INDUSTRIAL SPECIALISATION AND PUBLIC PROCUREMENT: THEORY AND EMPIRICAL EVIDENCE

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Abstract

This paper explores the impact of home-biased public procurement on the location of industries. It is shown theoretically and empirically that discriminatory procurement can offset other locational determinants. In the theoretical part, we demonstrate that a bias in public procurement towards domestically produced goods can counter agglomeration forces substantially. The empirical analysis draws on a cross-country, cross-industry data sample for the EU. In the full sample, the market-based determinants of industry location identified in the theory are significant in explaining EU industrial specialisation. However, these determinants lose statistical significance in the sub-sample of procurement-sensitive industries. In this sub-sample, proxies for the degree of liberalisation of public procurement relate positively to specialisation.

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This paper studies the effect of home-biased government procurement on the location of industries. We develop a theoretical model and subjects two predictions of the model to an empirical test. The impact of government procurement on international specialisation and on the volume of trade has been the object of interesting studies for about three decades. In the mid-seventies a number of studies showed that discriminatory government procurement might be equivalent to a non-tariff barrier to trade (for a review see Baldwin, 1984). In the context of European integration, Shoup (1967) already recognised the need to liberalise government procurement in order to achieve a truly integrated market. In the policy domain, the Single European Act (SEA) commits member states to the liberalisation of the tendering process. Yet, after over ten years from the launching of the SEA, many of its rules remain unimplemented (see CEC, 1996, and 1997). On the global scale, liberalisation of government procurement has been the object of international negotiations since the early 1970s. These negotiations resulted in the Government Procurement Agreement, the most recent version of which was signed by 22 countries in the context of the Uruguay Round (Hoekman and Mavroidis, 1997).

The question of whether government procurement affects international specialisation is interesting also for its welfare implications. In a static framework, a reduction of trade costs generally increases welfare. By the same token, liberalisation of government procurement is likely to be welfare improving, because it eliminates the inefficiency related to the home bias. In a dynamic framework things may be different. Recent theoretical research pointed to possibly undesirable welfare effects of economic integration. In these models, a reduction in trade costs can lead to an agglomeration of economic activity in a subset of the participating countries. Such agglomeration can exacerbate income inequalities across regions and countries (for a survey, see Ottaviano and Puga, 1997). If discriminatory procurement affects international specialisation, governments may be tempted to use this as a policy device to prevent agglomeration and the associated regional income inequalities. Such a policy would have two opposite effects on welfare. A welfare improvement would result from the fact that, for any given level of trade costs, incomplete specialisation yields higher welfare than agglomeration. On the other hand, a welfare loss would result from the inefficiency associated with discriminatory procurement. The balance is ambiguous (see Trionfetti, 1997b).

Understanding whether and how government procurement impacts on the pattern of specialisation is, therefore, important for the design of future integration policies.

Part I shows the theoretical results and identifies two testable hypothesis. Part II subjects the hypothesis to empirical test.

I. THEORY

We base our theoretical explorations on a Chamberlin-Heckscher-Ohlin (C-H-O) model along the lines of Helpman (1981). The C-H-O model is appropriate to our purposes because combines a constant-returns perfectly competitive sector with an increasing-returns monopolistically competitive sector. The presence of the latter sector is essential in order to generate the cumulative processes and the effects of government demand on which we are conducting our empirical investigation (an interesting review of cumulative process in models of monopolistic competition is in Matsuyama, 1995). In the C-H-O model, if there are as many goods as there are factors, inter-industry specialisation across countries is explained by factor endowments. We modify this framework by introducing a government sector and use this extended model to investigate two issues. First, we investigate the static effect of discriminatory government procurement on international specialisation. This requires only a simple extension of the C-H-O model. Second, we investigate the dynamic force generated by discriminatory government procurement and relate it to the dynamic forces driving the process of industrial location in new economic geography models. This requires the introduction of trade costs and a dynamic mechanism in the C-H-O model.

I.1. A Static Chamberlin-Heckscher-Ohlin Framework.

Technology, Supply and Factor-Market Equilibrium

The basic features of the model are as follows. There are two homogeneous factors of production, generically labelled as labour (l) and capital (k); two countries, indexed by i=1,2; and two sectors, labelled as agriculture (Y) and manufacturing (X).[1] The production technologies differ across sectors but are identical across countries. The agricultural sector produces food (Y) under perfect competition and is subject to a linearly homogeneous production function. The cost function associated with this technology is $c_Y(w_i,r_i)$ where the arguments are the remuneration to l and k. The manufacturing sector produces a differentiated commodity using a technology that requires a fixed cost $f(w_i,r_i)$ and a constant marginal cost $m(w_i,r_i)$. In order to make the factor intensities independent of the scale of firms, we assume that the functions $m(w_i,r_i)$ and

[1] In order to contrast factor endowments with government procurement as a determinant of international specialisation we use a *squared* model featuring the same number of goods and factors. If the number of goods

$f(w_i,r_i)$ use factors in the same relative proportion. Thus, factor proportions in the manufacturing sector depend only on relative factor prices and not on the scale of firm.[2] The cost function in the manufacturing sector is $c_X(w_i,r_i) = m(w_i,r_i)x_i + f(w_i,r_i)$. The demand functions for factors obtain from the cost functions through Shephard's lemma. We denote these demand functions as $l_S(w_i,r_i)$ and $k_S(w_i,r_i)$ with $S=Y,X$. Further, we assume no factor intensity reversals. Finally, in this Section only, we assume that trade costs are zero. The total number of varieties produced in the world, denoted by N, is endogenously determined, and so is its distribution between countries. By definition, we have that $n_1=N-n_2$, The world's factor endowment is exogenous and denoted by L and K. Countries factors endowments are exogenous and, by definition, $l_2=L-l_1$ and $k_2=K-k_1$. The equilibrium equations for countries $i=1,2$ are:

$$p_y = c_y(w_i, r_i) \qquad i = 1,2 \qquad (1)$$

$$p_x = m_x(w_i, r_i) \qquad i = 1,2 \qquad (2)$$

$$p_x = m(w_i, r_i) + f(w_i, r_i)/x_i \qquad i = 1,2 \qquad (3)$$

$$l_y(w_i, r_i)y_i + l_x(w_i, r_i)x_i n_i = l_i \qquad i = 1,2 \qquad (4)$$

$$k_y(w_i, r_i)y_i + k_x(w_i, r_i)x_i n_i = k_i \qquad i = 1,2 \qquad (5)$$

Equations (1) and (2) state the usual conditions that price equals marginal cost in both sectors and both countries. Equation (3) is the zero-profit condition in the manufacturing sector in both countries. Equation (4) and (5) represent the factor-market-clearing conditions. To close the model we need to describe the demand side in its two components, private and public.

exceeds the number of factors our results will hold *a fortiori* because discriminatory government procurement would "use-up" the degrees of freedom left in the pattern of specialisation.

