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Institutional Incentives and Rural Infrastructure Sustainability

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PREFACE

UNDER the terms of reference for the Decentralization: Finance and Management (DFM) Project, one early output of the Project is the preparation of a background or “state of the art” report. The challenge presented to the authors of this report was to answer the question: How can the likelihood of maintaining rural infrastructure be increased in developing countries so that rural infrastructure facilities are sustained over time rather than allowed to deteriorate long before their expected useful lives are completed? This volume represents our effort to meet that challenge.

As envisioned in the original project design, DFM brings three, heretofore poorly integrated branches of literature to bear on the problem of sustaining rural infrastructure: the new institutional economics, public finance economics, and institutional analysis. In this volume we demonstrate how theory derived from these bodies of literature can be woven together to improve our understanding of the difficulties many developed and developing countries experience in sustaining rural infrastructure facilities. Because this integration has not been attempted previously, many of the arguments contained here are unique to this document.

The focus of our discussion is the institutional arrangements (the structures of rules) within which rural infrastructure facilities are financed, designed, constructed, operated, maintained, and used. These arrangements, as they operate with regard to a specific type of facility in a particular physical and social environment, shape the incentives of individuals responsible for sustaining that facility. If the sustainability of infrastructure investments is to increase, institutional changes must be made that substantially alter incentives.

Examples of successfully sustained rural infrastructure cited in this volume indicate that considerable improvement in this difficult area is possible.

Several case studies drawn from the authors’ own experiences, from those of various donor agencies, and from the academic literature are presented to provide both successful and unsuccessful real-world examples of infrastructure sustenance efforts. As the relationship between theoretical concepts and the practical problems of infrastructure sustenance is not always obvious, these case studies serve to illustrate the concepts we discuss.

As decentralization has not been entirely successful as a strategy to alter incentives, we propose an alternative approach to the problem of designing institutional arrangements that are capable of sustaining rural infrastructure. First, we illustrate how the principles of the new institutional economics are related to problems of infrastructure sustenance, presenting the following specific arguments:

- Commonly, a large number of individuals with different personal preferences, interests, and resources participate in infrastructure development decisions.
- It is reasonable to expect that individuals will behave in opportunistic ways so as to further their own self-interests.

- In order to overcome opportunistic behavior, significant transaction costs must be incurred in negotiating, concluding, implementing, and monitoring the numerous agreements that are necessary if infrastructure facilities are to be sustained.
- A blend of both scientific and time and place information is necessary for the successful organization of infrastructure development efforts.
- When information is held in different degrees (asymmetrically) by the actors involved in decision making, additional occasions for opportunistic behavior in the form of adverse selection, moral hazard, shirking, and corruption arise.
- Institutions that can counteract these tendencies to engage in opportunistic behavior are necessary if the incentives that lead to undesirable outcomes are to be overcome. The heavy reliance on kinship networks in developing countries can be explained by the absence of effective counteracting institutions other than the family.

Certain attributes of rural infrastructure facilities themselves can undermine infrastructure development efforts. Two principle features of most rural infrastructure facilities are: (1) they can be used jointly by many individuals simultaneously; and (2) it is difficult to exclude users even if they do not contribute to the development and maintenance of the facilities. These attributes have often meant that these facilities are provided by public enterprises rather than by private enterprises.

It is important to distinguish between the production and provision of public services. Production, which entails the combining of inputs to produce outputs, can be carried out by private enterprises for many public services. Provision activities involve decision making regarding the quantity and quality of services to be provided and about how and for whom these services are to be made available. Often the public sector must be involved in provision because such activities are not profitable if undertaken by entrepreneurs on a private basis.

Public provision of services raises additional problems concerning the measurability of the quality of construction and the flow of services and creates opportunities for rent-seeking¹ activity, often by the most powerful persons in a society. In addition, economies of scale in production have often been cited in support of organizing production through a centralized national governing unit. Numerous small provision units can take advantage of these economies, however, if they are free to contract for production with larger jurisdictions or with specialized private contractors.

The attributes of the services yielded by rural infrastructures in combination with the incentives facing the multiple actors who are involved in the development of these facilities create an especially challenging set of problems. Our analysis systematically reviews five institutional arrangements with

¹ A rent is a return over and above one's opportunity cost. Rent seeking, then, is an effort to capture a profit greater than that which would be generated by competitive market forces. This extraordinary profit is often made possible by acts of government rather than by directing money, time, and other resources to productive activity. The resources expended by rent-seeking firms or individuals are wasted from society's viewpoint because they add nothing to social product. Noncompetitive bidding procedures are an example of rent seeking.

regard to how effectively they can be expected to overcome these problems. The institutions considered are a simple market, a differentiated market, a user group organization, and centralized and decentralized government hierarchies. We conclude from this analysis that:

- No single institutional arrangement is likely to overcome the varied transaction costs that characterize the provision and production of infrastructure facilities. These transaction costs include the costs of coordination, and information search, in addition to the strategic costs associated with shirking, adverse selection, moral hazard, free riding, rent seeking, and corruption.
- When this entire array of transaction costs is considered, one must recognize that tradeoffs are likely under alternative institutional arrangements. That is, a highly centralized arrangement may be able to overcome free riding and take advantage of highly technical information and economies of scale in production, but it may be able to do so only with the loss of time and place information. Furthermore, it can create additional opportunities for shirking, rent seeking, and corruption.
- Efforts to decentralize administration essentially involve changes in the production side of centralized structures. The career track of the personnel involved remains unchanged as does the array of incentives they face.
- In certain instances, user group organizations are able to overcome some of the transaction costs associated with infrastructure development. Where such groups rely solely on their own efforts, however, the costs of obtaining good technical information may be great, and, when such groups do not have the power to sanction rule breakers, free riding and shirking may abound.
- Donor organizations play critical roles in most major infrastructure development efforts in developing countries. Actors within these organizations also face incentives (i.e., rewards for “moving” large amounts of money) that can lead to adverse outcomes.

The design, construction, operation, and maintenance of rural infrastructure facilities and efforts to reduce transaction costs all require resources. Resource mobilization and allocation themselves often constitute a crucial impediment to sustained infrastructure development efforts. With respect to resource mobilization, we conclude the following:

- Desirable resource mobilization instruments must meet a variety of often competing criteria. These include revenue adequacy and growth, equity, efficiency, administrative feasibility, and political feasibility.
- The appropriateness of each of the various general resource mobilization instruments available largely depends on the nature of the service being financed and the objectives sought.
- The nature of the resource mobilization instruments employed also greatly affects the incentives to sustain the infrastructures being financed. For example, in-kind contributions by users may be considerably more effective than monetary contributions at overcoming tendencies of authorities to shirk or steal, because in-kind contributions are more visible; on the other hand, grant financing may create rather weak incentives for officials to invest in maintenance.

- The mere existence of resources is insufficient to ensure that they are used for infrastructure sustenance; the funds must be budgeted for that purpose. However, there are powerful incentives that can work against such budget allocations for maintenance. Institutional arrangements that provide for the creation of special-purpose organizations or the earmarking of funds may help to overcome these tendencies.

The search for ways to overcome the strong and diverse incentives that work against infrastructure sustenance has commonly focused on only two or three of the issues raised in our analysis. In our estimation, this search has been based on a truncated analysis of institutional arrangements that only emphasized the importance of utilizing scientific information, forestalling free riding, and capturing economies of scale. Our approach expands this list to account for additional transaction costs, particularly those associated with aggregating time and place information and reducing shirking, rent seeking, and corruption. In addition, we suggest that polycentric governance arrangements generate incentives that improve the sustainability of rural infrastructure development. Specifically, we argue that:

- Polycentric institutional arrangements generate greater opportunities for competition, which in turn creates incentives that lead to improved outcomes. Although coordination costs can rise under such arrangements, these higher costs must be evaluated with respect to the increased benefits produced. With greater numbers of competing organizations involved, gains can be realized by reducing the costs of opportunism, allowing contracting between a variety of organizations, and by permitting greater use of time and place information.
- In fact, polycentric arrangements are not unheard of in the developing world. Long-lasting indigenous organizations are commonly arranged polycentrically, suggesting that the benefits of such arrangements have been recognized by those most directly affected by the arrangements.
- Under any institutional arrangement, conflicts between the multiple actors are certain to arise. However, the effective operation of polycentric systems requires explicit investment in effective conflict resolution mechanisms because more independent decision-making authorities exist and because of the competitive nature of polycentric arrangements.
- Polycentric arrangements also enhance the likelihood that greater use can be made of the private sector in the production of rural infrastructures. In fact, public-private industry structures constitute a reasonable arrangement that can take advantage of scientific information and economies of scale in addition to constraining the opportunistic actions that impair successful infrastructure development.
- The problems of designing institutions for infrastructure development are entirely too complex to allow any blueprint approach to institutional change to succeed. Instead, the design *principles* must be considered in any design effort.

We conclude our analysis by specifically identifying the principles that should guide the designing of institutions for infrastructure development and maintenance. These principles vary according to what type of facility is involved. For those facilities used by an identifiable, localized group of individuals who obtain highly salient and substantial benefits from the provision of a facility, such as smaller-scale

irrigation systems, we suggest that donors invest in projects *only* when firm evidence exists that the facility's beneficiaries:

- are aware of the potential benefits they will receive;
- recognize that these benefits will not fully materialize unless the facility is maintained;
- have made a firm commitment to maintain the facility over time; and
- do not expect to receive resources for rehabilitating the facility if they fail to maintain it.

This can be accomplished by investing in infrastructure projects in which:

- The direct beneficiaries are willing to invest some of their own resources up front.
- The direct beneficiaries are willing to pay back a substantial portion of the capital costs (at low interest and over a long time, if necessary) and to undertake maintenance.
- The direct beneficiaries are assured that they can:
 1. participate in designing the project;
 2. monitor the quality of the construction work performed;
 3. examine the accounts that form the basis for their financial responsibilities;
 4. protect established rights in land, water, etc.; and
 5. hold contractors accountable for inferior workmanship that is discovered after the system is in operation.
- The granting agency is assured that:
 1. beneficiaries' commitments to repay costs will be enforced by appropriate legal action, if necessary; and
 2. beneficiaries have an effective organization with demonstrated capabilities to mobilize resources, allocate benefits and duties, and resolve local conflicts.
- All donors and the host government are firmly committed to the above principles and will not provide funds to bail out those beneficiaries who fail to meet their responsibilities.

The task of producing and sustaining facilities such as roads, which serve less easily identifiable beneficiaries scattered over a larger spatial area, is much more difficult. Donors should fund projects that meet the following criteria:

- The nature of rural road services, for example, is such that charges directly linking payments with benefits received are likely to be impossible to implement. Instead, broader public resource mobilization instruments are necessary.
- This places greater responsibility on the institutions that are responsible for aggregating preferences. The creation of multiple provision units for different types of roads, e.g., localized units for minor collector roads, larger units for roads connecting market centers, and even larger units for regional highways permits more efficient preference aggregation.

- Decisions regarding infrastructure investment should be contingent on up-front investments by user communities, which are also required to repay at least some portion of the capital costs.
- The requirement to repay loans implies, as well, that the provision units must have some general revenue-raising powers of their own. Revenues can be mobilized locally through local fees and taxes that reflect the benefits received from passable roads, e.g., property-based levies or local marketing fees. Larger jurisdictions may rely on indirect taxes on vehicle inputs, such as petroleum and tires, or on vehicle licenses.
- Where indirect taxes are already being collected by central governments, tax sharing based simply on use-level differences may be most appropriate.
- If revenue sharing or grant/loan funds for the purpose of maintaining roads are to be made available to local jurisdictions, national governments must be able to hold local units accountable for their use of these funds. Likewise, local units must be able to insist that revenues to which they are entitled are transferred to them by national government authorities.
- In addition to the organization of diverse provision units, however, those who are using and paying for infrastructure must have the opportunity to communicate their preferences to provision authorities and to hold these authorities to account for their decisions about infrastructure investment. This requires efforts directed toward creating an open and competitive political process.
- Because road construction and maintenance tasks can, and often do, involve complex contracting relationships between public authorities and between public authorities and private firms, the realization of high quality work depends crucially on the operation of a public judiciary or other conflict resolution mechanism that is independent of administrative authorities.

The principles contained herein and the suggested mode of analysis provide a general analytical approach to the problems involved in successfully developing sustainable rural infrastructure. Although this approach is not proposed as *the* answer to overcoming these problems, we feel that it is more likely to be successful than the cursory quick-fix analyses that commonly characterize efforts at improving this extremely difficult state of affairs.

Introduction

SUSTAINING investments in public infrastructure through proper maintenance and use is a problem facing rural and urban areas in both developing and developed countries. Cities and states within the United States increasingly face depletion of their public capital infrastructures due to insufficient maintenance and delayed repair. Problems are even more pronounced in developing countries where infrastructure maintenance has been foregone in urban and rural areas alike, due to severe resource constraints, numerous competing needs, and inappropriate incentives for those responsible for maintenance. Drainage systems in many large cities of developing countries are not properly maintained, resulting in dramatic floods that destroy considerable amounts of property, and sometimes lives, during the rainy season. In rural areas of the developing world, capital infrastructure deteriorates rapidly as maintenance is foregone or as facilities are misused. The result in each case is a decrease in service flows from infrastructure and, hence, a decrease in the efficiency of capital investment.

Successful infrastructure investments result in a flow of benefits that exceed the costs of constructing, operating, and maintaining facilities and, therefore, create additional income and stimulate production. Improved rural roads lower the costs of transporting agricultural inputs and outputs which, in turn, can raise farmgate prices of agricultural products and stimulate production. Irrigation facilities can increase the productive output of land by increasing crop yields and by making double or even triple cropping feasible.

Improvements to local water supply facilities can lower the costs of obtaining drinking water and can also have important positive effects on health by decreasing the incidence of waterborne diseases.

Beyond these direct impacts of rural infrastructure investments on the incomes of facility users are potential indirect impacts on local employment and incomes. Considerable evidence suggests that significant additional multiplier effects on rural nonfarm employment and income arise due to the linkages between rural farm and nonfarm activities (see Mellor and Johnston, 1984). As farm production and income rise, perhaps in response to improved infrastructure, increased demand is created for locally produced goods, such as farm equipment, and services, such as those provided by transporters and blacksmiths. The production of some of these goods and services is likely to be labor-intensive and, therefore, create additional opportunities for local employment. Furthermore, as emphasized by Mellor (1976), Mellor and Lele (1973), and Hazell and Roell (1983), middle-income farmers also purchase locally produced consumer goods and services, which are also produced with labor-intensive technologies. A recent paper by Haggblade, Hazell, and Brown (1989) cites studies showing that for each additional unit of agricultural income generated, from 0.5 to 0.8 additional units of local nonfarm incomes are produced. One infrastructure-related reason for the smaller multiplier effects in Africa (1.5) than in Asia (1.8) advanced by Haggblade et al. (1989:1185) is the limited possibility for irrigation in Africa, which in turn limits the demand for

locally produced pumps and other irrigation equipment.

Public infrastructure facilities are obviously not the sole cause of increased farm incomes in the rural areas of developing countries, but they constitute an important component of the growth process even in extremely low-income countries.¹ The implication of this is that increasing the long-term productivity of capital infrastructure in rural areas can promote regional economic development and help to create local off-farm employment opportunities.² Increasing the availability of productive rural infrastructures and ensuring that they are sustained is, therefore, a sensible objective.

Despite large potential benefits from public infrastructure facilities and their sustenance, the evidence also shows that in many countries throughout the world today, capital infrastructure investment is not sustained. Instead, capital facilities are built and operated for a relatively short period of time without adequate maintenance. They then deteriorate and fall into disuse. Failure to sustain infrastructure facilities is obviously wasteful in terms of the foregone resources originally invested in the facilities that could have been used for other purposes. We are, of course, not alone in recognizing this. Indeed, considerable attention has already been given to the issue of sustainability particularly by international lending and donor institutions. Because it is a concept we rely upon heavily throughout this volume, it is important to clarify what we mean by *sustainability*.

Various lending and donor institutions define sustainability differently, but they all use the term to evaluate projects that have received external financial support. Hence, the concern of these institutions is whether, once external support has ended, the supported activity continues through to the end of the

expected useful life of the project. For example, a recent review of the United States Agency for International Development's (USAID's) interventions in health programs defines sustainability as "a program's continuing to deliver services or sustain benefits after the donor's technical, managerial, and financial support has ended" (Buzzard, 1987:2). This definition does not consider the size of the benefits relative to the costs of sustaining them, although it might be presumed that if actors were willing to incur the costs necessary to keep benefits flowing, such incremental benefits would exceed the incremental costs. Nevertheless, decision makers who concern themselves only with the continuation of a project are at risk of forgetting that the creation of net positive benefits is the principal objective of any investment in development.

The World Bank avoids this risk by defining sustainability strictly in terms of the outcome of investments. It evaluates sustainability in regard to whether the economic rate of return of a project is at least equal to, if not greater than, the opportunity cost of capital (Cemea, 1987:3). This conceptualization is compatible with the objective of maximizing net social welfare because it requires a project to yield net benefits that exceed the total costs of the undertaking. Total costs include capital as well as operation and maintenance costs. Under this more stringent definition, there may be projects that continue to operate after a donor has left the scene but are not sustainable under this definition because the project has failed to yield benefits in excess of total costs.

We use the World Bank definition of sustainability in this volume because it focuses attention on the principal objective of infrastructure development: the creation of benefits through the utilization of scarce resources.³ This definition has the added

¹ For example, Ahmed and Hossain (1988) found significantly higher levels of local economic activity in Bangladesh communities that had better-developed rural infrastructure facilities than in localities where such facilities were either nonexistent or had deteriorated. Their findings also suggested that the poor shared in these benefits primarily because of the increased demand for labor services.

² This is not only the case in developing countries; for example, Eberts (1989) shows how public infrastructure and economic development are positively related across regions in the United States.

³ The concept of "sustainable development" has also been given considerable attention recently. A much broader concept than infrastructure sustainability, it refers to the quality of present development projects that safeguard the opportunities that future generations will have to continue making productive use of environmental resources (see World Commission on Environment and Development, 1987).

advantage of applying equally well to infrastructure activities that are undertaken without the support of externally supplied funds.

Under this definition of sustainability it is also possible that an infrastructure investment may not be sustainable under one set of circumstances but could be under another set. Consider, for example, the construction of a road embankment x kilometers in length. In the midst of this embankment is an unbridged gap that makes the road impassable during several months of monsoon floods. Such an investment would likely be undertaken only if *ex ante* estimates suggest that the road will yield positive net benefits during nine months of dry-season use. It could easily be the case, however, that *ex post* evaluations show that the road is not maintained simply because nine months of usage is inadequate to yield benefits in excess of the costs of carrying out the required maintenance. However, it is also possible that building a bridge that would allow the road to be used throughout the year would result in benefits that far outweigh the costs of the bridge, thereby achieving the objective of sustainability. In fact, an evaluation of sustainability should ignore the original costs of building the road because, once incurred, they are sunk costs and ought to play no role in subsequent decisions as to whether or not to invest in the bridge. Interestingly, in an instance such as this, it may well be the case that the incremental investment in the bridge, which is sustainable under our definition, can also result in *ex post* evaluations that the entire investment of the road plus the bridge was sustainable.

It is also quite possible that a facility's benefits are considerably larger than the recurrent costs of operating and maintaining it, but the facility is still not maintained. If an appropriate set of institutional arrangements are not in place—including methods of mobilizing resources from beneficiaries—a facility that should generate net benefits is allowed to deteriorate, leading to nonsustainability even though the infrastructure facility is potentially sustainable.

We argue throughout this volume that there are a variety of complex reasons, including inadequate maintenance, for the nonsustainability of many infrastructure undertakings in the developing world. In the next two sections of this chapter, we review the magnitude of maintenance problems in developing

countries today, then proceed to explain how decision making at all stages of infrastructure development—during design, construction, operation, and use—may affect the sustainability of the resulting facilities. We then preview the argument developed in the remainder of this volume by addressing briefly what we see as the principal determinant of nonsustainable infrastructure investments: the inappropriate incentives faced by the actors who participate in the design, construction, operation, maintenance, use, and financing of the facilities. That section is followed by a discussion of the primary evaluative criterion applied in this analysis—that of economic efficiency—and its relationship to such criteria as equity and accountability. We end the chapter with an overview of the chapters to follow.

Financial Aspects of the Capital Sustenance Issue

Investments in infrastructure facilities such as roads and bridges, irrigation systems, and water systems have played a major role in efforts to develop rural areas. A recent review of the World Bank's investments in rural development concluded that "Overall, expenditures on infrastructure account for nearly half the project costs for all RD [rural development] projects" (World Bank, 1988: 18). These investments have necessarily generated substantial operation and maintenance costs that must be met if the infrastructure facilities are to be sustained.

During the late 1970s and early 1980s, development analysts addressing the problem of infrastructure sustenance devoted considerable attention specifically to the problem of finance, a problem that has yet to be resolved. Heller (1974: 251) was one of the first to consider the finance problem. In his analysis of the recurrent cost problem in Kenya, he argues that efforts to undertake large-scale public investment programs in many developing countries have a "myopic quality" due to the assumption that projects will "actually realize their full productivity." He asserts that:

This loss in productivity arises from a neglect of the dynamic fiscal commitments engendered by public investments within the overall budgetary constraints in the public sector. It is perhaps obvious that, in order for any invest-

ment project to be fully productive, there must be future expenditure outlays for operations and maintenance. Yet unlike private investments there is no guarantee that a public sector project's social productivity will be reflected in its operating revenues (ibid).

An important contribution of Heller's work in Kenya and elsewhere has been the estimation of ratios that reflect net recurrent expenditure requirements relative to initial investment expenditures. These so-called "*r*" coefficients, when multiplied by the initial capital investment, estimate the flow of resources that must be forthcoming for an investment to reach its full productivity, i.e., be sustained. Heller (1979), for example, finds that *r* coefficients for feeder roads range from 6 to 14 percent, and those for trunk roads vary from 3 to 7 percent. This implies that for feeder roads, for example, an investment of one million dollars in construction will require an annual investment of \$60,000 to \$140,000 over the life of the roads for the upkeep and repair that will enable users to realize the maximum possible benefits. Ramakrishnan (1985: 118) found that *r* coefficients for water development activities in Kenya ranged from 16 to 44 percent during the period of 1976 to 1983. Thus, construction of new infrastructure facility brings with it continuing resource requirements for operation and maintenance that must somehow be met if infrastructure investments are to be sustained.

Where insufficient resources are available to operate and maintain infrastructure facilities, they deteriorate over time. Because the initial investments are not sustained, the facilities gradually fall into disuse. Summary evaluations by USAID of irrigation and road projects have all reached similar conclusions regarding the significance of inadequate maintenance. In a 1983 comprehensive evaluation of irrigation projects, the authors concluded:

The effective productive life of irrigation infrastructure is limited—often by more than the internal rates of return in project papers might indicate—but the deterioration and ultimate death of such systems can be hastened through poor design, environmental degradation, a lack of operational skills and inadequate preventive maintenance. Thus, gross inefficiencies in the system result, and transfiguration through

rehabilitation is required if production or income targets are to be met (USAID, 1983: 83).

Similarly, the authors of a summary report on eight evaluations of rural roads undertaken during 1979 and 1980 concluded:

Except in a few countries, maintenance of roads has been woefully neglected, as confirmed by six of the eight rural road impact evaluations. The deterioration of a road results in high political, social, economic, and environmental costs and may result in a complete loss of the original investment (Anderson and Vandervoort, 1982: 46).

The problem is, of course, not unique to USAID-funded projects. A recent review of the "road maintenance crisis" by the World Bank concluded that:

More than one-quarter of paved and one-third of the unpaved roads in 85 countries receiving roadway assistance from the World Bank already are in such poor shape as to require partial or complete reconstruction.

Over 40 percent of currently passable paved roads are at the critical stage where strengthening is necessary to prevent structural failure which would necessitate reconstruction.

An additional US\$4-5 billion is estimated to be necessary every year to slow future deterioration in the roads and highways of developing countries (Harral, 1987: 1).

Most sobering is the recognition that a principal cause of today's road maintenance crisis is the failure to maintain these roads in the past. If about \$12 billion had been spent on preventive road maintenance in the 85 countries, the \$40 to \$45 billion costs now required to reconstruct deteriorated roads could have been avoided (Harral, 1987: 1).

Insufficient finances are a major cause of inadequate levels of maintenance, but are by no means the only cause. Sustainment problems are more complex than simply finding the resources needed to cover operation and maintenance costs, as a recent study of the performance of large-scale, government-owned irrigation systems in five Asian countries illustrates. Scholars from the International Irrigation Manage-

ment Institute (IIMI) found that irrigation fees paid by farmers varied substantially from a low in Thailand of \$8.00 per hectare (ha) to a high in Korea of \$192.00 per ha. As shown in Table 1.1, the costs of operations and maintenance (O&M) also varied substantially from a low in the Philippines of \$14.00 per ha to a high in Korea of \$210.00 per ha. Only in the Philippines did the farmers contribute sufficient revenue to cover annual costs of maintaining these large-scale irrigation works.

Table 1.1 Revenue Collected, O&M Costs, and Estimated Benefits

	(1)	(2)	(3)	(4)	(5)
	Revenue from Farmers	Revenue O&M Costs	Revenue as a % of O&M	Benefits as a Percentage of O&M	Capital plus O&M
Indonesia	\$ 26	\$ 33	79%	370-1000 %	32-78%
Korea	192	210	91	278-370	38-71
Nepal	9	16	56	1000	82
Philippines	17	14	121	1428	102
Thailand	8	30	27	322	36

NOTES:

The entries in columns 1 and 2 are in \$US/hectare converted from local prices at official exchange rates in June, 1985.

The entries in column 3 represent column 1 as a percentage of column 2.

The entries in column 4 are estimated benefits of irrigation as a percentage of column 2. These estimates are based on internal prices of rice, which are held far above world prices. If calculated on the basis of world prices, the estimated benefits of irrigation would be a much smaller fraction of cost. (The ranges for Indonesia and Korea are based on low and high estimates for benefits.)

The entries in column 5 are estimated benefits of irrigation as a percentage of estimated capital costs. (The ranges for Indonesia and Korea are based on low and high estimates for benefits and for costs.)

When IIMI scholars examined the estimated benefits to be derived from these projects, they found

that they were disappointingly low, given the capital and recurrent costs associated with the projects. Only in the Philippines is it clear that farmers could actually have afforded to pay for the full capital and operating costs of these projects without being worse off than they were before the projects were constructed.⁴ These findings are unfortunately not at all unusual. Recent studies in Mexico, Bangladesh, and Pakistan have also found that recurrent costs are not met by irrigation fees and that estimated benefits from recently constructed, large-scale irrigation projects are not sufficiently high that farmers could afford to pay for the full costs of these projects from increased income (Repetto, 1986).

Consequently, the problem of sustainability involves issues that transcend the problem of maintenance and may involve problems at any and all stages of the infrastructure development process. We view the development of an infrastructure facility as a process that involves combining inputs (at various stages in the process) to produce desired effects. Rather than concentrating solely on maintenance activities, most of our analysis encompasses five integral stages in this process: design, construction, operation, maintenance, and use.⁵ Finance is important to each of these stages because each requires the utilization of scarce resources.

Phases of Infrastructure Development

Our principal objective in this volume is explaining why it is so difficult to sustain rural infrastructure. We consider maintenance (and its financing) to be a key determinant of sustenance, but maintenance cannot be adequately considered apart from the other activities involved in infrastructure development. The type and level of maintenance required is intimately related to how a project is designed, financed, constructed, operated, and used (see Uphoff, 1986b: 63-70).

The *design* stage of infrastructure development is frequently thought of as occurring prior to construction and as being undertaken by technically trained engineers. This is an accurate image for many new,

⁴ Data, rounded off, are from Small, et al. (1986: 35 and 37), as cited in Repetto (1986: 5 and 8).

⁵ Uphoff (1986b) identified the first four of these stages of infrastructure development. We add "use" to this list because, as will become apparent in the discussion to follow, alternative use modes can significantly affect the speed at which a capital asset deteriorates.

large-scale infrastructure projects, but not all. This image implies that the design of an infrastructure facility is based almost entirely on scientific and technical knowledge. In fact, effective design involves both technical knowledge as well as highly localized information. The importance of technical knowledge to the construction of a facility varies from one project to the next. Localized, or time and place information, however, is always needed to design sustainable infrastructure facilities because it ensures that the facilities will be well-fitted to the problems a specific group of people face at a particular time and place.

Design activities that are based exclusively on statistical summaries available to engineers who live in the capital city and/or who are unwilling to involve local users in the design process will not incorporate sufficient time and place information. Uphoff (1986b: 63) describes three well-documented cases in which farmers in the Philippines, in Nepal, and in Mexico "told engineers who were planning dams across rivers reaching high seasonal crests that the designs being drawn for that location would not stand up." The engineers refused to alter their original designs and in "all three cases, the dams washed out" (see D. Korten, 1980; Shrestha, 1980; Cernea, 1984). Evaluations of projects that provided facilities that have been effectively maintained substantiate the important role the ultimate users played in the design process (see Haratani, et al., 1981; World Bank, 1976).

Finance, like design, is frequently thought of as a one-shot activity. Indeed, some of the problems associated with infrastructure maintenance may stem from the presumption that the only major problem in financing infrastructure is the aggregation of funds to pay for design and construction. This view ignores the problem explored by Heller of obtaining adequate resources to operate and maintain a structure. The question of how to efficiently and equitably mobilize resources — monetary as well as nonmonetary — for infrastructure development is crucial.

Construction may be undertaken by any of a wide variety of public or private enterprises. Construction

activities may require the use of capital-intensive modes of production, such as those involved in the construction of a major road network or a large-scale irrigation project. Many construction activities, however, are not capital intensive and may be undertaken by enterprises that rely on relatively untrained laborers. Many small-scale, rural infrastructure facilities have been constructed by those who will use the facilities, relying on local materials and simple technology. Extensive literature on labor-intensive approaches to road building also exists (International Labor Organization, 1979, 1982; National Research Council, 1981; Beenhakker, 1988).

The design and construction of infrastructure facilities, including the activities involved in financing these phases, can be completed by relatively short-lived "projects." Organizing and financing operation, maintenance, and use, on the other hand, requires a long-term perspective.⁶ Infrastructure facilities vary in terms of how much and what type of labor is required for their *operation*. A rural road, for example, requires little, if any, additional labor to operate. The distribution of water to various subsections of an irrigation system, on the other hand, may require the daily attention of highly trained personnel. A school does not operate at all without teachers.

No infrastructure facility can continue to operate efficiently for its expected life without some level of routine and emergency maintenance. Generally speaking, *maintenance* is any activity that slows the deterioration of a facility, whether that deterioration has been caused by use or aging. Maintenance involves a number of different activities. Most important are routine activities that are performed throughout the life of a facility, and periodic activities that are undertaken at specified intervals. Maintenance, with its emphasis on retarding deterioration, should, therefore, be distinguished from emergency repairs and reconstruction and improvement activities. Repairs are those activities carried out in response to unexpected failures in the structure; reconstruction is designed to return the usefulness of the facility to its original level; and improvements

⁶ A recognition of this marked difference in the time perspectives of design and construction as contrasted to operation, maintenance, and use leads one to question the dominance of "projects" or "schemes" in the budgets of many developing world countries. "Project" budgets are well suited to the initial design and construction phases, but appear ill suited as mechanisms of support for continued operation and maintenance.

increase the quality or quantity of services available from a facility. For some rural infrastructure facilities, such as rural roads, it is not always easy to distinguish these various types of activities.

How much maintenance and what type of maintenance activity is needed depends not only on the infrastructure design and on local factors, such as the weather, but also to a great extent on the level and type of use of the facility. The appropriate maintenance activities for a rural road depend on the number and weight of vehicles using the road as well as on the type of the road and the quality of its construction. The cost of maintaining the walls of irrigation canals is affected by the nature and effectiveness of the rules regulating animal and vehicular traffic across the canals. Because maintenance requirements are determined by all of the other phases of infrastructure development, any effort to analyze failures to maintain a facility must consider the incentives facing participants in the design, construction, operation, and use of a facility, as well as the incentives of those responsible explicitly for maintenance.

Few of the benefits of maintenance activities are immediately or easily noticeable. Both of these characteristics increase the difficulty of designing institutions to induce substantial investments in maintenance. Any capital investment will operate for some period of time without much investment in routine maintenance.⁷ Many investments in routine maintenance primarily affect how a facility will operate at some future date rather than affecting how it operates today or tomorrow.⁸ Filling small cracks in the surface of a road has no immediate impact on the "ride" enjoyed by persons driving across that road; painting the metal gates of an irrigation system does little to improve their performance immediately.

The benefits of such investments are reaped in the future in the form of a reduction in the rate of deterioration that may be difficult to measure. The activities produce no easily identifiable outputs. To perceive a change in a deterioration rate requires considerable time and place information and

knowledge about how fast a facility deteriorates with or without various types of maintenance activities. Individuals, particularly public officials, must be strongly motivated if they are to use scarce resources to invest in efforts to reduce an imperceptible deterioration rate rather than in other activities producing more obvious and immediate returns.

One obvious way to instill motivation for maintaining an infrastructure facility is to hire individuals whose entire income depends upon their ability to keep a system in good repair. This requires, however, that someone else is motivated to provide the funds to employ the caretaker. In addition, one must design institutions that counteract the tendency to shirk on the part of the caretaker. These are not trivial tasks.

Although the task of designing institutions that generate the appropriate incentives for those expected to contribute to or actually undertake the maintenance of a facility is complex, it rests on two simple initial propositions:

1. The individuals who are expected to invest their own resources (including their own time and labor) in the maintenance of a rural infrastructure facility must perceive the benefits they obtain as a result of the resources they devote to maintenance to exceed the costs.
2. The existence of aggregate benefits from maintaining a facility that exceed aggregate costs is not sufficient to ensure adequate levels of maintenance over time.

We will return repeatedly to the challenges of institutional design throughout this volume.

Reasons for Lack of Infrastructure Sustenance

Identifying the reasons for the failure to sustain many capital investments and proposing remedies to reduce the squandering of resources in impoverished settings are difficult tasks. The cause of failure could occur at any or all of the stages of the infrastructure develop-

⁷ As we discuss in Chapter 5, infrastructure facilities vary in regard to how fast they deteriorate without routine maintenance. Some never break down totally and stop operating. They just deteriorate at a faster rate. Others break down often when not maintained and thus provide rapid feedback about their condition.

⁸ We are appreciative of several conversations with Ron Oakerson who has stressed the problems of time-delay and subtleness.

ment process; there is no solitary, easily identifiable cause. One cannot point to poor design, lack of resources, inadequate training, lack of coordination, opportunistic behavior, or overly centralized institutions as the single cause of the problem, even though some of the above are most likely involved whenever a particular infrastructure facility is inadequately maintained or completely abandoned.

On the other hand, we argue that there is one underlying analytic cause for the infrastructure maladies described above. That cause is the set or sets of perverse incentives facing participants in the design, construction, operation, maintenance, and use of infrastructure facilities. Improper incentives associated with the methods used to finance these activities will also contribute to their failure. In other words, when we find major investments in rural infrastructure deteriorating rapidly or abandoned a few years after construction due to an underinvestment in maintenance, we presume that some of the actors involved in the process of development (including maintenance) faced a set of incentives that rewarded them (or did not sanction them) for actions that yielded an unsustainable investment.

The design and funding of an infrastructure project involves human actors. These same persons or others undertake construction. Still others are involved in the day-to-day decisions about whether and how to operate, maintain, and use a particular facility. When facilities are located in blatantly inappropriate locations or when the resources required to build and/or maintain them exceed the resources available, the consequences are the result of human choice.

Rather than presume that the individuals involved intended to produce an infrastructure facility that was not sustainable, we prefer to assume that the individuals involved were rational decision makers trying to generate net benefits in a given situation. However, individual decision makers in charge of infrastructure development, maintenance, and use often face considerable uncertainty and some are opportunistic. These individuals may make decisions regarding infrastructure development that either purposely or inadvertently harm some members of a community, or that leave other members considerably better off. In other circumstances, individuals may be confident that a particular decision or action will

produce personal benefits for themselves, and may act on this basis; these actions can instead produce unintended or even harmful consequences for these individuals. When incentives are better matched to the situation, individuals make decisions that produce outcomes that are both personally and socially rewarding. In such cases, the advantage that one individual derives also produces benefits for others. In an optimal institutional arrangement, the incentives that an individual faces motivate the individual to generate net benefits rather than net costs for all. However, few operational institutions approach such optimality, and many generate incentives that lead to outcomes that are grossly suboptimal.

Nothing about the process of designing, financing, constructing, operating, maintaining, and using infrastructure facilities makes it impossible for humans to create systems of incentives that lead to relatively efficient and equitable outcomes. Many facilities have proved valuable enough to some communities that they regularly invest resources to sustain their continued operation. Farmers in Nepal, for example, invest substantial quantities of labor every year in maintaining irrigation canals constructed centuries ago (see Pradhan, 1983; Martin and Yoder, 1983).

Although not impossible, designing incentive systems that motivate individuals to develop and maintain rural infrastructure facilities in a manner that produces net benefits is more difficult than designing structures within which many other goods and services can be efficiently produced. The additional difficulty derives from the special characteristics of public facilities. This analysis carefully considers these characteristics and identifies those principles whose application to institutional reform might improve the incentives to produce sustainable infrastructure.

Underlying Objectives

As we stressed earlier, identifying means of maintaining existing infrastructure facilities is not the principal objective of this analysis. Some facilities are simply inappropriate for the situations for which they were built and should not be sustained. Instead, the primary objective of this analysis is to clarify the institutional design prerequisites for maintaining facilities whose operation is, or promises to be, economically efficient;

that is, the benefits to society exceed the costs of operating and maintaining them. When the resources necessary to operate and maintain a facility exceed the benefits to be gained from such activity, society would be better off allowing that structure to deteriorate.

