Second-best redistribution through public investment: a characterization, an empirical test and an application to the case of Spain

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Abstract

This paper develops an empirical methodology for assessing the optimality of public investment policy. The proposed test works by comparing the observed distribution of the stock of infrastructures across regions with the optimal allocation derived from a planning problem in which the observed degree of ex-post redistribution is taken as given. An application of the procedure to the Spanish case suggests that public investment has been too redistributive in this country.

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1. Introduction

Concern about the unequal development of different parts of their territory has often led governments to pursue active policies of regional redistribution. Over the last 20 years, many national governments and the European Union itself have devoted large amounts of resources to improving the productive capacity of their less developed regions, mainly through direct public investment in infrastructures (but also through training programmes and subsidies to private investment).

These policies have often been questioned. Perhaps, the main objection to them is that, since there exist better instruments for the redistribution of income across individuals, it...
would be preferable to assign public investment purely on efficiency grounds, so as to maximize national output and then carry out any desired redistribution through taxes and the social protection system.

This paper examines the validity of this criticism of regional policies under the assumption that there are exogenous limits to personal redistribution mechanisms. While the proposed two-stage policy is certainly optimal in a frictionless environment, I argue that some degree of redistribution through public investment is part of the optimal policy package in a second-best world where there exist limitations on the amount of redistribution that can be achieved through more direct means.

Hence, there is indeed room for regional policies. But this does not mean that the policies we observe in Europe and elsewhere are necessarily optimal. To evaluate them, we need a model that can be used to compute the optimal allocation of infrastructures across regions in a world with imperfect mechanisms for personal redistribution. In this paper, I use a simplified version of such a model, originally developed by Caminal (2002), adapted in a way that lends itself easily to calibration using readily available data and the results of some previous empirical studies. My version of the model takes as given the observed degree of ex-post regional redistribution through taxes and public spending and yields a simple characterization of the optimal (second-best) allocation of public investment across regions. This second-best allocation depends on the regional distribution of disposable income (after taxes and transfers) and involves a deviation from efficiency in favour of poorer regions.

The theoretical results are used to develop an empirical methodology for the evaluation of observed public investment policies that is applied to the case of Spain. The proposed procedure involves a comparison between the optimal allocation given by the model and the observed one, or more precisely, between the rates of return on infrastructure capital under both allocations. As can be expected, the results of the exercise carried out with Spanish data depend to some extent on assumptions concerning the values of two key parameters: one that captures the degree of social aversion to inequality and a second one that measures the “non-productive” fraction of the population—i.e., the weight of those who do not benefit directly from infrastructure investment in their region of residence and, as a result, favour an efficient investment policy because it maximizes the net transfers they receive through the social protection system. For plausible values of the second parameter, I find that the conclusion that redistribution through public investment has been carried too far in Spain holds for any degree of aversion to inequality.

The paper is organized as follows. Section 2 contains some general considerations about the suitability of public investment as a redistributive tool and develops a model of the optimal allocation of infrastructure across regions. Section 3 shows how this model can be used to test hypotheses concerning the optimality of the observed pattern of public investment and Section 4 illustrates the procedure using Spanish data. Section 5 closes with a brief summary and a discussion of some policy implications.

2. Should public investment be used as a redistributive tool and to what extent?

Perhaps, the main argument against investment-based redistributive regional policies is that there are better ways to achieve the same objectives. Critics of these programmes
often argue that it would be preferable to allocate infrastructure investment in accordance to a strict efficiency criterion, thereby maximizing aggregate output, and then perform any desired redistribution ex-post, through the tax and social protection systems.

It is certainly true that tax policies and social expenditure programmes are better suited than public investment for the redistribution of income. One key advantage of these instruments is that, since they can be tailored to individual circumstances, they will be more effective in reaching the neediest segments of the population than infrastructure investment, which works by raising the productivity of private factors and will therefore benefit employed workers and the recipients of capital income more than needier groups.

