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## Public expenditure and international specialisation

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# Public Expenditure and International Specialisation

**Marius Brühlhart**  
**Federico Trionfetti**

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# Public Expenditure and International Specialisation

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# CONTENTS

<b>1</b>	<b>INTRODUCTION</b>	7
<b>2</b>	<b>THEORY</b>	9
2.1	Public expenditure in a static model of international specialisation	10
2.2	Public expenditure in a dynamic model of international specialisation	15
<b>3</b>	<b>EMPIRICAL EVIDENCE</b>	19
3.1	The pull effect of public expenditure	20
3.1.1	Regressing specialisation on idiosyncratic demand	21
3.1.2	Adding endowments and input-output linkages	23
3.2	The spread effect of public expenditure	26
<b>4</b>	<b>CONCLUSIONS</b>	27
	REFERENCES	29
	DATA APPENDIX	31
Table 1	Demand Deviations and Specialisation in Production: Pooled Runs	32
Table 2	Demand Deviations, Supply-Side Locational Determinants and Specialisation in Production: Pooled Runs	33
Table 3	Demand Deviations, Supply-Side Locational Determinants and Specialisation in Production: Industry Runs	34
Table 4	The Spread Effect: Public Expenditure and the Intensity of Specialisation	35
Figure 1	Public procurement in an economic geography model	18
Figure 2	The Pull Effect: Public Expenditure and Industry Specialisation in Output Terms	36
Figure 3	The Pull Effect: Public Expenditure and Industry Specialisation in Value Added Terms	37
Figure 4	The Spread Effect: Public Expenditure and Industry Specialisation in Output Terms: All Industries	38
Figure 5	The Spread Effect: Public Expenditure and Industry Specialisation in Output Terms: NACE 290 Dropped	39
Figure 6	The Spread Effect: Public Expenditure and Industry Specialisation in Value Added Terms: NACE 290 Dropped	40
Appendix Table 1	Descriptive Statistics	41
Appendix Table 2	Correlations	42

## **Abstract**

It is widely recognised that public-sector purchasers tend to discriminate in favour of domestic suppliers. We study the consequences of home-biased public procurement on international specialisation. In the theoretical analysis we find two effects. First, a country will specialise in the sector for which it has relatively large home-biased procurement (the "pull" effect). Second, home-biased procurement can counter agglomeration forces and thereby attenuate the overall degree of international specialisation (the "spread" effect). Our empirical analysis, conducted on input-output data for the European Union, yields supporting evidence for the pull effect and some support for the spread effect.

## **Zusammenfassung**

Es ist hinlänglich bekannt, dass Käufer aus dem öffentlichen Sektor dazu neigen, lokale Zulieferer gegenüber ausländischen Produzenten zu bevorzugen. Wir untersuchen die Folgen solch Heimmarkt-bevorzugender Beschaffungspraktiken für die internationale wirtschaftliche Spezialisierung. In unserer theoretischen Analyse stoßen wir auf zwei Effekte. Einerseits finden wir, dass sich Länder tendenziell auf Industrien spezialisieren, auf die ein relativ großer Anteil ihrer öffentlichen Ausgaben entfällt. Wir nennen dies den Anziehungseffekt ("pull effect") öffentlicher Ausgaben. Andererseits zeigt unser Modell, dass ein international symmetrisch hoher Anteil der öffentlichen Hand an der Gesamtnachfrage industriellen Agglomerationskräften entgegenwirken kann und damit die Intensität der industriellen Spezialisierung einzelner Länder verringert. Wir nennen dies den Dispersionseffekt ("spread effect") öffentlicher Ausgaben. Im empirischen Teil ziehen wir Input-Output-Daten für EU-Länder heran. Sowohl der Anziehungseffekt als auch der Dispersionseffekt werden von den Daten bestätigt.

**JEL classification:** H5, F1, R3, R15

**Key words:** public expenditure, international specialisation, economic geography, European Union, input-output analysis

# 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. Public procurement typically accounts for 10-12 percent of industrialised countries’ GDP (European Commission, 1997). Discrimination by public purchasers in favour of local suppliers is a pervasive phenomenon, the motivations for which have been studied extensively. In this paper we investigate the consequences of home-biased procurement on the location of manufacturing. 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 1970-1985 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 industrial agglomeration. To study this question we extend the “new economic geography” model of *Krugman and Venables* (1995) to include home-biased procurement. 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. The larger body of research, reviewed in *Mattoo* (1996), took a partial equilibrium approach and studied the political interplay between the tendering entity and domestic and foreign bidders in various informational settings. *McAfee and McMillan* (1989), for instance, focused on the design of the optimal procurement mechanism in a setting where each bidder is better informed about his own cost than either the government or other bidders. They find that, if the foreign firm’s costs are lower in expectation than those of the home firm, the government minimises its



expected procurement costs by granting a preference margin to the home firm. The reason is that a discriminatory policy induces firms to reveal their private information about their costs and to prevent the most efficient firms from bidding too high. Interestingly, in their model, it is the efficiency of government procurement that motivates discrimination. Conversely, in *Branco* (1994), the home bias in public procurement stems from the assumption that profits of domestic firms enter the objective function of government while those of foreign firms do not, and government discrimination against foreign bidders causes profits to shift from foreign to domestic firms. Work by *Naegelen* and *Mougeot* (1998) has considered the efficiency argument and the profit-shifting argument in the same model and in a variety of informational settings. The optimal policy derived from this combined model results, once again, a discriminatory procurement mechanism. *Vagstad* (1995) discussed the consequences of a two-tier decision process with, on one side, a government (the agent) and, on the other side, a supranational entity (the principal). In *Weichenrieder* (2001) the home bias is justified by the desire to increase the capital intensity of local production and thereby to increase local taxable capital. While this literature focuses on the causes of the home bias, it does not explore the consequences of home-biased public expenditure on international specialisation.<sup>1</sup>

We depart from this line of research, which has focused on the *causes* of the home bias, by taking the home bias as exogenous and focusing on the *consequences* of this practice on international specialisation in a general-equilibrium setting. In this respect, 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 government procurement to international specialisation and is originally due to *Baldwin* (1970, 1984). His work shows that, in a Heckscher-Ohlin model, home bias in public expenditure is irrelevant for international specialisation. The reason is that home-biased government procurement crowds out private demand for domestic goods. Thus, the reduction in imports from the government is compensated by a corresponding increase in imports of the private economy. This somewhat counterintuitive result has been investigated further by *Miyagiwa* (1991), who demonstrated that Baldwin's "neutrality proposition" extends to a model of oligopoly with a homogeneous good. However, he found that, in a model with differentiated goods, home-biased procurement can affect domestic output. The reason is that when goods are differentiated, foreign and domestic goods are not perfect substitutes, and home-biased government demand does not therefore crowd out private demand for domestic goods entirely. We continue on this line of research by examining the consequences of home-biased procurement on international specialisation in a model featuring increasing returns and

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1 *Weichenrieder* (2001) uses a Heckscher-Ohlin general equilibrium model with technological differences. His main concern is to explain why governments are home biased. The consequences on international specialisation remain of secondary importance.

monopolistic-competition. We use the static version of this model to study the consequence of the home-biased expenditure on the location of industrial activity, and the dynamic version with agglomeration forces (new economic geography) to study the consequences of home-biased expenditure on the overall intensity of industrial concentration. These theoretical settings yields results that differ from those of the previous literature that we subject to theoretical investigation.