Households

Households in both countries are assumed to have identical and homothetic preferences. Specifically, we assume Dixit-Stiglitz preferences (i.e., a nested Cobb-Douglas-CES utility function) with Cobb-Douglas expenditure shares u and 1-u for X and Y respectively, and with elasticity of substitution of the CES sub-utility equal to the constant $s \in (1, \infty)$. Households are taxed in a lump-sum fashion. Homothetic preferences assure that the distribution of taxation among households does not affect aggregate demand. Maximisation of utility subject to the budget constraint yields households' demand functions. Adding the demand functions across households gives the aggregate demand from the households of country i. These take the following well-known functional forms: the demand from country i's residents for each variety produced in country i is $x_{ii} = p_{xii}^{-s} P_i^{1-s} u I_i^d$; the demand from country i's residents for each variety produced in j is $x_{ij} = p_{xij}^{-s} P_i^{1-s} u I_i^d$. P_i is the price index applicable to country i. p_{xii} is a f.o.b. price, and p_{xij} is a c.i.f. price. In the absence of trade costs, we simply have $p_{xii}=p_{xij}=p_x$ and $p_{xij}^{1-s} P_i^{1-s} = 1/N$ for any i=1,2. Although zero trade costs are assumed in this Section, we introduce this notation for future reference. I_i^d is households' disposable income equal to $I_i^d = (1-d)I_i$, where d_i is the taxation parameter and I_i is the inner product between the vector of factor endowments and the vector of factor prices (households have claims on k). Since profits are zero (equation 3), I_i is national income. For future reference we define private expenditure on manufactures $E_i^P \equiv u I_i^d$. The model as described so far is standard. We now introduce a new variant.

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[2] This convenient assumption appears in Markusen (1986).

Governments

Governments purchase goods which they use for their subsistence. The balanced budget requirement assures that expenditure equals tax collection. Tax collection amounts to $d_i I_i$ and is allocated among goods according to the parameter g_i. Government expenditure on the aggregate of manufactures is then $E_i^G \equiv g_i d_i I_i$, while its complement, $(1-g_i)d_i I_i$, is spent on the agricultural good. Expenditure on each variety of the manufactured good is simply E_i^G / N.[3]

We now introduce a parameter that represents governments' bias for domestically produced goods: $f_i \in [0,1]$. Specifically, a proportion f_i of government *i*'s purchases is reserved to domestic producers. The rest is equally divided among the *N* varieties produced in the world. Thus, the expenditure of government *i* on domestic manufactures is $f_i E_i^G + (n_i / N)(1-f_i)E_i^G$. The expenditure of government *i* on foreign manufactures is $(n_j / N)(1-f_i)E_i^G$.

The parameter f_i represents the degree of liberalisation in government procurement. A large f_i means low degree of liberalisation. For clarity of exposition we shall say that government *i*'s procurement is "fully liberalised" if $f_i = 0$, "discriminatory" if $f_i \in (0,1]$, and "fully discriminatory" if $f_i = 1$.

[3] Although the micro-foundation of government behaviour is not our main concern, it is worth pointing out that the behaviour described in the text can be formalised by assuming that governments produce a public good according to a Cobb-Douglas-CES production function with parameter shares *g* and 1-*g*, and with elasticity of substitution of the CES aggregate equal to the constant $s \in (1,\infty)$. Choosing the elasticity of substitution to be the same for households and the government is a convenient simplification but it is not necessary to the results, it only assures that the households and the government in the same location pay the same price for the manufactures. Finally, the constant per capita tax results from Lindahl's-type of taxation if we assume that the public good enters the utility function in a convenient way.

We close the model with the equilibrium equations in the goods market. We analyse the determinants of specialisation under liberalised procurement and under discriminatory procurement in turn.

Liberalised Government Procurement

Equilibrium in the market for the differentiated good requires that:

$$p_x Nx = E_1^P + E_1^G + E_2^P + E_2^G \tag{6}$$

Equation (6) closes the model. By Walras' law the equilibrium equation in the other market is redundant. Equations (1)-(6) determine three relative prices: p_x/p_y, w/p_y, r/p_y, the scale of firms in the manufacturing sector x_i and the output vectors [n_1, x_1, y_1] and [n_2, x_2, y_2]. With homothetic preferences, given commodity prices, the production patterns reflect factor endowments. For any relative price of goods, equations (1)-(3) determine factor prices and the scale of firms. Then, the factor-market clearing conditions, equations (4) and (5), associate one output vector to any factor endowment vector. We assume that factor endowments are such that the system yields non-negative values for the output of both goods in both countries. Given the assumption that *X (Y)* is capital (labour) intensive, it follows that the *l* (*k*) abundant country relatively specialises in the production of *Y* (*X*). This is the essence of the factor proportion theory of international trade in its C-H-O version (see Helpman, 1981). As long as government demand is *fully* liberalised, government procurement has no effect on international specialisation.

Discriminatory Government Procurement

When we set f ¹ 0, we need to add the domestic market clearing condition for the differentiated commodity (by Walras' law we neglect the foreign market). Specifically, we have to add the following equation to the system composed of (1)-(6):

$$p_x n_1 x = n_1 / N \left[E_1^P + (1-f_1)E_1^G\right] + n_1 / N \left[E_2^P + (1-f_2)E_2^G\right] + f_1 E_1^G \qquad (7)$$

Using (6), (7) and the fact that $n_2 = N - n_1$, we obtain the following expression:

$$\frac{n_i}{N} = \frac{f_i g_i d_i I_i}{f_i g_i d_i I_i + f_j g_j d_j I_j}. \qquad (8)$$

Note that n_i can take any value between 0 and *N*, depending on the relative size of non-liberalised procurement (right-hand-side of equation 8). This means that, with discriminatory government procurement, factor endowments are irrelevant for the determination of the pattern of specialisation. This result, may seem surprising at first sight, but, upon pondering, it is quite straightforward. Discriminatory government procurement creates market segmentation. In each country there is a market for public procurement that can be accessed only by locating production in the country. Because of internal economies of scale, the number of firms in the monopolistic competitive sector that locates in each country increases or decreases as the government demand for the locally produced differentiated good expands or contracts. [4] The size of the *X* sector in a country depends only on the size of the "home market", i.e., the size of the demand for domestically produced varieties of *X*, which is the r-h-s of (7).[5]

[4] An intuitive parallel that helps understanding equation (8) is the one of non-traded goods. What is the explanatory power of factor endowments in explaining the relative specialisation of a country in a non-traded good? The answer is "zero". The reason is that, since the good is non-traded, domestic supply must satisfy domestic demand irrespective of the country's factor endowment. If domestic demand is very large, the country will specialise in the production of the non-traded good even if its factor endowments do not mirror the factor intensity of the non-traded good. While the appeal to the non-traded good case may help the intuition, it is important to keep in mind that our model is fundamentally different. In the case of the non-traded good, domestic demand affects the pattern of specialisation in any case. Conversely, discriminatory procurement affects the pattern of specialisation only in the presence of economies of scale and monopolistic competition.

[5] If there are as many goods as there are factors this specialisation implies that factor prices will have to compensate for countries' relative factor scarcities and, therefore, that factor prices will, in general, not equalise across countries. If the number of goods exceeds the number of factors, government procurement determines the pattern of specialisation without affecting factor prices.

