DISCUSSION PAPER SERIES

No. 1841

# PUBLIC POLICIES, REGIONAL INEQUALITIES AND GROWTH

Philippe Martin

*INTERNATIONAL MACROECONOMICS AND INTERNATIONAL TRADE*


Centre for Economic Policy Research

ISSN 0265-8003

# PUBLIC POLICIES, REGIONAL INEQUALITIES AND GROWTH

**Philippe Martin**

Discussion Paper No. 1841
March 1998

Centre for Economic Policy Research
90–98 Goswell Rd
London EC1V 7DB
Tel: (44 171) 878 2900
Fax: (44 171) 878 2999
Email: cepr@cepr.org

CEPR Discussion Paper No. 1841

March 1998

## ABSTRACT

### Public Policies, Regional Inequalities and Growth*

This paper constructs a two-region endogenous growth model, where economic geography and public infrastructures play a key role. The model allows us to analyse the contribution of different types of redistributive public policies on growth, industrial geography and spatial income distribution. An improvement of infrastructures that helps decrease transaction costs inside the richest region increases spatial concentration of industries, increases the growth rate, and decreases the gap in income between the two regions. An improvement in infrastructure in the poor region has the exact reverse effect. In this sense, the paper highlights a non-trivial political trade-off between growth and spatial distribution of economic activities. Contrary to transfers and traditional regional policies, it is shown that a public policy that reduces the cost of innovation can attain the objectives of higher growth and more even spatial distribution of incomes and economic activities. From that point of view, these policies seem preferable to the regional policies that are now implemented in Europe.

JEL Classification: O40, R12, R58
Keywords: growth, geography, infrastructure, public policies, innovation

Philippe Martin
Graduate Institute of International Studies
11A Avenue de la Paix
1202 Geneva
SWITZERLAND
Tel: (41 22) 734 8950
Fax: (41 22) 733 3049
Email: martin@hei.unige.ch

*The author would like to thank the Swiss National Science Foundation Grant 12–50783.97, which provided support for this research.

Submitted 22 January 1998

# NON-TECHNICAL SUMMARY

Is there a risk that integration in Europe increases regional income disparities? Given the budgets allocated to regional policies to counteract this danger the answer of governments is clearly positive: the budget of regional policies has increased from ECU 3.7 billion in 1985 to ECU 18.3 billion in 1992 and will reach ECU 33 billion in 1999. For the period 1994–9, the Community's budget for structural policies represents one-third of total Community spending. Their main focus is to finance public infrastructures, especially transport, in the poorest regions in Europe. The emphasis on infrastructure is justified in part on the grounds that disparities in infrastructure in the EU are greater than disparities in incomes. The official position of the Commission is that regional policies are 'intended through investment to strengthen the economic base in recipient regions'. Regional policies are designed to be distortionary and not simple transfers, so as to alter the growth and the economic geography of European regions and the process of convergence in Europe.

Why does the possibility of increased regional inequalities pose a problem to policy-makers? From an efficiency point of view the answer is not obvious. Economists actually emphasize the economic gains which are produced by economic agglomeration, such as localized technological or pecuniary positive externalities. Immobile agents who must stay in regions in decline will suffer from regional inequalities, however, so that on equity grounds policies aimed at diminishing regional inequalities can be defended, especially in Europe where the labour mobility problem is more acute than in the United States.

The motivation of this paper is that, given the huge sums spent on regional policies and the political implications, it is important to develop an analytical framework to think about their economic impact. It is not too much of a caricature to assert that money spent in the name of regional policies in Europe is given with the belief that poor regions always benefit from it, so that regional inequalities are reduced, which therefore must be good for Europe as a whole.

This paper proposes an admittedly very partial and incomplete way to analyse some of the effects of regional policies on industrial geography, regional income disparities and growth. To do this, we use a model of endogenous growth and endogenous industry location, where infrastructures play a key role.

The model studies two trading regions (North and South, where North is assumed initially richer) where labour is immobile, but capital flows and location choice are free. Because of local positive technology spillovers, economic geography, described by the equilibrium location of industries, is a determinant of the common growth rate of innovation in the two regions. In this model, a more concentrated economic geography is more efficient, in the sense that it is more conducive to innovation and growth. This geography is also more unequal, however, as immobile workers of the poorer region suffer from such regional inequality.

Transaction costs exist both between regions (inter-regional transaction costs) and inside regions (intra-regional transaction costs) and public infrastructures influence these transaction costs. As transaction costs affect economic geography, changes in infrastructures change not only the geography of the economic activities, but also the growth rate of the whole economy, the differential in nominal incomes between the two regions and the income gap between workers and capital owners. The model stresses that, from a theoretical point of view, there exists a trade-off between aggregate growth and regional equity in terms of industrial location, so that regional policies that improve regional equity, for example by improving infrastructures in the poor region to attract firms, may not generate the most efficient geography (i.e. the geography most conducive to growth). By increasing the effective size of the market in the poor region, policies that improve infrastructures in the poor region and reduce transaction costs inside the region attract firms because of increasing returns to scale. By promoting a more dispersed economic geography, however, they reduce the growth rate and can also have the seemingly paradoxical result of inducing a more unequal distribution of incomes.

It is shown that infrastructure policies that help reduce transaction costs between the poor and the rich regions tend to induce relocation of industries to the rich region and therefore a more uneven spatial distribution of economic activities. Such a policy fosters innovation, the creation of new firms and therefore increases competition, however. This reduces the gap in incomes both between regions and between workers and capital owners inside each region through the reduction of monopolistic profits. Transfers to the poor region decrease both the inequity in industrial location (they induce relocation of firms to the South) and the income gap, but they reduce the overall growth rate.