While this observation certainly implies that the bulk of personal redistribution must be carried out through instruments designed specifically for this purpose, it does not necessarily follow that there is no need for redistributive regional policies. This stronger result (of strict separation between investment decisions and redistribution) will not hold if there are any limitations on the available mechanisms for ex-post redistribution that prevent the implementation of the first-best strategy of maximizing income through investment and redistributing it optimally ex-post. In practice, the existence of such limitations seems indisputable and existing fiscal systems do not guarantee that more efficient investment will bring about a Pareto improvement. My calculations for the case of Spain, for instance, suggest that any output gains derived from a more efficient investment policy would tend to stay disproportionately in the richer regions, leaving the poorer ones worse off than under the current situation.\(^1\)

Hence, the optimal policy package in a second-best world will involve some redistribution through public investment. Building on the work of Caminal (2002) in the remainder of this section, I will develop a model of the allocation of infrastructure investment across regions, which yields a simple characterization of this constrained optimum that is easy to implement empirically.

In Caminal’s (2002) model, the planner chooses regional investment levels together with a proportional income tax rate and a constant per capita lump sum transfer so as to maximize social welfare under the assumption that taxation is distortionary. To simplify things and facilitate calibration, I will take as given the overall volume of public investment, focusing only on its allocation across regions, and work with an alternative simplified description of the fiscal system. I will assume, in particular, that the representative resident of each region receives a net subsidy (or pays a net tax) that is an exogenously given fraction \( h \) of the difference between average gross income per capita in the country as a whole and his own gross income. Roughly speaking, the redistribution coefficient, \( h \), tells us what fraction of income disparities is eliminated ex-post by taxes and government expenditures.

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\(^1\) See de la Fuente (2001b). I estimate that a certain change in Spanish investment policy during the period 1990–1995 (which would increase the weight given to efficiency considerations) would have raised Spanish national income by around 300,000 million pesetas (mptas). This figure is the net result of an output gain of 600,000 mptas in a set of regions that comprise approximately 50% of the Spanish population and a loss of 300,000 mptas in the remaining ones. Taxes and public expenditures would redistribute part of the gains towards the second set of regions, but not nearly enough to fully compensate them. According to my estimates, their loss of disposable income would be around 170,000 mptas or a billion euros.
Another important simplification is that, while Caminal allows for a non-trivial income distribution within each region, I will work with a representative agent model. I will, however, allow for some heterogeneity by introducing a fictional region (region 0) to which I will attribute (independently of where they really live) all the non-productive citizens of the country—that is, all those individuals who do not benefit directly from productive public investment in their region of residence. I will return below to the question of what segments of the population should be included in this group. For now, the important thing to note is that, as Caminal (2002) emphasizes, the existence of this segment of the population tends to bring the optimal allocation of public capital closer to the one that would dictate the efficiency criterion. The reason is that the members of this group will be interested only in the maximization of aggregate income because the transfers they receive are an increasing function of this variable and are independent of the stock of public capital of the (geographical) region where they live.2

2.1. A simple model of the optimal allocation of infrastructure

Consider a country formed by $n + 1$ regions ($i = 0, 1, \ldots, n$) with shares $x_i$ in the national population that I will take as exogenously given. Regions 1 through $n$ are “real” geographical regions and region 0 is a fictional region to which I will attribute the entire non-productive population of the country, independently of its geographical region of residence. Gross income per worker in region $i$ is given by a per capita production function of the form

$$y_i = A_i f(p_i)$$

where $f(\cdot)$ is an increasing, concave and differentiable function, $p_i$ is the per worker stock of productive public capital in region $i$ and $A_i$ a productivity index that summarizes the effects of the endowments of private production factors and the level of technical efficiency of the region. Since the residents of region 0 are by assumption non-productive, I will set $A_0 = y_0 = 0$.