First Testable Hypothesis.

If data were available one could subject expression (8) to an empirical test. Unfortunately, while quantitative data on d_i exist, available data on g_i and f_i are only qualitative. For instance, with respect to g_i, we know in which sectors government procurement is an important component of demand and in which sectors it is not, we call the former "procurement sensitive" sectors and the latter "procurement insensitive". But we do not have good enough quantitative measures of g_i that can be used for empirical purposes. Yet, expression (8) gives us another insight that we can test: it says that, *if government procurement is discriminatory, the pattern of specialisation is not related to factor endowments, except by chance*. We put this result to a test. In the second part of this paper we find that the variables representing factor endowments and factor intensities are significant when we run regressions for non-sensitive sectors, but they are not significant when we run the regression for the sensitive sectors.

I.2. A Model with Cumulative Processes.

Recent research on industrial location has focused on the issue of cumulative processes which, once triggered, produce a strong specialisation pattern even over initially featureless space (Krugman, 1991; Venables, 1996). These "new economic geography" models emphasise the opposition between agglomeration and dispersion forces. When agglomeration forces prevail, the models predict the geographical concentration of an industry in a country. The point of attraction, which comes into existence endogenously, is the location which offers better access to output and/or input markets. In this section we show that discriminatory government procurement creates a dispersion force which can dominate agglomeration forces and thereby reduce the degree of international specialisation.

In order to tell a story featuring cumulative processes, we need to add two ingredients to the C-H-O model described above. One is positive trade costs and the other is intermediate inputs. To keep the model tractable, we now assume that there is only one factor of production, labour (*l*). Finally, we need a dynamic mechanism represented by the assumption that workers, who are internationally immobile, move to the sector that yields the highest wage.

Supply, Technology and Factor-Market Equilibrium

Economies of scale in the production of each variety of the differentiated commodity are represented by a fixed cost and a constant marginal cost, both in terms of a composite input *Z*. The input requirement per *x* units of output is: $Z = f + mx$. Each firm produces the composite input *Z* by means of a Cobb-Douglas combination of labour and an aggregate of all varieties of the differentiated commodity. This is: $Z = [l_{Xi} / (1 - m)]^{1-m} (C / m)^{m}$. The CES commodity aggregate *C* has the same elasticity of substitution as the consumption aggregate, but in this context it represents the aggregate of intermediate inputs. The source of agglomeration forces is in the fact that the manufacturing sector uses its own output as input. The firm's total cost function is $TC_i = (w_{Xi})^{1-m} (P_i)^{m} (f + mx)$. Each firm's demand for each domestic and foreign variety of manufactures to be used as input is derived from the cost function via Shephard's lemma. By aggregating these demand functions over firms we get the demand functions of the aggregate of all firms: $h_{ii} = p_{xii}^{-s} P_i^{1-s} m n_i TC_i$; and $h_{ij} = p_{xij}^{-s} P_i^{1-s} m n_i TC_i$. As for the agricultural sector, we normalise the technology to be $y = l$, which allows us to set $p_y = w_{Yi} = 1$.

Trade costs are assumed to be of the iceberg type: for one unit shipped only a fraction $t \in [0,1]$ arrives at its destination. The c.i.f./f.o.b. price relationship is, $p_{xij} = (1/t)p_{xii}$. Profit maximisation requires that the f.o.b. price be $p_{xii} = sm(s-1)^{-1} w_{Xi}$, and that the c.i.f. price be $p_{xji} = (sm/t)(s-1)^{-1} w_{Xi}$. The zero-profit condition in each country imposes that $p_{xii} = TC_i / x_i$. From this condition we obtain the optimal scale of the firm, that is independent of location (x_1=x_2), and is equal to $\underline{x}$=(✂/✍)(☞-1). The market clearing condition in the labour market requires that $a_y(w_{Yi})y + a_x(w_{Xi})x_i n_i = l_i$. The world's number of varieties is N=2g/(1-m). Finally, the modelling of household demand and government procurement is the same as in the previous section.

With these modifications to the C-H-O model we are in the same setting as in Krugman and Venables (1996), augmented with government procurement. There are two salient differences between this model and the one in the previous section. The first difference is the presence of trade costs, the second is the fact that each firm uses its industry output as input. These features and a dynamic mechanism generate the agglomeration and dispersion forces.

Equilibrium in the Market for Goods and Dynamics

If government procurement is fully liberalised, then it has no effect on the pattern of specialisation. Thus, we only need to concentrate on the case of discriminatory procurement. In writing the goods-market equilibrium equation we define private expenditure on manufactures as $E_i^P = uI_i^d + mn_i p_{xi} x$. Then, the market clearing conditions in the market for goods are:

$$\begin{aligned} p_{11}^{1-s} P_1^{s-1}\left[E_1^P + (1-f_1)E_1^G\right] + p_{11}^{1-s} P_2^{s-1} t^{s-1}\left[E_2^P + (1-f_2)E_2^G\right] + f_1 E_1^G / n_1 = p_{11}\, x \\ p_{22}^{1-s} P_1^{s-1} t^{s-1}\left[E_1^P + (1-f_1)E_1^G\right] + p_{22}^{-s} P_2^{s-1}\left[E_2^P + (1-f_2)E_2^G\right] + f_2 E_2^G / n_2 = p_{22}\, x \end{aligned} \qquad (9)$$

The left-hand side of the first equation in (9) reports the total expenditure on each of the domestic varieties in its three components: the first term is domestic residents' (firms and households) expenditure plus a proportion of liberalised government purchases; the second term is foreign residents' and foreign government expenditure, and the third term is the domestic government's fixed expenditure on domestic manufactures. On the right-hand side of the first equation we have the value of total supply of each of the domestic manufactures. The second equation is the analogous of the first one but refers to any of the foreign varieties.

In what follows we illustrate the static and dynamic characteristics of the system represented by equations (9).[6] Substituting the pricing rule, the demand functions, the costs functions, and the optimal size of firms into (9) gives an implicit relationship between the vector of manufacturing wages, $[w_{X1}, w_{X2}]$, and the allocation of labour between sectors $l \equiv l_{X1}/(l_{X1}+l_{X2})$. We call this implicit function $w(l)$, where we define $w(l) \equiv w_{X1}(l) - w_{X2}(l)$. Labour is assumed to be imperfectly mobile between manufacturing and agriculture, and it moves slowly into the sector which yields the highest wage. Since w_{x1} and w_{x2} move in opposite directions around their equilibrium value, the dynamics of the system can be conveniently represented by the following differential equation:

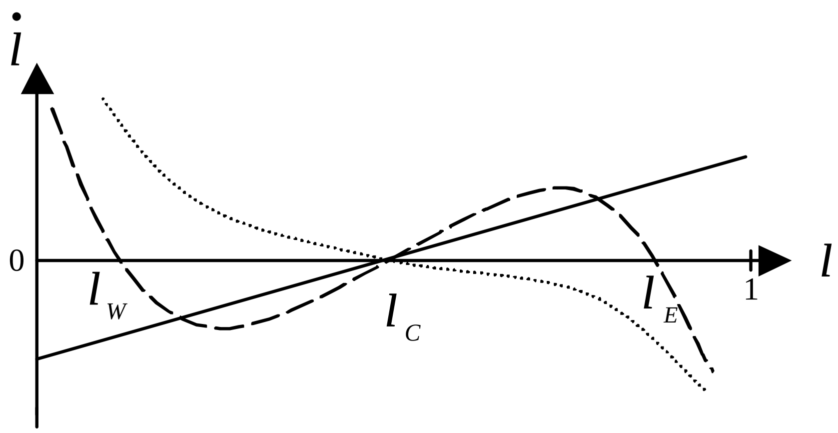
$$\dot{l} - w(l) = 0. \qquad (10)$$

The steady state of the system, i.e., $\dot{l} = 0$, is reached when the wages have reached their equilibrium value, i.e., when $w_{X1}(l) = w_{X2}(l) = w_Y = 1$. Replacing this value of wages in (9) gives an equation of the third degree in l. Therefore,

[6] The results described below and summarised in Figure 1 can be derived by use of numerical simulations (Trionfetti, 1997a), or by use of mathematical analysis (Trionfetti, 1997b). In the text we explain the procedure that leads to the results without reporting the mathematical passages.

there are three possible steady states (real solutions) of the system in the set [0,1]. We name the closest one to 0 the “Western” equilibrium (W), we name the middle one the “Central” equilibrium (C), and we name the one furthest away form 0 the “Eastern” equilibrium (E). Indexing the three possible solutions by r (r = W, C, E) we represent the solutions in Figure 1 by l_W, l_C, and l_E. One of these equilibria is easy to find, if we set all the parameters to be the same for both countries, then $l_C = ½$. We can study local dynamic stability around $l_C = ½$ by use of the phase diagram technique. Differentiation of (9) at $l_C = 1$, gives us $w'(l)$ which is the slope of the phase curve of differential equation (10). The slope is negative for high trade costs and may be (but is not necessarily) positive for low trade cots. Further, we can use (9) to see that, if procurement is discriminatory, then $\underset{l \to 0}{Lim}\, w(l) = \infty$ and $\underset{l \to 1}{Lim}\, w(l) = -\infty$. All this information is summarised in Figure 1.

Figure 1: Geographical Agglomeration with Public Procurement



When trade costs are high, only the Central equilibrium exists and is stable. When trade costs are low, three possibilities emerge.

(1) If government procurement is fully liberalised, then only the Central equilibrium exists, but it is unstable. Therefore, all the manufacturing sector eventually agglomerates in country *1* or *2*. This case is depicted by the solid line in Figure 1.

(2) If government procurement is discriminatory, but $f_i E_i$ is small in both countries, then all three equilibria exist, the Central equilibrium is unstable, and the other two are stable. Therefore, some but not all of the manufacturing sector eventually agglomerates in country *1* or *2*. This case is depicted by the dashed line in Figure 1.

(3) If government procurement is discriminatory, and $f_i E_i$ is large in both countries, then only the Central equilibrium exists and it is stable. Therefore, no agglomeration will take place regardless of trade costs. This case is depicted by the dotted line in Figure 1.

In addition to these three cases, a general result is that the distance between l_E and l_W increases as $f_i \rightarrow 0$ (*i=1 and 2*).[7]

Second Testable Hypothesis

The general result we subject to a test is that *the degree of specialisation increases as* f_i®*0* (*i=1,2*). Note that, because of the multiplicity of stable equilibria, the model does not predict the pattern of specialisation of each country. Using proxies for the parameter f_i, we find some evidence that the degree of specialisation increases as "f_i"$\rightarrow$0. This empirical test is, to our knowledge, the first attempt to cope with multiple equilibria in a new economic geography models.

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[7] A final note is in order. If l_W and l_E are not real, then there exists two real numbers $l_W \in [0,1]$and $l_E \in [0,1]$ such that all phase trajectories point at them. These two numbers are, therefore, two "long run equilibria" in the sense that l tends to them from any starting point except from l_C. All other features remain the same. In particular, it remains true that the distance between l_W and l_E increases as procurement becomes more liberalized.

II. EMPIRICAL EVIDENCE FOR THE EUROPEAN UNION

An empirical test of the predictions generated by our model requires two ingredients: suitable data and an econometric model. We discuss these issues first and then report results.

II.1. Data

The demands on data of a fully specified test for our model are formidable. We would need a three-dimensional panel, with geographical, industry and time dimensions. Ideally, each observation would provide information on each of the three dimensions for the size of the industry, the level of trade costs, factor requirements and rewards, the importance of government purchasing and the home-bias of government purchases. Such a data set does not exist. We therefore have to concentrate on what is essential as well as feasible.

The EU provides the best case study for our purpose, since, uniquely to our knowledge, comparable cross-country data on both the levels and the home-biases in public procurement are available (CEC, 1997). In the trade-off between cross-industry and cross-location disaggregation, we opt for country rather than regional data, hence allowing a higher level of industry disaggregation. When it comes to the choice of measurement units, most studies of international specialisation use exports as a proxy for industry size. Yet, the size of industries in terms of employment or output correlates less than perfectly with the volume of their exports. Hence, we use production rather than trade statistics for our analysis, at the cost of a higher level of sectoral aggregation.

Due to incomplete statistical reporting by EU countries, a second trade-off exists between the number of sample years and the number of cross-sectional observations. A panel data set would be highly unbalanced. We therefore conduct a cross-sectional study using data for 1989, when coverage was most comprehensive. Our data set, drawing on the Eurostat series “Structure and Activity of Industry”, covers 82 NACE 3-digit manufacturing industries in nine EU countries.[8]

The value and home bias of public procurement are notoriously difficult to measure. Through the public procurement study of the EU Commission’s Single Market Review (CEC, 1997), however, we avail of some relevant information for the EU. Unfortunately, there are no data on the importance of public procurement by industry and country. Across industries, the report identifies twelve sectors which are significantly affected by public procurement, without, however, quantifying the importance of procurement in each of these industries.[9] In addition, the report produces data related to the degree of liberalisation of government procurement, corresponding to 1-f in our model. Through a survey among firms selling to the public sector, the report could establish the shares of firms in each industry which regularly consult the EU’s publications of public contracts, Tenders Electronic Daily and the Official Journal, and the shares of firms which have sold to public bodies in other member states. It seems

[8] The Netherlands, Ireland and Luxembourg had to be excluded because of incomplete data coverage. The industries in the sample accounted for 22.5 million manufacturing jobs, which amounted to 96.7 percent of 1989 industrial employment in the nine countries.

[9] These sectors are (NACE codes in brackets): boilers and vessels (315), metal office furniture (316), office machinery (330), cables and wires (341), power generating equipment (342), telecoms equipment (344), motor vehicles (351), railway rolling stock (362), medical equipment (370), textiles and clothing (453), and paper (471, 472).

plausible that firms' pursuit of foreign public-sector contract is related inversely to the home-bias in the procurement by their domestic authorities.