The analysis in this paper is of a positive nature, but it may also be informative for trade policy, since the issue of liberalisation of public procurement has been and continues to be on the agenda of the WTO and other international organisations. Policy makers have long recognised that home-biased procurement may counter industrial relocation. Liberalisation of public procurement has been the object of a number of EC 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. 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 three 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 theoretical analysis confirms that Baldwin’s neutrality proposition holds for the perfectly competitive sectors, but it shows that home-biased procurement does affect specialisation in increasing-returns monopolistically competitive sectors. 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 ( $X$ ).<sup>2</sup> 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 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  $\tau \in (0,1]$  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  $N \equiv n_1 + n_2$ . The world's factor endowment is exogenous and denoted by  $L$  and  $K$ . Countries' factors endowments are exogenous, and  $L_1 \equiv L - L_2$  and  $K_1 \equiv K - K_2$ . The equilibrium equations are:

$$p_S = c_S(w,r), \quad S = Y, Z \quad (1)$$

$$p_X(1 - 1/\sigma) = m(w,r), \quad (2)$$

$$p_X = c_X(w,r,x), \quad (3)$$

---

2 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.

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

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

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  $v_{Si}$  ( $S=X, Y, Z$ ) and  $\sum_S v_{Si}=1$ , and with an elasticity of substitution of the CES sub-utility equal to the constant  $\sigma \in (1, \infty)$ . 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  $p_X^{-\sigma} P_i^{1-\sigma} v_{Xi} I_i^d$  and for each variety produced in  $j$  is  $\tau^\sigma p_X^{-\sigma} P_i^{1-\sigma} v_{Xi} I_i^d$ . The price index  $P_i = (n_i p_X^{1-\sigma} + n_j \tau^{\sigma-1} p_X^{1-\sigma})^{1/(1-\sigma)}$  is the price index applicable to country  $i$ ,  $I_i^d = (1 - \delta_i) I_i$  is households' disposable income,  $\delta_i$  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  $E_{Xi}^P \equiv v_{Xi} (1 - \delta_i) I_i$ .

Governments purchase goods that they use for their subsistence. The balanced budget requirement assures that expenditure equals tax collection. Tax revenue amounts to  $\delta_i I_i$  and is allocated among goods according to the parameter  $\gamma_{Si}$  ( $S = X, Y, Z$ ) with  $\sum_S \gamma_{Si} = 1$ . Government  $i$ 's expenditure on  $X$  goods is then  $E_{Xi}^G \equiv \gamma_{Xi} \delta_i I_i$ .<sup>3</sup>

Following *Baldwin* (1970, 1984) and *Miyagiwa* (1991), we introduce an exogenously determined parameter that represents governments' bias in favour of domestically produced

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3 Following *Baldwin* (1974, 1980) and *Miyagiwa* (1991), we leave the government's expenditure share and the taxation parameter exogenous. The same parameters would result from the assumption that governments produce a public good according to a Cobb-Douglas-CES production function with parameter shares  $\gamma$  and with a constant elasticity of substitution of the CES aggregate equal to  $\sigma \in (1, \infty)$ . A constant per capita tax would instead result from Lindahl-type taxation if we assumed that the government produces a public good that enters the utility function in a separable way.

goods:  $\phi_i \in [0,1]$ . Specifically, a proportion  $\phi_i$  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  $\phi_i$  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.<sup>4</sup> For clarity of exposition we shall say that government  $i$ 's procurement is "fully liberalised" if  $\phi_i = 0$ , "home-biased" if  $\phi_i \in (0,1]$ , and "wholly home-biased" if  $\phi_i = 1$ . Note that 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.<sup>5</sup>

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

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

$$p_X x = p_X^{1-\sigma} P_1^{\sigma-1} [E_{X_1}^P + (1-\phi_1)E_{X_1}^G] + \theta p_X^{1-\sigma} P_2^{\sigma-1} [E_{X_2}^P + (1-\phi_2)E_{X_2}^G] + (\phi_1/n_1)E_{X_1}^G \quad (6)$$

$$p_X x = \theta p_X^{1-\sigma} P_1^{\sigma-1} [E_{X_1}^P + (1-\phi_1)E_{X_1}^G] + p_X^{1-\sigma} P_2^{\sigma-1} [E_{X_2}^P + (1-\phi_2)E_{X_2}^G] + (\phi_2/n_2)E_{X_2}^G \quad (7)$$

where  $\theta \equiv \tau^{\sigma-1}$ . 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

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4 On the practice of this discriminatory behaviour see *Hoekman and Mavroidis (1997)*.

5 The relevant analytical results are available from the authors.

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 is Baldwin's neutrality proposition. His result, originally derived in a small-country partial-equilibrium model, extends also 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 embed Baldwin's neutrality proposition in a general equilibrium model.

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  $\phi_1 = \phi_2$ . 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:

$$\begin{aligned} \eta_i &\equiv n_i / N, & E_{XW} &\equiv E_{X1}^P + E_{X2}^P + E_{X1}^G + E_{X2}^G, \\ \varepsilon^P &\equiv \frac{E_{X1}^P + E_{X2}^P}{E_{XW}}, & \varepsilon^G &\equiv \frac{E_{X1}^G + E_{X2}^G}{E_{XW}}, \\ \varepsilon_i^P &\equiv \frac{E_{Xi}^P}{E_{X1}^P + E_{X2}^P}, & \varepsilon_i^G &\equiv \frac{E_{Xi}^G}{E_{X1}^G + E_{X2}^G}. \end{aligned}$$

We shock expenditure in such a way that world private and world public expenditure on each commodity remain unchanged, i.e.  $E_{SW}$  ( $S = X, Y, Z$ ),  $\varepsilon^G$ , and  $\varepsilon^P$  are held constant. This implies that the relative prices of commodities will remain unchanged, and the effect on

specialisation, if any, is due to changes in a country's share of world public and private expenditure  $\varepsilon_i^G$  and  $\varepsilon_i^P$ . Technically, this is achieved when we disturb the equilibrium by  $d\gamma_{xi} = -d\gamma_{xj}$ , and by  $dv_{xi} = -dv_{xj}$ . Differentiation around the equilibrium point, where  $n_1 = n_2$ , yields the following expression:

$$d\eta_i = \underbrace{\frac{(1-\theta^2)\varepsilon^P}{(1-\theta)^2 + 4\theta\phi\varepsilon^G}}_{\beta_1} d\varepsilon_i^P + \underbrace{\frac{(1+\theta)(1-\theta + 2\theta\phi)\varepsilon^G}{(1-\theta)^2 + 4\theta\phi\varepsilon^G}}_{\beta_2} d\varepsilon_i^G. \quad (8)$$

