Public policies, regional inequalities and growth

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Abstract

This paper constructs a two-region endogenous growth model where industrial location and public infrastructures play a key role. The model analyzes the contribution of different types of public policies on growth, economic geography and spatial income distribution. It implies that an improvement in infrastructures that reduces transaction costs inside the poorest region decreases both the spatial concentration of industries, and the growth rate, and increases the income gap between the two regions. Conversely, an improvement in infrastructure facilitating transactions between regions has the reverse effect. In this sense, the paper highlights a trade-off between growth and the spatial distribution of economic activities. Contrary to transfers and traditional regional policies, it is shown that public policies that reduce the cost of innovation can attain the objectives of higher growth and more even spatial distribution of both income and economic activities. From that point of view, these policies seem preferable to the regional policies now implemented in Europe. © 1999 Elsevier Science S.A. All rights reserved.

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1. Introduction

Is there a risk that integration in Europe increases regional income disparities?

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Given the budget of the regional policies supposed to counteract this danger, the answer of the governments is 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 1994–1999, the Community’s budget for structural policies represents a third of total spending, just after the Common Agricultural Policy. These policies aim at financing public infrastructures, with special regard to transportation, in the poorest regions of Europe. This emphasis on infrastructure is partly justified by the fact that disparities in infrastructure in the EU are greater than disparities in incomes.

This work originates from the belief that, given the huge sums spent on regional policies and their political implications, it is important to develop an analytical framework to think about them. Regional policies are justified by the conviction that the benefit accruing to poor regions might lead to a reduction in regional inequalities profitable 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) insist on the economic gains produced by economic agglomeration such as localised technological or pecuniary positive externalities. However, the fact that regional inequalities might hurt immobile agents in declining regions provides a justification for all measures meant to diminish them, especially in Europe, where this problem is more acute than in the US.

This paper proposes an admittedly very partial and incomplete way to analyze some of the effects of regional policies on industrial geography, regional income disparities and growth. With this aim, we use the model developed by Martin and Ottaviano (1999) 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 will be introduced following the static model in Martin and Rogers (1995).

The model studies two trading regions (North and South, with the North initially richer) where both capital flows and location choice are free. Transaction costs exist both between regions (inter-regional transaction costs) and inside regions (intra-regional transaction costs) and public infrastructures affect both kinds of costs. Given local technology spillovers, economic geography, described by the equilibrium location of industries, turns out to be a determinant of the common growth rate of innovation in the two regions. As transaction costs alter economic geography, changes in infrastructures will have an effect not only on the geography of the economic activities but also on the growth rate of the whole economy, the differential in nominal income between regions and the income gap

\[ \text{From an empirical perspective, see the papers in Haynes et al. (1996) on the role of infrastructures in regional growth.} \]
between workers and capital owners. The model displays, from a theoretical point of view, a policy trade-off between aggregate growth and regional equity. This implies that regional policies that improve regional equity, improving, for instance, infrastructures in the poor region in order to attract firms, may not generate the geography most favourable to growth. Contrary to transfers and traditional regional policies, we show that a public policy that reduces the cost of innovation, or other impediments to growth, attains both the objectives of higher growth and regional equity.

The next section introduces the basic features of the model, especially public infrastructures. Section 3 derives the equilibrium location of firms. Section 4 shows how the growth rate of the economy depends on geography and Section 5 determines income inequality. Section 6 analyzes the impact of different public policies.

2. A two-region model with infrastructures

We consider two regions, North and South, each endowed with a fixed amount of labour \((L)\) immobile between regions so as to abstract from that particular agglomeration channel. The regions are identical except for their initial income level.

Given the symmetry of the model, we concentrate on the specification of the North (variables referring to South are labelled by an asterisk). Preferences are instantaneously nested-C.E.S. and intertemporally C.E.S., with unit elasticity of intertemporal substitution:

\[
U = \int_0^\infty \log[D(t)^n Y(t)^{1-a}] e^{-rt} \, dr
\]

\(Y\) is the consumption of the homogeneous good (an agricultural good for example), \(\rho\) the rate of time preference and \(\alpha \in (0, 1)\) the share of expenditures

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5 Benabou (1993) and Benabou (1994) analyze 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.

