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# SUBSIDIES TO POOR REGIONS AND INEQUALITIES: SOME UNPLEASANT ARITHMETIC

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# ABSTRACT

## Subsidies to Poor Regions and Inequalities: Some Unpleasant Arithmetic*

This paper analyses the effect of different types of regional subsidies to poor regions on industrial location, employment, income inequality – between and inside regions – and welfare. We show that the impact on location of such subsidies is stronger when trade costs are low. When firms are mobile, regional subsidies that take the form of tax breaks or subsidies to the fixed cost lead to higher profits for all firms, even those not located in the region that gives the subsidy. If financed at the national level, such subsidies given to firms in the poor region increase regional income inequality as the rich region owns more capital. Hence, even though they constitute an official financial transfer from the rich to the poor region, they actually lead to an income transfer from the poor to the rich region. It also leads to higher inequality within regions. When financed at the local level, subsidies succeed in attracting firms. Besides, as regional subsidies to firms of the manufacturing sector in the poor region alter local competition and firm size, they may actually lead to a decrease of regional employment and production of that sector in the poor region. Finally, with relocation costs, such regional subsidies may hurt the poor region.

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## I. Introduction

One third of the EU budget goes to regional policies. This is the second item on the budget just after the Common Agricultural Policy and will account for €213 billion for the 2000-2006 period. On top of this, national governments themselves also spend large amounts on regional policies and subsidies or "State Aid" which are allowed by the EU up to a certain degree, which depends on how "disadvantaged" the region is. A substantial share of the budget of regional policies at the EU or at the national level, consists of direct or indirect subsidies to private firms located in poor regions. In the United States, Bartik (2002) estimates that roughly $20–30 billion in state and local government spending is devoted to such economic development programs annually, mostly in the form of tax breaks, with perhaps another $6 billion annually in support from the federal government.

The prime objective of the subsidies in the EU is to attract economic activities in poor regions based on the assumption that this will decrease regional inequality, increase employment, wages, and productivity in those regions. In the EU jargon, they are also supposed to enhance "social cohesion" meaning that they are supposed to reduce inequalities in a more general sense[1]. The aim of this paper is to show that regional policies may have other less obvious effects that are less welcome from a political point of view. For this, we analyze different types of subsidies and their effects on industrial location, regional income inequality, profits, employment and inequalities between workers and capital owners. This analysis is done in a very simple general equilibrium model with agglomeration forces.

Several insights arise from the study of subsidies in the presence of agglomeration forces when firms are mobile.

[1] The extent to which European regional policies have been successful is the subject of a lively empirical debate: the Commission (1999) has found a positive effect of regional policies on regional growth over the short term, i.e. over a five- or six-year period. But those macroeconomic studies look at the macroeconomic effect at the country level only, not the regional level. Combes and Overman (2003) among others have shown that, even if income per capita has slightly converged between Member States, it has diverged at the regional level during the same period. Boldrin and Canova (2001) find no effect of regional policies on regional convergence. More precisely, they find no evidence (with the exception of Ireland) that regions which received EU funds grew faster than others. De la Fuente (2000) finds a more positive impact of the EU policies for Spanish regions. Finally, Midlefart-Knarvick and Overman ( 2002) found that the geography of manufacturing remained very stable at the national level, while becoming more concentrated at the regional level since the 1980s.

Regional subsidies do attract firms – a result that would hold in almost any model, including models without agglomeration forces. Our first insight is that the impact of the regional subsidies becomes greater the higher is the level of goods-market integration. This is just a corollary of the home market effect, present in new trade models, but it has implications for regional integration. For example, if regional integration in the EU or among developing countries (MERCOSUR) and more generally if the decrease in transport costs continues to lower trade barriers without changing the level of permissible subsidies to firms in remote regions, the subsidies will lead to an increased distortion of the spatial allocation for industry.

The second insight is that when firms are mobile, regional subsidies to firms in one region lead to higher operating profits in *all* regions as the equilibrium geography is such that profits are equalized across regions. Thus, even firms that do not directly benefit from regional subsidies gain indirectly through the distortion on regional competition: as firms relocate to the region that provides the subsidies, competition becomes weaker in the other region so that profits increase there too. This raises interesting questions on the relation between spatial inequalities and individual inequalities, especially between immobile workers and owners of mobile capital and the impact of regional policies on these types of inequalities. Implicitly or explicitly, regional policies are based on the belief that if spatial inequalities are decreased then inequalities in general will be decreased. In a situation where capital is mobile but workers are not (or less so), this is not true. Not only do such subsidies increase inequalities between workers and capital owners. A subsidy given to firms that locate in the poor region can actually worsen nominal income inequality between the poor and the rich region: if profits increase due to the subsidy and most capital owners are in the rich region then these capital owners will disproportionately benefit from the subsidy intended to the poor region, and so will the rich region too. Hence, the subsidy to the poor region actually leads to a transfer from the poor to the rich region even when the subsidy is financed by a national proportional tax on income which falls therefore more heavily on the rich region. Another way to say this is that even though there is an official net transfer from the rich to the poor region, the net effective transfer of income is from the poor to the rich region. For this result to hold, it is not necessary that capital owners of the rich region own the firms that benefit from the subsidy in the poor region but simply that firms be mobile.

The third insight concerns the effect of the way subsidies are financed. Financing the subsidy requires a tax that reduces market potential, and so firms profits. Regional subsidies that

are financed at the national level have the largest effect on relocation. When the subsidy is financed by the region itself, the local tax that satisfies the budget constraint decreases local demand, and so reduces the initial impact of subsidy on relocation. Even when financed locally, regional subsidies lead to relocation in the region that gives the subsidy. Another way to put it is that the negative effect of taxing regional expenditure is more than compensated by the subsidies to regional production. A fourth insight is that whatever the way the subsidy is financed, and even though it targets firms of the manufacturing sector, it may lead to a decrease of employment and output of that sector in the poor region. The reason is that as firms relocate to the poor region, the increase in competitive pressure implies a decrease in their size.

Finally, we analyze the effect of relocation costs. If they are high enough so that subsidies for firms located in the poor region lead to no or little relocation, then the subsidy actually hurts the poor region because it generates a transfer from the poor to the rich region.

