parameter in question raises the value of ϕ_w, without overrunning the interval (0,1], and favouring dispersion. A negative derivative makes the range of variation of ϕ_w grow, in which concentration dominates. This digression on the dispersion and agglomeration forces is useful because it supports the economic intuition that the relevant parameters of (20) are characteristic of the manufacturing and services sectors.

Before beginning with the derivatives, in order to simplify them, we will use F, T and Ξ to denote the following expressions:

$$F = \left[\frac{\left(\varepsilon_1 - \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right) \frac{\mu}{\sigma} \right)\left(\varepsilon_2 - \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right) \frac{\mu}{\sigma} \right)}{\left(\varepsilon_1 + \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right) \frac{\mu}{\sigma} \right)\left(\varepsilon_2 + \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right) \frac{\mu}{\sigma} \right)} \right]^{-\frac{1}{2}} \tag{22}$$

$$T = \left[\left(\varepsilon_1 + \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right) \frac{\mu}{\sigma} \right)\left(\varepsilon_2 + \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right) \frac{\mu}{\sigma} \right) \right] \tag{23}$$

$$\Xi = \left[\left(\varepsilon_1 - \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right) \frac{\mu}{\sigma} \right)\left(\varepsilon_2 - \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right) \frac{\mu}{\sigma} \right) \right] \tag{24}$$

Because of the threshold condition in which we established at the end of the previous section, the three expressions above are positive.

We will begin with the analysis of the parameters associated with the manufacturing sector.

$$\frac{d\phi_w}{d\mu} = \frac{1}{2} F \frac{\left[-\left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right)\frac{1}{\sigma}\left(\varepsilon_2 - \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right)\frac{\mu}{\sigma} \right) - \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right)\frac{1}{\sigma}\left(\varepsilon_1 - \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right)\frac{\mu}{\sigma} \right) \right] T}{\gamma^2} - \frac{1}{2} F \frac{\left[\left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right)\frac{1}{\sigma}\left(\varepsilon_2 + \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right)\frac{\mu}{\sigma} \right) + \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right)\frac{1}{\sigma}\left(\varepsilon_1 + \left(\frac{\rho - 1}{(1+\lambda)\rho - 1} \right)\frac{\mu}{\sigma} \right) \right] \Xi}{\gamma^2} < 0 \tag{25}$$

$$\frac{d\phi_w}{d\sigma} = \frac{1}{2}F\frac{\left[\left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma^2}\left(\varepsilon_2 - \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right) + \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma^2}\left(\varepsilon_1 - \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right)\right]T}{\gamma^2} -$$
$$\frac{1}{2}F\frac{\left[-\left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma^2}\left(\varepsilon_2 + \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right) - \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma^2}\left(\varepsilon_1 + \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right)\right]\Xi}{\gamma^2} > 0$$

(26)

A greater percentage of expenditure in manufactures (μ) reduces ϕ_w, and thus acts as a centripetal force[5]. At the same time a greater elasticity of substitution between varieties of manufactured goods (σ) increases ϕ_w, favouring dispersion (if σ is infinite the product is homogeneous). Both effects are completely standard within New Economic Geography and well known since the seminal work of Krugman (1991).

Those relating to the services parameters are more novel. First, there is what we call the "services demand elasticity effect":

$$\frac{d\phi_w}{d\rho} = \frac{1}{2}F\frac{\left[-\left(\frac{\lambda}{((1+\lambda)\rho-1)^2}\right)\frac{\mu}{\sigma}\left(\varepsilon_2 - \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right) - \left(\frac{\lambda}{((1+\lambda)\rho-1)^2}\right)\frac{\mu}{\sigma}\left(\varepsilon_1 - \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right)\right]T}{\gamma^2} -$$
$$\frac{1}{2}F\frac{\left[\left(\frac{\lambda}{((1+\lambda)\rho-1)^2}\right)\frac{\mu}{\sigma}\left(\varepsilon_2 + \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right) + \left(\frac{\lambda}{((1+\lambda)\rho-1)^2}\right)\frac{\mu}{\sigma}\left(\varepsilon_1 + \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right)\right]\Xi}{\gamma^2} < 0$$

(27)

A services sector with little differentiation, closer to perfect competition, with very elastic demands for each variety of the services (high ρ) reduces ϕ_w and thus favours concentration, behaving as a centripetal force. The economic explanation of the above is as follows. When the elasticity of demand and substitution among the different varieties of services is high, the demand of manufacturing firms for these products is very price sensitive, bringing down the price of services more than in a situation with more rigid demands. Given operating profits in the industrial sector which must be compensated exactly with the payments associated with the two fixed costs, the relative cheapening of one of them (producer services) permits an increase in the part of those profits that goes to the other (the skilled workers); in short, higher payments for skilled labour in the industrial sector acts as a force encouraging concentration.

---

[5] When we discuss centripetal and centrifugal forces we always refer to the manufacturing sector. The main goal of this work is to see if services are a force of one or the other type for industry.

It will be observed how the two equivalent parameters σ and ρ, one for manufacturing and the other for services, influence the spatial equilibrium configuration of the industrial sector differently.

