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The empirics of spatial competition: Evidence from European regions

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Abstract:

The New Economic Geography literature allows detailed analysis of the factors that determine the location decisions of firms in integrated markets. However, the competitive process is modelled in a rather rudimentary way, and the empirical evidence has usually been obtained from reduced-form econometric specifications. This study describes a structural model that takes into account strategic interactions between firms. We investigate the relationship between the degree of perceived competition – not only from local firms but from firms in other regions – and geographic concentration. The preliminary results indicate that, in aggregate terms, local firms present stronger competition than firms in other regions. Moreover, it is confirmed that greater geographical concentration of production reduces market power, due to the intensification of local competition; however, its impact on production costs is unclear.

Key words: spatial competition, agglomeration, conjectural variations.
JEL classification codes: F15, L11, L22, L23, L60, R15, R32

Resumen:

La literatura de la Nueva Geografía Económica permite analizar con detalle los factores que determinan las decisiones de localización de las empresas en mercados integrados, pero en estos modelos el proceso competitivo se modela de manera rudimentaria. Además, la evidencia empírica normalmente se ha obtenido a partir de especificaciones econométricas en forma reducida. En este trabajo se desarrolla un modelo estructural donde se tienen en cuenta las interacciones estratégicas entre las empresas. Se investiga la relación entre el grado de competencia percibida, no sólo localmente sino también con respecto a industrias localizadas en otras regiones, y la concentración geográfica. Los resultados preliminares indican que, en términos agregados, la intensidad de la competencia local es más fuerte que la presión competitiva ejercida por industrias distantes. Además, se confirma que una mayor concentración geográfica de la producción reduce el poder del mercado debido a la intensificación de la competencia local, pero al mismo tiempo su impacto en los costes de la producción es ambiguo.

Palabras clave: competencia espacial, aglomeración, variaciones conjeturales.
Códigos de clasificación JEL: F15, L11, L22, L23, L60, R15, R32

1 Introduction

In the context of the industrial change that has characterized the last two decades, one of the corporate strategies implemented in order to adapt to the uncertainty of the markets and to reduce production costs has involved breaking down the productive process into a growing number of phases. These phases are usually carried out in separate establishments of decreasing average size, belonging to the same multiplant firm or to separate productive entities. This split in the value chain breaks up tasks that used to be integrated and increases the technical, functional and spatial division of labour. At the same time it favours the emergence of small specialized firms that act as suppliers and/or clients, creating networks of inter- and intra-firm linkages. This new model of industrial organization, based on the concept of productive decentralization, vertical disintegration and fragmentation, has clear implications for the spatial distribution of productive activities.

Since the second half of the eighties international trade and, most importantly, flows of foreign direct investment have emerged as new forms of international cooperation between firms. These characteristics of the internationalization of the economy are inherent in the globalization process and are the consequence of the reduction of tariff barriers, the progressive elimination of commercial restrictions and advances in transport and communications. All these developments facilitate the dispersion of economic activity, accelerate the diffusion of knowledge and technology, and promote integration on a worldwide scale. In the specific case of the European Union, the emergence of new competitors in international markets and the opening up and reorientation of East European countries has accentuated the pressure of globalization, while greater integration has eliminated commercial barriers between member countries, has created a single market and, in its latest phase, has allowed the adoption of a common currency.

Both the processes of European integration and globalization have radically changed the competitive environment of EU industry. Not only has the scope of competition changed, but its nature as well: the search for cost reduction has been replaced by the pressure to produce high quality goods, forcing firms to seek continuous improvements in their products and processes, and to make a greater commitment to innovation by entering into cooperation agreements both with suppliers and with clients. In this context, firms' location decisions are increasingly determined by the external context and by economies of scale that tend to promote geographical concentration.

From the theoretical perspective, new economic geography (NEG) analyses the centripetal forces that induce firms to agglomerate in space and the centrifugal forces that encourage them to separate. As Krugman (1995) argues, the main difficulties of traditional location theory lie in the assumed market structure. The analysis of economic geography requires the existence of imperfect competition and returns to scale that can be better described using the tools provided by the theory of industrial organization.

In this paper we ask whether European integration has caused a true unification of the market and whether it has removed the asymmetries existing between local production conditions. We also consider whether the envisaged changes in productive conditions will affect location decisions, thus promoting a greater geographic concentration within EU member states, or whether, on the contrary, they will generate dispersion forces that will tend to equalize the spatial distribution of economic activities. Regional differences in wages and productivity are critical when studying location decisions and difficult to eliminate due to the limited labour mobility in Europe.

The paper is organized as follows. Section two offers a brief review of the literature on vertical linkages and geographical agglomeration, as well as the spatial competition foundations of the NEG, in an attempt to combine the two approaches. The third section presents the model to be estimated. In the fourth section the estimation method is discussed and some hypotheses are presented and contrasted. Section five describes the database and the variables used in the estimation. The last two sections present the results and the conclusions.

2 Competition, vertical linkages and agglomeration

In his study of the phenomenon of industrial location, Marshall (1890) suggested that the geographical concentration of an industry allows the emergence in the vicinity of specialized producers of intermediate goods. A closely related idea, discussed by Stigler (1951), is that the spatial concentration of an industry can motivate vertical disintegration, that is to say, the tendency to obtain inputs through market exchanges with specialized suppliers instead of manufacturing them inside the company.

Following Adam Smith's famous theorem on the division of labour and the size of the market, Stigler (1951) demonstrated that when buyers and sellers concentrate geographically there are efficiency gains due to the greater specialization in the production of intermediate goods. Fujita (1990) formalized the argument using a model in which the production of final goods exhibits preference for variety of intermediate goods produced with decreasing average costs. A large industrial scale reduces production costs by means of a wide variety of specialized intermediate inputs.

Marshall and Stigler's idea that geographic concentration facilitates the emergence of a variety of specialized suppliers has given rise to an impressive body of theoretical literature. However, empirical evidence to validate these ideas has not developed at the same pace[1]. Case studies and other anecdotes have illustrated the emergence of specialized suppliers and have defined the phenomenon of vertical disintegration for specific cases of highly

[1] Duch (2004) surveys the empirical literature on the relationship between vertical integration and location.

agglomerated industries. Nevertheless, it is difficult to determine whether these examples are common practices or in fact just represent isolated cases.

From a strategic point of view, firms' location decisions depend on the trade-off between production costs and access to markets[2]. When trade costs are low, for example when a certain degree of integration exists between the different areas under study, firms are highly sensitive to differences in production costs. In contrast, in the presence of high trade costs, i.e. before the adoption of measures of trade liberalization, firms are tied to the markets and their location decisions are much less sensitive to costs differentials. At intermediate levels of trade costs, the distribution of firms in an imperfectly competitive industry is biased toward locations with better market access. These locations can, therefore, maintain greater real wages than other less central territories, as Krugman (1980) and Krugman and Venables (1990) have demonstrated.