I will assume that the central government has a given budget for infrastructure investment that must be allocated among the geographical regions and that it can redistribute income ex-post through taxes and subsidies. Letting $P$ denote the available investment funds per capita, the resource constraint requires that

$$\sum x_i p_i \leq P$$

Per capita disposable income in region $i$ ($x_i$) will be given by

$$x_i = y_i + z_i$$

---

2 Clearly, this will only be true as long as there is a national system of personal redistribution that is applied uniformly across all regions. Until now, this has (roughly) been the case in most European countries, but not in the European Union where there do not exist any significant redistribution mechanisms at the personal level. In the case of Spain, which I will analyze below, it is possible that the ongoing process of fiscal decentralization may gradually weaken this system in the future by giving regional governments greater discretion on tax and social protection policies. Such a development would strengthen the case for ex-ante redistribution through regional policies.
where \( z_i \) is the net per capita subsidy to residents of region \( i \) (or the taxes they bear if \( z \) is negative). The government’s budget constraint requires that the average value of these subsidies be non-positive, that is

\[
\sum i |z_i| \leq 0
\]  
(4)

Finally, the government chooses the instruments under its control so as to maximize the average welfare of its citizens, given by

\[
W = \sum i z_i U(x_i)
\]  
(5)

where \( U() \) is an increasing, concave and differentiable function that can be interpreted as either the (common) utility function of the residents of the different territories or as the function describing the policy-maker’s valuation of average income in each region. Notice that the concavity of \( U() \) is crucial for it amounts to the assumption that the policy-maker is averse to inequality. As a result, he will carry out some redistribution from rich to poor regions, even if this has a cost in terms of lower aggregate output.

It will be useful to consider two alternative versions of this problem. In the first one (that yields the strict separation result mentioned above), the central government can redistribute income without any limitations through lump-sum taxes and subsidies. Formally, the planner solves the following problem

\[
(P.1) \max_{p_i, z_i} \left\{ \sum_{i=0}^{n} x_i U(Af(p_i) + z_i) \text{ s.t. } \sum_{i=0}^{n} x_i p_i \leq P \text{ and } \sum_{i=0}^{n} x_i z_i \leq 0 \right\}.
\]

Forming the Lagrangian,

\[
\mathcal{L} = \sum_{i=0}^{n} x_i U(Af(p_i) + z_i) + \lambda \left( P - \sum_{i=0}^{n} x_i p_i \right) - \mu \left( \sum_{i=0}^{n} x_i z_i \right),
\]

where \( \lambda \) and \( \mu \) are the multipliers associated with the constraints (2) and (4), and differentiating it with respect to \( z_k \) and \( p_k \), we obtain the first-order conditions:

\[
Af'(p_k) = \frac{\lambda}{U'(x_k)} \text{ for all } k = 1 \ldots n
\]  
(6)

\[
U'(x_k) = \mu \text{ for all } k = 0, 1 \ldots n
\]  
(7)

Eq. (7) requires the equality of marginal utilities, and hence of disposable incomes, across all regions (including region 0). Given this result of “complete redistribution”, Eq. (6) implies that the marginal product of public capital should be the same in all geographical regions. Notice that this is a necessary condition for the maximization of national income, for its failure would make it possible to increase aggregate output by shifting resources to the region with the highest return. For future reference, let us take note of this condition of equal returns as the practical expression of the criterion for efficient investment.
It should be emphasized that this result of efficiency in investment only holds when there is complete redistribution. In fact, what Eq. (6) requires is the equality across regions of the marginal contribution of public investment to welfare, and not to output. The relevant term \((U'(x_i)A_if'(p_i))\) depends on two different factors: the contribution of public investment to output, measured by its marginal product, \(A_if'(p_i)\), and the contribution of this marginal increase in output to welfare, \(U'(x_i)\), which depends on the level of disposable income. If disposable income differs across regions, so will the optimal marginal productivities of public capital, implying a violation of the efficiency criterion. In particular, the marginal product of public capital will be greater than under the efficiency criterion (and the level of investment correspondingly lower) in those regions with high disposable incomes, and the opposite will be true in the poorer regions. Given this, it is not at all surprising that if we impose any reasonable restriction on the government’s capacity to redistribute income ex-post, the optimal policy will involve some deviation from efficiency in investment.