Second, there is what we call the "services production efficiency effect":

$$\frac{d\phi_w}{d\lambda} = \frac{1}{2}F\frac{\left[\left(\frac{\rho(\rho-1)}{\left((1+\lambda)\rho-1\right)^2}\right)\frac{\mu}{\sigma}\left(\varepsilon_2-\left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right)+\left(\frac{\rho(\rho-1)}{\left((1+\lambda)\rho-1\right)^2}\right)\frac{\mu}{\sigma}\left(\varepsilon_1-\left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right)\right]T}{\gamma^2} -$$
$$\frac{1}{2}F\frac{\left[-\left(\frac{\rho(\rho-1)}{\left((1+\lambda)\rho-1\right)^2}\right)\frac{\mu}{\sigma}\left(\varepsilon_2+\left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right)-\left(\frac{\rho(\rho-1)}{\left((1+\lambda)\rho-1\right)^2}\right)\frac{\mu}{\sigma}\left(\varepsilon_1+\left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right)\right]\Xi}{\gamma^2} > 0 \quad (28)$$

The more efficient the services sector is in production (low λ) the smaller is ϕ_w and, consequently, this fact favours the concentration of manufacturing; also, like all of the above, it is a reasonable result. In terms of costs and profits, the explanation is similar to the previous effect: a more productive services intermediate input lowers its associated costs for a typical manufacturing company which, given operating profits, frees up more funds for paying the other fixed factor: the skilled workers. Thus, in this case of very efficient services in production, we have behaviour typical of a centripetal force.

Third, there is what we call the "direct producer services effect":

$$\frac{d\phi_w}{d\varepsilon_i} = \frac{1}{2}F\frac{\left(\varepsilon_i-\left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right)T-\left(\varepsilon_i+\left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right)\Xi}{\gamma^2} > 0 \quad (29)$$

Expressed verbally, the smaller ε is – or, in other words, the smaller the percentage on a per-unit basis of skilled workers providing productive services directly in the industrial sector – the larger is the scope for concentration of manufacturing. The reason is simple: lower ε obviously means larger $(1-\varepsilon)$, which is the percentage of skilled labour dedicated to producing the services intermediate input, which is essential to the manufacturing sector. And as we mentioned earlier, this favours concentration. In short, this conclusion demonstrates the enormous importance of the producer services sector in the model, and hence in the configuration of the industrial landscape itself. The economic policy recipe associated with the derivative (29) is clear: if we want to encourage the concentration of industry, always remembering that ε cannot fall below the threshold given by (21), what should be done is to prioritise maximum

employment for skilled labour in the services intermediate input sector. We might think that the optimal manufacturing production structure may be fairly similar to the following: unskilled blue-collar workers, a small group of skilled white-collar workers providing their services in the companies themselves, and a large producer services sector outside the manufacturing companies which also employs skilled workers, and which the industrial companies systematically rely on; this is a structure not at all far from reality in many industrial sectors.

What economic mechanisms are behind the above description of the services sector? Basically, there are three: one, an initial increase in ε increases the number of manufacturing companies, which leads to more competition in the sector ("market crowding effect"), which lowers the local price index, and thus reduces operating profits, impacting wages for skilled labour in the manufacturing sector (W_i) and acting against the concentration of industry. The other two explanations have to do with the characteristics of the services sector itself. Two, the services are differentiated and have increasing returns, leading to much higher manufacturing production, as in the seminal contribution by Ethier (1982) regarding the existence of differentiated intermediate inputs with scale economies. Three, the services are not tradable, and this fact accentuates the strategic importance of the sector insofar as it cannot be imported from another region.

Finally, to conclude this section, despite having no effect on equation (20), the introduction of services as a final consumption good defines a potential centrifugal force. Individual income now has to be split among three goods, not two, to the extent that the part which goes to the services final good is taken totally or partly from what goes to manufactured goods, causing a decrease of μ: this favours dispersion.

The results of the previous paragraphs tend to reinforce Jansson's (2006) idea that the growth of the services sector and the gradual tertiarisation of modern economies have had a greater impact on the intermediate consumption services component than on the final consumption services component. In this context, in our model the consequences and the effects on the economic landscape come fundamentally from S (intermediate services input for the manufacturing sector) and not so much from Z (final consumption services goods).

4. EQUILIBRIUM AND STABILITY

This section attempts to determine in which region the skilled workers are located and to analyze the stability of these decisions. In order to determine the location, we assume that individuals move to the place that offers the highest current utility and that they are short-sighted. In order to see whether the symmetric equilibrium is stable or not and to establish the bifurcation diagram, we need to apply the two local stability tests that the NEG literature usually utilize.

