

Large Infrastructure Investments: Financing Mechanisms and Incentives in Decentralized Countries*

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Abstract

Infrastructure services crucially affect competitiveness and efficiency. They are essential but they usually require important amounts of public funds. In decentralized countries, regional governments cannot usually afford large infrastructure projects, so co-financing with the central government is required.

The aim of this paper is to demonstrate the influence of the central government financing mechanisms on the contract offered by the regional government for the construction, maintenance, and operation of the infrastructure. We prove that if the central government uses certain financing mechanisms (total cost coverage), the regional government may have no incentives to offer an efficient contract to the firm.

Key words: co-financing, incentives, infrastructure project.

JEL Classification: D82, H77, H50.

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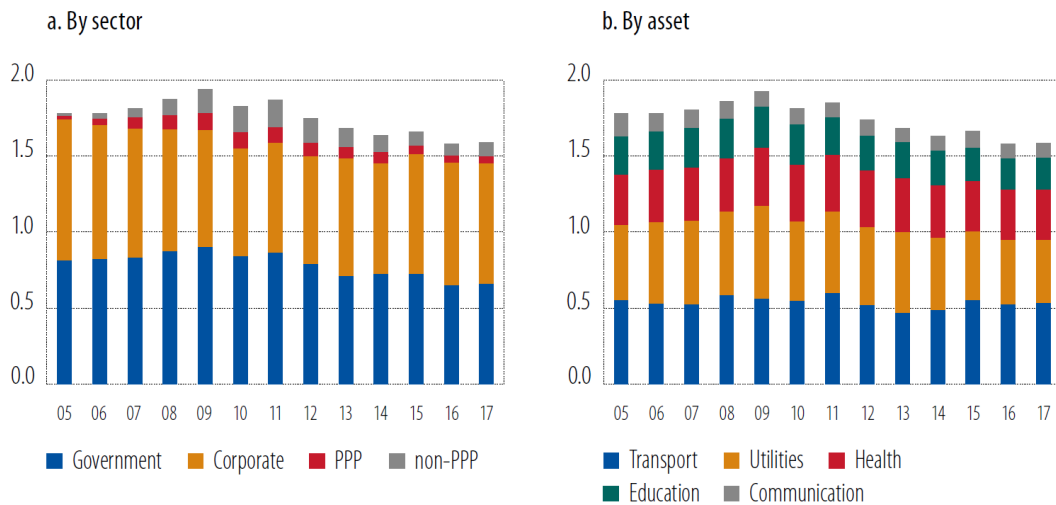
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I. Introduction

Infrastructures are essential in modern economies. They are crucial for their operation and efficiency for decades (World Bank, 1994). Although it is not a guarantee for desirable regional effects or even for economic growth,¹ infrastructure investment is a necessary condition for economic activity (de Rus and Socorro, 2010).

Due to its magnitude, infrastructures require important amounts of public funds. Figure 1 shows that, despite the financial crisis, the amount of public funds allocated to infrastructure investment rise to 1.6 per cent of GDP in European Union (EU). However, it stands below its pre-crisis levels (European Investment Bank, 2019).

FIGURE 1
Infrastructure investment (% of GDP)



Source: European Investment Bank, 2019

¹ See, for example, Gramlich (1994), Holtz-Eakin and Schwartz (1995) or Puga (2002).

Often, such amounts of money cannot be financed just by regional funds. For this reason, it is necessary to co-finance the investment with the national government,² which decides on the appropriateness of the project and the need for co-financing. Moreover, private initiative is necessary in these relationships for the construction of the new infrastructure, maintenance, operation and so on. The corresponding co-financing mechanism arise the problem of asymmetric information and could generate wrong incentives and lead to unwanted outcomes (for example in the cases in Section II).³

We can distinguish two levels in the construction, maintenance and operation of large infrastructures that involve co-financing mechanisms. The first level studies the relationship between the two levels of governments – national planner and regional government – in order to finance the new infrastructure. In other words, the first level analyses the institutional design in which funds are obtained by the regional government. The second level studies the relationship between the regional government and the firm that finally receives the funds in order to construct, maintain, and operate the infrastructure. In other words, the second level analyses the type of contract that the regional government offers the firm (de Rus and Socorro, 2010).

Although most of the literature concentrates on the second level, the first level is important regarding incentives. On the one hand, governments are not benevolent, i.e., they are not only worried about the welfare of the society (for example they have “political” objectives as elections). On the other hand, minimise the investment could not be the optimal solution for the regional government, i.e., there are equity objectives.

² The relationship is also possible between a local government and a regional government or a national government and a supranational organisation.

³ Although we do not consider federalism issues in the paper, we could have in mind also other federalism (non-economic) reasons for co-financing (for example, better adaptation to local preferences).

