Design of Investment Promotion Policies

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Keywords

infrastructure financing, sequential mechanisms, investment promotion, information disclosure

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Design of Investment Promotion Policies

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Abstract

Over the last twenty years, developing countries have experienced the massive shift of financing and the operation of infrastructure from the public to private sector. The paper analyzes how the government agency should structure the investment promotion policy. I develop a sequential contracting model between the government, investors and infrastructure providers and derive several properties of the optimal policy. The policy leaves investors uncertain about the project type and prescribes different levels of government support, in the form of tax or price distortions. However, the optimal policy does not change the expectations of investors about distribution of project returns. I characterize how the optimal policy depends on the revenue generation preferences of the government and the profitability of infrastructure projects in the country.

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JEL Codes: D82, D86, G38, L51, O2.

1 Introduction

Financing infrastructure projects presents one of the major challenges in developing countries. Starting in the beginning of the 1990s, growing budgetary pressures led governments to transfer financing and the operation of infrastructure from the public to the private sector.[1] This change has not eliminated the need for government support. Rather, it

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[1] The World Bank study on Private Participation in Infrastructure documents that during the 1990s developing countries transferred to the private sector the operation of almost 2,500 infrastructure projects with investment commitments of more than $750 billion.

has changed the form. First, investment opportunities need to be promoted to outside investors. Second, many socially valuable infrastructure projects cannot be implemented on a purely commercial basis without government support. The objective of this paper is to provide a theoretical framework to study the effectiveness of investment promotion policies.

Investment promotion policies of the government consist of designing rules for infrastructure project selection, award procedures, support and regulation. Typically, there are two negotiation stages between the government, infrastructure project operators and foreign investors (Sader 1999). At the first stage, the project operator (a local or foreign company with expertise in the field) approaches the government to reach an initial agreement on project development. Once the operator has exclusive rights on project development, it often invites other equity participants to build a consortium through a shareholder agreement. In general, the purpose of the consortium is to carry out a specific project. The consortium members then negotiate the terms of the project with the government. Successful negotiations result in a project or a concession contract with length of up to 30 years.

At the second stage, after a project is approved by the government, the operator must raise outside financing. According to the Foreign Investment Advisory Service[2] (FIAS), 75% of project costs are covered by debt, and foreign investors participate in 80% of all projects. But foreign investors do not automatically participate in an arbitrary privatization. FIAS estimates that the number of projects that are actually implemented is only 20-30% of the potential projects which have been negotiated between the government and the operators and which have obtained government approval. The question is how the government should select and support operators to maximize the number of implemented socially valuable projects.

The scope for active government policy in this paper comes from the fact that the

[2]The Foreign Investment Advisory Service (FIAS) is a joint facility of the World Bank and the International Finance Corporation (IFC) that provides advisory assistance to governments in developing countries to establish policy framework to attract foreign investors.

profitability of some of infrastructure projects is below financing costs. The pool consists of two types of projects. Both types are socially desirable. High return projects are commercially viable. Low return projects are not viable and need further government support to be attractive to investors. The government can improve the profitability of the initial pool of projects by designing selection rules and providing direct and indirect support. Examples of direct support are grants, equity participation and subordinated loans. Indirect support includes favorable price regulation and various guarantees. When the government has a high cost of public funding and cannot pay the costs of project support, revenues from awarding production rights on high return projects can be used as a source of funding on the low return projects. For example, the government can auction the exclusive rights to develop a telecommunication network in a profitable metropolitan area and use the raised funds to support the universal service obligations in rural areas.

In practice, infrastructure builders and operators have superior knowledge about the commercial value of a project. Consequently, they will have incentives to understate that value in order to qualify for government support. To solve the adverse selection problem, the government must decrease its likelihood of approving projects that require some kind of support. An interesting feature of this problem is the interaction between the minimum subsidy necessary to implement a low return infrastructure project, the share of approved low return projects, and the information that investors learn through the award procedure.

I derive the optimal government policy in a two stage model that reflects the investment promotion stage and the financing stage of the infrastructure project implementation. In the first stage, the government designs a policy that screens potential projects on the basis of project returns. The government has two policy instruments, the probability to approve the project, and the transfer. Each approved project is assigned a transfer that can be either the payment by the operator for production rights or the support subsidy. At the second stage, the investor observes the mechanism used by the regulator to approve projects and the transfers. The investor then uses this information to decide the terms of the financing contract and the size of the infrastructure project.

A simple screening mechanism is to impose a tax on high return project operators and use the revenue to subsidize a share of the low return projects. I show that this policy is suboptimal. Under this policy, the investor is perfectly informed about the project's returns. Complete information at the financing stage introduces a severe adverse selection problem at the investment promotion stage. The probability of approval of a low return project has to be substantially reduced to elicit information from the high return operators. In practical terms, operators of both project types request project support. In response, the government supports a only small number of projects. The result is the underdeveloped infrastructure.

The first result of this paper is that the optimal investment promotion policy leaves the investors uncertain about the project type and that a share of high return projects obtain a positive subsidy from the government. This is achieved by the means of a stochastic selection mechanism. With positive probability, the high return operator is assigned the same subsidy as the low return operator. In that case observing a subsidy leaves the investor uncertain about the project type and allows the operator to gain a positive rent. This is beneficial for the government because it reduces the cost of eliciting information about the project type from high return operators and, ultimately, results in a higher share of successfully implemented low return projects.

The second result is related to the expectations of the investor about the project type. Under asymmetric information, the investor distorts downwards the amount of financing offered for the low return project. The distortion is more pronounced the higher the belief of the investor that the project has high returns. Higher distortion translates into a higher subsidy that the government has to provide to support the project. I show that the optimal policy induces the smallest feasible distortion. Instead of increasing the expectations of the investor about the return of the pool of subsidized projects, the optimal policy keeps the expectation at the original level and provides the subsidy sufficient to make low return projects viable.

The last result deals with the feasibility and desirability of the promotion of low return projects. I show that there are two possible policy regimes. Under the first regime, the government policy promotes only high commercial value projects. This policy gains positive revenue for the government but results in low level of infrastructure development. Under the second regime, the focus of the policy is the promotion of low return projects. The government gains no revenue as all payments received from high return project operators are used to support low return projects. However, this policy enables the construction of more socially valuable infrastructure. The optimal choice between the two regimes depends on the preferences of the government and the distribution of projects in the economy. Surprisingly, as the number of high return projects and the profitability of these projects increase, the information costs of investment promotion become more pronounced and less low return projects built.

The policy implication of the theoretical analysis is that an investment promotion policy should not try to screen operators to identify the profitability of the projects and communicate this information to potential investors. Rather, the information content of the policy does not change investor's expectation about the project returns. At the same time, the government should design a scheme of financial support that makes low return projects financially viable and precludes investors from cherry picking high return projects.

The rest of the paper is organized as follows. In the next section I review the relevant literature. Section 3 presents the model and analyzes the full information benchmark. Section 4 derives the optimal financing contract for a given level of beliefs of the investor about the profitability of the project. Section 5 characterizes the optimal investment promotion policy and derives the main results of the paper. Section 7 discusses the policy implications and the conclusion follows. All proofs are in the Appendix.

