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Public Expenditure and Economic Geography

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ABSTRACT. – Adding public expenditure to the core-periphery model creates a linkage that can override the agglomeration forces. Consequently, the equilibrium distribution of economic activity depends upon the nature and allocation of public expenditure. Appropriate public expenditure eliminates the possibility that economic integration results in total agglomeration of manufacturing. A corollary is that (contrary to the core-periphery model) location matters even in the absence of transport costs. Tied aid, and international transfers are also considered.

Dépenses publiques et géographie économique

RÉSUMÉ. – Les dépenses publiques, dans un modèle centre-périphérie, créent une nouvelle liaison qui peut l'emporter sur les forces d'agglomérations. Par conséquence la distribution internationale de l'activité économique dépend de la nature et de l'allocation géographique des dépenses publiques. Des dépenses publiques appropriées éliminent la possibilité qu'une intégration économique déclenche l'agglomération totale. Un corollaire est que l'espace économique est important même en l'absence de coût de transport.

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1 Introduction

Many analysts believe that European economic integration favours the development of regions that are already rich. Consequently, deeper integration should be accompanied by increased funding of transfer programs such as the European Union's Structural Funds and Cohesion Funds. To quote the European Commission [1992]: "Without special efforts, weaker regions could, as they have done in the past, lose many of their most able workers or be starved of the finance needed to create local jobs. This is why the Single European Act of 1986 launching the single market went *hand in hand* with a radical reform of the EC's structural Funds in 1989." (italics added). The European Union (EU) spent over 14 billion ECU on the Structural Funds in 1993, a figure that has more than doubled since the Single European Act was adopted. New spending from the Cohesion Fund should more than double the 1993 figure by the end of the decade. Despite the magnitude of this spending and the importance of the regional convergence, very little theoretical work has focused on the question of how government expenditures influence the location of industrial activity.

The Krugman-Venables model offers an appealing theoretical apparatus to analyze the location effect of integration (see KRUGMAN [1991]; VENABLES [1996] and, KRUGMAN and VENABLES [1996]). Integration is modeled as a fall in transportation costs and, depending upon the initial level of transport costs, integration may lead to agglomeration. One well-known result is that total agglomeration – the core-periphery outcome – is a stable equilibrium at a sufficiently low level of trade costs.

This paper extends the Krugman-Venables model of economic geography in a way that permits explicit consideration of the location effects of programs such as the Structural Funds on location. In particular, the analysis is performed by casting public expenditure in the so-called core-periphery model of KRUGMAN [1991]. This paper shows that public expenditure can create a new source of 'backward' linkage that tends to favour dispersion over agglomeration. Using the extended model, the links between government expenditure and the location of industry are characterized. The paper shows that the location equilibrium (i.e., percentage of manufacturing in each country) depends on the nature and level of public expenditure. Certain types of public expenditure are shown to prevent geographical concentration regardless of the structural parameters of the model. A corollary of this is that (contrary to the core-periphery model) geographical location matters even in the absence of transport costs. Three types of international transfers are analyzed: pure transfers, tied aid, and joint expenditure. It is shown that the effect of all transfers on location will depend on the parameters regulating the allocation expenditure.

The main policy implication of this paper is that appropriate public expenditure can reverse the tendency for integration to worsen regional divergence. Therefore, the effect of European integration may be a matter of economic policy decisions rather than merely the mechanical consequence of a fall in transport costs.

The core-periphery model is certainly not the only framework that should be used to analysis the questions at hand. (see, for instance, the models of THISSE [1993] and FAINI [1984]). However, the simplicity of the core-periphery model makes it particularly suitable to explore the key issues. Government expenditure in the models is highly simplified. This paper assumes that governments collect taxes and spend the revenues on goods. In order to isolate the effect of public expenditure from other aspects of public finance I have made the following two assumptions. First, governments destroy the goods they purchase. This assumption serves the purpose of isolating the demand effect of public expenditure – which is the focus of this paper – from other effects that may arise from a specific use of the goods purchased by the governments [1]. Second, "footloose" labour is not taxed. This permits a separation of the effect on location due to "pure" expenditure from the effects of taxation policies [2]. It is not within the scope of this paper to address taxation policies. Authoritative scholars have extensively studied this issue (RAZIN and SADKA [1994]; BOVENBERG [1994]; RAZIN and SLEMROD [1990]; DIXIT [1985] among others). The separation of the taxation effect from the expenditure effect is made for analytical convenience but also reflects at least one (important) real situation, namely the budget of the European Union. The Commission of the European Union does not have the power to levy taxes. The resources are transferred from the member states to the Commission which, in turn, has the power to allocate expenditure. Finally, it is worth mentioning that the two assumptions above are not crucial to the result that will obtain. In section A.2 of the appendix, I sketch a model in which these assumptions are removed.

Despite these simplifications, the model shows that the sole effect of expenditure is indeed remarkable. This is so because public expenditure creates a new and independent geographical dimension; namely, a new source of backward linkage. The source of backward linkage in the standard core-periphery model depends only upon private demand. The circular causation is due to the fact that manufacturers tends to locate where the local demand is large local demand, but local demand is large precisely where the majority of manufacturers already chose to locate. Governments' expenditures add a new backward linkage by making the local demand larger or smaller than it would be if only private agents existed. This paper shows how this new linkage potentially dominates all others.

The remainder of this paper contains four parts. The first extends the core-periphery model to incorporate public finance. The second studies the performance of the extended model. The third part discusses the three types of intergovernmental transfer policies mentioned above. The last part

1. An example may be illuminating. Suppose a government purchases steel and locomotives and, instead of destroying them, builds railways. In this action there are two separate effects involved: 1) a public good is offered (namely transportation); and 2) public demand for steel and locomotive affects the size of the local market. Each of these two factors has an independent effect on location. This paper rules out the former and focuses on the latter.

2. "Footloose" labour is assumed to migrate to the country that offers the highest after-tax real wage. Since "footloose" labour does not pay taxes, migration decisions are not affected by taxation.

presents a summary and some concluding remarks. An appendix shows how the effect of the backward linkage created by government expenditure can be obtained from the mathematical solution to the model for the case of zero transport costs.