For this reason, their objectives can influence the first level. The institutional design affects incentives and the relationship between the firm and the corresponding government in an asymmetric information context.

The aim of this paper is to demonstrate the influence of the central government financing mechanisms on the contract offered by the regional government for the construction, maintenance, and operation of the infrastructure. In particular, this paper tries to find variations in the incentives previously held by a government that receives support from a superior level in an asymmetric information context (moral hazard) in order to analyse these incentives.

The rest of the paper is organised as follows. In Section II we provide some details on the real policies applied in some places. In the following section, we analyse literature. In Section IV we present the model setup and in Section V we develop a model that analyses the effects of different contracts between a regional government and a firm. Later, in Section VI we introduce the national government into the model in order to discover the co-financing mechanism effects. Section VII concludes.

II. Examples of co-financing

There are a lot of examples of co-financing systems for the construction, maintenance and operation of large infrastructures, but contracts are variants of simple fixed-price and cost-plus contracts in practice (Bajari and Tadelis, 2001). Moreover, we have observed the application of these mechanisms in response to the last financial crisis. In this section we briefly summarise four examples, and further details are included in appendix A.

First, infrastructure co-financing is a very common practice in Spain, as shown by the reference in the ‘Strategic Plan of Infrastructures and Transport’ to the funding strategies of the planned activities within it: ‘...counting on the participation of the regional and local government on the funding of concerted actions’.⁴ A clear example of co-financing in transport infrastructure projects are those regulated by the ‘Financing Agreements of Railway Infrastructures’. These are for co-financing the investments in railway infrastructure in a given geographical area. Through these agreements, the central government co-finances the third part of the costs of the works in some projects. This is a clear example of partial cost coverage financing mechanism, i.e., government finances a percentage of the real investment cost of the project.

Second, the ‘funding gap’ (the basic mechanism to co-finance infrastructures in the EU) consists of the difference between the present value of a project’s investment costs and the net present value of revenues during the project’s life, i.e., the part of the project that cannot be financed itself. The co-funding rate can reach 80 per cent of the financial net present value of the project. The higher the investment costs or the lower the net revenues are, the higher the total amount of funds is. This is another example of partial cost coverage financing mechanism.

Third, in 2008, in response to the economic world crisis, the Spanish Government created the ‘State Fund of Local Investment’.⁵ With this plan, the Government has the intention to create jobs and activate the economy. The plan is a type of total cost coverage financing

⁴ PEIT (2004).

⁵ Real Decreto-Ley 9/2008 (available at www.boe.es/boe/dias/2008/12/02/pdfs/A48125-48130.pdf).

mechanism since the national government finances the entire project cost investment of regional governments. The endowment of the Local Investment Fund will be distributed in a way proportional to the population corresponding to every municipality.

Finally, also in response to the financial crisis, in 2009 President Obama signed the American Recovery and Reinvestment Act, which includes the Transportation Investment Generating Economic Recovery (TIGER). As in the Spanish case, the financial mechanism used is a total cost coverage financing mechanism if the funds received by the state or local government make up 100 per cent of the total cost.

III. Literature review

As we have said above, we can distinguish two levels in the construction, maintenance and operation of large infrastructures that involve co-financing mechanisms. The first level studies the relationship between the two levels of governments – national planner and regional government – in order to finance the new infrastructure. The second level studies the relationship between the regional government and the firm that finally receives the funds in order to construct, maintain, and operate the infrastructure.

The literature corresponding to the first level is scarce in our knowledge.⁶ In relation to a multi-government environment, Caillaud *et al.* (1996a) study the elements and problems between decentralisation and centralisation, and they show the complementarities between two levels of regulation. First, they present the arguments in favour of

⁶ A menu of contracts is the solution suggested by most of the economic literature on the second level in order to deal with asymmetric information problems. However, they are rarely used in practice. Contracts are variants of simple fixed-price and cost-plus contracts (Bajari and Tadelis, 2001). For a review of the literature that analyses the problem of incentives in principal-agent models by economic theories of procurement that use mechanism design see Laffont and Tirole (1993).

decentralisation (communication and information processing costs and commitment issues). Second, they develop a model of organisation in the EU context, analysing the incentives and remarking on the problem of more information and less bargaining power of the national authority with respect to the central authority. On the same line are Caillaud *et al.* (1996b), who address the issue of optimal decentralisation, showing that complete centralisation is never optimal, but decentralisation (at least partial or even full centralisation) could be optimal, depending on model conditions. Huber and Runkel (2006) develop a theoretical model in order to find the effects of asymmetric information in order to explain why governments provide finance to other governments (on a lower level) with some types of grants (results show that second-best optimum cannot be implemented with unconditional block grants or open-ended matching grants). More recent papers are, for example, Jang *et al.* (2016), that studies reciprocity in co-financing public goods investments, and De Borger and Proost (2016), that studies conditions under centralized or decentralized pricing and investment decisions are preferable, in a federal state context, for excludable and congestible local public goods.