2 Relationship to the literature

This paper contributes to the literature on infrastructure financing and sequential mechanisms. Several recent studies have discussed the challenges of financing infrastructure in developing countries[3]. Laffont and Martimort (2005) analyze the design of incentives for provision of transnational public goods when the infrastructure project cannot be funded by a single country. They study how the external constraints imposed by the mechanism affect consumption, pricing and redistributive concerns of local governments. In a series of studies, Guasch, Laffont and Straub (2006, 2007, 2008) analyze the incidence of high frequency renegotiations of infrastructure concession contracts in developing countries. Rioja (2003) considers the issues of maintaining existing public infrastructure and shows that a balanced allocation between new investment and maintenance has positive effects on GDP for a sample of Latin American countries.

There are several studies on the political economy of foreign direct investment that analyze the effect of government preferences between revenue generation and infrastructure development on the optimal policy. Thomas and Worrall (1994) study the conflict between the short-term incentive of a developing country to expropriate foreign direct investment and long-term incentives to foster good relations with potential investors to attract more investment in the future. Justman (1995) models the link between investment in directly productive activities and establishing indivisible infrastructure. Investment in infrastructure can increase productivity, but a minimal level of productive activity is needed to justify it. The paper shows that the efficient level of infrastructure cannot be provided without ex-ante commitment to fair regulation of infrastructure fees. These studies are consistent with the results of this paper that the preferences of the government have a significant effect on the inflow of foreign investments.

This paper develops a sequential common agency model[4]. The government and the investor contract with a common agent, an operator. The investment promotion policy of the government imposes two types of externalities on the financing contract. First, it changes the set of feasible contracts by selecting the pool of approved projects and assigning a transfer to the project operator. Second, it affects the information of the

[3]Funding and managing infrastructure in developed countries is also challenging. See Bennett, Iossa (2006), Caillaud, Tirole (2004) and Martimort, Pouyet (2008) for discussion.

[4]See e.g. Baron (1985), Bergman and Välimäki (1998), Martimort (1999), Calzolari and Pavan (2006).

investor about the project type. I apply the results of Kartasheva (2011) and characterize the optimal mechanism without imposing restrictions on contracts that can be signed between the parties. To the best of my knowledge, this is the first paper that designs an optimal mechanism for investment promotion policies.

There is a number of empirical studies that document the importance of infrastructure for growth and the corresponding role of government policies. For example, Röller and Waverman (2001) analyze how telecommunication infrastructure affects economic growth. They find evidence of a significant positive causal link, especially when a critical mass of telecommunications infrastructure is present. Several other studies document the importance of information for investment promotion. Kinoshita and Mody (2001) provide empirical evidence that a Japanese firm's investment in an emerging market is positively correlated with its own previous investment in that market and also with the current investment by its competitors. It appears to reflect the value of private information for investment in the emerging economy. Morisset (2003) analyzes the effectiveness of investment promotion agencies in 58 countries and finds that policy advocacy, image -building and investor servicing to be most effective.

3 The Model

3.1 Preferences and technology

A government agency such as a ministry or a local authority aims to develop infrastructure. There is a pool of potential infrastructure projects in the country. Each project requires a large scale investment and is built by a private operator. The government and the operator are financially constrained and need to raise external funds to implement the project. A third party investor can supply funds to finance projects. The scope of the investment promotion policy comes from the fact that only a fraction of projects is financially viable.

There are two types of projects[5], a high return type H and a low return type L. The project operator is privately informed about the type. The distribution $(\nu, 1-\nu)$

[5] In Section 6 I discuss how the results depend on the two types assumption.

of projects (H, L) is common knowledge. I assume that the country has a continuum of projects with mass one available to implement. Each potential project type $i \in \{H, L\}$ is associated with one project operator.

The project type i of size q has return $\pi_i(q)$, where $\pi_H(q) > \pi_L(q)$. The profit function $\pi_i(q)$ is increasing, concave and satisfies the Inada conditions ($\pi_i' > 0$, $\pi_i'' < 0$, $\pi_i'(0) = +\infty$, $\pi_i'(+\infty) = 0$). We assume that a high return project has higher marginal profit, $\pi'_H(q) > \pi'_L(q)$, and its marginal profit decreases slower, $\pi''_L(q) > \pi''_H(q)$, than that of a low return project.

Building infrastructure of size q has fixed cost $F > 0$ and variable cost q. The financing contract between the operator and the investor is a debt contract. The investor provides funds $q + F$ for reimbursement of R. The profit of the investor under this contract is

$$V_I = R - r(q + F),$$

where r is the cost of capital. The profit of the operator type i net of financing cost is

$$\pi_i(q) - R.$$

I assume that an investor has all the bargaining power and offers a contract to the operator. This assumption is consistent with practice where investors are scares and highly involved in project development. In Section 6 I discuss how a competitive supply of capital affects the structure of the optimal policy.

Under complete information, the first-best financing scheme maximizes the joint surplus of the operator and the investor. The efficient project size q_i^* is defined by $\pi_i'(q_i^*) = r$. The project is financed if it yields non-negative net present value Π_i^*, where

$$\Pi_i^* = \pi_i(q_i^*) - r(q_i^* + F).$$

In the analysis of the model, I make the following assumptions:

Assumption 1. The net present value of a high return project is positive, $\Pi_H^* > 0$.

Assumption 2. The net present value of the low return project is negative, $\Pi_L^* < 0$.

Assumption 2 implies that low return infrastructure projects cannot be built without effective investment promotion policy. At the same time, Assumption 1 states that high return projects are commercially viable and do not require government involvement to raise financing.

The government has two, to a certain extent, conflicting objectives. It maximizes the social surplus $S(q)$ created by infrastructure of size q. Also, it values the revenue collected from the operator. The social surplus function is increasing, convex and satisfies the Inada conditions ($S' > 0$, $S'' < 0$, $S'(0) = +\infty$, $S'(+\infty) = 0$).

The policy instruments of the government are the probability p to approve the project and the transfer t. A positive transfer $t > 0$ means that the operator must pay the government in order to be approved. A negative transfer $t < 0$ means that the operator obtains a subsidy from the government for building the project. The transfer t can be interpreted either as a tax (subsidy), or the net effect of the distortion due to price regulation of infrastructure use. Both types of intervention are common in developing countries. Examples of positive transfers include the payment from the private operator to the government for a concession contract award, the investment obligations of the contract or the price caps on infrastructure services. Negative transfers are different forms of government support that range from direct expenditures to various types of guarantees.

The payoff of the government under policy (p, t) resulting in infrastructure of size q is

$$W = p[S(q) + t],$$

These preferences allow for the possibility that that the social value of infrastructure development $S(q)$ can be low and the government is tilted towards generating the revenue t.

The government does not have external resources to support infrastructure development, and the policy has to satisfy the balanced budget condition. The formal definition of the constraint is postponed till Section 3.3.

Investment promotion results in the pool of approved projects and the transfers that each operator of the pool is to pay to or receive from the government. The policy leads to investor's beliefs μ about the share of high return projects in the approved pool. If the beliefs and the transfer t are sufficiently high to make financing profitable, the investor offers a financing contract to the operator. The net profit of the operator approved under the government policy is

$$U_i = \pi_i(q) - R - t.$$

If the operator is not approved, his payoff is normalized to zero.