Economic efficiency, however, is not always the sole concern of efforts to sustain capital infrastructure. Equitable treatment of all persons within society often is of equal concern. Policies that redistribute resources to the poorer segments of society are of considerable importance in developing countries where distributions of wealth are highly skewed. Thus, while efficiency would dictate that scarce resources be used where they produce the greatest net benefit, equity goals may temper this objective, resulting in the development of facilities that benefit particularly needy groups.

Although we do not dispute the crucial importance of redistribution in some contexts, the primary focus here is on an efficient allocation of resources. This does not necessarily conflict with distributional goals. Infrastructure investments may be targeted toward particular segments of society, such as the poorest of the poor. These facilities should still be operated so as to maximize their outputs, such that the target groups can derive the largest benefits possible from the investment. Although any ultimate decision regarding tradeoffs between equity and efficiency must be made by developing world policymakers, maximizing returns from targeted investments is still preferable to a total lack of concern for the efficiency of investments of scarce resources.

Finally, we recognize that officials must be accountable to citizens concerning a facility's use. This may be especially true in the case of donor-financed facilities where effective resource utilization (meaning reasonably efficient use of resources in line with equity goals) is of great concern to those underwriting the project. Such an objective does not need to conflict greatly with efficiency and equity goals because, as we will argue in subsequent chapters, efficiency commonly requires that information about the preferences of citizens be available to decision makers, as does accountability. Institutional arrangements that aggregate this information will also assist in the realization of efficiency at the same time they serve to

increase accountability and to promote the achievement of redistributive objectives.

Overview of the Approach

With these objectives in mind, we begin our discussion with a set of examples intended to illustrate the complexities of the issues underlying infrastructure sustenance. Chapter 2 begins with a very simple example of capital investment by a single owner-user. Even in this simple case, the issues concerning maintenance are not trivial. This is followed by examples drawn directly from experiences in developing countries. Because we do not wish to convey the idea that infrastructure facilities in developing countries are never sustained, the cases include both instances of obvious failures as well as examples of where conditions have led those involved in the development and use of infrastructure to maintain their investments. By examining successes, we identify certain principles that explain these successful infrastructure investments and might be usefully employed in other settings.

The cases discussed in Chapter 2 lead us to argue that the many scholars who have advocated greater decentralization of development efforts have, perhaps, had good reasons for their policy prescriptions. The third chapter, therefore, considers first the diverse meanings that have been attributed to the term "decentralization" and then discusses several cases in the Philippines in which efforts to decentralize have had mixed results.

The difficulty of sustaining improvements in the performance of those involved in infrastructure development experienced by many decentralization programs points to the insufficiencies of the theories informing the design of these programs. In this volume, we develop a theory of human behavior within institutions that better explains the failure to sustain infrastructure and suggests policy reforms. To do this, we build on a rapidly expanding literature commonly referred to as "the new institutional economics." Within this literature, theoretical work on transaction costs and collective action is particularly relevant to the problem of infrastructure sustenance.

In Chapter 4, we apply transaction cost analysis to a situation in which multiple actors must make complex decisions about infrastructure development. Rural infrastructure facilities are frequently open to use by many individuals whose preferences, stakes, and use-patterns vary dramatically. These individuals may differentially obtain the benefits and pay the costs of rural infrastructure development. Further complicating the issue, many of the infrastructure investments of interest here are made by public officials acting as agents for a poorly specified public. This often means an even less direct link between the ultimate beneficiaries of maintenance efforts and those individuals who are responsible for undertaking such efforts.

Because many actors and considerable sums of money are involved in infrastructure development, there is a need for complex contracts among these actors. The persons involved in contracting require considerable information both prior to the signing of a contract and during its implementation. As Chapter 4 emphasizes, the difficulties involved in obtaining, processing, and controlling such information impose costs and provide opportunities for strategic behavior that may produce unintended results. The design of institutions that can counteract these incentives is essential.

The characteristics of rural infrastructure facilities that require collective action on the part of prospective users adds another source of complexity beyond that explored in Chapter 5. The problems of contracting among multiple actors attempting to limit the costs of opportunism have been analyzed principally in relation to private goods (see Williamson, 1979; 1985). We will consider these same problems in relation to such public facilities as rural roads, irrigation systems, and village water supply systems. Keeping nonpayers from enjoying the services provided by rural infrastructure is often difficult or inappropriate. In such cases, public provision for development activities is necessary. Public provision, however, poses several difficulties. For one, it creates opportunities for rent-seeking behavior. Furthermore, public authorities may not know whether maintaining a facility is worthwhile because of the difficulties of measuring the benefits generated by a facility within the technological constraints faced in most developing

countries. Determining just which public authority should develop and maintain a facility may also be difficult to determine. Substantial economies of scale can sometimes be gained from constructing large infrastructure facilities that, once built, provide services that are most effectively operated and maintained by smaller communities of users.

Decisions about rural infrastructure development usually involve long-term commitments; hence, time is an important factor in all such decisions. When investment decisions are made in a static environment, it is possible to project future flows of benefits and costs and calculate them in terms of present value. Uncertainty about the future will necessarily produce some specific investments that will over- or underestimate benefits and/or costs when these are actualized. Thus, some projects will be constructed that generate lower net benefits than presumed, and some projects that would have produced net benefits will not be undertaken. Some degree of error is unavoidable. The likelihood of errors in projecting benefits and costs is further increased by the fact that infrastructure investments are undertaken in a constantly changing environment.

Many rural infrastructure investments are intended to stimulate economic growth. Economic growth itself can produce changes in the patterns of demands for and uses of rural infrastructure (whether or not the growth itself was the result of past infrastructure investments). Thus, the structure of the situation itself may evolve over time. An infrastructure investment that makes economic sense at one juncture may not be economically viable at another. Predicting an evolving structure of demands is a risky enterprise. While we do not argue that all infrastructure investments that are later abandoned are the result of erroneous calculations at an earlier juncture, we do recognize that making fixed commitments in an evolving economy may constrain capabilities for corrective adaptations in the future.

Thus, while much of what follows concerns rural infrastructure sustenance, we stress that sustenance simply for the sake of sustenance is not an appropriate objective; maintaining past investments is justified only if the benefits of doing so exceed the costs, regardless of the amount of resources previously in-

vested. The long-term nature of infrastructure investments, often with slow rates of deterioration, and the problems this creates are also discussed in Chapter 5.

Given that the processes of infrastructure development and maintenance involve diverse individuals, all with their own preferences and perceptions of benefits and costs relating to complex goods in uncertain and, at times, evolving environments, it is little wonder that infrastructure sustenance has proven to be so difficult throughout the world. The design of institutional arrangements to change the structure of incentives facing individuals making decisions about infrastructure is obviously a crucial place to intervene in a policy process. Redesigning existing institutional arrangements to enhance their performance is a challenge.

Institutional arrangements can be roughly defined as the set of working rules used in any process to determine who is involved, what actions are available to participants, the kind of information available, how decisions will be made, and how benefits and costs are distributed. Much current institutional analysis relies on crude categories that identify institutional arrangements as either public or private, i.e., part of the state or the market. This leads to simple diagnoses of “market failure” and the need for “government intervention,” or of “state failure” and the need for “privatization.” As we explain in Chapter 6, the institutional arrangements involved in infrastructure development frequently defy any attempt to classify them as either public or private sector institutions. Many institutional failures do occur, but they are not simply the result of market or state failures.

While there are arguments in favor of highly centralized provision and/or production of certain services, such arguments are often supported by analysis that is truncated—based on only a partial consideration of the costs and benefits of such arrangements. Specifically, in Chapter 6 we suggest that policy reforms that focus on only the issues of free riding, economies of scale, and technical expertise can produce counterproductive consequences in regard to sustaining rural infrastructure facilities. Such truncated analyses omit consideration of rent-seeking behavior, shirking, and availability of local time and place information, which is necessary in the design of all infrastructure projects. We then use the inter-

mediate performance criteria that are implied by this broader conceptualization of the sustainability problem to evaluate alternative institutional arrangements for the provision and production of infrastructure. We conclude that no institutional arrangement will perform better than all others in regard to all performance criteria; tradeoffs are always necessary. Although no perfect institutions exist, it is possible to alter the rules-in-use in particular institutional settings and thereby improve the behavioral incentives that these rules create for all of the actors involved, including external donors.

Regardless of the degree of centralization of decision-making powers affecting infrastructure development and maintenance, there is always a need for mechanisms with which to mobilize the resources necessary to carry out these activities. Chapter 7 is devoted to a discussion of infrastructure finance issues. As suggested by Heller (1974), when infrastructure facilities are financed from a public fisc, the principal challenges are transforming the benefits generated from the facility into resources available for operating and maintaining the facility and then subsequently ensuring that the resources mobilized are actually used for their intended purposes.

A variety of finance instruments exist, but they vary in their effects on economic behavior, their treatment of persons in different circumstances, and their costs of administration. Those instruments that most closely link the resources mobilized and the benefits derived create the strongest incentives for compliance, while preserving an equitable outcome.

Given the numerous unintended and/or undesirable consequences of overly centralized institutional arrangements, decentralization provides a logical alternative arrangement. But, as we argue in Chapter 8, just as some previous analyses have oversimplified the choice between state versus market arrangements, the assumption that the only choice is between “centralization” and “decentralization” is also a gross oversimplification. We argue instead that a much more reasonable, albeit complex, approach to institutional arrangements is through noncentral or polycentric arrangements. The problems of rural infrastructure sustenance, including maintenance and control over use-patterns, are simply too complex for a simple arrangement to suffice. Instead, multiple,

nested institutions are needed. These complex institutional arrangements must be created if the constraints to achieving superior, if not optimal, levels of maintenance are to be overcome; and alternative arrangements must be analyzed if policy changes designed to relax some of these constraints are to be implemented.

Performance depends, however, on the quality of the match that is achieved between institutional arrangements and the attributes of the goods and services being produced in a particular social and physical environment. Therefore, the most important policy implication of our entire analysis is that the complexity of the rural infrastructure sustenance issue precludes any simple blueprint solution. Instead, analysis of the particular situation with a variety of interrelated institutional arrangements, with an imperative that the analysis recognize the incentives each arrangement provides, is much more likely to lead to improved institutional reform proposals.

The final chapter recaps the overall development of the arguments made in the volume, and suggests types of strategies that national governments and donor agencies might adopt to enhance the likelihood that infrastructure facilities, once constructed, will be maintained. While we feel strongly that the development of polycentric governance systems is a particularly desirable long-term goal, there are other interim strategies that can and should be pursued.

Infrastructure Sustenance and Maintenance Efforts

AS DISCUSSED in Chapter 1, decisions about the design, construction, operation, maintenance, and use of rural infrastructure in developing countries and about how to finance the different phases of infrastructure development all affect whether infrastructure investments are sustained over time. Thus, we view the problem of infrastructure sustenance as more complex than simply providing for adequate resources to meet recurrent cost needs and ensuring that maintenance is carried out. In some cases, maintenance is *the* primary problem to be solved. In other instances, direct maintenance is indeed a problem but it is also a symptom of deeper problems associated with other phases of infrastructure development. In this chapter, we examine how maintenance decisions are affected by the way design, construction, operation, use, and financing decisions are made.

To achieve sustainable infrastructure investments requires that the current, discounted value of future flows of benefits resulting from infrastructure investments exceed the value of past capital investments (including the cost of capital) plus the current, discounted value of future costs of operating and maintaining these investments. Maintenance activities are almost always required if capital infrastructure facilities are to yield services over an extended period of time. And, unless services are produced over an extended period of time, it is unlikely that initial investments will generate sufficient benefits to outweigh the costs of design and construction. Thus,

maintenance is nearly always a necessary condition for sustenance even though it is not by itself a sufficient condition.

The activities involved in maintenance are usually not very complex. The decision processes involved in determining an appropriate level and type of maintenance program, however, involve many complex considerations even when only a single, owner-user is involved in making these decisions. We begin our discussion of the complexity of decision making about long-term investments with the presentation of the case of a single, owner-user deciding about maintaining a private, capital investment. Using this simple model of private investments in maintenance activities, we can identify the variables that are likely to influence decisions about how much and what type of maintenance activity should be undertaken in more complex decision-making environments.

Once we have developed this simple model, we present several empirical cases to provide an experience-based context for our subsequent discussions of the principles we feel are keys for enhancing the sustenance of rural infrastructure. The first set of cases documents several instances of failure in the sustenance of a rural infrastructure facility. The second set suggests that, although problems are obviously associated with all maintenance efforts, sufficient maintenance has been forthcoming in some settings to sustain rural facilities. We close the chapter with some potential lessons to be learned from these empirical cases.

Factors Influencing the Maintenance Decisions of a Single Owner-User of Private Capital

To understand better why the inadequate maintenance of rural infrastructure is a common problem in developing countries, it is useful to begin with a simple model of capital maintenance that pinpoints the economic variables that enter into maintenance decisions.¹ An owner of capital, i.e., any durable or long-lasting input that yields services over a period of time, recognizes that the quantity and quality of services it delivers deteriorate over time due to the twin forces of aging and use. The rate of deterioration can, however, be slowed through maintenance. Because maintenance can increase the productivity of capital and/or prolong its useful life, maintenance itself is an investment. The basic economic model of investment suggests that maintenance will be undertaken only if it yields a rate of return greater than alternative uses of the resources so invested.

Several factors are likely to influence a decision to invest in maintenance. One is the expected benefits from maintenance activities. These could take the form of either additional benefits during each year of the life of the capital facility or an extension of its useful life. A second factor is the cost of maintenance. Higher maintenance costs are less likely to yield positive returns and, hence, should lead to lower maintenance efforts. If the capital facility is capable of yielding a positive return even without maintenance, maximization of returns will mean that the facility will be replaced when its useful life is ended. Because maintenance can extend this useful life, the costs of replacing the facility will also enter into the maintenance decision; higher replacement costs will, *ceteris paribus*, make maintenance a more attractive alternative. Finally, because these costs and benefits all occur over time and affect the future, the rate at which the future is discounted will also influence the maintenance decision. A high discount rate means that costs (and benefits) to be incurred in the future receive little weight in the decision; hence, if the rate of discount is sufficiently great, a decision maker may

forego maintenance (and the costs it requires) today even though it may mean that the capital must be replaced sooner in the future.

The discussion thus far has implied that maintenance is a simple binary yes/no choice. In actuality, for many capital facilities different types and levels of maintenance are possible. A complete model of maintenance must consider alternative maintenance regimes and the costs and benefits of each. Routine and emergency maintenance programs involve different sets of activities. Routine maintenance activities are supposed to be undertaken on a regular basis and, if undertaken properly, may allow the capital owner to reduce the need to carry out emergency maintenance, which is undertaken only when the flow of services from the capital structure is threatened or impaired. Again, the choice between routine and emergency maintenance is expected to depend on the perceived relative benefits of the two sets of activities and their relative costs and availability. In addition, however, the two types of maintenance and the demand for each may depend on the perception of risk by the capital owner. If routine maintenance is expected to lower the likelihood of a breakdown and the need for emergency maintenance, a capital owner who finds an emergency shutdown to be very costly is more likely to engage in routine maintenance than is an owner who would not be adversely affected by emergency shutdowns.

To this point, the discussion has assumed that decisions about investing in maintenance are made independently of the initial decision about investing in the capital facility. For existing facilities, the original capital cost as well as the cost of past maintenance are irrelevant to decisions about how the facility should be maintained now and in the future. In some cases, however, the maintenance decision is an integral part of the initial capital investment decision. Different types of capital that produce the same output may require different types and levels of maintenance. In this case, the initial planning decision concerning which type of capital yields the greatest return will depend on the expected flow of net

¹ The discussion here is intended to be nontechnical in order to provide the flavor of decision making about maintenance. For a more complex modeling of optimal maintenance policies under a variety of conditions in the private sector, see Jorgenson, McCall, and Radner (1967).

benefits from the maintained facility. Hence, one individual may opt for a capital investment that has low initial costs but is expected to require considerable upkeep (purchasing a ten-year-old truck, for example), whereas another may choose a more costly initial investment that may require less maintenance effort (such as purchasing a new truck). In a similar vein, the anticipated use of a capital investment may influence the initial choice. Some activities can use up capital more rapidly than others and, therefore, may require a higher level of maintenance effort if the useful life of the investment is to remain unaltered.

To illustrate these concepts, consider the hypothetical case of an owner-user of a truck. With "normal" maintenance the vehicle may be expected to travel 150,000 miles during its useful life. With more than "normal" maintenance, perhaps this mileage can be increased to 200,000 miles of travel whereas with less than "normal" maintenance, the truck may produce only 100,000 miles. Maintenance is not, of course, the only determinant of the useful life of a vehicle. The way the truck is driven can also affect its longevity or the cost of its operation. Furthermore, it could be the case that even without use, the metal in the truck will deteriorate in 20 years if not provided with maintenance in the form of protection from the weather.

It is expected that, other things being the same, higher replacement costs, lower maintenance costs, and less discounting of the future would each lead to higher levels of investment in maintenance. Furthermore, a trucker who fears being stranded late at night with a faulty transmission may be more likely to engage in routine preventive maintenance of the vehicle than an owner would who does not fear such an eventuality. Of course, as with most economic models, this assumes that the trucker is cognizant of the costs and benefits of maintenance activities and that the necessary inputs are available at some price.

As he or she shops for a new truck, a buyer is also likely to take into account the uses to which it will be put and the levels of maintenance these uses might require. Hence, the potential buyer of a truck who expects to travel mainly on super highways or city streets may opt for a different vehicle than he or she would if the vehicle will be used on unimproved tracks in open pit mines. The dust the vehicle would be

exposed to in a mine would require either considerably more maintenance or an engine designed to be used in such an environment. As most vehicle owners also recognize, the point will ultimately be reached where additional maintenance yields such small incremental benefits that it must be deemed uneconomical. Replacement of the vehicle remains the only viable alternative.

To summarize the "model" to this point, the level of maintenance undertaken by any single-owner of private capital is likely to be affected by a variety of factors. Although each decision maker may weigh these factors differently, in general one would expect that:

- Greater expected benefits from maintenance should *increase* maintenance.
- Higher capital replacement costs, including cost of credit, should *increase* maintenance.
- Greater risk aversion should *increase* maintenance.
- Greater availability of related inputs to maintain and use capital effectively should *increase* maintenance.
- Higher costs of maintenance should *decrease* maintenance.
- Higher discount rates should *decrease* maintenance.

Furthermore, the choice of the type of investment will also depend on the anticipated use of the capital and the maintenance requirements that such uses entail (together with the factors included in the list above). Also, after some point, no maintenance, routine or emergency, may be deemed economical in light of these factors.

An additional factor that complicates decision making about maintaining private capital investments is the fact that the purchaser of a private capital facility—such as a truck—does not know the full performance characteristics of the investment at the time of purchase. When purchasing a ten-year-old truck, for example, the level of future maintenance that may be needed is heavily dependant upon how the previous owner operated and maintained the truck.

When the investment decision was made, the new owner may have calculated estimated benefits and costs assuming one level of maintenance. Upon discovery that the "used truck" breaks down more frequently and requires more routine maintenance than predicted, the new owner faces some tough decisions. The new owner may decide that the truck is a "lemon" and not worth further investment. Operating it without maintenance until it stops or selling it to someone else may be better options than continued repair and maintenance.

One important lesson to be learned from this discussion of the maintenance decision process in the simplest case of a single-owner, privately owned capital good is that each of these variables may be perceived differently by decision makers, thereby leading to different levels of maintenance in different circumstances. A second important lesson is that even the simple case is extremely complex. This is because maintenance is not a one-time-only act but is, instead, a process. Maintenance decisions made at one point affect the need for subsequent maintenance and can alter the useful life of the investment. Hence, an "optimizing" model of maintenance is necessarily complicated even when only a single decision maker is involved.²

Although the same factors are called into play in any environment, the determination of optimal maintenance is more complex in public sector cases. In part, this is because the services provided by most rural infrastructure facilities are *jointly* used by more than a single person. For example, a rural road will be used by many people, each of whom may have quite different road use needs; in the case of an irrigation system, one farmer's use of water means that less is available for others. Secondly, multiple decision makers, many of whom are employed in the public sector, are generally involved rather than a single owner-user. Decision makers may perceive the costs and benefits of maintenance decisions differently and may also discount the future differently. Moreover, a

direct link among those making maintenance decisions, those benefiting from these decisions, and those bearing the costs of maintenance rarely exists in the public sector. Finally, in the resource-poor environment of most developing countries, the availability of funds may result in a level of maintenance considerably below that which an engineer might deem optimal.³

Still, investments in maintenance are not determined solely by economic wealth. Casual observation, particularly of privately owned capital in many developing countries, suggests that owners (no matter how poor) realize the benefits of maintenance of such varied capital as draft animals, rickshaws, and houses. Considerable efforts are made to keep these capital stocks operating and yielding benefits. At the same time, little doubt exists that a public sector capital maintenance "problem" faces many developing countries, as demonstrated in Chapter 1.

Examples of Maintenance Problems

Unfortunately, it is not difficult to find examples of failure to maintain infrastructure facilities in developing countries. Here we briefly review three documented instances in which inadequate maintenance has been clearly identified as one of the major problems associated with nonsustainable infrastructure investment. Although two of these cases involve multiple, joint users of capital services, the first example concerns a case much closer to the simple truck example presented above.

Maintenance of Road Maintenance Equipment

Although maintenance activities can be highly labor intensive, nearly all require complementary capital inputs as well. Even cleaning an irrigation canal, for example, is likely to require tools to extract the silty soil from the ditch. Various techniques are available for the maintenance of unpaved roads. Grading to smooth the road surface to facilitate traffic flow and

² Housing is a good example of a long-lasting private asset whose service levels and useful life can be significantly affected by maintenance. For an example of a mathematically complex optimal-control model of the maintenance of housing, see Dildine and Massey (1974).

³ Indeed, even in the United States, empirical work by Bumgarner, Martinez-Vazquez, and Sjoquist (1989) has suggested that those cities deemed to be "fiscally stressed" undertake less maintenance than fiscally healthy cities.

to foster rainwater runoff is one important maintenance activity. In some locations grading can be effectively undertaken using labor intensive techniques and, given the relative prices of labor and equipment inputs, may be economically efficient. In other cases, mechanical grading may be the only feasible method for removing corrugations in the road surface and for establishing the correct surface camber. Whenever capital equipment is required for such activity, arrangements for the maintenance of this equipment must also be made to ensure that it remains in good running order, available for use as needed.

The result of inadequately maintaining road maintenance equipment is, of course, that eventually the equipment becomes unavailable for use in maintaining roads. Considerable evidence exists that ensuring the proper maintenance of equipment such as a truck is a much more difficult task when the truck is a public property than when it has a private owner. For example, Jones and Robinson (1986: 1) report that in 1981 "availability rates [vehicles available for use as a ratio of the total fleet of vehicles owned] on the regrading projects in Western and Nyanza Provinces [Kenya] were found to average 39 percent for thirteen motor graders, eight of which were less than two years old. In the following year, the average had dropped to 31 percent." In other words, around one in three of the vehicles owned by the project were actually in use at any one time. A similar study in Ghana revealed availability ratios of only 10 percent.

Indifference to the need for maintenance does not, however, adequately explain the low availability of maintenance in every situation. Shortages of hard currency or import policies may limit the supply of spare parts or the complexity of the equipment may limit the supply of available trained labor to repair the equipment.⁴ Evidence exists, however, that even simple, low-cost maintenance procedures are frequently not undertaken. A recent review of the maintenance of road maintenance equipment associated with an USAID-sponsored project in Bangladesh, for example, revealed that equipment became inoperable

due to the lack of simple routine maintenance procedures. The review determined that road equipment availability rates were less than 20 percent (Decentralization: Finance and Management Project, 1989a: 30).

Thus, although much of this volume is devoted to failures to maintain jointly used capital infrastructure, the evidence suggests that even where capital services are not jointly used, lack of equipment maintenance can undermine efforts to improve maintenance activities. As will be elaborated upon in the following chapters, we attribute much of this failure to the nature of the incentives faced by those responsible for maintenance.

Rural Roads in Jamaica

It is not difficult to find examples of failures to maintain rural roads in spite of the evidence that considerable payoffs could be realized from such activity in many developing countries.⁵ In their overview of evaluations of eight USAID-sponsored road projects, Anderson and Vandervoort (1982: 10) state that "In five cases (Colombia, Liberia, Jamaica, the Philippines, and Honduras II), maintenance of project roads was neglected." Here we recapitulate one of those experiences, that of Jamaica.

The Jamaica Feeder Roads project was undertaken in order to improve feeder roads in rural Jamaica. The evaluation report (Berg, et al., 1980) on the project makes it clear that, because the project was based on unrealistic goals and assumptions, it ultimately produced relatively little in the way of lasting positive economic impact in spite of the US\$10 million contributed to the effort by USAID. Project funds were used to improve a total of 181 miles of roads located throughout the entire island of Jamaica except in Kingston Parish. USAID's contribution to the project also financed the purchase of 73 pieces of road building equipment as well as the "institutional development" of the Ministry of Works, which was the implementing agency.

⁴ Jones and Robinson note that simpler, albeit less effective, tractor-drawn graders showed significantly higher availability ratios, 72 percent, in four different Kenyan districts.

⁵ For recent reviews of the road maintenance issues in developing countries, see Herral and Faiz (1988), Robinson (1988), and Schroeder (1989).

Unlike many rural road projects that have as their primary goals enhanced economic development and income gains through increased agricultural production and marketing, the goal of this project was even loftier—urban peace. Apparently, it was hoped that by providing greater employment opportunities and by increasing agricultural productivity in the rural areas, fewer people would migrate to the urban areas of Jamaica where high unemployment, particularly among adolescents, was increasing the potential for considerable violence.

The project originally called for the production of low-technology road improvements consisting primarily of gravel surfaces, except in instances where the road gradient was so steep that gravel surfaces would be washed away by heavy rainfall. In these cases, a double bituminous surface treatment was to be used. These design standards were subsequently replaced by a new one that required that roads everywhere on the island be upgraded sufficiently to handle an average daily traffic (ADT) level of 100 vehicles. These new standards called for a double bituminous surface on the main travelway and a single bituminous surface on the shoulders. The higher standards significantly decreased the number of miles of road that could be improved given the size of the project—from 325 miles originally planned to only 181 miles completed. Additionally, the higher standards meant that considerably fewer unskilled jobs were created directly through the project than had been planned (1,262 person years actual compared with 5,250 planned) (ibid., 5).

Even more problematic for its long-term economic development effects, however, was that the *ex post* analysis revealed that few of the roads carried sufficient traffic to justify the level of new investments that were made. Average daily traffic on the busiest roads was estimated to be only about 25 vehicles per day (ibid., D-1). As the evaluators note, "While some roads appear marginally worthwhile (if the economy had grown), many do not. They are high-cost improvements with low traffic use" (ibid., D-1 - D-2).

Despite the low volume of traffic on the new high-quality surfaces, the evaluators found considerable road surface deterioration. Nearly one-half of the 84 miles inspected were found to require either a large

amount of pothole repair or major reconstruction and/or resurfacing (ibid., H-3). This was attributed to two factors. One was that some of the roads had been poorly designed. Inadequate drainage due to insufficient ditch depth and too few culvert cross-drains was seen as a major cause of the deterioration of road surfaces. A second finding of the evaluation team was that little or no maintenance had been carried out on the roads. (Of course, in light of the minimal traffic and potentially small benefits of such maintenance, perhaps the lack of maintenance efforts was a rational decision.) The implication here is that infrastructure design and maintenance efforts are both related to the sustenance of rural infrastructure.

In nearly all respects, the Jamaica Feeder Roads project can be viewed as a failure. This experience, however, yielded several important, albeit costly, lessons that are relevant to the discussion in the following chapters. One important project-implementation decision was the choice of a centralized agency, the Ministry of Works, to carry out the project. The evaluators note that, although this choice probably expedited the rate of progress on the project, it ignored the fact that the Ministry had experience primarily on major primary and national roads and "had little experience in and sympathy for low technology roads" (ibid., 2). The bulk of the rural roads in the country were managed by local parish councils. Total reliance upon a centralized agency probably contributed to the decision to build higher-standard, more capital-intensive roads. It may also explain the use of a single standard for all project roads. As the engineering analysis suggests, the choice of higher-standard roads was probably economical in mountainous areas (if adequately drained), but "the bituminous surface is an extravagant expenditure in the rolling to flat terrain of less intense rainfall" that characterized other portions of the island where project work was carried out (ibid., H-11).

The choice of project roads (consisting of 68 road segments, averaging less than three miles in length) was also quite centralized. Project roads were scattered throughout much of the island, perhaps reflecting a greater concern on the part of political leaders for spreading the improvements spatially than a concern for locating them in those areas where they might have had the greatest potential economic impact. Although local government bodies recommended roads

for improvement, members of a special task force consisting of employees of the Ministries of Finance, Agriculture, Local Government, and Works made the final choices.

Finally, although road maintenance was not a principle component of the project, the evaluation clearly indicates that none occurred. The evaluation does not, however, address the question of why maintenance was not undertaken. Maintenance efforts (or the lack thereof) are considered in the evaluation report under the heading "Institutional Analysis." The discussion there, however, focuses principally on the formal project loan agreement that specified only that the Government of Jamaica provide "a final plan for maintenance of all roads to be constructed or improved under the project" (*ibid.*, G-1) and ways to meet the costs of such maintenance. No attention is given to what incentives any of the multiple actors in the project or the users of the road might have had in undertaking maintenance.

Mahaweli Development Program in Sri Lanka

Transport costs are a relatively small part of the overall costs of agricultural production, which may help to explain why difficulties are encountered so often in maintaining roads. In the case of irrigation, however, the availability or absence of water to irrigate crops frequently means the difference between the success or failure of a farm family's crops. Those crops usually form an important part of the family's total income. In spite of the significance of keeping irrigation systems operating effectively through systematic maintenance, however, many irrigation systems are poorly maintained and, as a result, performance deteriorates rapidly after capital investments in construction or rehabilitation have been undertaken. On some systems, reservoirs and canals silt up rapidly,

weeds are allowed to clog the distribution works, malfunctioning control gates are destroyed rather than repaired, and canal walls are breached illegally in order to obtain water. What starts out as an engineering marvel may become a hydrologic disaster within a few years.

An extreme example of an unsustainable project illustrating many problems associated with irrigation development—including lack of maintenance—is the Mahaweli Development Program in Sri Lanka. This scheme has inspired the praise of its supporters and the scorn and despair of many critics.⁶ The Mahaweli Development Program was first conceived during the early 1960s as a way of harnessing the irrigation and energy potential of the Mahaweli Ganga that flows for 200 miles from the mountainous part of south-central Sri Lanka through the Dry Zone to the Bay of Bengal. The initial plan envisioned a 30-year construction period beginning in 1970 during which 15 new reservoirs, 11 power stations, and large numbers of canals to divert the flow of the Mahaweli Ganga into the seven rivers flowing through relatively undeveloped portions of the Dry Zone would be built. A total of 900,000 acres of land were to be irrigated (of which, more than 650,000 acres were then undeveloped), and 200,000 settlers were to be given land in the area (Jayawardene, 1986: 79). The 30-year scheme was projected to cost 6 billion Sri Lankan rupees (Rs.) (about US\$1 billion in 1970) (Ascher and Healy, forthcoming: 6-5).

Initial feasibility studies conducted by the United Nations Development Program (UNDP) and the Food and Agricultural Organization (FAO) paid scant attention to how water would get to the farmer or how the system would be maintained.

It was assumed by the planners that the farmers in each turnout would, on their own, organize them-

⁶ For accounts by supporters, see the recent history by de Silva (1987). For those by critics, see Chapter 6 in Ascher and Healy (forthcoming); Chambers (1975); Siriwardhana (1981).

selves for the equitable distribution of the water allocated to them. They also assumed that the farmers would maintain their field channels and irrigation structures on their own (Jayawardene, 1986: 79).⁷

The projected benefits of this project were based on an overly optimistic estimate of the amount of water that could be stored and released (around 6 million acre-feet per year) and of the discipline that would be exercised by Irrigation Department officials and by farmers in scheduling and using water. Newly settled farmers were expected to ration 8.3 feet of water over the major and minor growing seasons to produce two crops of paddy rice (Harriss, 1984: 319). With substantial investments in organization and monitoring, farmers in some Asian irrigation projects are able to use as little water as this to grow paddy rice. The average use of water in most parts of the Dry Zone of Sri Lanka at that time, however, was about 12 to 15 feet of water applied to the land over both seasons. Later estimates almost halved the amount of water potentially available from the completed works (Iriyagolle, 1978: 34-44, cited in Ascher & Healy, forthcoming: 6-17), and experience confirmed that much more water was applied by farmers than projected. Consequently, the projected area to be irrigated was scaled down by one-third in the early 1980s.

The World Bank and the Sri Lankan government funded the initial construction of two dams and power houses begun in March 1970. By 1977, 130,000 acres of irrigated land were opened, and a major resettlement project was initiated. Soon after, the Government of Sri Lanka announced the "Accelerated Mahaweli Scheme" and created a new Ministry of Mahaweli Development to compress the remainder of

the scheme into a five-year program at an estimated cost of Rs. 8 billion.

By 1978, estimates of the costs of the irrigation and settlement aspects of the project were Rs. 30 billion (about US\$1.9 billion). Using this estimate, the investment per family receiving 2.5 acres of land was "Rs. 75,000—over US\$4,800 in 1978 dollars—in a country with a *per capita* income of roughly \$250" (Ascher and Healy, forthcoming: 6-20). For this investment to yield a positive return, the farmers would have to be among the most skillful in the world producing highly valued crops on excellent land. Instead, the settlers were untrained, did not cooperate with one another to get field channels constructed or maintained, and frequently did not harvest a sufficient yield for their own subsistence, let alone contribute to the alleviation of the food deficit in Sri Lanka. In the early 1980s, Area H of Mahaweli was beset with the highest levels of chronic malnutrition in all of Sri Lanka (Siriwardhana, 1981: 55). Many farmers subsisted on food stamps issued by the Government of Sri Lanka or rations provided by the World Food Program (Hesselberg, 1986).

A large portion of the costs of the Mahaweli Scheme was contributed by donors,⁸ but a major portion of Sri Lanka's own capital has gone into the project as well. In 1982, for example, the Mahaweli Scheme absorbed 40 percent of the country's total capital budget (Ascher & Healy, forthcoming: 6-8). Tragically, alternative irrigation projects that might have yielded higher levels of return for much smaller investments were neglected.

There were, for instance, approximately 10,000 small tanks that only needed minor reconstruc-

⁷ Robert Chambers (1975: v) was also critical of the same study. As he stated:

"The UNDP/FAO Final Report on Mahaweli Ganga is remarkable for the attention paid to other agricultural inputs and their management to the neglect of water. The papers of the 1973 FAO/Sri Lanka Seminar on water management at the farm level have begun to open up the subject, and consequently to expose the gaps in knowledge and concern around the crucial organizational and operational aspects of water management. The general neglect of these aspects is partly explained by the common preoccupation with new capital works, partly by cramped vision from within the disciplinary boundaries, and partly by the awkward nature of water itself compared with land."

⁸ The World Bank has resisted contributing very much to the funding of this project after its initial involvement. Bilateral aid agreements, on the other hand, have been extremely generous. Ascher and Healy (forthcoming: 6-13-14) calculate that over Rs. 7.6 billion (approximately \$365 million in 1982 US currency) were provided in the form of grants or import support by Britain, Canada, Sweden, West Germany, Japan, Kuwait, and the European Economic Community, for which no repayment was required.

tion or renovation to be functional. It is estimated that 251,000 acres of land could have been made productive if 7,406 tanks were repaired and maintained. These smaller tank projects would have had much lower unit costs (Rs. 7,000 - 10,000/acre) than those of the Mahaweli (25,000-30,000/acre), a much lower import content (15 percent) than that of the Mahaweli (40 percent), and much greater labor intensity. Yet, the government did not focus on these projects because they were not as glamorous or politically advantageous. Moreover, these minor tank projects, if they had been taken up full-swing, would have undermined Sri Lanka's bait for getting on the lending agenda of the bilateral lending countries (Ascher & Healy, forthcoming: 6- 20-21.)

This strategy diverted huge amounts of resources from more promising projects desperately in need of maintenance for use on a project that has produced few benefits and little maintenance activity.

An evaluation of the control structures and maintenance levels on Mahaweli System H by an agricultural engineer serving as a USAID consultant to the Sri Lankan Irrigation Department provides a clear picture of the maintenance problems that existed less than five years after the completion of construction (Corey, 1986). Among his observations were the following:

- Many of the original farm outlets were placed at too low an elevation to permit irrigation of the land that was intended to receive water from these outlets. Farmers use this situation as an excuse to bypass authorized outlets with unauthorized outlets of their own.
- Maintenance of structures, as well as ditches and access roads, is virtually always poor. Leakage around drop structures started by burrowing animals, for example, is often not corrected before serious erosion and sometimes collapse of the structure has taken place. Erosion downstream of drop structures is often found, a situation that probably could have been prevented by riprap deposited at such points. Brush is often found growing in

ditches and access roads are often impassable.

- Authorities stated that it is impossible to get farmers to clear the ditches more than once a season at the start of irrigation, and then only if the farmers feel that the brush will seriously reduce their water supply (Corey, 1986: 158-159).

The Mahaweli system dramatically illustrates problems that occur in many large-scale, donor-funded irrigation projects in developing countries. The lack of maintenance on these projects does not simply stem from an inadequate level of budgetary support for maintenance activities. The poor maintenance levels result from how the projects were funded, how they were designed, how they were constructed, how they are operated, and how they are used. Separating the maintenance problem from the entire process of infrastructure development leads to a presumption that placing more requirements on host governments to cover recurrent costs will solve it. Placing the maintenance problem in the context of how these projects are financed, designed, constructed, operated, and used and the incentives that financiers, designers, builders, operators, and farmers face allows us to analyze what turns out to be a very complex problem in a manner that leads to improved policy recommendations.