2 A Model of Core-Periphery *cum* Public Finance

2.1. The Basic Structure

This model builds on the core-periphery model put forward by KRUGMAN [1991]. There are two sectors of production which will be called "agricultural" or "a", and "manufacturing" or "m". The agricultural sector uses a specific factor called "farmers" to produce a homogeneous good under constant return to scale. The conditions of perfect competition apply to this sector. The agricultural good is the *numéraire* and units are chosen such that the wage rate and the price in this sector are both 1. The manufacturing sector uses a specific factor called "workers" to produce a differentiated commodity under increasing returns to scale at the level of the firm. The world is composed of two countries, *1* and *2*. The population of the world is normalized to be 1 and is exogenously composed of μ "workers" and (1–μ) "farmers". Farmers are assumed to be sedentary and equally divided between the two countries. Workers are assumed to be "footloose". λ is the proportion of workers present in country *1* at any instant. The number of workers present in country *1* and *2* at any instant in time are therefore respectively: $\lambda\mu$; and (1–λ)μ. Since workers can migrate, the proportion λ may change over time. It is assumed that transporting the homogeneous good across countries is free. Conversely, transporting the manufactures across countries is costly. Transport costs take the well-known iceberg from. For each unit sent, only a fraction $\tau\,(0 < \tau < 1)$ arrives at its destination.

2.2. Government Expenditure

The governments' budget constraint is: $G_i = T_i$; $i = 1, 2$. G_i is total expenditure and T_i is the total taxation in terms of the homogeneous good levied by country *1*. I distinguish between two regimes. In the first regime each government purchases only national goods (domestic procurement); in the second regime each government purchases both national and foreign goods (liberalized procurement).

Under the liberalized procurement regime each government spends a proportion ψ of tax revenues on domestic commodities and the remaining proportion $(1 - \psi)$ on foreign commodities. Subsequently, within each of these shares, the government sub-divides the expenditure between manufactures and agricultural goods. These two sub-division between manufactures and agricultural goods may differ. For instance, government i may decide that, out of the expenditure on domestic commodities, a percentage δ_i will be devoted to manufactures, and the remaining $(1 - \delta_i)$

to agricultural goods. At the same time, it may decide that, out of the expenditure on the foreign commodities, a percentage δ_i' will be allotted to manufactures and the remaining $(1-\delta_i')$ to agricultural goods. In summing, each government has three policy instruments: the level of expenditure (G), the commodity allocation of expenditure (i.e., δ and δ'), and the geographical allocation of expenditure (i.e., ψ). The expenditure of government i is thus allocated as follows:

$$G_i \equiv \psi_i\,\delta_i\,G_i + \psi_i\,(1-\delta_i)\,G_i + (1-\psi_i)\,\delta_i'\,G_i; \quad i = 1,\,2 \tag{1}$$

The first term on the right-hand side of (1) is government i's expenditure on domestic manufactures; the second term is its expenditure on the domestic agricultural good; the third term is expenditure on foreign manufactures; and the fourth term is expenditure on the foreign agricultural good. The public expenditure of government i on each domestic variety and each foreign variety are respectively: $\mathrm{PEX}_{ii} = (G_i\,\delta_i\,\psi_i)/n_i$; and $\mathrm{PEX}_{ij} = [G_i\,\delta_i\,(1-\psi_i)]/n_j$. The PEXs turn out to be important in determining the long run pattern of specialization.

Under the domestic procurement regime each government has two instruments: the level of expenditure (G), and the allocation of expenditure between domestic manufactures and domestic agricultural good (the δs). In fact, replacing $\psi = 1$ in identity (1) gives:

$$G_i \equiv \delta_i\,G_i + (1-\delta_i)\,G_i; \qquad i = 1,\,2 \tag{2}$$

The public expenditure of government of country i for each variety PEX_{ii} equals $(\delta_i\,G_i)/n_i$.

2.3. **Demand and Disposable Income**

Each individual in country *1* (the choice of the country is irrelevant) maximizes the following utility function:

$$U_1 = \left(\frac{\left[\sum_{k=0}^{n_1} c_{11k}^{\frac{\sigma-1}{\sigma}} + \sum_{k=0}^{n_2} c_{11k}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}}{\mu} \right) \left(\frac{C_{A\,1}}{1-\mu} \right)^{1-\mu} \tag{3}$$

In the utility function, μ is the parameter representing the taste of the individual, $C_{A\,1}$ is the quantity of the homogeneous good consumed, c_{11k} is the quantity of the k-th variety produced in *1* and consumed in *1* by each individual of country *1*; c_{12k} is the quantity of the k-th variety produced in *2* and consumed in *1* by each individual of country *1*. n_1 and n_2 are the number of varieties produced in *1* and *2*. Finally, σ is the (constant) elasticity of substitution between each pair of varieties.

The burden of taxation is divided only among farmers. The proportion of taxation borne by each farmer is h_{ai}. Workers are assumed not to pay taxes, therefore $h_{mi} = 0$. The budget constraint of the individual in country *1* and belonging to sector s incorporates this fact:

$$(4) \quad \sum_{k=0}^{n_1} p_{11k}\, c_{11k} + \sum_{k=0}^{n_2} p_{12k}\, c_{12k} + C_A = w_{s1} - h_{s1}\, T_1; \qquad s = a,\, m$$

In equation (4) p_{11} is the f.o.b. price in *1* of each variety produced in *1*; p_{12} is the c.i.f. price in *1* of each variety produced in *2*; w_{sl} is the gross wage rate in sector s of country 1.

Aggregating demand functions across individuals and across sectors, we obtain the aggregate demand from the private sector of country *1* for each variety produced in country *1* and *2*. These are respectively [3]: $x_{11}^d = p_{11}^{-\sigma}\, P_1^{\sigma-1}\, \mu\, I_1^d$; and $x_{12}^d = p_{12}^{-\sigma}\, P_1^{\sigma-1}\, \mu\, I_1^d$; where $P_i = [n_i\,(p_{ii})^{1-\sigma} + n_j\,(p_{ij})^{1-\sigma}]^{1/(1-\sigma)}$ is the C.E.S. price index associated with the C.E.S. sub-utility, and I_1^d is the disposable income of the private sector in country *1*, net of taxes. This is: $I_1^d = (1-\mu)/2 + \lambda\mu\, w_{m1} - T_1$.

