XIV. Public Investment

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How should public investment projects be appraised?
Are overall public investment programs consistent with macroeconomic and institutional constraints?
How is the public investment programming problem solved in practice?

In many developing countries, public investment accounts for the bulk of total fixed investment, reflecting for the most part the central role played by governments in providing adequate infrastructure. While the rationale for extensive public sector investment activity at the theoretical level is generally linked to market failure and social objectives, at the operational level many governments are also involved in more commercially oriented investment activities. As a consequence, capital expenditure, together with associated operations and maintenance and debt servicing costs, often account for a large proportion of total public expenditure. This note reviews some key issues in public investment decision making from both the microeconomic and macroeconomic perspectives.

Project Appraisal

Irrespective of the type of investment activity undertaken, governments should use a systematic set of procedures to appraise alternative investments. For public investments that are essentially commercial in nature and for whose output the market is competitive, governments should follow the principles of private cost-benefit analysis. Otherwise, the appropriate decision rule should reflect social costs and benefits.

Social cost-benefit analysis

While there are a number of other decision rules (benefit/cost ratio, internal rate of return, and payback period) that can be used in applying social cost-benefit analysis, the **net present value rule** is the most reliable. According to this rule, a government should undertake all projects that generate a positive net present value (NPV). Within the limits of a fixed budget, however, governments should choose a subset of available projects in such a way that the NPV generated by available resources is maximized. The appropriate discount rate is the social opportunity cost of capital. Determining this is, however, controversial, given the usual divergence between the social rate of time preference and the rate of return on investment owing to capital market distortions. In practice, the tendency is to choose this key parameter to reflect market interest rates. There are also a number of other issues that arise in imparting a "social" (as distinct from private) dimension to the computation of net present value.

Valuation of nonmarketed commodities

Markets and hence prices may not exist for the output generated by many public sector investment activities, thus complicating the economic evaluation of such undertakings. In these cases, appropriate imputation of the

value of output is necessary, as for example with clean air, lives saved, penetration roads, or natural beauty. Indirect methods of valuation, including the use of information gathered in related markets or from **willingness-to-pay** studies, can be used to estimate the gain in **consumer surplus**, and hence to approximate the value of additional output associated with a project.

Shadow prices

The rationale behind the use of shadow prices is that market prices may reflect significant distortions, such as those related to taxes and subsidies, externalities, or regulation (of prices, wages, interest rates, and the exchange rate, for example). When this is the case, market prices do not reflect scarcity values of inputs and outputs. Appropriate adjustments should therefore be made. In practice, however, the computation of shadow prices can be a complex and time-consuming process. One approach involves the calculation of **opportunity costs**. For example, the shadow price of an input to a particular project depends on the extent to which supply and demand elsewhere is affected. In essence, this approach attempts to ensure that a project is undertaken only if resources are transferred from lower-value to higher-value uses. While by nature a highly detailed process, the opportunity cost approach is most practicable when only a few markets are significantly affected by a project. More sophisticated approaches—which attempt to take into account a much wider range of market interactions—have information requirements that are often difficult to meet in practice.

Risk

Private cost benefit analysis takes into account the risk and uncertainties associated with projects. It is often argued that this is less important with social cost-benefit analyses, since the government undertakes a wide array of projects which provides effective pooling of risks. An unexpectedly bad project will likely be compensated for by a surprisingly good one. To the extent that public projects are divisible and separable, there is an element of truth in this argument. However, in reality the public sector invests in some lumpy projects, often with close links between them and with other smaller projects—for example, building a dam to generate electricity may be closely related to the provision of irrigation. Moreover, projects share many of the same risks—for example, an exchange rate depreciation or an increase in world interest rates raises project costs across the board.

Like the private sector, the government should choose an efficient portfolio of projects: that is, one for which the overall return cannot be raised without entailing unacceptably high risk. A number of options are available to aid judgment in this area. **Sensitivity analysis** shows how the NPV of a project changes with the value of a given variable in the analysis. While sensitivity analysis is useful in determining the degree of risk to which a project is exposed, it does not provide a basis for choosing among risky alternatives. **Risk analysis** is a more complicated form of sensitivity analysis, in which variables that are regarded as the principal sources of risk are assigned probability distributions defined over the range of possible outcomes for each. Risk analysis suggests comparing the **expected** NPVs of alternative projects. **Discount rate adjustments** are another popular technique used to deal with the problem of risk. Riskier projects, it is argued, should be discounted at a higher rate. A **risk premium** can be derived using information on the relationship between market rates of return and risk (based upon the capital asset pricing model, for example). However, this assumes a large private investment sector and well-organized capital markets in which risk is constantly being priced. While this is a good assumption for a financially developed economy, it is less applicable for most developing countries.