The first term on the r.h.s. is the effect of private expenditure. For convenience we denote the first coefficient by  $\beta_1$ . This term shows that, *ceteris paribus*, large private expenditure on  $X$  results in large domestic output of  $X$  (remember that  $0 < \theta < 1$ ). The second term is the effect of government expenditure. For convenience we denote the second coefficient by  $\beta_2$ . This term shows that, *ceteris paribus*, large and home-biased government expenditure on  $X$  results in large domestic output of  $X$ . The sum  $\beta_1 + \beta_2$  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 ( $\varepsilon^G = 0$ ) or fully liberalised ( $\phi = 0$ ), then  $\beta_1 + \beta_2 = \frac{1+\theta}{1-\theta} > 1$ , which is the same as in the Helpman-Krugman model.<sup>6</sup> We can thus formulate a first 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  $X$ .*

It is interesting to inspect the relative size of  $\beta_1$  and  $\beta_2$ , because this gives us the relative size of the impact of private and government demand on international specialisation. The relative size of  $\beta_1$  and  $\beta_2$  depends on the relative size of  $\varepsilon^G$  and  $\varepsilon^P$ . However, if we define  $b_1 \equiv \beta_1 / \varepsilon^P$  and  $b_2 \equiv \beta_2 / \varepsilon^G$ , inspection of equation (8) shows that  $b_1 < b_2$  unambiguously as long as  $\phi > 0$ . The presence of the home bias makes the impact of public procurement larger than the impact of private demand when both are appropriately weighted by their size. This result may be expressed in the following proposition.

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6 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.

**Proposition 2:** *The size-weighted impact of home-biased public procurement is larger than the size-weighted impact of private expenditure.*

Henceforth, we refer to Propositions 1 and 2 as the “pull” effect of home-biased public procurement. To summarise, we have found that home-biased procurement influences international specialisation in some sectors but not in others, and that its size-weighted impact on the location of increasing-returns sectors 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 (no industrial agglomeration). At low trade costs agglomeration forces take over, and increasing-returns activity concentrates in a subset of countries (strong industrial agglomeration). 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 *Trionfetti* (2001) which, in turn, is an extension 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  $S = X, Z$ ; 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  $V = \alpha + \beta x$ . Each firm produces  $V$  according to  $V = [l/(1-\mu)]^{1-\mu} (X/\mu)^\mu$ , where  $\mu \in (0, 1)$  represents the importance of the industry’s output as its own intermediate input. Given this technology, the expression for total costs is  $TC_i = w_{Mi}^{1-\mu} P_i^\mu (\alpha + \beta x)$ . Finally, we should note that, unlike in the previous section, private



expenditure on  $X$  now includes firms' demand for intermediate inputs.<sup>7</sup> The expression for private expenditure then becomes  $E_{X_i}^P = v_{X_i}(1 - \delta_i)I_i + \mu n_i p_{X_i} x$ . The market-clearing equations are the same as in the static model (equations (5)-(7)), provided that we use the appropriate expressions for  $E_{X_i}^P$ .

Concerning the dynamics of the model, it is assumed that labour moves slowly into (out of)  $X$  as the wage in  $X$  exceeds (is smaller than) the wage in  $Z$ .<sup>8</sup> This assumption can be formalised with the two differential equations  $\dot{L}_{X1} = \xi(w_{X1} - w_{Z1})$  and  $\dot{L}_{X2} = \xi(w_{X2} - w_{Z2})$ , where  $\xi$  is an arbitrary constant.<sup>9</sup> The total number of varieties and world employment in  $X$  is 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 in  $X$  is constant, the two differential equations can be nicely compacted into one. Defining  $\omega \equiv w_{X1} - w_{X2}$ , 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:

$$\dot{\eta}_1 = \omega(\eta_1; \tau, \phi_1, \phi_2, \delta_1, \delta_2). \quad (9)$$

Equation (9) highlights the fact that  $\omega$  depends on the state variable  $\eta$ , on trade costs and on the public procurement parameters. The system is at rest when it reaches an internal solution or when the  $X$  sector is completely agglomerated in one country. Internal solutions are characterised by wage equalisation across sectors, i.e.,  $w_{Zi} = w_{Xi} = 1$  ( $i=1,2$ ). Complete agglomeration of  $X$  activity in one country is associated with wage inequality, i.e.  $w_{X1} > 1$  if  $\eta_1 = 1$ , or  $w_{X2} > 1$  if  $\eta_1 = 0$ . 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 called "agglomeration forces". The other two counteract the initial shock and are therefore referred to as "dispersion forces".

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7 Since profits are zero, firms' aggregate expenditure on  $X$  is  $\mu$  times firms' aggregate revenue.

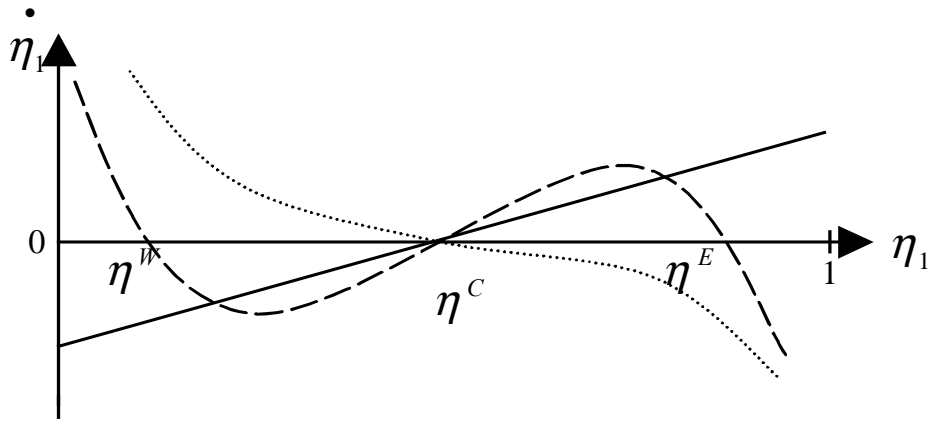
8 Alternatively, it could be assumed that labour is perfectly mobile across sectors and that firms move to the country that yields highest profits. The dynamics resulting from this alternative assumption would be identical to those we work with.

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

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 an 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 of 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. 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.

**FIGURE 1: Public procurement 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  $\eta^W$ ,  $\eta^C$ ,  $\eta^E$ . For simplicity, we assume countries to be identical in every respect, so that  $\eta^C = 1/2$ . In the previous section we were interested in the response of the equilibrium to asymmetric government demand shocks. Here we are concerned with the number and stability of the equilibria.<sup>10</sup>

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  $\phi_i E_{X_i}^G$  is small in both countries, the central equilibrium is unstable but there are two other equilibria with incomplete agglomeration ( $\eta^W$  and  $\eta^E$ ), 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  $\eta^W$  and  $\eta^E$  decreases as  $\phi_i E_{X_i}^G$  increases in both countries.
3. If public procurement is home-biased and  $\phi_i E_{X_i}^G$  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.

<sup>10</sup> The results illustrated in Figure 1, including the threshold values that define “large” or “small” government procurement and “high” and “low” trade costs, are derived analytically in *Trionfetti (2001)*.

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 size of home-biased procurement. This is shown in case 2.

