Public Expenditure and International Specialisation

September 2000

MARIUS BRÜLHART
University of Lausanne

FEDERICO TRIONFETTI
King's College London

ABSTRACT

We study the impact of home-biased public expenditure on international specialisation in general equilibrium models with increasing returns and monopolistic competition. It is found that home-biased procurement attracts increasing-returns industries to the home country (the "pull" effect) and attenuates the overall degree of industrial specialisation (the "spread" effect). Empirical evidence based on input-output data for the European Union confirms the existence of these links between public expenditure and the location of manufacturing activities.

JEL classification: H5, F1, R3, R15

Keywords: public expenditure, international specialisation, economic geography, European Union, input-output analysis

Corresponding author: Federico Trionfetti, School of Physical Sciences and Engineering, The Management Centre, King's College London, Franklin-Wilkins Building, 150 Stamford Street, London, SE1 8WA. (F.Trionfetti@kcl.ac.uk)

Acknowledgements:

The authors gratefully acknowledge financial support from the Swiss National Science Foundation, from the British Economic and Social Research Council ("Evolving Macroeconomy" programme, ESRC grant L138251002) and from the Commissariat Général du Plan (convention no. 5, 2000).

1. INTRODUCTION

This study investigates the consequences of home-biased government procurement on the patterns and the intensity of international specialisation. By “home bias” we refer to governments’ preference for domestic over foreign suppliers even if this practice implies that the cost of procurement might not be minimised. Rather than asking about the causes of this pervasive phenomenon, we investigate its consequences on the location of manufacturing activities.

First, we study whether and how public expenditure affects the location of industries across countries. For this purpose we extend the model of Helpman and Krugman (1985, Part III) to include home-biased public procurement. This model incorporates a constant-returns perfectly competitive sector and an increasing-returns monopolistically competitive sector. For the perfectly competitive sector our analysis confirms Baldwin’s (1984) neutrality proposition that government procurement is inconsequential for international specialisation. For the monopolistically competitive sector, our analysis instead yields the prediction that, *ceteris paribus*, a country will tend to specialise in the good for which it has relatively large home-biased procurement. Our empirical investigation based on input-output data for EU countries in 1970-85 supports this proposition: we find robust evidence of a “pull effect” of public expenditure on the location of manufacturing industries.

Our second focus is on the intensity of industrial concentration, i.e. on the “how much” rather than the “where” of international specialisation. To study this question we extend the “new economic geography” model of Krugman and Venables (1995) to include home-biased procurement. In this model, dispersion forces tend to prevail at high trade costs, and economic activity is spread evenly across countries; while agglomeration forces dominate at low trade costs, so that countries become specialised. We find that home-biased public expenditure, by acting as a dispersion force, reduces the likelihood that agglomeration forces prevail; and in the case that they prevail, public expenditure reduces the intensity of industrial agglomeration. An analysis of this link in our EU input-output dataset confirms the presence of such a "spread effect" of public expenditure on the location of manufacturing industries.

Previous work on public procurement has followed two principal paths. A first line of research has studied the political interplay between the tendering entity and domestic and foreign bidders in various informational settings. This literature includes Branco (1994), McAfee and McMillan (1989), Vagstad (1995) and a general treatment by Laffont and Tirole (1993). The home bias in public procurement stems from the fact that profits of domestic firms enter the objective function of government while those of foreign firms do not. This literature is rooted in a partial-equilibrium approach and does not, therefore, provide the most appropriate framework for a study of international specialisation patterns. We depart from this line of research by taking the home bias as exogenous and focusing on the consequences of this practice on international specialisation in a general-equilibrium setting.

Our study is closely related to a second line of inquiry on home-biased procurement, which, although initiated over 30 years ago, has remained relatively underexplored. This research programme links procurement to international specialisation and is originally due to Baldwin (1970, 1984). He used a standard Heckscher-Ohlin model to show that home-biased government procurement is irrelevant for international specialisation. Miyagiwa (1991) has demonstrated that Baldwin's "neutrality proposition" extends to a model of oligopoly with a homogeneous good but not with differentiated goods. We extend this research programme by examining the consequences of home-biased procurement on international specialisation in a monopolistic-competition model of trade and location.

The analysis in this paper is of a positive nature. Nevertheless, it is worth mentioning that the issue of liberalisation of public procurement has important welfare implications. For that reason, it has been and continues to be on the policy agenda of European and other international organisations. Liberalisation of public procurement has been the object of a number of EEC Directives in the context of the implementation of the Single Market, as well as of the Government Procurement Agreement in the context of the WTO Uruguay Round. Negotiations on this issue are ongoing, both in the EU and at the WTO. Policy makers have long recognised that home-biased procurement may counter industrial relocation forces. In its official assessment of the effects of the Single Market programme, the European Commission has for instance acknowledged that the liberalisation of public procurement may lead to "the rationalisation of Community production on a smaller number of sites" (Emerson *et al*., 1988, p. 53). As more conventional forms of protectionism are being whittled away, biased procurement thus receives increasing attention in international policy fora.

Our paper is structured as follows. In Section 2, we set out the theoretical model and derive two testable propositions. These propositions are tested empirically on input-output data for EU countries in Section 3. Section 4 concludes.

2. THEORY

We explore the impact of home-biased public expenditure on international specialisation in two settings that have become benchmark models of the "new trade theory" and the "new economic geography". Our analysis shows that, while Baldwin's neutrality proposition holds for the perfectly competitive sectors, home-biased procurement does affect international specialisation when we allow for increasing returns and monopolistic competition. We first use the "new trade theory" setting to investigate whether home-biased public expenditure can attract industrial activity to the home country, and then we turn to a "new economic geography" model to explore the impact of home-biased procurement on agglomeration and dispersion forces.

2.1. Public expenditure in a static model of international specialisation

In this section we extend the model developed in Helpman and Krugman (1985, section 10.4) by introducing government demand. This allows us to investigate the effects of home-biased government procurement on international specialisation.

The basic structure of the model is as follows. We assume two homogeneous factors of production, generically labelled l and k; two countries, indexed by i=1,2; and three sectors: X, Y, and Z. Two sectors are perfectly competitive (Y and Z) and one is monopolistically competitive (X).[1] Sector Z will serve as numéraire. Production technologies differ across sectors but are identical across countries. Sectors Y and Z are subject to a linearly

[1] We have to assume that there is at least one more good than there are factors, in order to obtain a factor-price equalisation set of full dimensionality. This is further explained below.

homogeneous production function and operate under perfect competition. The average and marginal cost functions associated with these technologies are $c_Y(w,r)$ and $c_Z(w,r)$, where the arguments are the remuneration to l and k. The X sector produces a differentiated commodity using a technology that requires a fixed cost $f(w,r)$ and a constant marginal cost $m(w,r)$. It is assumed that the functions $m(w,r)$ and $f(w,r)$ use factors in the same relative proportion. Thus, factor proportions in the X sector depend only on relative factor prices and not on the scale of firms. Since all X firms have identical costs, the optimal level of output is the same for all firms and is denoted by x. The average cost function of the X sector is $c_X(w,r) = m(w,r)+f(w,r)/x$. Demand functions for factors obtain from the cost functions through Shephard's lemma. We denote these demand functions as $l_S(w,r)$ and $k_S(w,r)$ with $S = X,Y,Z$. Further, we assume no factor intensity reversals. Finally, it is assumed that commodities Y and Z are traded internationally at zero costs while commodity X is traded internationally at a cost of the iceberg type. This means that for one unit of the X good shipped only a fraction $t \in (0,1]$ arrives at its destination. The total number of X varieties produced in the world, denoted by N, is endogenously determined, and so is its distribution between countries. The number of X varieties produced in country i is n_i and we have N n_1+n_2. The world's factor endowment is exogenous and denoted by L and K. Countries' factors endowments are exogenous, and L_1 L-L_2 and K_1 K-K_2. The equilibrium equations are:

$$p_S = c_S(w,r), \qquad S = Y, Z \tag{1}$$

$$p_X(1-1/s) = m(w,r), \tag{2}$$

$$p_X = c_X(w,r,x), \tag{3}$$

$$l_Y(w,r)Y_i + l_X(w,r)xn_i + l_Z(w,r)Z_i = L_i \qquad i = 1,2 \tag{4a}$$

$$k_Y(w,r)Y_i + k_X(w,r)xn_i + k_Z(w,r)Z_i = K_i \qquad i = 1,2 \tag{4b}$$

Equations (1) and (2) express the usual condition that marginal revenue equal marginal cost in all sectors and countries. Equation (3) states the zero profit condition in sector X in all countries. Equations (4a) and (4b) state the market clearing conditions for factors in all countries. These eight equations describe the supply side of the model.

To close the model, we need to describe the demand side in its two components, private and public. Households in both countries are assumed to have homothetic preferences. Specifically, we assume Dixit-Stiglitz preferences (i.e., a nested Cobb-Douglas-CES utility function) with Cobb-Douglas expenditure shares u_{si} (S=X,Y,Z) and $\Sigma_S u_{Si}$=1, and with an 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. Aggregating across households gives demand functions for the differentiated good. Country i's private demand for each variety produced in i is $x_i^d = p_X^{-s} P_i^{1-s} u_{Xi} I_i^d$ and for each variety produced in j is $x_i^d = t^s p_X^{-s} P_i^{1-s} u_{Xi} I_i^d$. The price index $P_i = \left(n_i p_X^{1-s} + n_j t^{s-1} p_X^{1-s}\right)^{1/(1-s)}$ is the price index applicable to country i, $I_i^d = (1 - d_i) I_i$ is households' disposable income, d_i is a 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, I_i is national income. For future reference, we define private expenditure on the X good in i as $E_{Xi}^P \equiv u_{Xi}(1 - d_i) I_i$.

Governments purchase goods that they use for their subsistence. The balanced budget requirement assures that expenditure equals tax collection. Tax revenue amounts to $d_i I_i$ and is allocated among goods according to the parameter g_{Si} (S = X,Y,Z) with $\sum_S g_{Si} = 1$. Government *i's* expenditure on *X* goods is then $E_{Xi}^G \equiv g_{Xi} d_i I_i$.[2]

Following Baldwin (1970, 1984) and Miyagiwa (1991), we introduce an exogenously determined parameter that represents governments' bias in favour of domestically produced goods: $f_i \in [0,1]$. Specifically, a proportion f_i of government *i*'s purchases is reserved to domestic producers. The remainder of government expenditure is allocated efficiently among suppliers from both countries. A large f_i therefore means a strong home bias. This simple assumption can represent two widely used discriminatory practices: (1) the outright exclusion of foreign bidders from domestic public tenders and (2) a domestic-content requirement imposed on foreign firms.[3] For clarity of exposition we shall say that government *i*'s procurement is "fully liberalised" if $f_i = 0$, "home biased" if $f_i \in (0,1]$, and "wholly home biased" if $f_i = 1$.[4]

Equilibrium in the product market requires the following equations to hold:

$$p_Z (Z_1 + Z_2) = E_{Z1}^P + E_{Z2}^P + E_{Z1}^G + E_{Z2}^G \tag{5}$$

$$p_X x = p_X^{1-s} P_1^{s-1} \left[E_{X1}^P + (1 - f_1) E_{X1}^G\right] + q p_X^{1-s} P_2^{s-1} \left[E_{X2}^P + (1 - f_2) E_{X2}^G\right] + (f_1 / n_1) E_{X1}^G \tag{6}$$

$$p_X x = q p_X^{1-s} P_1^{s-1} \left[E_{X1}^P + (1 - f_1) E_{X1}^G\right] + p_X^{1-s} P_2^{s-1} \left[E_{X2}^P + (1 - f_2) E_{X2}^G\right] + (f_2 / n_2) E_{X2}^G \tag{7}$$

[2] Governments' expenditure shares can be formalised by assuming that governments produce a public good according to a Cobb-Douglas-CES production function with parameter shares g_S, and with elasticity of substitution of the CES aggregate equal to the constant $s \in (1, \infty)$. A constant per capita tax would instead result from Lindahl-type taxation if we assumed that the government produces a public good which enters the utility function in a separable way.