6 Quah (1996) and Martin (1998) provide some empirical evidence for such trade-off for European regions. Quah finds that European countries which did not experience rising regional inequalities had lower growth.

7 Martin and Ottaviano (1999) analyze this trade-off 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. Matsuyama and Takahashi (1998) present a model where economic geography can be characterized by excessive or insufficient agglomeration due to the absence of certain markets and the lack of coordination of agents.
devoted to $D$. The latter is a composite good that, following Dixit and Stiglitz (1977), consists of a number of different varieties:

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

(2)

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

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

$$E = \sum_{i=1}^{n} \tau_D p_i D_i + \sum_{i=n+1}^{N} \tau_I p^*_i D_i + Y$$

(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 have been introduced. These, in the form of iceberg costs, affect both intra-regional ($\tau_D$) 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 we consider $\tau_D \neq \tau_I$. However, we will assume that the infrastructure that facilitates transactions between them is shared by the two regions so that $\tau_I = \tau^*_I$ and 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 cost of intra-regional transactions in the North is at least as low as in the South. As in Martin and Rogers (1995), we interpret these costs as directly related to the quality of infrastructures. We will regard a reduction of $\tau_D$ ($\tau_I$) as an improvement of intra-regional (inter-regional) infrastructure. Transaction costs affected by public infrastructures can be conceived as transport and telecommunication infrastructures. For example, the construction of a highway between Milan and Naples will be as an improvement in inter-regional infrastructure while a road between Milan and Florence as an improvement of intra-regional infrastructure of Northern Italy. As is common in the new geography models, there is no transaction cost for the numeraire good 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. It is assumed that the demand for this good in the whole economy is large enough that, since it is not

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5For a more detailed explanation of this way of modelling of infrastructures see Martin and Rogers (1995).
satisfied by production in only one region, in equilibrium the production is carried out in both. Free trade guarantees that the nominal wage rates are equalised across regions, while the assumption of unit input requirement and the choice of \( Y \) as the numeraire pin down the wage rate to 1 everywhere.

The differentiated good or service is produced in a monopolistically competitive sector with increasing returns to scale in the production of each variety. This, together with the assumption of costless differentiation, 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\(^6\)) and \( \beta \) units of labour. As labour is the only production factor 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, such that: \( p = p^* = \beta \sigma / (\sigma - 1) \). The operating profits of a producer are

\[
\pi = px - \beta x = \frac{\beta x}{\sigma - 1}
\]

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

Investment is needed to produce a new variety. This can be thought about as either the innovation required to start production of a new good or the physical investment to open a plant. In the first case, capital is immaterial, i.e. a patent, in the second, a piece of machinery. Here, we will interpret capital as a composite of these two. In both cases, the value of the firm that produces the new variety is the value of its capital unit. Once investment is performed, the entrepreneur has monopoly rights on the variety produced and the choice to freely relocate the production facilities across regions. This implies that there are no relocation costs on capital, be it a patent or a machine. If the entrepreneur decides to locate the production facility in the region where she does not live, she will repatriate 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 and firms in the world is fixed by the stock of capital at each point in time: \( N = n + n^* = H + H^* \).

Finally, we assume that there exists a safe asset, bearing an interest rate \( r \) in units of the numeraire, whose 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 \( \dot{E} = \dot{E}^* = r - \rho \), the difference between the interest rate and the rate of time preference. It turns out that in steady state \( E \) and \( E^* \) must be constant so that \( r = \rho \).

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\(^6\)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.
3. The equilibrium location of firms

Given the absence of restrictions on inter-regional capital flows, the equilibrium location is such that operating profits of firms are equal in both regions. No incentive to relocate production can exist in equilibrium. Hence, it must be \( \pi = \pi^* \) which implies \( x = x^* \). The next equilibrium condition is that demands (inclusive of transaction costs) equal supplies. The first order conditions for consumers give the usual demands for the different goods, so we get:

\[
x = \frac{\alpha L (\sigma - 1)}{\beta \sigma} \left( \frac{E \delta_p}{N[\gamma \delta_p + (1 - \gamma) \delta]} + \frac{E^* \delta}{N[\gamma \delta + (1 - \gamma) \delta^*_p]} \right)
\]

\[
x^* = \frac{\alpha L (\sigma - 1)}{\beta \sigma} \left( \frac{E \delta_p}{N[\gamma \delta_p + (1 - \gamma) \delta]} + \frac{E^* \delta^*_p}{N[\gamma \delta + (1 - \gamma) \delta^*_p]} \right)
\]

