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Infrastructure investment and incentives with supranational funding*

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Abstract

Public infrastructure investment is usually co-financed by supranational organizations. The selection of projects is supposed to be decided using the information provided by conventional cost-benefit analysis. Nevertheless, we show that the type of institutional design regarding the financing mechanism affects the incentives of national governments to reduce costs and increase revenues, affecting project selection, the infrastructure capacity, the choice of technology, and the type of contract used for the construction and operation of projects. With a total cost-plus financing mechanism there is no incentive in being efficient and the price charged for the use of the new infrastructure is zero, the market quantity excessive, and the level of supranational financing disproportionate. In contrast, with a sunk cost-plus financing mechanism social optimal pricing is always implemented, though there is no incentive in being efficient. Finally, with a fixed-price financing mechanism the maximal efficiency may be achieved, and the socially optimal pricing is always implemented.

Keywords: infrastructure project, incentives,, fixed-price, cost-plus

JEL Classification: D82, H50, L90

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1. Introduction

Infrastructure services -electricity, water and sanitation, telecommunications, roads, railways, ports, and airports- are crucial for the operation and efficiency of a modern economy (World Bank 1994). Although infrastructure investments are essential for economic activity, they require important amounts of public funds.[1] Large infrastructure projects are usually financed by regional and national governments, though sometimes they may be also financed by a supranational organization. The belief that countries would not invest enough in public infrastructure with their own budgets, and the strategic behaviour of political headquarters regarding these investments, explain why national large infrastructure projects are sometimes co-financed by a supranational organization. The rationale of supranational organizations in devoting funds to this aim is to facilitate the convergence, the regional competitiveness and employment, and the international territorial cooperation.

The European Commission is a clear example of a supranational organization that co-finances national infrastructure projects. In particular, it co-finances national and cross frontier infrastructure projects through the Structural Funds and the Cohesion Fund. Both the Structural Funds and the Cohesion Fund are intended to strengthen the economic and social cohesion of the European Union. The total funds allocated to achieve these objectives raise €340 billion for the period 2007-2013, and they are distributed through the European Regional Development Fund (ERDF), the European Social Fund (ESF), and the Cohesion Fund (European Commission 2005).[2]

[1] Although, infrastructure investment is a necessary condition for economic activity, it is not a guarantee for economic growth or desirable regional effects (see, for example, Gramlich 1994; Holtz-Eakin and Schwartz 1995; or Puga 2002).
[2] Not all these funds go to infrastructure.

In this paper we make use of a simple theoretical model to highlight the asymmetric information problems arising when a national (regional) project is financed by a supranational (national) organization. We distinguish two different levels regarding national infrastructure investment. The first level is related to the institutional design in which supranational (national) funds are obtained, that is, it focuses on the supranational (national) planner and national (regional) government relationship. Once supranational (national) funds are obtained, the second level is related to the selection of the contracts to be used for the construction, maintenance and operation of the infrastructure. Thus, the second level analyzes the national (regional) government and the contractor relationship.

Most of the economic literature concentrates on the second level. Recent economic theories of procurement use mechanism design to analyze the problem of incentives in principal-agent models (see Laffont and Tirole 1993 for a review of this literature). Although most theoretical papers in the literature suggest a menu of contracts to deal with asymmetric information problems, menu of contracts are rarely used in practice. Instead, the vast majority of contracts are variants of simple fixed-price and cost-plus contracts (Bajari and Tadelis 2001).[3] Fixed-price contracts have some advantages and disadvantages over cost-plus contracts. On the one hand, fixed-price contracts provide the strongest incentives for cost reduction (see Dalen and Gomez-Lobo 1996 and 1997; Jorgensen et al. 1997; or Gagnepain and Ivaldi 2002, for empirical evidence). On the other hand, fixed-price contracts leave all risk with the contractor, increasing the probability of renegotiation (Guasch 2004). On the contrary, cost-plus contracts suppose

[3] In fixed-price contracts, the contractor is offered a fixed quantity for completing the project. A cost contract does not specify a fixed price, but rather reimburses the contractor for the costs of the project.

no risk for the contractor but no incentives to reduce costs (Olsen and Osmundsen 2005).

There are infrastructure projects, like highways, where the basic problem for the introduction of a fixed-price contract is demand uncertainty. Project life may extend over 40 years and the usual fixed-term concession, a kind of fixed-price contract widely used in the world, has repeatedly turned into a cost-plus contract through renegotiation (Guasch 2004; Nombela and de Rus 2004). A solution to this problem is a new franchising mechanism based on flexible-term contracts and auctions with bids for total net revenue (Engel et al. 2001; Nombela and de Rus 2004). This new mechanism improves outcomes compared to fixed-term concessions, by eliminating traffic risk and promoting the selection of efficient concessionaires.