Nevertheless, this observation is only moderately interesting until combined with the actions of other economic agents. For example, Krugman (1991a, b) adds labour mobility to the picture. This enables locations close to bigger markets to offer higher real wages than those paid by firms in distant regions because the latter face higher transport costs if they want to sell their products in more dense markets. Thus, higher real wages attracts workers; this increases the market size and, in turn, causes a greater concentration of economic activity.

However, this explanation seems not to apply in the case of the European Union, since the degree of labour mobility is low – not only between different member states, but also within regions of the same country. But as Venables (1996), Ekholm and Forslid (1997) and Amiti (2001) have demonstrated, labour mobility is not the only factor that explains market size in different locations. If industries are vertically related through an input-output structure, then final producers form the market for intermediate goods. In this situation, market access considerations will push intermediate firms toward those regions with a relatively high share of final firms. In the same way, a high concentration of intermediate firms in a region will act as a centripetal force for final firms, because of the savings in transporting the inputs necessary for production.

Although the mechanisms of attraction and repulsion are clear in the NEG literature, the process of local (as well as spatial) competition is modelled rather rudimentarily. We know from spatial competition models that strategic interactions between firms are fundamental factors in the competition process in spatial markets. In the basic model of Hotelling (1929) when there is no price competition and decisions are simultaneous, market share rivalry induces firms to agglomerate. On the other hand, in the Hotelling model with quadratic costs

[2] As a modelling strategy for both traditional spatial competition and NEG models, spatial equilibrium is the outcome of the interplay between a set of dispersion forces and a set of agglomeration forces. For the sake of clarity, in what follows we will not enumerate all these forces. Readers interested can consult Fujita and Thisse (2002).

[d'Aspremont et al. (1979)] where firms choose location in the first stage and compete in prices in the second stage, the incentives to move away from competitors in order to relax price competition dominates the market share effect, leading firms to maximize their spatial differentiation (dispersion). Therefore, a basic conclusion in this approach is that price competition acts as an important centrifugal force.

If competition is relaxed, when products are imperfect substitutes due to their differentiation, for example, firms may find it strategically profitable to agglomerate. In contrast, if competition is defined by a Cournot setting and strategic interactions are less aggressive than under a Bertrand assumption, agglomeration is a general result, as shown by the partial equilibrium models of Anderson and Neven (1991) and Krugman and Venables (1990)[3].

In this way, the analysis of location patterns of vertically related firms not only requires the study of the mechanics of attraction and repulsion in terms of production costs and access to the markets, but should also consider the type of competition and the strategic interactions between firms, both horizontally and vertically. Therefore, the balance of centrifugal and centripetal forces has both a horizontal and a vertical component. Moreover, each one is defined on the basis of market access and production costs as well as on the basis of strategic interactions between vertically related firms.

In this paper we draw on the NEIO[4] literature to analyse the characteristics of spatial competition in regional industries throughout the European Union (EU). Note that our theoretical approach corresponds to ideas advanced by the different models of spatial competition. For instance, we know that the formation and the size of agglomerations depend on the relative balance of three different forces: i) the magnitude of agglomeration economies, mainly due to localization economies arising in a vertically integrated industry; ii) the intensity of spatial competition, and iii) the magnitude of transport costs.

It is well known from the theory of industrial organization that geographical proximity increases competition, inducing firms to disperse[5]. This suggests that firms' agglomeration or dispersion decisions depend on the relative intensity of localization economies and competition. Even if competition is relaxed, either through product differentiation in the case of price competition or by means of any form of collusive agreement (tacit or not) when competition is defined by market shares, firms will still want to disperse if transport costs are high. In a context where trade costs are decreasing, location decisions will then be defined by the balance between economies of agglomeration and the intensity of competition, not only with neighbouring firms, but also with distant firms that can penetrate the local market by means of exports.

[3] Under certain assumptions, this result does not hold (see Chamorro-Rivas, 2000).
[4] *New Empirical Industrial Organization*, the term used by Bresnahan (1989) and others.
[5] Although this has been a general and robust result in the spatial competition literature since d'Aspremont et al. (1979), the size of the spatial units used in the empirical analysis requires us to proceed with care. See section 5 and the appendix for a detailed description.

If firms and consumers are geographically dispersed and if the number of firms is small in relation to demand, for example due to the existence of indivisibilities in production, each firm can exploit a certain degree of market power in its local market. In other words, the presence of returns to scale prevents regional markets from being perfectly competitive because the differences in consumption location and, therefore, in transport costs, are a source of market power. Spatial competition is necessarily imperfect and should be studied in the appropriate context and with the appropriate models. Having recognized this, the balance of forces between transport costs and the organization of production is fundamental for the determination of the number of firms that compete in a region with a given population.

The essence of spatial competition was probably better described by Kaldor (1935), who argued that location decisions of firms determine the nature of competition between them in a specific way: regardless of the number of firms that operate in the industry as a whole, competition is localized because each company competes more intensely with its neighbours than with distant firms. Thus, spatial competition is inherently strategic, since each firm must worry about the behaviour of a small number of direct competitors, independently of the total number of firms in the industry. This suggests that the industry is not formed by independent clusters of firms: given the strategic interdependences between firms and their input-output complementarity relationships, all clusters are interrelated by a complex network of interactions.

Unfortunately, models of spatial competition are plagued by the frequent non-existence of equilibrium in pure strategies (Gabszewicz and Thisse, 1992). Research has therefore faced a modelling trade-off: either to appeal to mixed strategies, or to use monopolistic competition in which interactions between firms are weak. For the sake of simplicity, NEG models have retained the second option – which is not unreasonable once we address spatial issues at a macro-level. In addition, models of monopolistic competition have shown a rare ability to deal with a large variety of issues related to economic geography, which are otherwise unsatisfactorily treated by the competitive paradigm (Matsuyama, 1995). However, it should be kept in mind that spatial competition should not be ignored at the micro-level.

From these observations, and making use of the methodology proposed by the empiric literature on conjectural variations, we estimate the degree of perceived competition in a set of European regions and industries. We distinguish between conjectures related to horizontal competition – both local and with firms located in other regions (which we term “external”) – and those formed by the vertical relationships between final and intermediate firms. Thus, the first of these effects will indicate whether or not the European market is still segmented. The second effect, according to the postulates of the NEG, could give some idea of the intermediate input intensity as an agglomeration force.

3 Spatial competition and agglomeration: the model

The starting point of the empirical analysis is an industry distributed geographically in different regions. In region j, there are Nj firms that produce a final homogeneous good ***q*** from a homogeneous intermediate good ***x***. The inverse demand function for final goods in region j is given by

$$p_j = p(Q, z)$$

where p_j is the final good price in region j, Q is total quantity produced by industry, comprising the quantity of the final good produced in region j (Qj) and the quantity produced in other regions (Q-j), and ***z*** is a vector of demand shifters. It is assumed that the technology used for the transformation of the intermediate input into a final good is one of fixed coefficients where a 1:1 relationship is established, so that the production of final and intermediate goods can be represented by the same variable[6].