Another important aspect that makes the institutional design important is the difference between real and forecasted cost figures. Mismatches between prediction and reality in cost estimations are common (Flyvbjerg *et al.*, 2003a; 2004; Skamris and Flyvbjerg, 1997). Although one reason for these differences could be the current unperfected forecasting techniques, another reason is the institutional design and the type of contract signed. Contracts generate incentives that could explain the differences between real and forecasted figures (for example affecting the level of effort to minimise the cost).⁷ For

⁷ Nombela and de Rus (2004) shows that the type of contracts used in practise partially explains the usual failure or renegotiation of road concession contracts.

this reason, a correct institutional and contract design may mitigate the differences between real and predicted costs.

Two papers closer to our work are the following. Cella and Florio (2009) study the effects of co-financing in the EU Regional Policy with a multi-government model. They focus on optimal grants and ex-ante and ex-post evaluations. De Rus and Socorro (2010) analyse the effects of the type of mechanism design in terms of politicians' incentives, but they only consider two levels (national government and supranational planner), so the national government is the one that decides and carries out the investment. However, this work deals with a multi-government model with three levels: the national government, the regional government, and a firm. In this framework, we show that co-financing by a superior level of government may have adverse effects on the incentives of the regional government to offer an efficient contract to the firm.

In particular, this paper tries to find differences between the government incentives that receives support from a superior level in an asymmetric information context (moral hazard), and the previous incentives without this support. We know that the different types of contracts on the second level generate different results because they create incentives in different ways. However, we should take into account that if we choose different financing mechanisms these incentives will be also affected.⁸ First, we model a situation where there is no co-financing and we analyse the incentives of the regional government and a firm. Then, we introduce a superior level of government in order to see how the incentives have been affected. With this model, we can conclude that we should

⁸ There may be a conflict between agencies at the same level. For an analysis of the implication of this problem see Vickerman (2008).

not use a total-cost coverage mechanism if we want to maintain the incentives that previously have the firm to exert a high level of effort.⁹

IV. Model setup

Let us consider a country with two levels of government: the regional government and the national government. The regional government has a large infrastructure project that may be financed completely or partially by the national government. Once the national funds are obtained, the regional government contracts a firm to construct the infrastructure. We assume that the firm is risk neutral.

The moral hazard problem arises because the regional government cannot observe the level of effort exerted by the firm, and this level of effort affects the investment cost: the higher the effort exerted is, the higher the probability of low real investment costs is (de Rus and Socorro, 2010).¹⁰ We will see below what is envisaged by different levels of effort.

Let us denote by K the real investment cost paid by the firm, which may take two values: K^G (good) or K^B (bad) with $K^B > K^G$. The level of the investment cost depends on the effort exerted by the firm and on a random component. Since the value of K depends on these elements, it is also a random variable. So, we can write the probability of the value

⁹ We would like to highlight that we only want to find the effects of financing mechanisms in terms of incentives, and not the optimal method of financing or the optimal grant.

¹⁰As highlighted by de Rus and Socorro (2006), we can see an example of effort and lower cost in terms of lower operating cost in the British public transport operators during the 80s. They reduced their costs up to 40 per cent (Heseltine and Silcock, 1990; Jansson and Wallin, 1991; Nash, 1993; Mackie et al., 1995).

of K conditional on the effort exerted by the firm (e), which can take two different values: e^L (low) or e^H (high), with $e^L < e^H$. Formally:

$$\begin{aligned} & \left. \begin{aligned} \text{Prob}(K = K^G / e = e^H) &= P_G(e^H) \\ \text{Prob}(K = K^G / e = e^L) &= P_G(e^L) \end{aligned} \right\} P_G(e^H) > P_G(e^L) \\ & \left. \begin{aligned} \text{Prob}(K = K^B / e = e^H) &= P_B(e^H) \\ \text{Prob}(K = K^B / e = e^L) &= P_B(e^L) \end{aligned} \right\} P_B(e^H) < P_B(e^L) \end{aligned}$$

where:

$$P_G(e^i), P_B(e^i) \geq 0; \quad i = L, H$$

$$P_G(e^H) + P_B(e^H) = 1$$

$$P_G(e^L) + P_B(e^L) = 1.$$

On the one hand, the higher the effort exerted by the firm is, the higher the probability of low real investment costs is.¹¹ On the other hand, during the construction of the infrastructure, the firm may have to pay unexpected costs (Flyvbjerg, 2007; Flyvbjerg *et al.* 2002; Siemiatycki, 2009). In short, we may see K^G because the firm has exerted a great level of effort or just because, even though it has exerted a low level of effort, it had good luck.