Most papers analyzing the national government and contractor relationship in the second level assume that countries are governed by benevolent politicians looking for the maximum social welfare. However, we show that the institutional design regarding supranational funds in the first level may affect politicians' incentives and, thus, main results in the second level. Indeed, the supranational financing mechanism may take different forms. However, in an asymmetric information framework the characteristics of the financing mechanism may be crucial in terms of incentives. This paper examines the first level, where the supranational financing mechanism determines the incentives to select an efficient contract for the construction and operation of the infrastructure in the second level, that is, a contract looking for the minimum costs and the maximum revenues from the social point of view. Main results can be also applied to situations in which national governments finance regional infrastructure projects.

We focus on three kind of supranational funding mechanisms used in reality: *total cost-plus*, *sunk cost-plus*, and *fixed-price* financing mechanisms. With a total cost-plus financing mechanism a percentage of the difference between investments costs and the discounted profits of the project are covered by the supranational organization. Thus, both investment costs and maintenance and operating costs may be financed. On the contrary, with a sunk cost-plus financing mechanism the supranational organization covers just a percentage of the difference between investments costs and the discounted revenues net of maintenance and operating costs. Thus, in this case only sunk costs may be financed. This is the basic mechanism to co-finance infrastructure investments in the European Union, the so-called "funding-gap" method. The basic rationale of this mechanism is that the supranational agency finances a percentage (the so-called co-funding rate) of the difference between investment costs and revenues (net of operating costs). The total amount to be co-financed is higher the higher are the total investment costs and the lower are the revenues, so it is a kind of cost-plus financing mechanism which penalizes the revenue generating projects. Finally, with a fixed-price financing mechanism countries are granted with a fixed quantity to support the costs of the project chosen by the country.

The main objective of this paper is to highlight the importance of selecting the right financing mechanism in the first level. In particular, we prove that with a total cost-plus financing mechanism the price charged for the use of the new infrastructure is zero, the market quantity excessive, and the level of supranational financing disproportionate. In contrast, with a sunk cost-plus financing mechanism the socially optimal price is always implemented, though there is no incentive in being efficient. Finally, with a fixed-price

financing mechanism the maximal efficiency may be achieved, and the socially optimal price is always implemented.

This paper departs from the traditional literature in procurement and regulation (see Laffont and Tirole 1993) under several views. First, we focus on the supranational and national government relationship, while most of the literature concentrates in the second level, that is, the national government and firm relationship. Second, although public funds are obtained through distortionary taxation, the rent extraction is not one of the goals of the supranational planner. In conventional literature of procurement the regulator dislikes leaving a rent to the firm since any euro transferred to the firm costs $€(1+\lambda)$ to the society and reduces social welfare by $€\lambda$. In our case any euro transferred to the national government does not reduce social welfare, since it can be used to reduce the taxes within the country. Finally, we would like to highlight that the aim of this paper is just to analyze the incentive power of each type of financial mechanism in order to encourage efficiency and optimal pricing. However, we are not trying to find the level of the optimal grant.

The rest of the paper is organized as follows. In section 2 we describe the theoretical model and the asymmetric information problems arising in the supranational planner and national government relationship. In section 3 we compare the results obtained with a total cost-plus, sunk cost-plus, and a fixed-price financing mechanism as compared with the socially optimal results. A general discussion of the results and the financing design used by the European Commission is performed in section 4 and section 5, respectively. Finally, section 6 concludes.

2. A simple theoretical model

Let us consider a country with a large infrastructure project that may be financed by a supranational planner. The country is governed by a politician, who must decide the main characteristics of the project, makes a cost-benefit analysis, and report it to the supranational planner in order to be financed.

For the sake of simplicity, let us suppose only two periods. During the first period, the new infrastructure must be constructed. During the second period, the infrastructure is used by the citizens of the country. Let us denote by K the real investment cost paid by the national government for the construction of the new infrastructure. Such a cost may not coincide with the minimum investment cost k required for the construction. In fact, being efficient requires the politician to make an effort. Cost overruns are systematic in large infrastructure projects. These costs could reflect unforeseen events which lead to higher costs, though there is evidence of a systematic bias to favor the biggest projects or the introduction of the last and more expensive technology (Flyvbjerg et al. 2003).