In what follows we will analyze the effects of a local subsidy to firms producing in poor regions in a general equilibrium model of endogenous location. Three types of subsidy are successively studied: 1) a subsidy to profits of firms that locate in the poor region, that can be interpreted as a tax break 2) a lump sum subsidy to firms that locate in the poor region. This can be interpreted as lump sum tax break or a subsidy to the fixed cost, such as when land is given (or sold below market price) to the firm to build the plant. 3) a subsidy to production of firms located in the poor region, such as subsidies proportional to the number of jobs created by the firms. They work as a decrease of the variable cost of production. This is for example the case in France with the main instrument of regional policy, the *Prime d'Aménagement au Territoire* (PAT) which gives to firms located in poor regions a subsidy of around 10000$ per job created. Because the subsidy is given once and for all and that it can also finance R&D of those firms, the PAT has also the characteristic of a lump sum subsidy. France however appears as an exception in Europe. Most countries subsidize investment rather than employment at the regional level and this translates into subsidies to capital rather than labor (see Yuill et al, 1994 and Fuest and Huber, 2000). An important example is the subsidy program provided to Eastern Germany. According to Fuest and Huber (2000), 90% of the subsidies to firms locating in Eastern Germany take the form of investment subsidies. At the European level, more than 400 types of subsidies exist that can help firms in poor regions. They take so many forms that it is difficult to put them in one of these three categories. It seems quite safe to characterize them as a complicated mix of the three.

The existing papers most related to ours analyze the effect of taxes and subsidies in economic geography models. This is the case of Baldwin et al. (2003) who show that the impact of subsidies or taxes is subject to threshold effects, discontinuities and hysteresis which come directly from the "catastrophic" nature of the new economic geography models started with Krugman (1991). They also revisit the analysis of tax competition in geography models with agglomeration effects. This is also the case of Haufler and Wooton (1999), Ludema and Wooton (2000) and Baldwin and Krugman (2003). The closest paper is the one by Robert-Nicoud and Sbergami (2002) who analyze the effect of subsidies on location in a political economy model. The political structure they study is much richer than ours but they do not focus on the redistributive consequences of regional subsidies and assume lump sum taxes. Also, Forslid (2003) analyses similar issues in a three-region model. Finally, Owens and Sarte (2002) analyze in a very different model the impact of regional subsidies in a model with moving costs and market power to show that these subsidies can be used to reach a more efficient spatial allocation of firms.

The next section presents the framework, based on a model with capital mobility, labor immobility, increasing returns, the existence of operational profits and trade costs. To build up intuition we then analyze in section III a partial equilibrium version of the model where the issue of financing is overlooked. The general equilibrium analysis is presented in section IV: both subsidies to profits and lump sum subsidies, which are similar in their effects, are studied. Section V shows that regional subsidies to production have quite different effects on location and income inequality. Welfare and individual inequality issues are studied in section VI. Finally, we analyze the effect of relocation costs in section VII.

## II. Basic Framework

We will analyze the effect of regional subsidies in the "footloose capital" model developed by Martin and Rogers (1995) and further analyzed in Baldwin et al. (2003).

This model features agglomeration, if we define agglomeration as the tendency of economic activity to generate forces that encourage further concentration of economic activity. Agglomeration stems from the home-market effect, which implies that a more than proportionate share of industry locates in the larger market. Agglomeration in the footloose capital model,

however, is not self-reinforcing : there is no circular causality as in Core-Periphery models (Krugman 1991, Venables 1996), as there is neither labor mobility nor vertical linkages. In the footloose capital model, location of mobile capital is determined by an arbitrage condition that equalizes profits across regions. We will only analyze the case of perfect capital mobility so that issues of stability and catastrophic agglomeration are ignored. It means that capital incomes must not be consumed in the region where capital is located : profits can be repatriated and firms can relocate without costs. In this case the stock of capital is exogenous, and the value of capital is given by profits.

## II.1. Assumptions

There are two regions (North and South), two sectors, and two productive factors. Regions are symmetric in terms of tastes, technology, openness to trade, and labor endowments. The two sectors are referred to as manufacturing and traditional sector, and manufacturing is marked by increasing returns, monopolistic competition and iceberg trade costs. The traditional sector is assumed to produce a homogeneous good under Walrasian conditions (constant returns and perfect competition) and its output is traded costlessly.

The product factors are physical capital K and labor L, with K being the mobile factor and labor being the immobile factor. Physical capital can be employed in one region while its owner spends its reward in the other region – something that is clearly impossible when factors are associated with people as in the core-periphery model of Krugman (1991). Moreover, capital is only employed as a fixed cost of industrial firms; the variable cost only involves labor.[2] Importantly, the footloose capital model assumes that capital owners are completely immobile across regions. Thus, when pressures arise to concentrate production in one region, physical capital will move, but all of its reward will be repatriated to its country of origin. Total supplies of capital and labor are fixed, with the world's endowment denoted as $K^w$ and $2L$.

Because physical capital can be separated from its owners, the region in which capital's income is spent may differ from the region in which it is employed. We must therefore distinguish the share of world capital owned by Northern residents (we denote this as $s_K{}^o K/K^w$)

from the share of world capital employed in the North. Because we assume that each industrial variety requires one unit of capital (see below), the share of the world capital stock employed in a region exactly equals the region's share of world industry. Consequently, we can use North's industry share, i.e. $s_n \equiv n/(n+n^*)$, to represent the share of capital employed in the North and the share of all varieties made in the North ($n$ is the number of firms producing in the North, asterisk refers to the South).

The cost function of a typical industrial firm (the increasing-returns sector) is non-homothetic; the factor intensity of the fixed cost differs from the factor intensity of the variable cost. To keep things simple, we make the extreme assumption that the fixed cost involves only capital and the variable cost only involves labor. More specifically, each industrial firm requires one unit of $K$ and $a_m$ units of labor per unit of output. The implied cost function is: $p + w_L a_m x$

where $p$ and $w_L$ are the rewards to capital and labor, $a_m$ is the variable unit input requirement, and $x$ is firm-level output.

Technology in the traditional sector is kept as simple as possible. Producing traditional goods requires only labor, specifically, it takes one unit of labor to make one unit of this good. Note that this means that the increasing returns sector is intensive in the use of the mobile factor.

The representative consumer in each region has preferences given by:

$$\textbf{(2.1)} \qquad U = C; \qquad C \equiv C_M^{\mu} C_T^{1-\mu}, \quad C_M \equiv \left( \int_{i=0}^{n^w} c_i^{1-1/\sigma} \, di \right)^{1/(1-1/\sigma)}, \quad 0 < \mu < 1 < \sigma$$

where $C_M$ and $C_T$ are, respectively, consumption of the composite of manufacturing sector varieties and consumption of the traditional sector. Also, $n^w$ is the mass (roughly speaking, the number) of industrial varieties available worldwide, $\mu$ is the expenditure share on industrial varieties, and $\sigma$ is the constant elasticity of substitution between any two varieties. The indirect utility for the preferences in (2.1) is:

$$\textbf{(2.2)} \qquad V = \frac{E}{P}; \qquad P \equiv p_T^{1-\mu} \left( \int_{i=0}^{n^w} p_i^{1-\sigma} \, di \right)^{-\mu/(\sigma-1)}$$

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[2] Viewing K as physical capital, we can think of the fixed cost in the M-sector as a factory. We can also interpret it as a patent required to start the production of a variety.

where $E$ is Northern expenditure (i.e. after-tax disposable income), $P$ is 'perfect' price index, $p_T$ is the price of the traditional good, $p_i$ is the consumer price of industrial variety $i$ (the variety subscript is dropped where clarity permits).[3] Analogous definitions hold for Southern variables, all of which are denoted by an asterisk.