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 measures the extent of agglomeration of the manufacturing sector in region 1. To simplify, we define \( \delta_p = \tau_p^{1-\gamma} \). \( \delta_p, \delta^*_p \) are defined similarly. A higher \( \delta_p \) implies a better infrastructure facilitating intra-regional transactions in the North. This system can be solved for the equilibrium location:

\[
\gamma = \frac{\theta_p \delta^*_p}{\delta^*_p - \delta_p} - \frac{(1 - \theta_p) \delta_p}{\delta^*_p - \delta_p}
\]

where \( \theta_p = E/(E + E^*) \) is the Northern share of total expenditure or income. 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, due to increasing returns in the differentiated goods sector. We come back to the other determinants of location, and, in particular, to public infrastructures in Section 6.

The optimal size of firms in both the South and the North is then:

\[
x = \frac{\alpha L (\sigma - 1)}{\beta \sigma} \frac{E + E^*}{N}
\]

4. Equilibrium growth

The next step is to find the growth rate in this economy, that is how capital is endogenously accumulated. The innovation sector works as in Grossman and Helpman (1991): to build one more unit of the composite capital required to start production in the differentiated goods sector, an entrepreneur must employ \( \eta/n \) units of labour in the North and \( \eta/n^* \) in the South. This implies that, as in Martin and Ottaviano (1999), there exists a local spillover that makes the cost of
innovation in a region a decreasing function of the number of firms already located in that region, that is, a function of the diversity of the industrial structure.7

What is the empirical evidence underlying this type of spillover? Using the terminology of Glaeser et al. (1992), localised spillovers may be either of the Marshall–Arrow–Romer (MAR) type or of the Jacobs (1969) type. The former are generated by interactions among local firms in the same industry. In the latter local industrial diversity plays a positive role in fostering innovation and the build-up of knowledge and ideas. Here, the spillovers are of the second type, with the diversity of the industrial sector being a key factor. Jaffe et al. (1993), and Henderson et al. (1995) find evidence for Jacobs' spillovers. In particular, the latter show that new high-tech industries are more likely to take root in cities with a history of industrial diversity. Ciccone and Hall (1996) also show that there is a positive relation between density and productivity at the state level in the US, consistently with the effect of the spillovers we assume.

The fact that it is less costly to engage in investment in the region with a higher share of firms immediately implies that all the investment activity will take place there.8 As capital can freely relocate, its price and, therefore, its cost has to be the same in both regions, for them to engage in investment. In equilibrium, more firms operate in the North than in the South, so that the investment sector will only be active in the North, where the growth rate of the country will be determined.

A steady state of the model is defined as an equilibrium where \( \gamma = n/N \), the proportion of firms in region 1, is constant so that \( n, n^* \) and \( N \) grow at the same constant rate \( g = N/N \). To find the equilibrium growth rate, we must analyze the incentive to develop new varieties and firms. Calling \( v \) the value of a firm, which is also the value of its capital unit, the condition of no arbitrage opportunity between shares and the safe asset implies:

\[
r = \frac{\dot{v}}{v} + \frac{\pi}{v}
\]  

On an investment of value \( v \), the return is equal to the operating profits plus the change in the value of capital. This condition could also be derived by stating that the equilibrium value of a firm is the discounted sum of its future profits. Given free entry and zero profits in the investment sector, the value of a firm is equal to the marginal cost of the unit of capital required to start production in the firm: \( v = \eta/n \) is therefore another equilibrium condition so that \( v \) decreases at the rate of growth of \( n \):

7 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 (1996). In this 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.