For this we assume that skilled workers follow a Marshallian adjustment process:

$$\dot{h} = dh/dt = \begin{cases} W(h,\phi) & si & 0 < h < 1 \\ \min[0, W(h,\phi)] & si & h = 1 \\ \max[0, W(h,\phi)] & si & h = 0 \end{cases} \qquad (30)$$

where t is time, which is left implicit, and W(h,ϕ) is the difference between the indirect utility functions of the two regions:

$$W(h,\phi) \equiv \eta\left(\frac{W_1}{P_1^{\mu}} - \frac{W_2}{P_2^{\mu}}\right) \qquad (31)$$

where $\eta = \mu^{\mu}(1-\mu)^{1-\mu}$. Using equations (8) and (11) we obtain the two price indices:

$$P_1 = \frac{\beta\sigma}{\sigma-1}\left[\frac{H}{\alpha}\right]^{1/1-\sigma}\left[\varepsilon_1 h + \phi\varepsilon_2(1-h)\right]^{1/1-\sigma} \qquad (32)$$

$$P_2 = \frac{\beta\sigma}{\sigma-1}\left[\frac{H}{\alpha}\right]^{1/1-\sigma}\left[\phi\varepsilon_1 h + \varepsilon_2(1-h)\right]^{1/1-\sigma} \qquad (33)$$

Substituting (17), (32) and (33) in (31) we obtain the following expression for W(h,ϕ):

$$W(h,\phi) = \frac{\Phi}{\phi\left[\varepsilon_i h^2\left(\varepsilon_i - (\rho-1/(1+\lambda)\rho-1)\mu/\sigma\right) + \varepsilon_j(1-h)^2\left(\varepsilon_j - (\rho-1/(1+\lambda)\rho-1)\mu/\sigma\right)\right] + h(1-h)\left[\begin{array}{l}\varepsilon_i\varepsilon_j - (\rho-1/(1+\lambda)\rho-1)(\mu/\sigma)(\varepsilon_i+\varepsilon_j) + (\rho-1/(1+\lambda)\rho-1)^2(\mu/\sigma)^2 + \phi^2\left(\varepsilon_i\varepsilon_j - (\rho-1/(1+\lambda)\rho-1)\mu/\sigma\right) \\ + \phi^2(\rho-1/(1+\lambda)\rho-1)\mu/\sigma(1-(\rho-1/(1+\lambda)\rho-1)\mu/\sigma)\end{array}\right]} \times V(h,\phi)$$

$$(34)$$

where

17

$$\Phi = \eta(\rho-1)\mu L(\sigma-1)^{\mu}(\alpha)^{\mu/1-\sigma} \bigg/ 2\sigma\big((\lambda+1)\rho-1\big)(\beta\sigma)^{\mu}(H)^{1+2\mu-\sigma/1-\sigma}$$

where Φ is a positive parameter and

$$V(h,\phi) = \frac{2\phi\varepsilon_1 h + (1-h)\big(\varepsilon_2 - (\rho-1/(1+\lambda)\rho-1)\mu/\sigma + (\varepsilon_2 + (\rho-1/(1+\lambda)\rho-1)\mu/\sigma)\phi^2\big)}{[\varepsilon_1 h + \phi\varepsilon_2(1-h)]^{\mu/1-\sigma}} -$$

$$- \frac{2\phi\varepsilon_2(1-h) + h\big(\varepsilon_1 - (\rho-1/(1+\lambda)\rho-1)\mu/\sigma + (\varepsilon_1 + (\rho-1/(1+\lambda)\rho-1)\mu/\sigma)\phi^2\big)}{[\varepsilon_2(1-h) + \phi\varepsilon_1 h]^{\mu/1-\sigma}}$$

(35)

Equilibrium is obtained when $\dot{h}$ = 0; in this case the skilled workers have no incentive to move from one region to another. If W(h,ϕ) is positive the workers will move from region 2 to 1, and the other way around if it is negative. An inspection of (23) allows us to deduce that, in the last instance, all that matters is V(h,ϕ). As in the original article by Krugman (1991), the internal equilibria (0 < h < 1) are stable if the slope of V(h,ϕ) is not positive in an equilibrium range. Corner equilibria, which imply total concentration, are stable (again, see Krugman, 1991, or Fujita et al., 1999) in h = 0 if and only if V(0,ϕ) < 0 and in h = 1 if only if V(1,ϕ)>0.

To sum up, solving the model when the industry is agglomerated in one of the regions gives that the equilibrium is only sustainable for trade freeness above the so-called sustain point. This level of trade freeness will be obtained by setting (35), evaluated at h=1 or h=0. Conversely, regarding internal equilibria we can prove that V(h,ϕ) = 0 is verified at least three times for 0 < h < 1. We can also verify that one of those times corresponds to the symmetrical equilibrium h = 1/2. Now, as we have seen, for this to be stable, it must be true that $V_h(1/2,\phi)$ < 0, where the sub-index denotes the partial derivative of V in relation to the variable in question. This value of freeness is the so-called break point and is obtained by evaluating the derivative of (35) with respect to h at h=1/2.

To continue with the stability analysis we need to distinguish two cases, according to whether the distribution of skilled workers between the manufacturing sector and the services sector is the same or not in both regions.

3.1. Case 1

The simplest scenario is where $\varepsilon_1 = \varepsilon_2 = \varepsilon$, although the total numbers of skilled workers in each region may differ. In this particular case $V(0,\phi) = - V(1,\phi)$, so that for the corner equilibria to be stable, the following must be fulfilled:

$$\varepsilon - \frac{\rho-1}{(1+\lambda)\rho-1}\frac{\mu}{\sigma} + \left(\varepsilon + \frac{\rho-1}{(1+\lambda)\rho-1}\frac{\mu}{\sigma}\right)\phi_s^2 - 2\phi_s^{1-\sigma-\mu/1-\sigma}\varepsilon^{1-\sigma-2\mu/1-\sigma} = 0 \qquad (36)$$

where ϕ_s is the sustain point.