In the second version of the planning problem I will analyze, it will be assumed that the subsidy to the representative resident of each region is a constant fraction \(\theta\) of the difference between average income per capita in the whole country \((y)\) and his own gross income \((y_i)\). Under this assumption, average disposable income in region \(i\) \((x_i)\) will be given by

\[
x_i = y_i + \theta(y - y_i) = (1 - \theta)y_i + \theta y
\]

where

\[
y = \sum_i x_i y_i
\]

Hence, I am assuming that the operation of the entire fiscal system can be summarized by a single parameter \(\theta\) (which I will call the redistribution coefficient) and that taxes and transfers are non-distortionary in the sense that gross income levels, \(y_i\), are independent of \(\theta\). It is easy to check that the budget constraint requiring that net transfers be equal to tax revenues, i.e. that

\[
\sum_i x_i \theta(y_i - y) = 0,
\]

is automatically satisfied with this formulation.

Under these assumptions, the government’s problem can be written

\[
(P.2) \max_{p_i} \left\{ \sum_{i=0}^{n} x_i U \left[ (1 - \theta)A_if'(p_i) + \theta \sum_{j=0}^{n} x_j A_jf'(p_j) \right] \right\} \quad \text{s.t.} \quad \sum_{i=0}^{n} x_ip_i = P
\]

and differentiation of the appropriate Lagrangian,

\[
\mathcal{L} = \sum_{i=0}^{n} x_i U \left[ (1 - \theta)A_if'(p_i) + \theta \sum_{j=0}^{n} x_j A_jf'(p_j) \right] + \lambda \left( P - \sum_{i=0}^{n} x_ip_i \right)
\]
yields the first-order condition

\[ \frac{\partial \mathcal{L}}{\partial p_k} = x_k U''(x_k) (1 - \theta) A_k f''(p_k) + \sum_{i=0}^{n} z_i U''(x_i) \theta z_k A_k f''(p_k) - \lambda x_k = 0 \]

from where

\[ A_k f''(p_k) = \frac{\lambda}{(1 - \theta) U''(x_k) + \theta \sum_{i=0}^{n} z_i U''(x_i)} . \]

Hence, the ratio the marginal product of public capital in any two regions \( j \) and \( k \) must satisfy the following condition at an optimum:

\[ \frac{A_j f''(p_j)}{A_k f''(p_k)} = \frac{(1 - \theta) U''(x_j) + \theta \left( z_o U''(x_o) + \sum_{i=1}^{n} z_i U''(x_i) \right)}{(1 - \theta) U''(x_k) + \theta \left( z_o U''(x_o) + \sum_{i=1}^{n} z_i U''(x_i) \right)} \]  

(10)

Eq. (10) is simply the formal expression of the already mentioned condition for an optimum, namely that the contribution to welfare of the last euro invested in each region must be the same in all cases. To obtain it, I have taken into account the fact that, under my assumptions, investment in any region affects not only the income of its residents (which it does directly, through an increase in their productivity), but also the average income in the entire country and, through the ex-post redistribution system, the disposable incomes of all regions. As a result, the term that appears in the right-hand side (both in the numerator and in the denominator) is not the marginal utility of the region we are considering but a weighted average of this variable and the average marginal utility of all the citizens of the country (captured by the term inside the parenthesis), with weights that reflect the existing degree of ex-post redistribution, \( \theta \).

The implications of Eq. (10) are rather intuitive. Under the assumption that ex-post redistribution is incomplete (i.e., that \( \theta < 1 \)), the optimal marginal product of infrastructures will be lower in region \( j \) than in region \( k \) whenever \( x_j < x_k \). Hence, the optimal allocation of public capital will involve a “distortion” in favour of poor regions.\(^3\) Investment in low income regions will be higher than required by the efficiency criterion (and its return will be correspondingly lower) because, although its payoff in terms of output will be relatively low, its contribution to welfare will be high. The situation will be just the opposite in rich regions.

Eq. (10) also implies that the optimal degree of redistribution through public investment (which we can proxy by the dispersion of the optimal rates of return)
will be an increasing function of the level of regional inequality that remains after the operation of the ex-post redistribution system. If disposable income per capita is the same in all regions (or, equivalently, if $\theta = 1$) the right-hand side of Eq. (10) is equal to one and the rate of return on public capital should be the same in all regions, as required by the efficiency criterion. As income disparities increase, optimal investment levels will be set in order to partially offset them and this will translate into an increase in the dispersion of the optimal rates of return on public capital.