8 Audretsch and Feldman (1996) find that R&D activities are more concentrated spatially than production activities, consistent with our model.
Another equilibrium relation is the market clearing condition on the labour market. It implies that labour $(2L)$ will be employed either in the R&D sector $(\eta N/n)$, the constant returns sector $(LY + LY^*)$ or the increasing returns sector $(N\beta x)$:

$$2L = \frac{\eta N}{n} + LY + LY^* + N\beta x = \frac{\eta g}{\gamma} + \frac{\sigma - \alpha}{\sigma}L(E + E^*) \quad (9)$$

If a steady state exists with $g$ and $\gamma$ constant, then the equation above implies that expenditures must also be constant. In turn, intertemporal optimisation implies that $r = \rho$. Given this and the marginal cost pricing of capital $(v = \eta/n)$, the arbitrage condition $(8)$ can be rewritten as: $g + \rho = (\pi n)/\eta$. Using the equilibrium profits $\pi$ in $(4)$, the equilibrium size of firms in $(7)$ and Eq. $(8)$ and Eq. $(9)$, it is easy to find the growth rate:

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

Some of the usual determinants of growth in endogenous growth models are present here. A higher $\rho$ decreases the growth rate through an increase in present consumption at the expense of saving and investment in the innovation sector. A larger population $L$ increases growth because of the usual scale effect. A higher elasticity of substitution between varieties $(\sigma)$ decreases the monopoly power of each firm and, therefore, the incentive to create new firms. A higher cost of innovation, measured by $\eta$, also decreases the growth rate. Because of the local spillovers, the concentration of economic activities, $\gamma$, has a positive effect on growth as it decreases the cost of investment in the North, the region specialised in this activity (see Martin and Ottaviano, 1999).

Note also that the growth rate given in $(10)$ is the common growth rate of $H$, $H^*$, $n$, $n^*$ and $N$. Free capital mobility ensures that the North and the South can accumulate capital at the same rate. The North innovates and produces new capital, an activity that generates no profits. The South can and will buy some of these units of capital at the same rate as the North.

5. Equilibrium income inequality

The two preceding sections have determined the equilibrium location of firms, $\gamma$, as a function of the income inequality $\theta_k$, and the equilibrium growth rate, $g$, as a function of $\gamma$. To complete the solution of the model we have to determine how income inequality depends on the growth rate of the economy.

Per capita income levels in both regions are the sum of labour income, $1$ in both
regions, and capital income given by the product of total wealth and the propensity to consume ($\rho$, in our log utility case). In other words, instantaneous capital income is wealth multiplied by the equilibrium return, $r = \rho$. Per capita wealth in the North is then simply the constant $Hv/L$, as the capital stock $H$ is rising at the same rate as $v$ is decreasing. Aggregate income in the world is then: $(E + E^*)L = 2L + \rho \sum v$. The value of capital, given by the arbitrage condition (8) $v = \pi/(\rho + g)$, is the discounted sum of future profits. It is lower, the higher the growth rate since future profits decrease if more firms are created and enter the market. Using these identities and the equilibrium value of profits given by Eq. (4) and Eq. (7), we can find how income levels depend on the growth rate:

$$E = 1 + \frac{2\alpha h}{(\sigma - \alpha)\rho + \sigma g}, \quad E^* = 1 + \frac{2\alpha(1 - h)}{(\sigma - \alpha)\rho + \sigma g} \quad (11)$$

where $h = H/N$ is the share of capital owned by the North. Note that this share is constant over time as $H$, $H^*$, $N$ and $N^*$ grow at the same rate in both regions. $\theta_E = E/(E + E^*)$, the consumers’ share of expenditures and income in the North, is therefore:

$$\theta_E = \frac{1}{2} \frac{\sigma(g + \rho) + \alpha(2h - 1)}{\sigma(g + \rho)} \quad (12)$$

Note that as long as $h > 1/2$, that is, as long as the North is initially better endowed in capital than the South, then $\theta_E > 1/2$, that is, income per capita is higher in the North than in the South. This is the case as we assumed the North initially richer than the South ($H_0 > H^*_0$) and the growth rate of capital common to both regions. Note also that income inequality is decreasing in the growth rate. The reason is that the value of capital is lower with higher growth because of more future competition due to faster entry of new firms. As the North is relatively rich in capital ($h > 1/2$), the level of capital income declines more in the North than in the South, leading to decreasing income inequality.