The dispersion of industry is stable if the transport costs are high enough for ϕ to be lower than the break point, ϕ_b, which is defined as:

$$\phi_b \equiv \phi_w \frac{1 - 1/\sigma - \mu/\sigma}{1 - 1/\sigma + \mu/\sigma} \qquad (37)$$

where ϕ_b is the break point. As is well known, starting from (37) it can be proven that ϕ_b increases with σ and decreases with μ. But now, in our model, there are also characteristics of the services sector which affect the magnitude of the break point. As will be expected in light of what we have already seen, the larger ρ (services demand elasticity effect) is, the smaller ε (direct producer services effect) will be, and the smaller λ (services production efficiency effect) is, the lower the value of ϕ_b will be and the larger the field will be for the total concentration of manufacturing.

Meanwhile, as in the original core-periphery model, the so-called "no black-hole condition" exists, which establishes that, for the model to make sense and not always generate an equilibrium of total concentration, whatever the values of the parameters may be, it must be fulfilled that $\mu < \sigma-1$. Note that this condition is identical to that considered by FO, so it is also less restrictive than the one assumed in the traditional core-periphery model.

To summarise, all the possible equilibria are represented in the bifurcation diagram shown in Figure 1[6], in which the stable equilibria are depicted with a continuous thick line, and the unstable equilibria with a broken thick line. An Appendix explains in more detail some of the more technical and analytical aspects which enable us to arrive at this bifurcation diagram.

[Insert Figure 1 Here]

---

[6] The corresponding bifurcation is a tomahawk that now is affected by the characteristics of the service sector.

Figure 2 synthesises the effects of the key parameters of the services sector on the results of dispersion or concentration of the spatial equilibria. Thus a reduction in λ (very productive services sector, needs few skilled workers to produce one unit of output), an increase in ρ (high elasticity of demand and substitution between varieties of services, manufacturing sector very sensitive to the price of its intermediate services input) and a fall in ε (greater percentage of skilled labour used in the production of the intermediate services input) will lower both the sustain point and the break point, acting as centripetal forces and making the foreseeable result the total concentration of manufacturing. The opposite happens to the right part of the figure, which becomes more realistic where the values of λ and ε become greater and the value of ρ becomes lower.

[Insert Figure 2 Here]

3.2. Case 2

Now both the number of skilled workers and their distribution between sectors can differ in the two regions: $\varepsilon_1 \neq \varepsilon_2$. Analysing equation (35), in this case we obtain two different sustain points depending on whether the total concentration occurs in one region or another:

$$h = 0 \quad \varepsilon_2 - \frac{\rho - 1}{(1+\lambda)\rho - 1}\frac{\mu}{\sigma} + \left(\varepsilon_2 + \frac{\rho - 1}{(1+\lambda)\rho - 1}\frac{\mu}{\sigma}\right)\phi_{s2}^2 - 2\phi_{s2}^{1-\sigma-\mu/1-\sigma}\varepsilon_2^{1-\sigma-2\mu/1-\sigma} = 0 \quad (38)$$

$$h = 1 \quad 2\phi_{s1}^{1-\sigma-\mu/1-\sigma}\varepsilon_1^{1-\sigma-2\mu/1-\sigma} - \varepsilon_1 + \frac{\rho - 1}{(1+\lambda)\rho - 1}\frac{\mu}{\sigma} - \left(\varepsilon_1 + \frac{\rho - 1}{(1+\lambda)\rho - 1}\frac{\mu}{\sigma}\right)\phi_{s1}^2 = 0 \quad (39)$$

The sustain point of one region will be higher than in the other to the degree that the former uses a greater percentage of skilled labour in producing manufactured goods. That is, for equilibrium with total concentration to be stable in a region which dedicates a high percentage of its skilled labour to the manufacturing sector, the transport costs of goods between the regions must be close to free trade.

Additionally, to obtain the break point we must give concrete values to ε_1 and ε_2:

$$V_h(h,\phi) = \frac{\left[\left(2\phi\varepsilon_1 - \Omega\right)\left(\frac{1}{2}\varepsilon_1 + \frac{1}{2}\phi\varepsilon_2\right) - \left(\phi\varepsilon_1 + \frac{1}{2}\Omega\right)\frac{\mu}{1-\sigma}\left(\varepsilon_1 - \phi\varepsilon_2\right)\right]}{\left[\frac{1}{2}\varepsilon_1 + \frac{1}{2}\phi\varepsilon_2\right]^{\mu/1-\sigma}} -$$

$$\frac{\left[\left(-2\phi\varepsilon_2 + \Psi\right)\left(\frac{1}{2}\varepsilon_2 + \frac{1}{2}\phi\varepsilon_1\right) - \left(\phi\varepsilon_2 + \frac{1}{2}\Psi\right)\frac{\mu}{1-\sigma}\left(\phi\varepsilon_1 - \varepsilon_2\right)\right]}{\left[\frac{1}{2}\varepsilon_2 + \frac{1}{2}\phi\varepsilon_1\right]^{\mu/1-\sigma}}$$