[3] On the practice of this discriminatory behaviour see Hoekman and Mavroidis (1997).

[4] Our assumption that home bias appears only in public expenditure and not in private expenditure is one of pure convenience. In fact, all our results would carry through if we allowed both sources of expenditure to exhibit home bias, as long as the home bias of public-sector purchasers exceeds that of private agents. The relevant analytical results are available from the authors.

where $q \equiv t^{s-1}$. Equations (5)-(7) close the model. Equation (5) equates supply and demand for Z, where demand (r.h.s.) is represented in its four components: country 1's private and public expenditure and country 2's private and public expenditure. Equilibrium in the X sector requires two equations. Equation (6) and (7) represent the equality of demand and supply for any one variety produced in country 1 and 2 respectively. By Walras' law the equilibrium condition for Y is redundant. The system (1)-(7) is composed of 11 independent equations and 12 unknowns (p_X, p_Y, p_Z, x, n_1, n_2, Y_1, Y_2, Z_1, Z_2, w, r). Taking p_Z as the numéraire, the system is perfectly determined.

While all endogenous variables are determined simultaneously, it is useful to inspect the subsystem (4)-(7) for an intuitive understanding of what shapes the pattern of international specialisation. Given prices and firm scale x, equations (6) and (7) determine n_1 and n_2 as functions of private and government expenditure. Then, given n_1 and n_2, the four equations (4a) and (4b) determine the four unknowns Y_1, Y_2, Z_1, Z_2 as functions of factor endowments. This means that, while private and government demand determine international specialisation in the monopolistically competitive sector, factor endowments determine international specialisation in the perfectly competitive sectors. Moreover, we can confirm Baldwin's neutrality proposition by inspection of equation (5), which shows that world private plus government demand determine world output of Z (and Y) but not its international distribution. International specialisation in these sectors is fully determined by factor endowments *via* (4a) and (4b). Home bias in government procurement is therefore inconsequential for international specialisation in the perfectly competitive sectors. This result was derived by Baldwin (1970) in a partial-equilibrium small-country model, and we show that it extends to a two-country general-equilibrium setting.

A final note on the dimensionality of the model is in order. Trade costs segment the market for the differentiated commodity and, therefore, require two equations for that market. A two-by-two model would then have too many equations for factor prices to equalise. In order to restore full dimensionality of the factor price equalisation set we need one more commodity or one less factor of production. While in textbook treatments a two-by-one model with labour as the only factor of production is usually preferred (e.g. Helpman and Krugman, 1985, section 10.4), we have opted for a three-by-two model in order to highlight the role of factor endowments in determining international specialisation in the perfectly competitive sectors.

We now explore the effect of private and government demand on international specialisation. By inspection of the system (1)-(7) it is immediate that $n_1 = n_2$ is an equilibrium when countries are identical, i.e., when $E_{X1}^P = E_{X2}^P$, $E_{X1}^G = E_{X2}^G$, and $f_1 = f_2$. The nonlinearity of the model prevents us from deriving a simple reduced form. However, we can find the relationship we are interested in by differentiating the system (1)-(7) with respect to changes in private and public expenditure at the equilibrium point $n_1 = n_2$. It will be convenient to use the following definitions:

$$h \equiv n_1 / N, \qquad E_{XW} \equiv E_{X1}^P + E_{X2}^P + E_{X1}^G + E_{X2}^G,$$

$$e^P \equiv \frac{E_{X1}^P + E_{X2}^P}{E_{XW}}, \qquad e^G \equiv \frac{E_{X1}^G + E_{X2}^G}{E_{XW}},$$

$$e_i^P \equiv \frac{E_{Xi}^P}{E_{X1}^P + E_{X2}^P}, \qquad e_i^G \equiv \frac{E_{Xi}^G}{E_{X1}^G + E_{X2}^G}.$$

We shock expenditure in such a way that world private and world public expenditure on each commodity remain unchanged, i.e. E_{SW} (S = X,Y,Z), e^G, and e^P are held constant. This implies that relative prices of commodities will remain unchanged, and the effect on specialisation, if any, is therefore due to changes in a country's share of world public and private expenditure e_i^G and e_i^P. Technically, this is achieved when we disturb the equilibrium by $dg_{X1} = -dg_{X2}$, and by $du_{X1} = -du_{X2}$. Differentiation around the equilibrium point, where $n_1 = n_2$, yields the following expression:

$$dh = \underbrace{\frac{\left(1-q^2\right)e^P}{\left(1-q\right)^2 + 4qfe^G}}_{b_1} de_1^P + \underbrace{\frac{\left(1+q\right)\left(1-q+2qf\right)e^G}{\left(1-q\right)^2 + 4qfe^G}}_{b_2} de_1^G . \qquad (8)$$

The first term on the r.h.s. is the effect of private expenditure. For convenience we denote the coefficient of de_1^P by b_1. This term shows that, *ceteris paribus*, large private expenditure on *X* results in large domestic output of *X* (remember that 0 <   < 1). The second term is the effect of government expenditure. For convenience we denote the coefficient of de_1^G by b_2. This term shows that, *ceteris paribus*, large and home-biased government expenditure on *X* results in large domestic output of *X*. The sum $b_1 + b_2$ is a version of the "market size" effect (Helpman and Krugman, 1985, section 10.4). Effectively, we have decomposed the market size effect into a private and a public component. If government procurement is zero ($e^G = 0$) or fully liberalised ($f = 0$), then $b_1 + b_2 = \frac{1+q}{1-q} > 1$, which is the same as in the Helpman-Krugman model. [5]

It is interesting to inspect the relative size of b_1 and b_2, because this gives us the relative size of the impact of private and government demand on international specialisation. The relative size of b_1 and b_2 depends on the relative size of e^G and e^P. However, if we define $b_1 \equiv b_1 / e^P$ and $b_2 \equiv b_2 / e^G$, inspection of equation (8) shows that $b_1 < b_2$ unambiguously. Hence, the impact of home-biased public procurement is larger than the impact of private

[5] In the literature, the market size effect usually results from an expenditure shock that is generated by a change in country size, whereas here it results from a shock to the Cobb-Douglas expenditure share. In the context of this paper the two types of shocks have identical consequences.

demand when both are appropriately weighted by their size. This result may be expressed in the following proposition.

Proposition 1. *The country with relatively large home-biased public expenditure on the differentiated good X will, ceteris paribus, be relatively specialised in the production of X. The size-weighted impact of home-biased public procurement is larger than the size-weighted impact of private expenditure. We refer to this as the "pull" effect.*

In conclusion, we have found that home-biased procurement influences international specialisation in some sectors but not in others, and that its size-weighted impact is larger than the impact of private expenditure. In the empirical section we estimate equation (8) and find that for the sectors where home-biased procurement influences international specialisation the estimated parameters satisfy the inequality $b_1 < b_2$.

2.2. Public expenditure in a dynamic model of international specialisation

In "new economic geography" models, international specialisation is shaped by dynamic processes which result from the tension between agglomeration and dispersion forces. At high trade costs dispersion forces prevail and the industrial activity is evenly distributed across countries (weak international specialisation). At low trade costs agglomeration forces take over, and increasing-returns activity concentrates in a subset of countries (strong international specialisation). In this section we use such a model to study the effect of home-biased government procurement on the likelihood and intensity of industrial agglomeration.

We use a variant of the model in Krugman and Venables (1995). The demand side of the model is the same as in section 2.1 of this paper. The supply side needs some modification. We abstract from factor endowments and assume a single factor of production, labour, and we can thus also restrict the analysis to two sectors. Employment in each sector and country is denoted by L_{Si}, where $S = X,Y$; and $i = 1,2$. Analogously, wages in each sector and country are denoted by w_{Si}. By choice of units we set $w_{Zi} = 1$. As in the previous section, each variety of the differentiated good produced by the X sector is subject to economies of scale represented by a fixed cost and constant marginal costs. The difference is that the fixed and marginal costs are both in terms of a composite input V, which in turn is produced with labour and X itself. The input requirement per x units of output is given by $V = a + bx$. Each firm produces V according to $V = [l/(1-m)]^{1-m}(X/m)^{m}$, where $m \in (0,1)$ represents the importance of the industry's output as its own intermediate input. Given this technology, the expression for total costs is $TC_i = w_{Mi}^{1-m} P_i^{m}(a + bx)$. Finally, we should note that, unlike in the previous section, private expenditure on X now includes firms' demand for intermediate inputs.[6] The expression for private expenditure then becomes $E_{Xi}^{P} = u_{Xi}(1-d_i)I_i + m\, n_i\, p_{Xi}\, x$. The market-clearing equations are the same as in the static model (equations (5)-(7)), provided that we apply the appropriate expressions for E_{Xi}^{P}.

Concerning the dynamics of the model, it is assumed that labour is perfectly mobile between the Y and Z sectors, so that we have $w_{Yi} = w_{Zi} = 1$ ($i = 1,2$) at any time. Labour is only imperfectly mobile between the X sector and the other two sectors and moves slowly into (out of) the X sector as the X wage exceeds (is smaller than) the wage in the Y and Z sectors.[7] This

[6] Since profits are zero, firms' aggregate expenditure on X is m times firms' aggregate revenue.