## II.2. Equilibrium without subsidies

### *Traditional Sector Results*

Utility optimization implies that the demand function for the traditional good is $C_T=(1-m)E/p_T$ . Perfect competition in this sector forces marginal cost pricing, i.e. $p_T = w_L$ and $p_T^* = w_L^*$. In addition, costless trade equalizes Northern and Southern prices and thus indirectly equalizes wage rates internationally: $w_L=w_L^*$ as long as some traditional good is produced in both regions. This condition – the so-called non-full-specialization (NFS) condition – requires that no region has enough labor to satisfy world demand for the traditional good. The exact condition is that total world spending on this good, namely $(1-m)E^w$, where $E^w$ is world expenditure, is greater than the maximum value of production that is possible by either region, namely $p_TL$. This is assumed to hold henceforth. Assuming workers are perfectly mobile between sectors, we get that wages are equalized in all sectors. Taking traditional good as numeraire, we get that wages are equal in both region to one : $p_T=w_L=p_T^*=w_L^*=1$.

### *Manufacturing Sector Results*

Utility optimisation yields a constant division of expenditure between sectors, and CES demand functions for industrial varieties implies:

**(2.3)** $$c_j \equiv \frac{p_j^{-s} mE}{\int_{i=0}^{n^w} p_i^{1-s} di}; \; E = pK + w_L L$$

where $E$ is region-specific expenditure (and income when there is no taxation), $p$ is the Northern rental rate of capital, $K$ is the Northern stock ok capital, $w_L$ is the Northern wage rate.

[3] Using standard terminology, $P$ is 'perfect' since real income defined with $P$ measures utility.

As usual, Dixit-Stiglitz monopolistic competition and (2.3) imply that 'mill pricing' is optimal for industrial firms, so the ratio of the price of a Northern variety in its local and export markets is just τ. Thus:

**(2.4)**
$$p = \frac{w_L a_M}{1-1/s}, \quad p^* = \frac{t w_L a_M}{1-1/s}$$

Normalizing $a_M = \frac{s-1}{s}$, and replacing $w_L$ by one, we get the pricing rules of firms in the increasing-sector : domestic price is one, and export price is τ.

### *The Mobile Factor's Reward*

Since physical capital is used only in the fixed cost component of industrial production, the reward to capital is the Ricardian surplus of a typical variety, i.e. the operating profit of a typical variety. Since each unit of capital can be used to produce one industrial variety, the reward to capital would be bid up to the point where it equalled operating profit.

Under Dixit-Stiglitz competition, this operating profit is simply the value of sales divided by $s$. In symbols, this means $p=x/s$, where $x$ is the scale of production, and an analogous expression holds for the Southern operating profit, $p^*$. Using the demand function and mill pricing, we can write these equilibrium expressions for $p$ and $p^*$ as:

**(2.5)**
$$p = b\frac{E^w}{K^w}\left[\frac{s_E}{s_n + f(1-s_n)} + \frac{f(1-s_E)}{s_n f + 1 - s_n}\right]; \; b \equiv \frac{m}{s} < 1; \quad f \equiv t^{1-s}$$
$$p^* = b\frac{E^w}{K^w}\left[\frac{s_E f}{s_n + f(1-s_n)} + \frac{(1-s_E)}{s_n f + 1 - s_n}\right]$$

where $E^w$ is world income, with $s_E$ and $s_E^* = 1-s_E$ being the North's and the South's share of expenditure ; $s_n$ is the North's share of industry, and $s_E$ is the North's share of expenditure. Note that with one unit of capital per variety, $s_n$ is both the North's share of industry and its share of world capital employed in the North while $n^w = K^w$. Finally $f$ is the usual transformation of transaction costs, reflecting the freeness of trade: $f$ equals 0 when transaction costs are infinite, and equals 1 when transaction costs are null.

***The case without subsidies:***

The total level of income of the country is the sum of labor and capital income:

**(2.6)** $$E^w = 2L + p$$

where we assume that the two regions are of equal size and normalize the total stock of capital $K^w$ to 1. In the long run, with free relocation, profits are equalized across regions so that $p = bE^W$ and $E^W = \frac{2L}{1-b}$.

The spatial distribution of capital ownership is exogenous and given by $s_K$. With the assumption that regions are of equal size, we can define North's income as $E = L + s_K p$. The Northern share of total expenditure is therefore given by

**(2.7)** $$s_E = \frac{1}{2} + \frac{b(2s_K - 1)}{2}.$$

The North's share of industry $s_n$ correspond to the geographical equilibrium, that is when profits are equalized across region. Solving $p = p^*$, we find

**(2.8)** $$s_n = \frac{1}{2} + \frac{(1+f)(2s_E - 1)}{2(1-f)}$$

We assume that the differences in income shares and therefore capital ownership are not too large so that location is always at an interior equilibrium with $s_n < 1$.

# III. The Location Effect of Regional Subsidies: partial equilibrium

## III.1. Regional subsidies proportional to operating profits

We start the analysis of the location effect of these policies by overlooking the financing issue: hence this is only a partial equilibrium analysis. We first look at the effect of subsidies on the location of firms in the manufacturing sector given income shares. To simplify further we analyze in this section only a subsidy proportional to operating profits for firms located in the

South. This can be interpreted as a tax break on profits for firms located in the South[4]. Such a tax break in the traditional sector does not change anything, as this sector has zero operating profits. This particular form of subsidy has no impact on wages and therefore on labor income. In the section where we analyze the effects of subsidies in general equilibrium, we also study the effects of a lump sum subsidy, and the case of a subsidy to production to firms locating in the South.

The condition that operating profits must be equalized for location of firms to be an equilibrium becomes in the case of subsidies to profits: $p = (1+z^*)p^*$ where z* denotes the subsidy proportional to operating profits for firms located in the South and $p$ and $p^*$ are the operating profits given by equation **(2.5)**.