The politician may reduce the investment cost if it exerts enough effort. In other words, the higher the effort exerted, the closer are the minimum and the real investment cost to be paid for the construction of the new infrastructure. For the sake of simplicity, we assume that both the real and the minimum investment costs are related by the following expression:

$$K = k + \theta - e, \tag{1}$$

where e denotes the effort exerted by the politician in order to construct the infrastructure in an efficient manner. The parameter θ can be understood as an

inefficiency measure, implying that efficiency can never be achieved if the politician exerts no effort. Thus, e is defined in the closed interval $[0, \theta]$.

Notice that the real investment cost K tends to the minimum investment cost k as the politician exerts the maximum effort, that is, as the term $\theta - e$ tends to zero. However, the effort exerted in order to reduce the investment cost is not costless. Let us denote by $c(e)$ the cost of effort, with $c(e=0)=0$, that is, there is no cost of effort if no effort is exerted. We also assume that the marginal cost of effort is increasing in e, and $c'(e=0)=0$.

In general, national governments are better informed than supranational planners about the technical characteristics of their infrastructure projects and the set of options available for a given objective, and thus the minimum investment cost. For this reason, we assume that the supranational planner cannot observe (or verify) either the minimum investment cost k, or the effort e exerted by the politician in order to be efficient. Thus, the supranational planner faces a *moral hazard* problem.

The inverse demand function for the use of the new national infrastructure is denoted by $P(Q)$, where P denotes the price to be charged for the use of the new national infrastructure, and Q represents the market quantity, that is, the number of users of the new infrastructure. $C(Q)$ denotes the maintenance and operating costs for the use of the new national infrastructure, which is an strictly increasing and convex function of Q, privately known. Thus, since the supranational planner cannot observe the level of maintenance and operating costs, he faces an *adverse selection* problem. Let us denote

by Π the profits obtained during the second period for the use of the new infrastructure, that is, $\Pi = P(Q)Q - C(Q)$.

The utility function of the politician depends on his own private income X, the probability of reelection q, and the cost of effort. Formally:

$$Utility = X(1+\delta q) - c(e), \tag{2}$$

where δ denotes the discount factor. Notice that the private income is only obtained if the politician is governing the country.

The higher is the welfare of voters in the second period, the higher is the probability of reelection. Let us denote by VW the welfare of voters in the second period, which is the sum of their consumer surplus (CS), and the value of social expenditures (G). Formally:

$$q = f(VW), \text{ with } q' > 0. \tag{3}$$

$$VW = CS + G. \tag{4}$$

$$CS = \int_0^Q P(z)dz - P(Q)Q. \tag{5}$$

In general, both charge increases and social expenditures reductions carry significant political costs (Sobel 1998). Models of the political process, such as Downs (1957), Niskanen (1971), and Becker (1983), have often assumed that legislators attempt to maximize electoral support. Even if reelection may not be the primary factor motivation in their legislative behavior, it is still true that legislators react in predictable ways to the electoral costs and benefits of their choices. Thus, legislators will favor actions that increase the probability of reelection over decisions that lower it (Sobel 1998; Robinson and Torvik 2005).

Assumption 1: *Even if the investment cost is reduced to the minimum* k, *financing from the supranational planner is always needed, that is,* $k > \delta\ \Pi$, for every Q.[4]

By Assumption 1, supranational funds are always needed. In order to be financed, the national government must provide some information about the estimated losses (negative net present value of the project). The timing of the game is as follows: In the first stage, the supranational planner decides the financing mechanism to be used, and publishes it. In the second stage, given the financing mechanism, the politician decides the main characteristics of the project (that is, the levels of e and Q) in order to maximize his own utility. In the third stage, the politician makes a cost-benefit analysis of the project and reports it to the supranational planner. Finally, given this cost-benefit analysis and the financing mechanism, the national government receives the supranational funds, which are denoted by S.[5]

Recall that the supranational planner has no information about efforts and costs, and thus, he cannot verify whether the national government is reporting the minimum costs and the optimal charges in the cost-benefit analysis.

Assumption 2: *The value of social expenditures in the second period is always positive and depends both on the value of the project and the level of supranational funds in the*

[4] This is generally the case in transport and water infrastructures, where fixed (and sunk) costs are very high.

[5] Public funds are usually obtained through distortionary taxation and, thus, the economic literature usually assumes a shadow cost of public funds. However, as we have already stated in the introduction, in this paper we are not interested in finding the optimal level of supranational funds to be granted to national governments. In contrast, we are interested in analyzing the incentives behind different kind of financing mechanisms. Therefore, we can ignore the shadow cost of public funds.

second period. Formally: $G = g + (\frac{-K+S}{\delta} + \Pi)$, *with* g *being a positive parameter sufficiently high.*

The parameter g denotes the *ex ante* level of national funds devoted to social expenditures, while G denotes the *ex post* value of social expenditures, that is, once the national government has received the supranational financing and paid the costs of the large infrastructure project. Once the national government has paid all the costs of the project, extra public funds in the second period are used for social purposes. Thus, the higher are the value of the project and the level of supranational funds in the second period, the higher is the *ex post* value of social expenditures, the welfare of voters and the probability of reelection.