The paper also shows that public policies that lead to a reduction in the cost of innovation, and more generally that reduce impediments to growth, can lead to

higher growth, lower monopolistic profits for capital owners and a more even spatial distribution of incomes and economic activities. From that point of view, these policies, even though not regional in nature, seem preferable to the regional policies that are now implemented in Europe. Contrary to regional policies, they attain the objective of higher regional equity without being detrimental to growth.

**Introduction:**

Is there a risk that integration in Europe increases regional income disparities? Given of the budgets allocated to regional policies supposed to counteract this danger, the answer of governments is clearly positive: the budget of regional policies has increased from ECU 3.7 billion in 1985 to ECU 18.3 billion in 1992 and will reach ECU 33 billion in 1999. For the period 1994-99, the Community's budget for structural policies represents a third of total Community spending, the second item in the EU budget just after the Common Agricultural Policy. Their main focus is to finance public infrastructures, especially transport, in the poorest regions in Europe. The emphasis put on infrastructure is justified in part on the ground that disparities in infrastructure in the EU are greater than disparities in incomes.

The motivation of this paper is that given the huge sums spent by regional policies and of the political implications, it is important to develop an analytical framework to think about their impact[1]. It is not too much of a caricature to assert that money spent under the name of regional policies in Europe is given with the belief that poor regions always benefit of it, so that regional inequalities are reduced which therefore must be good for Europe as a whole.

Why does the possibility of increased regional inequalities pose a problem to policy makers? From an efficiency point of view, the answer is not obvious. Fujita and Thisse (1996) actually insist on the economic gains produced by economic agglomeration, such as localised technological or pecuniary positive externalities. However, immobile agents who have to stay in regions in decline will suffer from

[1] From an empirical perspective, see the papers in Haynes et al. (1996) on the role of infrastructures in regional growth.

regional inequalities so that, on equity grounds, policies that diminish regional inequalities can be defended especially in Europe where the problem is more acute than in the US.

This paper proposes an admittedly very partial and incomplete way to analyse some of the effects of regional policies on industrial geography, regional income disparities and growth. To do this, we use the model developed by Martin and Ottaviano (1996a) which marries an endogenous growth framework similar to Romer (1990) and Grossman and Helpman (1991) to a geography framework similar to Helpman and Krugman (1985) and Krugman (1991). The role of public infrastructures in this endogenous geography and growth model is then introduced following Martin and Rogers (1995) which is a static model.

The model studies two trading regions (North and South, where is North is assumed initially richer) where capital flows and location choice is free. Transaction costs exist both between regions (inter-regional transaction costs) and inside regions (intra-regional transaction costs) and public infrastructures influence these transaction costs. Because of local technology spillovers, economic geography, described by the equilibrium location of industries, is a determinant for the common growth rate of innovation in the two regions. As transaction costs affect economic geography, changes in infrastructures change not only the geography of the economic activities but also the growth rate of the whole economy, the differential in nominal incomes between the two regions and the income gap between workers and capital owners[2]. The model stresses that, from a theoretical point of view, there exists a policy trade-

[2] Benabou (1993 an 1994) analyses a related question, the impact of local human capital externalities on growth and income inequality. His focus however is on education and income inequality across agents in urban areas.

off between aggregate growth and regional equity[3] so that regional policies that improve regional equity, for example by improving infrastructures in the poor region to attract firms, may not generate the most efficient geography, that is the geography most conducive to growth[4]. Contrary to transfers and traditional regional policies, it is shown that a public policy that reduces the cost of innovation or other impediments to growth can attain both the objectives of higher growth and regional equity.

## II. A Two-Location Model with infrastructures

The model merges a location framework which is a variant of Krugman (1991) and Venables (1996), a growth framework similar to Romer (1990) and Grossman and Helpman (1991) and finally the modelling of public infrastructures as in Martin and Rogers (1995). There are two regions called North and South. Variables referring to South are labelled by an asterisk. Each region is endowed with a fixed amount of labour (L) assumed to be immobile between regions so as to abstract from that particular agglomeration channel. The two regions are identical except in their initial income levels to be described later.

Since the model is basically symmetric, we concentrate on the specification of the North. Preferences are instantaneously nested-C.E.S. and intertemporally C.E.S. with unit elasticity of intertemporal substitution:

$$U = \int_0^{\infty} \log\left[D(t)^{\alpha}\ Y(t)^{1-\alpha}\right] e^{-\rho t}\, dt \qquad \textbf{(1)}$$

[3] Quah (1996) and Martin (1997) provide some empirical evidence for such tradeoff for European regions.

[4] Martin and Ottaviano (1996) analyse this tradeoff from a welfare point of view to show that the optimal geography may entail more or less spatial concentration than the market equilibrium depending on the level of transaction costs.

where Y is the consumption of the homogeneous good (an agricultural good for example), $\rho$ is the rate of time preference, and $\alpha \in (0,1)$ is the share of expenditures devoted to D, a composite good which, following Dixit and Stiglitz (1977), consists of a number of different varieties:

$$D(t) = \left[ \sum_{i=1}^{N(t)} D_i(t)^{1-1/\sigma} \right]^{1/(1-1/\sigma)} \qquad \sigma > 1 \qquad (2)$$

where N is the total number of varieties available in the economy. Growth will come from an increase in the variety of goods and services measured by N. $\sigma$ is the elasticity of substitution between varieties as well as the own-price elasticity of demand for each variety.