Using the equality of operating profits and for a given distribution of expenditure $s_E$ (the share of expenditures in the North), which as we will see in the next section may be influenced by the subsidy itself, we get that the share of firms located in the North is:

**(3.1)** $$s_n = \frac{s_E(1-f^2) - f(1+z^* - f)}{(1-f)\left[1+z^* - f - z^* s_E(1+f)\right]} \qquad 0 < s_n < 1$$

As usual in geography models, the share of firms locating in a region is an increasing function of the share of expenditure of that region. Quite intuitively also, for a given distribution of expenditure $s_E$, an increase in subsidies to firms located in the South decreases spatial concentration in the North as:

**(3.2)** $$\frac{\partial s_n}{\partial z^*}_{s_E \text{ constant}} = -\frac{(1+f)^2 s_E(1-s_E)}{\left[1+z^* - f - s_E z^*(1+f)\right]^2} < 0$$

Note that lower interregional trade costs (higher $f$) magnify the relocation effect of the subsidy. The reason is that when those costs are low, firms are more willing to relocate to take advantage of a small differential in profits (whether due to market size or subsidies), as they can easily export to the region they leave. Profits in the North and in the South are given by:

[4] In the US, tax breaks, most notably reduced property taxes on new or expanded manufacturing facilities are the main instrument used for regional development (Bartik, Eisinger, and Erickcek 2003).

**(3.3)** $$p = (1+z^*)p^* = \frac{bE^w}{K^w}\frac{\left[1+z^*-f-s_E z^*(1+f)\right]\left(1+z^*\right)(1-f)}{\left[1-f(1+z^*)\right]\left[1+z^*-f\right]}$$

It can be checked that for a given level of total expenditure $E^w$, and expenditure shares $s_E$, firms' profits increase in both regions. In the South the reason is of course the subsidy. In the North, the reason is that as firms relocate in the South competition becomes less fierce and profits increase. Hence, the profit subsidy, in the case where capital is mobile, benefits firms in both regions.

### III.2 Regional subsidies and regional income inequality

If profits increase then regional income inequality may be affected by a regional subsidy because of possible regional inequalities in capital stocks ownership. Suppose that the EU funds a regional subsidy to attract firms in the South of Italy. If firms are mobile across the country, then the subsidy will raise profits for all firms in Italy so that capital owners, wherever they are located, will be the main beneficiaries of the policy. If most of the capital owners are in the North, which is quite plausible, then the subsidy whose objective is to help the South may actually increase income inequality between the two regions. We derive this somewhat paradoxical result here in a partial equilibrium framework where the issue of the financing of the subsidy is not considered. The next section conducts the analysis in general equilibrium. The total level of income and expenditure of the country is the sum of labor and capital income: $E^w = 2L + p$. The share of income of the North is: $s_E = \left(L + p\, s_K\right)/E^w$ where $s_K$ is the share of capital owned by Northerners which we assume to be more than 1/2, so that we take the North to be the rich region. We ask the following question: what does a small subsidy to firms located in the South do to regional income inequality which can be measured by $s_E$? It can first be shown that evaluated at $z^*=0$, a small increase in profits increases income inequality as long as where $s_K > 1/2$, using the fact that $p = \frac{2Lb}{1-b}$ for $z^*=0$ :

**(3.4)** $$\frac{\partial s_E}{\partial p}_{z^*=0} = \frac{(1-b)^2}{4L}\left(2s_K - 1\right) > 0$$

The subsidy is given to the South but it actually worsens nominal income inequality because Northerners benefit more from the subsidy than the Southerners. This is not due to the fact that Northerners own some firms located in the South but only to the assumption that the

North owns more capital than the South and that capital is mobile. Introducing a subsidy distorts local competition and increases capital owner's income, who are more numerous in the North. Hence, any increase in profits will raise regional income inequality because of unequal endowment in capital.

# IV. General equilibrium analysis

## IV.1. A local subsidy to profits financed by a national proportional income tax

Equation (3.1) tells us how the location of firms depends on the regional market size. Now we need to determine how the world distribution of expenditure is altered by changes in geography. The general equilibrium model accounts for four endogenous variables: the share of firms producing in the North $s_n$, the Northern share in total expenditure $s_E$, the equilibrium level of profits $p$ and that of the equilibrium tax rate $t$. We therefore need to solve four equations: the arbitrage equation which requires that profits are equalized across regions at geographical equilibrium, the budget constraint which just says the revenues of taxation on income must finance the subsidies, the resource constraint at the national level (of the labor market in this case), whereby labor supply is equal to labor demand which comes from the traditional and the manufacturing sectors, and finally the Northern share of total expenditure $s_E$.

We first look at the case in which the subsidy in the South is financed by a national proportional income tax. In this case, the share of expenditures in the North, $s_E$ , is not affected directly as both incomes and expenditures in the two regions are proportionately affected:

**(4.1)** $$s_E = \frac{(1-t)(L+ps_K)}{(1-t)(2L+p)}$$

It remains true that $E^w = 2L+p$ if we interpret it as pre-tax income. The government budget constraint implies:

**(4.2)** $$t(2L+p) = z^*(1-s_n)p^* = \frac{z^*}{1+z^*}(1-s_n)p$$

which says that national income taxation equals the subsidy rate ($z^*$) multiplied by the number of firms in the South $(1\text{-}s_n)$ and the equilibrium level of profits (net of the subsidy) $p^*$.

The resource constraint at the national level (of the labor market in this case) implies:

**(4.3)** $$2L = (1-t)(2L+p)(1-b)$$

This equation says that labor supply ($2L$) is equal to labor demand which comes from the traditional and the manufacturing sectors, which themselves come from the equilibrium on the goods market. This relation already uses the fact that in equilibrium, geography must be such that profits are equalized across regions. This then implies that as wages are not affected by the subsidies, profits must rise in both regions. This is because taxes are effectively a transfer from workers to capital owners. Equation (4.3) indicates that total expenditure must remain constant. Also equation (3.4) tells us how a change in profits affects regional income inequality. Finally, the location of firms is still determined by the arbitrage equation (3.1).