The technology of the final stage of production is represented by means of the cost function ***k(q,w)***, where ***w*** is the vector of factor prices and ***q*** the quantity produced by the individual firm. The intermediate good is produced in a vertically related industry characterized by a quantity setting oligopoly with a cost function ***c(x,w)*** where ***x*** is the quantity of intermediate goods produced. It is assumed that the market for intermediate goods is perfectly integrated and, in this case, no transport costs are incurred to acquire an intermediate input produced in distant regions[7]. If this industry sets prices according to a mark-up over an average marginal cost, $\overline{\mu} + c'(x, w)$ (for $\overline{\mu} \geq 0$), the profit function of each final producer located in j is

$$\pi_{ij} = \left[p_j - \overline{\mu} - c'(x, w)\right] q_i - k(q, w)$$

Assuming that each final producer chooses ***q*** to maximize profits, first order conditions would be

$$p_j - k'(q, w) = \overline{\mu} - q_i \frac{\partial p_j}{\partial Q}(1 + \phi_i) + q_i c''(x, w)(1 + \theta_i) + c'(x, w)$$

where ***c''(x,w)*** is the second derivative of the intermediate firm cost function, ϕ_i is firm i's conjectural variation parameter with respect to local and external competition, θ_i is firm i's conjectural variation parameter with respect to intermediate firms.

[6] This allows us to obviate the problem caused by the scarcity of statistical data at regional level.

[7] This is consistent with empirical evidence in international trade where tariffs are usually greater for final than for intermediate goods. Note that this assumption implies that intermediate goods are not spatially differentiated.

If we multiply the first order condition for profit maximization by q_i/Q_j, sum over all firms and divide by p_j, we have the following relationship

$$M_j = \bar{\mu}^* - \frac{S_j H_j}{\eta_j}(1+\Phi) + Q_j H_j \frac{c''(x,w)}{p_j}(1+\Theta) + \frac{c'(x,w)}{p_j} \tag{1}$$

where Mj is the industry's weighted price cost margin in region j, Sj is the regional share in total industry's production, Hj is Herfindhal's industrial concentration index in region j, η_j is the price elasticity with respect to the industry's total quantity demanded, and Φ is the firms' (share) weighted conjectural variation in the final goods market. This conjecture is composed by the weighted conjectural variation with respect to firms located in the same region ($\partial Q_j/\partial q_i$) and by the weighted conjectural variation with respect to external competition (firms located outside the region, $\partial Q_{-j}/\partial q_i$). The parameter Θ is the weighted conjectural variation with respect to the intermediate goods market[8].

For the empirical implementation, we assume that the corresponding intermediate goods cost function adopts the Generalized Leontief functional form and therefore becomes

$$c(x,w) = x\sum\sum \alpha_{ij}(w_i w_j)^{1/2} + x^2 \beta_i w_i \tag{2}$$

where, by symmetry, it is assumed that $\alpha_{ij} = \alpha_{ji}$. Substituting (2) in (1), and using the equality $\boldsymbol{q} = \boldsymbol{x}$ (1:1 relationship between intermediate and final goods) we obtain the industry's aggregate price cost margin equation as the equilibrium relationship in region j as

$$M_j = \bar{\mu}^* - \frac{S_j H_j}{\eta_j}(1+\Phi) + 2QS_j H_j \sum \beta_i \frac{w_i}{p_j}(1+\Theta) + \sum \alpha_{ij} \frac{(w_i w_j)^{1/2}}{p_j} + 2Q_j S_j H_j \sum \beta_i \frac{w_i}{p_j} \tag{3}$$

The first term on the right hand side (RHS) of the equation represents the margin over marginal cost that intermediate firms charge when taking advantage of market power. The second term measures the oligopolist distortion in the final goods market. We see that this distortion is positively influenced by the region's share in the industry's total output. The third term shows the possibility that final firms exercise some type of oligopsony power in the intermediate market, measured by the corresponding conjectural variation parameter. The rest of the expression represents parameters of the intermediate stage cost function.

[8] Recall that it has been assumed, basically due to the lack of detailed statistical information at the Europe-wide regional level, that the market for intermediate goods is perfectly integrated; so there is no spatial differentiation. Thus, it can be supposed that input purchases are carried out exclusively in the region in which the purchasing company is located.

In order to identify the parameters of the price cost margin equation in region j, it is necessary to jointly estimate the corresponding demand function:

$$\ln Q_j = \eta_0 + \eta_j \ln p_j + \eta_1 \ln p_1 + \eta_2 \ln p_2 + \eta_3 \ln y_j + \eta_4 \ln y_t \qquad (4)$$

where η_0 is the intercept, p_j the price in region j, p_1 the price of complements, p_2 the price of substitutes, y_j is per capita income in region j and y_t is average per capita income in the EU. Equations (3) and (4) augmented with the corresponding error terms form the spatial competition model to be estimated.

4 Estimation of the model and hypothesis testing

As already pointed out, the spatial competition model to be estimated is formed by two equations. In the first place, equation (3) represents the industry's supply relationship in region j, and mainly depends on aggregate quantity, industrial concentration and the share of the region in total sectoral output, as well as on some cost function parameters. The presence of the price-elasticity of demand in the second RHS term makes this equation non-linear in the parameters. Moreover, the aggregate quantity is the dependent variable of the demand equation, and thus forms a system of simultaneous equations. In this context, endogenous variables are correlated with disturbances in such a way that an instrumental variables estimator is needed to gain consistency.

Three techniques are generally used for joint estimation of the entire system of equations in the presence of cross-equation correlations of the disturbances: three stage least squares (3SLS), Generalized Method of Moments (GMM) and Full Information Maximum Likelihood (FIML). The first is an instrumental variable method for estimating systems of simultaneous equations where there may be endogenous variables in the RHS as well as contemporaneous correlation of the disturbances. The advantage of 3SLS over FIML is that the model does not have to be completely specified; the estimates for the equations and parameters can be consistent even if the exact form of the rest of the model is unknown[9]. Besides, 3SLS is far easier to compute than FIML and the benefit in computational ease comes at no cost in terms of asymptotic efficiency[10].

Thus, parameter identification requires joint, and preferably simultaneous, estimation of the price-cost margin equation and the demand function. Given the non-linearity of the margin equation and the endogeneity of some of the variables composing the system, specifically the relationship between the price-cost margin and the local concentration index, non-linear three

[9] For example, FIML would require additional equations for each of the exogenous variables; 3SLS estimates are consistent with the choice of suitable instruments.
[10] If disturbances are homoskedastic GMM estimates are asymptotically the same as 3SLS.

stage least squares (N3SLS) is the most appropriate method for estimation purposes[11]. The endogenous variables are M_j, Q, and H_j. The exogenous variables are S_j, w_k, w_l, p_j, p_1, p_2, y_j and y_t. We use the first lagged value of the endogenous variables as well as the full set of exogenous variables as instruments[12].