We can also look at the relation between geography, $\gamma$, and income inequality $\theta_E$ by using Eq. (10) and Eq. (12):

$$\theta_E = \frac{\gamma L + \rho \eta h}{2\gamma L + \rho \eta} \quad (13)$$

The expenditure and income share in the North decreases with $\gamma$, the share of firms locating in the North. This follows from the fact that industrial concentration in the North, reducing the cost of innovation, increases the growth rate and curtails the monopoly power of existing firms. This effect, that can be considered as a competition effect, implies that the equilibrium geography is stable: in general, not all firms will decide to produce in the North. There are several reasons for that. First, the competition effect drives firms owned by Northerners to relocate production in the South where competition is less fierce. Second, there is free
capital mobility. This allows Southerners to invest in capital accumulated in the North (in the form of patents or shares). Hence, the lack of an innovation sector does not prevent the South from accumulating capital: the initial inequality in wealth does not lead to self-sustaining divergence. No ‘circular causation’ mechanism which would lead to a core-periphery pattern, as in the ‘new geography’ models of the type of Krugman (1991), will occur. Here, the introduction of endogenous capital and free capital movements gives rise to the possibility of a stable interior solution equilibrium.  

Using Eq. (6) and Eq. (13), the equilibrium \( g \) is the solution to a quadratic equation given in Appendix A. The equilibrium growth rate follows from Eq. (10).

6. Geography, growth and public policies

We are interested in the impact of the different types of public policies on the industrial geography, \( \gamma \), on the geography of incomes and expenditures, \( \theta_e \), and on the growth rate of innovation, \( g \), that applies to the whole country. The location of firms matters for immobile agents 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 locally produced goods, transaction costs (intra-regional) are less than for goods imported from the other region because: \( \delta_n > \delta_a > \delta_r \). The price index that corresponds to our nested CES utility function is:

\[
P = ((\beta \sigma/(\sigma - 1))N^{1/(1-\sigma)}[\gamma \delta_n + (1 - \gamma) \delta_r]^{1/(1-\sigma)}
\]

in the North and

\[
P^* = ((\beta \sigma/(\sigma - 1))N^{1/(1-\sigma)}[\gamma \delta_n^* + (1 - \gamma) \delta_r^*]^{1/(1-\sigma)}
\]

in the South. Hence, an increase in spatial concentration in the North, \( \gamma \), benefits consumers in the North and hurts consumers in the South. As more goods are produced in the North and less in the South, consumers in the North pay less while consumers in the South pay more.

The disparity in real income across the regions depends on the disparity in nominal incomes, \( \theta_e \), given by Eq. (12), and on the disparity in the price indices defined above which itself depends on \( \gamma \). If \( \gamma \) and \( \theta_e \), industrial agglomeration and nominal income disparity, go in the same direction, then the impact on real income disparity is unambiguous. For example, an increase in \( \gamma \) and \( \theta_e \) implies that real income disparities increase between the North and the South as nominal income disparities increase at the same time as the price index decreases in the North and increases in the South. On the contrary, if nominal income disparity increases but industrial agglomeration decreases, the effect on real income inequality is ambiguous. In general, the impact of industrial agglomeration on the price index will be less important the better the public infrastructures. In particular, if inter-regional transaction costs are not very high, then the location of production

\[\text{See Baldwin (1998) and Baldwin et al. (1998) for models of growth and geography with catastrophic agglomeration due to imperfect capital mobility.}\]
will have little effect on the price indices and, therefore, on the real income disparities. In this case, the real income disparities will follow the nominal income disparities.

We can analyze the nature of the equilibrium and the effects of various public policies graphically. Eq. (6) provides a positive relation between $\gamma$ and $\theta_E$, the ‘home market’ effect. In Graph 1, this relation is given by the curve $\gamma(\theta_E)$ in the NE quadrant. Eq. (10) provides a positive relation between $\gamma$ and $g$. This is the spillovers effect: when industrial agglomeration increases in the region where the innovation sector is located, the cost of innovation decreases and the growth rate increases. This relation is given by the line $g(\gamma)$ in the NW quadrant. Finally, Eq. (12) provides a negative relation between $\theta_E$ and $g$. This is the ‘competition’ effect: the monopoly profits of existing firms decrease as more firms are created. As the North is more dependent on this capital income, the Northern share of income and, therefore, of expenditures decreases. This relation is described by the curve $\theta_E(g)$ in the SE quadrant.

Graph 1. Equilibrium growth, agglomeration and income inequality.