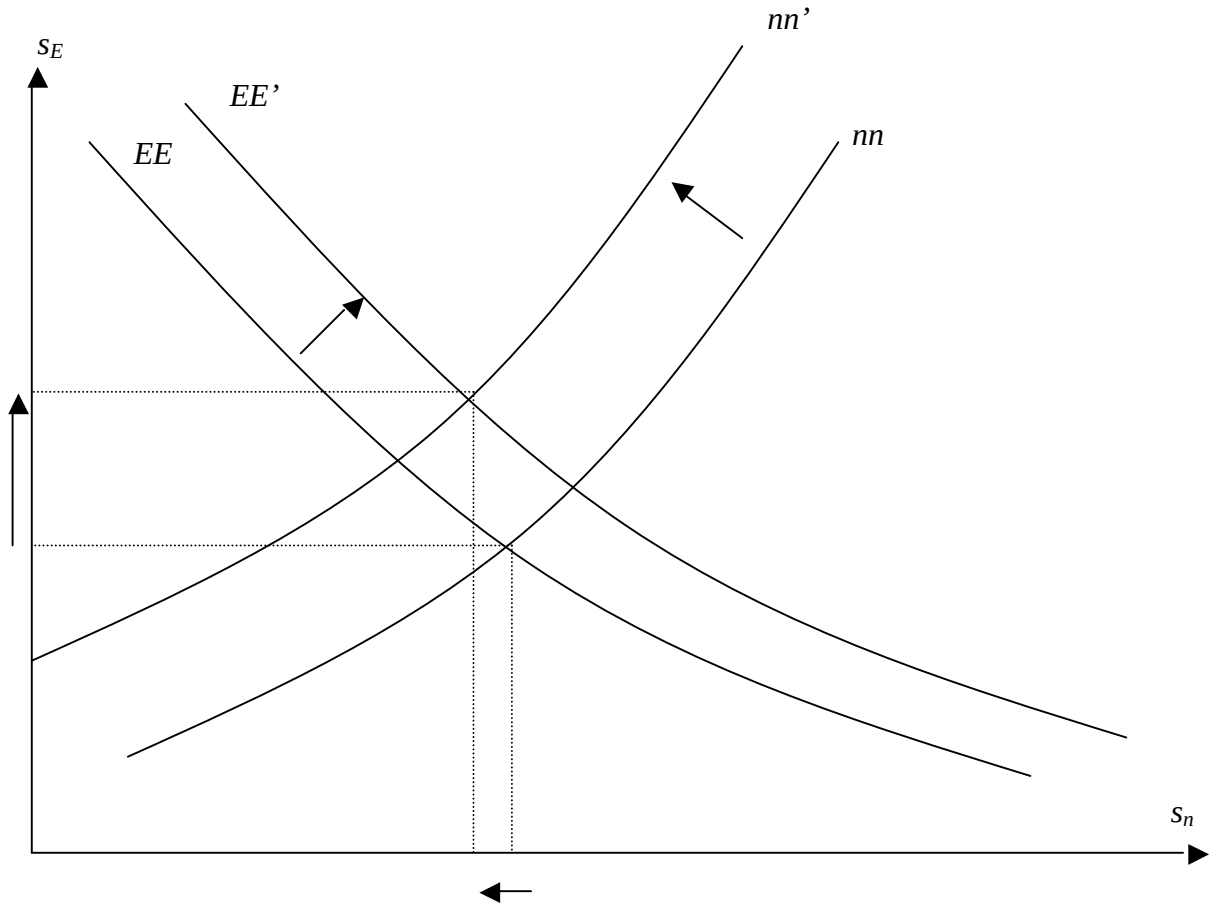
Putting these equations together, we get the following expression for the share of Northern expenditure:

**(4.4)** $$s_E - 1/2 = \frac{b(1+z^*)(2s_K - 1)}{2\left[1 + bz^*(1-s_n) + z^* s_n\right]}$$

This equation (we call it *EE* on figure 1 below) shows that for a given location of firms, the subsidy to Southern firms will increase income inequality in favour of the North as long as the North is richer than the South i.e. $2s_K - 1 > 0$ . Also, with positive subsidies, the share of income in the North decreases with spatial concentration in the North as less Southern located firms receive the subsidy.

Equation (3.1), the *nn* curve on figure 1 below, corresponds to the home market effect. The equilibrium location and income inequality is shown on figure 1 and is the solution to a quadratic equation too cumbersome to be revealing. An increase in subsidies to the South shifts both equilibrium relations. In equilibrium, income inequality rises and it can be shown that the net effect of the subsidy is a relocation towards the South.

Figure 1: the effect of a subsidy to firms in the South on firm location and income inequality




In the rest of the paper, we concentrate on the effects of small subsidies, i.e. we do comparative statics at $z^* = 0$. Profits (inclusive of the subsidy in the South) increase in both regions as:

$$\frac{dp}{dz^*}_{z^*=0} = \frac{dp^*(1+z^*)}{dz^*}_{z^*=0} = p(1-s_n) > 0$$

For income inequality, we get:

**(4.5)**
$$\frac{ds_E}{dz^*}_{z^*=0} = \frac{(1-b)(s_n - 1/2)(1-s_n)(1-f)}{1+f}$$

which says that regional nominal income inequality increases with the subsidy as long as the North has initially more firms than the South ($s_n > 1/2$) which means that the North has more capital than the South ($s_K > 1/2$ ). This is because the increase in profits mostly benefits the Northern region, which has more capital than the South. Note again that for this to be true, it is

not necessary for firms producing in the South and receiving the subsidy to be owned by Northerners. In general equilibrium, all that is required is that capital be mobile.

The policy implies an official financial transfer from the North to the South as the subsidy to Southern firms is financed by a proportional income tax: $tE$ is the share financed by the North and $tE^*$ for the South. As the South is poorer than the North, more of the subsidy is financed by the North than by the South. From this point of view, the regional policy looks redistributive towards the South. The general equilibrium analysis shows that the incidence of the subsidy is actually a net transfer of resources from the South to the North as the share of total income (which remains constant) that goes to the North increases. Again, capital mobility coupled with initial inequality of capital endowments (which presumably is the reason for the subsidy in the first place) explains that the subsidy is actually captured by Northerners..

At the same time, subsidies alter geography of production according to two opposite effects: first, firms relocate where income and expenditures rise because of the Home Market Effect; second, firms relocate where profit subsidies exist. The net effect is given by:

**(4.6)** $$\frac{ds_n}{dz^*} = -(1-s_n)\left[\frac{1}{2}(1-b)+bs_n\right] - \frac{f}{(1-f)^2} < 0 .$$

Using the restriction that $s_n < 1$ (the equilibrium is an interior one so that not all firms are located in the North), (4.6) is negative. Hence, the regional subsidy financed by a national proportional income tax leads to relocation of firms to the South. It can be checked that the effect of the subsidy of location increases with trade integration as measured by $f$ . The intuition is the same as in partial equilibrium. It can also be shown that the effect of the subsidy on relocation increases with trade integration (with $f$). Finally, because the region that receives the subsidy is poor and that regional income inequality increases with the subsidy, it can be checked that the general equilibrium effect is less than the partial equilibrium one (i.e. the absolute value of 4.6 is less than 3.2.).