The value, in terms of the numeraire Y, of per capita expenditure E is:

$$E = \sum_{i=1}^{n} \tau_D p_i D_i + \sum_{j=n+1}^{N} \tau_I p^*_j D_j + Y \qquad (3)$$

where n is the number of goods of the manufacturing sector produced in region 1 and $N = n + n^*$. As in Samuelson (1954) and in the economic geography literature, transaction costs in the form of iceberg costs have been introduced. These costs affect both intra-regional transactions ($\tau_D$) and inter-regional transactions ($\tau_I$). Both $\tau_D$ and $\tau_I$ are larger than 1 so that only a fraction of the good or service purchased is actually consumed. The quality of infrastructures in the North and the South can differ so that in general we will consider $\tau_D \neq \tau_D^*$. However, we will assume that the two regions share the infrastructure that facilitates transactions between them so that $\tau_I = \tau_I^*$. We also assume that $\tau_I > \tau_D^* \geq \tau_D$. This assumption implies that it is more costly to trade with an agent from the other region than with an agent in the same region and that the quality of infrastructures that facilitate intra-regional transactions in the North is at

least as good as in the South.

As in Martin and Rogers (1995), we interpret these costs $\tau_I$ , $\tau_D^*$, $\tau_D$ as directly related to the quality of infrastructures. We interpret a reduction of $\tau_D$ ($\tau_I$) as an improvement of intra-regional (inter-regional) infrastructure. These transaction costs that are affected by public infrastructures can be thought, in particular, as transport and telecommunication infrastructures. For example, the construction of a highway between Milano and Napoli will be thought of as an improvement in inter-regional infrastructure. The construction of a road between Milano and Florence will be thought of as an improvement of intra-regional infrastructure in the North (for a more detailed explanation of this modelling of infrastructures see Martin and Rogers, 1995). As it is common in the new geography models, there is no transaction cost for the numeraire good which is introduced to tie down the wage rate.

As to the supply side, the homogenous good is produced using only labour with constant returns to scale in a perfectly competitive sector. Without loss of generality, the input requirement is set to 1 for convenience. Moreover it is assumed that the demand of this good in the whole economy is large enough that it cannot be satisfied by production in one region only. This hypothesis ensures that in equilibrium the homogenous good will be produced in both regions. Hence, because of free trade, the nominal wage rates in the two regions will be equalised. In addition, the assumption of unit input requirement and the choice of Y as the numeraire pins down the wage rate to 1 everywhere.

The differentiated good or service is produced in a monopolistically competitive sector. The production of each variety exhibits increasing returns to scale. Together with the assumption of costless differentiation this ensures that each firm

will produce only its own variety. More precisely, starting the production process for each new variety requires the use of one unit of capital (the fixed cost at the source of economies of scale[5]) and $\beta$ units of labour. As labour is the only factor production in this increasing returns sector, we can think of its output as either goods or specialised services. Under these assumptions, optimal pricing for any variety gives producer prices $p=p^*=\beta\sigma/(\sigma-1)$. The operating profits of a producer are revenues minus labour costs:

$$\pi = px - \beta x = \frac{\beta x}{\sigma - 1} \qquad \textbf{(4)}$$

where x is the optimal output/size of a typical firm in equilibrium.

The investment sector is at the source of growth for it enables the number of differentiated goods to grow. To start production of a new variety, some investment needs to be performed. We can think of it either as the innovation requirement to start production of a new good or as the physical investment to open a plant. In the first case, we can think of capital as immaterial for example a patent. In the second case, we can think of machinery. We will interpret capital as a composite of these two. Once an agent (call her an entrepreneur) has performed this investment she has monopoly rights on the variety produced and can choose to freely relocate the production facilities between the two regions. If she decides to locate the production facility in the region where she does not live she then repatriates the profits. Initially, the North owns $H_0$ units of capital and the South $H_0^*$ with $H_0 > H_0^*$. The requirement that one unit of capital is used to start the production process for each variety implies that the total number of varieties in the world is fixed by the stock of capital at each

[5]This way of introducing economies of scale has been used in Flam and Helpman (1987) in a trade context and Martin and Rogers (1995) in a geography context.

point in time: $N = H + H^* = n + n^*$.

Finally, we assume that there exists a safe asset that bears an interest rate r in units of the numeraire. Its market is characterised by free financial movements between the two regions. The intertemporal optimisation by consumers then implies that the growth rate of expenditure is equal to the difference between the interest rate and the rate of time preference: $\dot{E} = \dot{E}^* = r - \rho$. It will turn out that in equilibrium E and $E^*$ are constant so that $r = \rho$.

## III. The equilibrium location of firms

Because inter-regional capital flows are not restricted, the equilibrium location is one where operating profits of firms are equal in both regions. It must be so in equilibrium so that no incentive to relocate production exists. Hence, it must be that $\pi = \pi^*$ which implies $x = x^*$. The next equilibrium condition is that demands (inclusive of transaction costs) equal supplies. The first order conditions of consumers give the usual demands for the different goods, so that the supply equals demand condition can be transformed into:

$$x = \frac{\alpha L(\sigma - 1)}{\beta\sigma}\left(\frac{E\delta_D}{N[\gamma\delta_D + (1-\gamma)\delta_I]} + \frac{E^*\delta_I}{N[\delta_I\gamma + (1-\gamma)\delta_D^*]}\right) \qquad \textbf{(5a)}$$

$$x^* = \frac{\alpha L(\sigma - 1)}{\beta\sigma}\left(\frac{E\delta_I}{N[\gamma\delta_D + (1-\gamma)\delta_I]} + \frac{E^*\delta_D^*}{N[\delta_I\gamma + (1-\gamma)\delta_D^*]}\right) \qquad \textbf{(5b)}$$

where $\gamma = n/N$, the share of varieties produced in region 1, is less or equal to 1. $\gamma$ will be a crucial parameter of the model as it will measure the extent of agglomeration of the manufacturing sector in region 1. Also, to simplify, we define $\delta_D = \tau_D^{1-\sigma}$ and $\delta_I$,