2.4. Supply

The technology of the manufacturing sector is assumed to exhibit economies of scale. The input requirement per x units of output is [4]: $L^M = \alpha + \beta\, x$. From the F.O.C.s for profit maximization, and making use of the large group assumption (DIXIT-STIGLITZ [1977]), we obtain the pricing rule $p_{ii} = [(\sigma\beta)/(\sigma-1)]\, w_{m1}$, which means that firms set prices as a constant mark-up over marginal costs. From the same conditions we obtain the relationship between c.i.f. and f.o.b. prices: this is, $p_{21} = (1/\tau)\, p_{11}$. Finally, the level of output for each firm, is independent of location, and obtains from the zero-profit condition. This is: $x^s = \alpha/\beta\,(\sigma-1)$.

2.5. Migration Decisions

Workers are assumed to move to the location that yields the highest indirect utility V_{mi}. Taking account of expectations and costs of moving would render the model, perhaps, more realistic but it would astray attention from the rather straightforward logic of this model. For the purpose of this paper I stay with this simple partial adjustment assumption widely adopted in the literature (KRUGMAN [1991], KRUGMAN and VENABLES [1996] among others). By use of (3), and recalling that workers are not taxed, the indirect utilities differential between location in country *1* and *2* is: $\Delta V_m = V_{m1} - V_{m2} = w_{m1}/P_1^\mu - w_{m2}/P_2^\mu$. It is apparent how no incentive or disincentive to migrate is a direct consequence of taxation.

3. Since the demand functions for each differential commodity are the same, henceforth I omit the index k. These demand functions refer to net quantities desired for consumption in I after accounting for the quantities perished in transport.

4. Since the technology is the same for each firm regardless of the country of location, there is no need to index the production function in order to identify each variety.

The law of motion is assumed to be described by the following differential equation:

$$\frac{d\lambda}{dt} = (V_{m1} - V_{m2}) \tag{5}$$

2.6. **Equilibrium**

Markets for factors within each country are assumed to clear at any instant for any given value of λ. The market clearing conditions for farmers are trivial. From the market clearing conditions for workers we derive the number of varieties produced in each country (at any instant) as well as the total number of varieties N. These are $n_1 = \lambda\mu/\alpha\sigma$, $n_2 = (1-\lambda)\,\mu/\alpha\sigma$ and $N = \mu/\alpha\sigma$. The markets for goods are also assumed to clear at any instant for any given value of λ. The equilibrium conditions are the following:

$$\begin{aligned} p_{11}\,x^d_{11} + p_{21}\,x^d_{21} + \mathrm{PEX}_{11} + \mathrm{PEX}_{21} &= p_{11}\,x^s \\ p_{22}\,x^d_{22} + p_{12}\,x^d_{12} + \mathrm{PEX}_{22} + \mathrm{PEX}_{12} &= p_{22}\,x^s \end{aligned} \tag{6}$$

Public expenditures appear in their general form. It is clear that when each of the two regimes will be analyzed, the PEXs will be replaced by their corresponding specifications. To explore the dynamics I follow KRUGMAN [1991] and proceed to plot a sequence of numerical solution to the (6). The plot of this sequence yields a sort of "numerically calculated phase diagram". In the rest of the paper I will refer to a generic distribution of workers as "λ", to an unstable equilibrium distribution of workers as "λ*", and to a stable equilibrium distribution of workers as "λ**".

3 The Performance of the Model

This model contains seven or more parameters, depending on the public expenditure regime; namely, the Structural Parameters (henceforth SPs) μ, σ, τ, plus the Public Expenditure Parameters (henceforth PEPs) G_1, G_2, δ_1, δ_2; ψ_1, ψ_2, δ'_1, δ'_2. Since this model builds on the core-periphery, I first choose a benchmark case that contains only the SPs (the core-periphery model). Second, I will compare it with cases containing the PEPs (core-periphery *cum* public finance).

3.1. **A Benchmark Case: the "Simple" Core-Periphery**

I replicate the substance of the core-periphery by assigning actual values to the three structural parameters. This exercise will yield the same results as in KRUGMAN [1991]. Figure 1 shows the sequence of numerical calculations of the indirect utilities differential for values of λ from zero to 1. The values of μ and σ I chose for the benchmark case are respectively 0.3 and 4. The

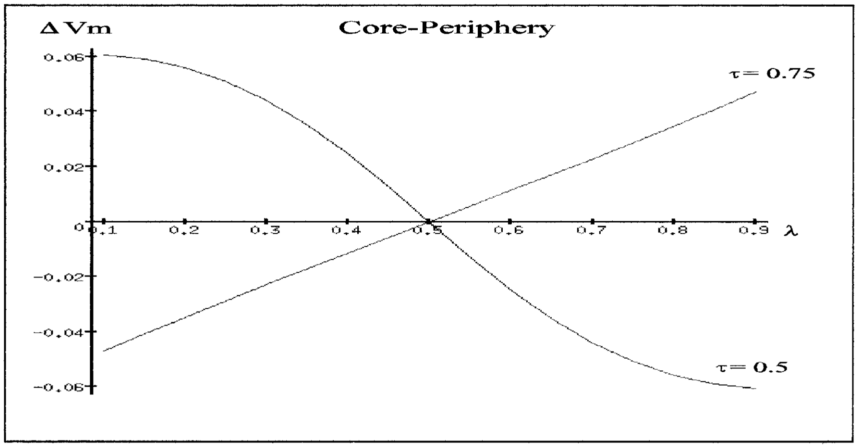

FIGURE 1

figure shows the two cases of $\tau = 0.75$ and $\tau = 0.5$. In the first case, complete specialization emerges as a long run equilibrium (i.e., $\lambda^{**} = 1$, or $\lambda^{**} = 0$ and $\lambda^{*} = 1/2$). In the second case incomplete specialization emerges as a long run equilibrium (i.e., $0 < \lambda^{**} < 1$). Which of the two situations occurs depends crucially on the level of transport costs. There is a level of transport costs that, other things being equal, is a threshold between complete and incomplete specialization in the long run. This paper shows that in the presence of public expenditure, regardless of transport costs, incomplete specialization occurs as a stable equilibrium. This result will prove to be robust also to changes in σ and μ. Moreover, the value of λ^{**} will reflects the allocation of public expenditures.