Although these unexpected costs could appear because the firm has bad luck, we should remember that regional government cannot observe the level of effort exerted by the firm.

¹¹ Formally, this implicates first-order stochastic dominance of $P_G(e^H)$ and $P_B(e^L)$ over $P_G(e^L)$ and $P_B(e^H)$ respectively (see Milgrom, 1981).

Literature has found an optimistic bias toward big projects or unnecessary technology (Flyvbjerg *et al.*, 2003b). Moreover, given the technology, it is frequent renegotiation between firm and government, that disincentives cost minimisation (Guasch *et al.*, 2008). Finally, the big difference between higher and lower effort at the construction stage is likely to be in the lifetime cost of the project when for example we consider maintenance.

We have to take into account that the money given to an inferior level by national or regional government are transfer and for this reason they are neutral in a cost-benefit analysis. But the amount of unnecessary investment due to exert a low level of effort are a waste of real resources, and this results in an efficiency loss.

Let us denote by $c(e)$ the cost of the effort exerted by the firm, with $c(e^L) < c(e^H)$, that is, the cost is increasing with the level of effort. We should remember since the regional government cannot observe the level of effort, it faces a *moral hazard* problem.

The timing of the game is as follows. First, the national government decides on the type of financing mechanism to offer the regional government. Second, given this financing mechanism, the regional government offers the contract to the firm that maximises its budget. Finally, the firm decides on the level of effort it will exert in order to maximise its expected profits.

The way the national government finances the regional government may have important consequences in terms of incentives. We cannot maintain a naïve point of view and believe that the introduction of a superior level of government in a contract signed by a firm and a regional government leaves this relationship unaffected. Actually, the method

of financing generates a chain of incentives that affects the achievement of results and the allocation of public funds if there are asymmetric information problems. Decisions on the first level affect the behaviour on the second level.

In order to analyse the consequences of the national financing mechanism for the regional government's incentives in an asymmetric information framework, let us start analysing as a benchmark the case in which there is no national financing (Section V). Later, in Section VI, we introduce this national financing into the model in order to answer the following question: how does the institutional design affect the incentives that the regional government previously had?

V. Benchmark case: no national financing

In this section we will just consider the relationship between the regional government and the firm. The former decides on the contract to offer the firm. The latter pays the investment costs and decides on the level of effort. In practice, the majority of contracts are variants of simple fixed-price and cost-plus contracts (see footnote 6). For this reason, we will consider just two kind of contracts: a cost-plus contract and an incentive contract, in order to show differences in firm behaviour.¹²

¹² We do not consider a fixed priced mechanism here because we would need an additional assumption. Specifically, our entire model has to take into account the relationship between the differences in cost investment with high and low effort ($E(K/e=e^L)-E(K/e=e^H)$) and the differences in the cost of exerting these efforts ($c(e^H)-c(e^L)$).

1. Cost-plus contract

With a cost-plus contract, the regional government pays the real investment cost plus an amount of money (T) that guarantees that the firm obtains at least its reservation utility (\bar{U}) for any level of effort (participation constraint). In other words, the firm pays the investment $[E(K / e = e^i)]$, receives the same amount of money plus $T [E(K / e = e^i) + T]$, and exerts the corresponding effort $[c(e^i)]$. Formally:

- If the firm exerts a high level of effort it obtains:

$$E(K / e = e^H) - E(K / e = e^H) - c(e^H) + T \geq \bar{U}. \quad (1)$$

- However, if the firm exerts a low level of effort it obtains:

$$E(K / e = e^L) - E(K / e = e^L) - c(e^L) + T \geq \bar{U}, \quad (2)$$

where:

$$\left. \begin{aligned} E(K / e = e^H) &= P_G(e^H)K^G + P_B(e^H)K^B \\ E(K / e = e^L) &= P_G(e^L)K^G + P_B(e^L)K^B \end{aligned} \right\} E(K / e = e^H) < E(K / e = e^L).$$

So, the minimum value of T that satisfies both expression (1) and expression (2) is given by:¹³

$$T = \bar{U} + c(e^H). \quad (3)$$

¹³ Recall that the regional government cannot observe the level of effort exerted by the firm, and thus the value of T should satisfy both constraints.

We can see that if $T = \bar{U} + c(e^L)$, (1) is not satisfied since $c(e^L) < c(e^H)$.

Lemma 1: *If the regional government chooses a cost-plus contract, it is more profitable for the firm to exert the level of effort e^L .*

See **Proof** in appendix B.