Distributional implications

Public investment projects often have distributional implications, and an issue arises as to the extent to which these should be reflected in investment decisions. One view is that distributional concerns are most efficiently addressed through taxes and transfers, and that such concerns should not impact upon cost-benefit analysis. However, if the government's ability to redistribute is limited by the range of available instruments or their potentially adverse efficiency consequences, a second-best case can be made for taking the distributional consequences of projects into account—either by explicitly attaching distributional weights to costs and benefits in computing NPV or by making less precise judgements about the impact of projects on inequality—and for deliberately pursuing distributional objectives explicitly through project choice. There are, however, limits to the concessions that can be made in terms of project choice and forgone efficiency to accommodate distributional objectives.

Public Investment Programming

In most developing countries, the aggregate cost of projects having a positive net present value far exceeds resource availability. A choice must therefore be made among alternative projects. The project appraisal techniques described above suggest that projects should be chosen to maximize their combined NPV. However, the size and composition of the public investment program (PIP) must also reflect macroeconomic and institutional constraints. It is the aim of public investment programming to maximize the NPV of the chosen projects subject to resource availability and these additional constraints.

Macroeconomic constraints

A PIP must be consistent with medium-term growth, balance of payments and inflation objectives. The note on *Public Expenditure, Stabilization, and Structural Adjustment* discusses the macroeconomic impact of expenditure in general terms. The principal conclusions are that growth is more a function of the composition of public expenditure than its level—with public investment being one of the main positive influences—and that the implications of public spending for stabilization policy are largely a policy choice, which reflects the stance of fiscal and monetary policies. In the context of a PIP, these general conclusions can be expanded upon.

Growth and stabilization

While most public investment probably makes a positive contribution to growth, some is clearly not very productive; as a consequence, the relationship between public investment and growth is generally much weaker than might be expected. For this reason, a high quality PIP should focus on those projects and sectors where investment is likely to be most productive. Structural adjustment programs often specify priority projects (such as infrastructure) and sectors (like export activities). To emphasize the importance attached to some investments, it is becoming increasingly common to define a **core investment program**. This also serves to protect such investments when public expenditure has to be scaled back as part of an adjustment effort.

Ideally, a PIP should be built up from the bottom, beginning with the most productive projects. However, in practice, an overall investment program tends to be purged of the least productive projects, and interest groups are typically more successful in preventing their pet projects from being excluded from the core than in arguing

for their inclusion. The quality of the PIP suffers as a result. Moreover, to the extent that the core is identified only once a scaling bank of spending has begun, the cutting of both core and noncore projects before prioritization takes on any urgency is clearly harmful.

Project financing can have important balance of payments implications. Where the PIP has large external financing needs, the impact on external debt service costs should be taken into account. The nature of the financing is clearly important; the more concessional the borrowing terms, the less binding will be the foreign exchange constraint. Moreover, to the extent that the PIP is geared toward efficient import substitution and export activities, debt service capacity will be increased. Project financing can also have inflationary consequences if excessive monetary expansion is involved, but again productive investments can ease inflationary pressures as long as private investment has not been crowded out in the process.

Fiscal and monetary policies

While active fiscal and monetary policies can be used to ensure stable growth, a PIP affects the scope for discretionary financial policy to a greater degree than implied by the direct impact of the investment involved. Capital projects usually give rise to additional budgetary costs in the form of operations and maintenance requirements—see the note on *Operations and Maintenance* for details. These requirements have to be taken into account, and it is for this reason that many developing countries formulate a **development budget** that explicitly captures all project costs. Offsetting these additional expenditures, however, there should be revenues generated by new economic activity. In addition to its domestic financing needs, a PIP can affect monetary policy in other ways. For example, projects are often financed by commodity aid, the domestic proceeds from the sale of which are placed in blocked counterpart funds to await donor authorization for their utilization. The resulting monetary contraction and the compensating expansion when these accounts are unblocked can complicate monetary management.

Institutional constraints

The size and structure of a PIP has to reflect the **responsiveness of the private sector**. Overall investment requirements of the economy should be apportioned between the private and the public sector on the basis of the comparative advantage of each and the interrelationships between the two. With a weak private sector, the public sector will inevitably have a larger role. But at the same time, the **administrative capacity of the public sector** may be weak. Projects vary in the amount of administrative resources required for their implementation and monitoring. Complexity of implementation, together with demanding physical and financial monitoring requirements, can represent binding constraints on project choice. **Distributional objectives** that cannot be described in sufficient detail to precisely weight benefits and costs as part of the microeconomic project exercise can instead be characterized more generally in terms of acceptable and unacceptable outcomes. In this regard, a PIP may build in sectoral priorities not only to redress structural bottlenecks within an economy, but also to meet broader distributional objectives (to redistribute from the urban to the agricultural sector, for example).