For a more detailed analysis of welfare effects of location see Martin and Ottaviano (1999).
We now analyze the effect of various public policies. We can first look at a direct monetary transfer to the South, a decrease in $h$ for instance, the relative endowment in capital. The initial impact is on $\theta_e(g)$ which decreases for a given growth rate (see Eq. (12)). This is shown in the SE quadrant of Graph 2.

In turn, the transfer in purchasing power ($\theta_e$ decreases) increases the market size of the South attracting firms there ($\gamma$ decreases, see quadrant NE). Because of local spillovers, the geography becomes less conducive to innovation so that the growth rate decreases (see quadrant NW). The economic geography in terms both of industrial location and nominal incomes becomes less unequal, so that real income inequality decreases but at the expense of the growth rate.

Suppose now that the public policy improves domestic infrastructures in the South, i.e. $\delta^S_{d}$ increases. The effect of such a policy is shown in Graph 3.
Graph 3. The effect of a decrease of intra-regional transaction costs in the South.

In this case, as easily checked from Eq. (6), $\gamma$ decreases for any given level of $\theta_E$ (see quadrant NE in Graph 3; $\gamma(\theta_E)$ shifts to the right). The intuition is that, as public infrastructure improves, transaction costs on goods produced and consumed in the South decrease, increasing the effective demand. Given increasing returns to scale, firms in the differentiated goods sector relocate to the South and $\gamma$ decreases. Relocation from the North, where the innovation sector is located, to the South brings about an increase in the cost of innovation reducing the growth rate of innovation. In this sense, the improvement in infrastructure of the South generates a less growth conducive geography and, through a reduction in the growth rate of innovation, it lessens competition, increasing monopoly profits to the benefit of capital owners in both regions. As capital owners are more numerous in the North, the inter-regional inequality in expenditures, measured by $\theta_E$, rises (see quadrant SE). The net effect on real income inequality is however ambiguous. Nominal income inequality has increased but the price index has decreased in the
South compared to the North. This is due to the fact that more firms produce in the South and that the cost of transporting locally produced goods to consumers in the South has decreased.

Note also that economic geography has not only an impact on inter-regional income inequality but also on a particular form of intra-regional inequality between workers and capital owners. When monopolistic profits increase due to a less concentrated geography (higher $\gamma$) and a lower growth rate, this increases the relative income gap between capital owners and wage earners. This is true in both regions.

We do not take into account the cost of such a policy. If this improvement in infrastructure is paid for by a monetary transfer by the North as is the case for regional policies, then the effect will be the combination of those studied in Graph 2 and Graph 3. Taking into account the financing would therefore reinforce the impact on the growth rate and on industrial agglomeration but would make the effect on nominal income inequality ambiguous.

Graph 4. The effect of a decrease of inter-regional transaction costs.
Graph 4 analyses 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, that is: \( \partial \gamma / \partial \delta_I > 0 \) in Eq. (6) (see proof in Appendix B) for a given income inequality. Hence, \( \gamma(\theta_L) \) shifts as shown in quadrant NE and the effect of such policy is qualitatively the exact opposite to the effect of a decrease of intra-regional transaction costs in the South analyzed in Graph 3.

As trade towards the South is made easier, it is less necessary to locate production in the South and firms can now take advantage of the scale economies in the North. The North can have a larger market either because it is richer \( (h > 1/2) \) and/or because it has better domestic infrastructure than the South \( (\delta_D > \delta_D^S) \). In the latter case, its effective demand is larger because less of the good produced in the Northern region is lost in transit for the consumers in the North. Hence, in this case, an improvement in inter-regional infrastructure has the opposite effect of an improvement in intra-regional infrastructure in the South: as \( \gamma \) increases, the growth rate of innovation, \( g \), increases, and \( \theta_L \) decreases as monopolistic profits of each capital owner decrease.