The model outlined in the previous section allows analysis of the competitive behaviour of firms in space. However, the conjectural variation parameter in the final stage is composed by firms' expectations with regard to the reactions of their local competitors and of firms located in other regions. Therefore, to be able to identify the parameters associated with each type of conjecture, we must modify the above specification in such a way as to obtain more information on the essential features of spatial competition. Thus, a simple modification is introduced to redefine the final stage conjectural variations parameter to include the market share of firms located outside the reference region and thus to account for the perceived degree of external competition. Hence, the following relationship captures the required modification

$$\Phi = 1 + \lambda_0 H_j + \lambda_1 S_{-j}$$

The equation shows that the weighted conjectural variation in region j depends on the local Herfindhal index, while the weighted conjectural variation that reflects the degree of external competition is captured by means of the share of the rest of locations different to region j in the industry's total production (S_{-j}).

Another important element is the identification of certain effects that may play an important role in the spatial competition process and are thus relevant for the industry's vertical organization structure and for the geographical concentration of production. Differentiating the price cost margin equation with respect to region j's share of production in total industry, Sj, we obtain the effect of spatial concentration on the margin (assuming that conjectural variations are constant in time):

$$\frac{\partial M_j}{\partial S_j} = -\frac{H_j}{\eta_j}(1+\Phi) + 2QH_j \sum \beta_i \frac{w_i}{p_j}(1+\Theta) + 2Q_j H_j \sum \beta_i \frac{w_i}{p_j} \qquad (5)$$

The first term on the right hand side of equation (5) is the effect of a change in geographical concentration on the market power that final firms can exert in their local market (the market power effect). The second term represents the distortion between price and marginal cost in

[11] It is also possible to iterate the 3SLS computation, but, unlike the standard estimation procedure, this method does not provide the maximum likelihood estimator nor does it improve the asymptotic efficiency. Consistency and asymptotic normality for this method-of-moments type estimator are proved in Jorgenson and Laffont (1974) and Gallant (1977).

[12] Actually, applying 3SLS to panel data is known as the Error Component Three Stages Least Squares (EC3SLS) estimation method. See Baltagi (1981).

the intermediate goods market, derived from the oligopsonist behaviour of final firms over the intermediate ones (the vertical externality effect). Finally, the third term on the right hand side of equation (5) is the effect of geographic concentration on intermediate goods production costs (the cost efficiency effect).

5 Data and variables

The model to be estimated comprises the price-cost margin equation, the demand function and the definition of the conjectural variations parameter. For estimation purposes, the following variables have been built:

Price – cost margin (M_j): as in most empirical studies, this is approximated by the quotient of the difference of value added and compensation of employees over the value of production:

$$M_j = \frac{VAB - R}{VBP}$$

Value added and compensation of employees were obtained from REGIO database for each sector and region. Thus, the value of production (VP) is the sum of value added and intermediate consumptions[13].

Herfindhal concentration index (H_j): given that there is no sufficiently detailed statistical information on individual firms' production shares, this variable is approximated by its numbers equivalent: that is, the number of identical firms that generate a given value of the index. Thus, the index is

$$H = \frac{1}{n}$$

The number of firms by region and sector is obtained from Eurostat's Structural Business Statistics[14].

In the case of the demand function it was not possible to obtain prices at regional level. Therefore, prices are national averages by sector and are the same for all the regions of a country, but they differ by sectors. Moreover, regional and EU average per capita income is included in the demand function. Specifically we have the following

[13] As a 1:1 relationship was assumed between final and intermediate goods, VP is just twice the value added.
[14] This measure of concentration may introduce some distortions in the results since we consider that all firms are the same size, meaning, in turn, that concentration is minimal.

Price of the good (p_j): Consumer price index for each country and each sector, from Eurostat.
Price of complements (p_1): Weighted average consumer price index (CPI) for all sectors excluding the CPI of the reference sector in the reference country.
Price of substitutes (p_2): Weighted average consumer price index for all countries excluding the CPI of the reference region (country).
Regional and EU average per capita income (y_j;y_t): obtained directly from the REGIO database.

The cost function requires the use of variables that approximate factor prices. It is assumed that the production of intermediate goods requires only labour and capital. These variables have been approximated by:

Price of labour (w_l): the quotient between compensation of employees and the number of workers by sector and region, index 1985=1.
Price of capital (w_k): to estimate this price we follow the methodology proposed by Oliveira-Martins et al. (1999) based on the following formulation:

$$r = \left[(i - \pi^e) + \delta\right] p_k$$

where r is the price of capital, i is the long run nominal interest rate, π^e is expected inflation, δ is the depreciation rate (fixed at 5%) and p_k is the capital formation deflator. Since many required variables were not available at regional level, figures at national level were used. Data have been obtained from the OECD Economic Outlook.

In addition to these variables, market shares of each region and sector (in terms of value added) are used (S_j), as well as the quantities of final and intermediate goods, both estimated by value added (Q). A panel is built with 104 regions from 11 EU countries for 1985-1995 the period and for 9 manufacturing sectors. The regions included are listed in table A.1 and the sectors in table A.2 in the appendix[15].

6 Results

The results of the estimation are presented in table 1. By assuming that the intermediate goods market is perfectly integrated, the number of parameters to estimate is reduced considerably. Therefore, only an average margin above marginal cost is estimated for intermediate goods, represented by μ. Moreover, a single sectoral conjectural variation parameter for the vertical

[15] It should be stressed, however, that the degree of spatial disaggregation is not optimal, since NUTS1 and NUTS2 regions are too big to capture the subtlety of spatial competition effects. The same applies to the industrial classification used. However, for a European level analysis, these were the only data available.

relationships in the industry will be considered, in an attempt to determine whether the final producers enjoy some oligopsony power over intermediate firms.

The results in table 1 show that the estimated parameters associated with the intermediate margin are statistically significant and intuitively interesting. In general, intermediate firms apply margins over marginal costs of about 20 and 30%, the largest being 29,86% in the *Ferrous and non-ferrous ores and metals* sector, and the smallest 21,6% in the *Paper and printing* sector. We can also confirm that in most sectors, final firms are price takers in the intermediate goods market as the parameters associated with weighted conjectural variations in this market are close to -1, the value for the conjecture associated with price taking behaviour. In four cases (*Non metallic minerals and mineral products*; *Food, beverages and tobacco*; *Paper and printing* and *Products of various industries*) the parameters obtained are not statistically different from zero, so we cannot rule out the possibility that in these sectors other types of behaviour are taking place (mainly Cournot-type conjectures), which means that final firms expect intermediate firms not to react to their strategic movements. In this situation we observe that, except for the *Products of various industries* sector, price cost margins in the intermediate goods market are smaller than in the rest, in which final firms are price takers[16].