3.2 Timing and equilibrium

The timing of the game is as follows. First, the operators learn the project type $i \in \{H, L\}$. Second, the government designs the investment promotion policy. Projects are approved according to the policy, and investors observe the policy and the outcome (p, t). Third, the investor offers a financing contract $(R, q + F)$. Lastly, if the operator succeeds in obtaining financing, the operator implements the project and makes payments R and t.

In the following I will examine the Perfect Bayesian equilibria of the game.

3.3 Mechanism for investment promotion

The investment promotion policy is a direct communication mechanism G between the government and the operator. The mechanism is composed of the message space M and a decision function $(p(m), \delta(m))$. Once an operator sends a message $m \in M$, it is approved with probability $p(m)$. Conditional on the approval, the government assigns a lottery $\delta(m)$ which determines the transfer, $\delta \in \Delta(\mathbb{R})$.

The Revelation Principle[6] applies in this game, and it is without loss of generality to study the optimal investment promotion policy within the class of direct mechanisms where the operator reports honestly his type $i \in \{H, L\}$ to the government, and the government takes the decision $(p(i), \delta(i))$.

In Kartasheva (2011) I show that the size of the support of the optimal lottery δ does not exceed the size of the type space. The next lemma summarizes the application of this

[6] See Gibbard (1973), Green and Laffont (1977), Dasgupta, Hammond, Maskin (1979), Myerson (1979).

result to the optimal mechanism G.

Lemma 1 *The lottery δ can be characterized with two transfers t_H and t_L. Once the operator reports i to the government, the lottery $\delta(i)$ assigns a transfer t_i with probability σ_i and a transfer t_j with probability $1-\sigma_i$, for $i, j \in \{H, L\}$, $i \neq j$.*

To fix ideas, I assume that $t_H > 0$ and $t_L < 0$. Since the lottery structure imposes no restrictions on probabilities σ_H and σ_L, this assumption is without loss of generality.

Lemma 1 enables the characterization of the budget constraint of the government. The mechanism G satisfies the balanced budget constraint when the subsidy costs are covered by taxes,

$$[\nu p_H \sigma_H + (1-\nu) p_L (1-\sigma_L)] t_H + [\nu p_H (1-\sigma_H) + (1-\nu) p_L \sigma_L] t_L \geq 0. \tag{1}$$

The investor observes the investment promotion policy of the government G (the mechanism) and the outcome of the policy. The investors' belief μ_i, $i = L, H$ that an approved project with transfer t_i has high return H is

$$\mu_H = \frac{\nu p_H \sigma_H}{\nu p_H \sigma_H + (1-\nu) p_L (1-\sigma_L)} \text{ and } \mu_L = \frac{\nu p_H (1-\sigma_H)}{\nu p_H (1-\sigma_H) + (1-\nu) p_L \sigma_L}.$$

3.4 Full information benchmark

To illustrate the government policy trade-offs and the role of asymmetric information, consider a situation where the government and the investor can perfectly observe the project type. The net payoff of project i is $\Pi_i - t_i$, where

$$\Pi_i = \pi_i(q) - r(q_i + F).$$

Assumption 2 implies that the L project is financed only when it receives government support, $t_L < 0$.

Assuming that the investor and the operator agree to undertake the project, the financing contract solves

$$\max_{(R,q)} R_i - r(q_i + F)$$
$$s.t.\ \pi_i(q) - R_i - t_i \geq 0.$$

Under this contract, the investor provides the first best amount of financing q_i^*, requires a reimbursement $R_i = \pi_i(q_i^*) - t_i$ and obtains net profit $\Pi_i^* - t_i$.

The participation constraint of the investor and the balanced budget constraint of the government determine the set of transfers that make financing feasible,

$$\begin{aligned} t_H &\leq \Pi_H^*, && (2) \\ -t_L &\geq -\Pi_L^*. && (3) \end{aligned}$$

$$\nu p_H t_H + (1-\nu) p_L t_L \geq 0. \quad (4)$$

The optimal investment promotion policy maximizes the payoff of the government

$$\max_{(p,t)} \nu p_H [S(q_H^*) + t_H] + (1-\nu) p_L [S(q_L^*) + t_L],$$

subject to (2), (3) and (4). In this program, the government faces the trade-off between maximizing the expected social surplus of infrastructure development $\nu p_H S(q_H^*) + (1 - \nu) p_L S(q_L^*)$ and the expected revenue $\nu p_H t_H + (1-\nu) p_L t_L$. The net effect of developing a low return project under full information,

$$D^{FI} \equiv (1-\nu)(S(q_L^*) + \Pi_L^*),$$

is a sum of the social gain due to infrastructure development $S(q_L^*)$ and the monetary cost of subsidizing the project Π_L^*. The sign of D^{FI} determines the investment promotion policy.

Proposition 1 *Under full information, the optimal investment promotion policy has two possible regimes. Under Regime I, the net effect of developing low return projects is negative, $D^{FI} < 0$. The government approves only high return projects, $p_H = 1$ and $p_L = 0$, and imposes a tax $t_H = \Pi_H^*$. The policy yields positive revenue $\nu \Pi_H^*$ and the government's payoff*

$$W_I^{FI} = \nu [S(q_H^*) + \Pi_H^*].$$

Under Regime II, the net effect of developing low return projects is positive, $D^{FI} > 0$. The government approves all high return projects, $p_H = 1$, and a share of low return projects,

$p_L = \frac{\nu}{1-\nu} \frac{\Pi_H^*}{(-\Pi_L^*)} < 1$. It imposes a tax on high return projects, $t_H = \Pi_H^*$, and pays a subsidy to support low return projects, $t_L = \Pi_L^*$. The government gains no revenue and obtains the payoff

$$W_{II}^{FI} = \nu[S(q_H^*) + \frac{\Pi_H^*}{(-\Pi_L^*)} S(q_L^*)].$$

The government's optimal policy is Regime II rather than Regime I when infrastructure has higher social gain S and the cost of developing low return projects $-\Pi_L^*$ is lower.

Are either of the optimal policies feasible under asymmetric information? Asymmetric information imposes no further costs for the implementation of Regime I. High return project operators need to reveal the type to be approved by the government. Low return project payoff is below the tax value. Thus honest reporting is a dominant strategy for both types of operators.

Regime II is infeasible under asymmetric information. Indeed, consider the ex-ante payoff of the operator under investment promotion policy G,

$$p_i U_i = p_i(\pi_i(q_i^*) - R_i^* - t_i).$$

Under asymmetric information, the type H operator has incentives to misreport its type. This enables it to benefit from the subsidy allocated to low return projects and gain the expected profit equal to

$$p_L(\pi_H(q_L^*) - R_L^* - t_L) = p_L(\pi_H(q_L^*) - \pi_L(q_L^*)) > 0.$$

The deviation by all high return operators breaks the balanced budget condition. The government collects no revenue and is unable to subsidize low return projects.

The rest of the paper studies optimal government policy under asymmetric information. The game is solved by backward induction. The next section describes the optimal financing scheme. Section 5 derives the optimal investment promotion policy and analyzes the information that the policy reveals to investors.