In an asymmetric information framework the financing mechanism chosen by the supranational planner at the beginning of the game considerably affects the incentives of the politician. In the next section, we discuss the consequences of the moral hazard and adverse selection problems that we have described throughout this section when a cost-plus or a fixed-price financing mechanism is used.

3. Cost-plus versus fixed-price financing mechanism

In this section we will consider that the supranational planner has already decided the financing mechanism to be used (either cost-plus or fixed-price), and such a decision is public information. Thus in this stage, given the financing mechanism, the politician must decide the levels of effort and market quantity in order to maximize his own

utility. We will compare the social optimum with the results obtained with a total cost-plus, a sunk cost-plus, and a fixed-price financing design.

3.1. Benchmark situation: The social optimum

Suppose there is no externality associated with the use of the new infrastructure and distribution issues are ignored. In this case, if the supranational planner were able to observe the level of efforts and costs of the project, he would choose the effort and market quantity in order to maximize the social net present value of the project, that is:

$$\underset{e,\,Q}{Max}\ SNPV = -K + \delta[CS + \Pi] = -k - \theta + e + \delta[\int_0^Q P(z)dz - C(Q)]. \tag{6}$$

The solutions of such a maximization program are given by:

$$\begin{aligned} e^{SO} &= \theta \\ P(Q^{SO}) &= C'(Q^{SO}), \end{aligned} \tag{7}$$

where superscript SO denotes the socially optimal solution. Thus, if the supranational planner were able to observe (and verify) efforts, he would ask the politician to exert the maximum effort in constructing the infrastructure in an efficient manner. Moreover, if the supranational planner were able to observe (and verify) the real costs of operating and maintaining the new infrastructure, he would set the price for its use equal to the marginal cost. This is summarized in the following proposition.

Proposition 1: *It is socially optimal to construct the infrastructure at the minimum investment cost and set the price for its use equal to the marginal operating and maintenance cost.*

The supranational planner would like the politician both to exert the maximum effort in being efficient, and to charge the use of the new infrastructure according to the marginal costs. However, efforts and marginal costs are not observable (and, hence, they cannot be part of a contract). Thus, the supranational planner should make use of the financing mechanism to provide the right incentives to the politician and implement the socially optimal efforts and price.

3.2. Total cost-plus financing mechanism

With a total cost-plus financing mechanism supranational funds are only obtained if the financial net present value of the project is negative. If this is the case, the supranational planner finances all the losses, that is:

$$S = \begin{cases} 0 & \text{if} \quad K \leq \delta\ \Pi \\ K - \delta\ \Pi & \text{if} \quad K \geq \delta\ \Pi. \end{cases} \tag{8}$$

By assumption 1, the financial net present value of the project is always negative, so the supranational planner will finance all the losses. Thus, by assumption 2, the *ex post* value of social expenditures in the second period is given by $G = g$.

The politician, given the financing mechanism, chooses the level of effort and market quantity that maximizes its own utility, that is:

$$\underset{e,\, Q}{Max}\ X(1+\delta q) - c(e) = X[1+\delta f(CS+g)] - c(e). \tag{9}$$

The supranational planner is financing all the losses and being efficient is costly, so the politician has no incentives to exert a positive effort in reducing the investment costs of the project, and he will choose to exert no effort at all: $e^* = 0$. On the other hand, the higher is the price for the use of the new national infrastructure, the lower is the consumer surplus of voters, and the lower is the probability of reelection. As a

consequence, the politician will choose the maximal market quantity and he will charge no price for the use of the new infrastructure: $P(Q^*) = 0$. All these results are summarized in the following proposition:

Proposition 2: *If the supranational planner uses a total cost-plus financing mechanism, the politician will exert no effort in being efficient, and the price for the use of the new infrastructure will be zero.*

If the effort exerted by the politician in being efficient and reducing the investment costs of the project is zero, the level of inefficiency will reach its maximal value. Moreover, if the price to be charged for the use of the new infrastructure is below the marginal operating and maintenance costs, the market quantity (number of users) will be excessive. Finally, since the project has the maximal investment costs and the minimal revenues, the supranational financing will be clearly excessive. These results are summarized in the following corollary.