The results also reveal that all the parameters associated with the price of complements have negative signs, as expected. Moreover, the price of substitutes has positive parameter estimates, except in the case of *Food, beverages and tobacco*. As for regional income elasticity, the majority of goods are normal (i.e., the sign of the parameter is positive) but in four sectors (*Ferrous and non ferrous ores and metals*; *Non metallic minerals and mineral products*; *Transport material* and *Food, beverages and tobacco*) the signs are negative, indicating that in these cases the goods are inferior. Nevertheless, the parameters estimated in these last three cases are not statistically significant. In the case of average EU income elasticity, the only sectors that present negative parameter estimates are *Ferrous and non ferrous ores and metals* and *Textiles and clothing, leather and footwear*[17].

Conjectural variations are presented in figure 1. The figure shows the degree of competition perceived by the different manufacturing sectors. The horizontal axis measures the conjectural variation with respect to local competition whereas the vertical axis shows the expected reactions regarding external competition (i.e. from firms located outside the region). The negative relationship found for all sectors means that when local competition is stronger, industries try to exploit market power in distant markets, maybe through cooperative agreements or by collusive behaviour. Regions with a high degree of local competition (when

[16] In a vertical oligopoly setting, the balance of forces when both upstream and downstream producers have market power is indeterminate. A future step in this direction would require the design of a Nash-bargaining solution in the intermediate goods market

[17] Own price elasticity is not presented in the table because it was estimated for each region in order to identify the market power parameter in the price-cost margin equation and it is used to recover the conjectural variation parameter. These and other estimates omitted are available from the author upon request.

the parameter of the conjectural variation referring to local competition is close to or greater than -1) present conjectural variations in relation to external competition close to zero, indicating that local industries do not expect neighbouring competitors to react to their strategic movements.

Table 1. Estimation results

	S1	S2	S3	S4	S5	S6	S7	S8	S9
I. Price-cost margin equation (dependent variable is M_j)									
α_{11}	-0.064***	0.191	0.122*	0.135***	0.148***	-0.004	0.185***	0.061*	-0.002
	(-9.178)	(1.354)	(1.653)	(5.903)	(3.459)	(-0.181)	(4.632)	(1.949)	(-0.042)
α_{22}	-0.062***	0.114	0.028	0.038***	0.059**	-0.032	0.065*	0.009*	-0.135***
	(-7.673)	(0.855)	(0.422)	(3.218)	(2.208)	(-1.324)	(1.944)	(1.716)	(-2.762)
α_{12}	-0.029***	-0.390	-0.283**	-0.284***	-0.380***	-0.009	-0.363***	-0.173***	0.029
	(-2.688)	(-1.439)	(-2.011)	(-6.884)	(-5.299)	(-0.230)	(-4.769)	(-3.980)	(0.273)
β_1	-0.017***	0.0004	0.0004	-0.001	-0.0004	-0.003***	-0.005***	0.005***	-0.0001
	(-6.834)	(0.100)	(0.671)	(-0.674)	(-1.012)	(-3.194)	(-4.973)	(3.232)	(-0.214)
β_2	-0.018***	0.000	0.001*	-0.001***	-0.002***	-0.002	-0.002	-0.003	0.000
	(-5.567)	(0.147)	(1.713)	(-2.620)	(-3.642)	(-1.196)	(-0.886)	(-1.598)	(0.332)
μ	0.299***	0.228***	0.280***	0.278***	0.246***	0.227***	0.267***	0.216***	0.298***
	(54.633)	(34.941)	(38.999)	(17.608)	(21.031)	(34.940)	(37.993)	(33.921)	(53.348)
Θ	-0.998***	-0.998	-0.997**	-1.001***	-1.024***	-1.001	-1.001***	-0.999*	-0.967*
	(-6.273)	(-0.359)	(-2.441)	(-3.233)	(-2.708)	(-1.385)	(-3.637)	(-1.871)	(-1.749)
II. Demand equation (dependent variable is lnQ)									
η_0	21.866***	5.213***	6.903***	8.877***	5.831***	6.602***	11.482***	5.275***	9.194***
	(38.312)	(20.277)	(22.002)	(54.557)	(22.361)	(85.788)	(54.093)	(43.882)	(49.501)
η_1	-8.375***	-4.471***	-4.471***	-3.453***	-6.231***	-0.200***	-3.324***	-2.552***	-5.911***
	(-26.202)	(-27.741)	(-28.791)	(-25.029)	(-29.631)	(-3.432)	(-22.840)	(-26.371)	(-63.068)
η_2	10.754***	3.222***	3.378***	2.391***	4.978***	-0.747***	2.344***	1.102***	5.449***
	(29.188)	(17.187)	(17.441)	(15.998)	(21.047)	(-13.495)	(14.466)	(9.335)	(49.861)
η_3	-0.018**	-0.0004	0.006*	0.013***	-0.005	-0.00002	0.003	0.010***	0.002
	(-2.085)	(-0.088)	(1.657)	(3.322)	(-0.846)	(-0.012)	(0.795)	(3.821)	(0.729)
η_4	-1.213***	0.591***	0.472***	0.368***	0.575***	0.525***	-0.032***	0.602***	0.214***
	(-19.604)	(20.628)	(13.893)	(19.765)	(19.569)	(61.286)	(-1.341)	(43.603)	(10.516)