4 Financing Contract

Given the investment promotion policy G, the investor observes the transfer t and holds beliefs μ that the project has high returns. If beliefs are such that the investor is perfectly informed about the project type, $\mu \in \{0,1\}$, the financing contract is a full information contract. Under asymmetric information, $\mu \in (0,1)$, the investor offers a menu of two incentive compatible contracts, (q_H, R_H) and (q_L, R_L), and the operator type i selects a contract (q_i, R_i).

The optimal financing contract maximizes the investor's expected payoff,

$$\max_{(q,R)} \mu(R_H - r(q_H + F)) + (1-\mu)(R_L - r(q_L + F)), \tag{5}$$

subject to the operator's incentive and the participation constraints for $i, j \in \{H, L\}$,

$$\pi_i(q_i) - R_i \geq \pi_i(q_j) - R_j, \tag{6}$$

$$\pi_i(q_i) - R_i - t \geq 0. \tag{7}$$

Proposition 2 *Under asymmetric information, the optimal financing contract entails the first best financing of the high return project, $q_H = q_H^*$, and a downward distortion of the low return project financing $q_L(\mu)$ implicitly defined by*

$$\pi'_L(q_L) = r + \frac{\mu}{1-\mu}(\pi'_H(q_L) - \pi'_L(q_L)). \tag{8}$$

The distortion is more pronounced when the beliefs of the investor are higher: $\frac{dq_L}{d\mu} < 0$. The net payoff of the high return project operator, $\Phi_H(\mu) = \pi_H(q_L(\mu)) - \pi_L(q_L(\mu))$, is positive and is decreasing in the beliefs: $\frac{d\Phi_H}{d\mu} < 0$. The net payoff of the low return project operator is zero.

Under asymmetric information, the cost of financing L project increases due to information rent paid to type H operator. To limit the rent of H type, the investor reduces financing to the L type operator until the marginal product of capital is equal to the marginal cost r plus the cost of information rent.

The investor participates in financing the two types of projects when both projects have a non-negative net return. The high return project gains net return Π_H^* and is financed when

$$\Pi_H^* - t \geq 0.$$

The return of the low return project depends on the beliefs of the investor μ, $\Pi_L(\mu) = \pi_L(q_L(\mu)) - r(q_L(\mu) + F)$, and $\frac{d\Pi_L(\mu)}{d\mu} < 0$. It is financed when

$$\Pi_L(\mu) - t \geq 0.$$

Higher beliefs μ make the distortion of the L project type more pronounced. This distortion is costly for the government. Were both project types profitable, the government would have chosen a passive policy resulting in the lowest beliefs $\mu = \nu$. Thus screening out a share of unprofitable L type projects has two effects on the financing. It translates into higher beliefs $\mu > \nu$ and reduces the size of L type projects, making them even less profitable. At the same time, it reduces the number of subsidized projects, and increases the government's revenue. The government's policy trades-off the two effects.

5 Investment Promotion Policy

The investor's information includes the mechanism G, the approval decision and the transfer. From Lemma 1, the optimal investment policy consists of a menu of two contracts that specify for each type i a probability of approval p_i and a lottery δ_i. The support of the lottery is two transfers t_H and t_L that lead to beliefs

$$\mu_H = \frac{\nu p_H \sigma_H}{\nu p_H \sigma_H + (1-\nu) p_L (1-\sigma_L)} \text{ and } \mu_L = \frac{\nu p_H (1-\sigma_H)}{\nu p_H (1-\sigma_H) + (1-\nu) p_L \sigma_L}.$$

The lottery $(\sigma_i)_{i=H,L}$ determines how much information is revealed to the investor. If a transfer t_i is assigned to each type i with probability one, $\sigma_i = 1$, then, regardless of the approval policy $\{p_L, p_H\}$, the investor can perfectly infer the type of project from observing t_i. Using a lottery $\sigma_H < 1$ leaves the investor uncertain about the operator's type and thus permits H type operator to gain rent at the financing stage (Proposition 2).

Hence, it reduces the cost of screening for the government. At the same time, the L type must be subsidized to realize the project. The government cannot benefit by reducing the probability that L type obtains the support, and $\sigma_L = 1$. The formal proof of these arguments is presented in the Appendix and summarized in the next Lemma.

Lemma 2 *The transfer lottery δ of the investment promotion policy has the following structure. Type H pays a tax t_H with probability σ_H and receives a subsidy t_L with probability $1-\sigma_H$. Type L receives a subsidy t_L with probability $\sigma_L = 1$. Observing transfers t_H and t_L results in beliefs*

$$\mu_H = 1 \text{ and } \mu_L = \frac{\nu p_H(1-\sigma_H)}{\nu p_H(1-\sigma_H) + (1-\nu)p_L}.$$

This result can be used to describe the set of constraints faced by the government. The H type operator earns a positive rent only when it is assigned a subsidy t_L and the investor is uncertain about the operator's type. The incentive constraint states that the probability of this event is higher when the operator reports honestly to the government,

$$p_H(1-\sigma_H) \geq p_L. \tag{9}$$

The participation constraints of the investor are

$$\Pi_H^* - t_H \geq 0, \tag{10}$$

$$\Pi_L(\mu_L) - t_L \geq 0. \tag{11}$$

Compared to the situation of full information, the subsidy $-t_L$ that the regulator commits to under asymmetric information is higher due to the distortion of the financing contract, $\Pi_L(\mu_L) \leq \Pi_L^*$.

Finally, the policy has to satisfy the balanced budget condition,

$$\nu p_H \sigma_H t_H + [\nu p_H(1-\sigma_H) + (1-\nu)p_L]t_L \geq 0. \tag{12}$$

The objective of the government is to maximize the expected payoff,

$$\max_{(p,t)} W = \nu p_H[S(q_H^*) + \sigma_H t_H + (1-\sigma_H)t_L] + (1-\nu)p_L[S(q_L(\mu_L)) + t_L],$$

subject to constraints (9), (10), (11) and (12). Decreasing the probability σ_H that type H pays a tax relaxes the incentive constraint (9). It also reduces the distortion of financing the L type $q_L(\mu_L)$, increases the type L project payoff $\Pi_L(\mu_L)$ and relaxes the participation constraint of the investor (11). However, decreasing σ_H also implies that the government has fewer resources to subsidize type L projects. To balance the budget (12), the government has to reduce the share of approved low return projects p_L.

In the next proposition I summarize the properties of the optimal investment promotion policy.