II.2. Econometric Specification

For an empirical test of the impact of public procurement policies on industry location we need to control for other locational determinants. We concentrate on three explanations offered by different strands of theory:

1. Countries specialise in industries whose factor intensities mirror their factor abundance. This is the central prediction of the 2*2*2 H-O model as well as of its C-H-O extension (see Jones, 1956, and Helpman, 1981).
2. Scale-sensitive industries will locate in the country with best market access. This is a generic result of models with increasing returns, monopolistic competition, and trade costs (see Krugman, 1980).
3. Vertically linked industries will tend to locate close to each other. This explanation is based on input-output linkages among firms and increasing returns in production (see Venables, 1996).

Our independent variable is derived from the specialisation index proposed by Hoover (1936):[10]

$$L^H{}_{ij} = \frac{S_{ij}}{\sum_i S_{ij}} \Big/ \frac{\sum_j S_{ij}}{\sum_i \sum_j S_{ij}}, \qquad (11)$$

where S_{ij} is the size of industry i in country j, expressed in terms of either employment or production. L^H is non-negative, and a value greater/smaller than one means the share of industry i is larger/smaller in country j than the average over all countries. We apply two transformations to this index, resulting in the following specialisation measure:

$$L_{ij} = \ln\left(\frac{S_{ij}}{\sum_i S_{ij}} \Big/ \underset{j=[1,n]}{\text{median}}\left[\frac{S_{ij}}{\sum_i S_{ij}} \right] \right). \qquad (12)$$

The first transformation is that the denominator is defined as the median, rather than the mean, of the share of industry *i* across the *n* sample countries. This eliminates the purely statistical effect of country size on the value taken by the specialisation index: without our adjustment, the variability of the index relates negatively to country size. The second transformation is to take the natural logarithm of the underlying ratio. The effect of this modification is to centre the measure symmetrically around zero.

Having defined our dependent variable, we proceed to estimate the following basic equation:

$$L_{ij} = \boldsymbol{a}_{ij} + \boldsymbol{b}^k \boldsymbol{X}_{ij}^k + e_{ij}\,, \qquad (12)$$

where $\boldsymbol{X}$ is a vector containing sets of locational determinants, labelled by *k*. In our specification, *k*=1,2,3 are variables derived from the theoretical models of Section I.

The individual sets of explanatory variables are constructed as follows.

$\boldsymbol{X}^1$ is the set of variables derived from Heckscher-Ohlin theory:

$$\boldsymbol{b}^1 \boldsymbol{X}_{ij}^1 = b_1^1 LINTENS_i + b_2^1 LABUND_j + b_3^1 LINTENS_i * LABUND_j\,, \qquad (13)$$

where *LINTENS*, the measure for labour intensity, is defined as an industry's ratio of labour costs to the value of production, computed across all countries. Correspondingly, *LABUND*, the measure for labour abundance, is a country's ratio of labour costs to the value of production, computed across industries. We define all non-labour inputs as one production factor. Consequently, we can

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[10] This index is sometimes attributed to Balassa (1965)19

model the prediction of the 2*2*2 Heckscher-Ohlin model, whereby labour (capital) abundant countries will specialise in labour (capital) intensive industries, by interacting the two variables in (14).

$\boldsymbol{X}^2$ is the set of variables derived from the "new trade theory":

$$\boldsymbol{b}^2 \boldsymbol{X}_{ij}^2 = b_1^2 SCALE_i + b_2^2 CENTRAL_j + b_3^2 SCALE_i * CENTRAL_j, \qquad (14)$$

where *SCALE*, the measure for scale economies, is defined as an industry's average output per firm. *CENTRAL*, our proxy for market size, is calculated as each country's centrality index, obtained from Keeble *et al.* (1986). The variables are interacted in order to reflect the stylised prediction of the theory that scale-sensitive industries will locate in countries with access to large markets.

$\boldsymbol{X}^3$ is the set of variables derived from the "new economic geography":

$$\boldsymbol{b}^3 \boldsymbol{X}_{ij}^3 = b_1^3 INTERMIND_i + b_2^3 INTERMCTR_j + b_3^3 INTERMIND_i * INTERMCTR_j, \qquad (15)$$

where *INTERMIND* measures the intermediate-input intensity of industries. Following Amiti (1997), intermediate-good intensity is measured as the difference between production and value added. *INTERMCTR* represents the availability in a country of intermediate inputs, also calculated as the difference between production and value added. This can be interpreted as a proxy for a country's "industrial base" (Venables, 1996). The variables are interacted, since we expect intermediate-input intensive industries to be relatively larger in intermediate-input abundant countries.[11]

[11] All interacted explanatory variables are constructed as deviations from their means. This "centring" of interacting variables minimises multicollinearity problems (see Jaccard et al., 1990).

We have derived two testable hypotheses from the theory. The first one says that, in the sensitive sectors, factor endowments are not correlated with the specialisation index. We test this prediction by running two separate regression of (13), one for the sensitive sectors and one for the non-sensitive sectors.

The second prediction is that the specialisation index is positively correlated with the degree of liberalisation of government procurement. We do this by taking the absolute values of our variables and estimate the following equation:

$$\left|L_{ij}\right| = a_{ij} + b^{k}\left|X_{ij}^{k}\right| + r_1 PPDUMMY_i + r_2 TEDUSE_i + e_{ij}, \qquad (16)$$

where *PPDUMMY* equals 1 for the procurement-sensitive sectors, and 0 otherwise. *TEDUSE* is the proportion of firms in each industry which make regular use of the EU's public tendering information, averaged over EU countries.

2.3 Results

In Table 1, we report the values of our specialisation measure, the dependent variable of subsequent analysis. Industries are ranked in decreasing order by the standard deviation of specialisation measures across countries. Hence, the further down an industry is placed in Table 2, the more dispersed it is across our nine sample countries.[12] One might glean some *prima facie* evidence on the localisation pattern of procurement-sensitive industries from this table, with the expectation that they should be positioned towards the bottom of the list. However, we find that the industries singled out in CEC (1997) are distributed quite evenly across our ranking, with two sectors standing out at the top of the list: data processing and railway rolling stock. Simple visual inspection of the data, therefore, gives us no reason to suspect an impact of public procurement on industrial specialisation in the EU. However, a valid test of the hypothesis that public procurement can offset other locational determinants needs to introduce controls for the latter.

We have estimated the base-line model specified in equation (13), using two alternative measurement units for the dependent variable: employment and production. The results are reported in the first two data columns of Table 2. We find confirmation of our expected relationships. The interaction effects all have the expected positive sign, and they are statistically significant in all cases. We can thus infer that all three locational forces - factor proportions, market access and linkages - are relevant determinants of the industrial specialisation patterns observed in the EU.[13]

In a second step, we have split our sample into observations pertaining to industries which are (or are not) significantly affected by public procurement. The results for the "procurement insensitive" industries are given in the third and fourth data columns of Table 2. Our model survives in this subsample: the signs and significance levels on interaction terms are unchanged. Hence, the locational determinants suggested by economic theory seem to have significant locational effects in those industries where public procurement plays an insignificant role. This picture changes when we look at the results for the subsample of "procurement sensitive" industries, listed in the last two columns of Table 3. The statistical significance levels on all interaction terms drop sharply, and none retains significance at the 5% level. In the employment specification, the RESET

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[12] Similarly, countries are ranked in decreasing order of the standard deviation across industries, from left to right.