[7] Alternatively, it could be assumed that labour is perfectly mobile across all sectors and that firms move to the country that yields highest profits. The dynamics resulting from this alternative assumption would be identical to those we work with.

assumption can be formalised with the two differential equations $\dot{L}_{X1} = x(w_{X1} - w_{Z1})$ and $\dot{L}_{X2} = x(w_{X2} - w_{Z2})$, where x is an arbitrary constant.[8] The total number of varieties and world employment in X will remain constant, because world expenditure on manufactures is assumed constant over time. Individual countries' employment in X can, however, change over time. Note that, since world employment is held constant, the two differential equations can be nicely compacted into one. Defining $w \equiv w_{X1} - w_{X2}$, and using the fact that labour market clearing implies that $n_1/(n_1+n_2) = L_{X1}/(L_{X1}+L_{X2})$, we can rewrite the differential equations as:

$$\dot{h} = w(h; t, f_1, f_2, d_1, d_2). \qquad (9)$$

Equation (9) highlights the fact that w depends on the state variable h, on trade costs and on the public procurement parameters. The system is at rest when it reaches an internal solution (incomplete specialisation) or when the X sector is completely agglomerated in one country (complete specialisation). Internal solutions are are characterised by wage equalisation across sectors, i.e., $w_{Zi}=w_{Yi}=w_{Xi}=1$ (i=1,2). Complete agglomeration of X activity in one country is associated with wage inequality, i.e. $w_{X1}>1$ if $h=1$, or $w_{X2}>1$ if $h=0$. Whether dispersion forces or agglomeration forces prevail depends on trade costs and on the parameters of government procurement. It is to this analysis that we turn now.

The economic mechanisms at work can be described in an intuitive way. For the sake of simplicity suppose that, starting from equilibrium, the system is perturbed by a random shock that increases the number of firms in 1 and decreases it in 2. This initial perturbation sets in motion four dynamic forces. Two of these forces reinforce the initial shock, and are therefore

---

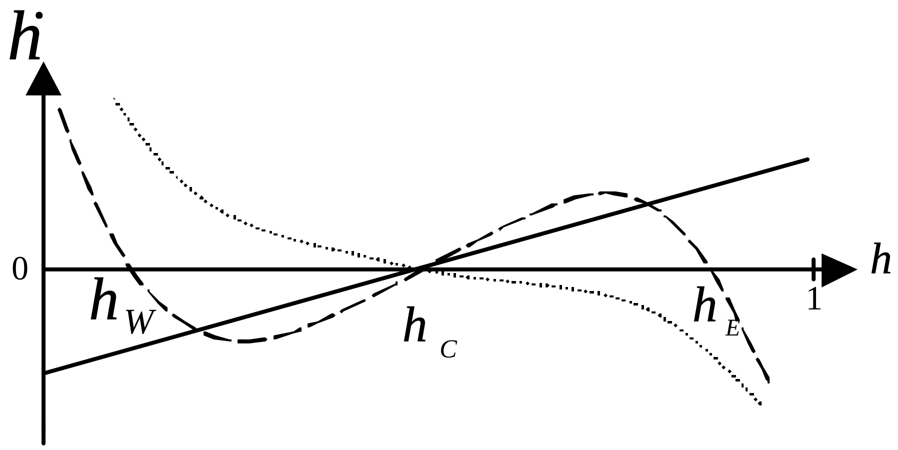
[8] This simplifying practice, which neglects expectations, is widely adopted in the literature and can be corroborated through examination of richer dynamic structures (see, e.g., Ottaviano, 1999).

called “agglomeration forces”. The other two counteract the initial shock and are therefore referred to as “dispersion forces”.

1. The expression for total costs reveals that the reduction of P_1 (and the increase of P_2) caused by the initial increase in n_1 and decrease in n_2 reduces total costs, thereby raising firms’ potential profitability in 1 (and reducing it in 2), and thus favouring further entry of firms in 1 (and pushing firms out of the market in 2). This mechanism, which is known as the *forward linkage*, tends to reinforce the initial disturbance and is, therefore, an agglomeration force.
2. The expression for private expenditure shows that increase in n_1 (a decrease in n_2) increases the expenditure on manufactures produced in 1 *via* an increase in the demand for intermediate inputs. This raises potential profitability in 1 (and reduces it in 2), thereby encouraging new entry if firms in 1 (and exit in 2). This mechanism, known as *backward linkage*, tends to reinforce the initial disturbance and is therefore an agglomeration force.
3. An increase in n_1 shifts the demand faced by each firms from country 1 to the left, and vice-versa in 2. This reduces the potential profitability in 1 and increases it in 2 thus discouraging further entry of firms in 1. This mechanism, known as the *competition effect*, counteracts the initial disturbance and is therefore a dispersion force.
4. Inspection of the r.h.s. of (6) and (7) shows that an increase in n_1 (decrease in n_2) reduces government expenditure on each variety produced in 1 and increases expenditure on each variety produced in 2, thus reducing potential profitability in 1 and increasing it in 2. This, in turn, discourages further entry of firms in 1 (while it encourages entry in 2), and therefore acts as a dispersion force. We refer to this force as the *“spread” effect* of home-biased public expenditure. The impact of this force is weakened as public procurement becomes more liberalised, and it disappears if procurement is fully liberalised.

The relative strength of agglomeration and dispersion forces determines the stability of the initial equilibrium. When trade costs are high enough dispersion forces always prevail, while agglomeration forces may dominate at low trade costs. We can illustrate the effect of home-biased procurement on the stability of the equilibria by use of a phase diagram (Figure 1). This considers only the case where trade costs are sufficiently low, i.e. such that, if procurement were fully liberalised, agglomeration would occur.[9]

FIGURE 1: Public expenditure and specialisation in an economic geography model



There are at most three equilibria in the set (0,1). Let us call the closest one to 0 the "western" equilibrium, the middle one "central" equilibrium, and the one furthest away from 0 the "eastern" equilibrium. These three equilibria are represented in Figure 1 by h_W, h_C, h_E. For simplicity, we assume countries to be identical in every respect, so that $h_C = 1/2$. In the previous section we were interested in the response of the equilibrium to asymmetric

[9] The results illustrated in Figure 1, including the threshold values that define "high" and "low" trade costs, are derived analytically in Trionfetti (2000b).

government demand shocks. Here we are concerned with the number and stability of the equilibria.

Three possibilities emerge.

1. If public procurement is fully liberalised, the central equilibrium is unstable, and the X sector completely agglomerates in country 1 or 2. This case is depicted by the solid line.
2. If public procurement is home biased but $f_i E_{Xi}^G$ is small in both countries, the central equilibrium is unstable but there are two other equilibria with incomplete agglomeration (h_W and h_E), which are stable. Therefore, some but not all of the X sector eventually agglomerates in country 1 or 2. This case is depicted by the dashed line. Furthermore, the distance between h_W and h_E decreases as $f_i E_{Xi}^G$ increases in both countries.
3. If public procurement is home biased and $f_i E_{Xi}^G$ is large in both countries, then the central equilibrium is stable. Therefore, no agglomeration will take place regardless of trade costs. This case is depicted by the dotted line.

The message emerging from these three cases is that home-biased procurement reduces the likelihood and intensity of industrial agglomeration. It does so in two ways. First, it may stabilise the central equilibrium, as is clear from a comparison of case 3 with case 1. Second, even if the central equilibrium becomes unstable, the intensity of agglomeration will relate negatively to the importance of home-biased procurement. This is shown in case 2.

Proposition 2. *Large and home-biased public expenditure in one or both countries reduces the likelihood and intensity of industrial agglomeration. We refer to this proposition as the “spread” effect.*

This is the second result that we can subject to empirical investigation, to which we turn next.

3. EMPIRICAL EVIDENCE

Our theoretical model focuses on the distinction between final expenditure of private agents and final expenditure of the government, assuming that the latter is more home biased than the former. Input-output tables provide the best statistical information for a sector-level empirical quantification of these two expenditure types. Our study is based on a cross-country set of comparable input-output tables which has been compiled by Eurostat and covers up to 11 EU member countries for the period 1970-1985 in five-yearly intervals.[10] These input-output tables distinguish 18 industrial sectors.

Before we analyse the relationship between countries' sectoral specialisation and their relative public and private expenditures, some discussion of the relative home biases in public and private spending is warranted. Our key assumption is that public-sector purchasers are more home biased than private agents. We do not seek to verify this hypothesis here, since evidence in its support has been produced elsewhere. Mastanduno (1991) and Hoekman and Mavroidis (1997) have provided compelling case studies. Trionfetti (2000a) has compared import shares between public and private purchasers in the Eurostat input-output dataset that we use here (confined to 1985), and he found that import propensities were lower for public than for private purchasers in 77 percent of all observations. Similarly, the European Commission (1997) reported that, in 1987, less than two percent of public purchasing of EU countries was awarded to non-national suppliers, compared to shares ranging between 25 and 45 percent for private-sector purchases, and it identified public procurement as one of the principal remaining obstacles to a fully-fledged Single Market. *A fortiori*, discriminatory

[10] Eurostat's input-output tables for more recent years use a less disaggregated sectoral classification for manufacturing industries and are therefore not considered in this paper. A detailed description of the data set is given in the Data Appendix.

public procurement must have been a pervasive phenomenon in EU countries during the 1970-85 period, which we cover in our empirical study.

3.1 The pull effect of public expenditure

The first proposition derived from our model stipulates that, other things equal, relatively large discriminatory government expenditure on the product of an increasing-returns industry will result in relatively large domestic output of that product.

We define industrial specialisation through the following measure (year subscripts implied):

$$OUTdev_{si} \equiv \left(\frac{OUT_{si}}{\sum_i OUT_{si}}\right) - \left(\frac{\sum_i OUT_{si}}{\sum_s \sum_i OUT_{si}}\right), \quad \text{where } OUTdev \in (-1,1), \tag{10}$$

and where OUT stands for output, s again represents industries and i stands for countries. In order to test the sensitivity of our results to the underlying definition of production, we compute the measure $VAdev$, which is based on value added data and constructed in identical fashion to $OUTdev$. The first summand in equation (9) is the exact empirical representation of h in our theoretical model, i.e. a country's share in world output of a certain industry. For the empirics we subtract from this the country's share in total world output as a scaling factor, so as to avoid spurious regression results linking expenditure and production shares solely through differences in country sizes. $OUTdev$ and $VAdev$ are centred symmetrically around zero, which represents the point where a country's share in the world production of an industry corresponds exactly to that country's share in the world's total manufacturing production. Appendix Table 1 reports the sectors of strongest and weakest specialisation according to $VAdev$ for each country.

Analogously, we construct a measure of idiosyncratic government demand (year subscripts implied):

$$DGOVdev_{si} \equiv \left(\frac{DGOV_{si}}{\sum_i DGOV_{si}}\right) - \left(\frac{\sum_s DGOV_{si}}{\sum_s \sum_i DGOV_{si}}\right), \quad \text{where } DGOVdev \in (-1,1). \tag{11}$$

DGOV stands for government expenditure, which we define as the sum of three expenditure headings in the input-output tables: "general public services" (NACE I810), "non-market services of education and research" (NACE I850), and "non-market services of health" (NACE I890). In addition, we compute a measure of idiosyncratic private demand *DPRIVdev* by applying the same formula to the expenditure category "final consumption of households on the economic territory" (NACE F01); and a measure of total idiosyncratic final demand *Ddev*, which is the sum of public and private final demand. The first summand in the expression for *DGOVdev* (*DPRIVdev*) is the exact representation of $\boldsymbol{e}_i^G$ ($\boldsymbol{e}_i^P$) in our theoretical model, while the second term provides the scaling factor needed to eliminate the possibility of contaminating regression estimates with pure country-size effects.