It is important to note however that the size of firms of the manufacturing sector located in the South decreases (and increases in the North) as:

$$\frac{dx^*}{dz^*}_{z^*=0} = -s_n x^* < 0$$

As the subsidy leads firms to relocate in the South, local competition intensifies which reduces demand for each variety produced in the South. Hence, each firm produce less in the South. Also, the subsidy effectively implies a lower expenditure share in the South if it is poor which further reduces demand for varieties produced in the South. More firms of the manufacturing sector produce in the South but at a smaller scale. This is the reason why the subsidy has an ambiguous effect on employment (and output) in the manufacturing sector $L_M^*$. This effect is given by the combined effect on the number of firms and their size and reduces to:

**(4.7)** $$\frac{dL_M^*}{dz^*}_{z^*=0} = x^* \frac{s-1}{s}\left[-(1-b)(1-s_n)(s_n-1/2)+\frac{f}{(1-f)^2}\right]$$

Hence, for a poor region (so that $s_K$ and therefore $s_n > 1/2$), the effect of the subsidy to firms of the manufacturing sector on production and employment of this sector is ambiguous. It may be negative if trade integration between the two regions is low enough, i.e. if $f$ is low enough. This result is at first sight paradoxical. Note that it does not hold if the subsidy was given to a rich region (if $s_K$ and therefore $s_n \leq 1/2$). The intuition is simply that if $f$ is low then few firms will relocate in the South. The reason why the ambiguity only holds for the poor region is that the subsidy leads to a reallocation of expenditure and therefore demand to the capital rich region.

## IV.2. A local subsidy to profits financed by a local proportional income tax

Regional subsidies are not always financed at the national level. Some are financed at the regional level. In this case, the effect of subsidies on location of firms is not so clear. On the one hand, firms will be attracted by such subsidies. On the other hand, the increase in the local tax on incomes will lead to a smaller market size, which will hamper firms profits. We now assume that only Southerners are taxed, so that the share of expenditures in the North $s_E$ increases automatically via a tax effect:

**(4.8)** $$s_E = \frac{E}{E^W - tE^*},$$

where $E$, $E^*$ and $E^W$ still define respectively Northern income, Southern income and the world income before the tax, as given in the previous section.

The location of firms is still determined by equation (3.1). The Southern government budget constraint now implies:

**(4.9)** $$t(L+p(1-s_K)) = z^*(1-s_n)p^* = \frac{z^*}{1+z^*}(1-s_n)p$$

And the resource constraint (of the labor market again) is:

**(4.10)** $$2L = (1-b)\left[2L + p - t(L+p(1-s_K))\right]$$

By construction (taxes and subsidies are pure transfers) we know that total expenditure ($E^w$-$tE^*$) must remain constant and equal to $\frac{2L}{1-b}$. Finally from equation (4.8) and using (4.9) and (4.10) we get that regional nominal income inequality increases with the subsidy :

**(4.11)** $$\frac{ds_E}{dz^*}_{z^*=0} = b(1-s_n)s_K$$

Again, even though the subsidy is given only to Southern firms, capital mobility implies that in general equilibrium the income inequality must rise in favour of the North. The subsidy is effectively captured by northerners. Quite intuitively, it can be checked that the increase in income inequality is larger in the case of local financing than in the case of a national proportional tax.

Finally, we get the relocation effect of the local subsidy financed by a local proportional income tax :

**(4.12)** $$\frac{ds_n}{dz^*}_{z^*=0} = \frac{1}{2}(1-s_n)\left[\frac{1+f}{1-f}b - 1\right] - \frac{f}{(1-f)^2} < 0$$

which can be proved to be negative. Hence, even though the locally financed subsidy leads to a decrease in expenditure in the poor region (the tax effect) and to increased income inequality (the effect on profits), it attracts firms in the poor region. When subsidies are financed locally, only Southerners pay the tax, so that the equilibrium tax rate is higher than in the nationally financed case. The increase in profits is the same, whereas the increase in regional income disparity $s_E$ is greater, which yields fewer firms to relocate to the South. Again, the effect on manufacturing employment and output in the poor region is ambiguous. If negative, the effect is more important

because less firms relocate to the South and the decrease in each firms size is the same under both forms of financing.

### IV.3. A lump sum subsidy financed by a national proportional income tax

Regional subsidies can take the form of a lump sum transfer to firms of the manufacturing sector which locate in the poor region. This may be the case for example if, as often happens, land is given to the firm to build the plant, if a lump sum tax break is given or if R&D is subsidized for firms located in the poor region. As the analysis and results are quite similar we only analyze the case of a subsidy financed at the national level and do not repeat all the steps.

The arbitrage equation now becomes

**(4.13)** $$p = p^* + F^*$$

where $F^*$ is the lump sum subsidy given to firms located in the South.

The government budget constraint becomes:

**(4.14)** $$t(2L + p) = F^*(1 - s_n)$$

The resource constraint and the share of expenditures in the North are still given respectively by equations (4.3) and (4.1). Differentiating this system around an equilibrium where $F^*$ is zero, we we get the variation of regional income disparity with respect to profit of manufacturing firms, which is the same expression as equation(3.4).

We find that all these results are proportional to the ones we obtain with a subsidy to profits financed by a national proportional income tax. Changes induced by a lump sum subsidy on our four endogenous variables (the share of firms producing in the North $s_n$, the share of expenditure in the North $s_E$, the equilibrium profits $p$ and the tax rate on income $t$) are just proportional to the effects of a subsidy to profits. The multiplying factor is the equilibrium value of profit : $p = \frac{2Lb}{1-b}$. Hence, for example, $\frac{\partial s_n}{\partial F^*}_{F^*=0} \frac{2Lb}{1-b} = \frac{\partial s_n}{\partial z^*}_{z^*=0}$

We thus conclude that a lump sum subsidy leads to a decrease in spatial concentration of firms together with an increase in regional income disparity, as in the case of a subsidy to profits.

## V. A local subsidy to firms production

Regional subsidies can also consist of a subsidy proportional to production or to the number of jobs created by firms. In this section we study the case of a nationally financed subsidy to both sectors productions in the South. As the traditional sector is perfectly competitive, marginal-cost pricing and zero profit condition imply: $w^* = (1+z^*)$. Hence, such a subsidy acts as an increase in labor productivity and raises the equilibrium wage in the South, as the labor markets are perfectly competitive.

