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PUBLIC AND PRIVATE PROVISION OF INFRASTRUCTURE AND ECONOMIC DEVELOPMENT[1]

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[1] Este trabalho faz parte de um projeto financiado pelo PNUD/BNDES sobre financiamento da infra-estrutura e crescimento econômico. Os autores agradecem o financiamento de ambas as instituições, ressaltando que as opiniões expressas em ambos os trabalhos são exclusivamente nossas. Queremos agradecer a Rodrigo Galvão pela excelente assistência de pesquisa. Todos os erros deste trabalho são nossos.

RESUMO

Este artigo examina o papel da infra-estrutura no crescimento econômico de longo prazo. Há duas seções: a primeira aborda o papel teórico dos gastos do governo nos modelos de crescimento, e a segunda provê alguns exemplos da participação do setor privado em investimentos de infra-estrutura. Com base num modelo simples de crescimento endógeno, concluímos que não obstante os grandes benefícios dos investimentos em infra-estrutura, é fundamental encontrar-se o processo adequado de financiamento desses investimentos. Dado que o desenvolvimento e a manutenção da infra-estrutura continuará a ser fundamental ao crescimento sustentado das economias em desenvolvimento, enfatizamos as lições sobre o financiamento bem como as advertências quanto à participação privada. Tais ensinamentos são importantes para a implementação dos mecanismos inovadores ora em uso em investimentos de infra-estrutura.

ABSTRACT

This paper examines the role of infrastructure in long run economic growth. The paper consists of two sections, the first concentrates on the theoretical role of government spending in models of growth and the second details examples of private participation in infrastructure development. Using a simple endogenous growth model we find that while the hypothesized benefits of infrastructure expenditures may be large they require care in matching appropriate financing. As the development and maintenance of infrastructure will continue to be pivotal to the long term success of growing economies, we emphasize the lessons on financing and the caveats of private participation to those who are exploring innovative mechanisms for infrastructure design.

1. Introduction

This paper surveys the literature on infrastructure and economic development and discusses several examples of private provision of infrastructure. The first section of the paper presents theoretical arguments for the role of government investment expenditures in long run economic growth. The second section discusses some of the empirical literature on the evidence for a positive relationship between infrastructure levels and growth rates. The final section presents examples of joint public/private participation in infrastructure project around the world.

2. Growth Theory

In the past decade there has been an explosion in the literature on economic growth. Sparked by papers by Romer(1986) and Lucas (1988), both theoretical and empirical economists have renewed their interest in the sources of long-run economic growth. On the theoretical side, work has proceeded in several directions. Initially, papers concentrated on providing workable mathematical solutions to growth models with constant or increasing returns to accumulated factors such as physical capital. However, mere assertions of increasing returns to scale were not satisfactory, both because of a lack of supporting microeconomic empirical evidence and because of the black box nature of the theory. However, the literature matured quickly and separate strands emerged: one focussed on issues such as R&D and technological sources of growth and another concentrated on the mechanisms for low income/low technology countries to achieve sustained high growth rates.[1]

These two branches of the growth literature effectively serve to analyze two distinct sets of countries. The former with its focus on the sources of technological

[1] This dichotomy is by no means the only, or even accepted, classification of the new growth theory. However, for the purposes of this project it will serve as a useful distinction.

change at the frontier is primarily relevant for advanced industrialized countries who advance their levels of technology by the development and adoption of the latest manufacturing, engineering, and management techniques. The latter branch concerns itself less with the movements of the technological frontier but rather with the sources of catch-up to that frontier by countries and regions starting from lower levels of physical capital stocks, educational attainment, technology, and income levels For the purposes of this paper we will limit our observations to this latter branch of the growth literature, ignoring numerous, substantial and important papers on R&D and technology.

The challenge posited to economists working the in the area of economic growth[2] was how countries with apparently similar standards of living in any particular year could have such varied growth experiences. This was the puzzle presented by Romer(1986) and Lucas (1988) and the driving source for both the empirical and theoretical literature. Any participant in the theoretical debate has to answer the elemental question of why long run growth rates vary so much across countries. A first step to answering this query is the provision of a coherent model of long run growth. Since we want to focus on infrastructure in economic growth, we will start by describing the role for infrastructure in the neoclassical model, or Ramsey-Solow model, and then in several models from the new growth theory.