3.1.1. Regressing specialisation on idiosyncratic demand

We can now relate our measure of international specialisation to idiosyncratic government demand. According to our first proposition, a pull effect would manifest itself through a positive relation between these two variables. As a first exercise we have produced bivariate plots for our four sample years, based on specialisation in output (Figure 2) and in value added (Figure 3). A positive relationship between the two variables is apparent, but the correlations look rather weak.[11]

Our second step was to regress specialisation on idiosyncratic demand. These results are reported in Table 1. Due to the scaling of our variables we could force the constant term to zero in all specifications – estimations with an intercept never produced a significant coefficient on the constant. Although our dependent variable is bounded, we proceeded with a linear specification, since we do not want to make out-of-sample predictions and since estimations based on limited dependent variable models produced substantially equivalent results for the relevant data ranges. In Model I of Table 1, we have simply regressed specialisation on *Ddev* in the pooled data. The significant positive coefficients confirm the finding of Davis and Weinstein (1998) that home markets matter for industrial location. Our result is particularly strong since we considered only demand for final products in our definition of "home markets" and could therefore eliminate the possibility of upward bias due to simultaneity between output and demand in the case where demand includes expenditure on intermediate products as well as on final goods.

In Model II of Table 1 we have estimated equation (8) in the pooled dataset by taking account separately of the private and public components of idiosyncratic expenditure. Both coefficients are positive and precisely estimated, but the coefficient on private demand deviations (0.55 for output, 0.39 for value added) is substantially larger than that on public demand deviations (0.08 and 0.09 respectively). These coefficients correspond to b_1 and b_2 of equation (8). Recall from Section 2.1 that in interpreting these coefficients one ought to keep in mind the different sizes of private and public demand of final manufactures. It is through

[11] We find a correlation coefficient of 0.20 between *DGOVdev* and both *OUTdev* and *VAdev*, pooled across sample years (see Appendix Table 2). These correlations are statistically significantly different from zero at the

$b_1 = \boldsymbol{b}_1 / \boldsymbol{e}^P$ and $b_2 = \boldsymbol{b}_2 / \boldsymbol{e}^G$ that the pull effect of a marginal dollar spent by public and private agents can be estimated. Appendix Table 1 shows that on average private demand was roughly ten times the size of government demand. Precisely, the average share of public expenditure in total final expenditure, $\boldsymbol{e}^G$, pooled across years in our dataset is 0.106. Our estimated b_1 is therefore equal to 0.61 in the output specification and to 0.44 in the value added specification, while our estimate of b_2 is 0.73 and 0.87 respectively. These results suggest the presence of a pull effect of public expenditure: an extra dollar spent by government has a stronger effect on attracting production in the relevant sector than an extra dollar spent by private agents. This effect is not statistically significant in the output specifications, but in the value added specifications the 95% confidence intervals of the estimated bs do not overlap.

In a third step, we have estimated the empirical version of equation (8) separately for each sample year (Models III to VI in Table 1). We find evidence of an increasing tendency in the pull effect of government purchases. Over the period of our sample, therefore, the impact of (discriminatory) public expenditure on the location of manufacturing activities seems to have grown.

Finally, we augmented the basic specification with the variable *GOVBIAS*, which is a proxy for the degree of bias in public procurement by industry and country. This variable is taken from Nerb (1987), who, based on a survey of 11,000 European firms in the mid-1980s, reported the percentage of firms who considered the opening of public procurement markets to be “very important”. This variable might be affected not only by the degree of bias of public purchasers in different industries and countries but also by the size of public

99.99 percent confidence level.

procurement. However, the correlation between the two variables turns out to be very small and statistically insignificant in our dataset (see Appendix Table 2). We therefore added that variable, as well as an interaction term with *DGOVdev*, to the baseline specification. The expected positive coefficients are found on our bias variables, and the estimated coefficients on idiosyncratic public and private expenditure are barely affected. This result suggests that the more biased public authorities are in their purchasing activities, the stronger is the pull effect of their expenditure. The data thus appear to support the intuitive prediction of our theoretical model.

3.1.2. Adding endowments and input-output linkages

Our theoretical setup in Section 2 is richer than the empirical specification that we have estimated so far. Specifically, the models incorporate two additional determinants of international specialisation: factor-endowment differences across countries combined with different factor requirements of sectors, and agglomeration forces based on input-output linkages among firms. We therefore extend the original empirical specification that was based on equation (8) by adding various combinations of the following regressors (year subscripts implied):

1. $PRIMARYinter_{si}$ = (Primary inputs used / Output)$_s$ * (Primary inputs produced / Manufacturing output)$_i$
2. $AGRIinter_{si}$ = (Agricultural inputs used / Output)$_s$ * (Agricultural inputs produced / Manufacturing output)$_i$
3. $ENERGYinter_{si}$ = (Energy inputs used / Output)$_s$ * (Energy inputs produced / Manufacturing output)$_i$
4. $CAPITALinter_{si}$ = (Fixed capital consumption / Output)$_s$ * (Capital stock per worker)$_i$
5. $WAGESHAREinter_{si}$ = (Wages / Output)$_s$ * (Wages / GDP)$_i$
6. $MANINPinter_{si}$ = (Manufactured inputs used / Output)$_s$ *

(Manufactured inputs produced / Manufacturing output)$_i$

The first five regressors are interaction variables capturing the factor abundance of countries and the factor intensities of industries, in the spirit of Heckscher-Ohlin theory. The sixth regressor is constructed in order to control for input-output linkages among manufacturing industries, which can give rise to endogenous geographical concentrations (an "industrial base") as described in Section 2.2. Details on the construction of these variables are given in the Data Appendix.

If factor endowments and input-output linkages are important determinants of industrial specialisation among EU countries, then we would expect to find positive and significant coefficients on all of the regressors. Our results for the entire dataset, a representative selection of which we report in Table 2, are largely consistent with those theoretical priors. We have experimented with varying specifications of the estimating equation as well as with estimation techniques that take account of potential year-specific heteroskedasticity.[12] Almost all of the estimated coefficients are positive, and many are statistically significant. The exception is the variable capturing input-output linkages, which seems very sensitive to the chosen specification and gives rise to significant positive as well as negative coefficients. A comparison of the results in Table 2 with those of Table 1 shows that inclusion of the additional regressors adds very little to the explanatory power of the model; R-squares are raised only slightly, and the estimated coefficients on *DGOVdev* and *DPRIVdev* are very stable. It is of course not unexpected that endowment differences explain a small share of observed specialisation differences across the relatively homogeneous countries of Western Europe; nor would it appear surprising that we struggle to pick up robust evidence of

[12] The estimation might be more efficient if one could account for potential correlation of disturbances across years. This cannot be done for the entire dataset, due to the unbalanced nature of the panel, but estimation on the subsample of countries for which we have observations for all four sample years produced substantially equivalent results.

geographical industry clusters based on input linkages, given that such concentrations of manufacturing activity would more likely appear in region-level data than in a country-level dataset.

The main aim of this exercise, however, is not to assess the relative explanatory power of alternative determinants of international specialisation, but to test the robustness of the estimated coefficients on the variables that represent idiosyncrasies in public and private final expenditure. Our estimated relationships turn out to be remarkably unaffected by the inclusion of any combination of additional control variables. The coefficients on *DGOVdev* and on *DPRIVdev* are always statistically significant, and their relative size is never significantly affected. We therefore conclude that demand idiosyncrasies are an important factor shaping the patterns of industrial specialisation among EU countries, and in particular that there is robust evidence of a pull effect from public expenditure.

As a complement to the pooled runs, we have also estimated our model of specialisation separately for each of the 18 industries in our sample. Table 3 reports these results. All variables with names ending on "*abund*" correspond to the country-level endowment abundance terms, i.e. the second multiplicand in each expression that defines the interaction terms given above. We find largely plausible coefficients on our control variables (food sectors are bigger in countries with abundant agricultural inputs, textiles and leather industries are smaller in countries with a large industrial base, etc.). There are a number of industries with statistically significant positive specialisation effects of public expenditure (metal goods, motor vehicles, other transport equipment, rubber and plastic, instrument engineering). On the other hand, there are industries where endowments have significant explanatory powers and expenditure shares do not (chemicals, meat products, timber and furniture, paper and printing). If we took our static model literally, we would attribute the former set of industries to the monopolistically competitive category, whilst the latter industries would be of the perfectly competitive type. However, some caution is warranted in the interpretation of these results. Most strikingly, we find implausibly negative and significant coefficients on the public expenditure variable for two industries, electrical goods and beverages. These counterintuitive results serve as a reminder of the large range of unexplained variation in our specialisation measures, and they are possibly due to correlation of idiosyncrasies in public expenditure with some other unobserved variable that determines specialisation. This caveat notwithstanding, the industry-by-industry regressions broadly support the earlier finding that demand deviations have significant pull effects on sectoral specialisation among EU countries.

3.2. The spread effect of public expenditure

According to our second theoretical proposition, the share of (discriminatory) public expenditure in an increasing-returns sector will relate negatively to the degree of specialisation of that sector across countries. This spread effect of government demand is not immediately evident in our dataset. Figure 4 plots industry averages of absolute specialisation measures (|*OUTdev*|) on the industry share of public expenditure scaled to domestic absorption. For each of the four sample years, we find a tight cluster of observations near the origin and a single outlier far to the northeast. Fitting a linear regression line to these data yields a statistically significant positive slope coefficient (Table 4, Model I). As such, the result is diametrically opposed to our theoretical proposition that government expenditure attenuates specialisation pressures.

It is worth taking a closer look at the data. Figure 4 shows that the single outlier in all years relates to the "other transport equipment" sector (NACE 290). If we drop this observation from the dataset, we find the expected negative impact of public expenditure on specialisation in output terms (Figure 5) and in value added terms (Figure 6). These negative relationships are confirmed by fitting a linear model to the censored dataset (Table 4, Model II). Hence, our data set as a whole appears to reject the spread effect, yet the elimination of a single industry overturns this result in favour of our proposition.