Finally, the profit of the regional government under a cost-plus contract π_{CP} is given by:

$$\pi_{CP} = -E(K / e = e^L) - T = -E(K / e = e^L) - c(e^H) - \bar{U}. \quad (4)$$

Corollary 1: *With a cost-plus contract, the high level of effort e^H can never be induced by the regional government.*

2. Incentive contract

Under this type of contract, the regional government must provide the firm with the right incentives to exert a high level of effort and, thus, it pays an amount of money depending on the result of the project. In this way, the regional government pays a greater amount of money if it observes a good result (K^G) instead of a bad result (K^B). Let us denote by T^G the payment received by the firm if the regional government observes K^G , and T^B if it observes K^B .

On the one hand, the participation constraint must guarantee that when the firm exerts a high level of effort it receives greater expected profits with the project than its reservation utility (\bar{U}):

$$P_G(e^H)(-K^G + T^G) + P_B(e^H)(-K^B + T^B) - c(e^H) \geq \bar{U}. \quad (5)$$

Denoting by:

$$\left. \begin{aligned} E(T / e = e^H) &= P_G(e^H)T^G + P_B(e^H)T^B \\ E(T / e = e^L) &= P_G(e^L)T^G + P_B(e^L)T^B \end{aligned} \right\} E(T / e = e^H) > E(T / e = e^L),$$

we can rewrite equation (5) as:

$$-E(K / e = e^H) - c(e^H) + E(T / e = e^H) \geq \bar{U}. \quad (6)$$

On the other hand, in order to induce a high level of effort e^H the regional government must guarantee that with this level of effort, the firm receives greater benefits than the benefits received if the effort exerted is e^L . This condition is the incentive compatibility constraint. Formally:

$$\begin{aligned} P_G(e^H)(-K^G + T^G) + P_B(e^H)(-K^B + T^B) - c(e^H) &\geq \\ P_G(e^L)(-K^G + T^G) + P_B(e^L)(-K^B + T^B) - c(e^L). \end{aligned} \quad (7)$$

We can rewrite equation (7) as:

$$-E(K / e = e^H) - c(e^H) + E(T / e = e^H) \geq -E(K / e = e^L) - c(e^L) + E(T / e = e^L). \quad (8)$$

We can see in the left side net benefits of the firm that exerts high level of effort, and in the right side we have the net benefits of the firm that exerts low level of effort, given the payment from the regional government that guarantee this constraint.

The profit of the regional government in this case (π_{IC}), i.e., the minimum amount of money given to the firm in order to satisfies equation (6), is given by:

$$\pi_{IC} = -E(T / e = e^H) = -E(K / e = e^H) - c(e^H) - \bar{U}. \quad (9)$$

Proposition 1: *The profits of the regional government are higher with an incentive contract than with a cost-plus contract.*

See **Proof** in appendix B.

Corollary 2: *If there is no national financing, the regional government chooses an incentive contract and induces the higher level of effort for the firm.*

VI. National financing

Let us now introduce a third element into the model. Suppose first that the national government totally or partially finances the regional government's infrastructure project. Second, the regional government decides on the contract to offer the firm. Finally, the firm exerts an effort and pays the investment costs of the project. Similarly to Section V,

we consider just two types of possible contracts: a cost-plus contract and an incentive contract. As far as the national financing mechanism is concerned, we consider three possible mechanisms: a total cost coverage financing mechanism, a fixed-price financing mechanism, and a partial cost coverage financing mechanism.

In each case we should keep in mind the benefits of the regional government (the amount of money received from the national government minus the amount of money that it pays to the firm) in order to analyse the incentives of the regional government to induce the high level of effort for the firm.

1. Total cost coverage financing mechanism

Through a total cost coverage financing mechanism, the national government finances all the costs that the regional government says it has. If the national government uses this mechanism of financing the regional government, the latter will always obtain the same benefits (zero) because it reports the “bill” to the national government and it pays, i.e., it does not matter which contract the regional government signs with the firm. For this reason, the regional government is indifferent between the two types of contract.

***Proposition 2:** If the national government uses a total cost coverage financing mechanism, the regional government has no incentives to induce the high level of effort for the firm e^H .*

See **Proof** in appendix B.

2. Fixed-price financing mechanism

Under a fixed-price mechanism the national government gives the regional government a fixed amount of money that is independent of the project's results. For this reason, the regional government is worried about the transfer that it has to give to the firm, because its benefits depend on it.

If the firm chooses a low level of effort (which is induced through a cost-plus contract), the investment costs are high and as we have seen in Section V the transfer to the firm is more costly to the regional government. For this reason, the benefits of the regional government are higher with an incentive contract since whether or not the regional government induces a high level of effort the amount of money that it gives to the firm is smaller.