The impact on real income disparities is ambiguous: nominal income disparities decrease but the impact on the price index in the two regions is more complex. In the South as \( \delta_I \) increases, the cost of importing goods from the North decreases. However, as some firms relocate to the North (\( \gamma \) increases), more of the goods have to be imported bearing a higher transaction cost (the inter-regional one) than the one faced if the good was produced locally. It can be shown (see Appendix C) that the first effect is larger than the second so that, following a decrease in the inter-regional transaction cost, the price index in the South decreases. In the North, both effects go in the same direction: the cost of importing goods from the South decreases and more firms decide to produce in the North. It can be shown that the price index decreases more in the South than in the North. The net effect on real income inequality is therefore ambiguous. As shown in Martin and Ottaviano (1999), if transaction costs between the two regions are already sufficiently low, the impact on price indices will not be very important. So, an improvement in infrastructures that help decrease the inter-regional transaction costs further will lower real income inequality between the regions.

A decrease in the intra-regional transaction costs in the North would have the same qualitative effect as those described here for the improvement of inter-regional infrastructures.

To take into account the effect of financing these infrastructures by the North, we need to combine the effects described in Graph 2 and Graph 4. The effect on nominal income inequality would be reinforced but the impact on the growth rate and on agglomeration would become ambiguous. If the unwelcome effect of such a policy (the increase in industrial agglomeration) were then reversed, it would imply that its induced positive impact on growth would also be reversed.

In the case of the public policies described above, all regional in nature, a
trade-off exists because they all have an undesirable side effect. They either lead to lower growth (the direct transfer to the South, the improvement of intra-regional infrastructures in the South) or to higher nominal income inequality (the improvement in intra-regional infrastructures) or to more industrial agglomeration (the improvement in inter-regional infrastructures). Taking into account the cost of financing these policies does not change this conclusion.

Is there a public policy that can attain both objectives of regional equity and higher growth 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, the \( g(\gamma) \) line shifts to the left and the equilibrium growth rate increases as the cost of innovation decreases (see quadrant NW in Graph 5). 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

Graph 5. The effect of a decrease in the cost of innovation.
in the South. This reduces the income differential between North and South, between workers and capital owners inside each region, and leads to firms’ relocation to the South.

It can be shown that in Eq. (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 D). Hence, a public policy that reduces the cost of innovation can attain both the objectives of higher growth and more equity. Both industrial concentration in the North and the income differential between North and South decrease so that the real income differential unambiguously decreases.

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 to the South, helps the creation of new economic activities and firms without any of the local bias that regional policies usually have.

Taking into account the financing of such a policy by the North (combining the effects described in Graph 2 and Graph 5) does not reverse these conclusions. The impact on nominal income inequality and industrial agglomeration would be reinforced. The net impact on growth may turn negative if the financial burden of the policy is so high that the effect on incomes and geography dominates the direct effect on the cost of innovation. This just says that the cost of such a policy should not be too high to have the desired effect on growth.

7. 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. Given that economic geography affects growth, public policies that alter 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 preferable. On the other hand, such an economic geography is detrimental to immobile workers in the poor region because, further away from the main production site, they have to pay higher transaction costs. 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 have to face this trade-off.

We have shown that the geography of industry location and income may be related in an interesting way. An increase in spatial concentration of firms in the North leads to a decrease in nominal income disparities between North and South because the competition effect that follows leads to a decrease of the monopolistic profits on which the North is more dependent than the South. A related point is that policies that affect industrial geography, have an impact on income inequality inside each region because they affect monopolistic profits of capital owners.

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 now in favour in Europe.

To our knowledge, this paper is the first to analyze in an integrated framework the role of public policies, especially public infrastructure policies, on growth, income and economic geography. Admittedly, our model is very incomplete and special in some of its assumptions so that our results may be too unfair to regional policies. Its main point, however, is to clarify some economic mechanisms that explain why regional policies can have complex and undesirable consequences and why they can have not only a local impact but also a national impact.

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Appendix A

The quadratic equation that determines the equilibrium \( \gamma \) is:

\[
2\gamma^2 L (\delta_D - \delta_I) (\delta^*_D - \delta_I) - \gamma [L \delta^*_D (\delta_D - \delta_I)] - L \delta_I (\delta^*_D - \delta_I) \\
- \rho \eta [\delta_D - \delta_I (\delta^*_D - \delta_I)] - \rho \eta [h \delta^*_D (\delta_D - \delta_I)] \\
- (1 - h) \delta_I (\delta^*_D - \delta_I) = 0 \quad (A1)
\]