**Proposition 3:** *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.*

A final clarification on the pull effect and spread effect is in order. Given an initial equilibrium ( $\eta^W, \eta^C$ , or  $\eta^E$ ) an increase of government 1’s share of world expenditure “pulls” the equilibrium to the right. Therefore, idiosyncratic home-biased government demand, all else equal, induces specialisation (“pull” effect). On the other hand, a symmetric increase in public expenditure relative to private expenditure stabilises the equilibrium. A rise in world government expenditure therefore “spreads” industries that might otherwise be subject to agglomeration forces across countries (“spread” effect). In sum,  $\eta_i$  is subject to two forces: the spread effect and the pull effect. Accordingly, in a cross-section setting, we would expect the variance of  $\eta_i$  to correlate positively with the variance of  $\varepsilon_i$  and negatively with  $\varepsilon_G$ :

$$Var(\eta_i) = c_1 Var(\varepsilon_i) + c_2 \varepsilon_G, \quad (10)$$

with  $c_1 > 0$  and  $c_2 < 0$ . We can use equation (10) to estimate the “spread” effect empirically while controlling for the “pull” effect.

### 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.<sup>11</sup> 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* (2000) 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 public procurement must have been a pervasive phenomenon in EU countries during the 1970-1985 period, which we cover in our empirical study.

### 3.1 The pull effect of public expenditure

The first two propositions derived from our model stipulate 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, and that this "pull effect" is stronger when exerted by public expenditure than when it comes from private demand.

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

$$OUTdev_{si} \equiv \left( \frac{OUT_{si}}{\sum_i OUT_{si}} \right) - \left( \frac{\sum_s OUT_{si}}{\sum_s \sum_i OUT_{si}} \right), \quad \text{where } OUTdev \in (-1,1), \quad (11)$$

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

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<sup>11</sup> 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.

compute the measure  $VAddev$ , which is based on value added data and constructed in identical fashion to  $OUTdev$ . The first summand in equation (11) is the exact empirical representation of  $\eta_i$  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  $VAddev$  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  $VAddev$  for each country.

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

$$DGOVdev_{si} \equiv \left( \frac{DGOV_{si}}{\sum_i DGOV_{si}} \right) - \left( \frac{\sum_s DGOV_{si}}{\sum_s \sum_i DGOV_{si}} \right), \quad \text{where } DGOVdev \in (-1,1). \quad (12)$$

$DGOV$  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  $\varepsilon_i^G$  ( $\varepsilon_i^P$ ) 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.<sup>12</sup>

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 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, confirming our Proposition 1. The coefficients on private demand deviations (0.55 for output, 0.39 for value added) are substantially larger than those on public demand deviations (0.08 and 0.09 respectively). These estimated parameters correspond to  $\beta_1$  and  $\beta_2$  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. It is through  $b_1 = \beta_1 / \varepsilon^P$  and  $b_2 = \beta_2 / \varepsilon^G$  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,  $\varepsilon^G$ , 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 according to our Proposition 2: 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. However, we cannot attribute statistical significance to this result, since the 95% confidence intervals of  $b_1$  and  $b_2$  overlap.

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12 We find a correlation coefficient of 0.20 between  $DGOVdev$  and both  $OUTdev$  and  $VAddev$ , pooled across sample years (see Appendix Table 2). These correlations are statistically significantly different from zero at the 99.99 percent confidence level.

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

### 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.  $PRIMARYinter_{si} = (\text{Primary inputs used} / \text{Output})_s * (\text{Primary inputs produced} / \text{Manufacturing output})_i$
2.  $AGRIinter_{si} = (\text{Agricultural inputs used} / \text{Output})_s * (\text{Agricultural inputs produced} / \text{Manufacturing output})_i$



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

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, reported 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.<sup>13</sup> 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 geographical industry clusters

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13 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.

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 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 significantly positive. In the third-last row of Table 2 we report the relevant *bs*, that is the coefficients appropriately scaled for the relative size of private and public expenditure. In line with our first two theoretical propositions for increasing-returns sectors,  $b_2$  is always larger than  $b_1$ ; although, for most specifications, this difference is not statistically significant. We therefore conclude (a) that both private and government demand idiosyncrasies are a significant factor shaping the patterns of industrial specialisation among EU countries, and (b) that idiosyncrasies in public-sector demand matter more than those in private-sector demand, i.e. there is evidence of a pull effect from public expenditure.

As a complement to the pooled runs, we have also estimated our model 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 power 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 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 third theoretical proposition, the share of (home-biased) 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 Ia). This result holds virtually unchanged when, following equation (10), we in addition control for the standard deviation of  $DGOVdev$  (Table 4, Model Ib). Our initial result is thus 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, Models IIa,b). Hence, our dataset 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 (including military). Inspection of the raw data reveals that in all sample years the most specialised countries (in terms of both  $OUTdev$  and  $VAddev$ ) 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 development of defence production across EU countries that resulted from the peace agreements signed after the second world war. 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.<sup>14</sup>

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<sup>14</sup> 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),

We estimated a linear relationship between the share of government expenditure in domestic absorption and the intensity of specialisation, allowing for year-specific fixed effects (Table 4, Models IIa,b). The negative and significant coefficient estimates provide support for the spread effect. We also find the expected positive partial correlation between the variance of government expenditure and the index of specialisation. Finally, we ran the regression separately for each sample year and obtained consistently negative parameter estimates (Table 4, Models IIIa-d). 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.<sup>15</sup>

Arguably 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 constrained in such an exercise by a lack of degrees of freedom.<sup>16</sup> Our empirical verdict in favour of the spread effect must therefore remain a qualified one.

## 4 CONCLUSIONS

This paper sheds light on the consequences of home-biased public expenditure on the pattern of international specialisation. The theoretical analysis is based on models in the mould of the new theories of international trade and economic geography, and the empirical estimations draw on an input-output panel data set for EU countries.

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while the corresponding shares for Germany and Italy were considerably lower at 44 and 25 percent respectively. This suggests that specialisation patterns in NACE 290 are shaped by the location of aircraft production, which is highly politicised at the supra-national level.

15 Controlling for the variance in government expenditure shares across industries does not significantly affect the estimated coefficients and standard errors on *DGOV/Absorption* in the year-by-year regression runs. To test the sensitivity of the result to the scaling of the regressors, we also estimated the model on the share of public expenditure in total final expenditure (instead of absorption), and found the results substantially unchanged. All these results are available from the authors.

16 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. These results are available from the authors on request.

In the theoretical part our paper contributes to the literature by studying the location effects of public procurement theoretically in models with both perfectly competitive and monopolistically competitive sectors and in models with cumulative agglomeration features. While our analysis confirms that home-biased procurement is neutral in perfectly competitive sectors, it suggests that there are “pull” and “spread” effects in monopolistically competitive sectors. The “pull” effect means that a country with relatively large home-biased government expenditure on a certain good will tend to host a relatively large share of world production of that good. The “spread” effect means that symmetrically large home-biased public procurement reduces the likelihood and intensity of agglomeration of increasing-returns industries.