Corollary 1: *If the supranational planner uses a total cost-plus financing mechanism, the level of inefficiency will be at its maximum. Moreover, both the use of the new infrastructure and the level of supranational financing will be excessive.*

3.3. Sunk cost-plus financing mechanism

Similarly to the previous case, with a sunk cost-plus financing mechanism supranational funds are only obtained if the financial net present value of the project is negative. However, if this is the case, the supranational planner finances just the

difference between investment (sunk) costs and net revenues, that is, operating losses are never covered. Formally:

$$S = \begin{cases} 0 & \text{if} \quad K \leq \delta\ \Pi \\ K - \delta\ \Pi & \text{if} \quad K > \delta\ \Pi \geq 0 \\ K & \text{if} \quad K > 0 > \delta\ \Pi. \end{cases} \tag{10}$$

By assumption 1, the financial net present value of the project is always negative, so the supranational planner will finance at most investment costs. Thus, by assumption 2, the *ex post* value of social expenditures in the second period is given by:

$$G = \begin{cases} \text{g} & \text{if} \quad \Pi \geq 0 \\ g + \Pi & \text{if} \quad \Pi < 0. \end{cases} \tag{11}$$

The politician, given the financing mechanism, chooses the level of effort and market quantity that maximizes its own utility, that is:

$$\underset{e,\,Q}{Max}\ X(1+\delta q) - c(e) = X[1+\delta f(CS+G)] - c(e), \tag{12}$$

where G is given by expression (11).

The supranational planner may finance all investment costs and being efficient is costly so, similarly to the previous case, the politician has no incentives to exert a positive effort in reducing the investment costs of the project, and he will choose to exert no effort at all: $e^* = 0.$ On the other hand, since maintenance and operating costs are never covered by the supranational organization, they should be covered by the national government. Thus, the social welfare of voters is maximized by setting the price for the use of the new infrastructure equal to marginal maintenance and operating costs: $P(Q^*) = C'(Q^*).$ All these results are summarized in the following proposition:

Proposition 3: *If the supranational planner uses a sunk cost-plus financing mechanism, the politician will exert no effort in being efficient, while the price for the use of the new infrastructure will be equal to marginal maintenance and operating costs.*

If the effort exerted by the politician in being efficient and reducing the investment costs of the project is zero, the level of inefficiency will reach its maximal value. However, in contrast to the previous case, with a sunk cost-plus financing design the politician has always incentives to charge the use of the new infrastructure at the socially optimal price. The reason is that, though consumers surplus is reduced if a positive price is charged, operating losses are not financed by the supranational organization and should be covered by reducing social expenditures. Thus, the social welfare of voters is maximized when the price is equal to the marginal maintenance and operating costs. These results are summarized in the following corollary.

Corollary 2: *If the supranational planner uses a sunk cost-plus financing mechanism, the level of inefficiency will be at its maximum. However, the socially optimal price is always implemented.*

3.4. Fixed-price financing mechanism

With a fixed-price financing design, the national government receives an *ex ante* fixed amount of money in order to finance its possible losses. Such a fixed quantity is independent of the level of revenues and costs of the project, that is: $S = s$, where s is a positive parameter.

By assumption 2, the *ex post* value of the social expenditures in period 2 with a fixed-price financing mechanism is given by: $G = g + \frac{s}{\delta} - \frac{K}{\delta} + \Pi.$

The politician, given the financing mechanism, chooses the level of effort and market quantity that maximizes its own utility:

$$\underset{e,\,Q}{Max}\ X(1+\delta q) - c(e) = X[1+\delta f(CS + g + \frac{s}{\delta} - \frac{K}{\delta} + \Pi)] - c(e), \tag{13}$$

which is equivalent to:

$$\underset{e,\,Q}{Max}\ X[1+\delta f(g + \frac{s}{\delta} - \frac{k+\theta}{\delta} + \frac{e}{\delta} + \int_0^Q P(z)dz - C(Q))] - c(e). \tag{14}$$

First order conditions lead to the following solutions:

$$\begin{aligned} X\frac{dq}{dVW} &= c'(e^*) \\ P(Q^*) &= C'(Q^*). \end{aligned} \tag{15}$$

Proposition 4: *If the supranational planner uses a fixed-price financing mechanism, the politician will exert a strictly positive effort in being efficient, and the price for the use of the new infrastructure will be equal to the marginal maintenance and operating costs.*

From expression (15) we can perform some comparative statics. On the one hand, the effort exerted by the politician with a fixed-price financing mechanism is higher, the higher is the private income that he obtains when is elected. On the other hand, the more sensitive is the probability of reelection to increases in the social welfare of voters, the

higher will be the effort exerted by the politician in being efficient. Finally, the lower is the marginal cost of effort, the higher is the effort exerted by the politician. If the private income of the politician is sufficiently high, the probability of reelection is sensitive enough and/or the marginal cost of effort is sufficiently low, the politician may choose to exert the maximum effort. This is stated in Corollary 3.