(40)

where

$$\Omega = \varepsilon_2 - \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma} + \left(\varepsilon_2 + \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right)\phi^2 \qquad (41)$$

$$\Psi = \varepsilon_1 - \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma} + \left(\varepsilon_1 + \left(\frac{\rho-1}{(1+\lambda)\rho-1}\right)\frac{\mu}{\sigma}\right)\phi^2 \qquad (42)$$

To reflect what happens with the number of equilibria and their stability, we will present two extreme cases in Figure 3 and Figure 4. The values used to draw the diagrams are as follows: $\mu = 0.3$ and $\sigma = 4$ (the same as in Krugman, 1991); on the services sector side $\rho = 5$ and $\lambda = 0.5$ are considered; in Figure 3 $\varepsilon_1 = 0.9$ and $\varepsilon_2 = 0.75$, while in Figure 4 $\varepsilon_1 = 0.9$ and $\varepsilon_2 = 0.25$. All the values comply with the restrictions imposed by the model (specifically, the no-black-hole condition, the non-full-specialisation condition, and above all the threshold condition (21) for ε_i).

[Insert Figure 3 Here]

[Insert Figure 4 Here]

We can comment briefly on both figures. First, the stable equilibrium in h = 1/2 disappears and, for high transport costs, there is dispersion, but not symmetrical. Specifically, the region with lower ε accumulates the greater percentage of industrial activity which, as is logical, is much more accentuated in Figure 4 for the values of ε_i. As trade barriers fall – that is, as we move from right to left – skilled labour gradually migrates to region 2, which has a greater percentage of skilled labour dedicated to the services sector, until the break point is reached. A little beyond this point total concentration is stable only in the region with lower ε. When trade costs fall enough to be to the right of ϕ_{s1}, concentration is also possible in the other region.

In short, both graphs are qualitatively similar, although Figure 4 shows the same characteristics but with greater intensity. In any case, and as another manifestation of the direct producer services effect, the region with the most skilled workers in services is the one with most industry when there is asymmetrical dispersion, and is the one which, for a greater range of values of the freeness of trade parameter, would accumulate all manufacturing if there were total concentration.

5. CONCLUSIONS

The main aim of this work is to analyse how the consideration of intermediate producer services, needed in the productive process of manufacturing, affects the localisation of that manufacturing industry. To do this, we need to begin with a New Economic Geography model which allows us to reach this end point. Here the Footloose Entrepreneur Model of Forslid and Ottaviano (2003) is revealed to be the most appropriate, for two reasons. On the one hand, it is flexible and easy to handle enough to be able to widen the range of final goods and inputs without diminishing the operability of the model. On the other hand, it is the first core-periphery model which, unlike Krugman's (1991) original, can be completely resolved with pen and paper, a desirable characteristic which is maintained in our extended and modified model.

The consensus that services are a key sector in present-day economics is very widespread. And not only due to the obvious evidence that they represent an important part of GDP in developed countries, a weight which has also grown in recent decades, but also because, in their condition as an intermediate input in many manufactured goods, they act as a catalyst for manufacturing, generating industrial gains in productivity and efficiency. To put it another way, producer services which present economies of scale can eventually transmit this characteristic to the manufacturer in question where they support the productive process.

This is the framework in which we define our model: three final goods (agricultural good, manufactured good and services) and three inputs (two primary, skilled and unskilled labour, and an intermediate input, producer services). The input–output relationship established between services and

manufacturing is especially important; manufactured goods are produced with unskilled labour, skilled labour and producer services. The producer services are differentiated, with increasing returns to scale, non-tradable and needing only skilled labour for their production, and are a fixed cost for manufacturing production.

One of the interesting aspects of the work is that, thanks to the model's special link structure, the industrial policy measures which a region can introduce in order to favour industrial activity in its territory become de facto services policy measures. Thus the recipes or characteristics which producer services must have to facilitate the localisation of manufacturers in a region are as follows: first, the "services demand elasticity effect". A services sector which is not highly differentiated, with very elastic demands for each variety of the services, favours the concentration of industry. When the elasticity of demand and substitution among the different varieties of services is high, the demand of manufacturing companies for these products is very price sensitive, bringing down the price of services; given operating profits in the industrial sector which must be compensated exactly with the payments associated with the two fixed costs, the relative cheapening of one of them (producer services) permits an increase in the part of those profits that goes to the other (the skilled workers); in short, higher payments for skilled labour in the industrial sector acts as a centripetal force.

Second, the "services production efficiency effect": the more efficient is production in the services sector (greater productivity), the easier it is for manufacturing to be concentrated. In terms of costs and profits, the explanation is similar to the previous effect: a more productive services intermediate input lowers its associated costs for a typical manufacturing company which, given operating profits, frees up more funds for paying the other fixed factor, the skilled workers. Thus, in this case of very efficient services in production, we have behaviour typical of a centripetal force.