3.2. **Core-Periphery *cum* Public Finance**

Introducing public expenditure I shall consider the two spending regimes illustrated above.

3.2.1. **Domestic Government Procurement**

The allocation of public expenditures is as described in identity (2). The values of μ and σ are as in the benchmark case. The PEXs are: $\mathrm{PEX}_{11} = \delta_1 G_1/n_1$, $\mathrm{PEX}_{22} = \delta_2 G_2/n_2$, and $\mathrm{PEX}_{12} = \mathrm{PEX}_{21} = 0$. First I introduce public expenditure in an "even" way, namely, $\mathrm{PEX}_{11} = \mathrm{PEX}_{22}$. This will help us focusing on some key concepts. The values of government expenditures are as follows: $G_1 = G_2 = 0.05$; $\delta_1 = \delta_2 = 1$. Figure 2 shows calculations for three values of τ, namely: 0.5, and 0.75 (as in figure 1), and 1.

In figure 2 it appears that, in all the three cases, as λ approaches one (zero), the value of ΔV_m approaches $-\infty\,(\infty)$. This asymptotic behaviour at the two extremes, is robust to changes in μ, σ, and τ (not shown in figure). To understand this mathematically consider the expression for the

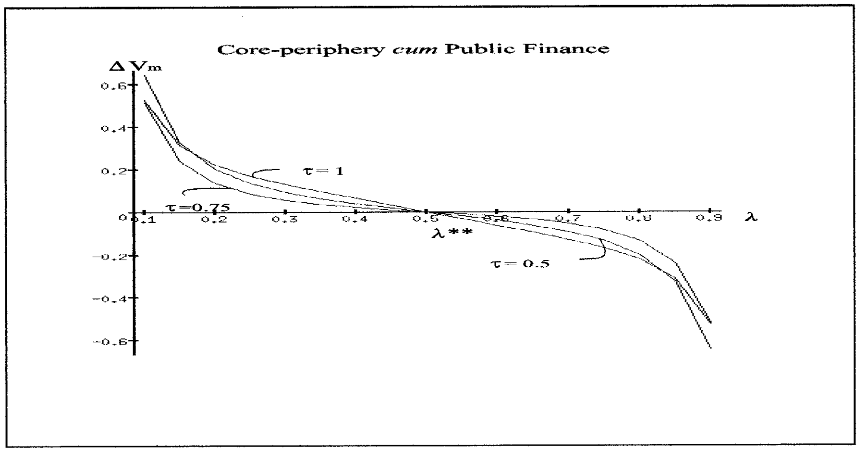

FIGURE 2

PEXs, these are: $\text{PEX}_{11} = (\delta_1 G_1)/\lambda\mu$; and $\text{PEX}_{22} = (\delta_2 G_2)/(1-\lambda)\,\mu$. These expressions show that as firms move out of country *1* (i.e., as λ tends to zero) government *1*'s expenditure on each domestic variety (PEX_{11}) goes to infinity, while government *2*'s expenditure on each of its domestic variety (PEX_{22}) goes to a finite number, namely to $\delta_2 G_2$. In terms of equations (6) this means that the left-hand side of the first equation goes to infinity while the left-hand side of the second equation remains finite. Consequently, since x^s is constant, it must be that p_{11} goes to infinity while p_{22} stays finite. But since prices are linked to wages through the mark-up relationship (see Section 2.4) if p_{11} goes to infinity so does w_{m1} and, consequently so does the indirect utility differential (note that the C.E.S. price indexes will always stay finite). The opposite happens as λ tends to one. This explains why $\Delta V_m \to \infty\,(\to -\infty)$ as $\lambda \to 0\,(\lambda \to 1)$. It is important to notice that this result does not depend on the magnitude of government expenditure. As it is clear by looking at the expressions for the PEXs, as long as $\delta_i G_i > 0$ (however small) it will always be the case that $\Delta V_m \to \infty\,(\to -\infty)$ as $\lambda \to 0\,(\lambda \to 1)$. In sum, while workers move from country *1* to country *2*, public expenditure on each variety of country *1* increases and public expenditure on each variety in country *2* decreases. This, in turn, would raise the indirect utility in country *1* and reduce it in country *2* despite the fact that the price index in country *1* increases and the price index in country *2* decreases. In other words, the more workers who leave country *1*, the larger the market in country *1* will be for those who stay [5]. It is apparent that complete specialization will not occur except as a result of policy.

5. It is worth pointing out that this mechanism would prevent complete specialization to occur as a long run equilibrium even if both workers and farmers are taxed, instead of farmers only. This is so because the burden of taxation would be divided between farmers and workers whereas public expenditure is "enjoyed" only by the workers.

Another interesting fact emerges as a corollary of the previous one. A well-known result of the core-periphery model is that "when transport costs are zero, location is irrelevant" (KRUGMAN [1991], p. 496). Figure 2 shows that in the *cum* public expenditure model, even in the absence of transport costs, location matters. In section A.1. of the appendix it is shown that the indirect utility differential is not zero when transport costs are absent, this means that public expenditure has *created* a new source of backward linkage.

Finally there is an important policy implication that flows from this result. Suppose, for instance, that governments build an inter-country railway instead of destroying steel and locomotives. This would show up in a contemporaneous reduction in transport costs (assume that the fall in transport costs in such that τ passes from 0.5 to 0.75). It is appearent that this would not modify the results of figure 2. Specifically it would not provoke the catastrophe pictured in figure 1 as predicted by the "simple" core-periphery model.

The next question is whether the long run equilibrium λ^{**} responds to the policy instruments (i.e., δ_1, δ_2, and G_1, G_2). The answer is positive. Indeed λ^{**} takes any "desired" value between zero and one in response to the setting of δ_1, δ_2, and G_1, G_2. This result is robust to changes in the structural parameters μ, σ, and τ. I discuss the details in the following three representative examples.