It is interesting to note that the marginal utility of the citizens of region 0 (the non-productive population) plays an important role in Eq. (10). Although this segment of the population does not benefit directly from public investment, it does benefit indirectly through the ex-post redistribution mechanism. And since the system assigns each member of this group a constant fraction of per capita national income, he or she always prefers an efficient investment policy that maximizes this magnitude. As a result, when the weight of region 0 is large, the optimal policy is close to the efficient one. Notice that if $x_0 U(x_0)$ is large (that is, if the share of non-productive citizens is large or their marginal utility is high because they are very poor), this term will dominate the other ones and the ratio that appears on the right-hand side of Eq. (10) will be close to 1, which is the value it would adopt under a pure efficiency criterion.

It should be clear that the model incorporates some highly restrictive assumptions that may in some cases affect the results of the empirical test I will propose below. The use of a representative agent, for instance, can be expected to bias the results in favour of additional redistribution through public investment because it amounts to the assumption that infrastructures have the same impact on the incomes of all (productive) residents of a region. In fact, it may be expected that the benefits from public investment will be roughly proportional to productivity. Hence, investment in infrastructure may actually increase income inequality within each region and this would decrease its attractiveness as a redistributive tool relative to the implications of this model. A factor that is likely to work in the opposite direction is that the model does not take into account the direct (“consumption”) benefits of infrastructure investment, which will be relevant also for non-productive residents.

Another important, and almost certainly incorrect, assumption is that infrastructure investment generates no cross-regional spillovers. This is a crucial issue for such spillovers would certainly affect the optimal allocation of investment, but there are no precise estimates of the magnitude and direction of these effects available in the literature that can be used to correct my calculations. I would expect that poor regions will derive greater benefits from additional investment in key infrastructures located in central areas (such as major national airports) than the reverse and, as a result, that the optimal allocation of public capital should be somewhat more skewed in favour of rich regions than the prediction of the model developed above.

Finally, I have also assumed that labour is not mobile across regions. This assumption has been made for the sake of tractability but it is probably not a bad approximation in the case of many European countries, and certainly in the case of Spain in recent years. In any

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4 See de la Fuente (1999).
event, labour mobility can be expected to weaken the impact of public investment on income per capita by triggering partially offsetting changes in migration flows. This will tend to magnify the changes in the allocation of infrastructures required to reach the optimum, as increases (decreases) in investment in any given region will be diluted by population inflows (outflows).

3. Too much or too little redistribution?

Given appropriate data and an assumption about the form of the utility function, the model developed above can be used to assess the optimality of observed public investment policies. The idea is quite simple: we can compute the optimal rates of return given in Eq. (10) and compare them with the observed rates of return on infrastructure to try to determine whether the regional distribution of the stock of this factor is close or far from the optimum and in what direction.

Assuming the utility function is isoelastic, Eq. (10) implies that the optimal rates of return (ROPT) on public capital (i.e., the optimal marginal product of this factor) in any two regions \( j \) and \( k \) will satisfy the following relation:

\[
\frac{\text{ROPT}_k}{\text{ROPT}_j} = \frac{(1 - \theta) \frac{1}{x^\sigma_j} + \theta \left( \frac{a_0}{x^\sigma_0} + \sum_{i=1}^n \frac{a_i}{x^\sigma_i} \right)}{(1 - \theta) \frac{1}{x^\sigma_k} + \theta \left( \frac{a_0}{x^\sigma_0} + \sum_{i=1}^n \frac{a_i}{x^\sigma_i} \right)}
\]

(11)

where the terms of the form \( 1/x^\sigma \) that appear in Eq. (11) are the marginal utilities of the representative residents of the different regions and the parameter \( \sigma \) measures the degree of aversion to inequality of the planner (or any interested observer). If \( \sigma \) is large, the marginal utility of disposable income is much higher for poor than for rich citizens and this increases the planner’s inclination to transfer resources from rich to poor regions so as to maximize total welfare.