$\delta_D$* are defined similarly. A higher $\delta_D$ implies a better infrastructure facilitating intra-regional transactions in the North. This system can be solved for the equilibrium location:

$$\gamma = \frac{\theta_E \delta_D^*}{\delta_D^* - \delta_I} - \frac{(1-\theta_E)\delta_I}{\delta_D - \delta_I} \qquad (6)$$

where $\theta_E$ = E/(E+E*) is the Northern share of total expenditure. This equation gives the equilibrium location of firms as a function of expenditures and infrastructures in the North and in the South. We can see that, as in the new trade theory and in the new geography, a home market effect exists since a higher level of local expenditures attracts firms. This is due to increasing returns in the differentiated goods sector. We come back to the other determinants of location, in particular public infrastructures, in section V.

The optimal size of firms in both the South and the North does not depend directly on the quqlity of infrastructures:

$$x = \alpha L \frac{\sigma - 1}{\sigma} \frac{E + E^*}{N} \qquad (7)$$

## IV. Equilibrium Growth

The next step is to find the growth rate in this economy that is to find how capital is endogenously accumulated. The investment sector works as in Grossman and Helpman (1991): to build one more unit of the composite capital which is required to start production in the differentiated goods sector, an entrepreneur must employ $\eta/n$ units of labour in the North and $\eta/n^*$ units of labour in the South. This

implies that, as in Martin and Ottaviano (1996a), a local spillover exists that makes the cost of investment in a region a decreasing function of the number of firms already located in that region[6]. These spillovers can be thought of as Jacobs' spillovers for which the direct observation of the production process helps entrepreneurs to innovate and invest to start producing new goods[7]. The fact that it is less costly to engage in investment in the location that has more firms immediately implies that all the investment activity will take place in the location that has a higher share of the firms. As capital can relocate freely, its price and therefore its cost has to be the same in both locations for both regions to engage in investment. Because of the fact that in equilibrium, the North will have more firms than the South, the investment sector will only operate in the North and the growth rate will be determined by the North.

A steady state of the model is defined as an equilibrium where $\gamma$, the proportion of firms in region 1, is constant and the number of varieties grows at a constant rate $g = \dot{N} / N$. Calling v the value of a firm, the condition of no arbitrage opportunity between shares and the safe asset implies:

$$r = \frac{\dot{v}}{v} + \frac{\pi}{v} \qquad (8)$$

On an investment of value v, the return is equal to the operating profits plus the change in the value of the patent. This condition can also be derived by stating that the equilibrium value of a firm is the discounted sum of future profits of the firm.

---

[6] Another way to get to the same type of result without assuming local technological spillovers is to introduce a pecuniary externality as in Martin and Ottaviano (1996b). In their model, the innovation sector requires manufacturing goods which also incur transaction costs so that if industrial concentration increases, the cost of inputs for the innovation sector decreases.

[7] A number of empirical studies (Jaffe et al., 1993, Audretsch and Feldman, 1996; Eaton and Kortum 1996; Cabellero and Jaffe 1995) show that growth-sustaining externalities have an important local component.

Given marginal cost pricing of patents, free entry and zero profits in the investment sector, $v = \eta/n$ is another equilibrium condition so that v decreases at the rate of growth g. As expenditures E and E* are constant in steady state, this implies that $r = \rho$.

Consider now the market clearing condition in the labour market which implies that labour supply will be employed either in the constant returns sector or in the increasing returns sector:

$$2L = \frac{\sigma - a}{\sigma} L(E + E^*) + \eta \frac{\hat{N}}{\gamma} \qquad \textbf{(9)}$$

Using the equilibrium size of firms in (7) and equations (8) and (9), it is easy then to find the growth rate:

$$g = \frac{2L}{\eta} \frac{\alpha}{\sigma} \gamma - \frac{\sigma - \alpha}{\sigma} \rho \qquad \textbf{(10)}$$

Because of the local spillovers, concentration of economic activities has a positive effect on growth as it decreases the cost of investment in the location specialised in this activity, the North (see Martin and Ottaviano, 1996a).

To complete the solution of the model we have to determine income levels in both regions: this is total wealth multiplied by the propensity to consume, which in our log utility case, is $\rho$. Wealth in the North is simply Hv. Hence, using the equilibrium value of capital, this implies that income in the North is: $L + (\rho\eta h)/\gamma$ where $h = H/N$ is the share of capital units owned by the North. Note that this share is constant over time as H, H*, N and N* grow at the same rate in the two regions. $\theta_E$ the consumers' share of expenditures in the North which is also the share of income in the North is therefore:

$$0_E = \frac{\gamma L + \rho\eta h}{2\gamma L + \rho\eta} \qquad \textbf{(11)}$$

This shows that expenditures in the North are larger than in the South ($0_E > 1/2$) as long as $h > 1/2$. This is the case as we assume that the North has initially a larger capital endowment and that capital stocks grow at the same rate thereafter.

There are two sources of income. One is the wage income which is equal in the North and in the South. The second is capital income. Because only the profits accruing to the initial stock of capital are pure rents, the income from capital is fixed by the initial distribution of capital. Note that the expenditure and income share in the North decreases with $\gamma$, the share of firms locating in the North:

$$\frac{\partial 0_E}{\partial \gamma} = \frac{\rho\eta hL(1-2h)}{(2\gamma L + \rho\eta)^2} < 0$$

This is because industrial concentration in the North reduces the cost of innovation and therefore the monopoly power of firms. This in turn decreases their value. As the North is relatively rich in capital ($h>1/2$) , this implies that the level of income decreases more in the North than in the South. Note that this effect, which we can think of as a competition effect, means that the equilibrium geography is stable. No «circular causation» mechanism will occur which would lead to a core-periphery pattern as in the «new geography» models of the type of Krugman (1991). Here, the introduction of endogenous capital and free capital movements makes an interior solution equilibrium stable[8].