Examples of Overcoming Maintenance Problems

In spite of the many examples of failures to sustain rural infrastructure in developing countries due to lack of maintenance, it should not be concluded that maintenance is never implemented in developing world settings. As suggested above, private owners of capital in these settings invest heavily in keeping their equipment in operating condition. Furthermore, there are cases in which jointly used infrastructure investments have been successfully sustained. Here we review four such examples that will be used as empirical examples in theoretical discussions in later chapters and as an empirical basis for our efforts to generalize about the conditions under which infrastructure facilities can be sustained.

Rural Roads in Bangladesh

Among the factors commonly cited as providing significant constraints to the maintenance of roads are technical difficulties, financial limitations, and institutional shortcomings (Harral and Faiz, 1988). The latter two are the principal foci of this volume; nevertheless, in some locations technical considerations significantly constrain road maintenance. Bangladesh provides a good example of a set of conditions that make low-cost road maintenance perhaps as difficult as any place on earth. The delta topography with its silty, clay soils and the almost total absence of any road-building aggregates mean that, without expensive heavy equipment to build highly compacted roads, the roads are particularly vulnerable to rapid deterioration due to water that infiltrates the road bed. One method of decreasing the likelihood of such infiltration is to ensure that water is not allowed to stand on the road surface or beside road embankments. This can be accomplished through routine maintenance activities that include filling depressions before they become major potholes and clearing culverts and bridges of materials that impede the flow of water past the road. But accomplishing such efforts requires the willingness and ability of those involved in road maintenance activities to perform these tasks.

A recent assessment of the rural road sector in Bangladesh concluded that in many sites, those responsible for such efforts, generally local governments, were not adequately carrying out these tasks (Decentralization: Finance and Management Project, 1989b). A variety of reasons were found, including insufficient resources, sets of incentives that did not encourage maintenance of roads, and road construction techniques that sometimes produced roads that were not maintainable. There were, however, some notable cases that demonstrate that technical problems can be overcome and that sufficient resources can be made available where the incentives to do so are sufficiently strong to encourage such efforts.

One such example was observed in the case of rural roads serving sugar mills. Sugar cane, once cut, rapidly deteriorates in quality; hence, it is crucial that the cut cane be moved quickly from the fields to the mill. Cane is a bulky, heavy product that is generally transported by bullock carts. Both the mills and the

growers are eager to keep the roads passable to these carts. In order to provide the resources for the development and maintenance of roads serving such mills, a small sugar cess is imposed by the mill on all cane brought to the mill. In addition, a portion of the sale price of the sugar is earmarked for road development. These resources together with the strong incentives to provide adequate transport of the cane to the mill has meant that sugar mill managers were "able to provide fairly good maintenance for the [road] infrastructure of significance to the intake of cane" (*ibid.*, A-97).

Similar incentives and arrangements characterize roads serving the tea estates, which are clustered together in northeastern Bangladesh. Again, it is economically advantageous for tea producers to transport their inputs and outputs over the public roads that in some cases serve only their estates. To facilitate this effort, a cess is imposed on marketed tea whose proceeds are used to help develop and maintain the roads serving the producers. Estate owners also reported supplementing these funds with their own to carry out some road work, e.g., filling potholes, in order to reduce the damage done to their transport vehicles (*ibid.*, A-76).

Whereas both sugar mill and tea estate road work is formally supported through marketing cesses, the assessment also found instances in which the economic benefits of road repairs to a small group of important users were sufficiently great to encourage them to undertake some maintenance on their own. Local private owners of buses realized their own personal livelihoods were dependent on the passability of a road. Therefore, the bus owners' association contributed the funds necessary to perform road repairs required to make an important local road useable again (*ibid.*, A-7).

The common attribute of these three cases is that, where the economic incentives are sufficiently strong, relatively small groups of users are capable of ensuring that road maintenance is performed, even in an environment as hostile to successful road development as Bangladesh. Such a finding is therefore in keeping with the underlying logic of the simple model presented at the beginning of this chapter, despite the public nature of the infrastructure facilities.

Bridges in Nepal

Well-placed, well-maintained bridges can substantially reduce transportation costs in the hill areas of Nepal. Pradhan (1980) provides an example of successful bridge-building efforts in these areas that relied heavily on resources and indigenous knowledge supplied by local users of the bridges. Of particular importance to our discussion is the role carefully considered incentives played in successful local resource mobilization. These incentives included local cultural traditions that have provided an environment conducive to development and maintenance efforts with minimal assistance from formal local governments (*panchayats*).

In 1958, His Majesty's Government of Nepal (HMG) initiated a suspension bridge-building program in order to spur rural development. Due to substantial technical and financial constraints associated with the construction of these types of bridges, however, the program proceeded very slowly. At this point, a local political representative realized that a simpler construction technology for suspended (rather than suspension) bridges was widely available at the local level in mountainous parts of the country. Suspended bridges had been constructed over short spans for centuries. Because this was a widely understood technology, the limited technical staff at the district level would not be needed to oversee construction.

The basic idea of the suspended bridge project that was eventually adopted was for the national government to provide specialized materials necessary for bridge construction that were not available locally—primarily steel cable and the iron for the fittings used to anchor the cables. These materials rather than monetary grants were made directly available to committees formed in the localities. This technique was adopted in an effort to reduce the amount of financial oversight of the project that was necessary and thereby reduce the fears of local villagers that local government officials were profiting illegally from the undertaking. This, it was hoped, would increase the willingness of villagers to participate in the project. Such participation was crucial to the success of the effort because all other locally available nonlabor and all necessary labor resources were to be provided by the areas being served by the bridges. Minor annual

maintenance was to be the responsibility of the localities; however, the cost of maintenance inputs required by such bridges would be minimal. Labor was the principal local resource contributed to the project. Considerable effort was required to carry the heavy coils of cable from the nearest road to the construction site, stones had to be collected to serve as anchors for the cables, and excavation was necessary for the anchors. In this instance, the cultural traditions of the communities involved also help to explain the overall success of the effort. Pradhan (1980: 32) notes that:

Contributions of voluntary labor have also been a part of the culturally recognized system of *Parma* (a household labor exchange system on a reciprocal basis). *Parma* takes place mostly during the planting and harvesting seasons and during the construction of individual houses in a village. So, the sharing of labor is a part of the culture in this region.

Such a system helps to ensure a reasonably equitable sharing of the burden of constructing infrastructure facilities. Furthermore, other households that were not able or willing to participate directly in the effort were asked to contribute food or money to those who did contribute. Additional cash contributions were also mobilized locally, primarily to pay local skilled workers—masons, carpenters, and blacksmiths—for their efforts.

The methods employed for local resource mobilization were successful because they took the incentives of all participants into account. Pradhan (1980: 36) reports that a total of 62 bridge projects were ultimately undertaken in the two phases of the bridge building program in Banglung District, with direct costs to HMG of only about US\$50,000. The amounts mobilized locally were substantially greater. These public infrastructure facilities provided net benefits to the entire community, and, apparently, nearly everyone participated in the efforts on a reasonably equitable basis. The project was not carried out in the spirit of "the government" providing the facility; instead, community participation was emphasized. And, given the economic circumstances in the locality, the bulk of the resources mobilized were in the form of nonmonetary inputs rather than in the form of cash, which would have been considerably

more difficult to mobilize and to safeguard from misappropriation. Finally, because the decisions concerning the location of the bridges were made locally, because the villagers themselves had participated in their construction, and because the consequences of not replacing worn rope and rotten planks on the bridges are potentially catastrophic, it is not surprising that the bridges continue to be maintained even though no formal provision for the maintenance of the bridges was made.

Malawi Village Water Supply Systems

Helping to improve supplies of potable water in developing countries has been a high priority of donors for the past two decades. Clean drinking water substantially lowers the high social costs associated with waterborne sicknesses (see Msukwa, 1981; Saunders and Warford, 1976; Schiller and Droste, 1982). Meeting the costs of piped water systems is, however, often difficult in many developing countries where naturally occurring water sources have been used freely for centuries. Because of the beneficial health effects of piped water, discouraging members of a community from consuming clean water by charging for it defeats the purpose of reducing communicable diseases. Even where central governments and donors finance water system development, local communities of users can only rarely sustain these systems over time. A review of these experiences places the blame for the failure of water supply systems in developing countries squarely on the lack of relatively simple preventative maintenance efforts (USAID, 1982).

In light of these problems, the successful completion over the past 20 years of 47 gravity-fed village water supply systems in Malawi is noteworthy. These systems are now famous for the soundness of the relatively simple technology used and for the sustained commitment of significant amounts of community labor for construction and maintenance (Bheenick, et al., 1989; Chauhan, et al., 1983; Glennie, 1983; Liebenow, 1981). This success can be explained, in part, by institutional arrangements for construction and maintenance that have accomplished at least two important objectives. They have been able to combine good time and place information about each construction site and modern engineering expertise in a productive manner and have also succeeded

in representing the different communities of interest associated with a network-type infrastructure facility. The potentially serious problem of financing the portion of maintenance costs (44 percent) paid by the central government, however, remains unresolved (Warner, et al., 1986: 43).

The villages served by these systems consist of clusters of homesteads that surround one of the many low, uninhabited mountains scattered throughout the country. The water for these simple, gravity-fed water supply schemes is diverted from unpolluted rivers originating at high elevations. The system consists of an uptake pipe, storage tanks, and a network of pipes and valves. Each system takes advantage of economies of scale by serving several villages and a large number of users. The Mulanji West water supply project, for example, contains 143 miles of pipeline that feeds 460 taps designed to serve 75,000 users in 120 villages (see Glennie, 1983).

As in the case of the Nepal bridges, the specialized construction materials (largely PVC and asbestos cement pipe) were supplied by external sources, in this case from the Ministry of Works and Supplies (MOWS), which was supported financially by a variety of public and private donors. In addition, because the technology being utilized was entirely new to the villagers, these agencies also financed the salaries of ministry personnel who supervised construction and maintenance. Supported by donors, MOWS funded a Project Manager for each project who supervised the many Project Assistants, who in turn supervised the community work teams. Village residents of the project area supplied the remainder of the inputs, principally the labor needed to dig and refill trenches, excavate tank sites, carry pipe from deposit sites, and plant grass over the pipeline.

The support of village leaders was crucial to the success of the projects. These persons formed a project committee, which oversaw the entire project. In addition, separate smaller committees were formed for each section, branch, and tap in each project. Project Assistants worked with the committees at these various levels to organize and monitor the relevant work teams. After construction was completed, project committees and tap committees were assigned responsibility for maintenance and repair of the system.

The array of committees established was well fitted to the task of ensuring that all who stood to benefit from a section of the facility contributed to its construction. All villages contributed to construction of the intake as well as the deeper and wider trenches needed for the large asbestos cement pipes that carried the water from the intake to the point where the water was diverted into branches. Branch committees coordinated work on the branches of the system that fed water into individual villages. The village committees then supervised the laying of pipe to individual tapstands and the construction of the surrounding tapstand aprons and soakways. These efforts to forestall free riding by a village or a person were important means of maintaining the motivation of the people doing the very hard physical work involved. Furthermore, by having participated to some extent in constructing all portions of the system that served their own village, all users could better appreciate the "network" character of the water system. They learned why failures at distant higher levels of the system were as detrimental to individual users as were failures at the individual tap they used.

Although all Project Assistants were given extensive technical training and most came from the areas in which they worked, they did not hold positions of any particular power or prestige among the villagers with whom they worked. In order to gain the full cooperation of the village work teams, each Project Assistant was teamed with a member of a local committee to supervise each day's work. Committee members were responsible to the team members who had elected them, and the Project Assistants were responsible to the Project Manager and the ministry for the technical quality of the work.

Responsibility for the maintenance of the water systems, once constructed, is currently shared between the ministry's Rural Water Section and system users. The local construction committee structure is reduced to the main water committee and tap committees for the purposes of overseeing maintenance. The main project committee supervises repair teams, tap committees, and intake caretakers, raises small sums of money for a given repair and to pay the caretaker, and reports any repair work that cannot be handled by the local repair teams to the staff of the Rural Water Section. Committee members contribute about one day per month to complete their duties. This commit-

tee also coordinates with a supervisor for the Monitoring Assistants (many of whom were formerly Project Assistants) who supervise and assist the repair teams. Each tap committee is responsible for the maintenance of a single tap. Members clean the tap site and soakway pit, raise funds to replace a worn out tap or repair a concrete apron, and report any problems to the repair teams. They contribute about one-half day's effort per month to these tasks. Repair teams consist of one person appointed by the village headman from each village served by a single branch line. These teams are responsible for routine maintenance tasks, such as repairing pipes and aprons and replacing taps. Teams receive some training in pipe repair from the ministry's Department of Water Supply and are assisted by the Monitoring Assistants when necessary. Team members contribute an average of about one day's work per month to these activities. The salaries of the supervisors and Monitoring Assistants are met by the department.

The final project evaluation report submitted to USAID found that the reliability of the water systems is generally very high (90 percent), indicating that the effectiveness of the repair teams is also high (Warner, et al., 1986: 69-71). Repair teams can generally replace broken pipes within two days. Although user communities contribute considerable labor to maintenance as well as assuming the cost of broken taps and the wages of an intake caretaker, as of 1986 the government was assuming about 90 percent of the cost of maintaining these systems. In the 1984-85 fiscal year, the Water Department introduced for the first time a budget line for the recurrent costs of maintaining both rural and urban water systems. The government now faces the task of raising revenues to meet a higher proportion of maintenance costs as donors withdraw funding. One proposal is that the government consider allowing metered private connections in villages (ibid., 44-46). This would, of course, introduce the problem of collecting water rates.

In these water supply projects, ordinary villages have demonstrated both a capacity and a willingness to provide an important part of the skills and resources required for construction and maintenance. The willingness reflects, in part, a growing recognition by the villagers of the benefits of piped water. It is also a response to the well-designed institutional arrangements used in construction and maintenance. These

have been quite successful in bringing together local knowledge of terrain and water use patterns and modern engineering expertise that has kept costs relatively low and produced appropriate infrastructures for specific environments. The institutional arrangements have also created several overlapping jurisdictional committees for construction and maintenance, in keeping with the network structure of the water supply scheme. This structure reflects that, while much of the damage to the system by users occurs at the tap end, no single subcomponent of the system can survive without efforts being made to maintain the higher portions of the system.

Zanjera Irrigation Systems In the Philippines

The *zanjera* irrigation systems in the northern tip of Luzon Island in the Philippines share some similarities with the Malawi village water supply systems described above. These systems draw heavily on locally evolved, indigenous institutions that are multi-layered in their designs. A key characteristic of *zanjera* systems is the central role given to small-scale irrigator communities who determine their own rules, choose their own officials, monitor the contributions of labor and materials by members, and construct and maintain their own diversion works and canals. The internal organization of each *zanjera* has been tailored to fit its own history and, thus, the specific rules in use vary substantially. In 1979, there were 686 communal irrigation societies in Ilocos Norte (Siy, 1982: 25).⁹ *Zanjas* range in size from a few hectares to more than 1,000 hectares (Coward, 1980: 206).

Many of these *zanjas* were formed by landless families who acquired well-specified use rights to farm land by entering into a *biang ti daga*, or a "sharing of the land" contract. Although each *zanjera* has its own rules, all the *zanjas* established using a *biang ti daga* contract were organized in accordance

with one set of general principles. Under this contract, a landowner retains ownership of the land and agrees to allow *zanjera* members to settle and farm his land so long as they construct and maintain an irrigation system for themselves and for the landowner. At the time of forming an association, each original participant in the *zanjera* is issued one membership share or *atar*. The total number of *atars* is set at this point.¹⁰

A share entitles the holder to one vote and the right to farm a proportionate share of the land acquired by the *zanjera*. It also obliges the holder to provide specific labor and material contributions to the irrigation system. Each *atar* holder must contribute one day's work during each work season declared by the *zanjera* plus a share of the materials required for construction. The system was thus developed as a mode of acquiring long-term, use-rights to land and the water to irrigate it without the prior accumulation of monetary assets. The basic institutional structure incorporates many features that help to explain why so many of these systems have been sustained over long periods of time.

Each *zanjera* is laid out differently, but under the *biang ti daga* contract, all share a similar underlying pattern. A land area is divided into three or more large sections—one near the head of the irrigation system, one near the tail of the system, and one in the middle. Each farmer is assigned a plot in each section. All members are thus in a fundamentally symmetrical position in relationship to one another: not only do they own rights to farm an equal amount of land but they all farm some land in the most advantageous location near the head of the irrigation system and some near the tail. In years when rainfall is not sufficient to irrigate all of the fields, sharing the scarcity equitably can be accomplished simply by closing off the channels that irrigate the bottom section of land.

⁹ Until 1923, when the first government-financed irrigation project was constructed, communal irrigation societies were the only form of irrigation management in the Philippines. In 1982, there were approximately 5,700 community irrigation systems serving approximately 45 percent of the irrigated area (World Bank, 1982: 8). For an interesting account of the early efforts to stimulate Irrigation Service Associations in the Philippines, see Bromley, et al. (1980).

¹⁰ Additional *atars* may be issued if a new irrigation canal is added to an old system by new members who can acquire a share by constructing the new works and then bearing their share of maintenance for the entire system.

Several parcels are set aside for communal purposes. A few parcels, located at the tail end of the system, are assigned to officials of the association as a payment for their services. Not only does this provide a positive reward for services rendered, it also enhances the incentives of those in leadership positions to try to get water to the tail end of the system. Other lands are retained to secure income for the *zanjera* itself. (See Coward 1979 for a detailed description of the *biang ti daga* contract.)

The members of each *zanjera* elect a maestro as their executive officer and other officials. In larger associations, they also select foremen and team leaders to supervise the construction activities.¹¹ The maestro faces the challenge of motivating individuals to contribute high levels of physically exhausting labor for routine maintenance and emergency repairs of control structures that have been washed out. Given the backbreaking effort required during the monsoon season and in extremely hot weather, this motivational task is of gargantuan proportions. The maestro is, of course, not simply dependent on his persuasive powers. Many inducements and sanctions are built into these systems by the rules that *zanjera* members have constructed for themselves. To illustrate how these systems work, we will describe one of them—actually a federation of nine *zanjeras*—in more detail, based on the work of Robert Siy (1982).

The Bacarra-Vintar Federation of *Zanjeras* constructs and maintains a 100-meter-long brush dam that spans the Bacarra-Vintar River approximately 500 kilometers north of Manila. The unpredictable and destructive Bacarra-Vintar River drains the north-eastern parts of the provinces. During the heavy rains each year, the river destroys the Federation dam constructed of bamboo poles, banana leaves, sand, and rock. In some years, the dam is destroyed three or four times during the course of the year.¹²

Several of the component systems in the Federation have been in operation for more than a century. In 1978, the Federation formally incorporated as a private corporation in response to the 1976 Philippine Water Code that authorized only individuals or “juridical persons” to apply for water rights. Given the history of litigation in the area (see M. Cruz, 1987), members of the Federation wanted secure water rights in the name of the Federation itself rather than in the name of individual *zanjeras*. The heads of all the component *zanjeras* form the Board of Directors. The maestro of *zanjera* Surgui—one of the founding *zanjeras*—always serves as the President and Chairman of the Board. In 1980, 431 individuals owned shares, or parts of shares, in at least one component *zanjera*. The smallest component *zanjera* had 20 members; the largest had 73 members (Siy, 1982: 85). Each *zanjera* is responsible for its own financial and internal affairs and owes no monetary (as distinct from material resource) obligations to the Federation.

The Board determines when the dam should be rebuilt or repaired. Rebuilding takes about a week—somewhat longer when the weather is unfavorable—and requires several hundred persons. Each *zanjera* is responsible for supplying construction materials as well as providing work teams (and the cooks and food to feed them). After spending a day preparing banana and bamboo mats, work teams on heavy boats begin pounding in the poles that form the foundation for the dam as the river swirls around them. Then the mats are woven around the poles and reinforced with sand and rock.

Each of the five *zanjeras* with the largest number of *atars* is considered one work team. The four smaller associations form two work teams. As the dam is laid out, its span is divided into seven sections that are roughly proportional to the size of the work teams and the difficulty of the terrain. This method

¹¹ Coward (1980: 207) indicates that in the larger *zanjeras* the land area is divided into “mini-units” or *sitios* of about 15-70 hectares. A unit leader (*panglakayen*) and assistant (the *segundo*) are selected by the members and are “responsible for the distribution and allocation of water and the settlement of disputes and enforcement of rules within their mini-unit” (Coward, 1980: 207).

¹² In 1926, the administrative predecessor of the National Irrigation Administration (NIA) attempted to build a permanent concrete dam on the Vintar River for the nearby Laoag-Vintar irrigation system, but it collapsed before it could be put to use. The NIA has since used a rubble masonry dam to divert water for that system that also is frequently destroyed by flood (see Ongkingco, 1973: 376).

of assigning work allows each team to monitor the progress of the others and engenders some spirited competition among teams. The work of maintaining the main canal is assigned in a similar manner. Work on distributary canals is organized by each *zanjera*, which divides itself into smaller work teams called *gunglos*, composed of from five to ten members.

Siy computed the total obligations (including work as well as attendance at meetings and celebrations) owed by *zanjera* members to their own association and to the Federation for 1980. The owner of a full *atar* share of the Santo Rosario *zanjera* was obligated to contribute 86 days during 1980 (the largest obligation); an owner of a full share in the Nibinib *zanjera* was obligated to contribute 32 days (the smallest). The average obligation across the Federation was 53 days (Siy, 1982: 92). Given that some *atars* are held jointly by several farmers, the average number of days per working member is somewhat less—around 39 days for the year.

In terms of the contemporary five-day-per-week schedule, this amounts to two months of work contributed without direct monetary payment. About 16,000 man-days were contributed by *zanjera* members to their own or federation projects during the year.¹³

Given the difficult, and at times dangerous, nature of the work, the level of attendance at the obligatory work sessions is amazing. On the average, members were absent somewhat more than two days out of the required 39, making the attendance rate about 94 percent. Fines assessed for nonattendance were fully paid in five of the *zanjeras*. A persistent reluctance to pay fines was found in only one *zanjera* (Siy, 1982: 98).¹⁴

As a device for mobilizing resources—a public finance mechanism—the *atar* system is amazingly simple and adaptable. It is easy for farmers with little education to understand and administer. Furthermore, it can easily be adapted to changing needs for input resources. If a flash flood damages the dam or canals, they can be repaired without extensive haggling over who will pay and how to accomplish the tasks. All *atar* owners know that they will be called upon (in proportion to their share ownership) to work for whatever length of time is needed to get the system repaired and back in operation. As Siy concludes:

Under such a system, the organization retains the flexibility and readiness to respond to conditions which are beyond its control: it can react promptly to situations that require immediate action without necessarily requiring members to contribute disproportionate or inequitable amounts of resources (1982: 59).

The *zanjera* system is one in which the users design, construct, operate, and maintain their own physical works, as well as mobilizing the needed resources for all of these activities. They devise their own rules to govern and manage the system. Even though extremely simple technology is used in an unpredictable and destructive environment, the irrigation systems have been sustained for long periods of time. In addition to the continued operation of these systems, another indicator of success is the ease with which any *atar* owner wishing to sell his rights can do so rapidly and at a good price.¹⁵

Conclusion

These four cases illustrate that development and maintenance efforts have been successful in several

¹³ Siy points out that this figure underestimates the actual amount of labor contributed to construction and maintenance as family members of *zanjera* members and members of neighboring *zanjeras* who receive the drainage waters of this system also contribute labor for major projects. Siy estimates that at least an additional 1,000 person-days are contributed by those who do not have specific obligations (Siy, 1982: 95).

¹⁴ It appears, however, that those who own less than a full *atar* share have a somewhat higher absentee rate—particularly those who own less than a fourth of a share. Members owning less than a full share and those owning a full share are equally reliable contributors of construction materials (Siy, 1982: 99).

¹⁵ The *zanjeras* are a distinct organizational form, but many other forms of communal irrigation systems in the Philippines share the characteristics of nested organizations and high resource mobilization of the *zanjeras* (see de los Reyes, 1980). Similar systems have been organized by farmers in many parts of the world (see E. Ostrom, 1990).

developing countries for a variety of rural infrastructure facilities, even though the examples of failures presented early in the chapter may be somewhat more typical of infrastructure development efforts in developing countries. In Bangladesh, individual users found it in their self-interest to assist in road maintenance efforts on some roads; in Nepal, bridge users combined their local resources with specialized resources supplied from the central government to produce well-constructed bridges; the Malawi water supply systems also involved combinations of resources supplied by local users together with those of the central government and external donors; and the holders of *atar* rights in the Philippine *zanjeras* mobilize a surprisingly high level of local resources year after year to keep their irrigation systems repaired and maintained.

In each of these cases, obvious benefits are generated for the users from the investments in infrastructure construction, repair, and maintenance made by the users of these systems. Just as an individual truck owner is likely to maintain his or her truck only if maintenance can be expected to yield benefits, expected benefits are also an important factor affecting the decision of users of jointly consumed rural infrastructure to invest their own resources in

maintenance. The first set of cases discussed above, however, makes it apparent that potential joint gain is an insufficient incentive to simulate maintenance activities. Users of rural roads in Jamaica would have received benefits had their roads been maintained. Mahaweli settlers would gain better yields if their systems were properly operated and maintained. The potential for benefits to be gained, however, is not sufficient to induce users to organize to achieve these benefits.¹⁶ There is more to the story.

One obvious similarity in the four success cases is that the users themselves have participated heavily in the various phases of infrastructure development. A key component to infrastructure sustenance may thus be an institutional environment in which local users play key roles in all development and maintenance decisions. In fact, the success of cases similar to the four discussed here has often led students and practitioners of development to call for greater decentralization of development efforts as a general development strategy, as well as to enhance the sustainability of infrastructure of all kinds in developing countries. For this reason, we turn next to a discussion of the concept of decentralization and its possible relevance to the problem of rural infrastructure sustenance in developing countries.

¹⁶The validity of the proposition by Mancur Olson (1965) that the presence of collective benefits is not sufficient to motivate individuals to organize to obtain these benefits is by now accepted by most social scientists. One is amazed, however, how frequently one finds in development planning documents the prediction that the beneficiaries will organize themselves because there are obvious benefits to be gained.

Decentralized Approaches to Infrastructure Development and Sustenance

AT LEAST since the early 1970s, highly centralized governmental authority has been widely considered a principal cause of the difficulties experienced in sustaining many large-scale donor-assisted projects in developing countries. Typical reforms have recommended decentralization as a way to reduce these problems (see, for example, Bell, 1977). The presumption that decentralization is the answer to sustainability problems has been supported by the success some groups have had in creating and maintaining appropriate infrastructure facilities (see Conyers, 1983; Cohen, et al., 1981; Landau and Eagle, 1981). We now have accounts of many cases similar to those described in the latter part of Chapter 2, in which users who are directly involved in decision making invest substantial resources in constructing and maintaining diverse local facilities (see Cernea, 1985; Uphoff, 1986a).

Although the evidence that “overcentralization” of governmental authority has contributed to the difficulties of sustaining investments in infrastructure is convincing, it is, on the surface, a rather general diagnosis. The dominant prescription for this condition, decentralization, has in turn, become a generic, all-purpose solution that lacks specificity and grounding in empirical and theoretical analysis. As Landau and Eagle (1981: 10) point out in their survey of the literature, “decentralization is presented as a solution to a rather large number of problems”. They argue that the claims for the effectiveness of decentralization are just that: claims and not hard facts.

In this chapter, we review how the concept of decentralization has evolved from a simple dichotomy to a multidimensional concept. Given the complexity and multiple meanings of the term, the precise intention of an infrastructure project involving a decentralization component is never quite certain. In practice, “decentralization” has frequently meant some deconcentration or temporary devolution of authority within a bureaucracy to lower-level officials, combined with enhanced opportunities for citizen participation. Involving both lower-level bureaucrats and citizens more effectively in infrastructure development can be expected to increase the quality of information available to decision makers and to enhance the motivation of participants to maintain something that they helped to create. The authority that is devolved from a central government to lower-level officials in the bureaucracy and to citizens, however, can easily be revoked by the same central government. Thus, the benefits of a decentralization program or project may not be lasting.

Consequently, we examine several infrastructure development programs within one country—the Philippines—that involved substantial devolution of authority within the national government itself and aspects of enhanced citizen participation. The programs received positive evaluation for their accomplishments and for the involvement of lower-level national government officials, locally elected officials, and citizens in the design as well as other key aspects of infrastructure development. In other words,

these programs are rightfully among the most successful decentralization efforts in developing countries. And yet, because no institutional changes were made that substantially affected the incentives of officials and citizens not in the program, later evaluations and studies found little evidence of sustained improvements. The difficulty of *sustaining* improvements underscores the need for further theoretical development to identify the factors that affect the incentives of public officials and citizens with regard to different aspects of infrastructure development.

Decentralization Efforts

Efforts to decentralize have taken many forms with a variety of underlying motivations.¹ In many, if not most, cases institutional reforms have been initiated by the political leadership of the central governments with the support of international development assistance organizations. These efforts have been aimed at developing a new partnership between the resources and energy of communities and the existing modern political leadership of the central government. The theoretical foundations of these efforts have been drawn from elements of democratic theory that stress the importance of participation by local people in the operation of their own public affairs (see Esman, 1980; Uphoff and Esman, 1974).

In some areas, the public "demands" for decentralization have been violent. Some of the institutional changes undertaken in response to very strong public demands for decentralization, however, were never really expected to yield positive results. Central governments reluctantly relinquished power and tried to recover it as soon as possible. The allocation of power and authority was viewed as a zero-sum game, in which authority allocated to local or regional authorities was considered to have been "taken away" from the center. Thus, in places such as Sudan where the need to decentralize was pressing, recent efforts to decentralize have not produced substantial long-run improvements (Khalid, 1985; Malual, 1987). The viability of a major redistribution of authority depends on the thorough understanding by the major actors that

all stand to gain in the long term from the redistribution.

Just as the underlying motives for decentralization have differed across settings, so have the types of institutional changes referred to as decentralization. A recent definition of decentralization exemplifies the variety of institutional changes that are now subsumed under this term:

[Decentralization] can be defined as the transfer of responsibility for planning, management, and the raising and allocation of resources from the central government and its agencies to field units of central government ministries or agencies, subordinate units or levels of government, semi-autonomous public authorities or corporations, area-wide, regional or functional authorities, or nongovernmental private or voluntary organizations (Pondinelli and Nellis, 1986: 5).

Given this diversity of meanings, considerable effort has been devoted to an elucidation of the diverse meanings of this term and of its evolution over time.

The Evolving Meaning of Decentralization

Several historical reviews of the term decentralization provide good accounts of how this term, which once had a well-specified referent, has been applied to a rapidly expanding array of changes in the institutional structure (Conyers, 1983, 1984; Mawhood, 1983; Mawhood and Davey, 1980; Cohen, 1980). The fairly consistent set of institutional changes introduced in the 1950s in preparation for the granting of independence to many African countries were the first modern referent for the term in the development literature. This "classic" decentralization, as Mawhood and Davey (1980: 405) describe it, was organized around five principles:

1. Local authorities should be institutionally separate from central government and assume responsibility for a significant range of local services (primary education, clinics and preven-

¹The literature on decentralization is extensive. See, for example, Bryan and White (1982, 1984); Esman and Uphoff (1982); Kee (1977); Landau and Eagle (1981); Leonard and Marshall (1982); Montgomery (1981); Rondinelli (1981); Rondinelli and Nellis (1986); Rondinelli, et al. (1987); Wunsch (1988).

tive health services, community development, and secondary roads being the most common).

2. These authorities should have their own funds and budgets and should raise a substantial part of their revenue through local direct taxation.
3. Local authorities should employ their own qualified staff, who could be seconded from the civil service if necessary in the early stages.
4. The authorities would be governed internally by councils, predominantly composed of popularly elected members.
5. Government administrators would withdraw from an executive to an advisory inspectorial role in relation to local government.

Mawhood (1983: 4) expressly refers to these newly created bodies, which often took the form of district or provincial councils, as "local governments." He excludes from his definition of local government both single-purpose local bodies and federal arrangements in which constitutional law provides for the sharing of large numbers of governmental functions and revenues between the federal and state governments. During the 1950s, *deconcentration* was the term used to refer to institutional changes that shifted the authority to make certain types of decisions from central government officials in the capital to central government officials in dispersed locations.

Since the second round of decentralization efforts began in the 1970s, the term decentralization has been used in the development literature to refer to an array of different institutional changes. As a result of this proliferation of institutional changes, a precise meaning for the term decentralization no longer exists. The political leadership of developing countries has tended to use the term indiscriminately to refer to any kind of institutional change. Many new initiatives that were called decentralizations did in fact involve extensive redistribution of executive authority among the employees of central ministries or bodies closely tied to them (deconcentration), but tightly constrained the independent legislative, taxing, and spending authority of what Mawhood called local governments.

Because governments had captured the term "decentralization" to describe what were in many

cases administrative reorganizations, the term *devolution* was coined by academic observers sensitive to the need to differentiate among radically different types of institutional changes. Devolution was applied to reorganization efforts that approximated "classic" decentralization in that significant degrees of independent legislative and fiscal authority were transferred to subnational governments. In an effort to make further important distinctions, two additional terms with which to categorize decentralization efforts have been adopted. These are *delegation*, referring to transfers of authority to public corporations or special authorities outside the regular bureaucratic structure, and *privatization*, referring to transfers of responsibility for public functions to voluntary organizations or private enterprises (Rondinelli and Nellis, 1986: 5; Rondinelli, McCullough, and Johnson, 1987: 4).

Multiple Dimensions of Decentralization

Debates about what labels can appropriately be attached to different reform efforts reflect the complexity of the content of the rule changes taking place. Cohen and his colleagues observe that "Decentralization is not one thing; nor is it even a series of degrees along a single spectrum or scale. For comprehensibility and utility in policy circles, the overarching abstraction 'decentralization' must be split into a host of separate, occasionally conflicting entities" (Cohen, et al., 1981: 5-6). For the purposes of discussing decentralization efforts in support of the poor, Leonard and Marshall (1982: 30) propose a typology based on four dimensions that can be represented by a matrix containing 24 subtypes of decentralization. Each institutional change can be located in one of these 24 cells depending on: (1) what type of organization is involved at both the intermediate and local level; (2) whether mediating organizations are representative, private, or agencies of the central government; (3) whether governmental bodies are generalist or specialist; and (4) whether representative entities are inclusive or alternative organizations limited to the poor.

Conyers (1985) has also emphasized that institutional changes regarded as decentralization vary widely on a number of different dimensions. She has identified at least five dimensions she believes are characteristic of all decentralization efforts. These

dimensions point to the deeper structure of the institutional changes involved in a decentralization effort. These dimensions are:

- the functional activities over which authority is transferred;
- the type of authority, or powers, which are transferred with respect to each functional activity;
- the level(s) or area(s) to which such authority is transferred;
- the individual, organization, or agency to which authority is transferred at each level; and
- the legal or administrative means by which authority is transferred (Conyers, 1985: 24).

Thus, recent scholarship on decentralization has stressed that the term refers not to phenomena that can be arrayed along a single dimension but rather to many different phenomena that can only be represented by multiple dimensions. While there is some overlap among the dimensions addressed by one scholar with those of another, the specific dimensions addressed have something of an *ad hoc* character. The reasons an analyst should choose one particular dimension over other possible dimensions are not always clear. These dimensions allow some additional descriptive discrimination, but do not necessarily help develop a cumulative body of knowledge about how various institutional changes affect the incentives of participants, their resulting actions, and the effects of their cumulated behavior.

The dimensions that Conyers uses to elucidate the deeper structure of decentralization efforts seem quite reasonable. But because they are not related to a broader theory that identifies the factors affecting the incentives that individuals in centralized or decentralized institutional arrangements face, they represent simply one of many efforts to identify important dimensions. What is needed is construction of a more general set of dimensions. The following chapters develop such a theory within the context of rural infrastructure development and sustenance. To provide a contextual basis for the discussion in subsequent chapters, it is useful to consider several ex-

periences with decentralization efforts over the past couple of decades.

Experiences with Decentralization in the Philippines

Just as there is a diversity in the conceptual meanings and dimensions of decentralization efforts, so there is a wealth of experience that derives from many decentralization efforts. It is hard to find national planning documents that do not mention terms at least tangentially related to decentralization, such as people's participation, bottom-up planning, or local initiatives. While this may only be rhetoric, little doubt exists that policymakers believe decentralization efforts will produce benefits, even if only by appeasing internal (and external) readers, many of whom are donors. International agencies have also supported efforts to give greater decision-making power to lower-level bureaucrats and to rural residents through support of rural development projects or sectorally specific infrastructure development projects.

We have chosen to analyze several efforts sponsored by the Government of the Philippines (with donor assistance) to undertake programs intended to enhance the sustainability of investments in rural infrastructures (either directly or as part of a broader program) through forms of decentralization. We focus on decentralization efforts in one, rather than multiple countries, for two reasons. First, we want to examine well-documented decentralization efforts that were evaluated as relatively successful projects. Second, we want to assess the long-term impact of decentralization efforts. Several projects involving both infrastructure design, construction, and maintenance and various types of decentralization have been undertaken in the Philippines with initial success. Given the extensive literature about these efforts and their long-term impacts, we believe there is more to be learned from a deeper analysis of decentralization efforts in one country than from a more cursory analysis of efforts in several countries.

Given the diversity of meanings of decentralization we have discussed above, no "typical" program captures all of the meanings of this term. Thus, we do not look upon the Philippine examples as "typical." Rather, these programs provide good illustrations of some of the short-term benefits and costs—as well as

the difficulties of achieving long-term results—of a few thoughtful efforts to decentralize decision making related to infrastructure development.