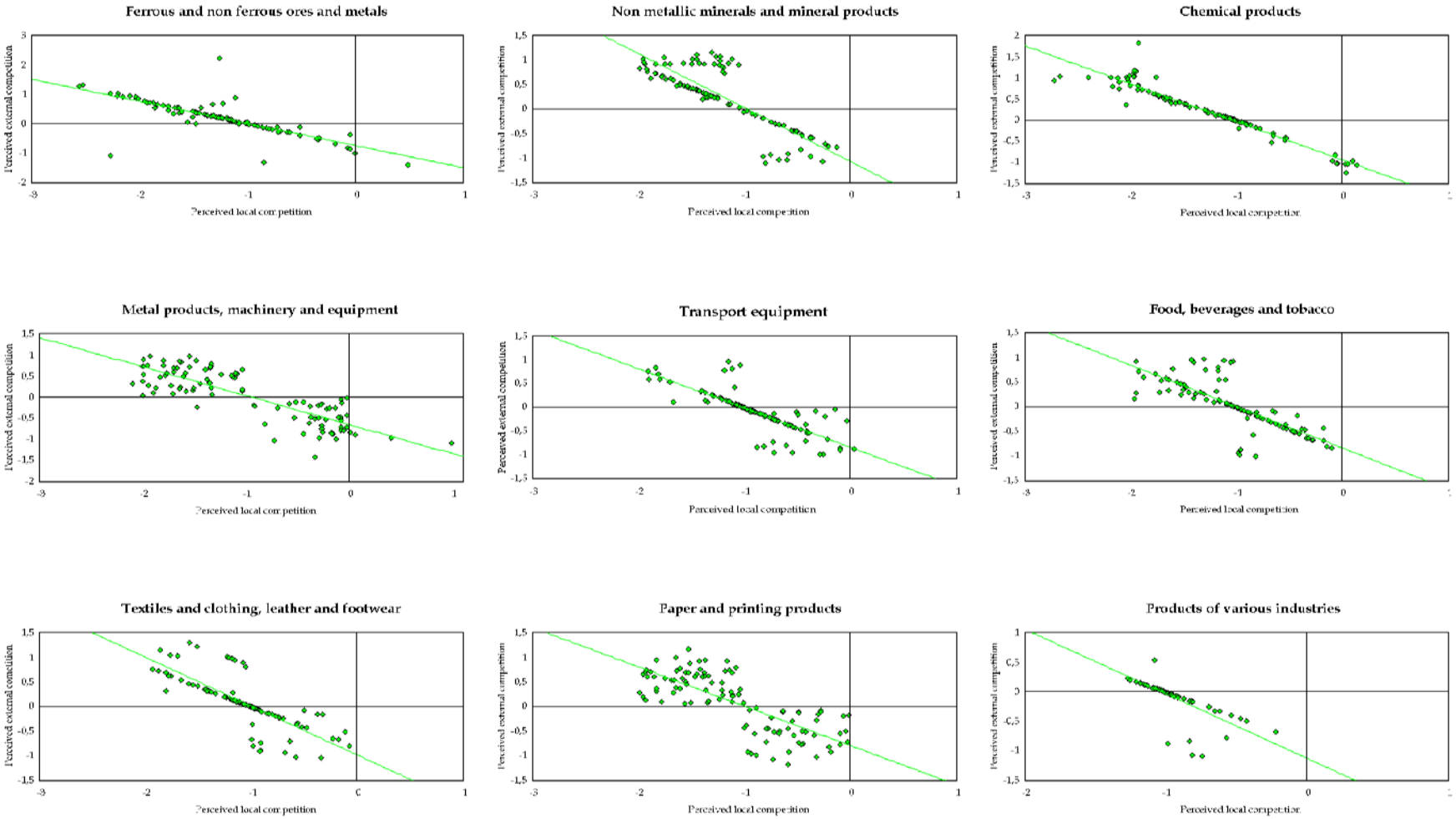
Notes: asymptotic t-statistic in parenthesis. *, ** and *** indicate statistical significance at the 90, 95 and 99 percent, respectively. The results are based on the joint estimation of the sector by sector set of equations (3) and (4) by means of the nonlinear three stages least squares (N3SLS) method. The codes for the different sectors are shown in table A.2 in the appendix. N=104, T=11 for 1985 to 1995.

We also find the opposite situation, in which local industries are less competitive but perceive that they face a stronger competition coming from contiguous or neighbouring regions. From the figure we observe that, in general terms, competition from local markets is perceived to be more intense than that from external markets. Most of the conjectures estimated for local competition are around -1 or below, which means that the intensity of the competition in the territory is high. So, in aggregate terms, firms do not expect their strategic movements to have consequences for prices, so it is not possible to exploit market power. On the other hand, perceived competition regarding external markets is more volatile. There are sectors that perceive that the firms located in other regions will act cooperatively, adapting their supply to the decisions taken by the firm located in the reference region. There are regional industries as well that estimate that their strategic movements will not induce their rivals to respond (Cournot) and in certain regions there are even sectors that also perceive greater competition in external markets and act as price takers.

The figure also shows the relationship between perceived competition in local and external markets. All sectors show an inverse relationship between local and external competition. This means that the stronger the perceived competition is in the local market, the higher the expected market power in external markets that industries think they can exploit, acting collusively in (price or) quantity setting. The inverse relationship between local and external competition shows that there is at least one source of market power for regional industries. If supranormal profits cannot be obtained in the local market, due to the intensity of competition in the region, they can be sought by exploiting market power elsewhere in the partially integrated market.

Table 2 relates the estimated conjectural variations with the changes observed in the geographical concentration of European industry in the 1985-1995 period. On average, conjectural variations with respect to local competition are around -1, indicating an average price taking behaviour in most of the local industrial markets. On the other hand, average perceived conjectural variations in competition from external markets are all near 0, suggesting that on average regional industries do not expect firms located in other territories, collectively, to respond to strategic movements. In a sense this result indicates a high degree of market segmentation in European industrial markets, since strategic action undertaken by an industry in a region do not seem to be compensated by strategic movements by firms located in other regions. Finally, given the homogeneity of local and external conjectural variation parameter estimates, there is no evidence of a relationship between the degree of competition and changes in the geographical concentration of the industry.

Figure 1. Local and external conjectural variations by region and sector



Source: Own elaboration.

Table 2. Change in geographical concentration 1985 -1995 and aggregate conjectural variations

	Geographic Concentration	Conjectural Variations	
		Local	External
Ferrous and non ferrous ores and metals	**-0.076**	-1.259	0.219
Non-metallic minerals and mineral products	0.005	-1.195	0.256
Chemical products	**-0.007**	-1.275	0.218
Metal products, machinery and equipment	**-0.010**	-0.945	0.005
Transport equipment	**-0.016**	-0.886	-0.102
Food, beverages and tobacco	**-0.017**	-1.008	0.024
Textiles and clothing, leather and footwear	**-0.050**	-1.047	0.065
Paper and printing products	0.036	-1.082	0.082
Products of various industries	0.009	-0.975	-0.054
Total	**-0.015**	-1.075	0.079

Notes: Geographic concentration was calculated for value added with an entropy index. The corresponding column shows the difference between the value of the index in 1995 relative to that for 1985. Thus a negative number indicates an increase in spatial concentration of production. Bold face numbers, hence, indicate the sectors that were more geographically concentrated in 1995 than in 1985. Local and external aggregated conjectural variation parameters are region-weighted averages from those obtained in the regression analysis.

Finally, the effects of greater geographical concentration on market power in final and intermediate markets as well as the effects on intermediate goods production costs are analysed. As we have already seen, table 1 indicates that the conjectural variations parameter in the intermediate goods market is statistically equal to -1 in six of the nine sectors, so for these industries the effect is null. For the three remaining sectors we cannot rule out the possibility that final firms may behave oligopsonistically in the intermediate goods market. To simplify, it is assumed that this distortion is null in all sectors. We therefore compare the two remaining effects, market power and cost efficiency, on the industry's weighted price-cost margin. The results are shown in figure 2.