Corollary 3: *If the supranational planner uses a fixed-price financing mechanism, the socially optimal effort may be implemented.*

With a fixed-price financing design the politician has always incentives to charge the use of the new infrastructure at the socially optimal price. The reason is that, though consumers surplus is reduced if a positive price is charged, additional profits are used for social expenditure purposes. Thus, the social welfare of voters is maximized when the price is equal to the marginal costs. This result is highlighted in Corollary 4.

Corollary 4: *If the supranational planner uses a fixed-price financing mechanism, the socially optimal price is always implemented.*

4. General discussion

In section 3 we analyze a principal-agent model in which a supranational planner (the principal) is interested in financing a large infrastructure project in some region in order to strengthen the economic and social cohesion of the countries. Financed countries (the agents) should construct the infrastructure, looking for the minimum costs and the maximum revenues compatible with optimal pricing. However, both objectives depend on unobservable efforts (moral hazard problem) and costs (adverse selection problem)

that, hence, cannot be part of a contract. Since efforts and costs are unobservable, the principal should provide the right incentives to national governments in order to exert the optimal efforts and charge the socially optimal price.

We have proven that a total cost-plus financing mechanism provides no incentives to minimize costs and charge a positive price for the use of the new infrastructure. As a result, with a total cost-plus design the market quantity is excessive and the level of supranational financing disproportionate. An excessive market quantity may impose additional costs to the society in terms of congestion, noise, pollution, accidents and other negative externalities associated with the use of large infrastructure services. With a total cost-plus design, infrastructure users do not pay for the negative externalities that they impose to the society. Thus, the polluter-pays principle[6] would be never satisfied. While this kind of financing mechanism is rarely applied by supranational organizations, it is frequently used by national governments to finance regional infrastructure projects.[7]

On the contrary, a fixed-price financing mechanism is a very high-powered incentive scheme, as national governments are now responsible for insufficient revenues and cost overruns, that is, they are the residual claimants for effort. In particular, we have proven that the socially optimal price is always implemented, while the politician exerts the

[6] According to the polluter-pays principle, an agent causing environmental damage or creating an imminent threat of such damage should, in principle, bear the cost of the necessary preventive or remedial measures.

[7] As an example, in Spain most rail infrastructure projects are financed through a total cost-plus financing mechanism from the Central Government to regional governments.

socially optimal effort if his private income is sufficiently high, the probability of re-election is sensitive enough and/or the marginal cost of effort is sufficiently low. [8]

A sunk cost-plus financing mechanism produces intermediate results. On the one hand, with such a financing mechanism the socially optimal price is always implemented. But on the other hand, a sunk cost-plus financing mechanism provides no incentives to being efficient.

It is worth pointing out that the incentives nested in the fixed-price financing mechanism induces the national government to introduce fixed-price contracts in the second level both for the construction and the operation of the project, in order to look for the minimum costs and the maximum revenues from the social point of view. This is an interesting result because, though the main problem associated to the auction and renegotiation of fixed-term concessions have been solved in the economic literature, the present institutional design of financing projects all over the world with cost-plus financing mechanisms does not induce the introduction of innovative fixed-price oriented contracts.

5. The European Commission and the funding-gap method

The so-called "funding-gap" method is the basic mechanism to co-finance infrastructure investments in the European Union. The funding-gap is the difference between the present value of project investment costs and the net present value of revenues during

[8] Supranational planners cannot influence politicians' private income or the sensitiveness of the probability of reelection, but they may be able to affect the marginal cost of effort. Based on previous national and international experiences, supranational planners may elaborate a general list of actions to be followed during the construction of large infrastructure projects in order to minimize investment costs. Even though efforts are unobservable, the effort exerted by politicians when following such instructions may be less costly, since politicians do not have to publicly justify their actions; they are just following the protocol designed by the supranational organization.

the project life. Thus, the funding-gap expresses the part of the project investment costs which cannot be financed by the project itself and that therefore need to be financed. This method is used for two main reasons: first, to ensure, on the one hand, that the project has enough resources to be implemented, and on the other hand, that it is not over financed; secondly, to ensure a minimum level of profitability to borrow money (European Commission 2006).

The basic rationale of this mechanism is that the supranational agency finances a percentage of the difference between investment costs and revenues (net of maintenance and operating costs). This is the so-called co-funding rate, which can reach the 80 per cent of the financial net present value of the project. The total amount to be co-financed is higher the higher are the total investment costs and the lower are the net revenues, so it is a kind of sunk cost-plus financing mechanism which penalizes revenue generating projects.