The Government of the Philippines has been among the relatively more centralized systems due to its colonial tradition and the centralizing effect of internal unrest. As we will discuss below, however, there have also been several attempts to decentralize in order to enhance the development of rural areas. The local governmental system has its foundations in the Spanish system with an overlay of American electoral institutions. During the late 1970s, the remainder of the traditional, indigenous forms of local government—the *barangay*—received some official encouragement. In 1972, the declaration of martial law initiated a period of “constitutional authoritarianism”, during which extensive authority over development was lodged in the office of the President (Simpas, et al., 1983). Since the overthrow of the Marcos government in 1986, the Aquino government has proposed a number of measures to decentralize control over local government. Thus, the issue of decentralization continues to be relevant to the contemporary governance arrangements of the Philippines.

The levels of representative government existing at the subnational level in the Philippines include provinces, cities, municipalities, and *barangays*. Outside the National Capital Region, which includes metropolitan Manila, the entire country is subdivided into provinces or chartered cities that govern the larger, urbanized areas. Cities are administratively independent of the provinces. The provinces, in turn, are fully subdivided into municipalities; each (rural) municipality generally contains one or more urbanized market centers together with the rural lands surrounding them. Finally, all municipalities and cities have been further subdivided into *barangays*. The *barangays*, or *barrios*, are led by elected officials but have few direct development responsibilities. Among all local governments, the *barangay* is the one that can be most accurately called an indigenous institution.

Governors are the chief elected officials in the provinces; elected mayors lead local governments in both the chartered cities and the municipalities. Municipalities and provinces together perform a

variety of services that, within cities, are entirely the responsibility of city governments. Generally, provinces are expected to play primarily a coordination and oversight role vis-a-vis the municipalities, although provinces do engage in some direct provision of services themselves, such as provision of provincial roads.

Line departments, previously ministries, generally have offices located in provincial capitals and carry out the bulk of the direct development investment activities. One major development/decentralization issue that, therefore, faces the Philippines (and many other developing nations) is the interplay between the line agencies represented at the local level and the officials elected locally to lead the provinces, municipalities, and cities. Generally, line agency personnel have direct control over considerably greater amounts of resources allocated from the national budget; local governments have historically been able to mobilize relatively small amounts of resources from the tax (principally the real property tax and a local business tax) and nontax instruments put at their disposal. A large portion of the resources available to provinces and municipalities is in the form of intergovernment transfers from the central government. Local fiscal autonomy in the use of these funds is further constrained, however, by several mandates that regulate how local governments are to allocate the funds and certain set-aside expenditures they must make for specific functions, such as the national police. An additional complication regarding fiscal affairs at the local government level is that the principal fiscal officers serving in the municipalities and provinces (local treasurers and tax assessors) are, in fact, deputed there by the central government’s Department of Finance.

The Government of the Philippines has struggled for over two decades with problems in implementing decentralization. The Provincial Development Assistance Program discussed below was one of the more important initiatives. That formal decentralization has never been fully implemented in the country is reflected in the current Aquino Government’s continuing attempts to devise a structure that will permit greater involvement by elected local officials in the allocation of departmental line agency budgets.

The Philippines' Provincial Development Assistance Program

The Provincial Development Assistance Program (PDAP) was undertaken from 1968 to 1981 with the support of USAID. The program provides an example of an externally supported initiative intended to increase the capacity of a formal governmental organization to assist in the development process. PDAP was implemented at the provincial level through the Government of the Philippines central ministerial bureaucracy. It was ultimately extended to 28 provinces. PDAP's objectives included:

1. Organization of a Provincial Development Committee chaired by the governor. The committee was intended to improve the development program of the province by increasing the amount of coordination among the various line ministries that carry out activities in the province as well as coordinating the development activities undertaken directly by the provincial government.
2. Creation of realistic development plans through the identification of needs, the establishment of priorities, the estimation of resource requirements, and the recommendation of actions to be undertaken.
3. Development of a provincial-level budgeting system for both capital and operating expenditures that recognized probable future budgetary constraints.
4. Improvement of the property tax assessment and collection process in order to generate additional resources for the province (as well as the municipalities within the province).
5. Improvement of the provincial equipment pool, especially for the purpose of developing and maintaining rural roads, irrigation systems, and other similar infrastructures that support rural economic development.
6. Encouragement of self-help projects by local governments and private organizations through financial, technical, or other assistance.
7. Improved training of provincial officials in skills that would assist agricultural and economic development (Iglesias, 1985: 43-44).

The project contained both activities designed to support infrastructure development and considerable amounts of technical assistance. This technical assistance was specifically intended to improve planning and management capabilities at the provincial level, rather than entirely at the ministerial level. Specifically, PDAP was "based on the assumption that decentralization could not be meaningful unless local governments had the technical and managerial capability to plan and implement local development activities" (Rondinelli, 1983: 188).

To accomplish this objective, program administrators turned first to the development of analytical tools that officials in participating provinces could use in planning and budgeting. Wunsch (1983) states that during its first phase, 1968-1972, PDAP produced such models as the Socio-Economic Profile, the Joint Work Plan, the Capital Improvement Program, the Equipment Pool Plan, the Quality Control Plan, two versions of Road Network Development Plans, a Performance Budget, the Provincial Comprehensive Plan, and the Real Property Tax Administration System. Most of these planning and management tools were developed by American consultants working with specialists from various central government agencies (Wunsch, 1983: 2; Iglesias, 1985: 46). The central PDAP staff then prepared manuals for use by participating provinces.

To encourage participation by the provinces, PDAP provided cost reimbursements for activities on "special projects" that included the improvement or construction of rural roads, *barangay* water supply systems, and rural service centers. The promise of additional resources for infrastructure investments provided a strong fiscal incentive for provinces to join PDAP. Wunsch (1983: 9) estimates that special project monies increased provincial budgets by an average of 10 percent. PDAP also helped to train equipment pool supervisors and mechanics, made loans to help construct equipment pool facilities, and assisted in the transfer of excess U.S. Government heavy road equipment to the provinces to support infrastructure development projects. Improvements in the administration of the real property tax were also supported by PDAP, which provided financial assistance for tax mapping and improvements in tax record keeping.

Although these were the principal program activities, the organizational linkages associated with the PDAP were particularly important in the decentralization of decision-making power. As Rondinelli (1983: 184) notes, the type of decentralization accomplished under PDAP was deconcentration. Prior to its implementation, provinces had insufficient technical abilities to permit provincial governors to hold their own against central ministerial line agencies in discussions about the allocation of funds in the central government budget. In their final external evaluation of PDAP, Landau et al. (1980: 7) note that at the inception of the project "provinces possessed little technical competence, severely limited revenue resources, and they were dominated by national ministries which all too often mandated provincial tasks without regard for local need, local desire, or local capacity—a practice which continues to date."

Interestingly, the program's history indicates that PDAP itself could have easily become just as inflexible in its approach to development. There were three distinct phases of the project. During the initial 1968-1972 phase, PDAP was managed by committee and relied on specialists from a variety of national government agencies, with day-to-day management supplied by an Executive Officer from the University of the Philippines' Local Government Center. Provinces participating in PDAP were required to establish provincial development staffs (PDSs) to assist the provincial governor in exercising his development functions. By the fall of 1972, 14 provinces had been designated PDAP provinces.

During the second phase, 1972-1976, responsibility for PDAP was transferred to the Office of the President. This transfer occurred simultaneously with the declaration of martial law in the country and brought with it profound changes in the way the central office of PDAP operated. First, a strong Executive Director took over management from the management committee, and a full-time PDAP staff was hired. More importantly, requirements concerning use of the planning procedures and manuals were rigidly enforced. Wunsch (1983) reports, for example, that because a mountainous province could not locate three hectares of flat land, as required in the Equipment Pool regulations, it was excluded from becoming a PDAP province, even though it could not have used the Equipment Pool machinery in any case due

to its terrain. PDAP also engaged in direct administration of infrastructure projects rather than assisting provinces in carrying out such undertakings. In essence, PDAP was operated during this period very much like other infrastructure-oriented line ministries of the Government. As Landau et al. note (1980: 7), "PDAP-Central was building a tightly controlled hierarchical system. We also observed that the sheer number of PDAP requirements overloaded an already impoverished provincial government."

During the final phase of the program (1976-1980), PDAP went into a period of decline. (The program had originally been scheduled to terminate in 1978.) Responsibility was transferred from the Office of the President to a Deputy Minister in the Ministry of Local Government and Community Development, where a special office was created for the program. By 1978 the program office had direct implementation responsibility for only a few USAID-sponsored special projects, including the *barangay* water project, the rural service center project, the rural roads project, and the real property tax administration project. However, the lack of any direct implementation responsibilities was not necessarily viewed negatively by PDAP evaluators. As a consequence of the previous training provided to provincial-level personnel by PDAP, the weakening of the central office of PDAP permitted provincial officials to take more initiative in decision making.

As Wunsch (1988: 13-14) makes clear, the positive results of PDAP would not have occurred had the program been implemented as planned. The PDAP design completely ignored the organizational incentives that were the key determinants of its success. The program inadvertently worked because the incentives provided by the promise of special projects encouraged provinces to join the program, which helped them to establish provincial planning staffs. Project money together with new administrative capacity and the desire to be reelected encouraged provincial governors to act more assertively than before. Specifically, Wunsch (1988: 13-14) notes that "provincial government had expanded its administrative ability, and was thereby developing and administering better local projects and programs, strengthening lateral cooperation among central-government sectoral officers posted to the provinces, and negotiating with

Manila offices to get central programs better attuned to local needs.”

Given the observed improvement in administrative capacity by the early 1980s, it is useful to ask whether the benefits perceived at that time have been sustained. At the close of the project, Landau et al. (1980: 15) concluded that PDAP and the special projects “have set in motion a process which, if sustained, promises to produce a *de facto* decentralization at the provincial level.” The key clause in this conclusion is, of course, “if sustained.” As governors and their staffs are succeeded and as local conditions change, the perceived improvements in the ability of provincial governments to administer local development efforts could decline.

We are not aware that any formal evaluation of the longer-term effects of PDAP has been made. There is, however, some evidence suggesting that not all of the improvements noted early in the decade are still being realized. One particular area of administrative improvement observed at that point concerned budgeting. The evaluators found that in some, but not all, provinces the PDAP-trained staff was playing an important role in the annual budget process (*ibid.*, 91). This, they argued, had increased the influence a governor could exert in that process and therefore was “a crucial element in strengthening his control over programs at the provincial level” (*ibid.*, 93).

A recent assessment of local government fiscal issues in the Philippines suggests, however, that at least certain aspects of strong financial management and budgeting cannot be said to characterize normal practices in selected provinces of the country. On the basis of visits to five provinces, Hubbell et al. (1989) concluded that, “budgeting practices are weak.” They base this conclusion on the following: (1) revenue forecasting is rudimentary and often does not consider known factors that will influence the jurisdiction’s revenues during the following fiscal year; (2) budget officers seldom provide executives with sufficient information for understanding the budget; and (3) many supplemental budgets are prepared each year (in

one province at least ten supplemental budgets were prepared during the 1988 fiscal year). The large number of supplemental budgets suggests that the budgeting exercise is regarded as little more than a required process with little relationship to the realities the province is likely to face during the fiscal year.²

In summary, the PDAP approach to supporting decentralization through a deconcentration of decision-making capacity was based on the expectation that by providing additional support for infrastructure improvements, provinces would have incentives to upgrade their administrative capacities. Over the course of the project, those results were realized, in great part, because of the diminished control that the central administrators of the project retained over activities at the provincial level. Unfortunately, it does not appear that these improvements resulted in lasting effects, at least in the area of financial budgeting, in which provinces are currently characterized as still employing weak fiscal forecasting procedures with little true fiscal planning.

Decentralization and Irrigation in the Philippines

The PDAP approach to decentralization provided external funding for a broad training program for the officials who would subsequently be involved in a diversity of “special” rural infrastructure projects. Overlapping with PDAP was a process initiated by the National Irrigation Administration (NIA) to involve farmer participation more effectively in infrastructure planning and development and to delegate more discretion to lower-level NIA officials. This effort was largely based on the seminal ideas of David and Frances Korten concerning the importance of building a learning process within the public sector, which had previously had a tendency to rely on a single blueprint for all of its projects of a particular type (see D. Korten, 1980 and F. Korten, 1985). Several experimental irrigation system rehabilitation projects were undertaken as a part of this effort. The evidence that these experimental projects improved the quality of the constructed infrastructures and enhanced the

² It should be noted that the position of budget officer, who is responsible for preparing provincial budgets, is new to the provinces, hence comparisons with the situation at the close of the PDAP project may be unfair. On the other hand, if provincial budgeting efforts were adequate previously, there would seem to be little reason to have created this new office.

willingness of farmers to maintain their own irrigation systems, once rehabilitated, is substantial. After describing these experimental projects, we will then examine similar NIA projects in the Philippines to which there appears to have been disappointingly little transfer from the successful experimental projects.

In contrast to many other Asian countries, the Philippines has had a better overall record of meeting its recurrent costs of investment in irrigation systems. As discussed in Chapter 1, the revenue received from farmers during the mid-1980s was about \$17.00 per hectare, while operation and maintenance costs were about \$14.00 per hectare (Small, et al., 1986, cited in Repetto 1986: 5). Thus, in contrast to Indonesia, Korea, Nepal, Thailand, and Bangladesh, Philippine farmers actually pay for operation and maintenance costs and contribute to the repayment of capital costs.³

Three types of irrigation systems are designated in the Philippines: (1) national systems that are large (usually over 1,000 hectares) and are owned, operated, and maintained by NIA; (2) communal systems that are smaller (usually under 1,000 hectares) and are owned, operated, and maintained by farmers; and (3) private systems that are also smaller than the national systems and frequently rely on groundwater sources. National irrigation systems constitute about 40 percent of the irrigated area in the Philippines; communal systems serve 49 percent of this area; and private systems serve 11 percent (Cabanilla, 1984: 5). Many communal systems are similar to the *zanjeras* we described in Chapter 2 in that they are designed, constructed, operated, and maintained by farmers using local materials and indigenous skills.

Communal systems have been sustained over the years as a result of extraordinary efforts on the part of the irrigators to mobilize resources to keep their irrigation systems repaired and maintained. Although communal systems have sustained themselves very well, the substantial amount of time that farmers allocate to maintain and repair fragile diversion works and canals detracts from the productivity of their farming efforts.

Consequently, the Government of the Philippines—like the governments of many other developing countries that are trying to enhance agricultural productivity—has attempted to assist communal irrigation systems through rehabilitation programs.

Farmers dependent upon these systems often seek government help in constructing permanent irrigation works. NIA has assisted communal irrigation systems, at no cost to the communal systems, since the early 1950s. The level of investment grew considerably faster, however, during the early 1970s (F. Korten, 1982).⁴ Once NIA had designed and constructed a rehabilitated system—usually without consulting the farmers who had originally constructed and managed their own systems—farmers were reluctant to take back operation and maintenance responsibilities.

In 1975, a presidential decree required NIA to recover the costs of irrigation construction from the farmers being served. Under this policy, irrigators' associations were "to provide 10 percent of the value of the construction assistance in the form of labor, materials, cash, and rights of way, and repay the remaining costs over a number of years without interest" (Bagadion and Korten, 1985: 55-56). Underlying this policy was a presumption that irrigators who paid to reconstruct their irrigation systems would be more likely to operate and maintain them after NIA had completed reconstruction.

Getting farmers to agree to repay the costs of reconstruction required some form of farmer organization that could enter into a contract with NIA. NIA, however, was a centralized, engineering agency with few staff oriented toward taking farmers' ideas seriously or to helping farmers organize themselves more effectively. NIA contracted with a different agency, the Farm Systems Development Corporation, to work with the farmers so that NIA could focus on the engineering aspects of the project. It turned out, however, that simply assigning the organizational task to another agency was not successful (Bagadion and

³ On the other hand, the actual level of maintenance observed on many of the national irrigation projects in the Philippines does not appear to be adequate. Cabanilla (1984: 3), for example, reports that NIA in the Philippines has had to rehabilitate its irrigation systems every seven years and attributes this rapid deterioration rate to poor operation and maintenance.

⁴ Even so, most of the funds allocated to NIA were spent on the large-scale projects NIA owns and manages. In 1979, for example, 94 percent of the NIA budget for construction, rehabilitation, and improvement was allocated to large-scale projects (Siy, 1982: 15).

Korten, 1985; Holloran, 1980). Instead of two separate tasks—engineering the system and organizing the farmers—the two activities were more closely intertwined than NIA officials originally thought. Farmers did not simply want to organize to finance the improvement of their systems—they were also interested in affecting the design and construction of the systems.

Consequently, in 1976, NIA set up a small, pilot project in one municipality in Central Luzon where full-time “catalysts” or Community Organizers (COs) were hired by NIA and assigned to live in an area where a communal system was about to be rehabilitated. Partial assistance for the pilot project was provided by the Ford Foundation. In terms of Leonard and Marshall’s (1982) dimensions of decentralization described above, this was a single sector program in which communal organizations, whose members included all farmers obtaining water from an irrigation system, mediated between the farmers and agency generalists (the COs) and specialists (NIA engineers) who had both been given enhanced decision-making authority.

The pilot project had mixed results. It was successful enough, however, that NIA decided to continue further experimentation. One important result was the discovery that the farmers had knowledge useful to the engineers.⁵

They knew the landholding patterns—and whether it would be possible to obtain rights of way in various areas. Often they pointed out land ownership boundaries proposing that where possible canals follow such boundaries to avoid taking too much land from any single farmer. They knew the rainy season conditions (the engineers’ survey often being done in the dry season) such as which creeks would swell after heavy rains and what areas would become water logged. They also knew soil conditions, pointing out where sandy soil might lead to significant loss from the canal (F. Korten, 1982: 14-15).

Studies of communal organizations were initiated by scholars from Philippine universities so that later work could be built upon substantiated knowledge of how communal irrigation systems operated in various types of Philippine environmental conditions (de los Reyes, 1980). In 1979, the Ford Foundation again helped support and staff the creation of a Communal Irrigation Committee composed of officials from the top ranks of NIA, from the Ford Foundation, and from local research institutes, who were provided with extensive information about project processes. Two new pilot projects were initiated with an overt goal of learning still more about how to strengthen irrigators’ associations.

A full-time social scientist resided in each project area to document activities as they occurred. The resident scientists were supervised by the academic scholars who had just completed the more general studies of communal systems. The resident scientists reported in writing to the Communal Irrigation Committee. Workshops, training courses, and detailed training manuals were developed from the experiences of the pilot projects so that information about this program was disseminated to NIA officials not involved in the pilot projects but who would be involved in the more extended experimental project.

The pilot projects clearly indicated that involving farmer participation in all phases of infrastructure development necessitated major changes in the way a national agency conducted its work. Consequently, NIA officials initiated a broader experimental participatory program, including a series of rehabilitation projects supported in 1980 by a loan of \$70 million from the World Bank (Bagadio and Korten, 1980, 1985). Under this program, when farmers asked to have their communal system rehabilitated, NIA regional staff were required to spend a month collecting data and preparing a comprehensive profile of the physical, social, economic, and legal conditions of the irrigation program that also identified problems to be solved. This replaced the typical engineering report preparation process that included only the drawing of

⁵ The first experimental project was one of those mentioned in Chapter 1 where local farmers told design engineers that the dam they were constructing would not survive local conditions. A typhoon occurred shortly after construction of the dam was completed and took it out of operation immediately.

blueprints and the calculation of cost/benefit estimates.

In the experimental program, considerable emphasis was placed on the importance of learning from prior experience and avoiding rigid formulae for how things were to be done. The format for the comprehensive profile, for example, was evolved after experiences in the pilot projects and the early experimental projects had been evaluated. Once senior NIA officials had approved a proposed rehabilitation project on the basis of the information contained in the profile, community organizers hired for this program⁶ spent time in the area helping local farmers strengthen their organizational capabilities so that farmers could participate actively in the design and planning stages of the rehabilitation. NIA engineers consulted with farmers about the location of proposed diversion works and field channels. Farmers were trained to record stream water levels for a period of time prior to the initiation of construction. All of this took both time and a reorientation of an engineering staff that had previously had the authority to make such decisions independently, without consulting the local farmers.⁷

Among the many innovative administrative procedures adopted in the experimental projects was the practice of submitting statements listing project costs

to the irrigators' association officials every three months during the construction phase (rather than at the end of the project). Farmers were thus able to monitor more closely the level and the appropriateness of charges and to verify the amount of their own contributions to their equity account. Farmers also made many suggestions concerning ways to keep construction costs as low as possible. Because the farmers had to pay back all construction costs, they insisted that materials be fenced and guarded, that employees not use project gasoline for private purposes, and that the number of canals to be dug and lined be kept to a minimum. Furthermore, efforts were made to change the criteria by which engineers were evaluated by NIA superiors from those based primarily on design expertise to those based on actual achievements, including whether or not the farmers accepted the reconstructed system (F. Korten, 1982: 21).

By the end of 1982, 21 rehabilitation projects had been completed under this experimental program, 19 of which had been successfully turned over to the respective irrigators' associations (Bagadion and Korten, 1985: 68).⁸ One of the most successful aspects of the program was the level of contributed labor that farmers allocated to operating and maintaining irrigation projects once rehabilitated. A well-documented example of the high levels of farmer resource

⁶ COs usually occupied temporary positions that lacked civil service status. Their temporary status was a problem that plagued both the experimental program and later efforts to use COs within NIA.

⁷ The process documentation reveals the myriad of small and large problems that occur in such a process. The farmers had to recruit members, register their association, develop bylaws, acquire water rights permits, collect water level readings, and participate in the survey of the physical layout of the system. All of these activities had to be accomplished within tight time constraints and in a manner that was satisfactory both to the farmers and to external officials (such as the National Water Resources Council, which had to approve their water rights permit). All of this was accomplished, but not without problems and conflict. Some of the mishaps are themselves informative about the types of relationships that have to be established to make this type of project work. Shortly after the NIA official in charge of undertaking a survey arrived in one project area, for example, he hired two local residents to assist him. This simple action does not seem at all objectionable. But the irrigation association officials were distressed by this action taken without consulting them, as they had been campaigning to get farmers to assist in the survey without pay in order to build up their equity. The association had difficulties getting farmers to participate in the survey process and tried five different strategies to obtain farmer input, none of which seemed to work very well (Ilo, et al., 1984: 33-36). Another problem involved the slow wage payments made by NIA to local contractors, handicapping the efforts to use local laborers rather than using external contractors. Because these problems were documented and then discussed by the Communal Irrigation Committee, ways of helping to cope with similar problems in future projects were devised.

⁸ A turnover rate of 90 percent was considered highly successful because NIA had previously "had so much difficulty in getting farmers to accept the systems once constructed" (Bagadion and Korten, 1985: 68).

mobilization is the Aslong system that was turned over to the farmers by NIA in 1981 (see Ilo, et al., 1984; Bagadion and Korten, 1985). Immediately thereafter, the area in which the Aslong system was located suffered several typhoons and repeated heavy rains that caused heavy damage to the system. Field researchers documented that during the first 14 months of operation, the irrigators' association organized 47 work days to repair various parts of the system. Members contributed 571 person-days of labor for this effort. During the same period, farmers also contributed 980 person-days of labor to distribute water and collect fees. In addition, a part-time operations manager, treasurer, and bookkeeper contributed 308 person-days of work. Thus, a total of 1,859 person-days was contributed by the farmers during the first 14 months of operation to keep the newly reconstructed system in good operation and repair. The annualized value of the labor and materials contributed to operation and maintenance activities was about \$3,390 in U.S. currency or about \$12 per hectare (Bagadion and Korten, 1985: 78).⁹

It is well substantiated that the projects undertaken as part of this experimental program to enhance the participation of farmers in the rehabilitation of communal irrigation systems were unusually successful. What is not substantiated is the long-term impact of this imaginative effort to build a more decentralized decision-making process in what was a highly centralized, national agency.¹⁰ Considerable effort was devoted within the experimental projects to recognizing previously established communal irrigation organizations and working directly with them to strengthen their capabilities while improving the engineering of their systems. Contemporaneous with the experimental projects, the Palsiguan River Multi-Purpose Project (PRMPP) was initiated in the Ilocos region of Luzon island where there are numerous *zanjeras*, similar to those discussed in Chapter 2. The PRMPP was charged with the responsibility of rehabilitating 172 communal irrigation systems. At the time of the initial technical and economic studies, no effort was made to identify local *zanjeras*, no

contact was made with them, and no reference was made to the extensive, existing studies of *zanjeras* (Visaya, 1982).

Project engineers viewed their task as creating new irrigation systems rather than rehabilitating existing ones. "The *de novo* orientation led to the design of a 1,000 hectare pilot area in which major canals were radically realigned" (Coward, 1985: 33). A study conducted by Benito Visaya reported that a majority, if not all, of the "designed canals are new ones, crisscrossing the canals of the existing *zanjera* systems. The proposal rotational areas, consequently, disregarded existing area boundaries of the irrigators' associations" (Visaya, 1982: 6, cited in Coward, 1985: 33). Social scientists associated with the experimental participatory program eventually helped reorient the NIA project to include reference to the previously organized *zanjeras* (Bagadion and Korten, 1985: 86; see also Angeles, 1983). But for this external intervention, NIA might well have destroyed more farmer organizations in this one project than had been established or strengthened under the experimental program.

Evaluations of irrigation programs undertaken by NIA after the experimental participatory program had proven itself also provide evidence that centralized decision making continued as the dominant mode of decision making within NIA even after the participatory program was acknowledged as a success. In the 1980 evaluation of the Philippine Small-Scale Irrigation Projects, for example, the evaluators criticized USAID for its cost/benefit methodology and NIA and the Farm System Development Corporation for their ineffective interactions with farmer organizations.

The methodological criticism contained in this evaluation is interesting for what it tells us about the tendency to overestimate benefits on donor-assisted irrigation projects. Steinberg et al. (1980: iii) point out that the cost/benefit analysis was based on an assumption that farmers would receive the government-subsidized price for rice. This price was offered for rice

⁹ This is the equivalent of 95 pesos per hectare. Small (1985) estimated NIA maintenance costs at about \$14.00 per hectare.

¹⁰ See D. Korten (1980 and 1981) for discussions of the more general approach taken in this project and D. Korten and Uphoff (1981) for a discussion of the problems involved in attempting to convince a central bureaucracy to adopt this kind of program.

to be sold in the export market that was 95 percent pure and had a moisture content of not more than 14 percent. Most of the farmers served by the small-scale projects, however, could not afford the mechanical threshers and driers needed to meet these standards. Consequently, the price that the farmers actually obtained for their rice was substantially lower than the amount projected in the cost/benefit analyses.

With a higher estimated benefit level than could be achieved, planning documents supported larger investments in mechanical pumps and other costly inputs than could be economically sustained. Many of the small-scale irrigation projects dependant upon electric or diesel pumps faced high recurrent costs including fuel and frequent repairs to the pumps due to damage from flooding and fluctuations in electrical current. Farmers also faced higher fertilizer and other input costs in order to obtain the increased yields. Even though gross farm income consistently rose as a result of these projects, net family income did not consistently rise and actually fell in some cases. With double cropping, fewer family members could earn wages in off-farm employment and input costs were substantially higher.

The high level of effective interaction between central government officials and farmers that characterized the experimental projects was not duplicated on the regular, small-scale projects. On one project, it was clear to the visiting evaluators that the "farmers had little idea of what they were facing" (Steinberg, et al., 1980: 4):

They did not know how much their semi-annual payment would be for their substantial loan of 215,000 pesos (\$30,000) at 6 percent over 12 years. Nor could they estimate the project cost of electricity. They had no anticipation of electric current problems or the impact of rising fertilizer prices. Clearly, FSDC [Farm System Development Corporation] extension workers had not adequately prepared the farmers for this undertaking (ibid.).

Among the final conclusions of the evaluation report was the following:

Irrigation systems are not primarily the domain of the engineer. . . Although engineering is necessary for effective irrigation, it is not sufficient. Irrigation projects should not be considered quick and easy means to expend program funds. Irrigation projects should not be developed in capital development offices, but in agricultural offices. As long as capital development offices exist in the field, there will be pressures to regard the spending of funds as more essential than their effective utilization (ibid., 14-15).

This conclusion, written in 1980, could have been authored in 1976 by those who initiated the experimental participatory irrigation program. Seemingly, the message did not reach parallel projects conducted at the same time in the same agency under the same general umbrella program.

An evaluation of the Bicol River Basin Development Program (BRBDP) conducted in 1982 (Sommer, et al., 1982) also leads us to question the capacity of highly centralized agencies to "learn" the lessons of decentralization from even their own experimental projects. The BRBDP was a large-scale, integrated rural development project involving construction of rural infrastructure (roads, irrigation structures, water supply systems) with broad objectives including a substantial increase in the socioeconomic well-being of the population living in the Basin. By 1982, USAID had made two grants and five loans totalling \$30.4 million and the Government of the Philippines had invested about \$75 million in the project (Sommer, et al., 1982: iv). To the broad set of objectives was added "a set of institutional innovations calling for decentralized decision making, local people's participation, and a multisectoral and integrated area approach" (ibid., iv). The 1982 evaluation was conducted after the program had been in existence for eight years, during which time a "large staff and institutional infrastructure have been put into place

and numerous plans and studies have been produced" (ibid., v).¹¹

But the "weak point in the institutional chain," according to the evaluation team, "is a critical one: The farmers, on whose behalf the whole program is conducted, have not participated in anything but a passive sense" (ibid., 14). NIA officials appeared to recognize this problem in those project areas under its control and assigned COs to several project areas overtly based on the experimental program described above. In several project areas visited, the evaluation team was impressed with the performance of the COs but ruefully pointed out that "NIA is already beginning, apparently for budgetary reasons, to reduce the number of its community organizers in some areas of the Bicol" (ibid., 14).

Furthermore, the evaluation team discovered that many pre-existing community groups were bypassed, or even dismantled, in favor of newer and larger groups created by top-down initiatives. As many as 26 pre-existing irrigators' associations had been recognized in one region of the project, but the "superimposition of new physical facilities and consequent realignment of membership areas" made for dramatic changes (ibid., 14). The leader of one of these associations indicated his misgivings by stating that "When lawyers and other government officials speak, everyone applauds. When farmers speak, no one listens. This is what has been happening in Bicol" (ibid., 14).

An appendix to the evaluation that focuses entirely on the participatory aspects of the Bicol project illuminates some of the possibilities and contradictions of attempting to decentralize within the context of a centralized program. The evaluation does not question the sincerity of NIA officials in trying to change the ways that they related to farmers. Several references are made to lessons learned from the prior experimental program. The use of COs was positively received by the farmers, and the COs themselves were en-

thusiastic about their work. Some felt that the technical staff at NIA considered the work of the COs a "nuisance cost" but thought that more doors were opening. One CO indicated that the most rewarding part of her job was in the field working directly with the farmers. "When in the project office, I get the feeling that the engineers do not really see any need for our work" (ibid., F-8). She further reflected that she felt a little guilty at times because her sympathies were with the farmers: "they are not getting water; the designs are faulty; construction is delayed—and yet I get my salary from NIA, and I want to defend it as well" (ibid.). A somewhat more jaded CO expressed her misgivings in the following manner: "We are not doing CO work, we are PR officers for NIA. What we do is sell a project. We often find ourselves in sympathy with the people, but then, we are NIA employees" (ibid., F-7).

A further example of both the sustained interest by high-level NIA officials in trying to affect a change in the way their agency operates and the difficulties of accomplishing major changes from the center is provided by the experience with organizing irrigators' associations on the Magat River Multipurpose Project (MRMP). The MRMP is one of the two largest systems in the Philippines and irrigates approximately 100,000 hectares. Both the World Bank and the Asian Development Bank provided loans in support of this project. "To justify its huge cost, the irrigation aspect of the project was required to attain a 200-percent rice cropping intensity within five years after project completion; to increase the average yield from 2.7 tons of paddy per ha [hectare] to 4.2 tons per ha per crop season; and to increase the net income of the farmer beneficiaries during the same period" (Bautista, 1987: 9). In the early years of the program, small, informal farmers' groups were organized to rotate water to individual holdings and to conduct routine maintenance of field canals. By 1980, over 1,500 of these groups had been officially organized. A survey of their activities found that only 50 percent of these

¹¹ At a later point in their evaluation, the team noted that the Program Office had become a "coordinator of committees, a receiving point for project reports, and only occasionally a packager of project proposals and solver of problems facing Basin projects. This appears a modest role for a 421-member staff. . . with a 1981 budget of more than \$1 million" (Sommer, et al., 1982: 13).

groups were actively engaged in water distribution activities. In that year, a major policy decision was made by the Agricultural Development Coordinating Council (ADCC)¹² to establish its own internal experimental program using many of the lessons learned from the experimental program involving communal irrigation systems discussed above (see Merry's forward in Bautista, 1987). The program adopted by the ADCC involved a less intensive use of "catalysts" than the earlier experimental program on communal systems. The catalysts, called Irrigation Association Advisors, were graduates in agriculture who were hired to provide agricultural advice to farmers and to assist them in organizing themselves.

A report describing this effort has been written by Honorio B. Bautista, the first recipient of an IIMI Special Award given to "irrigation professionals who have tried innovative approaches for improving the performance of irrigation systems." Bautista was asked to document his efforts to organize farmers as the Manager of the Agricultural Development Division of MRMP since 1976. His account provides a frank assessment of the considerable successes that his division achieved in organizing farmers along with the continued difficulties he and others have faced.

The first MRMP effort to federate the existing, small, informal, farmer groups into formally recognized Irrigation Associations (IAs) occurred toward the end of 1980. By April of 1986, 240 IAs had been established with 20,198 members who cultivated about 42 percent of the project service area or 40,766 hectares (Bautista, 1987: 5). Several incentives have helped to increase the participation of IA members in routine maintenance and in the collection of irrigation fees. Under this program, 138 IAs cleaned out specified sections of channels and were reimbursed a standard rate per kilometer per month.¹³ An overt performance evaluation of the maintenance work performed by IA members as compared to NIA

employees (dichtenders) and private contractors found the IAs' performance roughly equivalent to that of the other two groups (Bautista, 1987: 24-25). A collection incentive fee of 2.5 percent was given to each IA whose members paid 75 percent or more of the total fees owed to NIA. Those associations collecting 100 percent of the fees were rewarded with a bonus of 3 percent of the total collected.

The program to establish IAs on a large-scale, national project has had some notable successes. A major accomplishment is a direct savings (without any reduction in quality of maintenance) to NIA for maintenance activities undertaken by the IAs. In 1986, NIA paid a ditchtender assigned to maintain one section 17,000 pesos for the year; it paid an IA with similar responsibilities only 7,200 per year. The total savings to NIA was 900,900 pesos, most of which was reallocated for the repair of canals and the construction of farm roads (Bautista, 1987: 23). The money allocated to the IAs has been spent for a variety of purposes, but many of the associations have purchased residential lots and constructed concrete platforms that can be used by farmers to dry their rice.¹⁴

A careful reading of Bautista's report leads one to appreciate the considerable success of this program in reducing the out-of-pocket costs of maintenance, in creating strong farmer associations to enhance the productivity of the farmers, and in enhancing the likelihood that an investment in an irrigation system will be sustained over time. The report also illuminates the problems of accomplishing these substantial results within the context of a large, centralized agency. Simply getting the farmers to join the IAs has been challenging because the attempt to create them came long after the project was constructed.

The farmers at MRMP did not invest a single cent in the construction of the system. They were not even asked to contribute labor in the

¹² The ADCC was a coordinating body established to meet the requirements of the loans funding the project and involved all the major provincial agencies that were affected by the project. Monthly meetings were held to discuss the problems facing farmers in this project and to determine overall project policies.

¹³ The length of canal was based on the prior contract between NIA and a ditchtender to clear a specific length.

¹⁴ Achieving accountability in the use of these funds has not been easy. Earlier efforts to establish farmer cooperatives in the area had failed largely because account books were not required and officials were unwilling to hold individuals responsible for the misuse of funds. Bautista frankly addresses this problem and the techniques that MRMP has adopted for increasing accountability and gaining the confidence of the farmers that their IA funds will be handled honestly and fairly.

construction of the farm-level irrigation facilities. The IAs were organized after these facilities were constructed and water was flowing to their farms. Therefore, many members do not have the problem of getting water—the key function that binds people together in systems that were designed and constructed by the water users themselves, such as the 'Zangieras' of Ilocos Norte . . . (ibid., 20).

Farmers have been reluctant to join IAs. The ones that have been created are "located primarily at the middle or tail-end portions of irrigation canals, where insufficient and untimely water delivery was a common problem" (ibid., 29). Even where IAs are organized, farmers located near the headgate or who are rich enough that they do not need credit have refused to join. Persons interviewing these farmers have been told: "Why should I join an IA when both non-IA members and members pay the same amount of [irrigation fees] and receive a similar amount of water in the system" (ibid., 30). A member has to participate in the cleaning of the canal as well as in its emergency repair. A nonmember gets all the benefits without paying the costs. Consequently, the officials of the IAs have requested that membership become compulsory.

Further problems occurred within NIA itself. One of these was the insecurity of those responsible for organizing the IAs. During a budget crunch, 15 of the 19 trained Irrigation Association Advisors were laid off, and 15 untrained but permanent civil servants were transferred into the unit (ibid., 30-31).¹⁵ Furthermore, neither the Irrigation Association Advisors nor the IAs were assured of cooperation from the NIA employees assigned to the Operation and Maintenance (O&M) Division.

. . . most of them were afraid of having strong IAs that would take over their work after the project. Their suspicion became stronger when the Management started turning over to the IAs some Ditchtender Sections for partial O&M. Some Ditchtenders were transferred to other places while those who retired were not replaced. Their fear grew stronger when the

area covered by a Water Management technician was increased from 500 ha to 1000 ha due to the retrenchment policy of NIA. These changes made the work of the IA organizers more difficult and frustrating (ibid., 31).