Given estimates of regional disposable incomes and the redistribution parameter, the value of ROPT can be computed for specific values of the parameters \( \sigma \) and \( a_0 \). The observed rates of return to infrastructure investment (ROBS = \( Af(p) \)) can be calculated using an estimate of the regional production function and data on factor stocks. Alternatively, relative returns to infrastructure across regions (which are the required input for the calculation) can be approximated using data on the stock of this factor and on regional output. Under the assumption that the production function is Cobb-Douglas, it is easy to show that marginal products are proportional to average products, so relative rates of return on infrastructure can be computed using observed average products (i.e., the ratio of output to the stock of productive public capital in each region).

Once estimates of the relevant variables have been constructed, we need to check whether observed and optimal rates of return are approximately equal and, if this is not the case, to determine whether the differences between them reflect an excess or a deficit of redistribution through public investment. Since Eq. (10) is written in relative terms, I will
divide both optimal and observed rates of return by their respective sample averages and analyze the relationship between the variables so normalized. I will estimate, in particular, an equation of the form

\[(RROBS_i - 100) = c^*(RROPT_i - 100)\]  \hspace{1cm} (12)

where RROBS and RROPT denote the relative values of observed and optimal rates of return on public capital.

If the observed and optimal distributions of relative rates of return on infrastructure were the same, \(c\) would be equal to one. If the estimated value of \(c\) is significantly greater than one, the observed rates of return will be above their optimal values in those regions where the latter are high (that is, in the rich regions, where investment should be below its efficient level), and below their optimal levels in the regions where the latter are low (i.e., in the poor regions). Hence, we will be investing too little in the rich regions and too much in the poor ones, and we will have to conclude that the observed degree of redistribution is too high. If the value of \(c\) is below one, we will be in the opposite situation and the observed degree of redistribution through public investment will be too low.

Hence, the estimation of the slope parameter, \(c\), of Eq. (12) provides a test of the hypothesis that the observed regional allocation of public capital is optimal, and may be used to determine whether the observed degree of redistribution is higher or lower than the optimal one. It is important to note, however, that since different assumptions about the values of \(r\) and \(z_o\) will yield different sets of optimal rates of return, the sensitivity of the results to the values of these parameters should be carefully explored.

### 4. Is the allocation of public capital across the Spanish regions too redistributive?

In this section, I will follow the strategy outlined above to evaluate Spain’s regional investment policy. To perform the required calculations, I will use data on output levels, population and infrastructure stocks in the Spanish regions and estimates of their disposable incomes and of the degree of ex-post redistribution. The regional data refer to 1995 and come from the publications of Fundación BBVA (various years) and Mas et al. (various years). Regional output is measured by gross value added at factor cost. The measure of the (net) real stock of infrastructures includes roads and highways (including toll highways), ports, airports, railroads, urban structures and water works. The estimate of the regional redistribution coefficient I will use \((\theta = 0.33)\) is taken from de la Fuente (2001a), where I also construct regional fiscal balances that are used to estimate regional disposable incomes in the manner discussed below.\(^5\)

As suggested above, I approximate the relative return to public investment using the observed average product of infrastructure in each region. Given values of \(\sigma\) and \(\theta\), to

\(^5\) The fiscal balance of a region is defined as the difference between public expenditure in the region and the taxes born by its citizens. The estimates given in de la Fuente (2001a) refer to the period 1990–1998. Here, I use the average value over this period of per capita fiscal balances measured as a fraction of national income per capita. The estimate of the redistribution coefficient \(\theta\) is obtained from a regression of per capita regional fiscal balances on relative gross incomes per capita.
compute the optimal rates of return given in Eq. (11) I need estimates of regional disposable incomes ($x_i$) and population shares ($a_i$). The simplest case is the one where it is assumed that $x_i = 0$, that is, there are no non-productive citizens. In this case, $x_i$ is simply the share of region $i$ in the national population in 1995, which I will call $a_i$. Per capita disposable income in each region ($x_i$) is then obtained by adding to its gross income per capita (gross value added) its per capita fiscal balance. Hence, my measure of disposable income includes the value of the services provided by the government in each region as well as net cash transfers from the public budget.