The existence of pull and spread effects is explored empirically in an input-output dataset for eleven EU countries, covering the period 1970-1985. To our knowledge, this is the first empirical investigation of the effect of public procurement on international specialisation in a panel data setting with a full industrial cross-section. We find evidence in support of the pull effect. On average, a country with large government procurement on a good will tend to specialise in the production of that good. We also find that the effect of government demand on international specialisation is stronger than the effect of private demand. Further, we find empirical support for the spread effect. Industries that are subject to a relatively large share of public expenditure tend to be less concentrated across EU countries.

This study is purely positive in nature. Yet, our results may be informative for policy making, especially in the context of the WTO Government Procurement Agreement and of the EU’s ongoing effort to complete its single public procurement market.

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## 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		VAdev	
		OLS/beta coeff. (t stat)	R <sup>2</sup> No.obs	OLS/beta coeff. (t stat)	R <sup>2</sup> No.obs
<b>I</b>	Ddev	0.60 / 0.61 (10.41)***	0.37 627	0.47 / 0.42 (7.13)***	0.18 627
<b>II</b>	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
<b>III</b>	<b>1970:</b> DPRIVdev	0.59 / 0.63 (7.03)***		0.33 / 0.33 (2.69)***	
	<b>DGOVdev</b>	0.05 / 0.12 (1.13)	0.40 162	0.06 / 0.14 (1.01)	0.12 162
<b>IV</b>	<b>1975:</b> DPRIVdev	0.51 / 0.52 (5.77)***		0.34 / 0.32 (3.27)***	
	<b>DGOVdev</b>	0.05 / 0.11 (0.83)	0.30 162	0.01 / 0.01 (0.07)	0.10 162
<b>V</b>	<b>1980:</b> DPRIVdev	0.46 / 0.45 (4.96)***		0.37 / 0.33 (3.55)***	
	<b>DGOVdev</b>	0.08 / 0.14 (1.45)	0.25 159	0.09 / 0.14 (1.08)	0.15 159
<b>VI</b>	<b>1985:</b> DPRIVdev	0.64 / 0.50 (5.04)***		0.54 / 0.36 (3.47)***	
	<b>DGOVdev</b>	0.13 / 0.26 (2.77)***	0.35 144	0.19 / 0.31 (3.55)***	0.26 144
<b>VII</b>	DPRIVdev	0.51 / 0.48 (10.14)***		0.40 / 0.35 (6.88)***	
	<b>DGOVdev</b>	0.09 / 0.18 (3.28)***		0.10 / 0.19 (2.84)***	
	<b>GOVBIAS</b>	0.38 / 0.02 (0.63)		0.22 / 0.09 (2.35)**	
	<b>DGOVdev*GOVBIAS</b>	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 <sup>1</sup>		OLS <sup>1</sup>		OLS <sup>1</sup>		OLS with panel-corrected standard errors <sup>2</sup>		Feasible GLS (panel heteroskedasticity) <sup>3</sup>	
Regressand:	OUTdev	VAdev	OUTdev	VAdev	OUTdev	VAdev	OUTdev	VAdev	OUTdev	VAdev
Regressors:										
DPRIVdev	0.54 (11.38) ***	0.38 (6.60) ***	0.54 (11.52) ***	0.38 (6.65) ***	0.56 (9.26) ***	0.41 (6.52) ***	0.56 (14.88) ***	0.42 (9.67) ***	0.55 (15.15) ***	0.39 (9.81) ***
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) ***
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)
b <sub>1</sub> versus b <sub>2</sub> <sup>4</sup>	0.60, 0.73	0.43, 0.87	0.61, 0.73	0.43, 0.87	0.63, 0.69	[0.47, 1.13] *	0.63, 0.69	[0.47, 1.13] *	0.62, 0.63	[0.44, 1.00] *
Adjusted R <sup>2</sup>	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.

4 *b*<sub>1</sub> and *b*<sub>2</sub> are the estimated coefficients on *DPRIVdev* and *DGOVdev* respectively, divided by the relevant share of private/public expenditure in total expenditure. \*: 95% confidence intervals do not overlap.

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

<i>Regressors:</i> <i>NACE code: Industry</i>	<i>DPRIVdev</i>		<i>DGOVdev</i>		<i>GOVBIAS</i>		<i>GOVBIAS*</i> <i>DGOVdev</i>		<i>AGRIabund</i>		<i>ENERGYabund</i>		<i>CAPITALabund</i>		<i>MANINPabund</i>	
	<i>OLS</i>	<i>Beta</i>	<i>OLS</i>	<i>Beta</i>	<i>OLS</i>	<i>Beta</i>	<i>OLS</i>	<i>Beta</i>	<i>OLS</i>	<i>Beta</i>	<i>OLS</i>	<i>Beta</i>	<i>OLS</i>	<i>Beta</i>	<i>OLS</i>	<i>Beta</i>
	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>	<i>coeff.</i>
<b>1170: Chemicals</b>	-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
<b>1190: Metal goods</b>	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
<b>1210: Machinery</b>	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
<b>1230: Office machines</b>	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
<b>1250: Electrical goods</b>	-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
<b>1270: Motor vehicles</b>	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
<b>1290: Other transp. eq.</b>	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
<b>1310: Meat products</b>	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
<b>1330: Dairy products</b>	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
<b>1350: Other food</b>	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
<b>1370: Beverages</b>	-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
<b>1390: Tobacco products</b>	-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
<b>1410: Textiles, clothing</b>	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
<b>1430: Leather, footwear</b>	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
<b>1450: Timber, furniture</b>	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
<b>1470: Pulp, paper, printing</b>	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
<b>1490: Rubber, plastic</b>	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
<b>1510: Instrum. engineering and other manuf.</b>	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