Bautista concludes his report with the observation that MRMP has "just scratched the surface" of what is possible in developing effective IAs and warns that the achievements could be only "temporary in nature" and could "disintegrate the moment present assistance is withdrawn" (ibid., 38).

Conclusion

The problem of inadequately maintained infrastructures has often been attributed to the ineffectiveness of overly centralized, national agencies assigned responsibility for infrastructure development. Decentralization reforms inspired by this diagnosis have encompassed a wide variety of strategies. They have included: shifts in decision-making authority, both within national agencies and, at times, to organized beneficiaries; minor forms of deconcentration of authority within single agencies; and major shifts of decision-making authority to citizens. Most decentralization efforts in developing world settings, however, have involved efforts to shift decision-making authority to lower levels within a national agency and to create a mediation organization that enhances communication between beneficiaries and officials. Remarking on the longer-term outcomes of decentralization programs, Rondinelli, Nellis, and Cheema (1984: 27) reflected a general disenchantment among development professionals when they concluded that "Despite its vast scope, decentralization has seldom, if ever, lived up to expectations".

In this chapter, we have examined several decentralization efforts in the Philippines that were considered successful upon completion in an effort to understand what they accomplished and to assess their long-term impact. With regard to PDAP, it is hard to discern any long-term impact except, perhaps, an increased desire on the part of provincial officials for more autonomy. Regarding efforts to involve farmer

¹⁵ At least one of the Advisors was so valued by two of the IAs with whom she had been working that they hired her using their own funds after she was laid off by NIA.

participation in NIA decisions, the success of the original experimental program led to still further efforts within NIA to apply the lessons learned. These follow-on efforts also led to short-term achievements conducive to the sustenance of rural infrastructures, such as high levels of compliance with rules requiring the payment of operation and maintenance fees. On the other hand, the evaluations of several other NIA projects, including the Bicol River Basin Development Program and the Philippine Small-Scale Irrigation Projects, present a view of an arbitrary, centralized agency making decisions that deeply affect the future livelihood of the farmers using an irrigation system with little or no effort to involve them. Furthermore, the history of one of the participatory programs, the MRMP, written by a NIA official honored for his innovative and successful work, reveals the difficulties of achieving a really different style of decision making in an agency that fires three-quarters of its trained Advisors and sees itself threatened by the transfer of work assignments from lower-level civil servants to organized farmers.

In her many writings about this important effort, Frances Korten has repeatedly stressed the difficulties involved in reorienting large-scale bureaucratic agencies so that they will seek out the involvement of those who are supposed to be the beneficiaries of these programs (see in particular, F. Korten, 1983). Korten argues that major changes must be made in four aspects of agency management before one can gain a real shift in operational results. These include: (1) changing the locus of decision making; (2) changing the rewards built into evaluations of personnel; (3) changing the stability of personnel assignments; and (4) changing the attitudes, values, and skills of personnel (F. Korten, 1983).¹⁶ The external evaluations made by Steinberg et al. (1980) and Sommer et al. (1982) are consistent with Korten's analysis, as is the internal view of Bautista (1987). The first three variables in Korten's list relate to the institutional arrangements

that affect the incentives facing agency personnel. The fourth variable—the attitudes, values, and skills of personnel—is strongly affected by these incentives.

A recently published volume by Frances Korten and Robert Siy (1989) on *Transforming a Bureaucracy, The Experience of the Philippine National Irrigation Administration*, provides an important overview of the entire NIA experience. Many positive accomplishments both by farmers' organizations and by the NIA itself are well documented. The participatory program is one that has been able to sustain itself over time due to many subtle and some not so subtle changes in institutional arrangements. A major change has been the regular crediting of farmers' amortization payments to the NIA itself rather than to the national treasury. Provincial irrigation offices that were successful in achieving overall financial viability were able to retain 20 percent of their surplus to be allocated with considerable discretion including a limited incentive bonus to provincial NIA staff. In a chapter focusing on bureaucratic change in this volume, David Korten reflects on the overall effort to change the internal bureaucratic structure:

The root causes of underdevelopment are institutional. They are eliminated only through the transformation of inappropriate organizational structures. The NIA experience demonstrates the difficulty and the complexity of the task. It also demonstrates the possibilities and illustrates appropriate methods (ibid., 142).

We share the conclusion of many analysts that overcentralization of infrastructure decision making is one of the major sources of widespread difficulty in sustaining of rural infrastructures in developing countries. We are skeptical, however, that retaining central authority in a more decentralized form is as

¹⁶ Korten also points to five factors related to the communities involved that may prove to be obstacles to the long-term success of efforts to involve communities more actively in decision making affecting their own welfare: (1) lack of an appropriate community organization; (2) lack of organization skills; (3) poor communication facilities; (4) factionalism and differing economic interests; and (5) corruption. Korten's reflections are based not only on her experience in the Philippines but also on the work of Gomez and Myers in Venezuela, of both Maru and Gupta in India, of Maeda in Tanzania, and the general theoretical work of David Korten. (Case studies by these authors based on experience in the above countries are found in D. Korten and Alfonso, 1983.) Her work is also consistent with the findings of Meyers (1981) concerning decentralization efforts in Kenya.

effective in coping with infrastructure deterioration as other forms of “noncentral” decision making. We agree with the Kortens that “incentives” are at the core of the problem. Analysis of incentives and their consequences requires a more theoretical approach to the study of institutions and the incentives they produce than has characterized much of the literature on infrastructure sustenance. To understand incentives, one needs to understand how individuals who are interdependently linked are affected by the kind of information they possess, by the kinds of goods and services being provided and produced, and by the kinds of rules they use.

Problems of Multi-actor Capital Investments

WHEN A capital investment is owned by a single user as described in our first example in Chapter 2, and that individual derives the benefits and bears the costs of replacement and maintenance, it is reasonable to expect that the individual will continue to make investments in maintenance as long as the expected returns from this investment are greater than the expected costs.¹

As our examples from Jamaica, Sri Lanka, Bangladesh, Nepal, Malawi, and the Philippines illustrate, however, the sustenance of public infrastructure depends upon decisions made by many different actors who do not derive all the benefits nor bear the full cost of replacement and maintenance. Those who design or finance rural infrastructure facilities are frequently not the same individuals who construct, operate, maintain, and/or use them.

Those who use or maintain the facilities are seldom motivated to contribute as many resources to maintenance as they would be if they were the only beneficiary and contributor. The incentives facing various participants when planning infrastructure may differ from the incentives involved after construction. Furthermore, some individuals act as agents for

others, and the interests of the agent may differ from those of the principals. Coordinating the actions of diverse actors requires considerable expenditures of time and other resources devoted to the process of gaining agreement, monitoring activities, and evaluating performance. Thus, situations relevant to understanding infrastructure maintenance problems are far more complex and uncertain than that depicted in the initial model of capital investment we presented in Chapter 2.

Similar problems related to the uncertainty of the environment, the lack of relevant information, and the diverse interests of participants have been analyzed by scholars working in a tradition referred to as the "new institutional economics." Drawing on the seminal work of Frank Knight (1921), Ronald Coase (1937), John R. Commons (1959), and Herbert Simon (1946; 1972), scholars such as Oliver Williamson (1975; 1985) and Douglass North (1985; 1986) have challenged the validity and usefulness of assumptions about human behavior and the lack of attention to institutional arrangements that characterizes neoclassical economic theory. Most of the work in the new institutional economics has analyzed a diversity of factors that affect the type of contract or agreement

¹ This is not to imply that all private owners of capital behave identically in their maintenance decisions. Different persons face different relative prices, possess more or less information, perceive the benefits of maintenance differently, or have different discount rates and risk adversity.

that participants will select when they attempt to achieve long-term, joint benefits in an uncertain environment, while keeping total costs, including transaction costs, low.²

A fundamental working assumption used in this approach is that the performance of various types of institutional arrangements varies substantially depending on the particular types of problems to be solved—an assumption shared by the authors of this study. Incentives are the combined result of the set of rules (the type of contract) adopted to reward and constrain the benefits and costs of diverse activities. Prior work in this tradition has emphasized lack of information, opportunistic behavior, and uncertainty and has focused on the performance of diverse organizational forms used primarily in the private sector.

Many of the problems identified by this approach also characterize rural infrastructure development. Although still further problems are associated with the public nature of various attributes of rural infrastructure, it is useful to begin our analysis of the problems involved in achieving rural infrastructure sustenance by focusing on those problems that have been analyzed in the new institutional economics literature. In the remainder of this chapter, therefore, we concentrate on the problems of information, coordination, and control that stem primarily from the fact that rural infrastructure decisions involve multiple actors with different interests in long-term, complexly interdependent, and uncertain processes. In Chapter 5, we identify still further problems regarding rural infrastructures that arise because of the public nature of these goods and services. Due to the complexity and uncertainty of the situations we analyze, we use a model of the individual based on an assumption of bounded rather than extreme rationality.

Because this and other key working assumptions we make about human behavior differ from those used in many contemporary policy analyses, we will begin with a brief discussion of these assumptions.

Assumptions about the Individual

An impressive edifice of theory about human choice and its consequences has been constructed and usefully applied to situations that are characterized as certain or involving known risks (von Neumann and Morgenstern, 1953; Arrow, 1970; Arrow and Hahn, 1971). Axiomatic choice theory makes a series of assumptions about the individual as well as about the decision situation the individual confronts. The assumptions about the individual decision maker include complete information about the situation, well-behaved preference functions defined over all outcomes, and maximization as the objective. Individuals are faced with a finite set of alternatives that clearly lead to known outcomes that can be evaluated using a single underlying preference function. A typical decision situation is one in which all the consumers who decide how much of various goods to purchase in a market or the producers who decide how much of various goods to produce or sell have full information about the price and the characteristics of all goods.

It is frequently thought that the appropriate assumptions made about the individual are independent of the type of situation involved in an analysis. Thus, many scholars have presumed that, as one branches out from consumer and producer choices under certainty to more complex situations, the assumptions made about the individual developed in the initial theories should be maintained. The only thing changed are the assumptions made about the structure of the situation. Although the assumptions about the situation need to be changed, the assumptions made about the individual are thought to be general or universal.

A considerable amount of scholarly work has challenged the empirical validity and theoretical usefulness of viewing the assumptions made about the individual in axiomatic choice theory as the fundamental building block for a more general theory of human choice (Tversky and Kahneman, 1986; Nelson and Winter, 1982; Simon, 1972, 1987; Williamson, 1975, 1988). These empirical and theoretical challen-

² See Adelman and Thorbecke (1989) for a recent review of this literature applied to the role of institutions in economic development. See also Nabli and Nugent (forthcoming).

ges have been interpreted in different ways. Some scholars challenge the validity or usefulness of the assumptions made about the individual in axiomatic choice theory in any setting. Others have defended these assumptions against the empirical challenge arguing that it does not matter that the assumptions are patently false, since they are useful in generating predictions (Friedman, 1953).

We prefer to view these assumptions as quite reasonable working assumptions when one attempts to explain behavior in situations that approximate the "classical environment" for which these theories were originally developed. When individuals (1) face a finite number of known alternatives that are (2) tightly linked to outcomes that (3) have already been experienced and thus evaluated, and when (4) no single individual can make a noticeable impact on aggregated outcomes, the context in which decision making takes place is such that these assumptions about the individual are valid and, therefore, very useful.

Even when a particular situation does not quite meet all of the above conditions, it may still be useful to utilize the assumptions of axiomatic choice theory to construct an initial working model that predicts how individuals will behave and the consequences of this behavior (Koopmans, 1968). Thus, in our own attempt to understand infrastructure development processes, we sometimes begin with a single actor, posit known alternatives tightly linked to known outcomes, and presume a choice process of maximization of expected utility. This turns out to be a useful starting point for analyzing many situations.

As the complexity of the decision situations that individuals face increases and when the choices made by one individual are strongly affected by the choices made by others, the assumptions of axiomatic choice theory become less and less useful and should be altered. We wish to retain, however, the classical

political economy view that an individual's choice of strategy in any particular situation depends on how the individual views and weighs the benefits and costs of various strategies and their likely outcomes (Radnitzky, 1987). In our view, the costs and benefits that are taken into account are perceived costs and benefits. They include the time and resources devoted to establishing and maintaining relationships (Williamson, 1979) as well as the value that individuals attach to establishing a reputation for being reliable and trustworthy (Breton and Wintrobe, 1982). Furthermore, the individuals who calculate benefits and costs are fallible learners who vary in terms of the number and type of other persons whose perceived benefits and costs are important to them and in terms of their expressed opportunistic behavior.

Fallible learners can, and often do, make mistakes. For example, it was noted in the last chapter that the format of the profiles prepared by NIA regional staff and used in making investment decisions was changed over time as experience was gained. Mistakes are bound to occur in any uncertain setting; what is crucial are institutional incentives and rules that allow persons to learn from these mistakes. Fallibility and the capacity to learn can then be viewed as the assumptions of a more general model of the individual.³

When fallible and learning individuals interact in frequently repeated and simple situations, it is possible to model them as if they had complete information about the relevant variables for making choices in those situations. In highly competitive environments we can make the further assumption that the individuals who survive the selective pressure of the environment act as if they are maximizers (Alchian, 1950; Dosi and Egidi, 1987). When individuals are in a relatively simple situation where institutions generate accurate information about the variables relevant to a particular problem, the problem can be adequately represented as a straightforward, constrained maximization problem.

³ We thus share with David C. Korten (1980) a presumption of human fallibility and the capacity for learning, without sharing a presumption that the collective learning processes of all organized individuals are best described by a predefined set of stages. We presume that the various institutional arrangements that individuals use in relating to infrastructure facilities provide individuals different incentives and opportunities to learn. In some institutional settings, the incentives facing individuals lead them to repeat indefinitely the mistakes of the past; while in others, the rate of effective learning about how to make efficient and equitable infrastructure decisions is rapid. It is also the case that the repertoire of institutional design principles known to individuals also affects their capacity to change their institutions to improve learning and other outcomes when faced with repeated failures.

Many of the situations of interest in understanding infrastructure maintenance are uncertain, complex, and lack the selective pressure and information generating capabilities of a competitive market. Thus, we substitute the assumption of bounded rationality—that persons are intendedly rational but only limitedly so—for the assumptions of perfect information and utility maximization used in axiomatic choice theory (see Simon, 1965, 1987; Williamson, 1985). Because information search is costly and the information processing capabilities of human beings are limited, individuals frequently make choices based on an incomplete knowledge of all possible alternatives and their likely outcomes. With incomplete information and imperfect information processing capabilities, all individuals are capable of making mistakes in choosing strategies designed to realize a set of goals (V. Ostrom, 1986). Over time, individuals can acquire, however, a greater understanding of their situation and adapt strategies that result in higher returns.

Individuals do not always have access to the same information that is known by others with whom they interact. How much any one individual contributes to a joint undertaking is, for example, difficult for others to judge. When joint outcomes depend on multiple actors contributing inputs that are costly and difficult to measure, incentives exist for individuals to behave opportunistically (Williamson, 1975). Opportunism is deceitful behavior intended to improve one's own welfare at the expense of others. It may take many forms from inconsequential, perhaps unconscious, shirking to a carefully calculated effort to defraud others with whom one is engaged in on-going relationships. The opportunism of individuals who may say one thing and do something else further compounds the problems of uncertainty inherent in a given decision situation. The level of opportunistic behavior that may occur in any setting is affected by the norms and institutions used to govern relationships in that setting as well as by attributes of the decision environment itself. Later in this chapter we will discuss some of the norms found in developing world settings that

impinge on the level of opportunistic behavior expressed in various situations.

Environments vary in terms of how difficult it is to overcome the insufficiency of or the biases in available information as well as to reduce the opportunities to shirk or otherwise fail to meet fully prior understandings. The rules that individuals use for relating to one another in these situations enhance or exacerbate the quality and type of information they obtain and thus influence the type of actions they take. Both the initial structure of an environment and the institutional arrangements in use affect how and how well individuals learn about the relevant variables affecting their well being and how to do as well as they can to achieve their objectives in that environment. By overtly assuming bounded rationality and opportunism, one is led to explore how information, coordination, and control problems can be reduced.

Problems of Contractual Uncertainty and Transaction Costs

When multiple individuals are involved in environments where complex activities must be coordinated across space and over time, they may attempt to reduce the substantial uncertainties they face through various forms of implicit or explicit agreements. Contracts are simply the arrangements to which individuals agree for the direct or indirect exchange of any valued activities or objects for other activities or objects. Contracts are involved in all phases of infrastructure development from the initial agreement about the design and financing of a project through to the various forms of agreements (including tenders and employment contracts) involved in the operation, use, and maintenance of infrastructure facilities.

All contracting involves costly activity expended in the processes of achieving agreements *before* and continuing to coordinate activities *after* an initial agreement is reached in any uncertain environment. As experienced by individuals contemplating establishing a contractual relationship, these costs are per-

ceived as obstacles to the choice of a particular contract. Oliver Williamson (1985) identifies the costs associated with contracting activities as *ex ante* and *ex post* transaction costs.⁴ *Ex ante* transaction costs are largely coordination costs that exist to a greater or lesser extent whenever individuals engage in long-term relationships, even when they have the same objectives and refrain from all opportunistic behavior (see Marschak, 1971). *Ex ante* costs include at least the following:

- the resources spent in obtaining the relevant information needed to plan any long-term undertaking;
example: the resources spent investigating the technical feasibility of constructing a major capital facility such as a dam or highway and obtaining information about potential demands and benefit levels;
- the time and other resources spent in negotiating agreements among participants who may differ substantially in regard to their preferences, resources, and information;
example: the time devoted to negotiating an agreement between a donor and a host government concerning the type and location of infrastructure facility to be constructed, who will pay what proportion of the construction, operation, and maintenance costs, and how performance will be monitored;
- the resources spent in side-payments to gain the agreement of those who oppose a particular undertaking;
example: the subsidies awarded to supporters of legislators from urban areas to win their support for infrastructure projects that benefit primarily rural areas; and
- resources devoted to communicating with all relevant parties;
example: the costs of public tender announcements at the time of contracting for the construction of a project.

If it were possible for participants to envision all future contingencies, reach prior agreement about how they should be handled, and develop enforceable contracts, all transaction costs involved would be expended prior to agreement. Because these conditions are rarely met, *ex post* transaction costs are nearly always involved in long-term relationships involving multiple actors. Examples of *ex post* transaction costs include:

- monitoring the performance of participants;
example: the resources expended to inspect the work of contractors, demand replacement of faulty work, audit financial records, and ensure that deadlines are met;
- sanctioning and governance costs;
example: the costs expended in legal actions related to disputes about contractor, employer, or employee performance or devoted to establishment of organizations to govern on-going relationships among participants; and
- renegotiation costs involved when an initial agreement does not adequately deal with the problems that actually arise in practice;
example: the resources expended in gaining a new donor-host government agreement after an adverse project evaluation report or in restructuring an operating agency that is not performing an operation and maintenance activities effectively.

Some *ex ante* and *ex post* obstacles to contracting exist as a result of the potential for opportunistic behavior by participants in environments characterized by risk. The problems of adverse selection, moral hazard, shirking, free riding, and corruption all result from individuals' efforts to improve their own outcomes by consciously or unconsciously misleading others. We will refer to this subset of transaction costs as *strategic costs* to distinguish them from those transaction costs derived from the inevitable time and effort of negotiating, monitoring, and enforcing the

⁴ Cheung (1983: 3) defines transaction costs as "the costs of operating institutions." Most modern work on transaction costs traces its origin to the work of Ronald Coase (1937) who recognized the pervasiveness of transaction costs in all forms of coordination and argued that the choice of one form of contracting (the organization of a firm) would be selected over another form of contracting (exchange in a market) when the transaction costs of the first type of contract were less than the transaction costs involved in the second.

terms of a contractual agreement. A third type of transaction costs derive from the difficulties participants incur in acquiring and integrating information used in reaching decisions in the contracting, monitoring, and enforcement processes. Information search costs are closely related to strategic and coordination costs. The more information each party has about the characteristics of the other parties to an agreement, and the time and place context of the activities to be undertaken under the agreement, the lower the strategic costs to which they are likely to be exposed. The more transparent the nature of the potential hazards for all participants is, the easier it may be to decide on the terms of a contract, including the necessary monitoring and enforcement provisions. Institutional arrangements that help to generate information or distribute it thus serve crucial roles in reducing all types of transaction costs.

Given the crucial role information costs play in contracting activity, it is not surprising to find that serious obstacles to the development and maintenance of appropriate infrastructure facilities are associated with the difficulties of acquiring and integrating the necessary information. Information acquisition problems derive both from the characteristics of information itself and from its distribution in the world. Not only do important differences exist in the various types of information needed for infrastructure-related decisions (each type poses distinctive difficulties for those who must acquire it), but all types of information are asymmetrically distributed among those who will be involved in the development, operation, use, and maintenance of a given facility. In the following section we will focus on the difficulties posed by two major information problems. In subsequent sections we consider the importance of family and kinship structures for communities in developing countries that typically lack the institutional arrangements that minimize information problems. We also consider those arrangements that help to resolve disputes fairly that can be expected to arise from the absence of adequate information among contracting parties.

Information Asymmetries as Sources of Contractual Uncertainty

The information problems of relevance to understanding why rural infrastructure facilities are not maintained extend beyond those of inadequate initial

information and the need to learn more about the relevant situation. Decision makers concerned with infrastructure development may have different types of information available to them; likewise, the amounts of information available are likely to vary among participants. We begin our examination of the problems deriving from information asymmetries with a discussion of the problem of acquiring and integrating time and place information with scientific information in decision making. The more highly educated employees of public bureaucracies, in particular, are frequently unaware that they lack time and place information or that the absence of this type of information constitutes a problem in public decision making. Therefore, they have often been much less concerned about devising means of coping with this particular type of information asymmetry.

Time and Place Information and Scientific Knowledge

We assume that two types of information are used by individuals in making choices related to infrastructure development: time and place information and scientific knowledge (Hayek, 1945). Both types of information are needed in any effort to develop infrastructure that is sustained over a long time.

Time and place information is acquired by individuals living in an environment who come to know the nature of a specific physical and social setting. Examples of time and place information used in infrastructure development include knowledge of: (1) local social and physical environmental characteristics; (2) various types of production strategies employed in a region; (3) existence of physical capital presently underutilized in an area; and (4) existing institutional arrangements that could be used to construct or maintain infrastructure facilities. Scientific knowledge is acquired by individuals through education and/or experience about the *regularities* of relationships among key variables rather than the particular state of those variables in a specific context. The scientific knowledge conveyed in engineering schools, for example, is necessary in the design of large-scale capital structures such as dams, road networks, power plants, etc.

The "scientific knowledge" most donor organizations and ministry officials are eager to bring to bear

on development is that generated in Western research facilities. An understanding of regularities is, of course, not absent from local communities, including regularities highly relevant to engineering projects (see Brokensha, Warren, and Werner, 1980; Chambers, 1979; Horton, 1967). In most instances, however, communities could benefit from the application of some ideas generated by modern science. Combining relevant local knowledge with Western science should be the objective of all infrastructure development efforts.

Neither scientific nor time and place information alone is sufficient in the design of rural infrastructure that is likely to be sustained over the long term. Use of Western scientific knowledge alone is likely to produce engineering marvels that languish underutilized, consuming more resources than they produce. Use of local scientific and time and place information alone may produce faulty structures that cost more to construct, operate, and maintain than well-designed alternatives.

Actors are likely to have differential access to these kinds of information and are likely to weigh them differently when making decisions about infrastructure development. Irrigation Department engineers are likely to have had extensive formal engineering training and to believe that they know how to design irrigation works that will produce the largest possible regular flow of water from any particular source of water. They frequently view any waterworks constructed by farmers as not worthy of attention because the channels are frequently not laid out in an optimal pattern. Farmers, on the other hand, know a great deal about the specific behavior of a local water source at different times of the year and have frequently developed existing channels and diversion works that reflect carefully negotiated property rights in land and water. Farmers have been known to replace modern, efficient, cement weirs with their own primitive, "inefficient," wooden structures as soon as the engineers have completed a rehabilitation project when the "improved" structure did not allocate

water to various channels based on established water rights (Coward, 1980).

Making these two types of information available to the relevant decision makers poses significantly different problems. The newest scientific information regarding infrastructure design and operation is usually developed by a relatively small number of people. The problem here is how to make this available to widely dispersed communities that could make use of it. Time and place information is by definition widely dispersed; the problem is how to aggregate it and make it available to a relatively small number of relevant public officials. The problem of aggregating time and place information is frequently more difficult than that of dispersing scientific knowledge. Thus, for example, a single road design was used in the Jamaica road project rather than altering the design to fit particular local circumstances.

When one's job depends on pleasing superiors rather than local villagers, little motivation exists to acquire extensive accurate time and place information or local scientific knowledge. An example of the types of problems involved in transmitting simple delivery information upward in an agency-managed irrigation system in Indonesia was recently provided by John Colmey:

The source rivers in Indonesia are short and relatively fast. . . . The gate keeper is expected to read the gauges during the delivery period. . . . However, when I looked at the data in the manager's office and saw that flow rates over a series of issue periods almost exactly equalled the planned rates, I told the manager that it was not possible.

When we followed the feedback from the gate keeper upward, we found the data changed hands three or four times verbally or on slips of paper, and that, by the time it reached the chain of command, it exactly equaled the scheduled flow rates. The system was almost, at least on paper, 100 percent efficient (Colmey, 1988: 7).

Once officials are rewarded for reporting work performed in conformance to the plan or not sanctioned for inaccurate information, a vicious circle of inaccuracy can reinforce itself over time. Colmey points out that the higher-level irrigation officials in Indonesia usually "do not use the field data as it is not considered accurate, and the field staff collecting the information don't concern themselves with accuracy because the information isn't used" (Colmey, 1988: 7).⁵

The management of large irrigation projects is in the hands of public officials who are too far removed from the on-farm situation to know the conditions of efficient use, who lack economic incentives to achieve it even if they knew how, and who typically are bound by inflexible operating rules of water allocation impeding their response to economic incentives even if they had them.

In contrast to a lack of motivation and biases in transmission, which are the primary problems in the aggregation of time and place information, illiteracy and inadequate education are the major hindrances to the dispersal of technically sophisticated knowledge. Even in a largely illiterate community, however, the dispersal of improved technical information may still not be as difficult to accomplish as the aggregation of accurate time and place information to nonlocal decision makers. Farmers can gain substantially from the acquisition of relevant technical knowledge that increases their control over nature and, thus, the chances of improving their circumstances.

A key task of institutional design is the development of rules that enhance the likelihood that both types of information are brought to bear in the various

phases of infrastructure development. Levine (1980) describes an extremely successful, irrigation governance system in Taiwan structured to make officials far more aware of and sensitive to the particular events in a specific location. As a regular practice, irrigation officials must meet with intermediaries popularly elected by farmers to discuss broad policies and specific problems. All irrigation officials are subject to a performance rating. Furthermore, the "common irrigators" who actually open and close the irrigation gates are given technical training by agency personnel, but are responsible to and paid by the farmers.

This type of interaction between agency personnel and farmers has led to specific changes in the operation of the system that take into account both scientific and time and place information. For example, the design engineers of one system had planned to line the major channels in order to enhance the efficiency of water delivery. They estimated that water losses would be cut by 40 percent, and therefore recommended that water deliveries to the farmers be cut by 40 percent. The irrigation officials responsible for managing the system objected and insisted that field data be collected before any reduction of water deliveries went into effect. Field data substantiated the fears of the management officials. After the channels were lined, the amount of water delivered to the area was reduced but the final reduction was based on field data, rather than on the design projections. The consequent increase in efficiency tended to offset the reduction in water delivered without the adverse affect on the farmers that the originally proposed cutback would have had. Further, because the farmers were responsible for the maintenance of the smaller channels of this system, they noticed that lining the chan-

⁵ This is neither a recent nor a highly localized problem as is reflected in the following assessment by Crosson (1975: 522): "The management of large irrigation projects is in the hands of public officials who are too far removed from the on-farm situation to know the conditions of efficient use, who lack economic incentives to achieve it even if they knew how, and who typically are bound by inflexible operating rules of water allocation impeding their response to economic incentives even if they had them."

nels had reduced the amount of maintenance required. After obtaining technical information from system personnel, the farmers embarked on their own program of lining the smaller channels (Levine, 1980: 59).

Institutional arrangements that encourage individuals to acquire both good technical knowledge and good time and place information related to infrastructure development are, unfortunately, rare events in developing world settings (and many Western settings as well). As we will discuss below, it is not possible to provide a single blueprint for a set of institutional arrangements that will accomplish this task. But the Taiwanese irrigation systems described by Levine and some of the experimental Philippine irrigation systems described in Chapter 3 demonstrate that it is feasible to develop incentives that enhance the quality, accuracy, and appropriateness of the information generated from the regular activities of those who operate, maintain, and use infrastructure facilities.⁶

Other Types of Information Asymmetries

Time and place information and the latest Western engineering techniques are but two types of information that are usually not distributed evenly across a population. Other types of information are also commonly much more difficult for some people to access than for others. This is significant because asymmetries can lead to opportunistic behavior whereby the person who knows something that others do not know is able to benefit at the expense of others.

A very general form of information asymmetry occurs when individuals or goods vary widely on essential quality attributes that are extremely difficult to measure without substantial investment in time or other resources. When the attribute is personal, such as good health or well-developed skills, each in-

dividual knows his or her own attributes but finds it difficult to assess those of others without substantial effort. When the attribute relates to the quality of a good, such as an automobile, the owner of the good acquires information about the reliability of the automobile through experience. A potential buyer who lacks this experience, however, cannot know whether the automobile is a "peach" (above average in performance for its age) or a "lemon" (below average in performance for its age) (Akerlof, 1970).

Unless "counteracting institutions" have been devised to cope with these information asymmetries, various "adverse selection" and "moral hazard" problems may occur that substantially increase the costs of transactions. At a minimum, these increased transaction costs can be expected to reduce the volume of beneficial trades or productive activities. At their worst, when no counteracting institutions have been devised, information asymmetries can eliminate some types of mutually productive activity entirely.

The adverse selection problem was first extensively analyzed in regard to the difficulties facing health and life insurance companies. Without counteracting institutions—such as compulsory insurance—no *ex ante* incentives may exist for an enterprise to offer insurance of particular types. Health and life insurance for the elderly is one example. As described in an insurance textbook:

Generally speaking policies are not available at ages materially greater than sixty-five... The term premiums are too high for any but the most pessimistic (which is to say the least healthy) insureds to find attractive. Thus there is a severe problem of adverse selection at these ages (Dickerson, 1959: 333, cited in Akerlof, 1970: 493).

⁶ The process documentation of the Buhi-Lalo rehabilitation and expansion project conducted under the NIA participatory program between 1980 and 1983 in Southern Luzon detailed the benefits of farmers and engineers working together effectively in both the design and construction phases. Farmers were able to reduce the number and total length of irrigation ditches, thus saving on construction costs. More important, their "intimate knowledge of the topography of their area helped fit the ditch designs to the terrain of the area" (Ilo and Chiong-Javier, 1983: 233). Furthermore, all of the ditches performed as planned when operations were initiated. Engineer indicated that this "was rarely the case in nonparticipatory projects" (ibid.). Nor did the farmers later destroy a large number of the constructed channels, a frequent phenomena on nonparticipatory projects. And, on several of the channels, "farmers' groups began to maintain the ditches (which they had started to refer to as *theirs*) when these were made operational. . ." (ibid., 234).

The very process of increasing the price of insurance to cover the added risk of insuring a particular population leads those in that population with positive attributes (good health) to drop out and those in the population with negative attributes (bad health) to search out insurance opportunities more actively. The positive feedback between price increases and adverse selection processes can lead to a situation where it is no longer feasible to offer insurance of particular types without institutional devices that short circuit the adverse selection process.

A similar phenomenon can arise in infrastructure development in developing countries. For example, it is sometimes argued that public credit institutions be created in developing countries to manage revolving funds from which loans to local governments for infrastructure and other projects could be made. Communities that repaid their loans would be eligible to receive additional loans. In order to maintain the integrity of the fund, interest rates would have to be determined largely by the repayment rate. If no additional screening device is put into place prior to initial loan dispersals, one could anticipate that several loans would initially be made to localities that do not anticipate requesting additional loan funds and so are unlikely to repay their initial loans voluntarily. Some poorly governed communities may simply not be able to repay the initial loan. As the defaults mount and the interest rate rises, the fund may attract a larger and larger percentage of applications from communities that have no other credit prospects but who are the least likely to be able to repay a loan. The end result is either the exhaustion of the revolving fund or an astronomical rate of interest that frightens off all but those communities that intend to default on their loans. Either of these outcomes would mean the failure of a municipal credit institution that has been unable to take advantage of the pooling of assets and risks of all local governments.

George A. Akerlof (1970) pinpoints the lack of institutional arrangements that substantially reduce information asymmetry about the qualities that different goods (or persons) possess as a fundamental constraint on economic development. His central point is that without various types of institutional arrangements to help reduce the costs of these information asymmetries, many mutually profitable activities are not undertaken. His "lemons principle"

applies to several phenomena common to developing economies, including the problems of gaining credit and the costs of dishonesty. Three types of "counteracting institutions" used in Western economies—brand-name goods, chain stores, and licensing—are ways of guaranteeing the reputation of some actors and thereby reducing the risk that others must bear in engaging in long-term relationships (see also the safeguards discussed in Barzel, 1982).

To illustrate this argument, Popkin (1981) points out that it is extremely rare to find peasants sharing plough teams among families (or renting them without a driver), even though substantial economies could be achieved:

This is an instance where information problems prevent a form of market from emerging. When plough animals are returned to the owner (or to the collective), it is difficult to determine immediately if they have been overworked, abused, or otherwise damaged. If the water buffalo were overworked or if it has stepped in a hole and cracked a bone, the damage may not show up for several days by which time other persons who had used the animal could therefore have been responsible for the damage...So it is virtually unheard of to see plough animals rented without a driver or plough animals owned cooperatively. There have been, however, times when villagers have owned stud animals cooperatively because the problem of damage caused by overwork or abuse is apparently not so serious. (The amount of work the stud animal will do is roughly proportional to the number of females in the pen.) (Popkin, 1981: 68-69).

Even after a contract has been devised, asymmetry of information may alter the behavior of parties to the contract.

This phenomenon, which is known as the moral hazard problem, has been discussed most extensively in connection with the insurance industry. For example, owners of a building who previously took extensive pains to prevent fires may substantially reduce their efforts after purchasing fire insurance. The insurer who knows only about the previous record of vigilance is unlikely to detect changes in the

owners' behavior without additional investigations.

Problems rooted in information asymmetry arise in many contexts in the developing world. Indeed, as Moe has written:

Moral hazard and adverse selection are general problems whose potential is inherent in all contracting and hierarchical relationships... Consider what happens, for instance, when organizations decentralize. Tasks and authority are delegated to lower-level units in the expectation that they will use their specialized knowledge and productive capacities to contribute toward organizational ends; but the inevitable information asymmetries create incentive problems (Moe, 1984: 755).⁷

Moe goes on to explain how lower level decentralized units can use their superior information about local circumstances to their advantage. The problem of financing infrastructure maintenance provides some good examples of these dynamics. It is common to find higher levels of government providing money to a locality to build a capital facility with the implicit or explicit understanding that the locality will maintain the infrastructure. Yet, the central government is subsequently unlikely to know the extent of the locality's maintenance efforts. If local leaders anticipate that the facility will be replaced once it has deteriorated, they will have little incentive to maintain it (see Decentralization: Finance and Management Project, 1989).

In anticipation of this sequence of events, some central governments have attempted to attach "strings" to grant monies provided to locals by mandating that some portion of the transfers be used for the purpose of maintenance. Again, however, asymmetry of information makes it difficult for such mandates to be effective without considerable monitoring. Indeed, it is not uncommon for the recipient government simply to label some type of spending as "main-

tenance" when, in fact, the activities undertaken are no different from other "development" spending.⁸ Due to their control over information, local governments can get away with such behavior.

It is also the case that, at least in some developing countries, many facilities "provided" by local governments are "produced" by private contractors (for further discussion of the distinction between provision and production see Chapter 5).

Such arrangements require well-defined contracts to ensure that both parties to the contract are satisfied with the results. Preparing these contracts entails considerable transaction costs as does monitoring and auditing contract implementation. Unfortunately, many types of maintenance activities, especially routine maintenance, do not lend themselves easily to highly specific tender offers. That is, although it is easy to specify in a contract that a particular pothole is to be filled with a certain quality of bituminous material according to certain specifications, writing a contract to ensure that any bridge railings that need repainting are actually painted during some time period is harder to enforce due to the costs of obtaining all the necessary information. Hence, the information asymmetries that necessitate more complex contracts to ensure that routine maintenance is carried out can actually discourage such contracting efforts and, in turn, result in suboptimal routine maintenance.

Information asymmetries are at the root of another major problem in organizing mutually productive activities—shirking. Alchian and Demsetz (1972) point out that many goods involve interdependent *production* processes whereby the marginal contribution of any one input factor is not simply determined. In an interdependent production process, "individual cooperating inputs do not yield identifiable, separate products which can be *summed* to measure the total output" (Alchian and Demsetz, 1972: 779). Thus, the marginal products of each contributor are not directly observable.

⁷ An interesting series of articles examines the types of contracts used in the transportation sector of developing countries. These contracts reflect the different information asymmetries that are present and the various institutional arrangements established to reduce the costs of these asymmetries (see, for example, Heston, Hasnain, Hussain, and Khan, 1985; Otsuka, Kikuchi, and Hayami, 1986).

⁸ See Schroeder (1987) for a discussion of this phenomenon in Indonesia, as well as Bahl (1984) who noted the lack of oversight on the part of the Government of Bangladesh regarding its maintenance mandate in the rural works programme.