The first thing to note from the panels in figure 2 is that the market power effect is always negative, as suggested by theory. In other words, an increase in the geographic concentration of production reduces the market power of firms located in the now more agglomerated region since it intensifies competition among firms. Nevertheless, this effect is composed by both local and external market power. Although the results are not explained here, theory suggests that firms' local market power will decrease because of the increase in the intensity of competition in the more agglomerated region while at the same time their market power will increase in external markets, since in these markets the intensity of competition tends to diminish. The results obtained here show that the first of these effects is stronger than the second one and that, on aggregate, greater geographical concentration tends to moderate the market power of local firms. This is so because it is difficult to penetrate distant markets via exports, since exports incur additional transport costs. On the other hand, the effect of a

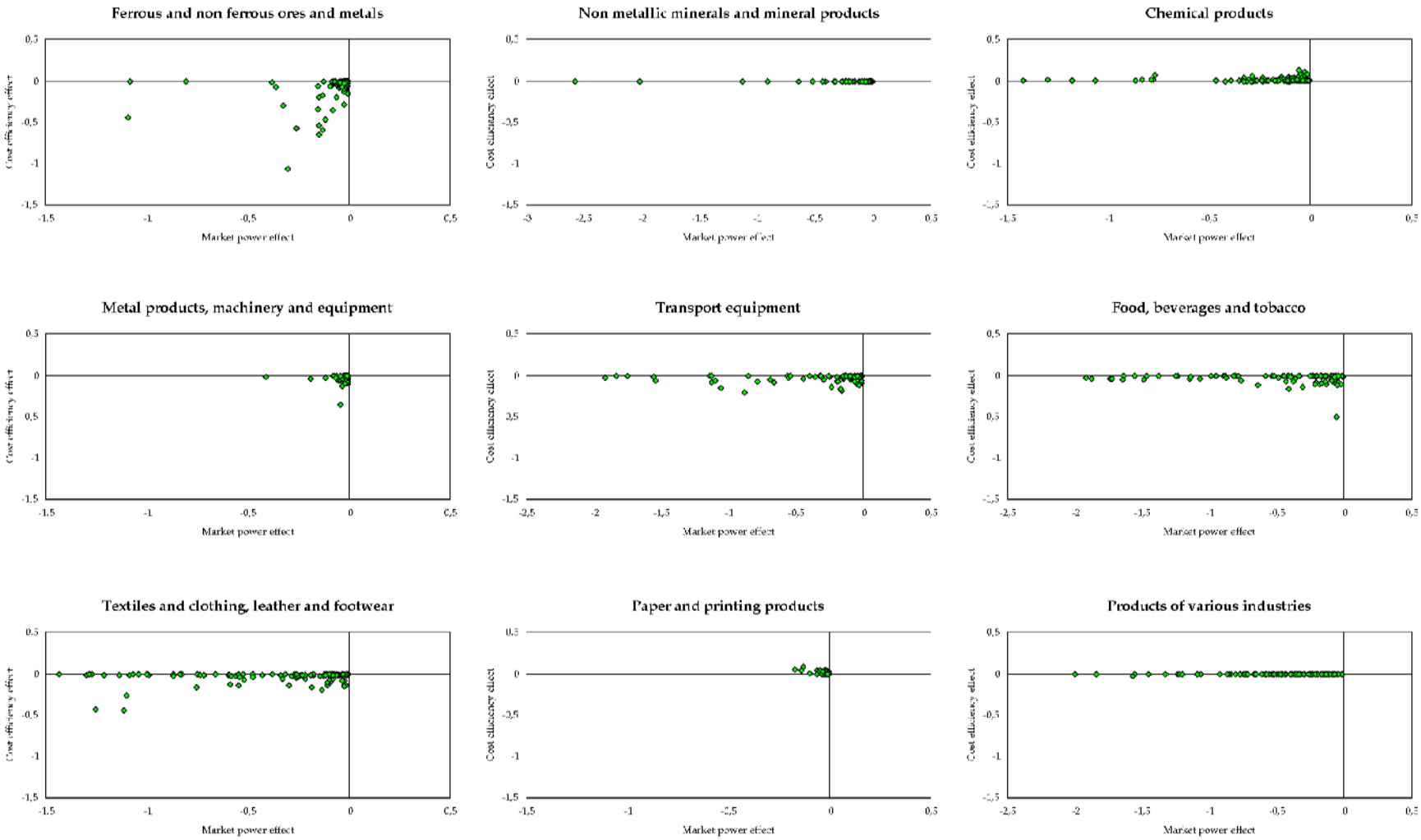
higher spatial industrial concentration on the intermediate costs of production is less clear and presents less dispersion. We observe sectors where the effect is null or almost null but others where the impact is substantial.

In figure 2 it is possible to distinguish three groups of activities. First are those in which the majority of the regions have negative market power and cost efficiency effects, that is, both market power and costs are reduced (e.g. *Ferrous and non ferrous ores and metals*; *Metal products, machinery and equipment* and *Paper and printing products*). The second group present a greater variability of the market power effect but a null or almost null effect on intermediate production costs. These include *Non metallic minerals and mineral products*, *Chemical products* and *Products of various industries* sectors. Finally, the third group comprises activities that present a stronger impact on intermediate production costs, usually a negative impact, while the market power effect shows higher dispersion. This group comprises *Transport equipment*, *Food, beverages and tobacco* and *Textiles and clothing, leather and footwear*.

The total effect, calculated as the sum of the market power and the cost efficiency effects, is always negative, indicating that a greater geographical concentration of production partially reduces the distortion caused by final firms' market power by intensifying competition at this stage of the productive process and provoking, at the same time, an average increase in the efficiency with which intermediate goods are produced. The source of these efficiency gains, associated with the geographical concentration of the final production, is a process of geographical concentration in the production of intermediate goods, as predicted by vertical linkage NEG models[18]. The cost complementarities of the agglomerated production of final and intermediate goods are reflected in the savings in the costs of transporting the intermediate goods and in the creation and consolidation of external economies in the territory.

[18] Nevertheless, the data at hand do not allow us to test this hypothesis.

Figure 2. Market power and cost efficiency effects by region and sector



Source: Own elaboration.

To determine whether this is the case, table 3 relates the changes in geographical concentration of the different manufacturing activities with (weighted) average market power and cost efficiency effects for each industry. The table indicates that the cost efficiency effect means that a higher geographical concentration of production increases productive efficiency because of the reduction of the costs of manufacturing intermediate goods. This efficiency necessarily is passed on to the final stage, since we have supposed that final firms are price takers.

Table 3. The effects of geographic concentration on market power and cost efficiency

	Geographic	**Effects**	
	Concentration	**Market power**	**Cost efficiency**
Ferrous and non ferrous ores and metals	**-0.076**	-0.0786	**-0.0798**
Non-metallic minerals and mineral products	0.005	-0.1401	0.0000
Chemical products	**-0.007**	-0.1944	0.0189
Metal products, machinery and equipment	**-0.010**	-0.0161	**-0.0228**
Transport equipment	**-0.016**	-0.2644	**-0.0273**
Food, beverages and tobacco	**-0.017**	-0.4179	**-0.0305**
Textiles and clothing, leather and footwear	**-0.050**	-0.4080	**-0.0420**
Paper and printing products	0.036	-0.0139	0.0093
Products of various industries	0.009	-0.5437	**-0.0005**
Total	**-0.015**	-0.2308	**-0.0194**

Notes: Geographic concentration was calculated for value added with an entropy index. The corresponding column shows the difference between the value of the index in 1995 relative to that for 1985. Thus a negative number indicates an increase in spatial concentration of production. Bold face numbers, hence, indicate the sectors more concentrated geographically in 1995 than in 1985. Market power and cost efficiency effects are region-weighted averages from those parameters obtained in the regression analysis.