***Proposition 3:** With a fixed-price financing mechanism, the regional government always has incentives to induce the high level of effort e^H . Thus, it will always offer an incentive contract to the firm.*

See **Proof** in appendix B.

3. Partial cost coverage financing mechanism

Finally, let us consider that the national government finances a percentage of the real investment cost of the project. The parameter $\alpha \in (0,1)$ indicates the percentage of the real investment cost financed by the national government.

It is interesting to see that if the value of α tends to the extreme values, the partial cost coverage financing mechanism tends either to the total cost coverage financing mechanism or to the fixed-price financing mechanism: if α tends to 0, the type of mechanism tends to the fixed-price, and as we have seen before, the effort exerted by the firm will be e^H ; in contrast, if α tends to 1, the type of mechanism tends to total coverage and for this reason, the effort exerted by the firm may be e^L (the regional government has no incentives to induce a high level of effort). In short:

$\alpha \rightarrow 0 \Rightarrow$ Fixed-price: e^H

$\alpha \rightarrow 1 \Rightarrow$ Cost-plus: e^L

The national government pays an amount of money equal to the proportion α of the total investment cost to the regional government, while the regional government pays the contract to the firm. Let us see these benefits under the two levels of effort induced by the regional government:

- *If the regional government chooses the incentive contract and induces e^H :*

If the regional government induces e^H , it pays to the firm the expected value of the transfer given that $e = e^H$ ($E(T / e = e^H)$), but it receives a proportion (α) of this amount of money. Formally:

$$\begin{aligned}
 & \alpha \left[E(K / e = e^H) + c(e^H) + \bar{U} \right] - E(T / e = e^H) = \\
 & = \alpha \left[E(K / e = e^H) + c(e^H) + \bar{U} \right] - E(K / e = e^H) + c(e^H) + \bar{U} = \quad (10) \\
 & = -(1 - \alpha) \left(E(K / e = e^H) + c(e^H) + \bar{U} \right).
 \end{aligned}$$

- *If the regional government chooses the cost-plus contract and induces e^L :*

In contrast, if the regional government chooses the cost-plus contract, it pays to the firm the expected value of the real investment cost given that $e = e^L$ plus the fixed transfer $T = \bar{U} + c(e^H)$ but it receives a proportion (α) of this amount of money. Formally:

$$\begin{aligned} & \alpha \left[E(K / e = e^L) + c(e^H) + \bar{U} \right] - E(K / e = e^L) + c(e^H) + \bar{U} = \\ & = -(1 - \alpha) \left(E(K / e = e^L) + c(e^H) + \bar{U} \right). \end{aligned} \quad (11)$$

As we can see, the regional government benefits are equal to the proportion $(1 - \alpha)$ of the total transfer to the firm.

Proposition 4: *If the national government chooses a partial cost coverage financing mechanism, for any $\alpha \neq 1$ the regional government has incentives to offer an incentive contract to the firm and induce the high level of effort e^H .*

See **Proof** in appendix B.

Table 1 summarises all the results.

TABLE 1
Summary of the relationship between the three parties

National Government	Total Cost Coverage Financing Mechanism		Fixed-Price	Partial Cost Coverage Financing Mechanism
Regional Government	Cost-Plus (Indifference)	Incentives	Incentives	$\alpha \neq 1$
Effort	e^L	e^H	e^H	e^H

*Corollary 3: If the national government finances the regional government and wants the firm to exert a high level of effort, the financial mechanism must be either a fixed-price method or a partial cost coverage financing mechanism. A **total cost coverage financing mechanism** generates no incentives to offer an incentive contract and induce a high level of effort.*

VII. Conclusions

In decentralized countries both central and regional governments usually finance large infrastructure projects. Then, regional governments use contracts for the construction, operation, and maintenance of the infrastructure.

Central governments may use different financing mechanisms to co-finance large infrastructure projects, such as a total cost coverage financing mechanism, a fixed-price financing mechanism, or a partial cost coverage financing mechanism.

In an asymmetric information framework, the central government financing mechanism may have important consequences in terms of incentives. In particular, in this paper we prove two important results:

a) If there is no national financing, the regional government chooses an incentive contract and induces the higher level of effort for the firm.

b) If the national government finances the regional government and wants the firm to exert a high level of effort, the former must not use a total cost coverage financing mechanism because it does not generate the correct incentives. The mechanism chosen must be either fixed-price or a partial cost coverage financing mechanism.

The use of certain central financing mechanisms will affect the regional governments' incentives to offer efficient contracts. We have to consider the mismatches between real and forecasted cost figures in investment projects found in literature, where institutional design and the type of contract signed could be a plausible explanation.

Efficient contracts imply lower costs and higher revenues for the project and they should be taken into account in a cost–benefit analysis. The amount of unnecessary investment due to exert a low level of effort results in an efficiency loss because this is a waste of real resources.