Proposition 3 *Under asymmetric information, the government's value of developing low return projects equals*

$$D^{AI} = (1-\nu)[S(q_L(\nu)) + \Pi_L(\nu)] - \nu[\Pi_H^* - \Pi_L(\nu)].$$

The optimal investment promotion policy has two policy regimes. Under Regime I, the net effect of developing low return projects is negative, $D^{AI} < 0$. Only high return projects are approved by the government and implemented, $p_H = 1$ and $p_L = 0$. The government imposes a tax $t_H = \Pi_H^*$ on high return operators and gains a positive revenue $\nu\Pi_H^*$. The government's payoff is

$$W_I^{AI} = \nu[S(q_H^*) + \Pi_H^*].$$

Under Regime II, the value of developing low return projects is positive, $D^{AI} > 0$. All high return projects and a share of low return projects are approved by the government, $p_H = 1$ and $p_L = \frac{\nu\Pi_H^*}{\nu\Pi_H^* - \Pi_L(\nu)} < 1$. Low return projects obtain a subsidy $t_L = \Pi_L(\nu)$. A share $\sigma_H = \frac{-\Pi_L(\nu)}{\nu\Pi_H^* - \Pi_L(\nu)} < 1$ of high return projects pays a tax $t_H = \Pi_H^*$ and gains zero net payoff. A share $1 - \sigma_H$ of high return projects receives a subsidy t_L and gains a positive net payoff $\Phi_H(\nu)$. The investor's beliefs depend on the transfer assigned to the approved firm. A tax t_H reveals that the project has high returns, $\mu_H = 1$. The subsidy t_L preserves the prior beliefs $\mu_L = \nu$. The government's payoff is

$$W_{II}^{AI} = \nu[S(q_H^*) + \sigma_H\Pi_H^* + (1-\sigma_H)\Pi_L(\nu)] + (1-\nu)p_L[S(q_L(\nu)) + \Pi_L(\nu)].$$

High return projects provide the government with the revenue necessary to support low return projects. Under full information, a tax is imposed on all high return project operators. This policy becomes infeasible under asymmetric information. Indeed, all high return project operators would understate the value of their projects and seek government support.

Incentive compatibility is achieved with two policy instruments. First, with a positive probability $1-\sigma_H$ the high return project operator obtains a subsidy t_L. Since all approved low return projects obtain the same subsidy, the investor is uncertain about the type of the operator who received a subsidy t_L. This allows the operator to gain the rent $\Phi_H(\mu_L)$. It also decreases the government's revenue because only a share of high return projects pays the tax. Second, the government reduces the probability of approving a low return project.

The information structure of the optimal policy is such that the investor who observes the transfer t_L maintains the prior beliefs $\mu_L = \nu$. This result echoes the discussion of the optimal financing contract. The investor's higher belief that the project is high return exacerbates the downward distortion on low return projects. The distortion is costly to the government because it increases the subsidy necessary to support the low return operator. Thus a policy that reduces the investor's belief also enables a decrease in the subsidy. However, the binding incentive compatibility constraint implies that $p_L = 1-\sigma_H$, and the best policy that can be implemented under this constraint is one which preserves prior beliefs ν.

Uncertainty of the investor about the project type reduces the net benefit of promoting low return projects, $D^{AI} < D^{FI}$. As a result, a government with asymmetric information must be more pro-development to implement policy Regime II.

Proposition 4 *The government's optimal policy is Regime II rather than Regime I when the social value of infrastructure S is higher and low return projects require less support $-\Pi_L(\nu)$. It is Regime I when the projects have higher fixed costs F, the returns of profitable projects Π_H^* are higher and the share of profitable projects in the economy ν is higher.*

Perhaps unexpectedly, higher profitability of commercially valuable projects Π_H^* and higher share of these projects in the economy ν reduce the likelihood that the government implements the policy that supports low return projects. This is because the information cost of promoting low return projects increases when the distribution of project types in the economy becomes more disperse.

6 Robustness

In this section I discuss how the properties of the investment promotion policy depend on the distribution of projects in the economy and the monopoly supply of capital.

6.1 More than two types

One interesting feature of the investment promotion policy is that the outcome of the policy, that is, an approval decision and a transfer, do not perfectly reveal the operator's type. The government chooses a policy that leads to partial revelation of types because it reduces the cost of information rent paid to the operator. In the case of discrete types, the partial revelation is achieved by assigning a stochastic transfer.[7]

When the support of operators' types is a continuum, the structure will be more complex. Laffont and Tirole (1988) analyze a dynamic two period model where an agent has a continuum of potential abilities and each period a principal offers a short term contract. They show that the optimal first period contract has a partition structure. Applied to the game considered in this paper with a continuum of project types, this result suggests that the policy will have the following structure. The type space is partitioned in a countable number of intervals and all operators' types from an interval are assigned the same transfer. The information effect of the government policy will be similar to the case of discrete types. Observing the transfer will not perfectly reveal the operator's type.

[7] In Kartasheva (2009) I consider a general case of a finite type space and show that an optimal decision is a lottery with the dimension of the support not exceeding the dimension of the type space.

6.2 Competitive supply of capital

One of the main assumptions of the analysis is that the investor is a monopoly supply of capital. Then an interesting question is whether competition among investors eliminates the need for investment promotion and leads to efficient financing of both project types. In this section I show that though competitive supply of capital improves welfare and promotes infrastructure development, it does not eliminate the need for the investment promotion policy.

I model competition in financing contracts in line with Rothschild, Stiglitz (1976) free-entry equilibrium. A large number of investors offer contracts (q, R) to approved project operators that were assigned a transfer t. An equilibrium is defined as follows.

Definition 1 *A pair of contracts* $C_H = (q_H, R_H)$ *and* $C_L = (q_L, R_L)$ *is a free entry equilibrium if and only if it is*

(i) incentive compatible, $\pi_i(q_i) - R_i \geq \pi_i(q_j) - R_j, i \neq j, i, j = H, L$;

(ii) individually rational for project operator, $\pi_i(q_i) - R_i - t \geq 0, i = H, L$;

(iii) individually rational for investors, $R_i - r(q_i + F) \geq 0, i = H, L$;

(iv) satisfies free entry condition, namely, there is no contract $C_e = (q_e, R_e)$ *that can be introduced faced to* C_H *and* C_L *and gain a positive market share,*

- *if* $\pi_i(q_e) - R_e \geq 0$ *for some* $i = L, H$*, then* $R_e - r(q_e + F) < 0$;
- *if* $R_e - r(q_e + F) \geq 0$*, then* $\pi_i(q_e) - R_e < 0$ *for all* $i = L, H$.

An important distinction of a competitive financial market from the monopoly supply of capital is that the project operator receives all the surplus generated by the project net of the transfer. Consequently, an operator prefers contracts that maximize the NPV of the project. As a result, competition solves the adverse selection problem and results in efficient financing.

Proposition 5 *Efficient contracts* $C_i^* = (q_i^*, R_i^*)$*, where* $\pi_i'(q_i^*) = r$ *and* $R_i^* = r(q_i^* + F)$*, constitute a free entry equilibrium at the financing stage.*

This result implies that the investment promotion policy of the government does not impose an information externality on the financing contract. At the same time, due to Assumption 2, low return operators need government support in order to be willing to borrow in a competitive market. Hence the optimal investment promotion policy maximizes the expected social welfare,

$$\max_{(p,t)} W = \nu p_H[S(q_H^*) + t_H] + (1-\nu)p_L[S(q_L^*) + t_L],$$

subject to incentive compatibility and participation constraints of operators, and the balanced budget constraint, $i, j = H, L$,

$$\begin{array}{ll} IC_i & p_i[\Pi_i^* - t_i] \geq p_j[\Pi_i^* - t_j], \\ PC_i & p_i[\Pi_i^* - t_i] \geq 0, \\ BB & \nu p_H t_H + (1-\nu)p_L t_L \geq 0. \end{array}$$