[13] Note that the joint explanatory power of our model is low, as we can account only for 7 percent of the variance in the dependent variable. Experimentation with country dummies (to capture effects such as differing industrial policies) and with industry dummies (to capture industry effects not contained in our model) did not produce significant increases in adjusted R^2.

test strongly suggests misspecification or omitted variables. Public procurement thus appears to reduce the relevance of the locational determinants identified in the three groups of independent variables. We find that factor endowments, centrality, and intermediate inputs are of little statistical significance as determinants of industrial location in the sectors with important public procurement. Hence, public procurement appears to influence the spatial distribution of industry significantly.

Caution must be applied in the interpretation of this result. First, the twelve industries tagged as procurement sensitive might happen to share other distinctive but unknown characteristics which significantly influence the location decisions of firms. Second, our interpretation of the result implicitly assumes that procurement is home-biased and thereby affects the spatial equilibrium. It would be desirable to substantiate this assumption with data. Yet, it is certainly striking that the sectors tagged as sensitive by the CEC (1997) are exactly those who happen to perform very differently in comparison to the other sectors when subjected to our econometric exercise.

Tests of the impact of government procurement according to equation (17) are reported in Table 3. The first two data columns show results calculated over the whole industry sample. Since we only have data on *TEDUSE* for the sensitive industries, this variable could not be included in the full-sample regressions. We find that our model performs very poorly in the specification using absolute values. This is not surprising, given the information content lost through this conversion. The coefficients on the procurement dummy are negative, as expected, but statistically not significant. In the last two columns of Table 3 we report results calculated only for the procurement-sensitive subsample, where we can include *TEDUSE*. The coefficients on this variable are positive, in line with our second hypothesis, and statistically significant. Industries with more liberalised procurement, therefore, seem to be more spatially concentrated in the EU.

CONCLUSIONS

This paper has formally explored the proposition that home-biased public procurement significantly affects the spatial distribution of industries.

We have formally derived two predictions. First, building on a model from the new trade literature, we have shown that discriminatory government procurement can countervail the pattern of specialisation which would emerge as a result of the influence of factor endowments. Second, using the theoretical framework of the new economic geography, we have shown that discriminatory government procurement can countervail the agglomeration forces deriving from intermediate inputs and market access.

Moving on to empirical verification, a cross-section analysis for nine EU countries supports the theoretical priors. In industries which are sensitive to public procurement, other locational determinants lose statistical significance. The degree of liberalisation of procurement markets (but not the share of industry sales to public purchasers) affects location of the “sensitive” industries. More liberalised procurement leads to stronger geographical concentration of industries.

Our work points to the importance of further empirical exploration. There is obviously scope for estimating the equations suggested here on data sets for other periods and countries. Only a data set with full numerical information on the size and bias of government procurement by industry and country would allow a complete and rigorous test of our models.

Table 1: Industrial Specialisation in the EU, 1989

(Specialisation index based on employment)

NACE		GR	P	DK	B	D	E	F	I	UK	*STD*[1]
3300[2]	Data processing etc.	n.a.	n.a.	-0.68	-1.79	0.07	-1.74	0.27	0.29	0.00	*1.00*
3620[2]	Railway rolling stock	0.60	n.a.	n.a.	1.28	-1.26	0.02	-0.82	-0.03	n.a.	*0.97*
4380	Carpets etc.	0.46	0.63	0.00	1.42	-0.74	-0.65	-0.73	-1.2	0.33	*0.97*
4510	Footwear	0.25	1.33	-1.3	-1.73	-1.06	0.33	0.00	0.8	-0.13	*0.93*
3640	Aerospace (prod., repair)	0.12	n.a.	n.a.	n.a.	-0.52	-1.39	0.62	-0.13	0.88	*0.91*
4400	Leather goods	0.00	0.77	-0.81	-1.15	-0.49	0.82	0.34	0.85	-1.02	*0.90*
3710	Precision instruments	0.00	-0.31	0.39	-0.05	1.57	-0.11	0.00	0.85	1.94	*0.90*
2450	Stone, minerals process.	0.03	0.28	0.00	-1.77	-1.28	0.39	-1.59	-0.56	0.07	*0.90*
3630	Cycles, motorcycles	n.a.	0.73	0.48	n.a.	-0.87	-0.17	0.00	0.76	-1.56	*0.88*
4610	Wood processing	0.02	2.14	-0.02	-0.25	-0.29	1.5	0.2	-0.66	n.a.	*0.84*
4640	Wooden containers	0.11	-0.17	-0.13	-0.16	-0.14	1.65	1.38	0.76	n.a.	*0.84*
4270	Brewing, malting	0.22	-0.26	1.11	0.59	0.07	-0.07	-1.16	-1.35	n.a.	*0.83*
4160	Grain milling	0.44	0.26	0.30	-0.31	-1.92	0.24	-0.92	-0.81	n.a.	*0.80*
4150	Fish, seafood	0.00	0.80	1.50	-1.14	-1.05	0.44	-1.10	-1.44	0.20	*0.79*
3270	Specialised machinery	n.a.	n.a.	0.00	-0.79	1.09	-0.38	-0.75	0.58	0.30	*0.77*
3430	Industr. electr. apparatus	-1.39	-1.44	n.a.	0.00	n.a.	0.84	-1.11	0.65	0.15	*0.76*
3460	Domestic el. appliances	0.16	-1.00	n.a.	-1.75	0.02	0.06	-0.02	0.39	-0.12	*0.76*
4940	Toys, sports goods	-0.18	-1.87	1.29	-1.52	0	0.12	0.64	-0.32	0.31	*0.75*
4190	Bread, flour products	-0.17	1.00	-0.28	0.17	0.00	1.33	-0.35	-0.64	0.90	*0.75*
4310	Wool	0.00	1.56	-1.25	0.54	-1.04	-0.63	-0.07	0.85	0.2	*0.71*
3720[2]	Medical equipment	n.a.	-1.15	0.66	-1.08	0.68	-1.06	0.16	-0.06	0.05	*0.71*
3230	Textile machinery	n.a.	0.01	-0.42	0.70	0.86	-0.01	-0.63	0.67	-0.64	*0.68*
4650	Misc. wood products	-1.16	n.a.	0.8	-0.06	0.71	1.23	-0.66	0.06	-0.09	*0.67*
3450	Radio, TV, sound eqmt	-1.59	0.52	n.a.	n.a.	-0.14	-0.81	1.01	0.29	0.00	*0.66*
2230	Processing of steel	-0.01	-1.14	-0.91	1.43	0.25	-0.60	0.20	0.00	0.35	*0.66*
3420[2]	Electr. machinery/plant	-0.48	-0.53	n.a.	-0.38	1.22	n.a.	0.78	0.00	0.36	*0.63*
4140	Fruit, vegetables	1.95	0.00	-0.20	0.48	-0.82	0.82	-0.20	0.02	-0.49	*0.61*
4110	Optical, photographic eq.	1.19	0.41	1.02	0.00	-0.62	0.98	-0.48	-0.32	-0.57	*0.61*
3440[2]	Telecom, el.-medical etc.	-1.41	n.a.	n.a.	0.55	0.94	-0.62	0.00	-0.30	0.60	*0.60*
2590	Misc. househ. chemicals	-0.91	-0.50	-1.16	n.a.	1.32	0.11	0.85	0.20	-0.13	*0.60*
4210	Cocoa, sweets	0.48	-0.60	0.89	0.43	-0.19	0.00	-0.02	-1.26	0.25	*0.59*
2550	Paint, varnish, ink	-0.28	0.00	0.45	1.22	0.76	-0.06	-0.08	-0.27	0.01	*0.59*
3260	Transmission equipment	n.a.	n.a.	-1.04	-0.13	0.77	-0.92	0.00	0.42	0.17	*0.57*
2480	Ceramic goods	0.00	0.67	-0.11	-1.10	-0.41	0.31	-0.50	0.41	0.02	*0.57*
3610	Shipbuilding	0.88	0.42	0.82	-0.94	-1.17	0.19	-0.98	-0.36	0.00	*0.57*
3130	Second. transf. of metals	-2.39	n.a.	-0.03	-0.28	0.03	0.73	0.86	0.22	-0.44	*0.53*
4120	Slaughtering etc.	-0.19	-0.28	1.75	0.00	-0.49	0.74	0.78	-0.07	0.62	*0.52*
3120	Forging, pressing etc.	n.a.	n.a.	n.a.	-1.13	-0.12	0.01	0.42	0.02	-0.01	*0.52*
3220	Machine tools	n.a.	-0.94	-0.29	0.04	0.93	-0.05	-0.40	0.77	0.16	*0.51*
3240	Food/chemic. machinery	n.a.	-1.46	0.74	-0.41	0.73	-0.52	-0.05	0.57	0.04	*0.51*
2410	Clay products	n.a.	1.52	-0.34	-0.08	-0.60	0.55	-0.80	0.07	0.17	*0.50*
4290	Tobacco products	1.7	-0.59	0.14	0.33	-0.88	-0.16	n.a.	0.23	-0.48	*0.50*
4630	Carpentry, joinery	-1.03	0.78	1.14	-0.15	-0.12	1.03	0	-0.38	0.04	*0.49*