In Section II we have showed four examples of co-financing mechanism and there were cost-plus or partial coverage. Moreover, literature highlight the majority use of cost-plus

or fixed price, but we should avoid the first in favour of the second, according to model results.

Although in this paper we use a very simple theoretical model we may be able to recommend decentralized countries not to use total cost coverage financing mechanism to co-finance large infrastructure projects, such as the economic measures that some countries have used during the economic crisis.

There are two directions where the model might be extended to provide a more realistic/richer description. On the one hand, most often the relationship between the firm and the Regional Government is a repeated game. The first question that arises is whether it is a limited period game or infinite. In the former case, under certain conditions game theory states the same results as in one period game (remember that government are elected for a limited period of time, so this situation is quite probable). In contrast, in the last case, there could be other equilibrium. For example, De Brux (2010) studies renegotiations of public–private partnerships. The paper sets up another point of view about renegotiation, and he states ‘...when parties are in repeated or multiple relationships, threats of sanctions or implicit promises on other contracts positively encourage contractors to take collective utility into account in deciding whether to renegotiate and, if so, how’.

On the other hand, we can consider the competition between communities for government funds. Socorro (2009) and de Rus and Socorro (2006) study this situation, where central government decides between projects from regional governments and face an adverse selection problem. They conclude if central government finances a percentage of the cost,

it finances projects that should not be funded, and it does not finance (or insufficiently finance) some socially desirable projects. One proposed solution is a fixed-price mechanism in order to solve information problems, which it is compatible with our model conclusions.

In order to verify the above and contrast all the assumptions in both situations, it is necessary the extension of our model which is beyond the objectives of this paper. The relevant question to our interest would be whether these considerations change the national government influence in regional government incentives.

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Appendix A

Most countries have a decentralized model for financing large infrastructure projects.¹ In these countries it is easy to see the mentioned financial mechanisms. In this appendix, we will see some examples of specific financing mechanisms used by countries or supranational planners.

1. Urban and metropolitan rail investment in Spain²

Infrastructure co-financing is a very common practice in Spain, as shown by the reference in the ‘Strategic Plan of Infrastructures and Transport’ to the funding strategies of the planned activities within it: ‘...counting on the participation of the regional and local government on the funding of concerted actions’.³

A clear example of co-financing in transport infrastructure projects is the following. The frame of the regulation of the relationship between the central government and the regional government is called ‘Financing Agreements of Railway Infrastructures’. These are for co-financing the investments in railway infrastructure in a given geographical area.

Through these agreements, the central government co-finances the third part of the costs of the works in some projects. Up to 1995, only investments that were considered a ‘priority’ were financed. However, since 1995 there has been a move towards co-financing investments provided that they do not exceed a specified amount of money and

¹ Regarding the characteristics of local financing in the EU see, for example, Bosch and Espasa (2006).

² The information is extracted from Socorro (2009).

³ See PEIT (2004).

that the rest is co-funded by regional governments. The problem is that the central government is financing the investment and it cannot clearly distinguish which projects are really socially optimal.

This is a clear example of partial cost coverage financing mechanism.

2. Co-funding rate⁴

The ‘funding gap’ (the basic mechanism to co-finance infrastructures in the EU) consists of the difference between the present value of a project’s investment costs and the net present value of revenues during the project’s life, i.e., the part of the project that cannot be financed itself.

This method is used for two main reasons (European Commission, 2006):

- The project needs to have enough resources to be implemented (and it is not over-financed).
- To ensure a minimum level of profitability to borrow.

The co-funding rate can reach 80 per cent of the financial net present value of the project. The higher the investment costs or the lower the net revenues are, the higher the total amount of funds is.

This is another example of partial cost coverage financing mechanism.

⁴ See de Rus and Socorro (2010) for a deep analysis.

3. State Fund of Local Investment (Spain)⁵

In 2008, in response to the economic world crisis, the Spanish Government created the ‘State Fund of Local Investment’.⁶ With this plan, the Government has the intention to create jobs and activate the economy. Put into legal terms: ‘...urgent actions in the municipal area for specially generating investments of employment’.

This plan consists of the destination of €8,000 million of the Spanish budget to local governments. Works have the following characteristics: they are works of local governments’ competence, they should be new and should start immediately, and their value has to be lower than €5 million.

In summary, the plan is a type of total cost coverage financing mechanism since the national government finances the entire project cost investment of regional governments. The endowment of the Local Investment Fund will be distributed in a way proportional to the population corresponding to every municipality.

In 2009 the Spanish Government created a new plan similar to the previous one.⁷ The objectives and conditions are almost the same, so the effects are also equal.⁸

⁵ For further information, visit www.economiasostenible.gob.es/balance-del-plan-e/.