As for the manufacturing sector, profit maximization under monopolistic competition yields: $p^* = p^* x^* (1+z^*) - a_M (1+z^*) x^* \Rightarrow p^* = \frac{a_M s}{s-1}$ and $p^* = (1+z^*)\frac{x^*}{s}$. Hence, a subsidy to both sectors production lets prices unchanged, whereas profits and wages in the South are multiplied by $(1+z^*)$. The arbitrage equation that determines the optimal location of firms is still given by: $p = (1+z^*)p^*$

The definition of the Northern share of expenditure is:

**(5.1)** $$s_E = \frac{(1-t)(L + p s_K)}{(1-t)[L(2+z^*) + p]}$$

The resource constraint becomes:

**(5.2)** $$2L = (1-t)(1-b)\left[L(2+z^*) + p\right]$$

Finally the government budget constraint when subsidies are financed by a national proportional income tax can be shown to be:

**(5.3)** $$tE^W = z^*(1-s_n)p + z^* L$$

Putting all this together, we find that the subsidy has a positive effect on profits in both regions (the same as in the case of a subsidy to profits) despite the wage increase in the South:

**(5.4)** $$\frac{dp}{dz^*}_{z^*=0} = \frac{2Lb}{1-b}(1-s_n) > 0$$

However, this type of subsidy on employment decreases regional after tax income and expenditure inequality as:

**(5.5)** $$\frac{ds_E}{dz^*}_{z^*=0} = -\frac{(1-b)^2}{4}\left[b(2s_K-1)(2s_n-1)+1-s_K\right] < 0$$

Another implication is that relocation to the South is more important in the case of a production subsidy than in the case of a tax break (subsidy proportional to profits) for firms located in the South. Indeed, the effect of the subsidy on geography of production, using equation (3.2), is given by :

**(5.6)** $$\frac{ds_n}{dz^*}_{z^*=0} = -\frac{(1+f)(1+b)^2}{4(1-f)}\left[1-s_K+b(2s_K-1)(2s_n-1)\right] - \frac{f}{(1-f)^2} - s_n(1-s_n)(1-f)$$

which can be shown to be larger in absolute value than (4.12). Agglomeration is decreased to a larger extent with this kind of subsidy as the market size of the poor region is increased due to the positive effect on Southern wages.

In the case of local financing however, the impact of a subsidy on employment is exactly the same than a subsidy on profits: income inequality increases between the two regions (the impact is given by 4.11) and firms relocate as in (4.12). The reason is that in this case the increase in wages is paid locally so that no fiscal transfer occurs from the North to the South. The only net transfer that takes place is the one through profit repatriation which benefits the North as profits increase and the North more capital than the South.

## VI. Welfare and inequality

The next issue to consider is the impact of subsidies on real net income in both regions. Changes in real income in this model may differ from changes in nominal incomes because subsidies have an impact on the price index through their effect on industry location. When firms relocate in a region, this leads to a decrease of the price index for agents located there. The reason is that less goods need to be imported from the other region so that trade costs have to be paid on a lower number of goods. A related question is the impact on real net incomes for workers and capital owners.

### VI.1. Welfare and regional inequalities

Real net income in both regions reflects regional welfare level, and is obtained by dividing the after-tax and subsidy expenditure by the perfect price index. Both levels depend on the evolution of world distribution of expenditure between regions, given that total expenditure remains constant. Welfare levels also depend on changes in price indices, because of the relocation of firms. Whatever the type of subsidy, changes in regional real net income are given by :

**(6.1)**
$$\frac{dV}{dz^*}_{z^*=0} = P^{-1}\left[\frac{2L}{1-b}\frac{ds_E}{dz^*}_{z^*=0} + \frac{2mL(1-f)}{(1-b)(s-1)(1+f)}\frac{ds_n}{dz^*}_{z^*=0}\right]$$

**(6.2)**
$$\frac{dV^*}{dz^*}_{z^*=0} = -P^{*-1}\left[\frac{2L}{1-b}\frac{ds_E}{dz^*}_{z^*=0} + \frac{2mL(1-f)}{(1-b)(s-1)(1+f)}\frac{ds_n}{dz^*}_{z^*=0}\right]$$

Results in terms of regional welfare will be obvious in the case of a local subsidy to production financed at the federal level. As both regional income disparity and agglomeration of firms decrease, the North loses and the South wins in terms of real income and welfare. However for other types of subsidies we studied, North experiences an increase in both regional income and regional price index, whereas it is the opposite changes for the South. We thus have to determine the net effect of subsidies to profit and lump sum subsidy on regional welfare.

From equation (6.1) and (6.2) it can be checked that changes in regional welfare are qualitatively symmetric: they change in opposite direction. When the subsidy is financed with a national tax, we find that welfare in the rich (poor) region always decreases (increases). However, with local financing and if the capital ownership is very unequally distributed, and trade costs are high enough, we find examples where welfare may decrease in the poor region. This is so even though firms do relocate in the poor region. The same results hold for the lump sum subsidy.

### VI.2. Inequality inside regions

Individual welfare corresponds to indirect utility as defined earlier, which is also equivalent to individual real disposable income. For the Northern region for example, it depends on factor rewards, price indices and the tax level:

$$V^i = \frac{(1-t)E^i}{P}$$

where $E^i$ is individual $i$'s nominal income, $t$ is the tax level, and $P$ is North price index.

We follow the tradition of international trade theory by analysing the effect of a subsidy on labor and capital incomes. Table 1 provides the relative increase or decrease of both factors nominal net reward, following the impact of the different subsidies, taking into account the effect of financing. This allows us to determine the evolution of intra-regional inequality, assuming that the capital is unequally distributed. As individuals living in the same region face the same price index and tax rate, we say that intra-regional individual inequality increases if capital nominal net income increases relative to labor. Intra-regional individual inequality increases in both regions when subsidies to profits or lump sum subsidies are given to firms, whenever they are financed by a national or a local proportional income tax, because these subsidies effectively lead to a transfer of resources from workers to capital owners.

On the contrary, intraregional individual inequality decreases in the South when a subsidy to production, financed at the is given in firms producing in this region. This hinges on the fact that labor income increases, while capital net-of-tax income decreases[5]. However, workers in the North loose and proportionally more so than capital owners so that in this sense inequality increases in the North. In the case of local financing, inequality increases in the North and decreases in the South.

[5] Profits and capital income increase, but not enough to compensate the increase in taxes.