The equilibrium $\gamma$ which describes the equilibrium economic geography is therefore non linear. Using equations (6) and (11), the equilibrium $\gamma$ is the solution to

[8] See Baldwin (1997) and Baldwin, Martin and Ottaviano (1997) for models of growth and geography with catastrophic agglomeration.

a quadratic equation which is given in appendix I.

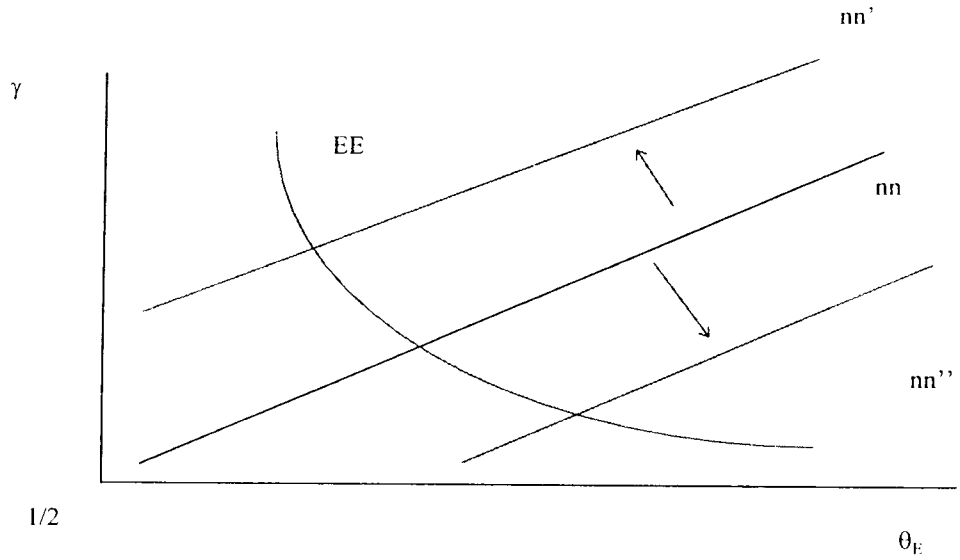
## IV. Geography, Growth and Public Policies

We are interested by the impact of the different types of public policies on industrial geography, i.e. on $\gamma$, on the geography of incomes and expenditures i.e. on $\theta_E$, and on the growth rate of innovation g that applies to the whole country. Industrial geography matters in our set-up because a region that has more firms also benefits from a lower price index. This is due to the fact that for goods produced locally, the transaction costs (intra-regional) are less than for goods imported from the other region. The price index that corresponds to our nested CES utility function is: $P^{\alpha} = (\beta\sigma/(\sigma-1))^{\alpha} N^{\alpha/(1-\sigma)} [\gamma \delta_D + (1-\gamma) \delta_I]^{\alpha/(1-\sigma)}$ in the North. In the South it is: $P^{\alpha}* = (\beta\sigma/(\sigma-1))^{\alpha} N^{\alpha/(1-\sigma)} [(1-\gamma) \delta_D* + \gamma \delta_I]^{\alpha/(1-\sigma)}$. Hence, from that point of view, an increase in spatial concentration in the North (an increase in $\gamma$) benefits consumers in the North and hurts consumers in the South.

We can analyse the effects of various public policies graphically. Equation (6) provides a positive relation between $\gamma$ and $\theta_E$. This is the «home market» effect. When the share of expenditures increases in one region, firms relocate to this region so as to benefit of economies of scale. Equation (11) provides a negative relation between $\theta_E$ and $\gamma$. This is the competition effect. When more firms concentrate in the North where the innovation sector is located, the cost of innovation decreases, the growth rate of innovation increases allowing more firms to enter. This diminishes the optimal size of firms and their monopoly profits. As the North is more dependent on this capital income, the Northern share of incomes and therefore expenditures decreases. These

two equilibrium relations on the geography of industry (the nn curve) and the geography of incomes/expenditures (the EE curve) are given on graph 1:

Graph 1: Improvements in intra-regional infrastructure and inter-regional infrastructure




The equilibrium industrial geography and expenditure shares are given by the intersection of the EE and nn curves. Note also that we can easily infer the equilibrium growth rate as it is a linear increasing function of the equilibrium $\gamma$ (see equation 10). Suppose that the public policy improves domestic infrastructures of the North, i.e. $\delta_D$ increases. In this case, as can be checked easily from equation (6), $\gamma$ increases for any given level of $\theta_E$ so that the nn curve is shifted leftward as shown on graph 1. The EE curve (see equation 11) is unaffected by the change in domestic infrastructures. This implies that an improvement in domestic infrastructure in the North attracts firms in the North ($\gamma$ increases), increases the growth rate of innovation (g increases) and decreases the share of expenditures of the North ($\theta_E$ decreases). The intuition is that as public infrastructure improves in the North, the (iceberg) transaction costs on goods produced and consumed in the North decrease so that the

effective demand for goods increases. This implies that because of increasing returns to scale, firms in the differentiated goods sector relocate to the North and $\gamma$ increases. Because of local spillovers, the cost of innovation in the North decreases and its growth rate increases. This burst of innovation also implies that, as more firms enter the market, the level of competition for existing firms increases, their size and monopolistic profits of firms decrease as well as their equilibrium value. As the North owns more of these firms, the value of incomes and expenditures in the North decreases more than in the South so that $\theta_E$ decreases. Note that economic geography has not only an impact on inter-regional income inequality but also on a particular form of intra-regional inequality, here between workers and capital owners. When monopolistic profits decrease because of a more concentrated geography (higher $\gamma$), this decreases the relative income gap between capital owners and wage earners. This is true in both regions.