In five of the nine industries considered, an increase in the geographic concentration is observed between 1985 and 1995 along with an increase in the intermediate goods productive efficiency. These industries are *Ferrous and non ferrous ores and metals*; *Metal products, machinery and equipment*; *Transport equipment*; *Food, beverages and tobacco* and *Textiles and clothing, leather and footwear*. Of the other industries Chemical products stands out, since the greater geographical concentration observed in the period 1985-1995 tends to increase the costs of production.

7 Conclusions

In this paper a structural model is developed and estimated to analyse the vertical organization of firms in space, as well as the effect of this organization on the degree of competition and geographical agglomeration. The model is applied to the specific case of nine industries and

104 regions of the EU in the 1985-1995 period. The estimations are carried out for each manufacturing sector using panel data techniques with fixed effects to capture differences between regions.

The estimated model is based on several results obtained from the spatial competition version of NEG theoretical models and, for the empirical implementation, on the empirical industrial organization literature. The system of equations developed and estimated allows analysis of diverse characteristics of industrial relationships in the different European regions considered. Of particular relevance are the estimated conjectural variations reflecting the degree of average perceived competition inside a sector, in both local and external markets. It is also possible to analyse the effects of greater geographical concentration on the market power of firms and on production costs of intermediate goods.

The results show that, in general, intermediate firms apply price-cost margins of between 20 and 30%. They also confirm that in most sectors final firms are price takers in the intermediate goods market. All the parameters associated with the price of complements have the expected sign (negative) and almost the same occurs with the price of substitutes, though their estimated coefficients are positive. The regional per capita income elasticity indicates that goods are normal except in the case of four sectors in which they turn out to be inferior.

The estimated conjectural variations present heterogeneous results, from which it is difficult to highlight clear patterns between the different regions and the different sectors. However, when the different degrees of perceived competition are reported for the different manufacturing sectors, both local and external, we observe that, in general terms, the expected competition from local markets is more intense than that from external markets. An inverse relationship is also observed between local and external competition in all sectors, indicating that the greater the perceived competition in the local market, the higher the market power that the industries feel they can exploit in external markets. This would suggest that firms always exploit some source of market power; when supranormal profits cannot be gained in local markets due to the intensity of competition in the region, they can be obtained by exploiting market power in other regions.

The relationship between the estimated conjectural variations and the changes in geographical concentration of European industry in the period 1985-1995 shows that, on average, conjectural variations with respect to local competition are close to -1, indicating a price taking behaviour in most local industrial markets. On the other hand, conjectural variations with respect to external competition are in the vicinity of 0, suggesting that, on average, regional industries do not expect firms located in other territories to respond collectively to strategic movements. This result indicates a significant degree of segmentation in the European markets. However, there is no evidence of a close relationship between the degree of competition and the changes in the geographical concentration of industry.

The effects of geographical concentration on market power and the cost efficiency of intermediate goods suggest that it is always negative, as theory suggests. This indicates that an increase in the share of production of a given region in a specific sector reduces the market power of the firms located there because inter-firm competition is intensified in this region. On the other hand, the effect of a greater spatial concentration on the intermediate goods costs of production does not present a clear pattern and shows less dispersion. In some sectors the effect is null or almost null, but in others its impact is quite substantial. The total effect, calculated as the sum of the two, is always negative, indicating that the geographical concentration of the industry mitigates the distortion derived from final firms' market power by increasing the degree of local competition and allowing efficiency increases in the production of the intermediate goods. One of the possible sources of these earnings may be the decision to co-locate final and intermediate production, allowing cost complementarities of specialized and agglomerated production to arise.

Finally, a word of caution is compulsory. Though the results obtained in this paper offer interesting insights concerning spatial competition and its effects on agglomeration, both the spatial and the sectoral disaggregation used are far from optimal because of data availability constraints, a fact that may reduce the explanatory power of the estimates. Moreover, a stronger empirical spatial structure is needed to determine the perceived degree of competition more accurately. The use of spatial econometrics techniques would provide interesting results.

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Appendix

Table A.1 Regions included

Germany (NUTS 1)		**Belgium (NUTS 2)**	
Baden-Württemberg	Niedersachsen	Région Bruxelles	Brabant Wallon
Bayern	Nordrhein-Westfalen	Antwerpen	Hainaut
Berlin	Rheinland-Pfalz	Limburg	Liège
Bremen	Saarland	Oost-Vlaanderen	Luxembourg-B
Hamburg	Schleswig-Holstein	Vlaams Brabant	Namur
Hessen		West-Vlaanderen	
Spain (NUTS 2)		**France (NUTS 2)**	
Galicia	Castilla-la Mancha	Île de France	Pays de la Loire
Asturias	Extremadura	Champagne-Ardenne	Bretagne
Cantabria	Cataluña	Picardie	Poitou-Charentes
País Vasco	C. Valenciana	Haute-Normandie	Aquitaine
Navarra	Baleares	Centre	Midi-Pyrénées
La Rioja	Andalucía	Basse-Normandie	Limousin
Aragón	Murcia	Bourgogne	Rhône-Alpes
C. de Madrid	Canarias	Nord - Pas-de-Calais	Auvergne
Castilla y León		Lorraine	Languedoc-Roussillon
Italy (NUTS 2)		Alsace	Provence-Alpes-C.
Piemonte	Marche	Franche-Comté	Corse
Valle d`Aosta	Lazio	**United Kingdom (NUTS 1)**	
Liguria	Abruzzo	North East	West Midlands
Lombardia	Molise	Yorkshire and Humberside	North West
Trentino-Alto Adige	Campania	East Midlands	Wales
Veneto	Puglia	East Anglia	Scotland
Friuli-Venezia Giulia	Basilicata	South East	Northern Ireland
Emilia-Romagna	Calabria	South West	
Toscana	Sicilia	**Netherlands (NUTS 1)**	
Umbria	Sardegna	Noord-Nederland	West-Nederland
Portugal (NUTS 2)		Oost-Nederland	Zuid-Nederland
Norte	Alentejo	**Denmark**	
Centro	Algarve	**Ireland**	
Lisboa e Vale do Tejo		**Luxembourg-GD**	

Source: Eurostat.

Table A.2 NACE RR-17 classification. Industry

Code	Sector
S1	Ferrous and non ferrous ores and metals
S2	Non-metallic minerals and mineral products
S3	Chemical products
S4	Metal products, machinery and equipment
S5	Transport equipment
S6	Food, beverages and tobacco
S7	Textiles and clothing, leather and footwear
S8	Paper and printing products
S9	Products of various industries

Source: Eurostat.