Example 1. The SPs are the following: $\mu = 0.3$, $\sigma = 4$ (these two as in the benchmark case), and $\tau = 1$. The PEPs are: $G_1 = G_2 = 0.05$; $\delta_1 = 1$, and I let $\delta_2 = 1$ in one case and $\delta_2 = 0.5$ in the other case. These two cases are depicted in figure 3. When $\delta_2 = 1$, the governments' expenditures affect the markets in the two countries evenly (i.e., $\mathrm{PEX}_{11} = \mathrm{PEX}_{22}$), and thus $\lambda^{**} = 1/2$. When $\delta_2 = 0.5$, locating in country *1* is relatively advantageous simply because the public expenditure is larger there ($\mathrm{PEX}_{11} > \mathrm{PEX}_{22}$). Therefore, the equilibrium location of manufacturing λ^{**} will shift to the right as shown in figure 3 and country *1* will get a larger share of manufacturing. In the appendix it is shown that in this example $\lambda^{**} = \delta_1 G_1/(\delta_1 G_1 + \delta_2 G_2)$. This shows that in order to influence the long run equilibrium it is sufficient to act on the allocation of expenditure (the deltas) rather than on the level (the Gs). This is important because it enhances the viability of the policy instrument. Moreover, it appears that λ^{**} takes values in the full range $[0, 1]$ in response to the allocation of expenditure. I call this result "the full effectiveness of allocation of expenditure".

Example 2. In this example the robustness of the "full effectiveness of allocation of expenditure" with respect to the structural parameters is examined. In order to do so the same values as in example 1 are assigned to the PEPs; conversely, the value of the SPs are changed to: $\mu = 0.5$, $\sigma = 4$, and $\tau = 0.75$. The result is shown in figure 4 which shows calculations for $\delta_2 = 1$, and $\delta_2 = 0.5$. When this case occurs, the effectiveness of the sole allocation is limited. Suppose the equilibrium had settled at $\lambda^{**} \approx 0.18$. If now δ_2 falls to 0.5, λ^{**} increases to approximately 0.3; if δ_2 falls further down, λ^{**} moves all the way above 0.9. By simply changing the allocation of expenditure, therefore, it is not possible to reach values of λ^{**} between 0.3 and 0.6. I call this case "limited effectiveness of allocation of

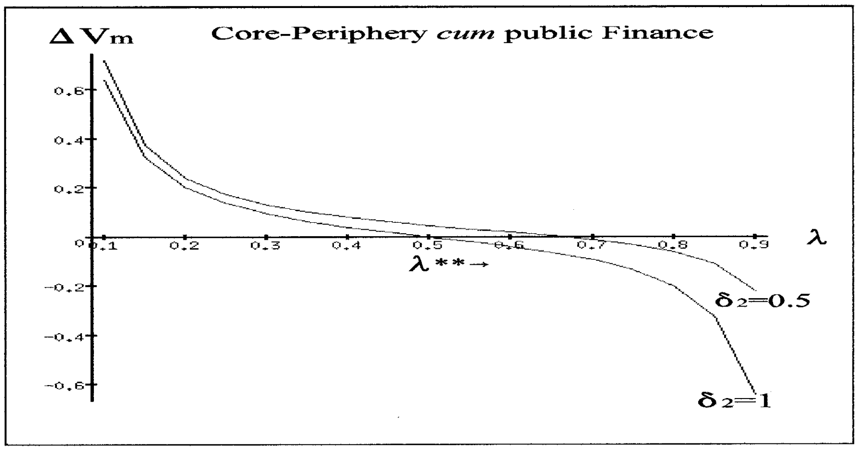

FIGURE 3

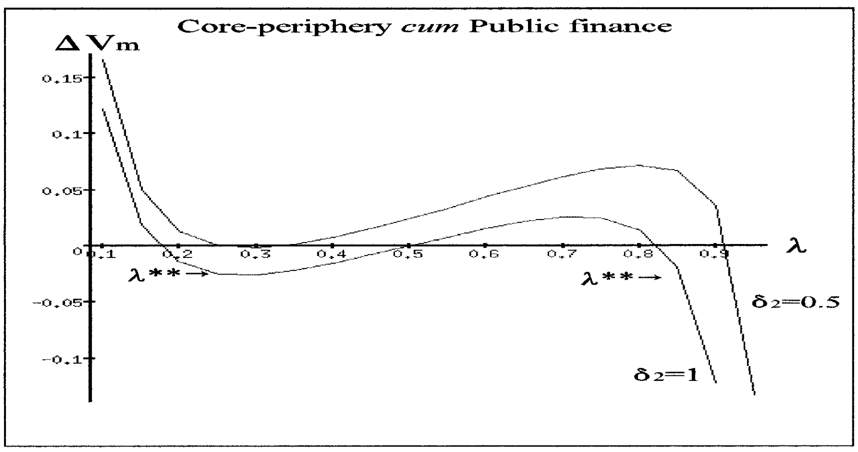

FIGURE 4

expenditure". Effectiveness is limited but not eliminated. It is still possible to obtain values of λ^{**} between the intervals $[0, \approx 0.3)$ and $(\approx 0.7,\ 1]$ by simply acting on the allocation of expenditure. Further, it remains true that incomplete specialization is the long run result [6].

6. Incidentally, an additional result emerges: in the *cum* public finance model it is possible that a series of stable and unstable equilibria, in which both countries have non-zero manufacturing, may occur (in our example there are two λ^{**} approximately at 0.18 and 0.82 in the case of $\delta_2 = 1$). The outcome does not appear to be a feature of the "simple" core-periphery model with only two countries (KRUGMAN [1991], p. 492, fn 3).

Example 3. When parameters are as in example 2, if the level of expenditure is increased enough, full effectiveness of allocation holds again. On the contrary, if public expenditure is set at zero in both countries, the model collapses into being the core-periphery and precisely into a case of complete specialization. This is summarized in figure 5 which shows the case $G_1 = G_2 = 0$, the case $G_1 = G_2 = 0.05$, and the case $G_1 = G_2 = 0.15$.