Third, the "direct producer services effect": skilled labour has two destinations: it is employed as the only input in the production of services, and also participates in the production of manufactures. Always remembering that the percentage of skilled workers employed in manufacturing cannot fall below a certain threshold, the recommendation if we want to encourage the

concentration of industry is to prioritise maximum employment for skilled labour in the services intermediate input sector. What economic mechanisms are behind the above description? There are basically three. One, an initial increase in the relative weight of skilled workers employed in manufacturing increases the number of manufacturing companies, which leads to more competition in the sector (the "market crowding effect"), which lowers the local price index, and thus reduces operating profits, impacting wages for skilled labour in the manufacturing sector (W_i) and acting against the concentration of industry. Two, the services are differentiated and have increasing returns, leading to a major contribution to the production of manufactures. Three, the services are not tradable, and this fact accentuates the strategic importance of the sector insofar as it cannot be imported from another region.

Finally, the introduction of a final consumption services sector potentially acts as a centrifugal force to the degree that it tends to reduce the percentage of expenditure on manufactures.

6. REFERENCES

Alonso-Villar, O., Chamorro-Rivas, J.M. (2001) How do producer services affect the location of manufacturing firms? The role of information accessibility, *Environment and Planning*, A 33: 1621–1642.

Anderson, F., Forslid, R (2003) Tax competition and economic geography, *Journal of Public Economic Theory,* 5: 279-303.

Antolin, P., Bover, O. (1997) Regional migration in Spain: the effect of personal characteristics and of unemployment, wage and house price differentials using pooled cross-sections, *Oxford Bulletin of Economics and Statistics*, 59: 215–235.

Antonelli, C. (2000) New information technology and localised technological change in the knowledge-based economy, in Boden, M., Miles, I., eds., *Services and the Knowledge-Based Economy*, London and New York: Continuum.

Baker, D. (2007) The impact of business services use on client industries: evidence from input-output data, in Rubalcaba, L., Kox, H., eds.,

Business Services in European Economic Growth, New York: Palgrave MacMillan.

Baldwin, R., Forslid, R., Martin, P., Ottaviano, G., Robert-Nicoud, F. (2003) *Economic geography & public policy.* University Press: Princenton, NJ.

Baldwin, R., Krugman, P. (2004) Agglomeration, integration and tax harmonization, *European Economic Review,* 48: 1-23.

Camacho-Ballesta, J.A., Rodriguez-Molina, M. (2009) Terciarización e industrialización de la economía española: un análisis input-output, *Papeles de Economía Española*, 120: 106–125.

Chiquiar, D., Hanson G.H. (2005) International migration self-selection, and the distribution of wages: evidence from Mexico and the United States, *Journal of Political Economy,* 13, 239-281*.*

Chiswick B.R. (1999) Are immigrants favorably self-selected? *The American Economic Review*, 89: 181-185.

Coffey, W.J. (2000) The geographies of producer services, *Urban Geography,* 21: 170-183.

Cuadrado-Roura, J.R., Maroto-Sánchez, A. (2010) Regional productivity growth in the European countries. The role of services. 50th Anniversary European Congress of the Regional Science Association International, Jönköping, Sweden.

de Vaal, A., van den Berg, M. (1999) Producer services, economic geography, and services tradability, *Journal of Regional Science*, 39: 539–572.

Docquier F., Lohest O., Marfouk A. (2007) Brain drain developing countries, *World Bank Economic Review,* 21: 193-218.

Ethier, W.J. (1982) National and international returns to scale in the modern theory of international trade, *The American Economic Review*, 72: 389–405.

Forslid, R., Ottaviano, G. (2003) An analytically solvable core-periphery model, *Journal of Economic Geography*, 3: 229–240.

Francois, J., Woerz, J. (2008) Producer services, manufacturing linkages, and trade, *Journal of Industry, Competition and Trade,* 8: 199-229.

Fujita M., Krugman, P., and Mori, T. (1999) On the evolution of hierarchical urban systems, *European Economic Review*, 43: 209–251.

Greenhalg, C., Gregory, M., (2001) Structural change and the emergence of the new service economy, *Oxford Bulletin of Economics and Statistics* 63: 629–646.

Guckenheimer J., Holmes P. (1990) *Nonlinear Oscillations, Dynamical Systems and Bifurcations of Vector Fields*. New York: Springer-Verlag.

Hansen, N. (1990) Do producer services induce regional economic development?, *Journal of Regional Science*, 30: 465–476.

Jansson, J.O. (2006) *The Economics of Services: Development and Policy*. Cheltenham: Edward Elgar Publishing.

Kox, H., Rubalcaba, L. (2007) The contribution of business services to European economic growth, in Rubalcaba, L., Kox, H., eds., *Business Services in the European Economic Growth*. New York: Palgrave Macmillan, 74-94.

Krugman, P. (1991) Increasing returns and economic geography, *Journal of Political Economy*, 99: 483–499.

Léo, P.Y., Philippe, J. (2005) Business services, the new engine of French regional growth, *The Service Industries Journal*, 25(2): 141–161.

Moyart, L. (2005) The role of producer services in regional development: what opportunities for medium-sized cities in Belgium?, *The Service Industries Journal,* 2, 213-228

O'Farrell and Hitchens (1990) Producer services and regional development: a review' of some major conceptual and research issues, *Environment and Planning A*, 22: 141–54.