3150[2]	Boilers, reservoirs, tanks	-0.66	-0.02	0.33	0.12	0.25	-0.19	1.05	-0.34	0.00	*0.49*
3140	Structural metal prods	-0.88	n.a.	0.44	0.38	-0.31	0.52	-0.70	0.23	-0.34	*0.48*
4550	Household textiles	-0.59	n.a.	0.37	0.00	-0.89	0.13	n.a.	-0.55	0.19	*0.47*
4370	Textile finishing	0.82	n.a.	-0.85	0.28	-0.46	0.18	-0.23	0.82	-0.28	*0.47*
4220	Animal feed	-0.69	0.36	0.01	0.02	-1.09	0.17	0.00	-0.53	-0.13	*0.47*
3280	Misc. machinery	-0.67	-1.36	1.28	-0.01	0.64	-0.59	0.00	0.26	0.63	*0.46*
2510	Basic industr. chemicals	0.00	-0.91	-0.56	0.60	0.69	-0.59	-0.01	0.21	0.21	*0.46*
2560	Misc. indust. chemicals	-0.59	0.17	-1.14	0.63	n.a.	0.14	0.38	-0.53	-0.16	*0.45*
3470	Electric lamps, lighting	n.a.	0.13	n.a.	0.63	0.00	-0.45	-0.33	-0.58	0.12	*0.45*
2420	Cement, lime, plaster	1.51	0.09	n.a.	-0.10	-0.53	0.31	-0.15	0.25	-0.84	*0.45*
4360	Knitting	1.17	1.2	-0.18	-0.58	-0.81	-0.14	0.00	0.35	0.02	*0.43*
4730	Printing etc.	-0.18	-0.02	0.74	0.08	-0.39	0.00	0.15	-0.61	0.57	*0.42*
2210	Iron, steel	-0.31	-0.73	-0.91	0.96	0.14	0.20	-0.16	0.35	n.a.	*0.41*
4230	Misc. food products	0.87	-0.72	0.65	-0.13	0.00	0.37	-0.39	-0.42	0.58	*0.40*
4130	Dairy products	0.48	0.34	0.75	0.00	-0.85	-0.10	0.37	-0.06	-0.20	*0.40*
4280	Soft drinks	0.99	0.37	n.a.	-0.02	-0.36	0.73	-0.14	-0.32	0.02	*0.40*
3210	Agricultural machinery	-0.81	-0.47	1.17	0.30	0.00	-0.04	0.04	0.66	-0.52	*0.39*
4810	Rubber products	n.a.	-0.58	-0.76	-0.71	0.01	0.1	0.43	0.1	-0.01	*0.38*
1400	Mineral oil refining	1.61	0.00	-0.32	-0.18	0.00	0.06	0.69	0.58	-0.05	*0.36*
4530[2]	Clothing, accessories	0.92	0.75	-0.76	-0.15	-0.74	0.07	-0.25	0.25	0.00	*0.34*
2240	Non-ferrous metals	0.80	-1.91	-2.05	0.79	0.10	-0.19	-0.02	0.00	0.09	*0.34*
2220	Steel tubes	0.17	n.a.	0.15	-0.12	0.11	-0.60	-0.21	0.28	-0.50	*0.34*
4320	Cotton	1.85	2.34	-1.36	0.32	-0.32	0.00	-0.09	0.3	-0.41	*0.30*
4620	Semi-finished wood pr.	0.93	0.05	-0.06	0.23	-0.41	0.27	-0.2	-0.15	n.a.	*0.29*
3160[2]	Metal goods, tools	0.00	0.18	0.14	-0.51	0.19	0.09	-0.38	-0.42	-0.10	*0.29*
4720[2]	Paper/board processing	-0.14	-0.4	0.47	0.16	0.00	-0.14	0.32	-0.13	0.59	*0.28*
2470	Glass, glassware	-0.58	0.16	-0.95	0.62	-0.12	0.00	0.26	0.02	-0.10	*0.28*
3410[2]	Insulated wires, cables	0.04	0.23	n.a.	-0.38	n.a.	-0.43	0.00	-0.14	0.21	*0.27*
4670	Wooden furniture	-0.61	-0.14	0.54	0.02	-0.16	0.47	-0.31	0.08	0.00	*0.26*
2430	Concrete etc.	0.00	-0.02	0.80	0.32	-0.25	0.33	-0.07	0.08	-0.20	*0.25*
3110	Foundries	-1.40	0.21	-0.27	-0.57	0.07	0.00	0.01	0.08	-0.04	*0.25*
3250	Misc. heavy plant	-1.94	-0.50	0.73	0.08	0.29	-0.36	-0.16	0.13	0.00	*0.23*
4390	Misc. textiles	1.33	0.98	-0.29	0.00	-0.21	0.15	0.3	-0.03	-0.30	*0.22*
2580	Soap, cosmetics, etc.	0.80	-0.05	-0.40	-0.06	0.05	0.16	0.46	-0.12	0.00	*0.21*
3500	Motor vehicles	-2.10	-0.93	-1.52	0.14	0.40	0.03	0.28	0.00	-0.16	*0.20*
2570	Pharmaceuticals	0.12	-0.36	0.59	-0.07	-0.32	-0.03	0.11	0.25	0.00	*0.19*
2601	Man-made fibres	0.00	-0.35	-0.14	0.34	0.13	-0.15	0.11	0.03	-0.03	*0.17*
4710[2]	Pulp, paper, board	0.70	0.76	-0.2	0.11	-0.13	0.04	-0.01	0.00	-0.17	*0.11*
4830	Plastics	-0.23	-0.33	0.34	-0.06	0.15	0.00	0.00	0.03	0.08	*0.07*
STD[1]		*0.92*	*0.85*	*0.80*	*0.70*	*0.66*	*0.58*	*0.54*	*0.51*	*0.45*	