The familiar reduced-form solution of the neoclassical model shows that long run growth rates are determined exclusively by 'exogenous' technological change and perhaps, the rate of growth of population, or the effective labor force. Private capital is accumulated to the point where marginal returns exactly equal marginal costs of forgone consumption and the capital-output ratio is maintained into the indefinite future. Fiscal policy, including but not limited to infrastructure expenditures, can only affect growth rates along the transition to the steady state.[3]

[2]From this point forward, references to economic growth and development ignore the sustained progress of technological leaders and refer instead to the growth performance of follower countries and regions.

[3]As mentioned earlier, we will continue to ignore the sources of exogenous technological progress.

Thus any increased growth due to fiscal policy will be temporary in nature and independent of long run growth rates after attaining the steady state.

This lack of relationship between long run growth and available policy instruments in the neoclassical model is one of the sources of interest in the new growth literature. Endogenous growth models offer the possibility of transforming the temporary growth rate effects of infrastructure spending and other fiscal policy into permanent ones. To provide a framework for understanding the role of government activity, both on the expenditure and revenue sides, we start with an endogenous growth model with constant returns to capital.[4] We consider three cases for the provision of government services, that where the services are rival and excludable, non-rival and non-excludable, and finally, rival but non-excludable[5]. These three cases illustrate both the potential public good aspects of government (infrastructure) spending as well as the possibility of external returns to private firms from the provision of government services. The last case comes closest to that of infrastructure expenditures where the usefulness of a road or port to an individual producer declines as more producers use the facility.

The production function for an individual producer in the first case, where services from government expenditures are rival and excludable, is given by

$$y = Ak^{1-\alpha}g^{\alpha}.$$

Each of the n producers is entitled to some excludable fraction, G/n, of aggregate government purchases, G. As specified, there are constant returns to scale for both private capital and public expenditures (taken as given by the firm) taken together, allowing for the possibility of positive long run growth without exogenous increases in the level of technology given by A. Assuming that the government balances its current budget, the efficient size of the government sector is given by $\partial y/\partial g = 1$, which implies that $g/y = \alpha$. In this setup if government expenditures are financed by a lump-sum tax, then the social and private rates of return coincide and the

[4] Private capital is broadly construed in this case and can encompass both physical and human capital. Government-related capital is excluded.

[5] This section closely follows Barro (1990) and Barro and Sala-i-Martin (1990).

growth rate in the economy is optimal. If the expenditures are financed by a proportional tax on output at rate τ, the social and private returns on investment will coincide if the marginal tax rate were zero. If $\tau > 0$ the private return is lower than the social return, private firms underinvest, and the growth rate in the economy is too low. Some form of lump sum taxation is needed to correct the inefficiency and raise the overall growth rate to the socially optimal level.

The second formulation considers the case where the entire expenditure of government purchases is available to each private producer, i.e. non-rival and non-excludable. The individual's production function can now be written with aggregate government spending entering directly:

$$y = Ak^{1-\alpha}G^{\alpha}$$

Now an increase in aggregate government spending affects all private firms, in other words there is an aggregate increase in output. As in the previous case, efficiency require that $Y/G = \alpha$. Little has changed from the case where the government provides investment goods to individual firms. Lump-sum taxation still leads to the first-best outcome with socially optimal growth rates and proportional taxation reduces growth below the socially optimal level.

The final case where the good is rival but not excludable includes the possibility of congestion effects in public service provision. This situation most closely approximates the position of road, ports and other infrastructure. Formally, this can be seen in the private production function

$$y = Ak^{1-\alpha}\left(G/Y\right)^{\alpha}$$

where each producer has access to a level of services, G/Y, increasing in G but decreasing as other producers increase their output and aggregate output rises. As long as the government maintains a constant level of congestion there are constant returns for each producer in private and public investment. Since each producer takes the level of service provision as exogenous, there is an incentive to increase output and thus induce congestion costs. For each producer to realize the

congestion costs he imposes on others, the optimal tax is a proportion user fee at the rate, $\tau = G/Y$. In this case the optimal outcome does not involve lump sump taxes but rather proportional taxation, which would have produced sub-optimal outcomes in either of the other cases. The overriding lesson for practitioners concerned with infrastructure provision and long run growth prospects is that the financing must match the services provided. In particular, the public good and external effects aspects of the service provision must both be considered when designing revenue policy for infrastructure financing.