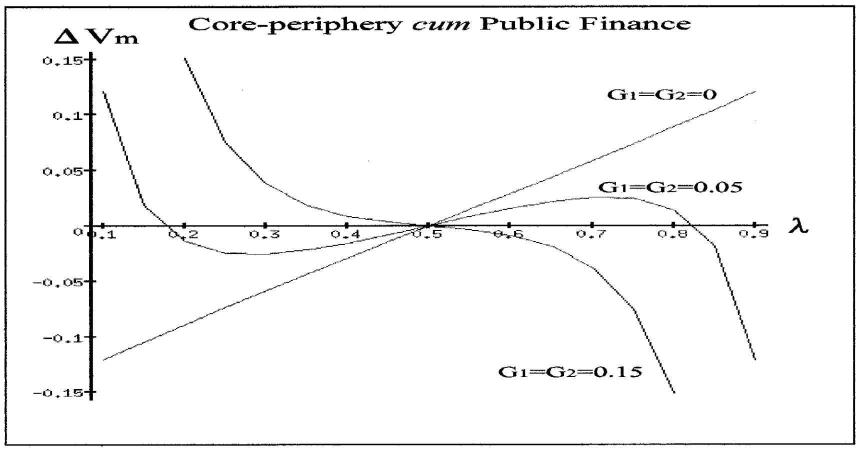

FIGURE 5

Many controlled numerical calculations have shown that the cases of full effectiveness are “more frequent” than cases of limited effectiveness.

3.2.2. **Liberalized Procurement**

The mechanism through which public expenditure affects location under this regime is the same as in the domestic procurement regime. Therefore I will not show additional figures, rather I discuss briefly the results. Public expenditure is allocated as explained by identity (1). The PEXs are: $\mathrm{PEX}_{11} = (\psi_1\, \delta_1\, G_1)/n_1$; $\mathrm{PEX}_{22} = (\psi_2\, \delta_2\, G_2)/n_2$; $\mathrm{PEX}_{21} = (1 - \psi_2)\, \delta_2'\, G_2/n_1$; and $\mathrm{PEX}_{12} = (1 - \psi_1)\, \delta_1'\, G_1/n_2$. In order to examine the responses of λ^{**} we have to control for six parameters (besides G_1 and G_2). For clarity of exposition I will treat them in pairs.

a) Degree of liberalization of government procurement: the larger the ratio (ψ_1/ψ_2) is, the larger λ^{**} is. This effect will be larger, the larger the value of δ_1' and δ_2'.

b) Allocation of public expenditure on foreign manufactured goods: the larger the ratio (δ_2'/δ_1'), the larger is λ^{**}. This effect is stronger the smaller is the value of ψ_1 and ψ_2.

c) Allocation of public expenditure on the domestic manufactured good: the larger the ratio (δ_1/δ_2), the larger is λ^{**}. This effect is stronger the larger the value of ψ_1 and ψ_2.

The results show that localization of manufacturing is not influenced by the degree of liberalization of government procurement *per se*; rather, it is influenced by the way foreign procurement is allocated. Indeed, it is possible that a government purchases a large part of its procurement abroad (small ψ), and that, at the same time, this has a very small effect in discouraging location in its country. This would be so because the largest part of foreign procurement is composed of the foreign homogeneous product (low δ'). The opposite case is also possible [7].

4 Intergovernmental Transfers

In order to examine the effects of the transfers on λ^{**}, it is convenient to look at how each transfer scheme affects the PEXs. This is done by comparing the total public expenditure on each variety in the presence of a transfer scheme with the total public expenditure on each variety without a transfer scheme. The analysis is cast in the framework of a liberalized government procurement regime. It becomes clear that the same conclusions apply, *mutatis mutandis*, to the case of domestic procurement. In the absence of transfers, the total public expenditures on each variety of country *1* and *2* are respectively:

$$(7) \qquad \begin{cases} \mathrm{PEX}_{11} + \mathrm{PEX}_{21} = \dfrac{1}{n_1}\left[\psi_1\,\delta_1\,G_1 + (1-\psi_2)\,\delta_2'\,G_2\right] \\ \mathrm{PEX}_{22} + \mathrm{PEX}_{12} = \dfrac{1}{n_2}\left[\psi_2\,\delta_2\,G_2 + (1-\psi_1)\,\delta_1'\,G_1\right] \end{cases}$$

Let us now consider pure transfers, tied aid, and joint expenditure in turn.

4.1. Pure Transfers

Under this scheme, government *2* transfers an amount "Tr" of its tax revenue to country *1* (the choice of the country is irrelevant). The budget constraints of the two governments thus become: $G_1 = T_1 + \mathrm{Tr}$; and $G_2 = T_2 - \mathrm{Tr}$. As a consequence of the transfer, the total

7. Abstracting from the specification of this model, imagine a case where country 1 buys steel and locomotives and (instead of destroying them) improves domestic infrastructures so as to make domestic location more appealing. This is not enough to attract firms, indeed the opposite result may happen. If all the material to build the infrastructures is bought from firms of country *2*, producers of country *1* may decide to relocate in *2* so as to enjoy the public demand for their product.

expenditures on each variety of government *1* and *2* become respectively: $\mathrm{PEX}_{11}+\mathrm{PEX}_{21}=(1/n_1)\,[\psi_1\,\delta_1\,(G_1+\mathrm{Tr})+(1-\psi_2)\,\delta_2'\,(G_2-\mathrm{Tr})]$; and, $\mathrm{PEX}_{22}+\mathrm{PEX}_{12}=(1/n_2)\,[\psi_2\,\delta_2\,(G_2-Tr)+(1-\psi_1)\,\delta_1'\,(G_1+\mathrm{Tr})]$. Comparing these expressions with (7) it appears that if $\psi_1\,\delta_1=(1-\psi_2)\,\delta_2'$ and $\psi_2\,\delta_2=(1-\psi_1)\,\delta_1'$ – call this case "symmetrical allocation" – the transfer has no effect on λ^{**}. This fact tells us that it is not a transfer *per se* that matters to the determination of the geographical distribution of manufacturing. For a transfer to be effective it is necessary that the allocation of expenditure is asymmetrical. Indeed, it is likely that asymmetry occurs. If this is the case, the effect of a transfer on λ^{**} can be either of two ways. If $\psi_1\,\delta_1>(1-\psi_2)\,\delta_2'$ and $\psi_2\,\delta_2>(1-\psi_1)\,\delta_1'$, then λ^{**} increases. Conversely, if $\psi_1\,\delta_1<(1-\psi_2)\,\delta_2'$ and $\psi_2\,\delta_2<(1-\psi_1)\,\delta_1'$ a transfer from country *2* to country *1* reduces the number of manufacturing firms in the country that receives the transfer. In the other two possible cases, the result depends again on the PEPs. It is interesting to notice that the effect of any transfer can be obtained also by means of an appropriate agreement on the setting of the parameters of government expenditures (an appropriate change in the ψs and the δs).