When the non-productive fraction of the population is positive ($x_o > 0$), the procedure is modified in the natural way under the assumptions that (i) the share of this group in the population is the same in all geographical regions and (ii) the income per capita of its members (which comes entirely from government transfers) is given by $\theta y$ in all regions. In this case, $x_i$ is the weight of the productive population of geographical region $i$ in the national total and can be obtained from the observed population shares ($a_i$) using:

$$x_i = (1 - x_o)a_i$$  \hspace{1cm} (13)$$

Next, I reestimate the per capita disposable income of the productive population, subtracting from the total disposable income of each region the part imputed to its non-productive citizens and reducing the denominator in proportion to the population I am now attributing to region 0. Denoting by $x_i$ my original estimate of per capita disposable income in region $i$ by $x_i = (1 - x_o)x_i'$, the average disposable income of the non-productive population and by $x_i'$ the disposable income of the productive segment of region $i$'s population, we will have

$$x_i = (1 - x_o)x_i' + x_o x_o,$$

from where

$$x_i' = \frac{x_i - x_o x_o}{1 - x_o}$$  \hspace{1cm} (14)$$

Using the variables constructed in this manner, I estimate the relationship between the observed and optimal rates of return given in Eq. (12) under different assumptions concerning the values of $\sigma$ and $x_o$. Fig. 1 illustrates the result for specific values of these parameters, which, as I will argue below, can probably be considered reasonable. The observed rate of return on infrastructure investment (normalized by its sample average) is measured on the vertical axis and the normalized optimal rate of return on the horizontal one. The flatter line is the diagonal (although it does not look like it because the scale is different in each axis) and corresponds to the case where $c = 1$, indicating that the observed and optimal rates of return are equal on average. In those regions located above the

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6 As the representative agent assumption, the assumption of a uniform share of non-productive citizens across regions can be expected to bias the results in favour of redistribution through public investment, thereby reinforcing my conclusion that it has been carried too far in the case of Spain. In fact, the weight of this group is higher in the poorer regions than in the richer ones. This implies that income differences across (the productive residents of) both groups of regions are actually lower than I am assuming and that the need for redistribution is correspondingly lower.
diagonal, the observed return on infrastructure is higher than the optimal one, signaling that investment is too low given its expected return and the region’s disposable income. The steeper line describes the fitted relation between observed and optimal rates of return. In the case shown in the figure, the fitted line is steeper than the diagonal (that is, $c > 1$), implying that the observed degree of redistribution is too high given the assumed values of the parameters.

As I have already noted, the result of the estimation will depend on the values of $\sigma$ and $\zeta_0$ that are used to compute the optimal rates of return. Table 1 shows the estimates

![Diagram](image)

**Table 1**

<table>
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<th>$\sigma$</th>
<th>$\zeta_0 = 0$</th>
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<td>0.64</td>
<td>2.45</td>
<td>3.57</td>
<td>4.99</td>
<td>9.31</td>
</tr>
<tr>
<td>5</td>
<td><strong>0.51</strong></td>
<td>4.28</td>
<td>6.88</td>
<td>10.41</td>
<td>22.21</td>
</tr>
<tr>
<td>8</td>
<td><strong>0.32</strong></td>
<td>38.63</td>
<td>74.26</td>
<td>130.57</td>
<td>371.86</td>
</tr>
</tbody>
</table>

Shown in boldface are the estimates of $c$ which are below one and those for which the $p$-value of the Wald test for the null hypothesis that $c = 1$ is greater than 0.15.
of $c$ obtained for different combinations of these parameters. I have highlighted in bold type those cases in which I cannot reject with a reasonable degree of confidence the hypothesis that the observed distribution of the stock of infrastructures is approximately optimal or even falls short of the optimal degree of redistribution. If it is assumed that the entire population is productive (that is, if $z_o = 0$), the conclusion about the optimality of the observed distribution of the stock of public capital depends crucially on the value of the parameter that measures the degree of aversion to inequality ($\sigma$). The hypothesis that the degree of redistribution is too high can be rejected for all values of $\sigma$ higher than two.