Each member of a production team knows how much effort he or she contributes but may not know how much others contribute without expending considerable effort to monitor their activities. Each is motivated to reduce their effort somewhat—to shirk—when they are interdependently related, because part of the effects of their shirking are borne by others. To solve this problem, Alchian and Demsetz argue that production teams prefer to abandon market exchanges and rely instead upon the organization and monitoring skills of an entrepreneur-monitor who retains the “residuals” or “profits” after all the input factors have been paid. The residual claimant is thus highly motivated to monitor production behavior closely to reduce shirking. “The costs of metering or ascertaining the marginal products of the team’s members is what calls forth new organizations and procedures” (Alchian and Demsetz, 1972: 780). In essence, Alchian and Demsetz see a firm, with its monitoring capabilities, as a “counteracting institution” superior to the market at coping with the problems of shirking.⁹

Alchian and Demsetz claim that the most efficient institution at counteracting the problem of shirking is always the private firm, whose owner(s) (through a single manager) retains residual profits, is the central party to all contracts with suppliers of labor or other inputs, and can sell part or all of the ownership rights. Their claim has not gone without challenge (see Marglin, 1974; Leibenstein, 1983; Williamson, 1975). Leibenstein, in particular, has identified the importance of shared norms about the quality and pace of work and also indicates that workers themselves may be the most effective monitors of other workers’ efforts if they care about the quality of the outputs they are producing.

Profit-making firms are not the only “counteracting” institutions used to reduce shirking in production activities. Many well-developed, common-property institutions have also devised rules and monitoring strategies that reduce incentives to shirk. The *zanjera* institutions of the Philippines described in Chapter 2 provide a good example of indigenously designed

institutions that use a remarkable array of rules and strategies to limit shirking during both construction and maintenance of diversion dams and irrigation canals. This is obviously a substantial task when it is realized that, at least in 1980, an average of 37 days of arduous labor were contributed by 431 members of the component *zanjeras* (Siy, 1982).

The use of work teams for all communal work helps to overcome the temptation to shirk. These teams all work at the same time and engage in informal competition among themselves related to the quality and speed of the work. The work teams are kept relatively small so that each member can monitor the inputs of others while the competition among work teams stimulates each to check the work of the other teams. Such monitoring is crucial because shoddy work can result in the collapse of the diversion dam. Careful attendance records are kept in account books that are open for inspection by anyone; again, an effective deterrent to shirking because the information is available to all. Fines are assessed at the end of the year—in a public meeting—on members who have not contributed their share of work. Positive rewards are given immediately to those who contribute—food and drink is provided at the end of each work day. The mixture of positive and negative sanctions, combined with the opportunities for all members to monitor what the others are doing, has enabled a communal, nonprofit organization to cope quite effectively with the problem of shirking.

Although Alchian and Demsetz originally pointed to the problem of interdependent production activities as a key source of information asymmetries, the possibility of an asymmetrical distribution of information arises whenever one person or group (a principal) employs someone else (an agent) to undertake activities for the principal. The principal faces the problem of rewarding or punishing the agent so as to motivate the agent to undertake activities that are most congruent with the principal’s interest. How to design an appropriate set of rewards and punishments in an environment where random events (such as the weather, or changes in the preferences or actions of

⁹ As Steven Cheung (1983: 8) has graphically illustrated, members of a team may be willing to hire a monitor themselves in order to reduce shirking, even when this involves the imposition of severe sanctions. Teams of Chinese workers who towed heavy wooden boats along a shore used to hire a “monitor” to whip those who shirked.

other actors) affect the outcomes of interest to the principal has been the subject of an extensive literature (see Ross, 1973; Mitnick, 1974, 1980; Harris and Raviv, 1978). This literature is instructive as to the difficulty of designing precise contracts specifying exact incentive systems to ensure that agents are fully motivated to undertake activities that are in their principal's interest. Agents who are strongly motivated to cheat on their principals are rarely constrained by a contract alone.

One form of principal-agent contract is "tax-farming." Under such arrangements, private entrepreneurs bid for the right to act as agents of the state by collecting revenues statutorily due to the state. The winning bidder pays the amount bid directly to the state and then has the right to collect the taxes owed. Such systems were used in ancient Rome (see Levi, 1983: 71-94) and are still used to collect certain fees and taxes in South Asia and North Africa (see Azabon and Nugent, 1986; McCullough and Steubner, 1985). The principal (the government) is assured of obtaining revenues while the agent (the winning bidder) has the incentive of collecting all taxes due. The risk under such arrangements is that the agent uses the position it has purchased to extract revenues in excess of those legally due; hence, monitoring is still necessary if the arrangements are to result in a just system.

Kinship Networks as Counteracting Institutions

In light of the significance and pervasiveness of problems of information asymmetries, one would expect individuals to have devised a diverse array of institutions that counteract their impact. The extended family and the wider ethnic group constitute what is probably the most widely used category of such institutions. Due to the basic biological functions the family performs, it can be thought of as an example of an institution that has, to some extent, been spontaneously generated. The different forms that the extended family has taken in each historical period in similar natural environments indicate, however, that this institution has also been, to some extent, the result of conscious design. Institutional analysts explain familism—the reliance upon kin networks for organizing an array of activities that extend far beyond raising children and supporting the elderly—by reference to either ignorance of alternative institutions that

counteract the information problems mentioned above or the inability to create institutions that effectively accomplish this end (Ben-Porath, 1980; Datta and Nugent, 1988; Landa, 1981; Pollak, 1985; Popkin, 1979; Sabetti, 1984). These more analytic treatments have built on an extensive literature that describes patron-client relationships (Bailey, 1969; Banfield, 1968; Powell, 1970; Scott, 1969) and patrimonial regimes (Jackson and Rosberg, 1982; Pipes, 1974; Yang, 1987; Young and Turner, 1985) as they operate in much of Southern Europe, Asia, Africa, Latin America, and the Soviet Union.

That the family is an effective institutional arrangement within which to carry on a significant number of important transactions accounts for the continuing importance of kinship relationships in all cultures and all types of economies. Even in highly industrialized countries, people buying a used car, choosing a business partner, or making a personal loan often prefer to rely on kinsmen or other people they know well. The absence of effective institutional arrangements that permit individuals to contract confidently with individuals outside their family or ethnic group, however, places important limits on the efficiency and dynamism of an economy. Improving the entrepreneurial opportunities of all members of a political economy depends critically upon creating institutional arrangements that facilitate transactions among nonkin.

The advantages of using the family as a governance mechanism for contractual relationships lie in the capacity of this category of institutions to limit opportunistic behavior and to reduce transaction costs and information asymmetries (Ben-Porath, 1980; Pollak, 1985). The childhood socialization process that takes place within all family groups provides opportunities to shape persons who can work well together. This process produces powerful ties of affection and instills family loyalty. Feelings of guilt generated by acts of disloyalty serve to limit opportunistic behavior among kin. Ties of affection among members also mean that families have sanctions at their disposal for use against those guilty of misconduct that are independent of and more powerful than those available to public officials.

Opportunism and moral hazard are also reduced by the fact that all members of a kin group have a stake

in the success or failure of their joint efforts. Landa (1981, 1988) has shown how trust between Chinese businessmen decreases as a function of the distance of their kinship relationship. Shared language, moral standards, and expectations mean that the transaction costs of reaching an agreement even about a new activity are low. Members of a family who have known each other for long periods of time are well acquainted with the character traits of fellow members that cannot be readily evaluated by outsiders. When choosing a factory worker, a contractor to maintain drainage ditches beside a road, or a person to control the gates of an irrigation channel, an individual knows in advance whether he is getting a "lemon" or a "peach" if that employee, contractor, or gatekeeper is a close kinsman. The monitoring costs of the employer in these cases are reduced by the fact that both he and his employee are likely to have a similar stake in the "proper" performance of the assigned task, however that may be defined.

An exclusive reliance on kinship networks can, however, also impose important constraints on the efficiency of the individual firm and on the economy as a whole (Pollak, 1985). Although ties of affection among family members help to bind the group together, conflicts among members may spill over into decision making with adverse consequences. Some inheritance rules, such as primogeniture, may provide strongly divergent incentives for siblings depending upon their sex and birth order. Although family members may have better information about the character of kin than outsiders, they may also, as a result of ties of affection, be less willing than an outsider to discipline family members guilty of shirking.

In many cases, the extended family provides for the necessary complementarity and specialization of labor (Rosenzweig and Wolpin, 1986), but in others it may provide a supply of labor or credit of insufficient size to make it possible to benefit from economies of scale in production. Succeeding generations of family members may fail to provide the aptitudes and experiences needed by the family to support the enterprises upon which they depend. An entrepreneurial person dependent upon kin for suppliers, distributors, creditors, and laborers is especially likely to suffer when rapid technological changes occur and when the entrepreneur attempts to establish

a new type of business never before undertaken by anyone in his wider family group.

And finally, as a provider of insurance, kin groups may be able to cope well with the problems of moral hazard and adverse selection, but they form a relatively small group across which to pool risk (Datta and Nugent, 1988; Nugent, 1985). In addition, many members may face similar risks. A single localized disaster could devastate all persons contributing to an insurance pool.

Nepotism and Corruption

Exclusive reliance upon kin to staff a government bureau or to construct and maintain roads has these same advantages and disadvantages. Kinsmen are particularly easy employees or contractors with whom to communicate, their strengths and weaknesses are well known, and most have a stake in the operation of a public enterprise similar to that of their employer. On the other hand, kinsmen may be more difficult for a superior officer to fire and may not be the most qualified candidate for a job. The disadvantages of nepotism detract from the long-term productivity of a public or private enterprise. Both the employer and the political economy as a whole would be better off if the employer were able to rely on institutions that minimize exposure to hazards in drawing upon a wider population of employees and contractors.

In most less-developed countries, persons who achieve or acquire positions of considerable influence may well have done so with the help of kinsmen and, therefore, feel morally obliged to award jobs and contracts to other kinsmen. There is no doubt that this makes improving the governance of these countries more difficult (Leonard, 1984). Although this sense of obligation is a *common* feature of these diverse cultures, the moral force of this obligation is not, however, a *natural* feature. The force with which kinship obligations are felt derives in large part from situations in which: (1) other employers are expected to select employees and contractors only from among their own kinsmen; and (2) the cost of holding public officials to account for their actions is quite high (see Loveman, 1973). If the cost to officials of nepotism and poor performance in general could be increased and made more certain in the context of public endorsement of equitable employment policies, the moral

force of the kinship obligation would be reduced. In most cultures, capable persons who cannot or will not cultivate the connections necessary to their success feel keenly the fundamental unfairness at the individual level of nepotistic systems.

As James Scott (1976) has pointed out, corrupt behavior is not limited to nepotism. In many cases, public service positions and other favors within and beyond the discretion of public officials to distribute are often exchanged for extra-salarial benefits with anyone willing to pay the price, regardless of family or ethnic status (see Wade, 1985). Feelings of obligation to kinsmen are absent from these breeches of the law. Corruption covers a wide range of activity, from efforts to extort money for the expeditious forwarding of telephone connections, to the purchase of civil service positions, to efforts to influence legislators to adopt legislation that will protect a monopoly position. Institutional analyses of corruption emphasize the temptations generated for individuals prone to opportunistic behavior: by situations exhibiting one or more of the following characteristics:

- Decision-making authority is concentrated in a small number of central government positions;
- Public goods are often provided free or at subsidized rates and demand greatly exceeds supply;
- Public officials often determine access to these goods and otherwise play an extensive role in the economy as regulators or production managers;
- Institutions such as independent courts that provide contractual certainty are absent; and
- Public service salaries are low (Buchanan, Tollison, and Tullock, 1980; Jagannathan, 1987; Rashid, 1981; Tollison, 1982).

Institutional reforms widely adopted in less developed countries to reduce corruption as well as to alleviate the effects of low incomes and enhance equity have created many such situations. Provisions that removed authority from large numbers of local "traditional" authorities and reassigned it to a few civil servants in order to increase the responsibility of

public officials have instead created public officials who are no more exposed to the efforts of ordinary citizens to hold them accountable for their actions than before and who, in addition, have insufficient access to time and place information. In fact, some of these officials may find themselves in a position to extract "rents" from individuals seeking control of monopolies or access to scarce subsidized or free goods. Efforts to provide equal, low-cost access to telephone service, for example, have created a huge backlog of unserved customers who are eager to offer extra-salarial rewards to accommodating telephone operators (Rashid, 1981). In the name of protecting consumers, extensive commercial building code requirements have been adopted, raising product prices, increasing the entry costs to prospective new entrepreneurs, and inviting payoffs to those authorized to verify compliance with the codes. Legal traditions shielding civil servants from liability as well as the absence of independent judicial authorities make it extremely costly for ordinary citizens to bring charges against officials or enforce contracts against those who enjoy the protection of politically powerful individuals. And, finally, efforts to contain the rise in civil servant salaries as a means of overcoming large budgetary deficits have further increased the temptations to which public officials are exposed.

One method of reducing the incentives public officials face to engage in corrupt activities is found in the Nepal suspended bridges case discussed in Chapter 2. Rather than transferring monetary resources to localities, ministry officials transferred the raw materials needed for the bridges. Because it is much more difficult to extract some portion of building materials—especially those like steel cable that have few alternative uses—than it is to extract money, local officials were constrained from "skimming" the transferred resources.

Conclusion

Negotiating, concluding, and implementing the contracts or governance arrangements that are needed to enable a large number of individuals with different preferences, resources, and stakes in the outcome to design, construct, operate, manage, and use rural infrastructure facilities is a difficult and costly process. *Ex ante* and *ex post* transaction costs are always involved in communicating preferences, negotiating

alternative means of solving problems, and allocating the side-payments that may be needed to gain agreement. These costs will exist whether or not opportunistic behavior is exhibited by the participants. The amount of transaction costs involved is affected by the attributes of the individuals involved, the specific types of infrastructure, and the type of institutional arrangements used to organize decision making by multiple individuals about particular infrastructure facilities.

In addition, all multi-actor decisions about the design, construction, operation, maintenance, and/or use of rural infrastructure facilities will involve some errors, given both the fallibility of humans and the difficulty of obtaining an optimal blend of technical expertise and knowledge of the local people, their needs, and the physical systems involved. The cost of the errors due to lack of an appropriate complement of both types of information are affected by the same three variables that affect coordination costs: attributes of the individuals involved, attributes of the

infrastructure facility, and attributes of the institutional arrangements.

In this section we have also examined “strategic costs” that derive from opportunistic strategies that can be adopted by individual parties to an agreement. These costs exist because information and power are not always symmetrically distributed to all participants. The asymmetry provides opportunities for some individuals to use information or power opportunistically to reap personal benefits at the expense of others. We have examined four types of opportunistic behavior in this chapter that can generate substantial costs in regard to infrastructure development: adverse selection, moral hazard, shirking, and corruption. We will discuss a fifth type of strategic cost—free riding—in Chapter 5. The factors that affect strategic costs are the same set that affect other transaction costs—attributes of the individuals, of the infrastructure facilities, and of the institutional arrangements. The next two chapters will further expand this analysis.

Attributes of Rural Infrastructure

THE INFORMATION problems discussed in Chapter 4 characterize many situations in which individuals face incentives that lead them to produce unintended and undesirable outcomes. Without counteracting institutions to ameliorate problems related to shirking, adverse selection, moral hazard, corruption, and inadequate blends of time and place information with scientific knowledge, individuals are not able to achieve as much as they could if counteracting institutions were in place. These problems are far more frequent than a casual reading of most introductory political science, public administration, or economics textbooks would lead one to suspect.

The problems discussed in Chapter 4 characterize situations that involve private as well as public goods. Private goods are used primarily by a single individual or firm, which can exclude others from consuming the good. Potential users of private goods have considerable choice as to whether or not to consume. Rural infrastructure facilities, on the other hand, are used by many individuals or firms and are costly to “fence off” so as to preclude potential beneficiaries from enjoying benefits without paying. In other words, rural infrastructure facilities are characterized by attributes that frequently lead to their provision by public

enterprises, rather than by private enterprises. To understand the challenge of designing counteracting institutions able to cope with failures to sustain rural infrastructure facilities, we need to focus on a set of attributes shared to a greater or lesser extent by all jointly used facilities. These attributes further increase the difficulty of designing counteracting institutions to offset perverse incentives that lead to inadequate maintenance of rural infrastructure.

Provision and Production of Rural Infrastructure

Before we discuss the attributes of rural infrastructure, it is useful to distinguish the *provision* of rural infrastructure facilities from the *production* of these capital assets. The distinction between provision and production has been applied in many studies of public economies in the United States.¹

In private economic exchanges, the difference between provision and production is so obvious that little attention is paid to it. Individuals and households decide which private goods they want to provide for themselves and how they are going to provide them—by purchasing from someone else or by producing them in their own household. In the public realm, a

¹ For an early discussion of these concepts, see Musgrave (1959) and V. Ostrom, Tiebout, and Warren (1961). For applications of these concepts, see E. Ostrom, Parks, and Whitaker (1978); Advisory Commission on Intergovernmental Relations (ACIR) (1987, 1988); V. Ostrom, Bish, and E. Ostrom (1988).

unit of government that provides a facility, such as a rural school, is frequently also the producer of the facility and of the flow of services therefrom. Provision and production are both undertaken by the same agency. There is no logical necessity, however, that the unit providing for rural infrastructure facilities must also produce them. It is frequently the case, for example, that one or more governmental units provide for a road that is actually built by a private contractor.

In the public sector, provision refers to decisions made through collective choice mechanisms about:

- the kinds of goods and services to be provided by a collectivity;
- the quantity and quality of the goods and services to be provided;
- the degree to which private activities related to these goods and services are to be regulated;
- how to arrange for the production of these goods and services;
- how to finance the provision of these goods and services; and
- how to monitor the performance of those who produce these goods and services.

The organization of provision relates primarily to consuming, financing, arranging for production, and monitoring the production of a set of goods and services. Thus, in regard to rural infrastructure development, provision refers to the entire set of activities involved in articulating the demand for, financing, arranging for the production of, and monitoring the production of the activities related to both the construction and maintenance of a facility. The organizational arrangements related to the provision of the construction of a facility may differ rather substantially from those related to the provision of its main-

tenance. A highly organized process may exist to design and finance large-scale infrastructure projects. This process may or may not involve the ultimate users but will frequently involve design engineers trained to undertake site studies of various types.

There may be few, if any, ways for anyone to articulate a demand for or a willingness to finance ways of maintaining an infrastructure facility once it has been constructed. If there is no organization that is responsible for the long-term care of a particular structure, provision of maintenance may simply be overlooked in the flurry of competing needs calling out for public attention. This is particularly likely where deterioration due to a lack of maintenance is a slow process and the competing needs are much more obvious. The allocation of resources to maintenance may be more likely where the organization in charge of the facility is responsible exclusively for that activity, e.g., an irrigation system users group. The implication of this line of reasoning is that maintenance efforts are more likely to be financed and undertaken where organizations have been established that provide one or a few closely related goods and services rather than a diverse set of goods.²

Production refers to "the more technical process of transforming inputs into outputs—making a product, or, in many cases, rendering a service" (ACIR, 1987: 7). Once a unit of government has decided to "provide" particular types of infrastructure, it must then decide whether it will produce the infrastructure facility itself, mandate other enterprises to produce it, encourage its production through financial incentives given to other units of government, or contract with private or public agencies to produce the infrastructure.

In analyzing the attributes of rural infrastructure that generate difficulties for which counteracting institutions are needed, it is useful to separate those attributes that primarily influence the provision or

² In the United States, where some communities finance from single-purpose funds services that in other locations are financed from a general fund, there is some evidence that proprietary fund administrators are more sensitive to long-term costs, including maintenance, than are general fund managers who pay more attention to the immediate budget constraints facing the jurisdiction. See Sharp (1986), who attributes a portion of this difference to the fact that proprietary fund accounting requires reporting of asset depreciation.

consumption of infrastructure facilities from those that primarily affect their production. The next section discusses these provision-side attributes; it is followed by a discussion of attributes that relate primarily to the production of rural infrastructure.

Provision/Consumption Attributes of Rural Infrastructure

We first consider a set of four attributes that distinguish goods and services that normally are provided by "public" rather than "private" institutional arrangements. These are goods and services whose benefits, once provided, can be enjoyed jointly by many people simultaneously. Indeed, enjoyment cannot be withheld easily from any individual, who, to the contrary, may have little choice whether or not to consume something he or she may or may not consider a "benefit." The possibility of enjoying benefits without contributing to the provision of public goods can, in some circumstances, be expected to stimulate rent-seeking behavior on the part of both public officials and private citizens. In addition, we will discuss the difficulty of predicting the potential flow of benefits from an investment in a particular public facility.

Nonexcludability and the Free-rider Problem

Nonexcludability is cited by scholars as the hallmark of a good that must be provided publicly, as contrasted to goods that can be provided privately. "Goods whose benefits can be withheld costlessly by the owner or provider display excludable benefits" (Cornes and Sandler, 1986: 6). When the benefits of a good are available to a group, whether or not members of the group contribute to the provision of the good, the good is characterized by problems of exclusion.

When it is very costly to exclude individuals from enjoying benefits from the provision of an infrastructure facility, private, profit-seeking entrepreneurs,

who must recoup their investments through *quid pro quo* exchanges, have few incentives to provide such services on their own initiative.³ Because problems of exclusion characterize much rural infrastructure, profit-seeking entrepreneurs are likely to underinvest in such facilities.

Where exclusion is costly, those wishing to provide a good or service face a potential free-rider or collective action problem (Olson, 1965). Individuals who gain from the maintenance of a local road, for example, may not wish to contribute labor or taxes to maintenance activities, hoping that others will bear the burden. This is not to say that all individuals will free ride whenever they can obtain the benefits of infrastructure provision without contributing. What we want to stress, however, is that the incentive to be a free rider exists in all situations where potential beneficiaries cannot be excluded unless they contribute to the provision of a good or service.⁴

As mentioned above, the benefits of maintenance are frequently quite subtle and time-delayed. When the benefits of maintenance may be shared by all users whether or not they have contributed to maintenance, we can begin to see how truly difficult this problem is: Why should I use very scarce resources that could produce many tangible results for me today or tomorrow to produce a change in the future rate of deterioration of an infrastructure shared by myself and everyone else using it? It takes an extraordinarily well-crafted set of institutions to offset the many incentives to invest resources in almost any other way than in the maintenance of infrastructure facilities that benefit a large group of individuals.

A variety of institutional arrangements help beneficiaries of collective action to overcome free-rider incentives.

Provision by a governmental unit organized at a local, regional, or national level is one institutional

³ This is the classic market failure argument made by Musgrave (1959) and others following in his footsteps.

⁴ The incentive to shirk is closely related to the incentive to free ride. Shirking relates to the production of goods while free riding relates to the provision of goods. Where the same individuals engage in both provision and production of the same infrastructure and its maintenance, the distinction is hard to make.

strategy to overcome free-rider problems, but not the only available strategy. Private groups, which can control their own membership, are also able to overcome some problems of collective action.⁵ Overcoming free-rider behavior dependent on strictly private institutions requires skilled leaders who are able to devise coordination mechanisms that assure their members that: (1) the benefits they receive will be greater than their costs; (2) their contributions are necessary to the achievement of the collective benefit; and (3) most beneficiaries will contribute their share of needed inputs (Popkin, 1981; Frohlich and Oppenheimer, 1971, 1974; Frohlich, Oppenheimer, and Young, 1971). Designing voluntary arrangements to overcome free-rider incentives is extremely difficult for both the construction and maintenance of large-scale, capital-intensive projects.

Problems of exclusion generally increase the difficulty of designing institutions that adequately reflect preferences. When exclusion is feasible, preferences are revealed as a result of many *quid pro quo* transactions. Producers learn about preferences as a result of consumers' willingness to pay for various goods offered for sale. Where exclusion is not feasible, designing preference revelation mechanisms that honestly reflect beneficiaries' preferences and their willingness to pay is a difficult task whether the providing unit is organized in the public or the private sphere. In very small groups, those affected are usually able to discuss their preferences and constraints on a face-to-face basis and to reach a rough consensus. In larger groups, decisions about infrastructure are apt to be made through mechanisms such as voting or the delegation of authority to public officials organized in hierarchies.

Expressing preferences through voting involves several key difficulties not found in *quid pro quo* transactions:

1. Voting mechanisms do not automatically translate diverse citizen preferences into a well-defined preference order for a community as a whole (Arrow, 1951). The order in which alternatives
- are presented and other aspects of voting procedure strongly affect outcomes (Shepsle, 1979).
2. Even if voting mechanisms were adequate translators of individual preferences for single goods, voting decisions are rarely confined to provision decisions concerning one and only one good. Citizens must usually vote for officials who make many decisions regarding the provision of different goods and services. An official may represent a citizen closely in regard to one type of infrastructure and not in regard to a second (Bish, 1971).
3. All votes are given equal weight no matter how intense the preferences of some voters. Both voters with strong preferences and indifferent voters would be better off in settings where vote trading is possible (Buchanan and Tullock, 1962).
4. Voters may lack a sense of responsibility for their choices and therefore invest little in searching for information about issues. A voter who perceives his vote of little consequence to the outcome has little incentive to invest time in analyzing issues and may well make poor choices (Buchanan, 1960).
5. Those who will benefit more than others from the provision of a particular type of good are motivated more than others to advocate its provision through interest group and other political activities.
6. If the costs of provision are spread evenly over a population, opposing the provision of a good that benefits one group disproportionately more than others may be more costly in time and energy devoted to opposition than bearing the added costs of taxation.
7. Groups that are already effectively organized may be able to mobilize political support leading to an overinvestment in rural infrastructure, generating a disproportionate benefit for the or-

⁵ The theory of clubs has evolved to analyze situations where strictly private arrangements suffice to overcome free-rider problems (see Buchanan, 1965; Sandler and Tschirhart, 1980; Cornes and Sandler, 1986).

ganized groups.

8. On the other hand, groups that are not effectively organized such as poor farmers living in isolated rural areas of many developing countries, may not be able to mobilize enough electoral support in national or province-wide elections to obtain investments in rural infrastructure facilities that would generate substantial economic benefits over costs.

Use of nonvoting mechanisms to transmit information about citizen preferences is also problematic. Relevant time and place information is embedded in citizen preferences and may be very difficult for even highly motivated officials to gain access to without preference-aggregating institutions. As suggested in the previous chapter, the delegation of authority to make decisions about infrastructure to officials organized hierarchically in public agencies involves distortions as information is transmitted up and down hierarchical channels (see Williamson, 1975; Downs, 1967; Campbell, 1974).

Problems of exclusion may derive from several sources, including the property law relevant to particular types of infrastructure facilities. Local farmers may have the physical capability to exclude potential beneficiaries from an irrigation system at a relatively low cost, but they may be legally precluded from doing so. Institutional arrangements can thus reinforce incentives to free ride thereby creating situations in which free riding is rampant; or they may help to counteract the force of these incentives so that the problem of free riding is reduced.

Rural infrastructure facilities also vary greatly as to how costly it is to exclude potential beneficiaries from access to a facility. The costs of excluding potential beneficiaries from a well, for example, are usually quite low. It is not at all unusual to find wells owned privately, with fees collected by the owner before allowing nonowners to draw water. It is not always easy, however, to introduce water fees in the operational phase of a project where users were not involved in the design or construction phases. Bigelow and Chiles (1980) describe a USAID-funded project in Tunisia in which project funds were used to purchase water pumps and pay "guardians" to operate and maintain them, but did not supply the fuel needed to

run them. In some areas, the users organized themselves into a provision unit, decided on a fee schedule, collected fees, and kept good financial records. In other sites, attempts by the guardians to establish fees were resisted by users, and the guardians were removed. The study illustrates the feasibility of user fees for such small-scale infrastructure projects as well as the capability of even poorly educated and resource-poor individuals to organize themselves effectively. It also reveals the problems that can arise when projects are designed primarily by central government or donor agency officials and essential elements of the operation and maintenance of a rural infrastructure facility are ignored.

In contrast to wells, it is very costly to fence and set up toll booths at limited access points along a major highway connecting many villages to marketing centers. If the road is not used heavily, the costs of collecting tolls could easily exceed the revenue generated. Excluding potential beneficiaries from some types of infrastructure, once provided, may not only be infeasible, it may result in inefficiencies. These inefficiencies are discussed more extensively in Chapter 7.

Some analysts use exclusion as the single attribute distinguishing goods and services that are most appropriately provided using market mechanisms from those that must be provided by a government. This leads to policy proposals that suggest the use of market mechanisms for all rural infrastructure where low-cost exclusion is feasible, including community wells, elementary schools, and primary health care facilities. There may be good reasons for public sector involvement in the provision, and potentially, in the production of such services. We view the feasibility and cost of excluding potential beneficiaries from rural facilities as but one of several important attributes that need to be considered when designing institutions related to the provision of these facilities. The capacity to exclude is necessary, however, if one wants to rely on direct user charges to finance all or part of the provision of the facility or its operation and maintenance. Indirect user charges can be utilized, though, if there is a complementary good characterized by ease of exclusion, such as fuel, that someone using a facility, such as a rural road, must also use. A tax on fuel that is then allocated for road construction and maintenance serves as an indirect user charge.

When the costs of exclusion are low, diverse forms of user fees can be considered as one means of paying for part or all of the provision of such services. When the costs of exclusion are extremely high, user fees drop out of serious consideration in the design of appropriate financial arrangements.

In summary, problems of exclusion exacerbate the difficulty of designing institutions that motivate individuals to make economic investments in maintenance activities in several ways:

1. When those who benefit from maintenance cannot be excluded from receiving the benefits of these activities, they are motivated to "ride free" on the contributions of others.
2. Without counteracting institutions, free-rider incentives lead to an underinvestment in the provision of rural infrastructure and its maintenance.
3. To overcome the free-rider problem, decisions about infrastructure provision must be made collectively by either a governmental unit that can force beneficiaries to contribute monetary or other resources to provide for infrastructure maintenance or a private organization that can exclude nonmembers from enjoying benefits.
4. Voting mechanisms that are frequently used to make collective decisions are quite imperfect methods for translating individual preferences into collective choices.
5. Unless crafted with considerable care, reliance on simple voting mechanisms can lead to substantial over- or underinvestment in rural infrastructure and its maintenance.

Rural infrastructure facilities vary considerably, however, with regard to the severity of the problems of exclusion involved. Whenever institutional arrangements can be designed to allow for effective exclusion of nonbeneficiaries, it is possible to rely both on more effective modes of preference revelation as well as on diverse methods of resource mobilization, including user charges.

Problems of Rent Seeking

Assigning responsibility for the provision of an infrastructure facility to a government agency helps

considerably to reduce the opportunities for consumers to free ride. Public authorities can penalize those who enjoy benefits but do not pay their taxes or user fees. Free riding on the part of ordinary consumers, however, does not exhaust the potential strategic behavior associated with the provision of infrastructure facilities. Officials face strong incentives to instigate infrastructure investments of greater scale and complexity (and, therefore, greater cost) than would be warranted by a sober prediction of the returns that can be expected to follow from the investment (see especially Repetto, 1986). Special categories of potential consumers, such as large landowners, may stand to gain so much from infrastructure projects that they actively seek out public funds for projects generating disproportionate benefits for themselves, but yielding less total benefits than total costs.

In contrast to the passive attitude of an irrigator who sits back and hopes that others will undertake the tasks involved in improving a canal he will later make use of in watering his land, irrigation officials may actively seek out donors to fund the development of an irrigation system. The official does this not with the expectation of improving his own access to water (although this may also happen), but in order to improve his own position within a government agency. Given this motivation, the productivity of any particular investment is of secondary interest.

Indeed, large loans or grants needed for a new high-tech irrigation system to be built by an irrigation ministry serve ministry officials better than a smaller loan for making selective improvements on an existing system, even though the latter investment would come closer to generating returns exceeding the costs of the investment. The official's main concern is that the influx of large amounts of funds supports the employment of more subordinates, thereby increasing his power and prestige (see Niskanen, 1971). Projects also offer opportunities for officials to extract extrasarial benefits from those selling the equipment or construction materials that the agency will purchase in order to complete the facility. Because project funds come as bilateral country-to-country or multilateral agency-to-country transfers, frequently neither officials nor farmers personally bear any risk for the repayment of the loan funds invested in ways that produce few benefits. In such a context, severe biases

operate with few checks in favor of large, expensive infrastructure projects operated through public agencies.

Problems of Joint Use

Another attribute that all rural infrastructure shares is the considerable extent to which its flow of services can be used simultaneously by multiple individuals or firms. Because infrastructure facilities can be jointly used, the characteristics of the users and the degree of subtractability of each individual's use are important factors affecting the incentives of the joint users.

Distinguishing the infrastructure facility (the capital stock) from the flow of services produced by the facility helps to clarify the nature of the problem of sustaining rural infrastructure capable of supporting joint use. Infrastructure facilities include many different types of capital assets such as roads and bridges, community wells, schools, irrigation canals, and sewers. These can all be thought of as capital stocks capable, under the appropriate conditions, of producing flows of services over their expected life.

Individuals consume (use) the flow of services produced by infrastructure facilities rather than directly consuming the facilities themselves. Thus, farmers in a rural community consume transport services rather than a local road. Irrigators consume water rather than an irrigation system. School children obtain an education rather than consuming a school system.

Hence, the expected life of rural infrastructure facilities is always longer than the use periods of consumers. Some users may return to use the flow of a particular facility many times, others may use it only once. The relevant time perspective of users may, therefore, vary markedly from the relevant time perspective of the designers and financiers of the facility itself. These differing perspectives make it difficult to match benefits and costs to provide proper incentives in decision making.

Characteristics of the Users.

The number of individuals using the same facility may vary from the 20 to 50 families that jointly use a community well or piped water system in a small village to the thousands of individuals who may use a

major artery of a rural road system. The size of the group receiving joint benefits is a variable that has been given considerable attention in the theoretical literature (see Olson, 1965; Chamberlin, 1974; McGuire, 1974; R. Hardin, 1982). In a very small group, the problem of reaching agreement about what patterns of use reduce the wear and tear on a facility and how to provide adequate maintenance may be resolved in an informal, purely voluntary, face-to-face manner. But even in a very small group, incentives to free or "easy ride" on the contributions of others are still quite strong (as anyone who has shared living quarters with others will understand).

Without some form of organization in which individuals accept a set of mutual responsibilities and monitor each other to be sure that these responsibilities are carried out, everyone will tend to wait for someone else to undertake the onerous tasks involved in maintaining a facility. Organizing individuals to carry out mutual responsibilities is much easier in a small group than it is in a large group. In a small group, individuals have better information about each others' preferences, are apt to know who will benefit the most from various ways of providing an infrastructure, and have a more realistic understanding of the costs of constructing, operating, and maintaining an infrastructure. Thus, the decision-making costs borne by a smaller group are less than those facing a larger group. A smaller group may therefore be able to solve the problem of how to assign rights and responsibilities to one another using informal or very simple institutional arrangements, whereas a large group will have to rely on formal mechanisms and sanctions to accomplish the same tasks.

The degree of concentration or dispersion of a set of joint users also affects the ease with which ways of sustaining infrastructure can be adopted. If most of the users live in the same village and see one another regularly as they use a facility, they can more easily recognize who authorized users are and can easily communicate about use and maintenance as they go about their daily work. If those who jointly use the same facility are highly dispersed, few mechanisms are available to ease the problems of determining how the facility should be used to reduce the rate of deterioration and how maintenance activities should be undertaken and paid for. Solving problems of infrastructure maintenance when users are many and

widely dispersed is far more difficult than when users are small in number or highly concentrated.

A third characteristic of joint users of an infrastructure facility affecting the performance of institutions designed to cope with provision and maintenance problems is the relative homogeneity of their assets and preferences. Individuals holding relatively homogeneous assets will be affected in a similar way by rules that allocate responsibilities. Thus, in the *zanjeras* irrigation system, where each farmer is assigned a plot in each section of the irrigated area, there is a greater homogeneity of interests than if a farmer has land only at the headwaters or at the tail end of the system. A single set of rules used by heterogeneous users, however, produces different stresses and tensions. If all the users of a rural road, for example, rely on bicycles or light vehicles, open-access rules for all-weather conditions may produce reasonable levels of wear and tear on the road. If some users of a road, however, rely on heavy trucks, a single passage by one of the trucks after major rains may produce such deep ruts that the road is no longer passable for those using lighter modes of transport.

The homogeneity of interests of those who use a resource also reduces the problems involved in using voting mechanisms to translate individual preferences into expressions of collective choice. The problems of cycling and indeterminacy that can occur where heterogeneous preferences are present (see Plott, 1967; McKelvey, 1976) are reduced when a more homogeneous group is involved in joint use.

Subtractability of the Flow.

Jointly used infrastructure facilities can generate services that are entirely subtractable upon consumption by one user; in other instances, consumption by one does not subtract from the flow of services available

to others.⁶ In a recent technical survey of the literature on public goods, Cornes and Sandler (1986: 6) define "rivalry in consumption or perfect divisibility" to be present when "an agent's consumption of a unit of a good fully eliminates any benefits that others can obtain from that unit." The distinction between the joint use of an infrastructure facility and the partly or fully subtractive use of units of the flow of services from that facility is rarely made in the literature and has resulted in substantial confusion.

The services produced by infrastructure facilities are rarely consumed entirely by one individual. The subtractability of the flow of services from such facilities may, however, vary substantially (see Blomquist and E. Ostrom, 1985, and E. Ostrom, 1985, for earlier discussions of the difference between the facility and the flow). The withdrawal of an acre-foot of water from an irrigation canal by one farmer means that there is one acre-foot of water less for anyone else to use.⁷ Most agricultural uses of water are fully subtractive, whereas many other uses of water—such as for power generation or navigation—are not fully subtractive. Most of the water that passes through a turbine to generate power can be used again downstream. When the use of a unit of flow by one individual subtracts that quantity from what is available to others, and the flow is scarce relative to demand, users face intense incentives to try to obtain as much as they can of the flow whenever they can for fear that it will not be available later.