Source: Eurostat (Series: “Structure and Activity of Industry”)

[1] standard deviations

[2] “procurement sensitive” sectors, according to CEC (1997)

Table 2: Determinants of Industrial Specialisation in the EU, 1989

(dependent variable = nat. log of Hoover index based on production/employment; White-corrected *t* values in brackets)

Industries (no. of observations)	All (684)	All (684)	Procurement insensit. (588)	Procurement insensit. (588)	Procurement sensitive (96)	Procurement sensitive (96)
Dependent variable	Employment	Production	Employment	Production	Employment	Production
CONSTANT	-0.06476 (-2.44) **	-0.08813 (-3.24) ***	-0.06299 (-2.16) **	-0.08874 (-2.95) ***	-0.08531 (-1.40)	-0.08817 (-1.37)
LINTENS	-1.81092 (-1.94) *	-2.66721 (-2.96) ***	-2.54379 (-2.63) ***	-3.36488 (-3.54) ***	3.53625 (1.02)	2.25543 (0.63)
LABUND	-0.98109 (-0.93)	-0.44625 (-0.41)	-1.16560 (-1.01)	-0.42748 (-0.36)	-1.11507 (-0.37)	-2.64726 (0.43)
LINTENS*LABUND	32.02002 (2.95)***	42.91117 (3.99) ***	25.35387 (2.09) **	36.08576 (3.04) ***	53.98301 (1.46)	82.18379 (1.96) *
SCALE	-0.00013 (-0.92)	-0.00014 (-0.99)	-0.00009 (-0.71)	-0.00011 (-0.78)	-0.00065 (-0.88)	-0.00070 (-0.94)
CENTRAL	-0.00001 (-0.498)	-0.00002 (-1.16)	-0.00001 (-0.90)	-0.00002 (-1.48)	0.00003 (0.82)	0.00001 (0.37)
SCALE*CENTRAL	0.0000002 (3.24) ***	0.0000001 (2.48) **	0.0000001 (2.95) ***	0.0000001 (2.19) **	0.0000004 (1.69) **	0.0000004 (1.58)
INTERMIND	0.06144 (0.08)	-0.54028 (-0.73)	-0.53810 (-0.70)	-1.11865 (-1.50)	5.88483 (1.87) **	5.02200 (1.51)
INTERMCTR	-0.53049 (-0.66)	-1.15613 (-1.40)	-0.77190 (-0.89)	-1.43180 (-1.57)	0.68253 (0.29)	0.27125 (0.12)
INTERMIND* INTERMCTR	18.62979 (2.11) **	12.90382 (1.61)	20.00 (2.17) **	14.46238 (1.69) *	25.07201 (0.81)	19.40028 (0.64)
R^2	0.10	0.10	0.10	0.10	0.21	0.22
F (Pr>F)	6.76 (0.00)	8.04 (0.00)	6.37 (0.00)	7.15 (0.00)	2.05 (0.04)	2.58 (0.01)
Ramsey RESET (Pr>F)	1.73 (0.16)	0.65 (0.58)	1.84 (0.14)	1.10 (0.35)	2.25 (0.08)	0.43 (0.73)

***, **, *: significant at 1%, 5% and 10% levels.

Table 3: Public Procurement and Industry Concentration

(dependent variable = absolute value of specialisation measure; White-corrected *t* values in brackets, 96 procurement-sensitive industries)

Industries (no. of observations)	All (684)	All (684)	Procurement sensitive (96)	Procurement sensitive (96)
Dependent variables	Employment	Production	Employment	Production
ABS_CONSTANT	-0.36424 (-0.82)	-0.98088 (-2.04)**	-0.82342 (-0.71)	-0.88057 (-0.81)
ABS_LINTENS	-1.23154 (-1.37)	-0.92245 (-0.98)	-2.19494 (-0.95)	-3.13254 (-1.22)
ABS_LABUND	1.09395 (0.80)	1.00405 (0.74)	-1.95529 (-0.57)	-4.40553 (-1.16)
ABS_LINTENS* ABS_LABUND	28.05963 (1.55)	21.54763 (1.21)	67.07979 (1.80)*	87.16650 (2.01)**
ABS_SCALE	-0.00007 (-0.37)	0.00002 (0.08)	-0.00040 (-0.18)	0.00115 (0.43)
ABS_CENTRAL	0.00001 (0.70)	0.00001 (0.72)	-0.00001 (-0.12)	0.00007 (0.85)
ABS_SCALE* ABS_CENTRAL	0.000001 (0.60)	0.0000002 (0.12)	0.000001 (0.83)	0.000002 (0.21)
ABS_INTERMIND	-1.11026 (-0.21)	7.42171 (1.57)	-3.11161 (-0.22)	3.62903 (0.29)
ABS_INTERMCTR	1.12272 (1.74)*	2.01854 (2.92)***	0.81878 (0.48)	0.83776 (0.52)
ABS_INTERMIND* ABS_INTERMCTR	2.73986 (0.35)	-9.95529 (-1.43)	9.29692 (0.45)	-0.32848 (-0.02)
PPDUMMY	-0.04021 (-0.81)	-0.03201 (-0.59)		
TEDUSE			0.01115 (2.34)**	0.00961 (1.70)*
R^2	0.05	0.04	0.26	0.22
F (Pr>F)	2.59 (0.00)	2.22 (0.02)	3.66 (0.00)	2.58 (0.01)
Ramsey RESET test (Pr>F)	0.38 (0.76)	2.53 (0.06)	3.36 (0.02)	1.83 (0.15)

***, **, *: significant at 1%, 5% and 10% levels.

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