Note also that, because of the infrastructure improvement in the North, the price index in the North decreases. This is due to the fact that the level of transaction costs decreases but also to the fact that more firms decide to locate in the North. As transaction costs are lower for intra-regional trade than for inter-regional trade, this relocation also reduces the effective cost of goods for the Northerners. So, even though nominal income decreases in the North, its real level may increase.

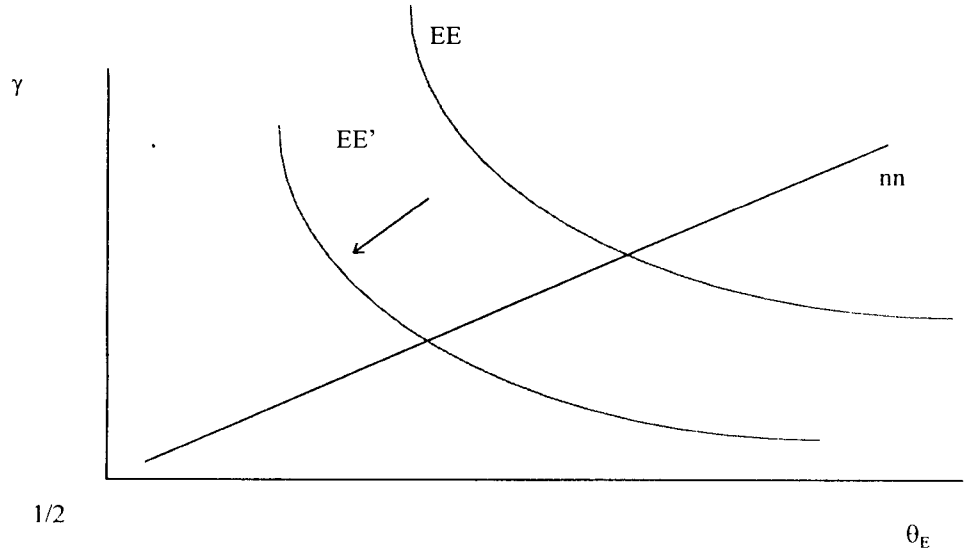
A marginal improvement of public infrastructure in the relatively capital poor South has the exact inverse impact as it shifts the nn curve rightward and leaves the EE curve unaffected. It attracts firms to the South so that $\gamma$ decreases. This lowers the price index in the South and increases it in the North. Because industries leave the North where the innovation sector is located, the cost of innovation increases so that

the growth rate of innovation decreases. In this sense, the improvement in infrastructure in the South generates a less efficient geography. By decreasing the growth rate it has the further effect of reducing competition and therefore of increasing monopoly profits to the benefit of capital owners both in the North and in the South. As capital owners are more numerous in the North, the inter-regional inequality in expenditures, measured by $\theta_E$, rises. Hence, such a policy is detrimental to growth and even though it generates a more equal geography in terms of industrial location, it actually leads to a more unequal geography of incomes.

We can also analyse the effect of improving infrastructure that helps inter-regional trade (an increase in $\delta_I$). In this case, as long as the North has a larger market size than the South, this improvement in inter-regional infrastructure will increase the attractiveness of the North as an industrial location, that is $\partial\gamma/\partial\delta_I > 0$ in equation (see proof in appendix II). As trade in the South is made easier, it is less necessary to locate production in the South and firms can now benefit of scale economies in the North. The North can have a larger market either because it is richer ($h > 1/2$) or/and because it has better domestic infrastructure than the South ($\delta_D > , \delta_D^*$). In the latter case its effective demand is larger because less of the good produced in the North region is lost in transit for the consumer in the North. Hence, an improvement in inter-regional infrastructure has the same effect as an improvement in intra-regional infrastructure in the North: $\gamma$ increases so that the growth rate of innovation increases, and $\theta_E$ decreases as monopolistic profits of each capital owner decrease.

Finally we can analyse the effect of a direct monetary transfer to the South which can think as a decrease in h. In this case, note that the nn curve is not shifting only EE curve is shifting to the left as shown on graph 2.

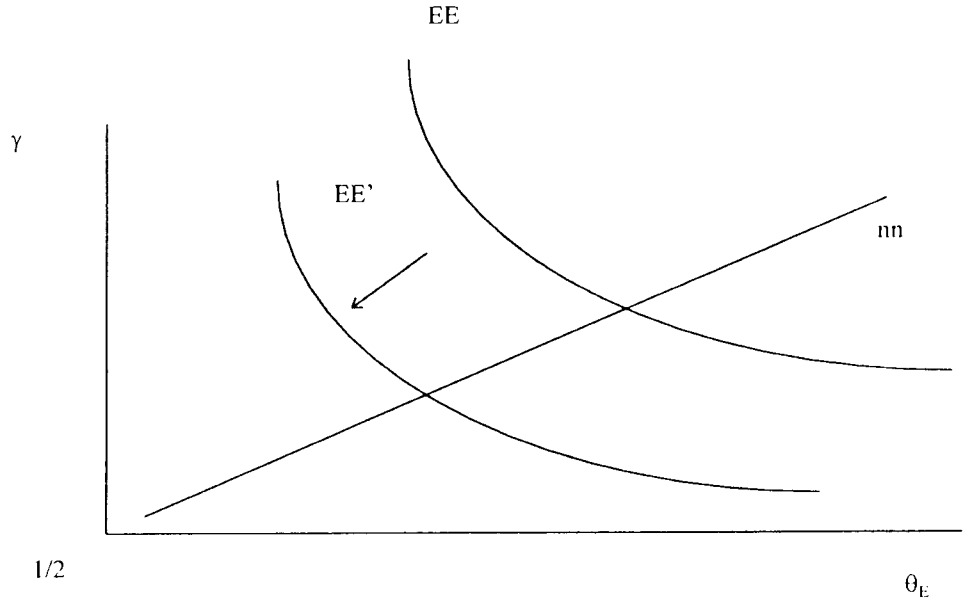
Graph 2: The effect of a direct transfer to the South