Unless effective rules are used to allocate fully subtractive service flows, some individuals will be able to grab considerably more than others, leading to noneconomic uses of the flow and high levels of conflict among users. The absence of effective allocation rules also affects the incentives of users to maintain a system. A farmer located at the tail end of an

⁶ This attribute has been given a wide diversity of names in the technical literature, including divisibility and jointness of consumption. At low levels of use a facility producing subtractive use-units may not be characterized by rivalry, however, because many use-units are available to potential consumers. As the demand for subtractable use-units rises, rivalry increases.

⁷ An acre-foot is the volume of water required to cover one acre of land with one foot of water.

irrigation system that lacks effective allocation rules has little motivation to contribute to the maintenance of the system because he only occasionally receives his share of water.⁸

Similarly, a farmer located at the head-end of such a system is not motivated to provide maintenance services voluntarily because he will receive a disproportionate share of the water whether or not the system is well maintained.

Consequently, for infrastructure facilities whose flows are highly subtractive, institutional arrangements related to the allocation of the flow of services are intimately tied to the problem of maintenance. It is highly unlikely one can solve maintenance problems without careful attention to the efficiency, fairness, and enforceability of the rules specifying who can appropriate how much of the service flow, at what times and places, and under what conditions. Furthermore, unless responsibilities for maintenance are linked in a reasonable fashion to benefits obtained, the beneficiaries themselves will resist efforts to insist that they take responsibility for maintenance.

In those cases in which multiple uses are made of infrastructure facilities, consumption by one user may seriously interfere with consumption by other users. Use of a rural farm-to-market road by heavy trucks, for example, may make the road impassable for others. Allowing farm animals to use a community water source may rule out the use of the source as a domestic water supply. A system that produces a flow of goods under one set of conditions of use may produce a flow of "bads" under other conditions (Buchanan, 1970).

Problems of Measurement

Although the measurement of some attributes of virtually all goods is difficult, measuring the attributes of

and the benefits produced by infrastructure facilities presents numerous challenges to those responsible for provision and monitoring. Measurement problems occur in all phases of infrastructure development—design, construction, operation, use, and maintenance. In the design phase, it is often extremely difficult to obtain a reliable estimate of the benefits likely to result from the investment in a particular facility. Making such an estimate requires the following information:

- an estimate of the life of the facility given assumptions about the type of use-patterns and the level of maintenance expected;
- an estimate of the units of service outputs whose quality may vary over time;
- an estimate of the value of the flow of services to beneficiaries; and
- the adoption of an appropriate discount rate for converting future flows of benefits into present values.

The first three items require estimates that are subject to substantial errors. Rules of thumb are used for all four types of information. Fifty years is frequently used as the "life of the project" for irrigation systems notwithstanding the extreme variation in the useful life of previously constructed systems. Fifty years may be a reasonable time horizon given debt financing and interest rates, but there is nothing of special merit in the 50-year period as such. Furthermore, different actors may use different time horizons as well as different discount rates in their implicit or explicit calculations.

The quantity and value of use depend on many factors unknown at the time of project design and evaluation. It is rare indeed that the number of hectares

⁸ See Harriss (1977) for a grim description of the lack of effective allocation rules and maintenance of irrigation projects in Sri Lanka. See also Perera (1986) and Uphoff (1985a, 1985b, 1985c) for how a major effort to change the institutional structure and the basic relationships among farmers on the Gal Oya project in Sri Lanka dramatically reversed what had been a "hydrological nightmare."

of land irrigated by recently constructed irrigation systems in the developing world approaches the number specified in the original project plan (see, for example, Harriss, 1984). Social conventions among project evaluators tend to affect the discount rate used. Given all the rules of thumb and gross estimates that are involved in project evaluation, the "actual" benefits derivable from investment in an infrastructure facility are rarely measured with much certitude or reliability.⁹ The benefits derivable from small-scale projects with lives of 10 to 20 years can probably be estimated relatively accurately; the larger and longer term the project is, however, the greater the disparity one should presume between estimated and realized benefits. This problem can be exacerbated in the case of major infrastructure projects in which a network of new roads is to be built, thereby greatly expanding the amount of land under cultivation; this, in turn, is likely to expand the overall production of crops, thereby altering product prices. The vagueness of such measurements means that overly optimistic assessments of project benefits may quite easily result, particularly if those basing decisions on the outcomes of such benefit-cost calculations, e.g., agents of development assistance institutions, themselves face requirements to "move" large amounts of funds.

Difficulties in measurement continue in the construction phase. Whether a physical facility will survive over a long period of time depends first of all on the quality of the construction process and the materials used. In many cases, simple examination of the completed facility will not reveal even to a trained observer whether important steps were omitted in construction. Any facility using cement, for example, will deteriorate rapidly unless the cement has been reinforced, cured, and sealed properly. Unless construction contractors who plan to remain in business know they will be identified with inadequately constructed facilities, they face incentives to shirk in construction efforts. Posting bonds may be one means

of reducing this incentive, but the problem of determining cause and culpability for faulty construction work remains. Incentives to shirk, steal materials, distort records, bribe inspectors, and generally to avoid complying with costly construction processes frequently exist. Such incentives more frequently characterize large-scale construction projects than small-scale projects where most participants know who is responsible for inadequate construction. Most larger-scale construction projects utilize inspectors to examine key steps in the process before the next step covers up earlier work. If inspectors are poorly paid and operate in a setting where public corruption is a normal way of doing business, inspections, however, may do little more than offer inspectors opportunities to line their pockets.

Similarly, the frequency and quality of maintenance activities may not be easily observable. To be most effective, many types of routine maintenance activities must be completed before the need for maintenance is obvious. Equipment requires regular oiling and the replacement of worn parts; wooden structures need to be painted regularly; irrigation canals need to be desilted and weeded each year or the operation of these facilities will begin to decline. The absence of maintenance is often difficult for users of a system to detect until it has been deferred too long. Good maintenance requires well-tailored rules that provide incentives to those responsible for maintenance to conduct these activities in a timely and appropriate fashion. Many successful instances of maintenance activities undertaken over long periods of time by organized user communities involve the use of small teams of users who are assigned well-demarcated tasks whose completion can easily be monitored by themselves and by others (Coward, 1980; Siy, 1982).

The ease of measuring use-patterns also varies from one type of rural infrastructure to another. It is difficult to observe and record exactly who uses (and how much) facilities that cover a large terrain. Without adequate measures of use-patterns, it is ex-

⁹ Irrigation experts are frequently uneasy about the effect of using discount rates of 10 or 15 percent in estimating flows of benefits and costs. "It is responsible sometimes for the haste to get benefits, the dropping of components to lower early costs, the ignoring of large late-arising benefits and costs ... and worst of all, the fraudulent manipulation of forecasts to ensure that the project arithmetic produces the minimum cut-off rate of return" (Carruthers, 1988: 25).

tremely difficult to determine the benefits derived from a system and, thus, efficient and equitable forms of direct or indirect payment. Users have every incentive to underestimate the value of an infrastructure facility to them; providers have every incentive to overestimate the value to users. One of the most challenging institutional design tasks is devising low-cost means of monitoring use-patterns and assigning benefits and costs.

Degree of Choice in Consumption

Goods and services differ in the extent to which individuals living in a given community have effective choice over whether or not to consume the "good" once produced. All residents living in a village that is sprayed with a pesticide receive the "benefits" of this public health program, whether or not they desire it. When a particular facility is critical to economic production in an area, as is often the case with irrigation systems, residents must make use of the facility that is provided to them whether or not it adequately serves their needs. The absence of choice means that critical information about the preferences of beneficiaries is lost. (The producer of private goods obtains information about the preferences of consumers by measuring the choices that they make in response to the different goods made available.) Unless special measures are taken to obtain this information, it is highly likely that the facility provided will produce a flow of benefits considerably different from what could have been provided if consumer interests were taken into account.

Production /Attributes of Rural Infrastructure

The attributes just discussed relate primarily to the provision or consumption side of infrastructure development and are the attributes that are most frequently cited as the reason for public provision of much rural infrastructure. Various attributes of the production of these goods and services also need to be taken into account by provision units (frequently units of government). To the extent, for example, that a

particular type of rural infrastructure is characterized by substantial economies of scale, arranging production with a large-scale producer will be more efficient than arranging production with a small-scale producer. But simply because production is characterized by substantial economies (or diseconomies) of scale does not mean that the provision unit has to be at the same scale as the production unit. It is possible for small-scale provision units (e.g., local units of government) to arrange for production with large-scale production units (e.g., large private contractors or even the national government). Alternatively, it is also possible for large-scale provision units (e.g., national units of government) to arrange for production with small-scale production units (e.g., local contractors or the residents of a particular village). In discussing the attributes of production, we will turn first to economies of scale because this attribute is so frequently used as the foundation for recommending provision as well as production by national governments.

Economies of Scale

Infrastructure facilities may vary considerably in terms of the economies or diseconomies of scale involved in the original design and construction of the facility and in regard to the operation, use, and maintenance of the system. Economies of scale, which mean that costs per unit of output are less at higher levels of output than at lower output levels, have two important implications for capital infrastructure design and operation.

First, decreasing costs over higher levels of output mean that normal market mechanisms will lead to monopolistic production and the allocative inefficiencies that monopolies create. This is the classic case of "natural monopolies" discussed at length in the public finance literature (Stiglitz, 1986). In such cases, public sector intervention is deemed necessary to overcome the failure of the market in the same vein as market failure due to the problems of nonexcludability and nonsubtractability discussed above. This is the argument underlying public provision of services such as

urban water supply or telephone and electric utilities, none of which are characterized by problems of non-excludability nor nonsubtractability but still require public sector intervention in order to increase allocative efficiency.¹⁰

The second implication of decreasing costs concerns the most efficient organization of the design, construction, and operation of capital facilities that yield economies of scale. Design and construction of infrastructure facilities usually involve at least some modest levels of economies of scale simply because these facilities all involve some initial investment in capital. But the economies involved in building a water purification plant may be considerably less than the economies involved in building rural roads.

In some very successful development projects, for example, the initial design of projects is undertaken by a large-scale agency, but the actual construction of specific subsections of the project is carried out by small-scale, locally organized, groups. The Malawi self-help water supply program discussed in Chapter 2 was one such project. In addition, the most appropriate scale for organizing design and construction may not be the most appropriate scale for operating and/or maintaining an infrastructure facility itself. For example, the maintenance of field canals is frequently best undertaken by relatively small groups of irrigators who are intimately familiar with the canals and thus know where silt accumulates, which channels are weakened by heavy flows of water, and where tree roots and weeds are likely to be a problem. The actual construction of the same field canals may most economically be accomplished by a fairly large engineering firm that can amortize specialized construction equipment over many such projects. (The knowledge of the farmers themselves about the lay of their own land and the pattern of rainfall and runoff in their area may, however, be very important in the design of these canals.)

Furthermore, in any large and complex infrastructure project, different parts of the system may require different maintenance strategies and different scales

of operation. In regard to irrigation projects, for example, Abeywickrema (1986: 23) points out that maintenance of the headworks requires a highly trained technical staff to perform regular maintenance and to handle emergency repairs rapidly when breakdowns occur. The operation and maintenance of large distributory canals may require the presence of full-time paid personnel. Few farmers observe more than a limited section of a canal, and they are not motivated to undertake either operation or maintenance activities. Farmers and official guards complement one another on the large canals. On the other hand, both the operation and maintenance of field canals may best be undertaken by the farmers themselves, both because they have the time and place information necessary to keep these parts of the systems working and because the importance of improved performance of these canals may be sufficiently noticeable to the individual farmer that he will be motivated, given appropriate institutional arrangements, to keep them in good condition.

Different scales of production can also be used advantageously in cases where not all types of necessary road maintenance require similar amounts of capital investments by those carrying out the maintenance. This is a feature of a maintenance by contract scheme currently being implemented on national highways in Pakistan (Kampsax International, A/S, 1986). "Two-tier" contracting is being utilized; one "tier" is for simple, routine maintenance, while the other is for more complex, periodic maintenance. Because routine maintenance includes simple activities like vegetation control, drain cleaning, and simple repairs to shoulders, culverts, and bridges, contractors do not need to own expensive, specialized equipment to carry out the contracts. Hence, small contractors are eligible to bid on these contracts. To provide performance incentives for contractors, contracts are also restricted to bidders residing within the area through which the highway passes so that local residents can pressure the contractors to carry out their responsibilities properly. The more complex types of maintenance that include repaving, regravelling, and

¹⁰ Problems still arise, however, because the marginal cost pricing rules that are required to achieve allocative efficiency lead to a failure to cover total operating costs of utilities.

major repairs to bridges are reserved for larger contractors who can demonstrate greater technical competency and access to capital. Thus, even maintenance efforts can take advantage of economies of scale, but only where such economies are significant.

Asset Specificity

The assets used in producing rural infrastructure facilities include general purpose assets that can be redeployed in other activities without cost. Examples of such general purpose assets include dump trucks used in constructing roads that can also be used in many other kinds of construction projects. A contractor purchasing a dump truck for a road project is not investing in an asset that will sit idle in the future if the contractor does not obtain another contract to build roads.

On the other hand, some capital equipment used in producing roads, e.g., large road rollers, cannot be redeployed in other construction activities. A contractor investing in this type of equipment is exposed to a considerable loss if he were to fail to win future road construction contracts. Williamson (1988) argues that parties to a transaction that involves high levels of asset specificity will desire protective safeguards in their contractual relationships before they are willing to make major investments that would be lost should they be unable to continue to make productive use of these assets. Therefore, one argument in favor of public production in addition to public provision of some facilities is that the assets used in production are so specialized that private contractors cannot afford to invest in their acquisition.

Even where the specificity of the equipment precludes private ownership, arrangements can be made to allow private production of construction or maintenance. For example, while the government may own assets such as large road rollers, they may be used under lease arrangements by private contractors where the lease payments include all operating costs plus amortization. In order to avoid improper use

of the equipment, the leases might also specify that the government will provide an operator to ensure that the private contractor does not misuse the equipment or fail to maintain it properly.

Another important institutional arrangement that promotes efficient production even where the public sector retains ownership of highly specific assets is to allow all public (as well as private) organizations to bid on construction and maintenance projects. For example, one public organization such as a district that owns a road roller should be able to bid to provide road rolling services to another jurisdiction. This helps to ensure that the equipment is utilized most fully and that the competition can drive down the costs of carrying out the construction or maintenance activity.

There may also be ways to increase the likelihood that assets purchased for one purpose can be put to alternative use. For example, instead of relying on specialized bulldozers, ordinary tractors with grader blades can be used, albeit less efficiently, for road construction. The efficiency loss associated with the road-building activity can be offset by an overall greater utilization of the tractors in alternative pursuits.¹¹

Co-Production

Some services, such as education, health, and law enforcement are, by their very nature, services that cannot be produced by professionals alone. The production of these services requires the active participation of the consumer in their production. Infrastructure appears at first glance not to require the active co-production of its consumers. This is misleading. An infrastructure facility can, indeed, be produced by a government agency or a contracting firm without the active co-production of those who are to receive the benefits of it. But to receive the benefits generated by many infrastructure facilities, beneficiaries themselves may have to participate in related production activities. A farmer served by a new farm-to-market road receives benefits as a result

¹¹ For a discussion of various technologies in the road sector, see Swaminathan and Lal (1979).

of goods that now come to him at lower transportation costs. The farmer passively consumes these benefits. The farmer is, however, an active co-producer of lower costs by transporting his own produce to market.

Consequently, rural infrastructure facilities that are designed, sited, and funded without any participation by at least a subset of the future users of the facility are less likely to be effectively used than those for which potential consumers are involved in these phases of development. Furthermore, access and use rules are needed to reduce the costs that one set of users can impose on others of any intensively used infrastructure. Again, in the case of rural roads, an embargo may be placed on the use of a road during the rainy season when it is particularly vulnerable to damage due to use. Unless these rules are understood and agreed to by the users, it is unlikely that any set of external enforcers will be able to ensure adherence to these rules by themselves. Reports written by officials of the Mahaweli Development Project, for example, repeatedly stress that it is *impossible* to get farmers to undertake the level of maintenance that irrigation officials think they should (see Corey, 1986). Thus, the users of a facility are always co-producing the order (or disorder) with which they jointly use a facility. At the same time, the nature of different types of capital infrastructure can make this task more or less difficult. For example, users of a road that serves numerous beneficiaries, many of whom do not live within the community itself, are likely to find it much more difficult to reach agreement concerning access rules than are users of a local water supply system.

Rate of Deterioration

Infrastructure facilities differ greatly in terms of how sensitive their continued survival is to the patterns of use and maintenance they experience. In some instances, lack of maintenance can bring on rapid deterioration; in other cases, the rate of deterioration is so slow, at least initially, as to be imperceptible to the user. Consider, for example, the maintenance of capital equipment. If a bearing on a road roller is not greased, it will soon burn out and may render the entire piece of capital equipment inoperable. On the other hand, failure to change the oil in a truck will slowly decrease the lubricating efficiency of the oil and only after

some period of time will the engine finally fail to operate.

The rate at which rural infrastructure deteriorates may also depend on the original design and construction of the facility. A road constructed with a thick bed of crushed rock and several layers of surfacing materials may survive use by light vehicles and trucks for a much longer period of time without maintenance than a gravel road constructed in the same location and subjected to a similar pattern of use. The initial construction costs of the gravel road, on the other hand, may be a fraction of the investment needed to construct the sturdier road.

The differences in rates of deterioration and the perceptibility of this decline in the effectiveness of the facility are likely to affect, as well, the willingness of users to undertake maintenance activities. For example, users of an irrigation system soon realize that, unless certain activities such as clearing weeds and silt out of field channels are carried out annually, the system will fail. It is much more likely that these activities will be undertaken than actions that will enhance the effectiveness of the system only over the very long run.

Vulnerability to Breakdown

When a process is organized in a serial manner, a breakdown at any one stage stops work at all subsequent stages. In contrast, a process organized in a parallel manner is rarely brought to a halt when something goes wrong in one sub-part. The Malawian water systems that tap mountain streams are examples of serial processes. To obtain water in an individual tap, one needs to start at the source and develop a serial network of storage and delivery mechanisms. If the intake pipe located in the stream is destroyed, or if even a single valve controlling the flow out of the storage structures below breaks down, no water is delivered to any taps connected to this single source. A water supply system utilizing several sources of water—a stream plus several wells, for example—is a parallel process. If one well breaks down, water can still be supplied to the system from the stream and/or the other wells.

The reliability with which an infrastructure facility continues to generate a useful flow of services for those who are served depends on three factors: (1)

the extent to which the facility is designed and constructed as an exclusively serial structure; (2) the amount of resources invested in the design, construction, operation, and maintenance of those linkages (and/or alternatives) that could stop the entire system from operating; and (3) the way relevant decision makers are linked in an institutional arrangement related to this facility (see Thompson, 1967; Landau, 1969; Lerner, 1987; Cioffi-Revilla, 1987; and Malone, 1987).

Designers of rural infrastructure do not always have much choice as to whether a particular facility is primarily a serial or a parallel structure. If there is only one source of water available to supply a village, the underlying structure of the resulting water supply system will be serial. If something adversely affects the single source of water, the entire system will be adversely affected. In such systems, however, it is possible to increase or decrease the probability of system breakdown. In the Battar irrigation scheme in Nepal, for example, the vulnerability of a water supply system dependant upon a single source was greatly exacerbated by the way it was designed. Instead of relying on gravity flow involving technological skills already known to the local farmers, the designers of this project created a "marvel of engineering design, involving lift pumps and piped water to supply each of the 120 individual two-hectare units" (Uphoff, 1985a: 366). When operating, the system enabled farmers to meter the supply of water precisely to meet their needs. Any water supply system in the hilly part of Nepal would be primarily a serial system. Reliance on hydroelectric power and on equipment that was unfamiliar to the farmers, however, greatly increased the likelihood that the entire system would be inoperable. "As the farmers had feared, the water supply was interrupted whenever hydroelectric power was diverted to Kathmandu" (ibid.). Furthermore, any breakdown in the regulating devices meant an interruption in the supply until someone knowledgeable about the sophisticated technology could repair the system.

The costs of the breakdown of a particular link in an infrastructure system to the users of that system depend on the availability and the cost of the nearest "substitute." The costs to the users of a road network,

for example, of the collapse of one bridge, depend on how well interconnected the road network is with alternative ways of crossing a river. If a ferry system is still operating in a nearby location, the costs of breakdown to the users may be relatively low. On the other hand, if the only way one can get to a market on the other side of a river is to travel a full day on an alternative route, the costs of breakdown may be extremely high. The breakdown of a single part of a road network may mean the difference between whether or not highly perishable crops can be delivered to a market before they rot.

The costs of breakdown to system users can be reduced by an increased investment in redundant linkages, backup systems, or the quality of the materials used in the key links. In some instances, the costs of breakdown to the users are less than the costs involved in any available method for reducing the expected probability of breakdown. In this case, it is not economically efficient to develop alternatives. In some instances, investing in a relatively inexpensive "back-up" system may be less expensive than major improvements in the reliability of the key linkage. The spare tire that many people keep in their cars, for example, is frequently not of very high quality. If a flat tire occurs on many roads, all one needs is a replacement tire for a short distance until one reaches a service station. If repair stations are, however, few and far between, the best strategy may be entirely different. One might then invest in more expensive tires on the car itself as well as more expensive and numerous spares.

The way that a series of decisions are linked in an institutional arrangement can also affect the likelihood and costs of breakdown. Thus, a physical system that could be organized largely as a parallel system involving a low risk of failure might be governed and managed by a human system that is linked entirely in a serial or bureaucratic fashion. Breakdown at any one of the key links in the serial decision-making system can then delay the entire process even though the physical system is not inherently a serial process. Complaints about "red tape" are usually associated with decision-making arrangements that are linked in an extended serial chain.

Conclusion

Rural infrastructure development is a complex phenomena due to the many attributes of infrastructure that create disincentives for individuals to design, construct, operate, and maintain these facilities effectively and efficiently. Some problems stem simply from the fact that infrastructure facilities by nature have potentially long, useful lives. Thus, decisions concerning their initial design and subsequent maintenance are extremely difficult to perfect.

Even greater problems arise, however, when it is recognized that the bulk of the rural infrastructure of interest in the developing world is influenced greatly by public sector decision making. Although good reasons for public sector involvement in the *provision* of these facilities exist, this section has shown that the requirement for public sector *production* is less clear-cut. Among the principal arguments for public sector provision of rural infrastructure are the nonexclusion and nonsubtractability traits of the services provided. Although these features themselves create complications in ensuring an efficient flow of services, the task is made even more difficult because of problems in measuring benefits and linking usage of the facility to deterioration in the flow of services. Designing adequate institutional arrangements to overcome these difficulties is, therefore, a huge task.

Analyzing the Performance of Alternative Institutional Arrangements

THE IMPORT of the last two chapters is that perverse incentives are endemic in the development and maintenance of rural infrastructure facilities. Without effective, counteracting institutions, major problems involving overprovision of expensive facilities funded by others and underprovision and poor distribution of the maintenance of these facilities are to be expected. Even with effective counteracting institutions, maintaining rural infrastructure at an economically efficient level will always be difficult. A change from one type of institutional arrangement to another may reduce some costs and increase others. Whether the net effect of a change of institutional arrangements is positive, neutral, or negative depends on how the costs and benefits of several effects balance out. Institutional arrangements for infrastructure development currently in use in many developing countries apparently exacerbate (or, at least do not effectively correct) many problems. Massive investments in infrastructure are left to deteriorate at a rapid rate due to an underinvestment in maintenance.

The presumption that central governments must provide certain types of rural infrastructure is based on analysis of why markets would fail to generate a sufficient investment in infrastructure that are characterized by a lack of exclusion and joint consumption. This analysis compares two idealized forms of organization: a simple market and a single governmental hierarchy. Analysts also focus on a limited set of problems to be solved (or costs to be reduced), such as how to gain economies of scale, how to utilize modern technology, and how to reduce free riding.

Because markets cannot solve these problems for many types of rural infrastructure, it is presumed that a central government can. Naive policy prescriptions assign sole responsibility to a central government for providing and producing rural infrastructure.

This presumption that central governments must provide most public goods and services underlies the policy prescriptions in the new field of development administration. This well-intentioned approach to development was similar to the modes of policy analysis accepted simultaneously in North America and Europe, beginning in the late 1950s and continuing through the 1960s (see Albertin, 1982; Dearlove, 1979; E. Ostrom, 1972, 1983b; Sharpe, 1981). At that time, conducting successful "wars" on poverty, illiteracy, and disease were thought to require the concentrated decision-making authority of a chief executive and the top ranks of the ministries of a national government. Assuming that development was choked by an unmanageable accumulation of traditional and colonial institutions with oligarchic characteristics, institutional reform was directed at perfecting and increasing the capacity of the new development-oriented national bureaucracies. The newly independent countries were assumed to require a single center of ultimate authority in order to coordinate the efficient use of resources, to override the influence of entrenched oligarchies, and to instruct their multi-ethnic populations about the benefits of common nationhood. Accepting the recommendations of scholars and donor agencies to concentrate power in the center was also consistent with the ambitions of

the political leaders of developing countries to gain control over the political life of their countries. Weakening the control of subnational decision-making bodies and gaining control of tax revenue and development assistance from abroad removed potential bases of operation for political competitors. Western development assistance organizations generally supported efforts by leaders of non-Communist regimes to limit political competition, assuming that democratic forms would evolve over time if minimal political stability could be maintained (Huntington, 1968).

The results of these efforts to consolidate and nationalize the public sector have been disappointing. With a few striking East Asian exceptions, the economic health of most developing countries even after years of assistance is still fragile. Natural disasters, oil price shocks, and warfare have contributed heavily to the problems of many countries, particularly in Africa. Virtually all analysts agree that the institutional reforms of the 1960s contributed significantly to this dismal record. Many analysts now agree that overcentralization has stymied, instead of stimulated, efforts to find creative solutions to the problems of infrastructure development and other public sector issues (Uphoff, 1986b; Rondinelli, 1987; Cheema and Rondinelli, 1983; Esman and Uphoff, 1984; Chambers, 1983; Coward, 1980; Cernea, 1985).

Advocating the necessity of centralized, national regimes to achieve presumed economies of scale, to utilize modern scientific knowledge, and to solve the free-rider problem has ignored other important intermediate and overall performance criteria and other forms of institutional arrangements beyond markets versus states. Chapters 4 and 5 have presented a richer set of potential problems that may be involved in infrastructure development beyond those of economies of scale, acquiring scientific knowledge, and discouraging free riding. This chapter develops an approach for analyzing a fuller set of institutional

arrangements, using a more extensive set of intermediate and overall performance criteria. To do this, we first present an overview of the performance criteria we intend to use, derived from discussions in Chapters 1, 4, and 5. Then we use this more comprehensive set of performance criteria in a comparative evaluation of several types of institutional arrangements related to the provision and production of rural infrastructure.

Intermediate and Overall Performance Criteria

Systematic comparison of the performance of institutional arrangements for providing and producing goods and services with diverse characteristics is a recently developed and still evolving field of inquiry.¹ In the zero transaction cost environment of neoclassical economics, one can easily demonstrate that open, competitive markets push producers to seek combinations of land, labor, and capital that produce private goods at their lowest possible cost per unit. Similarly, consumers obtain and pay for the best mixture of goods and services obtainable, given the resources available to them. Thus, compared to other institutional arrangements for providing and producing private goods, an open competitive market keeps production costs at as low a level as is feasible and distributes goods to those who have the highest marginal value for them. Overall efficiency is achieved as well as fiscal equivalence. Although markets generate substantial incentives toward the creation of wealth, without subsidies of some sort, markets do not redistribute current resources from wealthier to poorer individuals.

Serious consideration of transaction costs involved in the provision and production of even some types of private goods has made the comparative evaluation of institutional arrangements a more complex undertaking than classical theories of market performance. In addition to the focus on production costs, the coordination, information, and strategic

¹ The work of institutional economists, such as Coase and Commons, can be considered as foundational for comparative analysis between markets and firms and the work of V. Ostrom and Tiebout as foundational for comparative analysis in the public sector.

costs involved in transacting have been added to the analysis. When transaction cost analysis is added to production cost analysis, some institutional arrangements that had previously been misunderstood or considered inefficient have been evaluated more positively (see Williamson, 1985). Furthermore, transaction cost economists do not conclude that markets are always the best institutional arrangements, even for private goods.²

When one adds the additional characteristics of goods and services normally provided by public sector institutions—infrastructure development, in particular—the variables that need to be taken into account in a systematic comparison of the costs and benefits of diverse institutional arrangements expand substantially. Both production costs and transaction costs can be used as intermediate criteria to evaluate performance. As discussed in Chapter 1, we use the criteria of efficiency, equity, and accountability as our overall criteria. Efficiency requires a comparison of total benefits with total costs, while accountability and the two aspects of equity—fiscal equivalence and income redistribution—also require examination of both benefits and costs. Evaluating how institutional arrangements compare in terms of intermediate criteria is quite a challenge. Because these overall criteria require a summary of all costs and all benefits, only very detailed studies can even begin to derive approximate measures of efficiency, equity, and accountability. Thus, an analytical examination of the likely tradeoffs between intermediate costs is valuable in attempting to understand comparative institutional performance.

Before using production and transaction costs as intermediate performance criteria, let us summarize the diverse types of costs that we will use as intermediate criteria in comparing institutional arrangements. Because we wish to examine both the *production* and *provision* of rural infrastructure, we will use the term *transformation costs* for what are most frequently referred to as *production costs*. It is awkward to talk about the production costs of provision ac-

tivities, even though there are identifiable transformation costs involved in both production and provision activities.

On the *production* side of infrastructure development (including design, construction, operation, and maintenance), we identify the following types of costs:

- **Transformation costs** - the costs of transforming inputs (land, labor, and capital) into outputs (the design and construction of an infrastructure facility or its operation and maintenance). Transformation costs are directly affected by the characteristics of the good and services involved and by the scale of production and type of technology adopted including their susceptibility to breakdown.
- **Transaction costs** - increases in transformation costs associated with coordination, information, and strategic costs.
 - *Coordination costs* are the sum of the costs of the time, capital, and personnel invested in negotiating, monitoring, and enforcing agreements among actors.
 - *Information costs* are the sum of the costs of searching for and organizing information and the costs of errors resulting from a lack of or an ineffective blend of knowledge about time and place variables and general scientific principles.
 - *Strategic costs* are the increased transformation costs that are produced when individuals use asymmetric distributions of information, power, or other resources to obtain benefits at the cost of others. The most frequent kinds of strategic costs related to production activities are shirking, adverse selection, moral hazard, and corruption (or fraud).

² A brief review of the questions pursued in the *Journal of Law, Economics, and Organization* reveals the complexity of variables and analyses involved.

Transaction costs are directly affected by the characteristics of the goods and services involved, the scale of production and technology used, and the particular rules used to govern transactions.

While analytically separate, transaction costs are normally recorded simply as part of the transformation or production costs of a firm. The time and personnel allocated to transacting within a production firm or bureau and across production enterprises to organize production can vary substantially from producer to producer—even those producing the same mix of outputs, using similar technologies.

Providing goods and services also involves transformation and transaction costs. These costs are frequently ignored in private sector institutional arrangements as they are largely borne by those who consume goods and services. Those who bear these costs control their investment in provision activities, to a large extent.³ Provision costs in the public sector are substantial even though they are recorded in many different locations and are extremely difficult to identify and measure. In regard to provision we identify the following:

- **Transformation costs** - the costs involved in: (1) transforming citizen preferences about outcomes and about their willingness to pay into articulated demands for packages of publicly provided goods and services; (2) arranging for financing and producing these packages; (3) monitoring the performance of producers; (4) regulating use patterns of consumers; and (5) enforcing compliance with taxation and other resource mobilization measures.

Transformation costs are directly affected by the characteristics of the goods and services involved, the scale of the provision unit, the technologies used in aggregating interests, arranging financing and production, monitoring producers, regulating users, and enforcing

compliance.

- **Transaction costs** - increases in transformation costs associated with coordination, information, and strategic behavior.

- *Coordination costs* are the sum of the costs of the time, capital, and personnel invested in negotiating, monitoring, and enforcing agreements about provision among actors.

- *Information costs* are the sum of the costs of searching for and organizing information and the costs of errors resulting from a lack of or an ineffective blend of knowledge about time and place variables and general scientific principles.

- *Strategic costs* are the increased transformation costs that are produced when individuals use asymmetric distributions of information, power, or other resources to obtain benefits at the cost of others. The most frequent kinds of strategic costs related to provision activities are free riding, rent seeking, and corruption.

Transaction costs are directly affected by the characteristics of the goods and services involved, the scale of provision units, and technologies used for interest aggregation, monitoring, regulating, and policing, and the particular rules used to govern transactions.

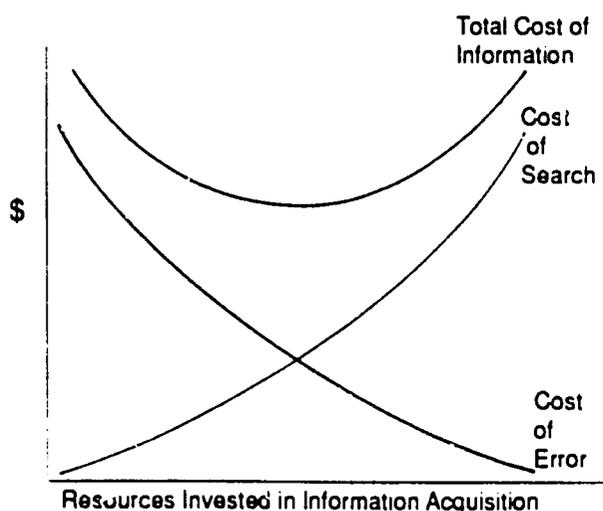
Tradeoffs exist between most of these costs and even within broad categories of costs. For example, reducing the costs of errors resulting from a lack of information about time and place variables (such as the immediate destruction of a water diversion mechanism because irrigation design engineers had insignificant knowledge about local conditions) requires an investment of resources to obtain better information about local conditions. Investments in obtaining information tend to reduce the costs of errors from a lack of information. Thus, as shown in

³ Consumers may organize into buyer's cooperatives or information acquisition groups to reduce individual costs related to provision. Some free riding may occur whereby nonmembers of these organizations acquire benefits without paying. As consumers demand that government agencies take a more active role in consumer protection, the costs of providing private goods begin to resemble more closely those associated with providing public goods.

Figure 6.1, total cost of time and place information is composed of two components: the cost of errors due to a lack of information and the cost of acquisition and use of information (cost of search).

In an environment where one could make a careful estimate of both the cost of error and the cost of search, it would be possible to make an optimal investment in information search so as to acquire information up to the point at which the marginal cost of new information just equaled the marginal benefits of reduced error. Participants in infrastructure development rarely have such complete information about costs. We cannot assume that optimal investments are made. What we do assume is that the level and shape of the total cost of time and place information varies across physical domains and institutional arrangements.

Figure 6.1. Components of Information Costs



Thus, farmers with many years of experience in irrigating lands from a river acquire intimate knowledge about the velocity of the river at different times of the year and about the soil types present in their fields. This time and place information is acquired as a by-product of other activities without much investment of resources in information search activities. When these farmers then engage in design, construction, and maintenance activities, total costs of time and place information are low because both the costs of error due to lack of place-specific information and the costs of information acquisition are relatively low.

It is far more costly for employees of national ministries to acquire time and place information than it is for locally-elected officials. This is because this type of information cannot be obtained as a by-product of day-to-day activities unless these officials are assigned to a particular location for a long period of time (something that rarely happens) and are highly motivated to seek it out. Consequently, we can assume that the costs of error due to a lack of time and place information are higher. On the other hand, we would expect that the costs of acquiring relevant scientific information would be lower in a national bureaucracy than in a farmer-managed irrigation system.

Recognizing that there are tradeoffs between intermediate costs is an essential component to comparative institutional analysis. It is never possible to reduce all costs to zero. Thus, if one institutional arrangement has lower costs with regard to one intermediate criteria, it is apt to have higher costs somewhere else. The key question is whether the differences simply offset one another or whether a net gain in efficiency is achieved.

Analyzing Institutional Arrangements

Although there is a rich array of institutional arrangements, an extremely sparse vocabulary is available in contemporary discourse to describe these arrangements. As soon as one departs from the usual market versus state or centralization versus decentralization dichotomies, one finds few well-accepted terms to describe the variety of institutions that operate—sometimes quite successfully—to cope with sustaining rural infrastructure. Considering only these dichotomies severely handicaps the analyses of social problems as well as efforts to design and redesign institutions.

We focus now on the diversity of institutional arrangements used in the contemporary developing world to provide and produce rural infrastructure facilities, and how these counteract or exacerbate the intermediate costs discussed above. In analyzing the structure of an institutional arrangement, the analyst investigates who is involved, what their stakes and resources are, and how they are linked to one another and to outcomes in the world. Specifically, the analyst identifies the types of actions that actors can take, the type of information available to them, how actions

lead to outcomes, and how rewards and punishments are allocated in light of the outcomes achieved and the actions taken. Then the analyst predicts the actions and aggregated outcomes that are most likely given the structure of the incentives. When the predicted actions and outcomes are verified in the empirical setting, the analyst has provided an initial explanation for what is being observed. The patterns of outcomes can then be evaluated using various intermediate and overall performance criteria.⁴

In the remainder of this chapter, we illustrate how five institutional arrangements—a simple market, a differentiated market, a user group, a centralized national government, and a decentralized national government—would be expected to perform in the provision and production of specific types of private and public infrastructure.