**Table 1 : Relative evolution of capital and labor net-of-tax nominal incomes:** $\frac{1}{R^i}\frac{dR_i}{dz^*}$ ; $R_i = \text{income of factor i}$

| | | |
|---|---|---|
| Subsidy to profits financed by a national proportional income tax[6] | Labor in both regions | $-b(1-s_n) < 0$ |
| | Capital in both regions | $(1-b)(1-s_n) > 0$ |
| Subsidy to profits financed by a local proportional income tax | Labor in the North | $0$ |
| | Capital in the North | $1-s_n > 0$ |
| | Labor in the South | $\frac{-p}{E*}(1-s_n) < 0$ |
| | Capital in the South | $\frac{L(1-s_n)}{(1-b)E^*}\left[1+b\left(2s_K-1\right)\right] > 0$ |
| Subsidy to production financed by a national proportional income tax | Labor in the North | $-\left[\left(1-s_n\right)b+\frac{1-b}{2}\right] < 0$ |
| | Labor in the South | $\frac{1-b}{2}+bs_n > 0$ |
| | Capital in both regions | $-\left[s_n-\frac{1}{2}\right]\left(1-b\right) < 0$ |
| Subsidy to production financed by a local proportional income tax | Labor in North | 0 |
| | Capital in North | $1-s_n > 0$ |
| | Labor in South | $\frac{1}{2}(1-b)+b\,s_n > 0$ |
| | Capital in South | $-\left[s_n-\frac{1}{2}\right]\left(1-b\right) < 0$ |

[6] The lump sum subsidy has a qualitatively similar result.

## VII. Relocation costs

Up to now we have assumed that firms can relocate costlessly between regions. This certainly implies that we overestimated the impact of regional subsidies on firms relocation decisions. Empirical studies usually find that those policies have very small effects. This is the case in the US (see for example Mills, 1997). This is also the case in Europe: Crozet, Mayer and Muchielli (2003) show that regional policies have no or very little effect on the location choice of FDI in France. One natural reason may be relocation costs.

We introduce relocation costs in a very simple way following Baldwin et al. (2003). We assume that a firm that relocates from one region to another pays a proportional relocation cost of *(1- k)*, where *0 £ k £ 1* is a measure of the freeness of capital mobility. To simplify further, we assume that it is a one time cost and analyze situations where it already has been incurred so that current income is unaffected. Also, to keep the analysis short we will focus on the case of a subsidy to profits (or a tax rebate) for firms located in the South financed by a national proportional income tax. The analysis is similar for other types of subsidies.

The first effect of relocation costs is that if they are high enough, no relocation will occur so that a no-relocation band exists. To see this, we ask the following question: starting from a situation without subsidies (*z*=0*), how much relocation costs need to be for firms in the North to decide not to relocate if a subsidy is given in the South? To answer this question we need to find *k* such that: $k < \bar{k} = p / p^{*}(1+z^{*})$ where $p^{*}$ and $p$ are evaluated at $s_n = \bar{s}_n$ with no subsidy (i.e. as given by equation (2.8). We also assume that before the experiment, agents are fully diversified in their portfolio, so that all firms are owned by all agents proportionally to their capital ownership. This just means that financial market is perfect and there exists no domestic bias in investment. This implies that the change in profits in the North and the South affects agents proportionally to their capital ownership.

In this case, profits (including subsidies) are not necessarily equalized across regions, and the share of expenditure in the North is:

**(7.1)**
$$s_E = \frac{(1-t)E}{(1-t)E^w} = \frac{L + \bar{s}_n s_K p + (1-\bar{s}_n) s_K p^{*}(1+z^{*})}{2L + \bar{s}_n p + (1-\bar{s}_n) p^{*}(1+z^{*})}$$

Using the government budget constraint, the resource constraint and the definition of profits given by equation (2.5), we find a non linear equation in $\bar{k}$ which is not very revealing. Numerical simulations show that $\bar{k}$ is increasing in trade costs (or decreasing in $f$). This is intuitive as we know that when trade costs are low, firms are more footloose to take advantage of larger marker size or, in this case, subsidies. Hence, no relocation is more likely to occur with relatively high trade costs. In this case, it is also easy to check that profits in the North increase and that profits in the South net of the subsidy decrease (they of course increase with the subsidy). The reason is that because the North owns more capital than the South, and that the subsidy is effectively a transfer to capital owners, nominal income net of taxes decreases in the South and increases in the North. This in turn increases demand and profits in the North. Hence, if relocation costs are high enough so that no relocation occurs, Southern expenditure (income net of taxes) decreases and the price index is unchanged. As indirect utility is given by $V^* = (1-t)E^* / P^*$ this implies that welfare in the South decreases with the regional policy that subsidies firms located in the South and which, nominally is a transfer from North to South.

When the relocation cost is low enough ($\bar{k}$ is high enough), then relocation occurs. In this case, the arbitrage equation that determines the equilibrium geography is: $p^* k(1+z^*) = p$ which using the definition of profits gives an equilibrium relation between the Northern share of firms $s_n$ and the Northern share of expenditures $s_E$:

**(7.2)** $$s_n = \frac{s_E(1-f^2) - f\left[k\left(1+z^*\right) - f\right)\right]}{(1-f)\left[k(1+z^*) - f - s_E(1+f)(k(1+z^*)-1)\right]}$$

which implies that relocation to the South following the subsidy is lowered due to relocation costs. Again, if relocation is small enough due to high relocation costs (but not too high so that some relocation occurs), the subsidy may have a negative welfare impact for the South as income inequality worsens and the price index in the South does not decrease much. Note also that with relocation costs, the effect of the subsidy on employment in the manufacturing sector is even more negative (or less positive) than without relocation costs.

## Conclusion

Subsidies to attract firms in specific regions exist on both sides of the Atlantic. However, the EU has gone much further than the US in terms of a federally financed program of regional policies which aim is to help poor regions. One reason for this transtlantic divide on the role of regional policies is the difference in labor mobility: the strong American mobility explains why the phenomenon of spatial concentration of economic activities in the United States has not been accompanied by a process of per capita income divergence among the American states. When workers follow mobile capital (physical or human) from regions in decline to regions experiencing growth, the problem of spatial equity becomes much less acute. This is one reason why, in the United States, the question of regional or spatial planning policies has never become such a significant issue as it is in Europe. In Europe, the immobility of workers coupled with capital mobility has implied that agglomeration effects has led (in some cases) to an increase in regional income inequalities. In turn, this explains why a demand for public policies that gives incentives to firms to follow where workers want to stay has emerged. This paper can be interpreted as a word of caution on those policies. We have shown that the very facts that are supposed to justify the demand for such policies, i.e. labor immobility, capital mobility and regional income inequality, can generate "perverse" effects of policies that give subsidies to firms that locate in poor regions. In particular, we have shown that in a general equilibrium model, a policy that looks like an official transfer from the rich to the poor region actually becomes the reverse due to initial income inequality and capital mobility. Individual inequality may also increase with these subsidies. In particular, workers living in the rich region may in effect be financing a subsidy that mostly benefit capital owners living in the poor or the rich region.

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