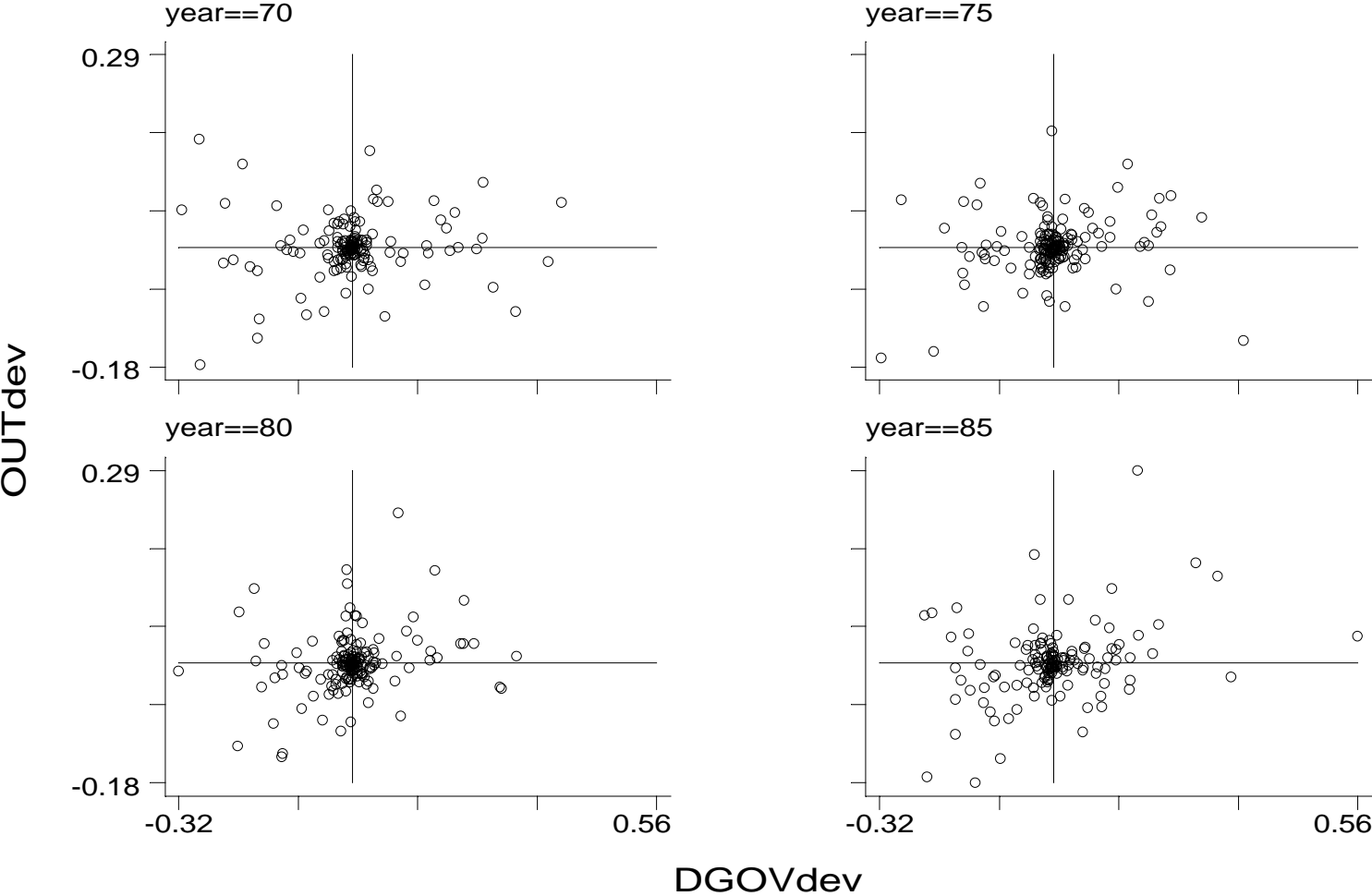
Dark shading: statistical significance at 1% level, light shading: statistical significance at 5% level.

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

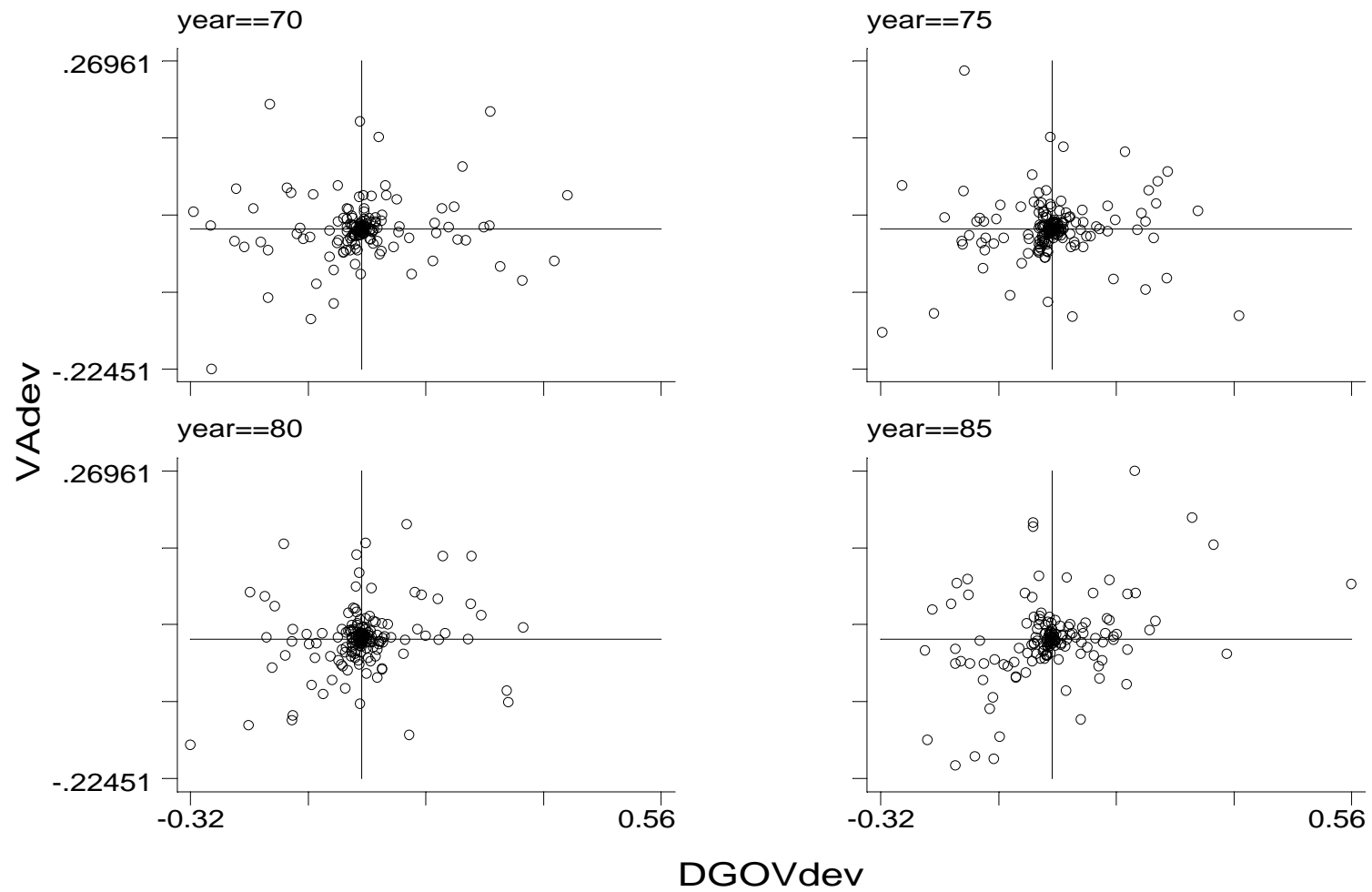
Model	Notes	Regressand: Regressors:	Mean  OUTdev		Mean  VAdev	
			OLS/beta coeff. (t stat)	R <sup>2</sup> No. obs	OLS/beta coeff. (t stat)	R <sup>2</sup> No. obs
I a	<b>All industries</b> Year fixed effects	DGOV/Absorption	0.06 / 0.23 (2.74) <sup>***</sup>	0.09 72	0.03 / 0.11 (1.09)	0.10 72
I b	<b>All industries</b> Year fixed effects	DGOV/Absorption	0.06 / 0.24 (2.98) <sup>***</sup>	0.13 72	0.03 / 0.11 (1.31)	0.18 72
		<b>Std. dev. of DGOVdev</b>	0.07 / 0.21 (2.00) <sup>**</sup>		0.12 / 0.29 (2.16) <sup>**</sup>	
II a	<b>NACE 290 dropped</b> Year fixed effects	DGOV/Absorption	-0.17 / -0.26 (-1.68) <sup>*</sup>	0.11 68	-0.23 / -0.29 (-2.05) <sup>***</sup>	0.19 68
II b	<b>NACE 290 dropped</b> Year fixed effects	DGOV/Absorption	-0.16 / -0.24 (-1.51)	0.13 68	-0.19 / -0.26 (-1.94) <sup>*</sup>	0.23 68
		Std. dev. of DGOVdev	0.05 / 0.13 (1.23)		0.08 / 0.22 (1.69) <sup>*</sup>	
III a	<b>1970</b> <b>NACE 290 dropped</b>	DGOV/Absorption	-0.02 / -0.34 (-1.25)	0.12 17	-0.01 / -0.22 (-0.85)	0.05 17
III b	<b>1975</b> <b>NACE 290 dropped</b>	DGOV/Absorption	-0.02 / -0.28 (-1.26)	0.08 17	-0.03 / -0.34 (-1.47)	0.12 17
III c	<b>1980</b> <b>NACE 290 dropped</b>	DGOV/Absorption	-0.02 / -0.29 (-1.28)	0.08 17	-0.03 / -0.37 (-1.63)	0.14 17
III d	<b>1985</b> <b>NACE 290 dropped</b>	DGOV/Absorption	-0.04 / -0.38 (-1.49)	0.14 17	-0.05 / -0.45 (-1.79) <sup>*</sup>	0.20 17