Is it justifiable to drop NACE 290 from the dataset for the purpose of this exercise? In principle, since it is the sector that exhibits by far the largest share of public-sector demand (see Figure 4), NACE 290 might provide our most reliable observation. On the other hand, there are good reasons to believe that the allocation of production in many subsectors of this industry are not primarily driven by market forces. Around two thirds of output values in NACE 290 are accounted for by aircraft production. Inspection of the raw data reveals that in all sample years the most specialised countries (in terms of both *OUTdev* and *VAdev*) were the UK and France, while Italy and Germany are consistently situated at the bottom of the specialisation scale. This pattern bears a remarkable resemblance with the distribution of defence production across EU countries, which is largely shaped by the constraints imposed on Germany and Italy after the second world war rather than by market forces. A case can thus be made for considering the high absolute specialisation index for NACE 290 as the outcome of determinants that are outside our modelling framework. Based on this argument, we proceeded to work with a censored dataset, excluding NACE 290.[13]

[13] Four-digit data, taken from the OECD's Comtap database, show that in 1985 production of aircraft accounted for 67 (66) percent of output in the "other transport equipment" industry in the UK (France), while the corresponding shares for Germany and Italy were considerably lower at 44 and 25 percent respectively. This

We estimated a linear relationship between the share of government expenditure in domestic absorption on the intensity of specialisation, allowing for year-specific fixed effects (Table 4, Model II). The negative and significant coefficient estimates provide support for the spread effect. To test the sensitivity of the result to the scaling of the regressors, we estimated the model on the share of public expenditure in total final expenditure (instead of absorption), and found the result substantially unchanged (Table 4, Model III). Finally, we ran the regression separately for each sample year and obtained consistently negative parameter estimates (Table 4, Models IV-VII). The year-by-year coefficients are statistically significant only in one of eight cases, but, given the small sample size at the year level and the stability of the estimated coefficients, our finding seems quite robust.

It may be argued that our test of the spread effect could be biased due to unobserved determinants of the intensity of industrial specialisation that are statistically correlated with public expenditure shares. This is a valid concern, but we face two problems in trying to address it. First, theory does not serve as a useful guide to the specification of control variables in such an exercise. While trade and geography models are useful in predicting where certain types of industries will concentrate, they do not provide us with priors on what features make certain industries more or less concentrated across countries. Second, the conventional empirical method to address such uncertainty in a context like ours is to introduce dummy variables for unknown panel-specific effects; but we are seriously constrained in such an exercise by a lack of degrees of freedom.[14] Our empirical verdict in favour of the spread effect must therefore remain a qualified one until such a time when we

suggests that specialisation patterns in NACE 290 are shaped by the location of aircraft production, which is highly politicised at the supra-national level.

can draw on some formal priors about what other factors may influence the overall degree to which different industries are spread or concentrated across countries.

4. CONCLUSIONS

We have investigated the consequences of discriminatory public expenditure on the pattern of international specialisation. First, we studied this issue theoretically in models with both perfectly competitive and monopolistically competitive sectors. While our analysis confirms that the impact of home-biased procurement is neutral with respect to international specialisation in perfectly competitive sectors, we have identified two effects of home-biased public expenditure that appear in monopolistically competitive sectors. First, we demonstrated the possibility of a "pull" effect of discriminatory public expenditure: home-biased government expenditure on a certain good will tend to attract production of that good to the country. Second, we identified a "spread" effect: home-biased public expenditure by all countries reduces the likelihood and intensity of agglomeration of increasing-returns industries in a subset of countries.

The existence of pull and spread effects was then explored empirically in an input-output dataset for the EU, covering the period 1970-85. We found evidence in support of both effects. On average, a country with large government procurement on a good will tend to specialise in the production of that good. We also found evidence that the effect of government demand on international specialisation is stronger than the effect of private demand. Further, we have found some evidence of the spread effect. Industries that are

[14] Estimation of the model with industry as well as year fixed effects in the censored dataset produced consistently negative coefficients on public expenditure shares, but statistical significance was never found.

subject to a relatively large share of public expenditure tend to be less concentrated across EU countries.

Our study is purely positive in nature. We find that public expenditure matters for international specialisation and can counteract agglomeration. This raises the important question of the associated welfare effects, which we leave for future research.

These results are available from the authors on request.

BIBLIOGRAPHY

Baldwin, Robert E. (1970) *Nontariff Distortions of International Trade*. Brookings Institution, Washington, DC.

Baldwin, Robert. E. (1984) "Trade Policies in Developed Countries". In: R. Jones and P. Kenen (eds.) *Handbook of International Economics*. Amsterdam, North Holland.

Beck, Nathaniel and Katz, Jonathan N. (1995) "What To Do (And Not To Do) With Time-Series Cross-Section Data". *American Political Science Review*, vol. 89, pp. 634- 647.

Branco, Fernando (1994) "Favoring Domestic Firms in Procurement Contracts". *Journal of International Economics*, vol. 37, pp. 65-80.

Davis, Donald R. and Weinstein, David E. (1998) "Market Access, Economic Geography and Comparative Advantage: An Empirical Assessment". *NBER Working Paper*, No. 6787.

Emerson, Michael; Aujean, Michel; Catinat, Michel; Goybet, Philippe and Jacquemin, Alexis (1988) *The Economics of 1992: The E.C. Commission's Assessment of the Economic Effects of Completing the Internal Market*. Oxford University Press.

European Commission (1997) *Single Market Review: Public Procurement*. Kogan Page, London.

Helpman, Elhanan and Krugman, Paul (1985) *Market Structure and Foreign Trade*. Cambridge (Mass.), MIT Press.

Hoekman, Bernard M. and Mavroidis, Petros C. (eds.) (1997) *Law and Policy in Public Purchasing: The WTO Agreement on Government Procurement*. University of Michigan Press, Ann Arbor (MI).

Krugman, Paul and Venables, Anthony J. (1995) "Globalization and the Inequality of Nations". *Quarterly Journal of Economics*, vol. 110, pp. 857-880.

Laffont, Jean-Jacques and Tirole, J. (1993) *A Theory of Incentives in Procurement and Regulation*. MIT Press, Cambridge, MA.

Mastanduno, Michael (1991) "Do Relative Gains Matter? America's Response to Japanese Industrial Policy". *International Security*, vol. 16, pp. 73-113.

McAfee, R. Preston and McMillan, John (1989) "Government Procurement and International Trade". *Journal of International Economics*, vol. 26, pp. 291-308.

Miyagiwa, Kaz (1991) "Oligopoly and Discriminatory Government Procurement Policy". *American Economic Review*, vol. 81, pp. 1321-1328.

Nerb, Gernot (1987) "The Completion of the Internal Market: A Survey of European Industry's Perception of the Likely Effects". *Research on the Costs of Non-Europe: Basic Findings*, European Commission, Brussels.

Ottaviano, Gianmarco I.P. (1999) "Integration, Geography and the Burden of History". *Regional Science and Urban Economics*, vol. 29, pp. 245-56.

Trionfetti, Federico (2000a) "Discriminatory Public Procurement and International Trade". *World Economy*, vol. 23, pp. 57-76.

Trionfetti, Federico (2000b) "Government Procurement, Economic Integration, and Income Inequality". *Review of International Economics*, forthcoming.

Vagstad, Steinar (1995) "Promoting Fair Competition in Public Procurement". *Journal of Public Economics*, vol. 58, pp. 283-307.

DATA APPENDIX

Our input-output data are taken from the Eurostat "National Accounts ESA" series. We have data for 18 NACE two-digit manufacturing sectors, up to 11 EU countries and four sample years (1970, 1975, 1980 and 1985). The country coverage in each sample year can be gleaned from Appendix Table 1. We did not use more recent data, since the available level of sectoral disaggregation in data after 1985 is significantly lower. The data for 1970 and 1975 were converted into deutschmarks at current exchange rates, and those for 1980 and 1985 were converted into current ECUs. The sample contains up to 630 country-industry-year observations.

Most of the interaction terms used in the model underlying Tables 2 and 3 are based on variables taken from the input-output database:

- *PRIMARYinter*: "Primary inputs used" is defined as the value of goods from NACE industries I010-I150 (agricultural and mineral products, power) that are used as intermediate inputs in the 18 manufacturing sectors in the home country. "Primary inputs produced" is the total value of output of NACE industries I010-I150 that is produced in the home country and used as an input in one of the manufacturing industries.
- *AGRIinter*: "Agricultural inputs used" and "produced" are defined equivalently, but restricted to NACE industry I010 (agriculture, forestry and fishing).
- *ENERGYinter*: "Energy inputs used" and "produced" are defined equivalently, but restricted to NACE industries I020-I150 (power and mineral products).
- *WAGESHAREinter*: This is based on the heading "gross wages and salaries" in the input-output tables (NACE F010). Coverage of this variable over countries and years is incomplete.
- *MANINPinter*: "Manufactured inputs used" is defined as the value of goods from the 18 NACE industries I270-I510 (manufacturing) that are used as inputs for production in those sectors in the home country. "Manufacturing inputs produced" is the total output of NACE industries I270-I510 that is produced in the home country and used as an input in one of those industries.

For the construction of *CAPITALinter* we used data on "fixed capital consumption" in the input-output table (NACE F080), and values for "capital stock per worker" are taken from the Penn World Tables. Coverage of this variable over countries and years is incomplete.

TABLE 1: Demand Deviations and Specialisation in Production: Pooled Runs

Model	Regressand: / Regressors:	***OUTdev*** OLS/beta coeff. (t stat)	R^2 No.obs	***VAdev*** OLS/beta coeff. (t stat)	R^2 No.obs
I	***Ddev***	0.60 / *0.61* (10.41)***	0.37 627	0.47 / *0.42* (7.13)***	0.18 627
II	***DPRIVdev***	0.55 / *0.53* (11.22)***		0.39 / *0.33* (6.59)***	
	DGOVdev	0.08 / *0.16* (2.94)***	0.32 627	0.09 / *0.17* (2.75)***	0.15 627
III	1970: ***DPRIVdev***	0.59 / *0.63* (7.03)***		0.33 / *0.33* (2.69)***	
	DGOVdev	0.05 / *0.12* (1.13)	0.40 162	0.06 / *0.14* (1.01)	0.12 162
IV	1975: ***DPRIVdev***	0.51 / *0.52* (5.77)***		0.34 / *0.32* (3.27)***	
	DGOVdev	0.05 / *0.11* (0.83)	0.30 162	0.01 / *0.01* (0.07)	0.10 162
V	1980: ***DPRIVdev***	0.46 / *0.45* (4.96)***		0.37 / *0.33* (3.55)***	
	DGOVdev	0.08 / *0.14* (1.45)	0.25 159	0.09 / *0.14* (1.08)	0.15 159
VI	1985: ***DPRIVdev***	0.64 / *0.50* (5.04)***		0.54 / *0.36* (3.47)***	
	DGOVdev	0.13 / *0.26* (2.77)***	0.35 144	0.19 / *0.31* (3.55)***	0.26 144
VII	***DPRIVdev***	0.51 / *0.48* (10.14)***		0.40 / *0.35* (6.88)***	
	DGOVdev	0.09 / *0.18* (3.28)***		0.10 / *0.19* (2.84)***	
	GOVBIAS	0.38 / *0.02* (0.63)		0.22 / *0.09* (2.35)**	
	DGOVdev*GOVBIAS	3.59 / *0.17* (3.86)***	0.32 560	1.83 / *0.08* (1.17)	0.18 560

Notes: See text for definition of variables and data. t statistics are White-adjusted. ***/**/*: statistically significant at 1/5/10% level.