Proposition 6 *Under competitive supply of capital, the government's value of developing low return projects equals*

$$D^C = (1-\nu)(S(q_L^*) + \Pi_L^*) - \nu(\Pi_H^* - \Pi_L^*).$$

The optimal investment promotion policy has two policy regimes. Under Regime I, the net effect of developing low return projects is negative, $D^C < 0$. The government approves only high return operators, $p_H = 1$, imposes a tax $t_H = \Pi_H^*$, and gains welfare

$$W_I^C = \nu[S(q_H^*) + \Pi_H^*].$$

Under Regime II, the value of developing low return projects is positive, $D^C > 0$. The government approves all high return operators, $p_H = 1$, and imposes a tax $t_H = -\frac{(1-\nu)\Pi_L^*\Pi_H^*}{\nu\Pi_H^* - \Pi_L^*} > 0$; it approves a share of low return operators, $p_L = \frac{\nu\Pi_H^*}{\nu\Pi_H^* - \Pi_L^*} < 1$, and provides support $t_L = \Pi_L^* < 0$. The government gains welfare

$$W_{II}^C = \nu[S(q_H^*) + \frac{(1-\nu)\Pi_H^*}{\nu\Pi_H^* - \Pi_L^*} S(q_L^*)].$$

Compared to the case of monopoly supply of capital, competition increases probability of approval of low return operators, the net value of developing low return projects, and the welfare.

The structure of the investment promotion policy is similar to the policy obtained under monopoly supply of capital. All H type operators are approved and have to pay the tax in order to finance the support of L type operators. The difference is that competition increases the net effect of developing low return projects by eliminating the distortion of the financing contract. As a result, it increases the expected welfare of the government and the net profit of the high return operators. These results imply that financial development fosters infrastructure financing but does not eliminate the need for the investment promotion policy.

7 Policy Implications and Discussion

The analysis has several policy implications. The optimal policy does not induce full disclosure of information about project profitability. By limiting the information available to the investor, the government can increase the pool of projects that succeed and attract financing. This conclusion is consistent with the experience of developing countries in designing investment promotion policies. In a comprehensive survey of government investment promotion agencies in a wide sample of countries, Wells and Wint (2000) conclude that agencies focusing on providing a platform for information exchange about opportunities in the country and coordinating among different branches of the government are more successful in attracting investments. Investors need to be provided with information that allows them to make consistent entry decisions. At the same time, the investment policy should not be involved with project specific decisions.

The set of feasible policies and the choice of the policy is determined by the preferences of the government. A government with strong preferences for infrastructure development designs a policy that focuses on coordination of information and support functions. However, this policy does not raise revenue. On the contrary, emphasis on revenue creation leads to a policy which promotes exclusively high profitability projects and is informative about project characteristics.

The feasibility of the policy depends on the distribution of potential projects in the country. If the share of highly profitable projects is low, promotion of these projects is the only feasible policy. One implication of this result is that infrastructure development in this case cannot be achieved by relying entirely on the private sector. It is consistent with recent observations by policy makers (Estache (2004)) that though there was rebalancing from public to private financing in the infrastructure in developing countries during the 1990s, its geographic and sector distribution was very uneven. The lowest income countries and poorest regions in middle-income countries still have to rely on public financing.

8 Conclusion

The paper analyzes the optimal design of investment promotion policies. The main conclusion of the paper is that investment promotion policy must balance the benefits of better information about the potential profitability of projects and the cost of excluding low return projects. The optimal mechanism that describes the pool of projects approved by the government, the information revealed to potential investors and the structure of the government support. I show that a government which focuses on revenue generation will select a full revelation policy, separating high and low return projects. The policy results in excluding low return projects from financing. At the same time, the government that focuses on infrastructure development will reduce the information revealed to the investors in order to maximize the amount of projects that obtain financing. However, the ability to implement this policy depends on the initial profitability of investing in the country. If it is low, promoting high return projects may be the only feasible policy, and external support, like official assistance, is needed for infrastructure development.

Appendix: Proofs

Proof of Proposition 1. The optimal investment promotion policy under full information solves

$$\begin{aligned}\max_{(p,t)} W^{FI} &= \nu p_H[S(q_H^*)+t_H]+(1-\nu)p_L[S(q_L^*)+t_L]\\ &\quad \textit{subject to}\\ &\quad \Pi_H^*-t_H\geq 0,\\ &\quad \Pi_L^*-t_L\geq 0,\\ &\quad \nu p_H t_H+(1-\nu)p_L t_L\geq 0.\end{aligned}$$

Denote by $\rho_H > 0$, $\rho_L > 0$ and $\beta > 0$ the Lagrangian multipliers of the constraints. The first order conditions of the program are

$$\begin{aligned} p_H &: \ \nu S(q_H^*)+\beta\nu t_H > 0,\\ p_L &: \ (1-\nu)S(q_L^*)+\beta(1-\nu)t_L = 0,\\ t_H &: \ \nu p_H-\rho_H+\beta\nu p_H = 0,\\ t_L &: \ (1-\nu)p_L-\rho_L+\beta(1-\nu)p_L = 0.\end{aligned}$$

The left hand side of the first order condition with respect to p_H is positive, implying that the government cannot gain by excluding H type projects, $p_H = 1$. First order conditions with respect to t_H and t_L imply that $\rho_H = \nu p_H(1+\beta)$ and $\rho_L = (1-\nu)p_L(1+\beta)$. Thus if $p_i > 0$ then $\rho_i > 0$, $i = H, L$.

Regime I. $\rho_H > 0$, $\rho_L = 0$. Then $p_L = 0$, $t_H = \Pi_H^*$, $t_L = 0$ and $\beta = 0$. The government's expected payoff is equal to

$$W_I = \nu(S(q_H^*)+\Pi_H^*).$$

Regime II. $\rho_i > 0$, $i = H, L$. Then $t_H = \Pi_H^*$, $t_L = \Pi_L^*$. If $\beta > 0$, then $p_L = \frac{\nu}{1-\nu}\frac{\Pi_H^*}{(-\Pi_L^*)} < 1$ and $\beta = \frac{S(q_L^*)}{(-\Pi_L^*)} > 0$. The government expected's payoff is equal to

$$W_{II} = \nu(S(q_H^*)+\frac{\Pi_H^*}{(-\Pi_L^*)}S(q_L^*)).$$

If $\beta = 0$, then $p_L = 1$ and the budget constraint fails.

Regime I is optimal when $W_I > W_{II}$, or $D^{FI} = (1-\nu)(S(q_L^*)+\Pi_L^*) < 0$. Otherwise, Regime II is optimal. ■

Proof of Proposition 2. Assuming that constraints IC_H and PC_L are binding, the reimbursement schedule writes

$$R_H = \pi_H(q_H) - [\pi_H(q_L) - \pi_L(q_L)] - t, \tag{13}$$

$$R_L = \pi_L(q_L) - t. \tag{14}$$

The investor's problem reduces to

$$\max_q \mu(\pi_H(q_H) - rq_H - [\pi_H(q_L) - \pi_L(q_L)]) + (1-\mu)(\pi_L(q_L) - rq_L) - t.$$

The optimal financing scheme is

$$\pi'_H(q_H) = r \tag{15}$$

$$\pi'_L(q_L) = r + \frac{\mu}{1-\mu}[\pi'_H(q_L) - \pi'_L(q_L)] \tag{16}$$

It is straightforward to verify that the neglected IC_L and PC_H are satisfied. If the solution to (16) is negative, then $R_L = q_L = 0$. The operator's rent is $\Phi_H = \pi_H(q_L) - \pi_L(q_L)$ and $\Phi_L = 0$.