Practical considerations

Public investment programming is complex, since the three elements of the programming problem—the set of worthwhile investment projects, the macroeconomic and institutional constraints, and the available resources—are interdependent. For example, an initially affordable investment program may promote growth

but threaten macroeconomic stability, in which case financial policies will have to be tightened; this in turn reduces resource availability, so that the investment program is no longer affordable. A less ambitious program may lead to stable growth, but because it elicits a poor private sector response the growth rate will be low and the scope for redistribution limited. A somewhat more ambitious program may adequately meet growth, stabilization, and distributional objectives, but necessary fiscal tightening (say through labor shedding) may undermine the capacity to administer the program. The problem is clearly an iterative one; moreover, it may not converge without conceding some objectives.

The type of public investment programming undertaken by the World Bank in the context of public expenditure reviews attempts to reflect the above linkages. In practice, however, this is often not feasible. Thus examples of best practice include detailed information on the major projects and sectors, an estimate of the resource envelope, an assessment of institutional limitations, and (sometimes) an outline of the macroeconomic framework. However, the macroeconomic framework is rarely specified in great detail, and focuses mainly on the growth-investment-savings linkage as an input into determining the resource envelope. Moreover, there is not much explicit "programming". Rather, country authorities are urged to draw up a PIP specifying core projects, and the Bank then reviews the outcome in light of the above considerations. The emphasis is very much on improving the capacity of countries to undertake such an exercise themselves. It may therefore be some time before public investment programming fully reflects available information and analytical techniques.

Country Illustrations

Capturing ecological and environmental benefits in project analysis in Nigeria

The quality of soil of the arid zones of northern Nigeria has been threatened by the lack of protection against natural forces. Consumption of fuelwood, land clearance, and pressures on the land from farm cattle grazing have resulted in a substantial depletion of the tree stocks that serve as an environmental equilibrating factor. The lack of windbreaks in the region results in multiple environmental problems. Chief among these are (i) loss of topsoil due to wind erosion, (ii) reduced soil moisture and greater surface evaporation, as a result of both the lack of shade increasing wind velocities, (iii) reduced natural soil nutrient recycling, (iv) decline in soil fertility as a result of the diversion of crop residues and animal dung for fuel, (v) greater and more frequent storm damage to crops, especially immediately following seed germination, and (vi) gully erosion. Afforestation efforts would reduce current rates of soil erosion, and hence improve agricultural productivity over the medium term. Shelterbelts, a linear planting of six to eight rows of trees, spaced 200 meters apart, could each protect approximately 40 square kilometers of farmland.

Traditionally, cost-benefit analysis of afforestation projects has concentrated on the direct benefits of the tree products themselves. When this traditional methodology is applied to the arid zones of northern Nigeria, the net present value is negative. Clearly, however, a proper project appraisal should value the indirect and external ecological benefits of such an afforestation project, especially since available evidence indicates that well-designed and properly oriented shelterbelts have significant impacts on crop yields. In addition to the direct benefits of the tree products themselves (including firewood, fruit, and poles), a thorough cost-benefit analysis should value (i) the benefits of preventing further declines in soil fertility and hence agricultural productivity, (ii) the benefits of improving current soil fertility, and (iii) the benefits of an increased availability of fodder. Under highly conservative assumptions about ecological benefits, allowance for the indirect and external benefits

(together with the direct benefits) raises the net present value of such a project substantially. This reflects the fact that shelterbelts, through their effects on agricultural productivity and despite the fact that their impact is felt from seven to ten years after planting, can raise gross farm income by 15 to 25 percent. Even under alternative assumptions, the net present value of the project remains high (Table 1).

Table 1. Nigeria: Net Present Value of Shelterbelts
(In naira per hectare farmed, using a 10 percent discount rate)

	Net Present Value
Wood benefits only	-95
Base case—indirect benefits added	170
Low-yield, high-cost case	110
High-yield case	221

Source: Anderson (1989).

Public investment programming in Madagascar

A three-year public investment program was established in February 1989. The PIP called for a significant real expansion of public investment along with a reorientation of investment toward infrastructure and an improvement in project quality. The financing of the PIP is on highly concessional terms, with about two-thirds financed through foreign aid—of which 40 percent is in grants and 60 percent is concessional loans—while 16 percent is to be domestically financed by the National Economic Development Fund and the remainder by other loan sources. Because of the magnitude of the PIP and the desire to ensure that PIP implementation and allocation proceed according to schedule, the government established a task force to monitor public investment expenditure systematically and regularly. At the same time, in recognition of the potential administrative and implementation difficulties that might be encountered, the government established a trigger mechanism which would allow for a mid- (as well as medium-) term adjustment of public investment expenditures and hence the overall financial operations of the government. Under this mechanism, if public investment was less than FMG 209.0 billion for the first six months of 1989 (compared to an annual investment program of FMG 470.7 billion), or if the sectoral allocations diverged significantly from the planned allocations, the government would reduce its public investment program for the rest of 1989 and for the 1990-92 period accordingly. This mechanism was triggered, and a revised PIP put in place, after six months. While a

core PIP was never a part of the strategy, the downscaling of the original PIP was consistent with such a concept.

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