The transfer in purchasing power ($\theta_E$ increases) increases the market size of the South and therefore attracts firms there ($\gamma$ increases). Because of local spillovers, the geography is becoming less conducive to innovation even though the economic geography in terms of industrial location and purchasing power is becoming less unequal.

Is there a public policy that can attain both efficiency and equity objectives or is the policy maker condemned to this trade-off? Suppose that the policy maker can decrease the cost of innovation in the economy $\eta$, through subsidies to R&D for example or more generally through public policies that reduce impediments to innovation, what will be the effect on geography and growth? In this case, as shown on graph 3, the EE curve shifts to the left and the nn curve is left unchanged.

Graph 3: A decrease in the cost of innovation




Does this imply, as for the previous case of a transfer, that growth decreases? It can be shown that in equation (10), the exogenous decrease in the cost of innovation more than compensates the endogenous decrease in spatial concentration (the decrease in $\gamma$) so that the net effect is an increase in the growth rate (see proof in appendix III). The intuition is that, as growth increases, more firms enter the market reducing the monopolistic power of existing firms and, therefore, the income of capital owners who are more numerous in the North than in the South. This reduces the income differential between North and South, the income differential between workers and capital owners inside each region and leads to firms relocation to the South. Hence, a public policy that reduces the cost of innovation can attain both the objectives of efficiency (the growth rate increases) and equity (both industrial concentration in the North and the income differential between North and South decrease). If subsidies to R&D, increased competition on goods markets and labour markets, improved education infrastructure etc... can decrease the cost of innovation for firms, then this kind of policy may yield more desirable outcomes than traditional transfers or

regional policies. Note that such a policy leading to the relocation of economic activities in the South helps the creation of new economic activities and firms without any of the local bias that regional policies usually have.

## VI. Conclusion

This paper has presented a simple model of growth, geography and public policies. Even in such a simple framework, some interesting results can emerge. Because economic geography affects growth, public policies that affect industrial location also affect growth. We have shown that the problem with public policies attempting to affect economic geography through infrastructure or through transfers, presumably to generate a more equal spatial distribution of economic activities, is that, if they obtain this result the consequence may be lower growth for both regions. This is due to the fact that the presence of local spillovers implies that spatial industrial concentration is conducive to lower costs of innovation. Hence, a trade-off exists between spatial equity in industrial location and aggregate growth. From this point of view, a more specialised and concentrated economic geography is more efficient. This trade-off has important consequences for public policies because regional policies either in the form of an improvement in public infrastructures that favour intra-regional trade or in the form of direct transfers to a poor region can lead to a less efficient economic geography. Regional policies supposed to help convergence can also have paradoxical results. For example, a policy that improves infrastructures in the South and generates a more equal distribution of industries also increases monopolistic profits and can then induce a more unequal distribution of

incomes.

Geography and growth, and therefore policies that affect them simultaneously, have also an impact on income inequality inside each region because it affects monopolistic profits of capital owners. The paper also shows that policies that lead to a decrease in the cost of innovation, through subsidies for example, can lead to higher growth, lower monopolistic profits for capital owners and more even spatial distribution of incomes and economic activities. From this point of view, these policies seem preferable to the regional policies that are now in favour in Europe.

Admittedly, our model is a very incomplete and special in some of its assumptions and our results may be too unfair to regional policies. However, to our knowledge it is the first to analyse in an integrated framework the role of public policies, especially public infrastructure policies, on grow

*Appendix I:*

The quadratic equation that determines the equilibrium $\gamma$ is:

$$\begin{aligned} &2\gamma^2 L(\delta_D-\delta_I)(\delta_D^*-\delta_I) \\ &-\gamma\left[L\delta_D^*(\delta_D-\delta_I)-L\delta_I(\delta_D^*-\delta_I)-\rho\eta(\delta_D-\delta_I)(\delta_D^*-\delta_I)\right. \\ &\left.-\rho\eta\left[h\delta_D^*(\delta_D-\delta_I)-(1-h)\delta_I(\delta_D^*-\delta_I)\right]\right]=0 \end{aligned} \tag{A1}$$

The valid solution (the other root is more than 1) is:

$$\gamma=\frac{L\delta_D^*(\delta_D-\delta_I)-L\delta_I(\delta_D^*-\delta_I)-\rho\eta(\delta_D-\delta_I)(\delta_D^*-\delta_I)+\sqrt{\Delta}}{4L(\delta_D-\delta_I)(\delta_D^*-\delta_I)} \tag{A2}$$

$$\begin{aligned} \Delta=&\left[L\delta_D^*(\delta_D-\delta_I)-L\delta_I(\delta_D^*-\delta_I)-\rho\eta(\delta_D-\delta_I)(\delta_D^*-\delta_I)\right]^2 \\ &+8L\rho\eta(\delta_D-\delta_I)(\delta_D^*-\delta_I)\left[h\delta_D^*(\delta_D-\delta_I)-(1-h)\delta_I(\delta_D^*-\delta_I)\right] \end{aligned}$$