3. Empirical Evidence

Following Barro (1990) and Aschauer (1989), there has been an explosion of empirical work on the role of government spending, both consumption and investment, on the differential long run growth rates across countries and regions. Several different empirical approaches have competed in the literature but the overall agenda has been common across methodologies: to determine if higher rates of government expenditure, particularly on infrastructure, can increase long run growth rates.[6]

Aschauer's stimulating article (1989) concluded that the nonmilitary public capital stock (investment) is far more important in increasing aggregate productivity than either non-military or military spending (consumption). He concluded that "a 'core' infrastructure of street, highways, airports, mass transit, sewers, and water systems has [the] most explanatory for productivity." He estimates that a 1% increase in the ratio of public to private capital stocks raises total factor productivity by 0.39%, a substantial rise. While numerous authors have attacked both the methodology and point estimates in his paper, this remains the basis for most analyses of the role of infrastructure in long run productivity growth.

Some recent work on the role of fiscal policy in economic growth has also concluded that there is a role for the public provision of infrastructure in raising

[6] This paper will not detail the methodologies except to mention that a parallel literature has evolved discussing the econometric properties of the various estimators.

long-run growth rates. Easterly and Rebelo (1993) find that the share of public investment in transport and communication is strongly related to growth rates after controlling for standard variables in a cross-section regression framework. Canning, Fay and Perotti (1992) find that telephones and electricity have positive significant effects on growth, but that the role of roads and railways is less clear-cut. All these studies warn that the causal, statistical relationship between infrastructure and growth is difficult to assess and that the estimated coefficients seem implausibly high, although some microeconomic work suggests that there are high social rates of return to the provision of infrastructure.

4. Examples of Private Participation

The preceding sections have explored the public provision of infrastructure and estimates of its effect on the aggregate rate of economic growth. However, especially in the case of a developing economy such as Brazil, the limitations on the availability of public funds may yield suboptimal levels of investment in infrastructure. These difficulties may be particularly acute in regions within the country that are at low levels of development relative to more advanced regions. The implied lowering of growth rates due to underprovision of infrastructure is substantial and over the course of a decade yields dramatically lower output. We attempt to provide insight into alternative mechanisms of infrastructure provision and their associated advantages and pitfalls in this section.

To leverage public funds as much as possible it is generally desirable to set up some sort of public-private combination in the financing of development projects. This is particularly difficult for the case of infrastructure due to the public good nature of the product. In fact, there are few examples of private infrastructure provision even in developed countries.

The remainder of this paper concerns itself with examples of private participation in the provision of infrastructure, in particular roads which are the form of infrastructure most likely to incorporate joint public and private activities. A

concluding section follows.

4.1. California's Private Highways

In 1989 the legislature in the state of California passed a bill that authorized up to four franchise transport projects. All the approved projects were for toll highways, a critical element of the infrastructure in a state dominated by automotive transportation. The franchise agreements were signed in January 1991.[7]

The common characteristics of the franchise roads included state ownership of the completed highways; the franchised party would propose, design, assemble, clear and construct the facility and retain the concession rights to operate the roads for at least 25 years. There was no head-to-head competition for each project; the consortiums submitted transport proposals and negotiations of the agreements took place after the projects had been approved for selections.

Among the basic characteristics of the agreements themselves were specifications of basic service options and mandated state design and construction standards (particularly important because of the high probability for earthquake damage to infrastructure in the state). The toll rates were left unregulated but maximums were imposed on rates of return, ceilings ranging from 17% to 21%. There were incentive bonuses to allow returns to exceed these maxima. One particular peculiarity of this agreements was that formal environmental review, a major hurdle for any large-scale public project, was conducted after the project was chosen, adding a large degree of uncertainty to the overall project success and profitability. A brief description of the four projects follows.