Assumption $\pi''_H(q) > \pi''_L(q)$ implies that the distortion of the low return project size is increasing in beliefs,

$$\frac{dq_L}{d\mu} = \frac{1}{(1-\mu)^2} \frac{\pi'_H(q_L) - \pi'_L(q_L)}{\pi''_L(q_L) - \frac{\mu}{1-\mu}[\pi''_H(q_L) - \pi''_L(q_L)]} < 0.$$

The rent $\Phi_H(\mu)$ is decreasing in beliefs μ, $\Phi'_H(\mu) = [\pi'_H(q_L) - \pi'_L(q_L)]\frac{dq_L}{d\mu} < 0.$ ■

Proof of Lemma 2. The optimal investment promotion policy of the government must satisfy the following set of constraints. The incentive compatibility constraints of the operator are

$$p_H[\sigma_H\Phi_H(\mu_H) + (1-\sigma_H)\Phi_H(\mu_L)] \geq p_L[\sigma_L\Phi_H(\mu_L) + (1-\sigma_L)\Phi_H(\mu_H)], \tag{17}$$

$$p_L[\sigma_L\Phi_L(\mu_L) + (1-\sigma_L)\Phi_L(\mu_H)] \geq p_H[\sigma_H\Phi_L(\mu_H) + (1-\sigma_H)\Phi_L(\mu_L)]. \tag{18}$$

The participation constraints of the investor are

$$\begin{aligned}
\sigma_H(\Pi_H^* - t_H) &\geq 0, &(19)\\
(1-\sigma_H)(\Pi_H^* - t_L) &\geq 0, &(20)\\
\sigma_L(\Pi_L(\mu_L) - t_L) &\geq 0, &(21)\\
(1-\sigma_L)(\Pi_L(\mu_H) - t_H) &\geq 0. &(22)
\end{aligned}$$

These constraints state that whenever an operator type i is assigned the transfer t_j with a positive probability, $i, j \in \{H, L\}$, the payoff of the project of type i must be non-negative.

The budget constraint of the government is

$$[\nu p_H \sigma_H + (1-\nu)p_L(1-\sigma_L)]t_H + [\nu p_H(1-\sigma_H) + (1-\nu)p_L\sigma_L]t_L \geq 0. \qquad (23)$$

The optimal government policy maximizes the expected payoff

$$\begin{aligned}
\max_{(p,t)} W &= \nu p_H[S(q_H^*) + \sigma_H t_H + (1-\sigma_H)t_L]\\
&\quad +(1-\nu)p_L[\sigma_L(S(q_L(\mu_L)) + t_L) + (1-\sigma_L)(S(q_L(\mu_H)) + t_H)]
\end{aligned}$$

subject to constraints (17)-(23).

There are three possible lottery structures: (a) double randomization, $\sigma_i \in (0,1)$, $i = H, L$; (b) randomization of H type, $\sigma_H \in (0,1)$ and $\sigma_L \in \{0,1\}$; (c) randomization of L type, $\sigma_H \in \{0,1\}$ and $\sigma_L \in (0,1)$.

Under randomization of the L type in (a) and (c), constraints (21), (22) and $\Pi_L(\mu_i) < 0$, $i = L, H$ imply that $t_H < 0$ and $t_L < 0$, and thus the budget constraint (23) cannot be satisfied. Hence, randomization of the L type is not feasible, and the only possible lottery structure is (b).

Suppose that type L is assigned a transfer t_H with probability one, $\sigma_L = 0$. Then either $t_H < 0$ and (23) fails, or $t_H > 0$ and the lottery fails to satisfy (22). Hence, $\sigma_L = 0$ is not feasible.

The only feasible randomization structure is (b) with $\sigma_L = 1$. Under this structure $\mu_H = 1$ and $\mu_L = \frac{\nu p_H(1-\sigma_H)}{\nu p_H(1-\sigma_H)+(1-\nu)p_L}$. These beliefs produce the operator rent profile

$$\begin{array}{ll}
\Phi_H(\mu_H) = 0, & \Phi_L(\mu_H) = \pi_L(q_H^*) - \pi_H(q_H^*) < 0,\\
\Phi_H(\mu_L) = \pi_H(q_L(\mu_L)) - \pi_L(q_L(\mu_L)) > 0, & \Phi_L(\mu_L) = 0.
\end{array}$$

This profile simplifies the incentive constraints to

$$p_H(1-\sigma_H) \geq p_L,$$
$$0 \geq p_H \sigma_H \Phi_L(\mu_H),$$

which implies that the incentive constraint of the L type always holds. The participation constraints of the investor and the budget constraint of the government become

$$\begin{aligned}
&p_H(1-\sigma_H) \geq p_L,\\
&\Pi_H^* - t_H \geq 0,\\
&\Pi_L(\mu_L) - t_L \geq 0,\\
&\nu p_H \sigma_H t_H + [\nu p_H(1-\sigma_H) + (1-\nu)p_L]t_L \geq 0.
\end{aligned}$$

These imply that a feasible policy must have $t_L < 0$ and $t_H > 0$. ■

Proof of Proposition 3. Under the lottery described in Lemma 2, the optimal investment promotion policy solves the problem

$$\begin{aligned}
\max_{(p,t)} W &= \nu p_H[S(q_H^*) + (\sigma_H t_H + (1-\sigma_H)t_L)]\\
&\quad +(1-\nu)p_L[S(q_L(\mu_L)) + t_L]\\
&\quad \textit{subject to}\\
&\quad p_H(1-\sigma_H) \geq p_L,\\
&\quad \Pi_H^* - t_H \geq 0,\\
&\quad \Pi_L(\mu_L) - t_L \geq 0,\\
&\quad \nu p_H \sigma_H t_H + [\nu p_H(1-\sigma_H) + (1-\nu)p_L]t_L \geq 0.
\end{aligned}$$

Denote by $\lambda_H > 0$, $\rho_H > 0$, $\rho_L > 0$ and $\beta > 0$ the Lagrangian multipliers of the constraints. The first order conditions of the optimal policy are

$$\begin{aligned}
p_H:&\quad \nu\sigma_H S(q_H^*) + (1-\nu)p_L \tfrac{dS(q_L(\mu_L))}{dq_L}\tfrac{dq_L}{dp_H} + \lambda_H(1-\sigma_H) + \rho_L \tfrac{d\Pi_L(\mu_L)}{dq_L}\tfrac{dq_L}{dp_H} + \beta\nu t_H > 0,\\
p_L:&\quad (1-\nu)(S(q_L(\mu_L)) + p_L \tfrac{dS(q_L(\mu_L))}{dq_L}\tfrac{dq_L}{dp_L}) - \lambda_H + \rho_L \tfrac{d\Pi_L(\mu_L)}{dq_L}\tfrac{dq_L}{dp_L} + \beta(1-\nu)t_L = 0,\\
t_H:&\quad \nu p_H \sigma_H - \rho_H + \beta\nu p_H \sigma_H = 0,\\
t_L:&\quad \nu p_H(1-\sigma_H) + (1-\nu)p_L - \rho_L + \beta(\nu p_H(1-\sigma_H) + (1-\nu)p_L) = 0.
\end{aligned}$$