As we have already proven, with a sunk cost-plus financing mechanism, national governments have no incentives to minimize costs or charge a price different from marginal maintenance and operating costs. Thus, though there is no incentive in being efficient, in absence of externalities the socially optimal price is implemented. With the funding-gap method only a percentage of the difference between investment costs and revenues (net of maintenance and operating costs) are financed. In this case, contrary to the simple sunk cost-plus financing mechanism analyzed in subsection 3.2, there are some incentives in being efficient. However, we would like to highlight that the cost reducing effort is always lower than in the case of a fixed-price financing mechanism. In particular, the higher the co-funding rate, the lower the effort in being efficient, and

the higher the distance between the incentive power of the funding-gap method and the fixed-price financing mechanism.

Suppose now that there are one or more externalities associated with the use of the new infrastructure (either pollution, congestion, noise, or accidents). In this case, optimal pricing requires the price to be equal to social marginal costs. Nevertheless, with the funding-gap method (which is a kind of sunk cost-plus financing mechanism), national governments may have no incentives to charge a price higher than marginal operating costs. In particular, if the externality has no negative effect on the welfare of voters (or its negative effect is lower than the effect of a reduction in consumer surplus) national governments have incentives to charge a price equal to marginal operating costs instead of a price equal to social marginal costs. However, this fact is contrary to the European Commission's interests regarding the price of infrastructure services. Quite the reverse, the European Commission has always recommended social marginal cost pricing for infrastructure services in the European Union. Some clear examples are:

- The European Commission Green Paper "Towards fair and efficient pricing in transport" (1995). The Green Paper suggests social marginal cost pricing, a higher degree of cost recovery and transparency as principles for a new infrastructure pricing system.
- The European Commission White Paper "Fair Payment for Infrastructure Use" (1998). The White Paper includes once again the idea of social marginal cost pricing.
- Directive 2001/14/EC (26 February 2001). The general claim in this directive is the establishment of marginal cost pricing for rail infrastructure in the European Union.

- Directive 2004/35/CE (21 April 2004). This directive claims for the application of the polluter-pays principle in order to prevent and remedy environmental damages.

Despite the general results of the funding-gap method and the European Commission's interests on optimal pricing, there is another situation in which the final price charged for the use of the infrastructure may not coincide with the social optimum. In particular, suppose a national government asking for European funds to finance a large infrastructure project in its country. Within the country, there are two levels of governments: the central government and regional governments. Once supranational funds are obtained, the national (central) government pays the costs of the new infrastructure, while the corresponding regional government decides the main characteristics of the project, such as price, quantity and effort in being efficient. Even though the European Commission uses a kind of sunk cost-plus financing mechanism (the funding-gap method), if the national (central) government applies a total cost-plus financing mechanism to the regional government, the final result is no incentives in being efficient and charge a positive price: $e^* = 0$ and $P(Q^*) = 0$.

With the incentives embodied in the funding-gap method, it is remarkable that member countries have not devoted a great deal of effort to the economic selection of projects, or to the introduction of fixed-price contracts for the construction of new infrastructures. An *ex post* evaluation of a sample of projects co-financed by the Cohesion Fund in the period 1993-2002 concludes that national governments have been focusing primarily on timely commitment of the available funding, paying less attention to the technical contents and economic priority of projects (ECORYS Transport 2005). The evaluations

generally fail to assess the quantitative contribution of the project to the declared objectives. Problem descriptions and analyses are sometimes lacking. Moreover, it was generally impossible to determine whether projects were technically sound, and this deficiency led to: improper designs; technical amendments after approval, but before the start of the construction; late amendments to design/tender dossiers; late start of implementation; cost overruns due to additional activities for the contractor, who is then in a good position to claim additional costs; longer implementation periods than foreseen; and too many requests for the extension of the implementation period. The document concludes that "the evaluators have found only pragmatic criteria for the co-financing rate. In addition some basic dilemmas exist between general policy objectives and the rules applied for calculation of the co-financing rate. In particular the polluter-pays principle is only partially adopted since increasing user charges is discouraged by the present system of determining the co-financing rate" (ECORYS Transport 2005).