⁶ Real Decreto-Ley 9/2008 (available at www.boe.es/boe/dias/2008/12/02/pdfs/A48125-48130.pdf).

⁷ Real Decreto-Ley 13/2009 (available at www.boe.es/boe/dias/2009/10/27/pdfs/BOE-A-2009-17001.pdf).

⁸ In legal terms: the new fund is ‘...destined to finance the accomplishment for the Council Towns of investments of municipal competition that generates employment and actions of social nature, which contribute to the economic, social and environmental sustainability’. The new concept is the introduction of ‘sustainability’.

4. Transportation Investment Generating Economic Recovery (USA)⁹

Also in response to the financial crisis, in 2009 President Obama signed the American Recovery and Reinvestment Act, which includes the Transportation Investment Generating Economic Recovery (TIGER). The latter has the objective of ‘...including measures to modernize our nation’s infrastructure, enhance energy independence, expand educational opportunities, preserve and improve affordable health care, provide tax relief, and protect those in greatest need’.

The fund amounted to \$1.5 billion and states and local governments could apply for it. The funding received may be used for up to 100 per cent of project costs (but priority must be given to projects for which federal funding is required to complete an overall financing package that includes non-federal sources of funds).¹⁰

As in the Spanish case, the financial mechanism used is a total cost coverage financing mechanism if the funds received by the state or local government make up 100 per cent of the total cost.

⁹ For further information see www.dot.gov/recovery/ost/ or Federal Register/Vol. 74, No. 115 (<http://edocket.access.gpo.gov/2009/pdf/E9-14262.pdf>).

¹⁰ At the end of 2009, the Department of Transport (DOT) was authorised to award \$600 million in TIGER II Discretionary Grants. This appropriation was similar to that of TIGER.

Appendix B.

1. Lemma 1

If the regional government chooses a cost-plus contract, it is more profitable for the firm to exert the level of effort e^L .

Proof: Given the value of T in expression (3), and substituting into equations (1) and (2), it is more profitable for the firm to exert the level of effort e^L , since $c(e^H) > c(e^L)$. ■

2. Proposition 1

The profits of the regional government are higher with an incentive contract than with a cost-plus contract.

Proof: If we want to prove that the regional government prefers an incentive contract to a cost-plus contract, we should compare (4) and (9):

$$\begin{aligned}\pi_{CP} &= -E(K / e = e^L) - T = -E(K / e = e^L) - c(e^H) - \bar{U} < \\ \pi_{IC} &= -E(T / e = e^H) = -E(K / e = e^H) - c(e^H) - \bar{U},\end{aligned}$$

because:

$$E(K / e = e^L) > E(K / e = e^H) \blacksquare$$

3. Proposition 2

If the national government uses a total cost coverage financing mechanism, the regional government has no incentives to induce the high level of effort for the firm e^H .

Proof: If the regional government chooses a cost-plus contract, the regional government's benefits are the amount of funds received from the national government minus the amount of funds given to the firm:

$$\pi_{CP} = (E(K / e = e^L) + c(e^H) + \bar{U}) - (E(K / e = e^L) + c(e^H) + \bar{U}) = 0.$$

In contrast, if it chooses an incentives contract:

$$\pi_{IC} = (E(K / e = e^H) + c(e^H) + \bar{U}) - (E(K / e = e^H) + c(e^H) + \bar{U}) = 0.$$

We can see that under both contracts the benefits for the regional government are the same (zero), so it is indifferent between one and the other. ■

4. Proposition 3

With a fixed-price financing mechanism, the regional government always has incentives to induce the high level of effort e^H . Thus, it will always offer an incentive contract to the firm.

Proof: The regional government's benefits are:

$$\pi = T_N - T_F,$$

where:

T_N : national transfer to the regional government.

T_F : regional transfer to the firm.

T_N is always the same (fixed) but T_F is always greater with a low level of effort according to equations (4) and (9), so the regional government's benefits are greater if it induces e^H ■

5. Proposition 4

If the national government chooses a partial cost coverage financing mechanism, for any $\alpha \neq 1$ the regional government has incentives to offer an incentive contract to the firm and induce the high level of effort e^H .

Proof: If α is equal to one (the national government pays the entire "bill"), the regional government will obtain the same benefits under any effort exerted by the firm:

$$-(1-\alpha)(E(K / e = e^H) + c(e^H) + U) = 0,$$

$$-(1-\alpha)(E(K / e = e^L) + c(e^H) + U) = 0.$$

However, with $\alpha \neq 1$, the regional government obtains greater benefits with a high level of effort because:

$$E(K / e = e^H) < E(K / e = e^L) \blacksquare$$