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

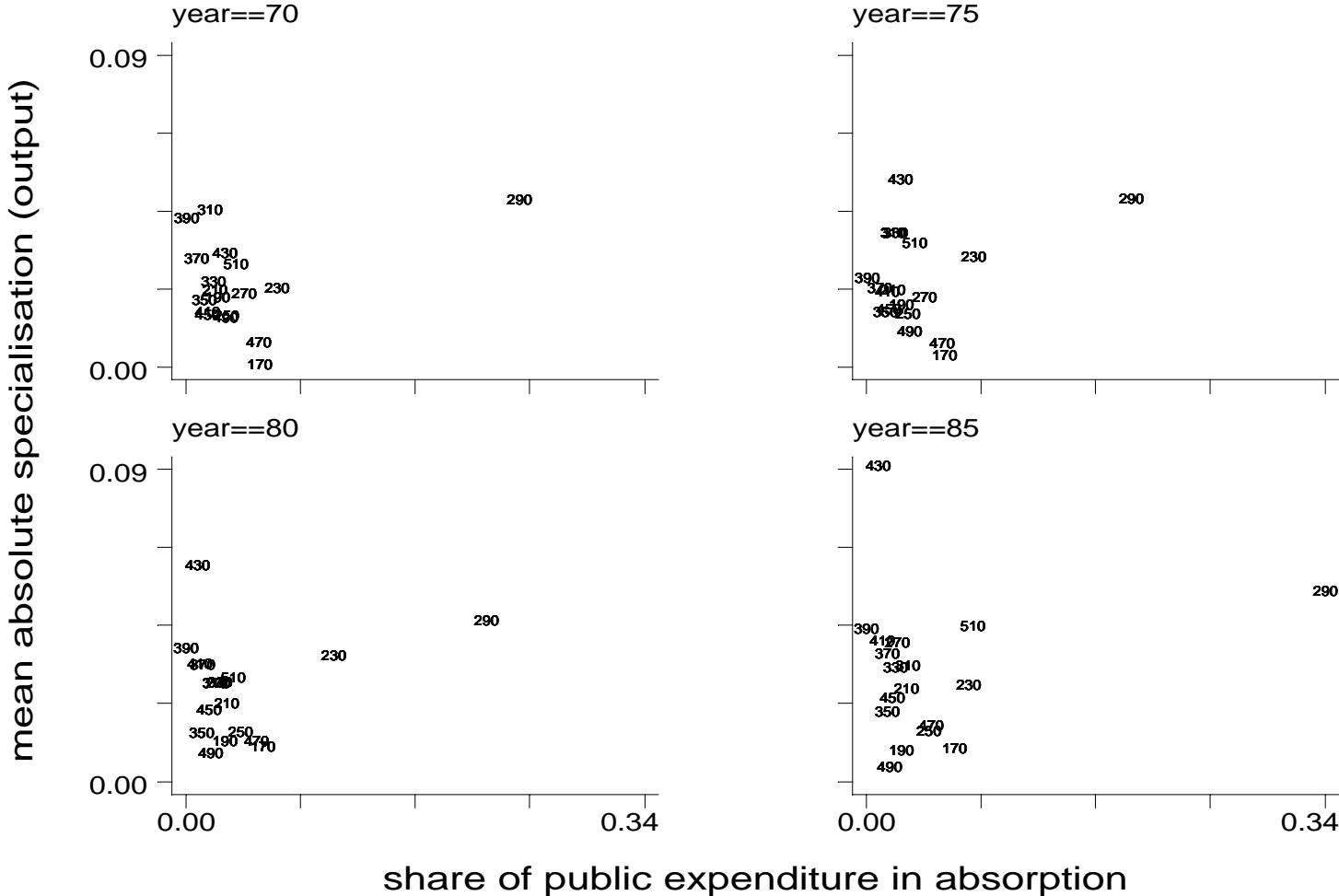
**FIGURE 2: The Pull Effect: Public Expenditure and Industry Specialisation in Output Terms**