These disappointing results are not completely unexpected. As we have already discussed, national and regional governments are in general more informed than supranational planners about the costs and benefits of the infrastructure projects to be constructed in their own regions, and they do not necessarily share the same objectives. With the funding gap method governments have incentives to manipulate project evaluations to get more funds from the supranational planner. Cella and Florio (2007) suggest that the European Commission should include ex-post evaluation and that national governments should be offered a reward for disclosing additional information on firms' technology. However, as shown in this paper, the incentive problems inherent in the funding gap method cannot be solved with an ex-post evaluation. With the funding-gap method national governments have incentives to ex-ante manipulate the

characteristics of the project (such as the investment cost or the price to be charged for the use of the new infrastructure) in order to get more funds from the supranational planner. Once supranational funds are obtained, the project may be exactly implemented as initially reported. Thus, an ex-post evaluation cannot solve this ex-ante problem of incentives.

As we have already pointed out, cost overruns are systematic in large infrastructure projects. These costs could reflect unforeseen events, though there is evidence of a systematic bias to favor the biggest projects or the introduction of the last and more expensive technology (Flyvbjerg et al. 2003). The funding gap method does not exacerbate this strategic behavior, since, in general, the European Commission budget constraint is not binding and national governments do not need to report lower ex ante costs to get their project financed. Therefore, the incentive problem dealt with in this paper is of a different nature of the systematic bias identified by Flyvbjerg et al.

In a context of asymmetric information and different objectives, the relationship between national governments and supranational planners cannot be modelled in a conventional cost-benefit analysis framework. The existence of information asymmetries and conflicting interests requires a different approach in which incentives are explicitly accounted for. Florio (2007) proposes to move away from the current low-powered incentive European Union co-financing mechanism, essentially an investment cost part-reimbursement scheme, towards a more incentive-based system. As we have already discussed in section 4, the fixed-price financing mechanism may provide the necessary incentives to reduce costs and charge the socially optimal price. Moreover, with the funding-gap method, the cost-benefit analysis is just a bureaucratic requirement

for national governments to obtain supranational funds. However, with the fixed-price financing mechanism, the cost-benefit analysis is a very useful tool for governments to allocate in the most efficient way the supranational funds, minimizing the opportunity costs of public financing.

However, we would like to stress that the problem of giving national governments an *ex ante* fixed amount of funds is that, although it is a very high-powered incentive scheme, the European Commission loses its influence on the selection of projects. This is not the position of the European Commission, which establishes infrastructure investment priorities for the member countries.[9] An intermediate solution is to substitute the funding-gap method by an alternative financing scheme based on an *ex ante* fixed-price funding linked to generic objectives like investing, in "accessibility", "water waste treatment", or "environmental quality", a mechanism that should be dissociated in any case from costs and revenues.

Finally, we would like to highlight that in this section we are only concerned about the incentives inherent to the funding-gap method in comparison with the incentives of other financing mechanisms, such as the fixed-price financing mechanism or the total cost-plus financing mechanism. Redistributive issues and the way in which these financing mechanisms should be implemented are out of the scope of the present paper.

[9] The Sapir Report (Sapir et al. 2004) has proposed a wide reform in order to concentrate the European Union resources on the new Member States and delegate the project planning to them. Such a proposal has been rejected by the European Union. Florio (2005) argues that the European Commission is in a unique position to capitalize infrastructure knowledge across countries and regions. This learning mechanism has an intrinsic value that will be entirely lost by the full delegation of planning and evaluation (Cella and Florio 2007)

6. Conclusions

Public infrastructure investments are considered a key element not only for economic growth and competitiveness, but also for the improvement in the quality of life. The stock and composition of public capital matters and supranational governments such as the European Commission allocate a significant amount of their budget to support the construction of new projects in transport, water, electricity and other economic and social infrastructures.

Information asymmetries create moral hazard and adverse selection problems which can be mitigated or compounded depending on the financing scheme chosen by the supranational agency. Given the informational problem, making the financial support conditional to the *ex ante* net present value of the project is not appropriate, especially when the incentive to make up the social value of the project leads to more funds.

There are two levels in the process of funding, construction and operation of co-financed infrastructure projects. The first one relates to the institutional design, in which supranational and national governments, or national and regional governments, negotiate the projects to be financed. Once the financing institutional design has been decided, the second level relates to the selection of the concessionaire for the construction and operation of the project. The selection of fixed-price contracts for this second level has been plagued with renegotiations all over the world and a type of variable-term concession with cost pass-trough have been proposed to solve most problems of risk allocation. Nevertheless, the incentive to use fixed-price contracts in the second level is very low when a cost-plus design is the base of the institutional design in the first level (financing system).

The supranational financing mechanism should not be related to costs to recover the interest of national governments in productive and allocative efficiency. The financing mechanism should not be related to revenue either; in other words, it should be unrelated to demand and pricing. Optimal social pricing increases social surplus and, therefore, it should be encouraged. A subsidizing scheme which penalizes cost efficiency and the optimal pricing should be avoided.

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