TABLE 2: Demand Deviations, Supply-Side Locational Determinants and Specialisation in Production: Pooled Runs

Model:	**I**		**II**		**III**		**IV**		**V**	
Estimation method:	*OLS* [1]		*OLS* [1]		*OLS* [1]		*OLS with panel-corrected standard errors* [2]		*Feasible GLS (panel heteroskedasticity)* [3]	
Regressand:	***OUTdev***	***VAdev***	***OUTdev***	***VAdev***	***OUTdev***	***VAdev***	***OUTdev***	***VAdev***	***OUTdev***	***VAdev***
Regressors:										
DGOVdev	0.08 (2.86)***	0.09 (2.72)***	0.08 (2.86)***	0.09 (2.72)***	0.08 (2.56)***	0.13 (3.76)***	0.08 (4.56)***	0.13 (6.46)***	0.07 (4.17)***	0.11 (6.16)***
DPRIVdev	0.54 (11.38)***	0.38 (6.60)***	0.54 (11.52)***	0.38 (6.65)***	0.56 (9.26)***	0.42 (3.76)***	0.56 (14.88)***	0.42 (9.67)***	0.55 (15.15)***	0.39 (9.81)***
PRIMARYinter	1.68 (3.88)***	1.37 (2.43)**								
AGRIinter			2.91 (7.29)***	2.22 (3.73)***	2.72 (7.57)***	2.15 (4.21)***	2.72 (5.60)***	2.15 (3.92)***	2.65 (5.60)***	2.01 (3.85)***
ENERGYinter			0.12 (0.17)	0.37 (0.38)						
CAPITALinter	1.47 (1.67)*	1.23 (1.06)	0.64 (0.73)	0.58 (0.48)						
WAGESHAREinter					1.49 (2.24)***	2.39 (2.55)***	1.49 (2.86)***	2.39 (4.11)***	1.56 (3.05)***	2.48 (4.43)***
MANINPinter	0.26 (0.73)	1.50 (2.27)**	-0.04 (-0.11)	1.28 (1.89)*	-0.43 (-1.34)	-0.73 (-1.84)*	-0.43 (-0.99)	-0.73 (-1.50)	-0.39 (-0.92)	-0.62 (-1.33)
Adjusted R^2	0.33	0.17	0.36	0.18	0.37	0.27	n.a.	n.a.	n.a.	n.a.
No. Obs.	627	627	627	627	555	555	555	555	555	555

***/**/*: statistically significant at 1/5/10% level.

[1] White-adjusted *t* statistics in brackets.
[2] Years defined as panels. Beck and Katz (1995) adjusted *z* statistics in brackets.
[3] Years defined as panels. Observations are assumed to be heteroskedastic across panels, but uncorrelated across panels and non-autocorrelated within panels. *z* statistics in brackets.

TABLE 3: Demand Deviations, Supply-Side Locational Determinants and Specialisation in Production: Industry Runs
(dependent variable = *VAdev*, 35 observations)

Regressors: / *NACE code: Industry*	***DPRIVdev***		***DGOVdev***		***GOVBIAS***		***GOVBIAS* DGOVdev***		***AGRIabund***		***ENERGYabund***		***CAPITALabund***		***MANINPabund***	
	OLS coeff.	*Beta coeff.*	*OLS coeff.*	*Beta coeff.*	*OLS coeff.*	*Beta coeff.*	*OLS coeff.*	*Beta coeff.*	*OLS coeff.*	*Beta coeff.*	*OLS coeff.*	*Beta coeff.*	*OLS coeff.*	*Beta coeff.*	*OLS coeff.*	*Beta coeff.*
1170: Chemicals	-0.08	*0.27*	-0.01	*-0.06*	0.16	*0.25*	4.59	*0.45*	0.24	*0.28*	-0.06	*-0.07*	0.31	*0.33*	0.001	*0.002*
1190: Metal goods	0.09	*0.14*	0.14	*0.49*	0.13	*0.10*	0.38	*0.02*	-0.21	*-0.15*	-0.30	*-0.19*	0.26	*0.17*	-0.04	*-0.08*
1210: Machinery	0.22	*0.53*	-0.06	*-0.14*	-0.07	*-0.02*	8.76	*0.22*	-0.69	*-0.31*	0.23	*0.10*	-0.40	*-0.16*	0.21	*0.23*
1230: Office machines	0.70	*0.98*	0.02	*0.03*	-0.04	*-0.02*	-2.37	*-0.15*	-0.44	*-0.16*	0.08	*0.03*	-0.35	*-0.11*	0.05	*0.04*
1250: Electrical goods	-0.13	*-0.12*	-0.11	*-0.31*	0.10	*0.07*	0.80	*0.05*	0.41	*0.22*	0.47	*0.23*	-0.10	*-0.05*	0.60	*0.80*
1270: Motor vehicles	0.10	*0.05*	0.46	*0.88*	-0.11	*-0.04*	-1.18	*-0.04*	-0.69	*-0.22*	0.60	*0.19*	-0.86	*-0.25*	0.14	*0.11*
1290: Other transp. eq.	0.14	*0.11*	0.49	*0.69*	-0.06	*-0.01*	3.92	*0.17*	0.69	*0.14*	0.24	*0.05*	-0.15	*-0.03*	-0.13	*-0.07*
1310: Meat products	0.11	*0.10*	0.06	*0.09*	0.19	*0.12*	0.66	*0.02*	1.33	*0.66*	-0.41	*-0.20*	1.36	*0.68*	0.09	*0.12*
1330: Dairy products	1.76	*0.74*	0.08	*0.05*	0.76	*0.21*	1.71	*0.03*	1.40	*0.30*	0.54	*0.12*	0.18	*0.04*	0.18	*0.09*
1350: Other food	0.91	*0.23*	0.22	*0.33*	0.68	*0.37*	2.24	*0.08*	1.14	*0.48*	0.32	*0.14*	-0.004	*-0.002*	-0.22	*-0.23*
1370: Beverages	-0.02	*-0.05*	-0.22	*-0.75*	-0.02	*-0.01*	3.26	*0.25*	0.61	*0.32*	-0.10	*-0.05*	0.50	*0.26*	0.11	*0.14*
1390: Tobacco products	-0.04	*-0.02*	0.11	*0.21*	-0.31	*-0.07*	-3.42	*-0.17*	-1.64	*-0.28*	0.19	*0.03*	-1.18	*-0.20*	-1.23	*-0.52*
1410: Textiles, clothing	2.28	*0.72*	-0.19	*-0.23*	0.25	*0.07*	8.43	*0.10*	-0.27	*-0.08*	-0.62	*-0.16*	0.10	*0.03*	-0.89	*-0.63*
1430: Leather, footwear	3.29	*0.76*	0.002	*0.002*	0.15	*0.03*	1.23	*0.03*	-0.07	*-0.01*	-0.82	*-0.14*	0.54	*0.09*	-0.88	*-0.42*
1450: Timber, furniture	0.57	*0.48*	-0.12	*-0.7*	-0.30	*-0.14*	-5.03	*-0.31*	-0.68	*-0.27*	-0.70	*-0.26*	0.12	*0.04*	-0.57	*-0.57*
1470: Pulp, paper, printing	0.11	*0.12*	-0.16	*-0.35*	-0.03	*-0.02*	4.75	*0.21*	0.48	*0.31*	0.52	*0.30*	-0.59	*-0.34*	0.25	*0.39*
1490: Rubber, plastic	0.05	*0.11*	0.11	*0.84*	-0.04	*-0.04*	-0.79	*-0.13*	-0.45	*-0.47*	0.08	*0.08*	-0.22	*-0.21*	-0.11	*-0.29*
1510: Instrum. engineering and other manuf.	0.46	*0.31*	0.38	*0.08*	0.04	*0.02*	0.37	*0.01*	0.27	*0.07*	0.21	*0.05*	-0.37	*-0.09*	-0.04	*-0.03*

Dark shading: statistical significance at 1% level, light shading: statistical significance at 5% level.

TABLE 4: The Spread Effect: Public Expenditure and the Intensity of Specialisation
(Intercept coefficients not reported)

		Regressand:	***Mean |OUTdev|***		***Mean |VAdev|***	
Model	*Notes*	*Regressors:*	*OLS/beta coeff.* *(t stat)*	R^2 *No.obs*	*OLS/beta coeff.* *(t stat)*	R^2 *No.obs*
I	• All industries • Year fixed effects	***DGOV/Absorption***	0.06 / *0.23* (2.74)***	0.09 72	0.03 / *0.11* (1.09)	0.10 72
II	• NACE 290 dropped • Year fixed effects	***DGOV/Absorption***	-0.17 / *-0.26* (-1.68) *	0.11 68	-0.23 / *-0.29* (-2.05) ***	0.19 68
III	• NACE 290 dropped • Year fixed effects	***DGOV/Total final expenditure***	-0.02 / *-0.32* (-2.71) ***	0.14 68	-0.03 / *-0.34* (-2.96) ***	0.22 68
IV	• 1970 • NACE 290 dropped	***DGOV/Absorption***	-0.02 / *-0.34* (-1.25)	0.12 17	-0.01 / *-0.22* (-0.85)	0.05 17
V	• 1975 • NACE 290 dropped	***DGOV/Absorption***	-0.02 / *-0.28* (-1.26)	0.08 17	-0.03 / *-0.34* (-1.47)	0.12 17
VI	• 1980 • NACE 290 dropped	***DGOV/Absorption***	-0.02 / *-0.29* (-1.28)	0.08 17	-0.03 / *-0.37* (-1.63)	0.14 17
VII	• 1985 • NACE 290 dropped	***DGOV/Absorption***	-0.04 / *-0.38* (-1.49)	0.14 17	-0.05 / *-0.45* (-1.79) *	0.20 17

***/**/*: statistically significant at 1/5/10% level.

FIGURE 2: The Pull Effect: Public Expenditure and Industry Specialisation in Output Terms