The valid solution (the other root is more than 1) is:
\[ \gamma = \frac{L\delta^*_D(\delta_D - \delta_i) - L\delta_i(\delta^*_D - \delta_i) - \rho \eta (\delta_D - \delta_i)(\delta^*_D - \delta_i) + \sqrt{\Delta}}{4L(\delta_D - \delta_i)(\delta^*_D - \delta_i)} \]

\[ \Delta = \left[ L\delta^*_D(\delta_D - \delta_i) - L\delta_i(\delta^*_D - \delta_i) - \rho \eta (\delta_D - \delta_i)(\delta^*_D - \delta_i) \right]^2 \]
\[ + 8L\rho \eta (\delta_D - \delta_i)(\delta^*_D - \delta_i)[h\delta^*_D(\delta_D - \delta_i) - (1 - h)\delta_i(\delta^*_D - \delta_i)] \]

This root is less than 1, i.e. there is less than full agglomeration of economic activities in the North, if \( h, \delta_i \), and the difference between \( \delta_D \) and \( \delta^*_D \) are not too large. The equilibrium value of \( \theta_E \) follows from Eq. (13) and the equilibrium value of \( g \) follows from Eq. (10).

**Appendix B**

The partial derivative of \( \gamma \) with respect to \( \delta_i \) in Eq. (6) is:

\[ \frac{\partial \gamma}{\partial \delta_i} = \frac{\theta_E \delta^*_D}{(\delta^*_D - \delta_i)^2} - \frac{(1 - \theta_E)\delta_i}{(\delta_D - \delta_i)^2} - \frac{(1 - \theta_E)}{(\delta_D - \delta_i)} \]

(A3)

To look separately at the role of differences in income and in infrastructure levels, first assume that domestic infrastructures are of the same quality in both regions i.e. \( \delta_D = \delta^*_D \) then:

\[ \frac{\partial \gamma}{\partial \delta_i} = \frac{(2\theta_E - 1)\delta_D}{(\delta_D - \delta_i)^2} \]

This is positive as long as \( \theta_E > 1/2 \), that is as long as the North has 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 Eq. (11)).

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

\[ \frac{\partial \gamma}{\partial \delta_i} = \frac{(\delta_D \delta^*_D - \delta^2_i)(\delta_D - \delta^*_D)}{2(\delta^*_D - \delta_i)^2(\delta_D - \delta_i)^2} \]

(A4)

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 C

We analyze the impact of an improvement in inter-regional infrastructures on the price indices of the regions in the case where $\delta_p = \delta_p^*$:

$$
\frac{\partial P^*}{\partial \delta_i} = - \left( \frac{\beta \sigma}{\sigma - 1} \right) N^{1-\sigma} \left[ (1 - \gamma) \delta_p + \gamma \delta_j \right]^{\frac{1}{1-\sigma}} \left[ \gamma + (\delta_i - \delta_p) \frac{\partial \gamma}{\partial \delta_i} \right]
$$

$$
= - \left( \frac{\beta \sigma}{\sigma - 1} \right) N^{1-\sigma} \left[ (1 - \gamma) \delta_p + \gamma \delta_j \right]^{\frac{1}{1-\sigma}} \left[ 1 - (\delta_i - \delta_p) \frac{\partial \gamma}{\partial \delta_i} \right]
$$

Hence both price indices decrease. Using the results above, and the fact that $\theta_k > 1/2$ and $\gamma \delta_p + (1 - \gamma) \delta_i > (1 - \gamma) \delta_p + \gamma \delta_i$ it can be proved that a $\frac{\partial (P/P^*)}{\partial \delta_i} < 0$, so that the relative price index changes in favour of the North.

Appendix D

We want to prove that $d g / d \eta$ is negative. From Eq. (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 $\delta_p = \delta_p^*$. For this, we differentiate Eq. (6) and Eq. (13) in the text and eliminate $d \theta_E$. After simplification, one gets the following elasticity:

$$
\frac{\partial \gamma}{\partial \eta} \frac{\eta}{\gamma} = \frac{L \rho \eta (2h - 1)(\delta_p + \delta_i)}{L \rho \eta (2h - 1)(\delta_p + \delta_i) + (\delta_p - \delta_i)(2L\gamma + \rho \eta)^2}
$$

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

References