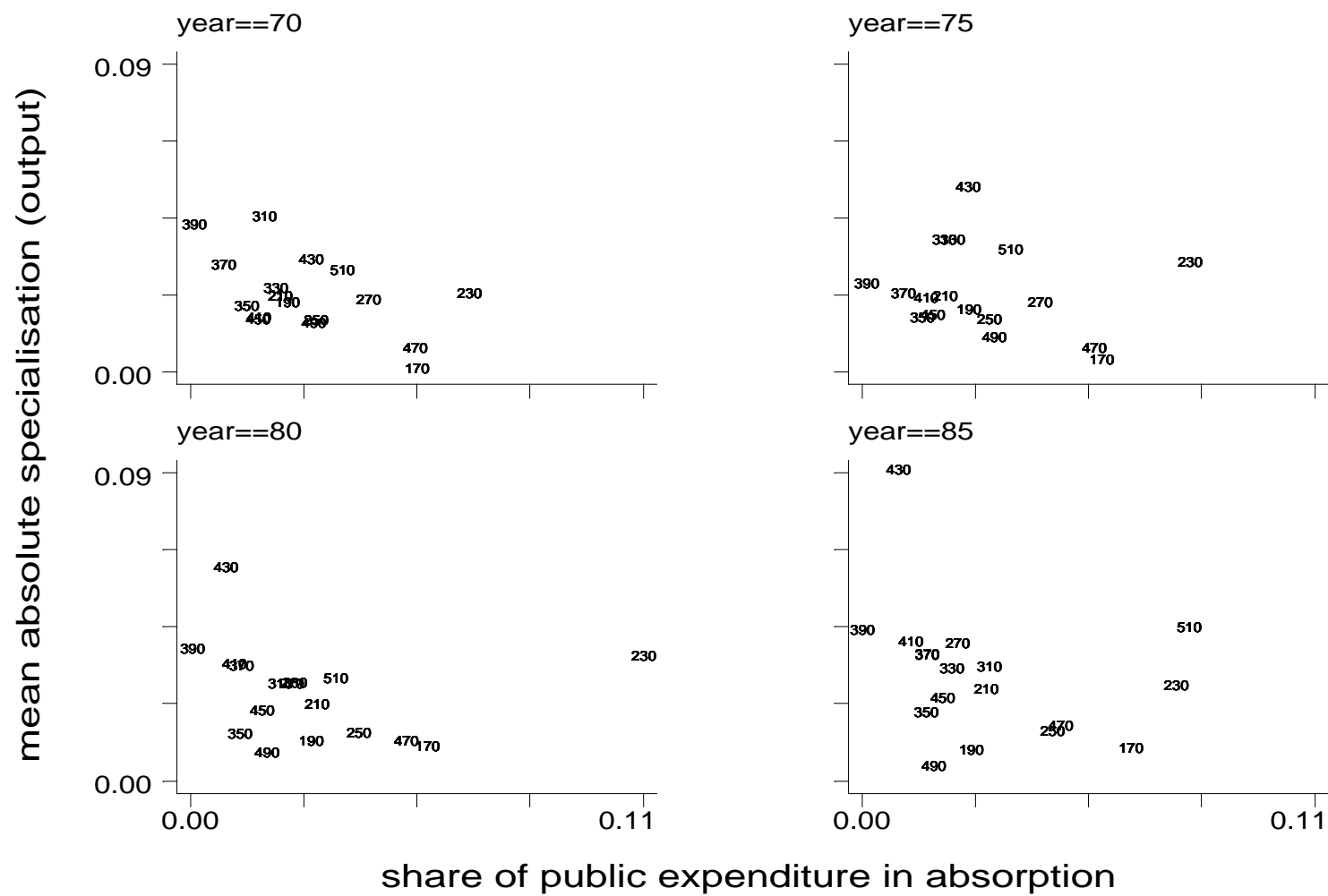
**FIGURE 3: The Pull Effect. Public Expenditure and Industry Specialisation in Value Added Terms**



**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))**

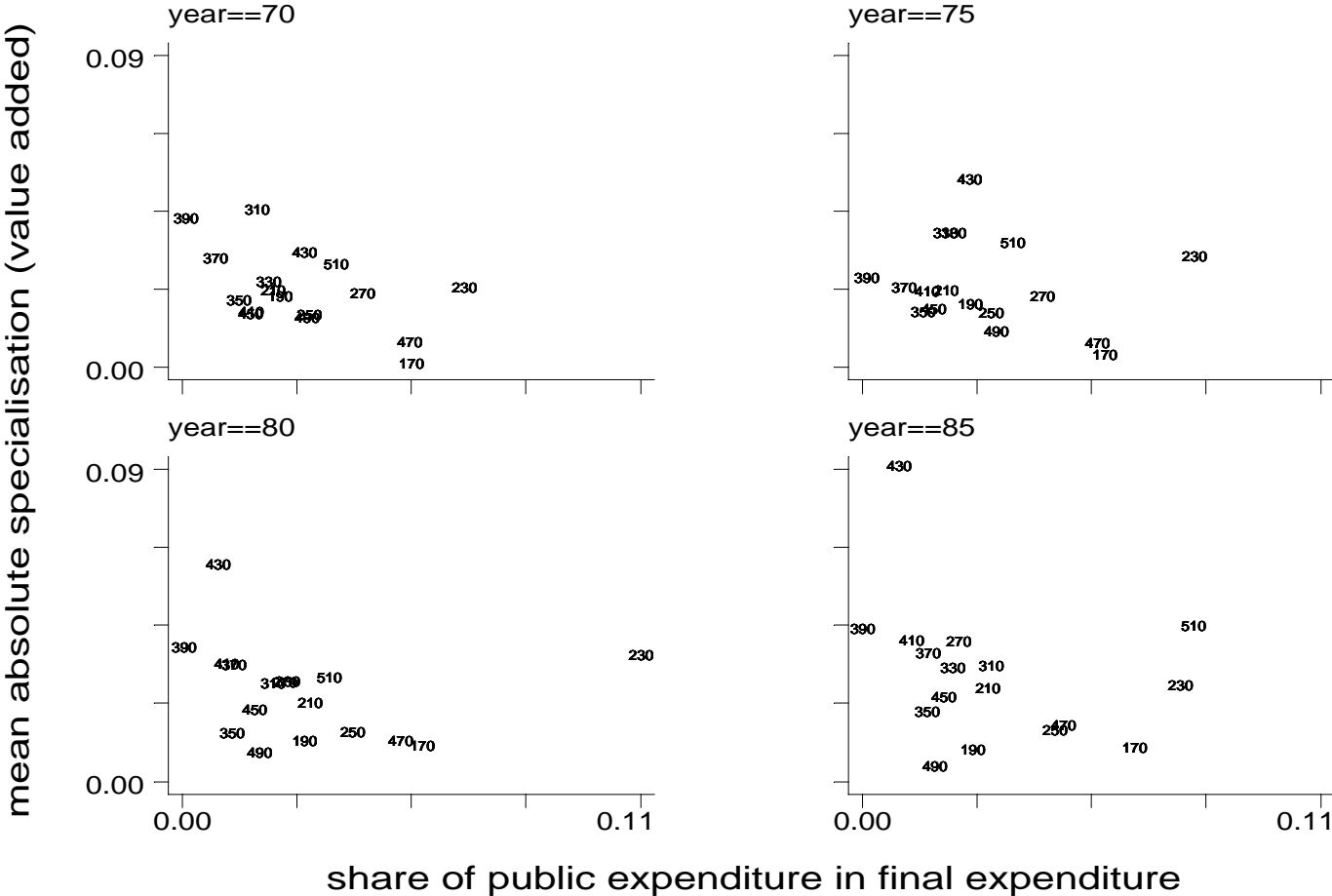


**FIGURE 5: The Spread Effect: Public Expenditure and Industry Specialisation in Output Terms: NACE 290 Dropped (NACE codes)**





**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 <sup>1</sup>	Sector of weakest specialisation <sup>1</sup>
<i>Belgium</i>	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	<i>Meat products</i>	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		
<i>France</i>	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		
<i>Italy</i>	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		
<i>Portugal</i>	80	0.331	0.016	Textiles, clothing	<i>Machinery</i>
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		
<i>Luxemburg</i>	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 (*VAd<sub>dev</sub>*) in most recent available sample year.

**APPENDIX TABLE 2: Correlations**

	VAdev	Ddev	DGOV dev	DPRIV dev	DBIAS	PRIMARY inter	AGRI inter	ENERGY inter	CAPITAL inter	WAGESHARE inter	MANINP inter
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								
<b>DGOVdev</b>	<b>0.20*</b>	0.40*									
<b>Ddev</b>	<b>0.42*</b>										

\* : statistically significant at the 1% level.