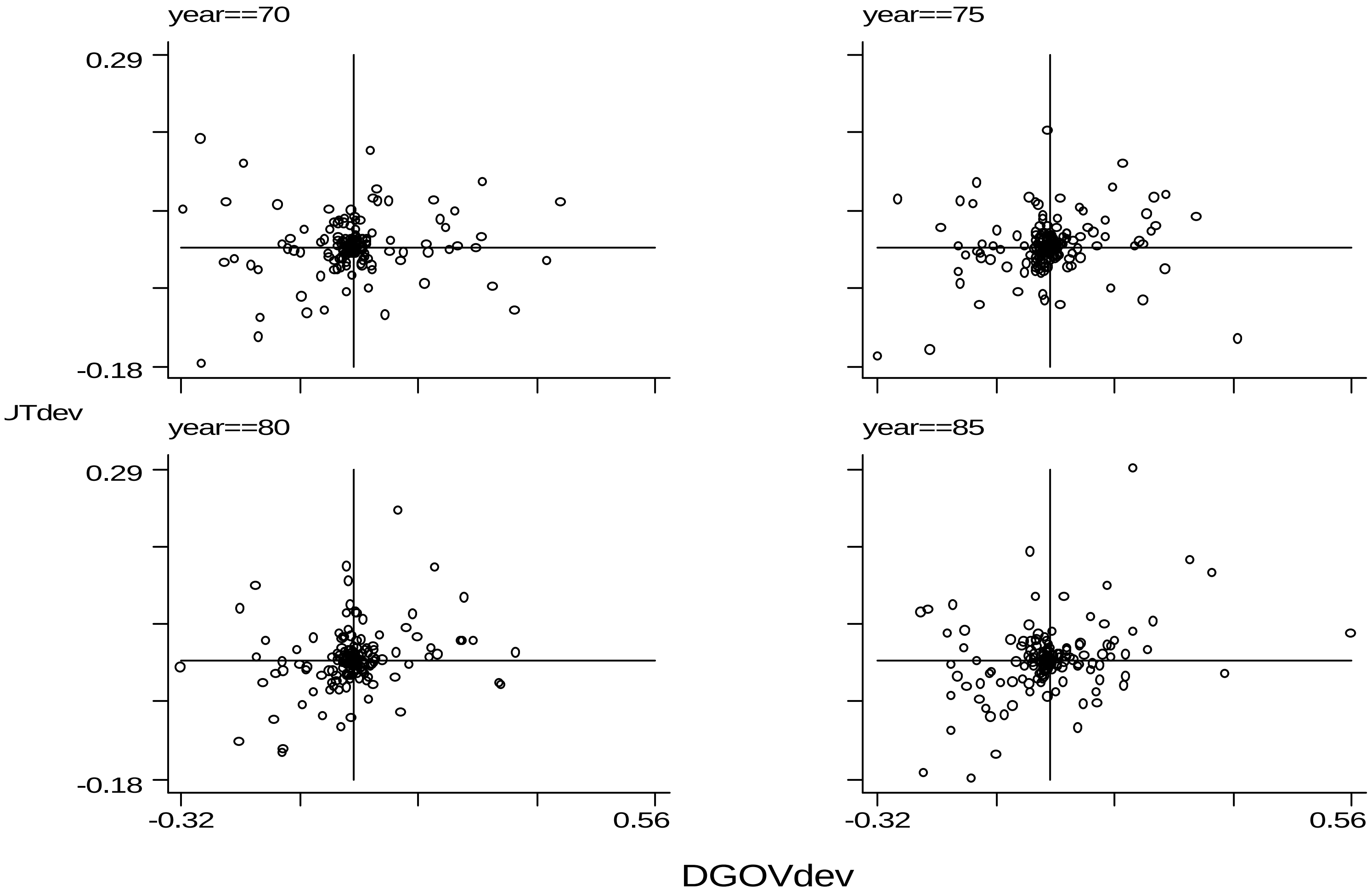


FIGURE 3: The Pull Effect Public Expenditure and Industry Specialisation in Value Added Terms

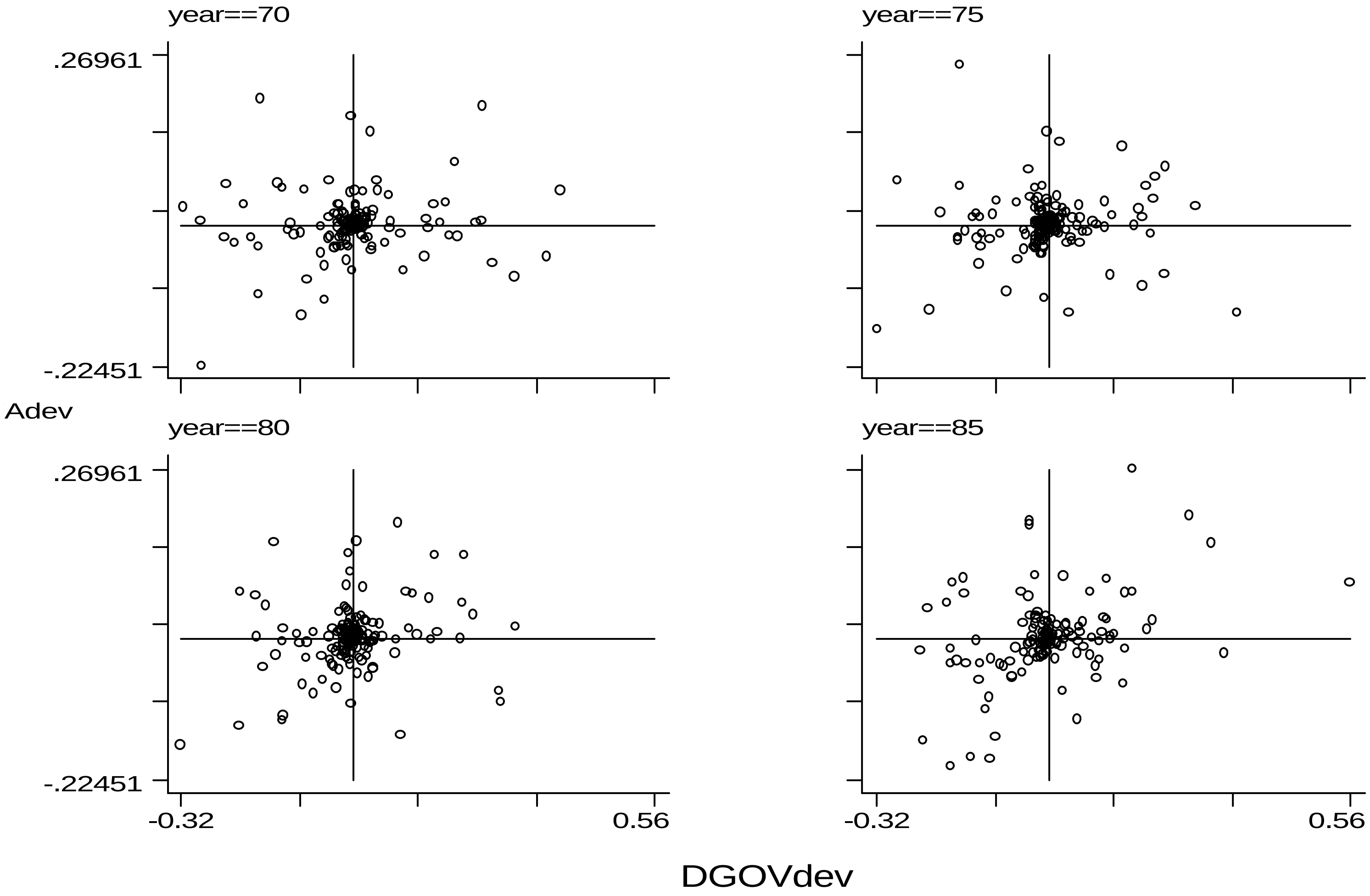


FIGURE 4: The Spread Effect: Public Expenditure and Industry Specialisation in Output Terms: All Industries

(NACE codes; public expenditure in mn DM (1970/75) and in mn ECU (1980/85))

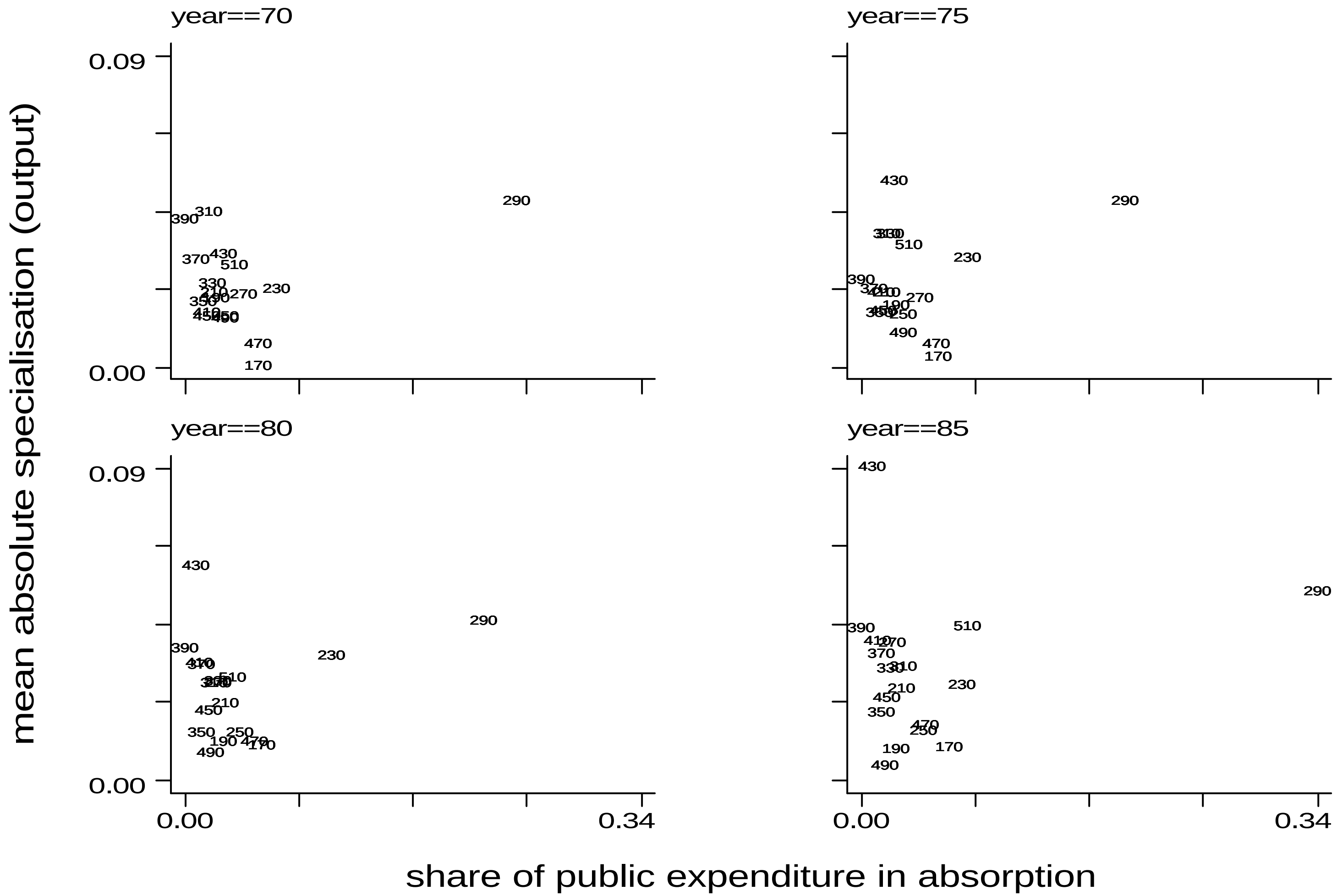


FIGURE 5: The Spread Effect: Public Expenditure and Industry Specialisation in Output Terms: NACE 290 Dropped

(NACE codes)