Oulton, N. (2001) Must the Growth Rate Decline? Baumol's Unbalanced Growth Revisited, *Oxford Economic Papers*, 53: 605–27.

Peeters, J., de Vaal, A. (2003) Explaining the wage gap: intra-industry trade, services linkages and falling transportation costs, *Journal of Economic Inequality*, 1: 251–280.

Robert-Nicoud, F. (2005) The structure of simple 'New Economic Geography' Models (or, On identical Twins), *Journal of Economic Geography 5, 201-234.*

Rubalcaba-Bermejo, L. (1999) Business Services in European Industry: Growth, Employment and Competitiveness, Brussels: European Commission.

van Marrewijk, C. (2005) Geographical economics and the role of polution on
location, *ICFAI Journal of Environmental Economics,* 3: 28-48

van Marrewijk, C., Stiborab, J., de Vaal, A., Viaene, J.M. (1997) Producer
services, comparative advantage and international trade patterns,
Journal of International Economics, 42: 195–220.

7. APPENDIX

The bifurcation pattern that emerges at the break point is determined not only in
$h=1/2$, because the internal equilibrium for $V(h,\phi) = 0$ is verified at least three
times for $0 < h < 1$. Under this circumstance, as well as the equilibrium with
maximum dispersion already mentioned, there are two other equilibria whose
conditions can be obtained by a standard analysis of the function $W(h, \phi)$, which
is symmetrical around $h = \frac{1}{2}$ due the symmetry of the model. Specifically, the
stability conditions are:

$$W(1/2, \phi)=0 \,\forall\, \phi \qquad\qquad (A1)$$

$$W(1/2, \phi_b)=0,\ W_{h\phi}(1/2, \phi_b)>0 \qquad\qquad (A2)$$

$$W_{hh}(1/2, \phi_b)=0, W_{hhh}(1/2, \phi_b)>0 \qquad\qquad (A3)$$

These three properties express that, if $h = 1/2$ and $\phi = \phi_b$, we have an
equilibrium with an eigenvalue of zero. The fulfilment of all of them was
synthesised in Figure 1 and the sign of these properties could be calculated,
applying (21) and the no-black-hole condition. Property (A1) expresses that $h =$
$1/2$ is always an equilibrium the properties (A2) and (A3) are the transversality
conditions of the equilibrium. These conditions imply that, if $W_{hh}(1/2, \phi_b) = 0$ (this
is the necessary condition for the existence of bifurcations), but we have
$W_{h\phi}(1/2, \phi_b) > 0$ for the implicit function theorem and theorem 3.4.1
(Guckenheimer and Holmes, 1990, 148–50) the equilibrium forms a curve which
is tangential to line ϕ_b. If we add to this the last transversality condition,
$W_{hhh}(1/2, \phi_b) > 0$, the equilibrium curve has a quadratic tangency with ϕ_b and
locally is to one side of this line, in this particular case on the left or, in other
words, there should be a sustainable full agglomeration equilibrium at a lower
trade freeness than the break point, so that we have a sub-critical bifurcation or,

as it is known in the New Economic Geography, a tomahawk bifurcation. In fact, as can be seen in Figure 1, due to this last transversality condition, we find that the value of transport costs for the break point, ϕ_b, is higher than for these costs at the sustain point, ϕ_s. Otherwise, as in the Core Periphery model, in this location, the phenomenon known as hysteresis would take place because, whenever ϕ is higher than ϕ_s, the model features stable, long-run equilibria.
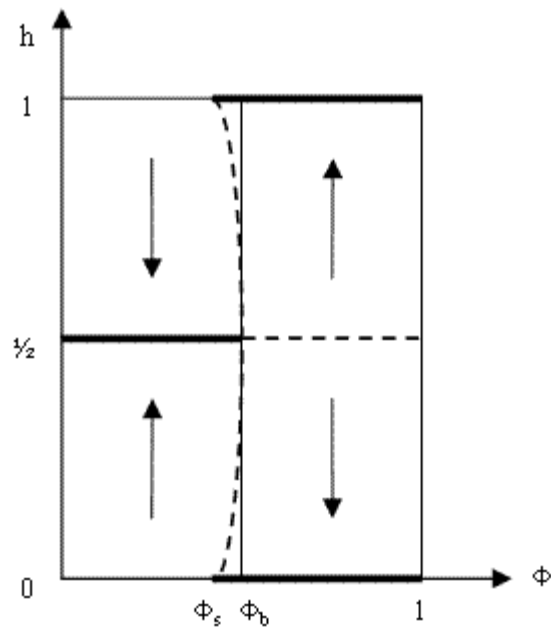
Figure 1. Bifurcation diagram