4.1.1. State Route 57

This road was designed to relieve congestion on parallel routes in Orange County and was extremely expensive, costing $700 million for a total of 11 miles of highway. Pricing features included peak load tolls and the entire project included no

[7]Sources for this section include Fielding and Klein (1993) and Gomez-Ibanez and Meyer (1993).

direct government financial assistance. All financing was to be generated by the toll revenues on the road while the government provided the rights-of-way for the original construction.

4.1.2. State Route 91

As with State Route 57, this highway was designed to relieve congestion on parallel roads. No direct government financial assistance was included, again the government provided the right-of-way on the median of an existing highway. Toll revenues were expected to cover construction and maintenance costs and while there was the provision for peak load pricing of tolls, high occupancy vehicles (3 or more people) travelled free.

4.1.3. State Route 125

This road was more directly related to the economic growth of the region being a development road 10 miles long with an estimated cost of $40 million per mile. The main service provision was for residents and trucks travelling to the maquiladora plants located in nearby Mexico. The land for the highway was to be contributed by local real estate developers, about two thirds of the total land costs ($30 million) with some contributions from local governments ($15 million), the bulk of the financing was to be generated from toll revenues. Due to the complicated three-way negotiations over land and financing, problems arose over obtaining the necessary right-of-way and over the amount of local government contributions.

4.1.4. Midstate Toll Road

Another development road, this was the longest and most costly proposed highway consisting of two stages totalling 85 miles. The first stage of 40 miles was estimated at a cost of $600 million with government contributions expected to amount to 25%-33% of the total cost. Tolls were again to be a substantial source of revenue, while in this case local landowners were not expected to participate.

4.2. Virginia's Private Roads

In 1988, the Virginia state legislature authorized the construction of private toll roads in the state.[8] To obtain a franchise, the proposed project had to obtain regulatory approval from the state transportation board, local jurisdictions and the state corporation commission. After obtaining such approval, the contract between the operator and the Department of Transportation specified standards, inspection procedures and oversight provisions. Subsequently the operator was obligated to undertake an environmental review and route assembly. As in California, competition for a specific project was precluded, however unlike the California roads, the state corporation commission had approval on all toll rates to fix appropriate rates of return.

4.2.1. Dulles Toll Road Extension

One example of a private road proposed under this enabling legislation was the Dulles Toll Road Extension, a development road. At 15 miles long, its cost was estimated at $300 million, excluding costs of acquiring the rights-of-way, some of which were expected to be donated and whose cost was estimated to be $60 million. Tolls were to be the main source of revenue, with the rates of return negotiated directly. The project was financed with a sale-leaseback scheme.

4.3. Spain's Experience with Private Roads

Spain's private road program had its golden years during the 1960s and 1970s.[9] The 1980s saw a shift back to tax-financed roads. The Autopistas, at the private roads are called, were once operated by 13 companies, of which 12 were private. Of the twelve private companies. nine are still operating today, the other three have been taken over by the government during the 1980s.

[8]Sources for this section include Fielding and Klein (1993) and Gomez-Ibanez and Meyer (1993).

[9]The primary source for this and the remaining sections is Gomez-Ibanez and Meyer (1993).

The private Autopistas have certain defining characteristics. They tend to be located in the wealthier regions of Spain, regions which could afford to finance private highways. Poorer regions continue to finance roads out of tax revenues. Foreign capital was used as a financing alternative whenever possible; nominally to improve the balance of payments and to avoid crowding out of domestic private investment. Provisional requirements were that more than 45% of total costs should be financed through foreign loans; more than 10% of financing had to be in the form of equity and less than 45% should be financed through domestic loans.

The government offered guarantees for 75% of the foreign loans and protected companies from foreign exchange fluctuations. A reversion fund was established so that at the end of the concession periods firms could pay all debts and equity obligations. All firms had to be fully capitalized and no direct subsidies were provided. Initial toll rates were specific to each concession and tolls would increase according to an inflation formula based on steel, oil, and labor costs.