4.2. **Tied Aid**

One particular scheme of transfer is called Tied Aid (TA). With this scheme, country *2* transfers an amount "Tr" of its tax revenues to country *1* with the proviso that the latter spends the transfer on goods produced in country *2*. Expressions (7) become: $\mathrm{PEX}_{11}+\mathrm{PEX}_{21}=(1/n_1)\,[\psi_1\,\delta_1\,G_1+(1-\psi_2)\,\delta_2'\,(G_2-\mathrm{Tr})]$; and $\mathrm{PEX}_{22}+\mathrm{PEX}_{12}=(1/n_2)\,[\psi_2\,\delta_2\,(G_2-\mathrm{Tr})+(1-\psi_1)\,\delta_1' G_1+\delta_1'\mathrm{Tr})]$. By comparing these expressions with expressions (7) it appears that the effect of Tied Aid can be to either lower or raise the value of λ^{**}. If, for instance, government *2* spends a large portion of its tax revenues on domestic manufactures (large ψ_2 and δ_2) and, conversely, country *1* – however spending the received amount Tr on goods produced in country *2* – purchases only agricultural goods from country *2* ($\delta_1'=0$), the likely effect of the tied aid is to increase the number of manufactures produced in country *1*. Many cases may occur. The important point is that the effect of the tied aid, as well as of any transfer, depends on the public expenditure parameters.

4.3. **Joint Expenditure**

Under this scheme, the governments of the two countries pool their tax revenues and delegate the spending decision to an *ad hoc* authority named *union* [8]. The budget constraint of the *union* is therefore as follows: $G_u=T_1+T_2$. The *union* allocates its expenditure in the following way: $G_u=\psi_{1u}\,\delta_u\,G_u+\psi_{1u}\,(1-\delta_u)\,G_u+(1-\psi_{1u})\,\delta_u'\,G_u+(1-\psi_{1u})\,(1-\delta_u')\,G_u$.

8. It is assumed that all tax revenues are pooled instead of just a portion of them. This does not imply any loss of generality. Partial pooling is simple to work out.

In this expression the parameters have analogous meaning to those in expression (1). The PEXs are: $\mathrm{PEX}_{u1} = (1/n_1)\,(\psi_{1\,u}\,\delta_u\,G_u)$; and $\mathrm{PEX}_{u2} = (1/n_2)\,[(1-\psi_{1u})\,\delta'_u\,G_u)]$. A comparison of these expressions with expressions (7) shows that if $\mathrm{PEX}_{11} + \mathrm{PEX}_{21} = \mathrm{PEX}_{U1}$ and $\mathrm{PEX}_{22} + \mathrm{PEX}_{12} = \mathrm{PEX}_{U2}$, the joint expenditure scheme is not different from independent spending. If these equalities do not hold, many cases may occur. Yet the important point is that the likely effect on λ^{**} from switching from an independent spending scheme to a joint spending scheme depends on the parameters of public expenditure of the *union* respect to those of the countries.

5 Conclusion

This paper focuses on the effect of public expenditure on location in the framework of the core-periphery model. The major results are the following.

(1) Public expenditure in the core-periphery creates a new and independent source of geographical dimension; namely, a new source of backward linkage. This insures that incomplete specialization occurs in the long run. It has been shown that in all of the cases considered there was a stable equilibrium where the manufacturing was divided between the two countries. This result occurs regardless of the value of the structural parameters, in particular it has been shown that location matters even in the absence of transport costs.

(2) Public expenditure is an effective instrument that can be used to influence the long run geographical distribution of manufacturing (λ^{**}). This distribution, in fact, takes any desired value in response to the setting of the parameters of public expenditure. For a quite large constellation of values of the parameters, it is simply the allocation of expenditure that influences equilibrium location (λ^{**}), in these cases the level of expenditure can be small. This is important because enhances the viability of the instrument. For a small constellation of values of the parameters, it is necessary that the level of expenditure is high in order to obtain the same effectiveness on λ^{**}. The important policy implication of this two results is that deeper integration (i.e., reduction in transport costs) when accompanied by appropriate public expenditure never results in geographical agglomeration. Rather, the equilibrium location can be influenced through the use of the policy instrument.

(3) Transfer policies do not influence location *per se*. For the transfer to affect location it is necessary that the transfer implies a change in the overall allocation of public expenditures. In general, the effect of the transfer depends on the public expenditure parameters. It is possible that a transfer results in a decrease of the share of manufacturing present in the country that receives the transfer. Similarly, Tied Aid does not necessarily benefit the country awarding the transfer. Finally, should the countries abandon independent spending and decide to delegate the expenditure to an

independent authority, the effect on location would depend on the allocation of the authority's expenditure compared to the allocation of expenditure of the two countries.

There are many ways in which this model could be extended, three of which seem promising. First, the welfare effects of the use of the policy instrument could be investigated. This could lead to new results obtained from a political equilibrium type of set-up. Second, the location effects of re-distributional policies could constitute an interesting line of further research. Third, it would be desirable to enhance this analysis with some empirical work.

APPENDIX

A.1. When transport costs are absent ($\tau = 1$) the price index is the same in the two countries. Therefore the indirect utility differential depends only on nominal wages and it obtains from equations (6). Taking account of this, differential equation (5) becomes:

$$\frac{d\lambda}{dt} = \frac{1}{\mu}\left(\frac{\delta_1 G_1}{\lambda} - \frac{\delta_2 G_2}{1-\lambda}\right) \tag{8}$$

The fact that the indirect utility differential – right-hand side of (8) – is not zero when transport costs are absent shows how public expenditure has created a new source of geographical dimension. Plotting the phase diagram of (8) would show that the phase curve intersects the abscissae only once and with a negative slope, therefore the (single) equilibrium point is stable [9]. This (globally) stable equilibrium is at $\lambda^{**} = \delta_1 G_1/(\delta_1 G_1 + \delta_2 G_2)$. It is now straightforward to derive mathematically for the case $\tau = 1$ the results that have been obtained numerically for the cases $\tau \in (0, 1]$.

A.2. In order to focus on the new backward linkage created by government procurement in the text I used two strong assumptions: (1) government purchases are destroyed and (2) workers are not taxed. In this section I remove these assumptions and allow the model to take a more general formulation.