The left hand side of the first order condition with respect to p_H is always positive, implying $p_H = 1$. Conditions with respect to t_H and t_L and $p_H = 1$ imply that $\rho_H = \nu p_H \sigma_H(1+\beta) > 0$ and $\rho_L = (\nu p_H(1-\sigma_H) + (1-\nu)p_L)(1+\beta) > 0$. Hence $t_H = \Pi_H^*$ and $t_L = \Pi_L(\mu_L)$. Finally, the condition with respect to p_L implies that $\lambda_H > 0$ and the incentive constraint is binding. The investor's beliefs under this policy are $\mu_H = 1$ and $\mu_L = \frac{\nu p_H(1-\sigma_H)}{\nu p_H(1-\sigma_H)+(1-\nu)p_L} = \nu$, that is, the investor observing t_L maintains prior beliefs ν.

Regime I. If $\beta = 0$, then $p_L = 0$, $\sigma_H = 1$ and $t_L = 0$. The government obtains the payoff

$$W_I^{AI} = \nu[S(q_H^*) + \Pi_H^*].$$

Under Regime I, the payoff of the government under asymmetric information equals the payoff under full information, $W_I^{AI} = W_I^{FI}$.

Regime II. If $\beta > 0$, then p_L and σ_H are determined by the incentive constraint of the H type and the budget constraint,

$$p_L = 1 - \sigma_H,$$
$$\nu\sigma_H\Pi_H^* + [\nu(1-\sigma_H) + (1-\nu)p_L]\Pi_L(\nu) = 0.$$

Solving for p_L and σ_H, we obtain

$$p_L^{AI} = \frac{\nu\Pi_H^*}{\nu\Pi_H^* - \Pi_L(\nu)} < 1 \text{ and } \sigma_H^{AI} = \frac{-\Pi_L(\nu)}{\nu\Pi_H^* - \Pi_L(\nu)} < 1.$$

The share of approved L types under asymmetric information is lower than the share under complete information, $p_L^{AI} < p_L^{FI}$. Indeed, $p_L^{AI} < p_L^{FI}$ is equivalent to $\nu\Pi_H^* + (1-\nu)\Pi_L^* - \Pi_L(\nu) = \nu[\Pi_H^* - \Pi_L(\nu)] + (1-\nu)[\Pi_L^* - \Pi_L(\nu)] > 0$. The last inequality holds because $\Pi_H^* > \Pi_L(\nu)$ and $\Pi_L^* > \Pi_L(\nu)$. The government's expected payoff equals

$$W_{II}^{AI} = [\nu S(q_H^*) + (1-\nu)p_L^{AI}S(q_L(\nu))] + \nu\sigma_H^{AI}\Pi_H^* + [\nu(1-\sigma_H^{AI}) + (1-\nu)]\Pi_L(\nu).$$

Regime II is optimal if and only if $W_{II}^{AI} > W_I^{AI}$, or equivalently,

$$D^{AI} = S(q_L(\nu)) + \Pi_L(\nu) - \frac{\nu}{1-\nu}[\Pi_H^* - \Pi_L(\nu)] > 0.$$

Compared to optimal policy under complete information, the government which implements Regime II must be more pro-development, that is, it has to have higher value S. ■

Proof of Proposition 4. Differentiation of D^{AI} with respect to S, F, Π_H^* and $-\Pi_L(\nu)$ immediately obtains the results. ■

Proof of Proposition 5. In a separating equilibrium, the two contracts (q_H, R_H) and (q_L, R_L) maximize the payoff of types H and L, respectively,

$$\pi_i(q_i) - R_i - t$$

subject to incentive constraint (6) and participation constraint (7) of the operator, and the participation constraint of the investors for each type of contract,

$$R_i - r(q_i + F) \geq 0.$$

It is immediate to verify that the efficient contracts (q_i^*, R_i^*), where $R_i^* = r(q_i^* + F)$ are incentive compatible. Indeed, constraint (6) is satisfied because $q_i^* = \arg\max_{q_i} \pi_i(q_i) - r(q_i + F)$. Thus, as long as the transfer is sufficiently high to satisfy (7) of the low return project L, both operators build efficient level of infrastructure. There exists no pooling equilibrium. Indeed, any pooling contract can be crowd out of the market by an efficient separating contract. ■

Proof of Proposition 6. Type H has incentives to misreport the type to the government in order to obtain a subsidy intended for type L. The government provides incentives to H type by reducing the probability of approval of the L type. To find an optimal policy, I assume that constraints IC_H, PC_L are binding, and verify the other constraints ex-post. The assumption implies

$$\begin{aligned} t_L &= \Pi_L^* < 0, \\ t_H &= \Pi_H^* - \frac{p_L}{p_H}(\Pi_H^* - \Pi_L^*) > 0. \end{aligned}$$

The an optimal approval policy (p_H, p_L) maximizes

$$W = \nu p_H[S(q_H^*) + \Pi_H^*] + p_L[(1-\nu)(S(q_L^*) + \Pi_L^*) - \nu(\Pi_H^* - \Pi_L^*)]$$

subject to the binding BB constraint,

$$\nu p_H \Pi_H^* - p_L[\nu(\Pi_H^* - \Pi_L^*) - (1-\nu)\Pi_L^*] \geq 0.$$

It is immediate to show that $p_H = 1$. The probability of approval of low return projects depends on the sign of the net effect of developing these projects,

$$D^C = (1-\nu)(S(q_L^*) + \Pi_L^*) - \nu(\Pi_H^* - \Pi_L^*),$$

where the first term is the net welfare gain/loss of low return projects and the second term is the cost of information rent that has to be paid to the high return operators to implement the policy.

If $D^C < 0$, then

$$\begin{aligned} p_L &= 0, \\ t_L &= 0, \\ t_H &= \Pi_H^*. \end{aligned}$$

The policy obtains expected social welfare

$$W_I^C = \nu[S(q_H^*) + \Pi_H^*].$$

If $D^C > 0$, then the government policy is

$$\begin{aligned} p_L &= \frac{\nu\Pi_H^*}{\nu\Pi_H^* - \Pi_L^*} < 1, \\ t_L &= \Pi_L^* < 0, \\ t_H &= -\frac{(1-\nu)\Pi_L^*\Pi_H^*}{\nu\Pi_H^* - \Pi_L^*} > 0. \end{aligned}$$

The government provides support for a share $p_L < 1$ of low return projects, and requires a payment for production rights from high return operators. In contrast to the case of a monopoly investor, the high return operator obtains a positive profit. The policy results in the expected social welfare

$$W_{II}^C = \nu[S(q_H^*) + \frac{(1-\nu)\Pi_H^*}{\nu\Pi_H^* - \Pi_L^*} S(q_L^*)].$$

Immediate comparison between the policy characteristics under monopoly and competition obtains that competition increases p, D, W. ■

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