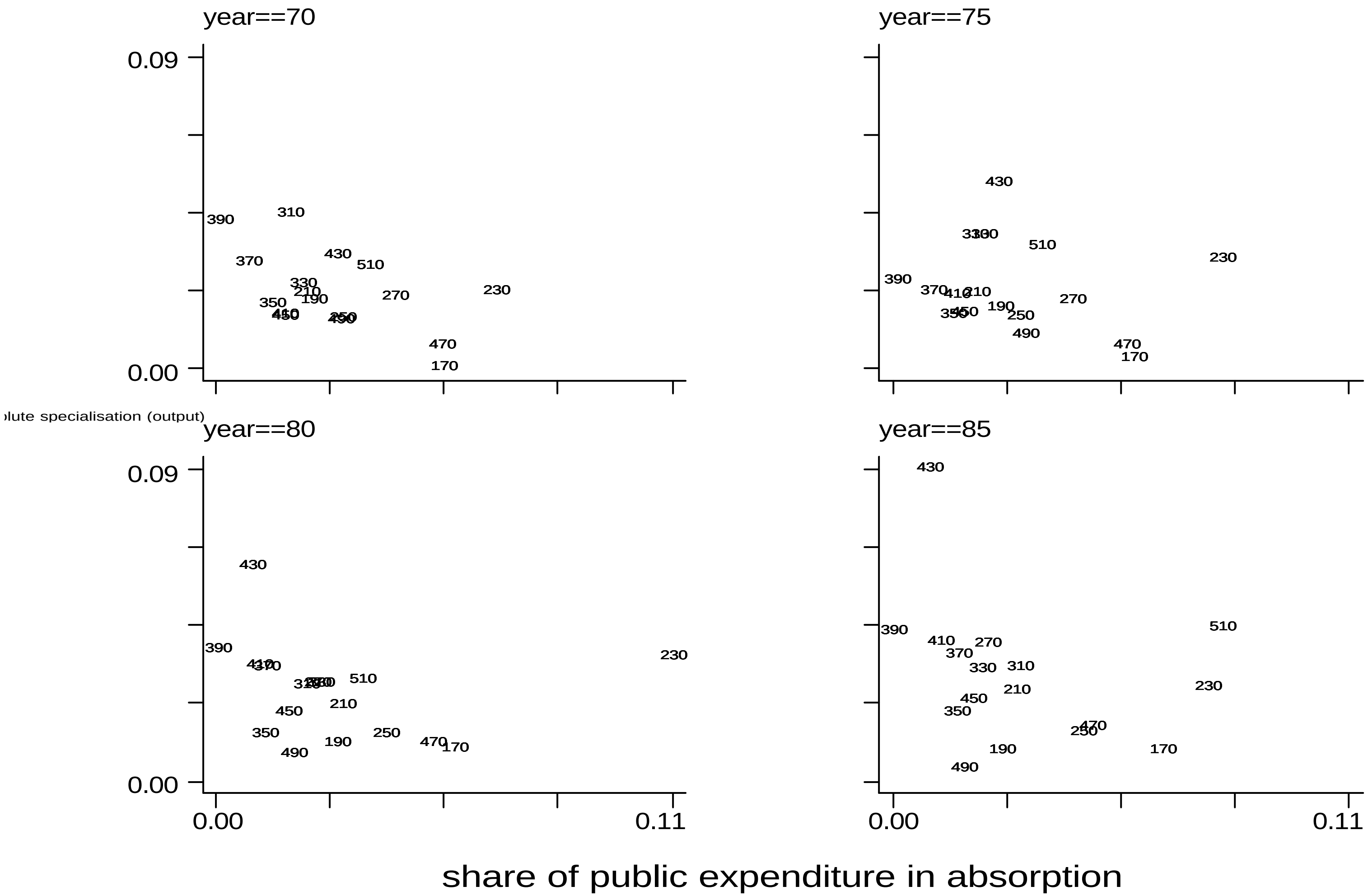
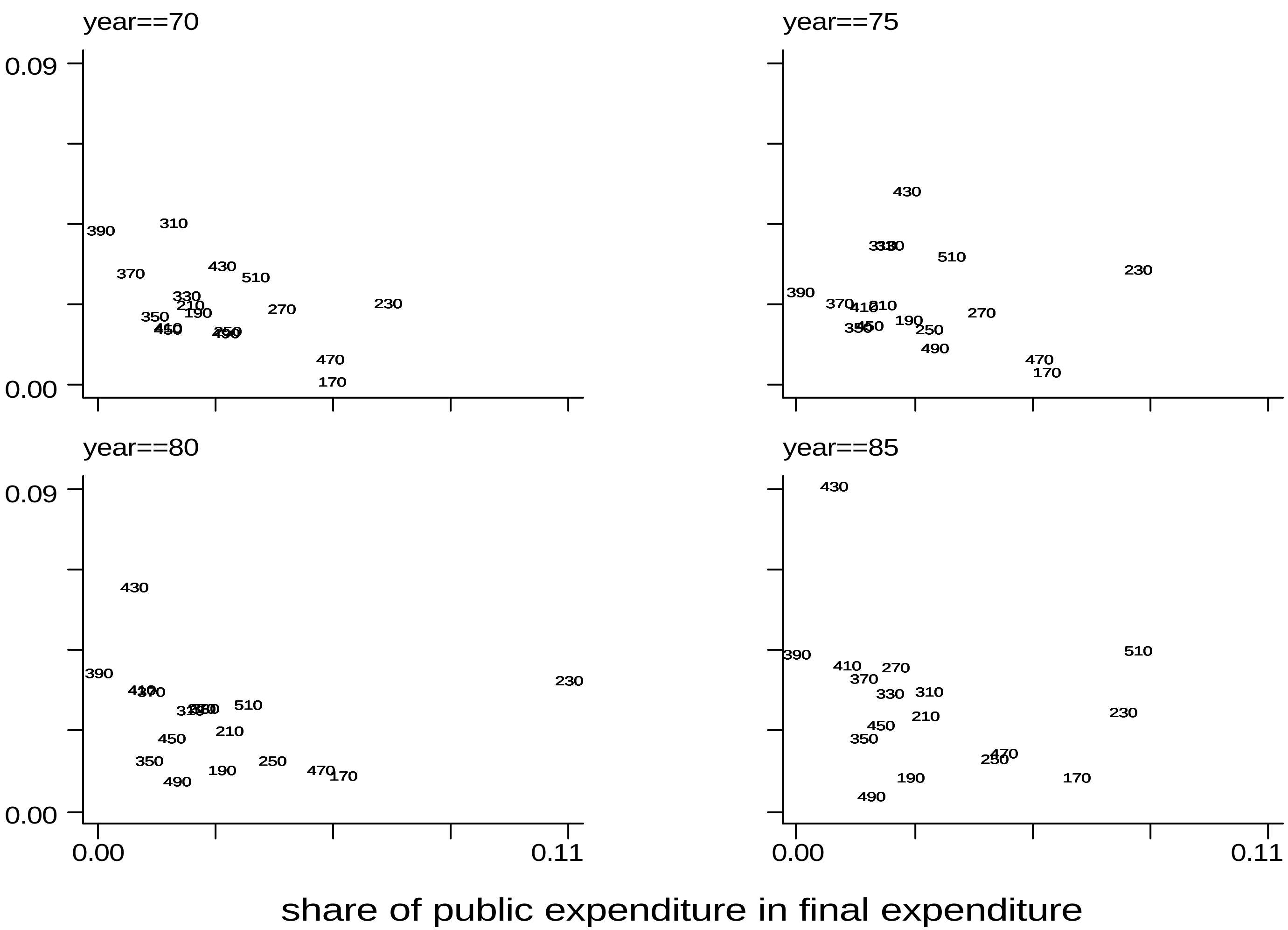


FIGURE 6: The Spread Effect: Public Expenditure and Industry Specialisation in Value Added Terms: NACE 290 Dropped

(NACE codes)



APPENDIX TABLE 1: Descriptive Statistics

Country	Year	Share of private final demand in manufacturing output	Share of public final demand in manufacturing output	Sector of strongest specialisation[1]	Sector of weakest specialisation[1]
Belgium	**70**	0.349	0.020	Instrument engineering & other manuf.	Machinery
	75	0.338	0.019		
	80	0.344	0.021		
West Germany	**70**	0.273	0.040	Motor vehicles	Tobacco products
	75	0.274	0.046		
	80	0.273	0.041		
	85	0.252	0.041		
Denmark	**70**	0.385	0.041	Meat products	Motor vehicles
	75	0.356	0.044		
	80	0.324	0.047		
	85	0.321	0.040		
Spain	**75**	0.425	0.013	Leather, footwear	Machinery
	80	0.378	0.024		
	85	0.370	0.030		
France	**70**	0.330	0.029	Other transport equipment	Tobacco products
	75	0.334	0.030		
	80	0.328	0.028		
	85	0.325	0.040		
Italy	**70**	0.379	0.013	Leather, footwear	Tobacco products
	75	0.344	0.019		
	80	0.314	0.017		
	85	0.300	0.024		
Netherlands	**70**	0.354	0.023	Tobacco products	Office machines
	75	0.337	0.018		
	80	0.325	0.025		
	85	0.271	0.029		
Portugal	**80**	0.331	0.016	Textiles, clothing	Machinery
U.K.	**70**	0.347	0.050	Tobacco products	Leather, footwear
	75	0.289	0.049		
	80	0.275	0.066		
	85	0.284	0.076		
Ireland	**70**	0.552	0.011	Office machines	Motor vehicles
	75	0.464	0.019		
	85	0.363	0.019		
Luxemburg	**70**	0.616	0.013	Rubber, plastic	Office machines
Sample Average	**70**	0.398	0.027	(n.a.)	(n.a.)
	75	0.351	0.029		
	80	0.321	0.032		
	85	0.311	0.037		

[1] calculated on the basis of value added data (*VAdev*) in most recent available sample year.

APPENDIX TABLE 2: Correlations

	VAdev	*Ddev*	*DGOVdev*	*DPRIVdev*	*DBIAS*	*PRIMARYinter*	*AGRIinter*	*ENERGYinter*	*CAPITALinter*	*WAGESHAREinter*	*MANINPinter*
OUTdev	0.77*	0.61*	0.20*	0.54*	0.05	0.13*	0.21*	0.02	0.12*	0.24*	0.05
MANINPinter	0.12*	0.04	-0.01	0.02	0.06	0.07	0.18*	0.01	0.13*	0.10	
WAGESHAREinter	0.24*	0.17*	-0.04	0.17*	0.09	0.29*	0.33*	-0.07	0.19*		
CAPITALinter	0.10	0.12*	0.09	0.08	0.03	-0.002	0.18*	0.15*			
ENERGYinter	0.02	0.01	0.01	-0.003	0.13*	-0.05	0.08				
AGRIinter	0.16*	0.05	-0.003	0.01	0.02	0.65*					
PRIMARYinter	0.10	0.02	-0.02	0.02	-0.05						
GOVBIAS	0.09	-0.04	0.08								
DPRIVdev	0.35*	0.75*	0.09								
DGOVdev	0.20*	0.40*									
Ddev	0.42*										

* : statistically significant at the 1% level.