Governments are assumed to collect taxes and provide publicly an impure public good G (such as the mail service or the police service) [10]. They do it by use of a CES-Cobb-Douglas technology which uses labour of the homogeneous good sector and the varieties of the manufactured good. The government production function is:

$$G_1 = \left(\frac{1}{\mu}\left[\sum_{k=0}^{n_1} g_{11k}^{\frac{\sigma-1}{\sigma}} + \sum_{k=0}^{n_2} g_{12k}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}\right)^{\mu}\left(\frac{L_{AI}}{1-\mu}\right)^{1-\mu} \tag{9}$$

9. Differential equation (8) has separable variables and an explicit solution could be sought. For the purposes of the stability analysis, however, it is sufficient to study the qualitative behaviour of it.

10. By impure public good I mean a good which is "rival" but "non-excludable" and, therefore, subject to congestion in consumption. This definition, which I take from Barro and Sala-i-Martin [1992], departs slightly from the traditional Samuelsonian classification of public goods. Barro and Sala-i-Martin maintain that this definition comprises many types of public services, such as transportation, public utilities, courts of justice, highways and even national defense. There are several ways to determine the level of G. One possibility is that the government decides the level of G by solving an efficient provision problem. In this case the optimal level will be determined by the condition that the average willingness to pay equal the average cost of producing the public good. Another possibility is that domestic residents vote for the level of G. In this case the optimal level of G is determined by the condition that the willingness to pay of the median voter equal his or her contribution to the cost of providing G. In this model, given the assumption on the sub utility $u(G_1, L_1)$, it turns out that the optimal level of G is undeterminate. In what follows it is assumed that $\underline{G}_1 = \underline{G}_2 \equiv \underline{G}$.

Each government minimizes the amount of taxes necessary to finance the production of a given level of government good $\underline{G}$. Thus the government problem is:

$$(10) \quad \text{Min}\, T_1 = \sum_{k=0}^{n_1} p_{11k}\, m_{11k} + \sum_{k=0}^{n_2} p_{12k}\, m_{12k} + L_{1A} \quad \text{s.t.} \quad G = \underline{G}$$

The government's demand for each variety as input are: $g_{11} = p_{11}^{-\sigma}\, P_1^{\sigma-1}\, \mu\, T_1$; and $g_{12} = p_{12}^{-\sigma}\, P_1^{\sigma-1}\, \mu\, T_1$. The cost function of this minimization problem is $T_i = \underline{G}\, P^{\mu}$. The liberalized government procurement regime is considered and, for convenience, we set $\psi_i = 1/(1 + \tau^{\sigma-1})$.

Each individual in country *1* (the choice of the country is irrelevant) maximizes the following utility function:

$$(11) \; U_1 = \left(\frac{1}{\mu} \left[\sum_{k=0}^{n_1} c_{11k}^{\frac{\sigma-1}{\sigma}} + \sum_{k=0}^{n_2} c_{12k}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \right)^{\mu} \left(\frac{C_{AI}}{1-\mu} \right)^{1-\mu} + u\,(G_1,\, L_1)$$

We have made the strategic simplification that households' utility function parallels governments' production functions. The sub-utility $u\,(G_i,\, L_i)$ reflects the congestion in consumption of the public service. For simplicity it is assumed that the sub-utility $u\,(G_i,\, L_i)$ takes the form $u\,(G_i,\, L_i) = G/L_i$. Both farmers and workers are taxed. Governments adopt the Lindahl's taxes which, in this set up, turns out to be a poll tax [11]. The budget constraint of the individual in country *1* and belonging to sector *h* incorporates this fact:

$$(12) \; \sum_{k=0}^{n_1} p_{11k}\, c_{11k} + \sum_{k=0}^{n_2} p_{12k}\, c_{12k} + C_{AI} = w_{hl} - \frac{T_1}{L_1}; \qquad h = s,\, m,\, g$$

Workers are assumed to move to the location that yields the highest indirect utility V_{mi} according to the migration equation (5) in the text. The indirect utility of workers in country/state *1* is:

$$(13) \; V_{M1} = \left(\frac{w_{M1} - T_1/L_1}{P_1^{\mu}} \right) + u\,(\underline{G},\, L_1) = \frac{w_{M1}}{P_1^{\mu}} - \frac{\underline{G}_1}{L_1} + u\,(\underline{G}_1,\, L_1)$$

The second equality is obtained by use of the fact that $T_i = \underline{G}_i\, P_i^{\mu}$. The indirect utility differential $\Delta V_M = V_{M1} - V_{M2}$ is therefore:

$$(14) \; \Delta V_M = \left(\frac{w_{M1}}{P_1^{\mu}} - \frac{w_{M2}}{P_2^{\mu}} \right) - \left(\frac{G_1}{L_1} - \frac{G_2}{1 - L_1} \right) + \left[u\,(G_1,\, L_1) - u\,(G_2,\, L_2) \right]$$

There are three channels through which governments influence location decision. To these three channels correspond the three terms in (14).

11. As known, Lindahl's taxes are designed to support the efficient provision of public good.

The first term in (14) is the real wage differential as it emerges from market equilibrium conditions (6). The second term reflects international (or interstate) differences in taxation. The third term points at the differences in the level of public services. Most of the literature on location theory and on fiscal competition has focused on the last two terms (for a review of former see NIJKAMP and MILLS [1986]; for the latter see RAZIN and SADKA [1994]. In this literature, in order to influence location, governments intervene directly on the last two terms in (14). For instance, governments may adopt a tax scheme that favours the mobile factor, thus influencing location through the second term in (14); or may offer infrastructures, services, or amenities so influencing location through the third term in (14). In this paper none of these channels is at work Notice that the last two terms in (13), as well as in (14), cancel out. The absence of these channels does not mean that they are not important. Simply, in models of economic geography there is a third channel trough which governments affect location. A channel that has not been explored so far in the literature. This is the effect that goes through the first term in (14). Government procurement, as a component of aggregate demand, affects equilibrium prices and wages (see equation (6)) and through that it affects migration decision. As this channel has a strong impact on the spacial configuration of economic activity this paper has focused on it, so neglecting (for clarity of exposition and for tractability of the model) the other two traditional channels.

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