4.4. Private Roads in France

France has experimented with private roads since the 1970s. Of the four private concessionaires, however, only one is still is current operation. The other three were absorbed by the government. The four private concessionaires were consortia of French public works construction firms and French banks. The banks had a small share of total stockholding and were involved mainly to receive fees from the issuance of bonds. The construction companies intended to make profits in the building of the roads rather than in the management of the finished roads, thus presenting a conflict of interest.

The government chose the routes for each project and the consortia proposed detailed designs and financial, management and operating plans. A jury chose proposals based on the size of cash advances from the state, equity and reserves committed by shareholders, loans guaranteed by the state, the quality and reliability of the traffic projections and the proposed speed of project completion. The

government tried to spread the projects out among the various consortia.

Problems for the private concessions in the 1970s concentrated on the oil price shocks and subsequent increases in construction costs, increased financing costs due to rising interest rates, and decreased demand due to domestic recession. The ministry of finance regulated tolls and was reluctant to approve increases. In addition, the three private concessionaires eventually taken over by the government suffered from generally poor management.

4.5. Other Private Roads

4.5.1. Malaysia

In 1987, the government agency in charge of the construction of a major north-south highway went bankrupt and decided to privatize its ambitious project. A concession was given to a firm whose main shareholders were senior government officials. Other private firms were discouraged from applying as the government gave preferential treatment to the single firm. The arrangement was for the government to lend part of the money for construction and an addition amount upon completion. On parts already completed the government would transfer operations to the firm, but retain any existing debt. Traffic levels were guaranteed by the government and some interest rate and exchange rate risks were absorbed by the government. Additionally there was protection against government policy changes. In spite of these arrangements, the firm still had difficulty in raising the necessary outside financing.

4.5.2. Indonesia

In Indonesia, private firms have become involved in toll road joint ventures with the government. Legislation forbids private firms to be sole operators or contractors in toll road projects. While construction costs were originally intended to be financed by the private sector through equity and debt, in practice this has not been the case.

The arrangements for the roads were to have included rights-of-way paid for by the state and competitive proposals. Concessions were eventually awarded to consortia of politically prominent citizens and government officials. Debt was issued by the development bank of Indonesia and other government owned banks. A substantial share of the equity was supplied by a government agency through previously built infrastructure. The remaining equity was converted to a form of sweat equity rather than publicly financed. Some of the toll roads have revenue sharing agreements with adjacent or connecting government roads that are quite generous.

Some of the reasons for the extensive government involvement seem to include time pressures to build the roads quickly, insufficient domestic capital markets for such large projects, and the lack of foreign financing due to the presidential control of toll rates, thus increasing the risk of adverse revenue flows in the future.

4.5.3. Thailand

Thailand's experience is mostly with private urban expressways in Bankok, having had little success with intercity private roads. In the case of the urban expressways, the private investment was used to complement public investment. Concessions have generally not been awarded competitively; private financing played a substantial role with 20% equity and 80% debt of which two thirds of the equity was foreign and all the debt was raised on domestic Thai capital markets. The government bought the land, receiving land lease fees during the project. The private firm agreed to a formula on sharing tolls with the government agency.

5. Conclusions

This paper has explored the role of infrastructure in economic development from both a theoretical and empirical perspective. Using a simple endogenous growth model we found that while the hypothesized benefits of infrastructure expenditures may be large they require care in matching appropriate financing. Both the public

good nature of infrastructure as well as any potential external effects, positive or negative, must be considered when devising the relevant financing package.

Empirical evidence on the role of infrastructure in augmenting long run growth rates is still relatively scarce. This is due to both a lack of good regional data sets and to the recent nature of the advances in the theoretical literature. However, work done so far suggests large positive payoffs to high levels of infrastructure and conversely deleterious effects on aggregate performance of underinvestment in this form of capital.

A perennial problem facing developing, and industrialized economies, even one as advanced as Brazil, is a shortage of public funds for long term investment projects. As a result, increasingly in recent years governments have turned to joint public/private financing arrangements for infrastructure, particularly roads. We survey the known projects that involve both public and private roles documenting their characteristics and some revealed problems.

As the development and maintenance of infrastructure will continue to be pivotal to the long term success of growing economies such as Brazil, we emphasize the lessons on financing and the caveats of private participation to those who are exploring innovative mechanisms for infrastructure design.

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