$\downarrow\lambda \quad \uparrow\rho \quad \downarrow\varepsilon$

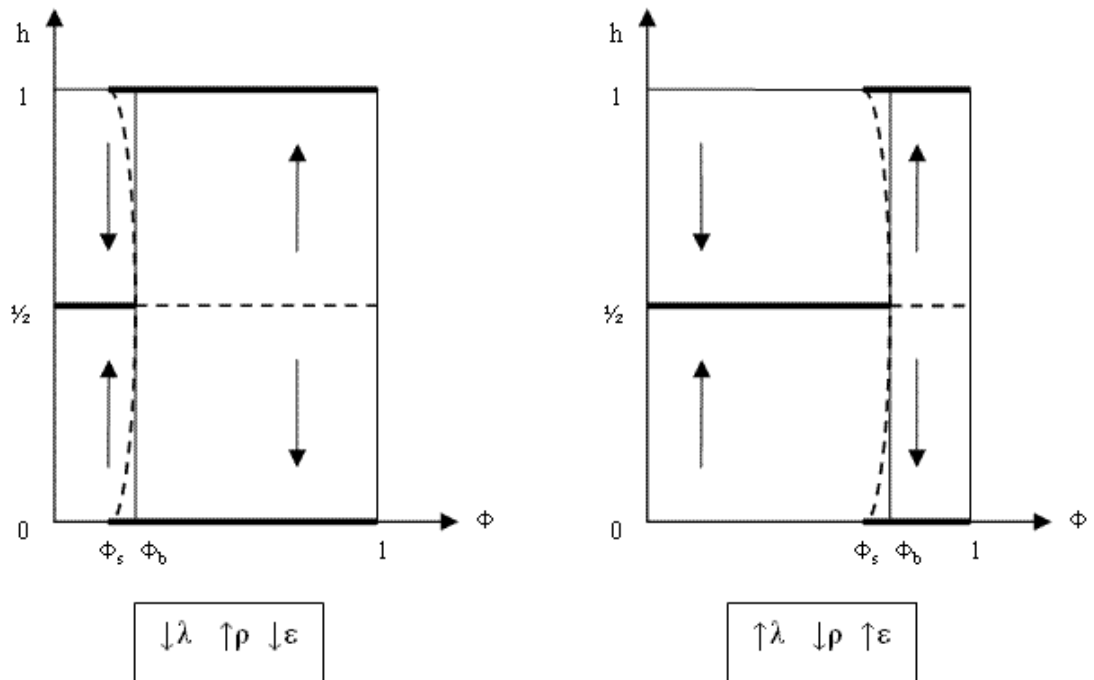$\uparrow\lambda \quad \downarrow\rho \quad \uparrow\varepsilon$

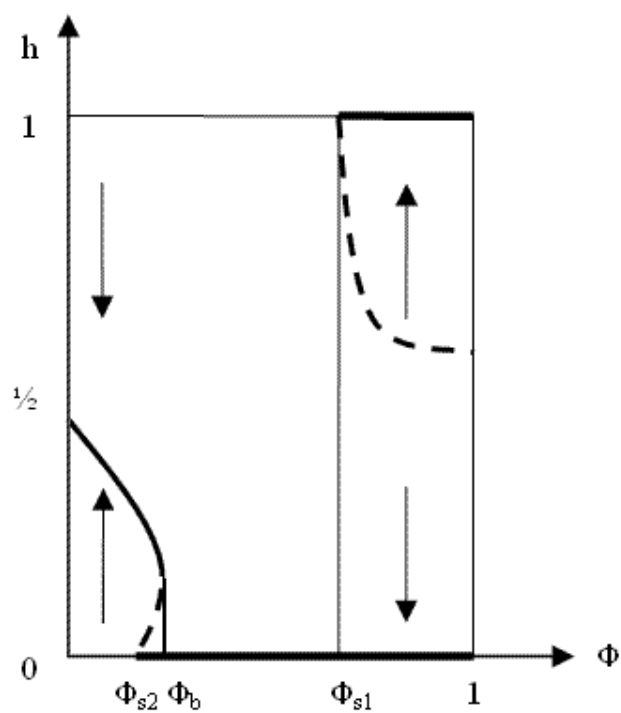Figure 2. Effects of the parameters of the services sector

Figure 3. High percentage of skilled workers in manufacture in both regions, but higher in region 1
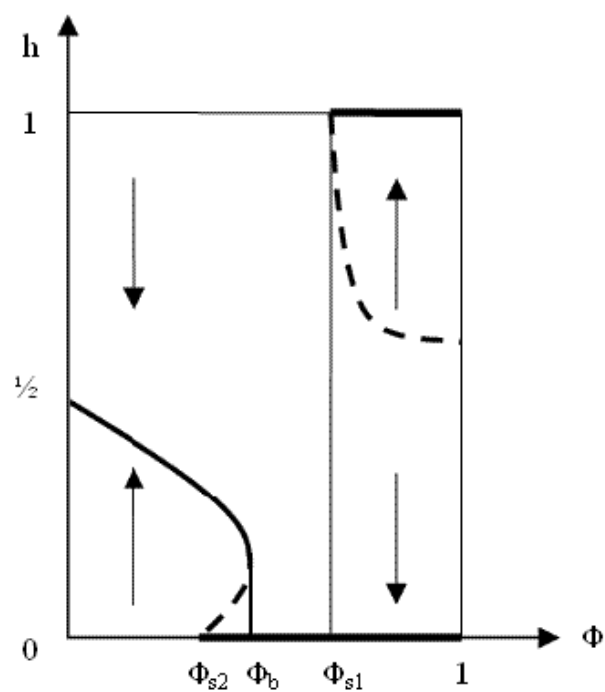

Figure 4. High percentage of skilled workers in manufactures in region 1