*Appendix II:*

The partial derivative of $\gamma$ with respect to $\delta_I$ in equation (6) is:

$$\frac{\partial\gamma}{\partial\delta_I}=\frac{\theta_E\delta_D^*}{(\delta_D^*-\delta_I)^2}-\frac{(1-\theta_E)\delta_I}{(\delta_D-\delta_I)^2}-\frac{(1-\theta_E)}{(\delta_D-\delta_I)} \tag{A3}$$

To look separatly at the role in differences and incomes and in infrastructure levels, first assume that domestic infrastructures are of same quality in both regions i.e. $\delta_D = \delta_D^*$, then:

$$\frac{\partial\gamma}{\partial\delta_I}=\frac{(2\theta_E-1)\delta_D}{(\delta_D-\delta_I)^2} \tag{A4}$$

This is positive as long as $\theta_E > 1/2$, that is as long as the North as a larger expenditure

level than the South. This is the case as we assume that the North is initially richer in capital than the South: h > 1/2 (see equation /11)).

Suppose now that there is no difference in expenditure levels between North and South so that $h = \theta_E = 1/2$, then:

$$\frac{\partial \gamma}{\partial \delta_I} = \frac{(\delta_D \delta^*_D - \delta_I^2)(\delta_D - \delta^*_D)}{2(\delta^*_D - \delta_I)^2(\delta_D - \delta_I)^2} \qquad \textbf{(A5)}$$

This expression is positive as the first term in the numerator is positive because of our assumption that the inter-regional transaction costs are larger than the intra-regional costs, and the second term is positive as long as domestic infrastructure in the North is better than domestic infrastructure in the South.

*Appendix III:*

We want to prove that $dg/d\eta$ is negative. From equation (10), we see that this is equivalent to proving that $e = (d\gamma/\gamma)/(d\eta/\eta)$ is less than 1. We will prove this for the case when $\delta_D = \delta_D^*$ . For this, we differentiate equations (6) and (11) in the text and eliminate $d\theta_E$. After simplification, one gets the following elasticity:

$$\frac{\partial \gamma}{\partial \eta}\frac{\eta}{\gamma} = \frac{L\rho\eta(2h-1)(\delta_D + \delta_I)}{L\rho\eta(2h-1)(\delta_D + \delta_I) + (\delta_D - \delta_I)(2L\gamma + \rho\eta)^2} \qquad \textbf{(A6)}$$

which is less than 1 as h > 1/2.

***References***


- Audretsch, D. B., and M. Feldman, 1996, «R&D Spillovers and the Geography of Innovation and Production,» *American Economic Review*, volume 86, number 3, 630-640.
- Baldwin, R.E., 1997, 'Agglomeration and Endogenous Capital', GIIS manuscript.
- Baldwin, R.E., P. Martin and G. Ottaviano, 1997, « Global Income Divergence, Trade and Industrialisation: The Geography of Growth Take-Offs », GIIS manuscript.

- Benabou, R., 1993, « Workings of a City: Location, Education and Production », *Quarterly Journal of Economics*, 108, 619-652.

- ----------, 1994, « Human Capital, Inequality and Growth: A local Perspective », *European Economic Review*, 817-826.

- Dixit, A., J. Stiglitz, 1977, «Monopolistic competition and optimum product diversity», *American Economic Review*, 67 (2), 297-308.

- Eaton, J. and S. Kortum (1996) 'Trade in ideas: Productivity and patenting in the OECD,' *Journal of International Economics*, 40, pp 251-278.

- Flam, H. and E. Helpman, 1987, «Industrial Policy under Monopolistic Competition», *Journal of International Economics*, vol. 22, 79-102.

- Fujita, M. and J.F. Thisse, 1996, «Economics of Agglomeration», Journal of Japenese and International Economics.

- Haynes, K., K. Button, P. Nijkam and L. Qiangshang, 1996, Regional Dynamics, vol. 2, Edward Elgar.

- Helpman E. and P. Krugman, 1985, *Market Structure and Foreign Trade*, MIT Press, Cambridge MA.

- Grossman, G. and E. Helpman, 1991, *Innovation and Growth in the World Economy*, MIT Press, Cambridge MA.

- Jaffe A., Trajtenberg and R. Henderson, 1993, «Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations», Quarterly Journal of Economics.

- Krugman, P., 1991, «Increasing Returns and Economic Geography», *Journal of Political Economy*, 99, 483-499.

- Martin P., and G.I.P. Ottaviano, 1996a, «Growing Locations: Industry Location in a

Model of Endogenous Growth», forthcoming in *European Economic Review*.

- Martin P., and G.I.P. Ottaviano, 1996b, «Growth and Agglomeration», CEPR discussion paper n° 1529.

- Martin P., 1997, «Can Regional Policies Affect Growth and Geography in Europe?», forthcoming in *World Economy*.

- Martin, P. and C.A. Rogers, 1995, «Industrial location and Public Infrastructure», *Journal of International Economics*, 39, 1995, 335-51.

- Quah, Danny, 1996, «Regional Cohesion from Local Isolated Actions: I. Historical Outcomes,» LSE.

- Romer, P., 1990, «Endogenous Technical Change», *Journal of Political Economy*, 98, 5, part II, S71-S102.

- Samuelson, P.,1954, «The Transfer Problem and Transport Costs, II: Analysis of Effects of Trade Impediments,» *Economic Journal*, volume LXIV, 264-289.

- Venables, A. , 1996, 'Equilibrium location with vertically linked industries,' *International Economic Review*, vol. 37, No.2, 341-359.