This ambiguity tends to disappear once I assign to $z_o$ (the non-productive share of the population) values above 10%. Notice than when $z_o$ is positive, the estimated value of $c$ varies with $\sigma$ in a non-monotonic way following a U-shaped pattern. The decreasing branch of the U is easily explained: the optimum is close to the efficient distribution of investment when the planner is not very averse to inequality, and will become more redistributive as his aversion to inequality becomes stronger. When $z_o > 0$, however, this situation will eventually be inverted because a planner who is very averse to inequality will put a very high value on transfers going to the non-productive population (which is the poorest group) and this will make him want to invest efficiently. For relatively high values of $z_o$, the conclusion that the observed allocation of public capital is too redistributive will hold for any value of the coefficient of aversion to inequality.

This takes me to the question of what may be a reasonable value for $z_o$. If we interpret the model literally, $z_o$ would be the fraction of the population that is not currently employed and, since this figure is well above 50%, the conclusion that moving towards a more efficient investment policy would be a good idea would be inescapable. But if we try to interpret the model in a more reasonable way, the problem becomes harder because there are important segments of the non-employed population that benefit rather directly from (current or past) infrastructure investment. These groups include the dependents of employed workers and a good share of those in retirement, as their pensions will (generally) depend on their social insurance contributions, which are proportional to their wages and therefore, presumably, to their level of productivity.

It is not easy, therefore, to identify the “correct” value of $z_o$. To give us some idea of the range of potentially reasonable values of this parameter, Table 2 shows the weight in

| Share in the total population around 1995 of various types of less-favoured groups |
|---------------------------------|------------------|
| Not employed                    | 69.58%           |
| Population over 65              | 15.13%           |
| Unemployed                      | 9.04%            |
| Unemployed not entitled to contributive insurance payments | 7.46%        |
| Recipients of non-contributive pensions | 1.29%         |
| % of households whose members are all unemployed | 3.11%          |
| % of persons who live in poor households | 18.08%        |

Sources: Fundación BBVA, Family Budget Survey of 1991 and Yearbook of Labour and Social Statistics for various years between 1991 and 1995. The poverty threshold for the figure in the last row is set at 50% of average Spanish income per capita.
the total Spanish population of various disadvantaged groups that may be plausible candidates for inclusion in region 0. On the basis of these data, it may be tentatively concluded that \( z_o \) should be somewhere between 9% (if we consider only the unemployed not entitled to contributive insurance payments and the recipients of non-contributive pensions) and 18% if we include all those who live in poor households (defined as those whose per capita income lies below one half the national average). For this range of values of \( z_o \), all estimates of \( c \) are greater than one, although it is also true that with \( z_o = 0.10 \) we cannot confidently rule out the possibility that the observed policy is optimal for some values of \( \sigma \). Hence, my conclusions must be somewhat tentative. But the exercise does suggest that, in all likelihood, the regional allocation of the Spanish stock of infrastructures is too redistributive. A change in investment criteria in the direction of greater attention to efficiency considerations would most likely be desirable independently on the degree of aversion to inequality of the observer.

5. Conclusion

In this paper, I have argued that redistributive regional policies can be justified as part of the optimal policy package in a second-best world where there are limits on the feasible degree of ex-post personal redistribution. The optimal intensity of such policies will depend on the amount of regional inequality that remains after ex-post redistribution, on the degree of social aversion to inequality and on the fraction of the population that does not directly benefit from infrastructure investment through higher wages or income from capital.

My analysis of the Spanish case suggests that current regional policies have exceeded this optimal degree of redistribution. Hence, average welfare could be increased by raising the weight given to efficiency considerations in the regional allocation of infrastructure investment. In practice, this would involve investing a lot more in some of the richest regions and considerably less in some of the poorest ones.

I will conclude with two brief comments on the implications of my results for the design of European cohesion policy. The first one is that my conclusions cannot be directly extrapolated to the EU as a whole. Since per capita income differences across member countries are large and there is very little ex-post redistribution going on at this level, the same type of analysis is likely to lead to very different conclusions. The second comment is that the reorientation of Spanish public investment policy that I am advocating would almost surely be in conflict with the criteria governing the allocation of the EU Structural Funds that cofinance a significant fraction of such investment. In my view, it may be desirable to switch to national criteria for the allocation of these funds, leaving their regional distribution at the discretion of member states.

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References


Mas, M., Pérez, F., Uriel, E., various years. El stock de capital en España y sus comunidades autónomas (FBBVA, Bilbao).