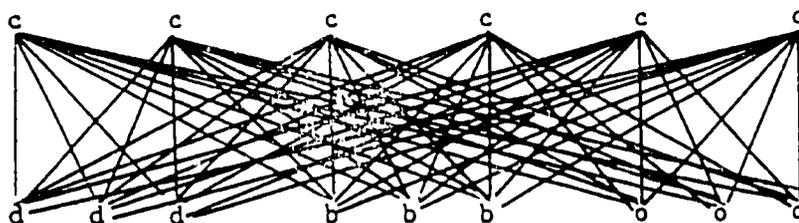
A Simple Market for Infrastructure Development

Let us consider a group of citizen-consumers who would benefit from the provision and maintenance of various types of infrastructure facilities and a group of potential designers, builders, and operators-maintainers⁵ of these facilities. (See Malone, 1987, for a

discussion of the general modeling technique we use in this chapter.) If the only institutional arrangement available to these citizens for developing infrastructure facilities is a simple market, we can envision the process of providing and producing as shown in Figure 6.2. Each individual citizen-consumer is responsible for provision. Each must seek out the producers (designers, builders, and operators-maintainers) necessary for each and every infrastructure project he or she wants undertaken. Infrastructure financing is accomplished through a series of *quid pro quo* exchanges between citizen-consumers and the various artisans involved. Similarly, the demand for various types of infrastructure design, construction, and operation-maintenance activity is articulated directly by citizen-consumers to the producer involved.

Such a simple market could easily be used for organizing the provision and production of private capital investments used by a single household, such as housing. Each family unit is completely responsible for its own provision, deciding whether it wants to undertake a task itself or hire someone else to do it. Each family is free to negotiate with all designers, search for builders, and negotiate a contract with one particular builder. Finally, a family unit either selects the gardeners, plumbers, electricians, and house-

Figure 6.2. A Simple Market for Infrastructure Development



KEY: c = citizen consumers, d = designers, b = builders, o = operators-maintainers

⁴ The method of institutional analysis that we are using is described in Kiser and E. Ostrom (1982) and E. Ostrom (1986); and applied in E. Ostrom (1990); Wynne (1989); Schaaf (1989); Yang (1987).

⁵ Throughout this discussion we combine operation and maintenance to reduce complexity.

cleaners who will be hired to maintain the house over the long term or decides to produce these activities within the household.

The rules underlying such a market are relatively simple. All artisans and citizen-consumers are permitted to be buyers or sellers at their own initiative, and no one is allowed to take the property of others without a mutual agreement on acceptable terms of exchange. The availability of monitors to enforce property rights and arenas in which conflicts about property rights can be resolved are essential to the operation of a simple market and to holding the various parties accountable.

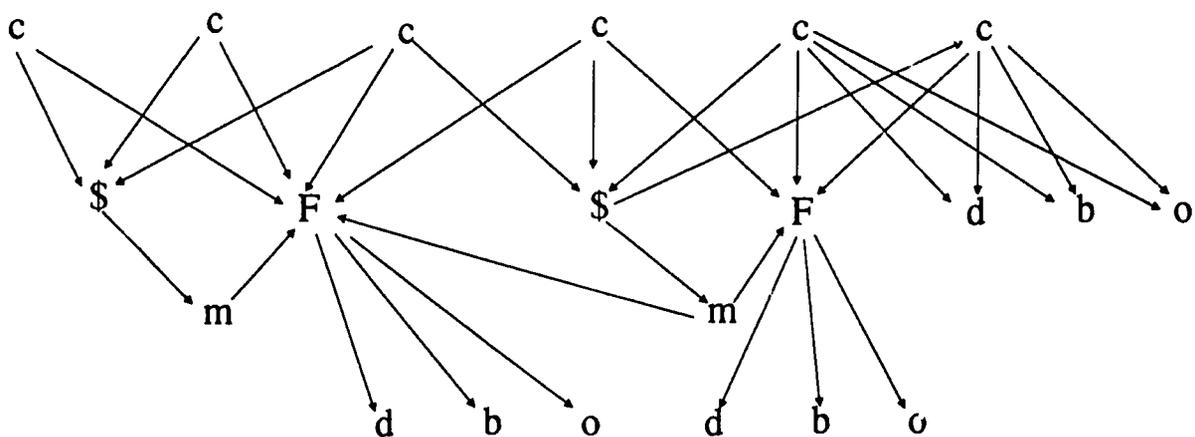
A Differentiated Market for Infrastructure Development

If the only institutional arrangement available was that of a simple market, information asymmetries would reduce the number of beneficial trades actually transacted in the process of providing and producing even a private investment such as housing. Families vary substantially in their earning capacity and their credit worthiness. Without financial institutions that can aggregate funds, share risk, hold property under various types of mortgage arrangements, and screen out unreliable family units, many long-term transactions related to housing would not occur. Similarly, design-

ners and builders vary substantially in their skills, knowledge, integrity, and capacity to bear risk. Establishing firms to combine the skills of several different workers, monitor internal performance, share risk, and establish a reputation is one type of institutional differentiation likely to occur related to housing. Financial institutions may also insist on certain monitoring activities during construction before they will agree to credit arrangements. Thus, many of the problems related to contractual uncertainty, risk, and information asymmetries discussed in Chapter 4 may lead to the development of more complex institutional arrangements, such as are illustrated in Figure 6.3, when individuals attempt to provide and produce long-term, capital investments.

In a differentiated market, instead of each consumer negotiating personally with numerous artisans, consumers may choose from a smaller number of construction firms who employ artisans on longer-term contracts, monitor their performance, and attempt to build reputations for high performance. Some consumers may be able to choose from a full array of potential producers and financial institutions; others may face a more limited set. (We assume sufficient competition among producers and financial institutions that no one has a monopoly position.) In addition to firms, some independent artisans continue to offer

Figure 6.3. A Differentiated Market for Infrastructure Development



KEY: *c* = citizen-consumers, *\$* = financial institutions (banks, credit rings, etc.), *m* = quality monitor, *F* = construction firms, *d* = designers, *b* = builders, *o* = operators-maintainers

services as well. Consumers who wish to make a large investment may also obtain loans from financial institutions after they have established credit worthiness and sufficient property to secure the loan. Financial institutions are likely to inspect the construction to ensure that quality standards are met. The underlying rules of a differentiated market enable individuals to "hostage" property in exchange for credit and to engage in long-term employment contracts involving mutual responsibilities and duties.⁶

As we have argued above, the performance of institutional arrangements depends on the type of goods and services that individuals attempt to provide and produce. For private capital investments such as housing, rough estimates can be made of the intermediate costs of production and provision discussed on pages 83-84. On the production side, for example, transformation costs involved in a differentiated market are likely to be lower than those in a simple market because firms capture economies of scale unavailable to individual craftsmen. Coordination costs are likely to be lower in the differentiated market because the number of potential linkages involved in completing a project is lower. Individuals involved in either a simple or a differentiated market would have access to accurate time and place information conveyed through the medium of prices. One could surmise, however, that artisans operating in a simple market are less likely to have access to the latest scientific information than are firms operating in a differentiated market because firms can more easily afford to invest in the acquisition of technical information. Adverse selection, moral hazard, and shirking problems are apt to be higher in the simple market than in the differentiated market where counteracting institutions have been devised specifically to cope with these problems.

On the provision side, transformation costs are low for both simple and differentiated markets be-

cause each family unit decides for itself how much and what type of housing is desired. Coordination costs will be lower in a differentiated market because the number of producers with whom one would need to communicate has been reduced. Obtaining information about specific preferences involves few costs in either case. Without intermediate organizations on the provision side (such as consumers' unions), individuals may not have access to scientific information (for example, about the dangers to health of using some building materials) in either case. Free riding, rent seeking, and corruption are not problems in either a simple or a differentiated market.

The total level of benefits achieved in the simple market is likely to be less than in the differentiated market because many potentially beneficial transactions would not be completed without the help of the counteracting institutions involved in the differentiated market. Thus, the differentiated market is likely to be more efficient (providing greater benefits *and* lower costs). In both types of markets, those who pay the costs are the primary beneficiaries of the investment and no redistribution is likely to occur. The addition of banks, firms, and monitors in a differentiated market is apt to increase the overall accountability of all participants in provision and production transactions.

In Table 6.1, we have arrayed intermediate costs as well as the four overall performance criteria. Based on the above analysis, an L, M, or H in each row indicates whether the associated costs or performance levels would be "low," "medium," or "high." For the first 15 rows in the table, L should be interpreted as positive because it represents a judgment that an intermediate cost will be comparatively low. In the last four rows, however, an L should be interpreted as less desirable than an M or an H, for efficiency, fiscal equivalence, and accountability; for redistribution, the interpretation depends on the reader's position

⁶ In any particular setting, many specific rules about credit, mortgages, creation of firms, monitoring, etc., may be present. In this section we present highly simplified situations and rule structures to illustrate a mode of analysis rather than the more detailed analysis one would undertake in an in-depth study of a specific problem.

regarding the desirability of fiscal equivalence and redistribution.⁷

Table 6.1.
The Comparative Performance of Institutional Arrangements Related to the Provision and Production of Housing

	Simple Market	Differentiated Market
Intermediate Production Costs		
Transformation costs	M	L
Transaction costs		
Coordination costs	H	M
Information costs		
Time and place	L	L
Scientific	H	M
Strategic costs		
Shirking	L	L
Adverse Selection	M	L
Moral Hazard	M	L
Corruption	L	L
Final State Provision Costs		
Transformation costs	L	L
Transaction costs		
Coordination costs	H	M
Information costs		
Time and place	L	L
Scientific	H	H
Strategic costs		
Free Riding	L	L
Rent Seeking	L	L
Corruption	L	L
Overall Performance Criteria		
Efficiency	M	H
Fiscal Equivalence	H	H
Redistribution	L	L
Accountability	M	H

Key: L = low, M = medium, H = high

User Group Organization for Infrastructure Development

Now let us consider how these institutional arrangements would perform in the provision and production of a jointly consumed infrastructure, such as a small-scale irrigation system that benefits the small set of citizen-consumers included in the analysis. We will contrast the simple market and the differentiated market with a third type of institutional arrangement found in some settings to cope with the provision and production of small-scale irrigation systems. This type of institutional arrangement involves the creation of a user group to which all those using the irrigation system belong. A simplified representation of this type of institutional arrangement is presented in Figure 6.4.

The production side of the differentiated market structure remains the same. The major change between Figures 6.3 and 6.4 is the organization of the citizen-consumers themselves (the provision side). The following type of rule structure underlies this situation. A group of farmers (the citizen-consumers in this situation) decides to construct an irrigation system that will serve only those citizen-consumers who initially buy shares in the enterprise (or those who later purchase shares offered by the user group). Those who own shares are then assigned a weighted vote equal to the amount of shares they own. The officials of the user group are chosen from among the members of the user group using some form of a voting rule.

When water is obtained, it is distributed according to the amount of shares owned. Each shareholder must contribute a proportionate share of resources to the user group each year (in the form of commodities and/or funds) that are used to pay persons to operate the control works and to guard the canal so that water is distributed according to an agreed-upon formula. Each shareholder is also responsible for contributing a defined share of the labor each year when the user

⁷ The entries in the tables presented in this chapter are based primarily on informed conjectures rather than tight analytical conclusions. Analytical models such as those of Malone (1987) and Cohen et al. (1981) have informed our judgment. Models of this type could be used in developing the arguments more rigorously.

group collectively cleans out the canals and undertakes any emergency or routine repair work on the canals.⁸

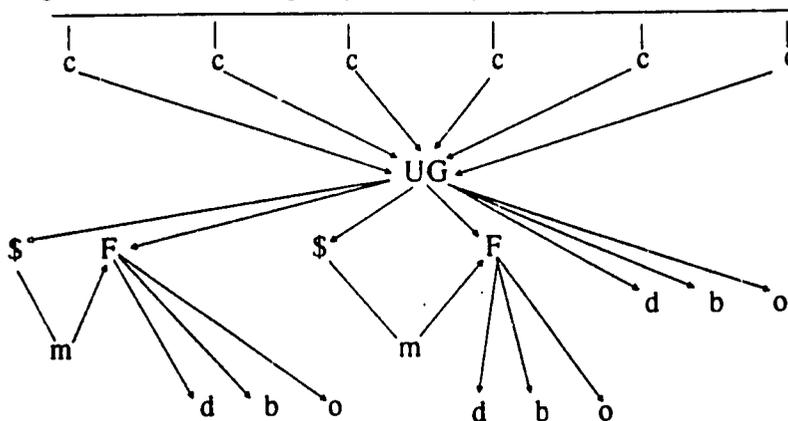
Assuming that the construction and operation of a small irrigation system are within the technical competence of the local designers, builders, and operators, any of the three sets of institutional arrangements described above could potentially be used to provide and produce such a system. In general, the differentiated market performs better than the simple market, and the user group structure built on top of the differentiated market has the potential to perform better still. All of the intermediate costs on the production side remain the same for a differentiated market and for a user group organization built on top of a differentiated market as shown in Table 6.2.

The major difference for a user group built upon a differentiated market relates to the costs of free riding. So long as the user group is able to exclude noncontributors from the enjoyment of irrigation water and is able to monitor and enforce the required contribution of monetary, commodity, and labor inputs so that conformance to the rules is relatively high, the user group arrangement will solve the free-rider problem; the two types of market arrangements will

not.⁹ The incentive to free ride, particularly in the provision of maintenance activities, does not appear when a user group is effectively organized; it is offset to a substantial degree by other incentives. The members of a user group are able to monitor each other's activities closely as a by-product of other activities. The absence of a member who fails to join the others on the day set aside to clean out the channels is easily noticed. His reputation as a reliable member of the community, which is of considerable importance in such communities, is adversely affected. Although overt sanctions are used in user groups to reduce free-riding behavior, the reduction largely results from the increased information that all members have about each other's activities and the importance of a good personal reputation in such settings.

The provision side does not remain the same. Transformation costs on the provision side must increase at least somewhat for a user group as contrasted to a simple or differential market. Farmers must now discuss their preferences and come to a common agreement about design and operating characteristics and maintenance strategies. If the farmers involved have similar interests (e.g., they own roughly the same size farms, grow similar crops, share religious values,

Figure 6.4. User Group Organization for Infrastructure Development



KEY: *c* = citizen-consumers, *UG* = user group, *\$* = financial institutions (banks, credit rings, etc.), *m* = quality monitor, *F* = construction firms, *d* = designers, *b* = builders, *o* = operators-maintainers

⁸ This description of a user group rule configuration is a simplified version of the rules used in many such groups located in Nepal and the Philippines (see Martin and Yoder, 1983; Siy, 1982; Bagadion and Korten, 1985; Coward, 1985).

⁹ The user group must, however, be able to sanction its own members by threatening to withhold water, charge fines, and/or impose social sanctions on non-conforming members.

and tail-enders are not strongly disadvantaged), coordination costs will remain relatively low. Coordination costs will always be higher when consumers are organized than when they are not organized, but how much higher depends on the homogeneity of the individuals involved and the rules they use for aggregating preferences.

Table 6.2
The Comparative Performance of Three Institutional Arrangements Related to the Provision and Production of Small-Scale Irrigation Systems

	Simple Market	Differentiated Market	User Group
Intermediate Production Costs			
Transformation costs	M	L	L
Transaction costs			
Coordination costs	H	M	M
information costs			
Time and place	L	L	L
Scientific	H	M	M
Strategic costs			
Shirking	L	L	L
Adverse Selection	M	L	L
Moral Hazard	M	L	L
Corruption	L	L	L
Intermediate Provision Costs			
Transformation costs	L	L	L+
Transaction costs			
Coordination costs	L	L	L+ or M
information costs			
Time and place	M	L	L
Scientific	H	H	H
Strategic costs			
Free Riding	H	H	L
Rent Seeking	L	L	L
Corruption	L	L	L
Overall Performance Criteria			
Efficiency	L	L	M or H
Fiscal Equivalence	H	H	H
Redistribution	L	L	L
Accountability	M	H	H

Key: L = low, M = medium, H = high

Both rent seeking and corruption should be low when a user group organizes provision. The resources used for providing the infrastructure come from the group that benefits rather than a public treasury to which others contribute. Thus, investment decisions are made with the knowledge that those making the investment will be able to use *only* their own resources rather than those of others. Given this close association between the source of input resources and the benefits, it is unlikely that a group would overinvest in new facilities. In such settings, underinvestment due to uncertainty about benefits and costs is more likely than overinvestment. Underinvestment may also occur if the resources directly available to the user group are insufficient to undertake the investment and reasonable credit is not available.

As soon as collective provision exists, there is always the possibility that some individuals will invest in activities to obtain a disproportionate share of benefits, thus spending resources in unproductive activities. This type of rent seeking, however, is minimized if the user group is relatively homogeneous in structure. If, on the other hand, leaders have a disproportionate say in how benefits are allocated, rent seeking can characterize even these close-to-home institutions.¹⁰ Corruption is also minimized because many user groups do not mobilize large amounts of cash, which is the easiest resource to exploit in corrupt transactions. A farmer has more control over how group resources are utilized if the farmer personally performs required maintenance labor rather than giving an official cash to hire laborers to perform the maintenance. While crops can be used to pay irrigation officials to deliver more than the authorized amount of water to a farmer's gate, such the delivery and the subsequent payoff in crops are far more likely to be observed when the farmers themselves are part of the operation and maintenance crews.

In regard to the four overall performance criteria, the major difference between the user group arrangements on the one hand and either type of market arrangement on the other relate to efficiency and accountability. Given the free-riding problems in-

¹⁰ Traditional leaders who exert undue influence in village affairs in the rural areas of some developing countries are, thus, rent seekers.

volved in either of the market arrangements, many potential benefits cannot be achieved until some form of collective provision is established with effective sanctions against those who do not contribute. Differentiated market institutions increase accountability on the production side. User groups that maintain open records concerning labor and other contributions by members and how monetary resources are distributed increase accountability on the provision side and rely on the more accountable production-side arrangements of the differentiated market.¹¹

The incapacity of individuals relying strictly on market institutions to overcome free-riding problems has led many analysts to call for the provision of infrastructure facilities by a central government. Such policy prescriptions are frequently made without distinguishing among those facilities, such as small-scale irrigation systems, that serve a relatively small, well-defined set of individuals, and those facilities, like large-scale irrigation systems or a highway network, that serve a large and less well-defined set of individuals. As discussed in Chapter 2, many small-scale infrastructure projects are designed, constructed, operated, and maintained quite effectively by those most directly affected, relying on some form of user group organization similar to the simplified version analyzed above. It is obvious, however, that this method of organizing provision is not sufficient when the type of infrastructure involved serves a large and difficult-to-define set of beneficiaries.

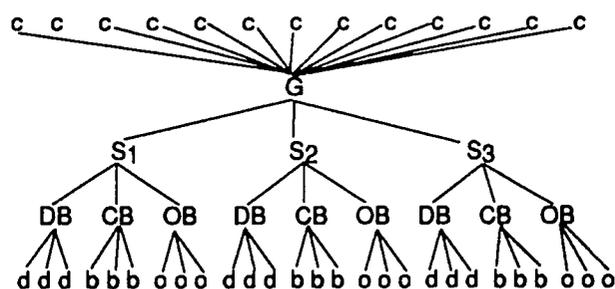
Centralized National Government Hierarchy for Infrastructure Development

Let us now consider the problem of designing, constructing, operating, maintaining, and using large-scale infrastructure facilities. To do so, we need to examine a fourth type of simplified institutional arrangement—that of a centralized, national govern-

ment. A diagram of this type of institutional arrangement is shown in Figure 6.5.

The organization of both sides of the provision-production nexus in this case is radically different from the organization of the three types of institutional arrangements we have considered so far. On the provision side, instead of a small set of citizen-con-

Figure 6.5.
A Centralized National Government for Infrastructure Development



KEY: C = citizen-consumers
 G = central government
 Si = sectoral ministry (e.g., irrigation, agriculture)
 DB, CB, OB = Design, Construction, and Operating Bureaus within each sector ministry
 d = designers
 b = builders
 o = operators-maintainers

sumers who act independently (as in the two market situations) or collectively (as in the user group situation), a large set of citizen-consumers residing

¹¹ Many indigenous institutions like the *zanjeras* described in Chapter 2 have extensive internal mechanisms to assure accountability. When user groups are created by external authorities and rely primarily on monetary resources rather than in-kind resources, accountability can be a problem.

throughout an entire nation faces a constrained set of choices. At periodic intervals, these citizen-consumers select a set of full-time officials. Between elections, groups of citizen-consumers can try to influence those officials to use their authority to obtain desired benefits for their supporters. On the production side, another set of full-time officials is organized in specialized production bureaus within ministries that are organized along sectoral lines.

Both sets of officials are employed full-time, and their future careers depend on pleasing those who help them retain and/or advance their positions. The incentives facing both sets of officials in a centralized regime can lead to a compounding of perverse consequences regarding decisions about the infrastructure facilities to be designed and constructed and the investments to be made in operation and maintenance activities. The actual costs of producing and providing rural infrastructure facilities by a large-scale central agency will vary substantially from one project to another. To focus our discussion, we will examine the incentives involved in the construction and the operation and maintenance (O&M) of a large-scale irrigation system.¹² The anticipated performance results for both production and provision of construction and O&M are summarized in Table 6.3. Let us first examine the production side.

Table 6.3
The Performance of a Central Government Bureau Related to the Construction and O&M of a Large-Scale Irrigation System

	Construction	Operation & Maintenance
Intermediate Production Costs		
Transformation costs	L	L
Transaction costs		
Coordination costs	M to H	M to H
Information costs		
Time and place	H	H
Scientific	L	L
Strategic costs		
Shirking	M	H
Adverse Selection	L	L
Moral Hazard	L	L
Corruption	H	H
Intermediate Provision Costs		
Transformation costs	M	M
Transaction costs		
Coordination costs	M	M
Information costs		
Time and place	H	H
Scientific	H	H
Strategic costs		
Free Riding	L to M	L to H
Rent Seeking	H	L
Corruption	H	L
Overall Performance Criteria		
Efficiency	L to H	L to M
Fiscal Equivalence	L	L
Redistribution	?	?
Accountability	L to M	L to M

KEY: L = low, M = medium, H = high

¹²The discussion herein is consistent with many descriptions of the incentives and behavior of public officials in central agencies who are responsible for constructing and operating large-scale irrigation systems (see Ascher and Healy, forthcoming; Wade, 1984; Chambers, 1980a; Coward, 1980; Harriss, 1984).

Anticipated Performance on the Production Side

Whether a national bureau contracts with private enterprises to construct large-scale irrigation systems or constructs them with its own personnel, we assume that it is able to capture economics of scale. Thus, we presume low transformation costs related to construction.¹³ Although an assumption of low transformation costs related to operation and maintenance is more difficult to justify, we will make this assumption in order to focus on coordination, information, and strategic costs (see Table 6.3).

Let us now turn to the other intermediate costs. In regard to coordination costs on the production side, we expect them to be higher than our earlier examples because lower-level bureaucrats in a centralized agency must obtain permission from higher-level bureaucrats before proceeding with many tasks. Furthermore, efforts to enhance the accountability of governmental agencies frequently increase coordination costs substantially. All stages of an infrastructure project will be reviewed by various officials, and establishing a proper paper trail requires that substantial resources be devoted to coordination efforts. Thus, coordination costs will vary from medium to high depending on the particular administrative procedures used.

Information costs related to time and place would be high in most central bureaus with respect to both construction and maintenance. The problems that design engineers encounter in obtaining accurate information about stream flow from the maps and other data available to them have already been discussed. Obtaining appropriate information related to maintenance is even more difficult for a central bureau. Minor failures in an irrigation system can occur anywhere, at any time. A local flash flood can cause a small washout within an hour. Yet maintenance personnel located an hour or two from this site may not even know it rained. By the time the information about a small problem is obtained by repair crews, a

minor repair job may have become a major reconstruction project. Information costs related to scientific information, on the other hand, should be relatively low in a national bureau.

We expect the problem of shirking to be higher in a national bureau than in simple or differentiated markets or user group arrangements. When coordination costs are high, individual incentives to keep their jobs as easy as possible lead, however, to increased overall costs. Frequently, civil servants with the best of intentions find themselves in situations where the demands on their time and energy require them to keep the effort they spend in supervising projects as low as possible. One way of reducing project monitoring time is to approve a smaller number of larger projects, thereby avoiding the need to supervise many smaller projects, whether or not this results in higher or lower costs of producing infrastructure facilities.

An example from the Philippines illustrates how high coordination costs and the incentive to reduce personal effort can work against selecting the lowest cost projects. The governor of Laguna Province offered the National Irrigation Administration (NIA) 50,000 pesos to be used for improving the operation of the region's irrigation systems. Funding was subject to the approval of the plans by the College of Agriculture at the University of the Philippines. NIA engineers proposed spending all the funds on one project to line the main canal of one system with concrete. The project review revealed that the water leaking from this canal was used anyway by the farmers in the project area, and that, consequently, the proposed expenditure would not improve the operation of the system. Instead, several other projects were proposed that *would* increase productivity, such as constructing small-scale drainage checks or additional farm ditches. Ultimately, the funds reverted unused to the Provincial treasury rather than being devoted to the suggested small-scale improvement. The incapacity or unwillingness of agency officials to oversee a number of small projects led to the abandonment of the smaller scale projects.

¹³ The recorded production costs of many large-scale irrigation projects are extremely high. Rather than challenge the well-accepted presumption that large-scale agencies will capture economies of scale, we presume that these recorded costs are largely attributable to the higher coordination, information, and strategic costs associated with this arrangement.

It was clear that the burden on the limited staff in planning and overseeing many small implementation activities, plus the intensive involvement with individual landowners and tenants over rights-of-way, etc., were such that it was in the bureaucracy's, if not the farmers' interest to refuse the money (Barker, et al., 1984: 46-47).

Whether the bias toward supervising large projects is considered the result of shirking, high coordination costs, or a combination of both, overall efficiency is reduced when small and productive projects are rejected in favor of large projects, especially when the larger projects produce no net benefits.

We also expect shirking to be higher in Operations and Maintenance Divisions than in Design and Construction Divisions. All employees are likely to find some tasks more fulfilling than others. Most engineers gain greater satisfaction from their involvement in the design and construction of a system than from overseeing the maintenance of completed systems. Furthermore, bureaucratic rewards may go to those engaged in successful design and construction projects, rather than to those involved in the harder-to-evaluate job of organizing effective maintenance regimes. Thus, internal and external incentives tend to counteract shirking to a somewhat greater extent in regard to construction. On the other hand, few internal or external incentives counteract shirking in O&M. It is almost impossible to monitor how a maintenance engineer or his staff spend their time, and few bureaucratic punishments can be administered to those who spend time on personal tasks rather than on maintenance.

Opportunities for corruption exist in regard to both construction and O&M, but the amount of illegal side-payments can be much larger related to construction.¹⁴ Jagannathan (1987: 111) describes how the process works some places.

For instance, suppose tenders are called for a highway construction project worth \$1 million. Tender papers and award of contract to the

lowest bidder will be perfectly in order. Informal agreement (before or after the contract finalization) will, however, be reached by which the contractor is allowed to use substandard material and pad up labor costs so that his costs amount to only \$750,000. The balance of \$250,000 is then shared between the concerned individuals.

Opportunities for illegal side-payments are not limited to the letting of contracts. Positions as the operators and maintainers of large-scale irrigation projects, for example, provide many opportunities to receive regular payments. The difference in the quantity and quality of crops that can be grown with the aid of a regular supply of water versus those that can be grown with an irregular supply means that many farmers are perfectly willing to pay a regular fee to a lower-level irrigation official to ensure the predictable delivery of water to their field gates. Robert Wade (1984, 1985) has documented the prices irrigation officials charge farmers for various types of public services as well as those that higher-level officials charge lower officials for lucrative postings.

The incentives that public officials face must be understood in the context of the generally low salaries they receive, their limited career advancement opportunities, their poor working conditions, and the opportunities (both legal and illegal) available to them in different types of work assignments. Most central government employees prefer to live in the capital of their country, where they can obtain a better education for their children and thus enhance their children's opportunity for a better future. Health services for themselves and their families are also better. Their own career opportunities can be enhanced by working where they can be observed by superiors rather than working out in the countryside where their activities may not be noticed by the central bureau. With regard to infrastructure, this leads to a strong preference for work associated with the design and construction of large systems that generate many employment positions in the central bureau.

¹⁴ In some cases, the opportunities for illegal side payments are so substantial that individuals may consider the purchase of official positions as an investment (see Wade, 1984, 1985; Jagannathan, 1987: Chapter 8).

Assignment to activities related to the operation and maintenance of infrastructure projects implies assignment to posts in the countryside. Many administrative officials assigned to smaller jurisdictions attempt to maintain two households—one for their family living elsewhere and a minimal living arrangement for themselves where they have been assigned. Once assigned to the countryside, many officials devote considerable energy to arranging ways of being reassigned to duties in the capital city.

The working conditions of officials assigned to an O&M division in the countryside are also considerably more difficult than those of officials working in the capital. The commitment of the governments of many developing countries to using the central treasury to ensure continued employment of a substantial proportion of the educated population, combined with the extreme budgetary constraints of these countries, has meant that the budgets of many administrative bureaus are almost totally committed to salaries. Few funds are available to purchase the supplies officials need to carry out their duties. Thus, O&M officials are frequently assigned to large districts without a bicycle or a gasoline budget. It is hardly surprising that public officials responsible for infrastructure O&M are not able to properly supervise these processes when they lack the necessary funds to enable them simply to visit the roads, water supply systems, or irrigation systems within their jurisdiction.

Given the low salaries and the high costs of keeping two households, the incentive to search out opportunities to earn extra funds while in the countryside (while urgently trying to get reassigned) is understandable. Relatively few opportunities arise from investments of time and energy in the maintenance of an existing system. The opportunities for additional income arise when goods and services can be withheld from potential beneficiaries unless side-payments are

made, and when side-payments are involved in the award and supervision of contracts for the construction or maintenance of infrastructure. Thus, central government irrigation officials working in the O&M division of an irrigation project will tend to devote more energy to allocating water to individual farmers who are willing to contribute funds or commodities in return, than to maintaining structures that benefit many users in a diffused manner.¹⁵

This is not to say that all administrative officials in centralized regimes are necessarily corrupt or shirkers. One finds many devoted public officials in all systems who resist the temptations afforded by the systems. What this analysis does suggest, however, is that centralized regimes produce incentives that enhance the opportunities for corruption and shirking, yet generate few counteracting pressures for officials to refrain from these practices. Furthermore, once shirking and corruption practices are well established in large, centralized bureaucratic systems, those who attempt to fight the problem from within are vulnerable to retributory actions by their peers and their superiors. Consequently, corrupt actions occur with considerable frequency in both construction and O&M. The size of the illegal side-payments received when supervising construction projects, however, can be considerably larger than the size of the payments given by farmers to O&M personnel for various services performed.

Anticipated Performance on the Provision Side

In the above discussion, we focused exclusively on the likely performance of central government agencies in regard to producing large-scale irrigation projects. Now, let us examine the provision side, including the transformation of preferences and willingness to pay into specific infrastructure development processes and the monitoring and enforcement

¹⁵ Similarly, the opportunities for private return in regard to road maintenance are not associated with actually getting roads well maintained but in devising ways that contractors can reduce the quality of their maintenance activities in return for a side-payment from the savings created for the contractor.

of procedures related to operation and use. Assuming a competitive, democratic selection process, each citizen-consumer participates in general elections of national officials who run on platforms representing their promised positions regarding future investments of public funds. Many campaign promises involve projects that are strongly preferred by some group of supporters, such as the members of an electoral district or a relevant group (urban voters, ethnic groups, individuals sharing class interests, etc.).¹⁶

One cannot presume, however, that the outcome of a national election is a clear articulation of majority preferences about the proposed investments and allocations to be made from a central treasury. More realistically, the outcome is the selection of a set of actors who will each try to obtain as much as possible for the group he or she must please in order to stay in office. Even if this behavior were not endemic, the problems of aggregating the preferences of heterogeneous populations discussed in Chapter 5 lead to the conclusion that the outcome of a national election cannot be interpreted as a reliable indication of the most preferred set of public policies to be pursued.¹⁷

Costs for obtaining time and place and scientific information are high when provision is organized by one very large unit. Citizens located in one setting cannot know much about what is needed elsewhere. Likewise, officials know little about the preferences of any citizens other than those who are highly motivated and organized to obtain disproportionate benefits. Even gaining reliable information about the effectiveness of various policies (scientifically grounded, policy knowledge) is extraordinarily costly when all policies have to be adopted for an entire

country without experimentation undertaken by smaller units.

As discussed in Chapter 7, many taxes levied in developing world countries are collected by the central government and placed in a general fund from which most expenditures are allocated. The general fund becomes a "common pool" for all central government officials. Because the source of funds is not directly related to particular public sector activities, all elected officials are motivated to obtain as much of the general fund as possible for projects that benefit their constituents.

Each official weighs the observable benefits of specific projects more than the costs. (Benefits are visible and can be directed toward specific sets of supporters; costs are relatively hidden and can be spread across all taxpayers.) Some form of logrolling among elected officials will occur—the particular form of logrolling depends on the specific set of rules used to make central government decisions. If strong institutional constraints on logrolling processes do not exist, it is highly likely that such efforts will lead to substantial overinvestments in some types of public projects and major underinvestments in other types of projects.¹⁸

Let us now turn to the problem of free riding. A presumed advantage of governmental provision over private provision is a government's capacity to prevent free-riding behavior. Yet this is not always the case. For example, as reported in Chapter 1, the actual revenue collected from farmers in many developing countries does not even begin to cover the O&M costs of government-run irrigation systems, let alone contribute to capital costs. In Bangladesh, farmers con-

¹⁶ Whether the promises are made primarily to voters organized in specific territorial districts or to individuals dispersed throughout the country who share a class or ethnic interest depends on the particular voting rules in use. For this analysis, the point is that promises will be made to some groups to provide them with higher levels of benefits than others.

¹⁷ In many developing countries, the central government is not chosen at a general election. Whether the central government is elected or not, however, is not central to the analysis and does not affect our conclusions. The officials within a military government, or any other form of nonelected government, are still faced with the problem of allocating scarce resources to different districts and groups in a society. Whether they stay in office and improve their position depends on satisfying these relevant groups. Whether officials are elected or not, direct links are absent in fully centralized regimes between the perception by public officials of the benefits from a particular project and their perception of costs.

¹⁸ See Weingast, Shepsle, and Johnson (1981) for an excellent analysis of logrolling mechanisms and Ferejohn (1974) and Mayhew (1974) for empirical tests of these models in the U.S. context.

tribute only 13 percent of the costs of O&M; in Thailand, only 26 percent (Repetto, 1986:5). It is hard to precisely interpret the repeated findings that farmers do not actually contribute required fees. As we will discuss in Chapter 7, the likelihood that farmers will comply with government-imposed taxes or fees depends on many factors, including whether their perceived benefits are at least as great as the required assessment. What is obvious is that governments in many developing countries do *not* solve shirking problems on the production-side nor willingness-to-pay problems on the provision side.

Anticipated Overall Performance

In regard to our overall performance criteria, efficiency varies from low to high across projects, and fiscal equivalence is rarely achieved. Given the difficulties outlined above in regard to intermediate criteria, it is not surprising that central government agencies in most countries cannot be expected to perform at a high level with regard to any of the four overall performance criteria arrayed on Table 6.3. The example of the Mahaweli project in Sri Lanka described in Chapter 2 provides a realistic illustration of these problems confronted in regard to both construction and O&M. A system such as this would have to be rated as performing at a low level in regard to overall efficiency, fiscal equivalence, redistribution, and accountability. Our discussions of the NIA in the Philippines illustrate that central agencies can perform far better when their design and construction activities are planned in conjunction with the beneficiaries and when O&M is also open to participation by beneficiaries.¹⁹

Whether the poor are subsidized to some extent by the wealthy is almost impossible to know without detailed analysis. All too frequently, careful analyses have instead shown redistribution to be in the opposite

direction. Whether redistribution actually occurs is difficult to establish theoretically, and should instead be determined empirically.

The Problem of Truncated Analyses of Central Government Performance

The above discussion has stressed some of the costs of reliance on a single, large-scale government to provide and produce the design, construction, operation, and maintenance of rural infrastructure. The presumption that jointly consumed infrastructure goods must be provided and produced by centralized, national governments derives primarily from three concerns: free riding, economies of scale in production, and technical expertise. A national government is presumed to counteract the lack of provision of needed infrastructure facilities due to free riding, as well as reduce the costs of producing capital intensive goods due to economies of scale achieved by large production bureaus. The technical skills needed to design and construct (and, in some cases, to operate) capital-intensive facilities are presumably possessed by national government agencies and by no others.

These presumptions have considerable surface validity. If the only institutional arrangements that could be used to provide large-scale infrastructure projects were a centralized governmental regime on the one hand and strictly private arrangements such as the user group (or the two types of market arrangements) on the other hand, the advantages of the central regime in counteracting free riding and lowering production costs could be impressive.

These presumptions are, however, based on a truncated analysis. First, the set of intermediate performance criteria is limited primarily to only three of the fifteen we use in our analysis: production costs, free riding, and costs of securing scientific knowledge.

¹⁹The NIAs in Korea and Taiwan are also considered to be among the better performing central agencies with regard to both construction and O&M. USAID investments in Korean irrigation projects have resulted in well-engineered projects, completed close to schedule, and resulting in predicted increases in crop yields. The investment in large-scale irrigation, as compared to other potential investments, is hard to evaluate as efficient given that the price paid to farmers for producing rice has been highly subsidized. Steinberg, et al. (1980b: 15) conclude that: "Korea could import at least 50 percent more rice than it could produce domestically with the same expenditure." In Taiwan, farmers are well organized at several levels and are much more involved as key participants in managing irrigation systems than they are in most countries where a national agency plays a major role (see Levine, 1980).

Second, the set of alternative institutions being considered is truncated. A wide variety of polycentric institutional arrangements is possible, including various public and private large-scale, medium-scale, and small-scale enterprises in complex networks of provision and production. Third, attention has focused on the design and construction of infrastructure, with little attention to operation and maintenance. Although the production costs of design and construction activities may be lower for larger-scale agencies in major projects, the production costs of operating and maintaining these same projects may be higher when they are undertaken by a central agency than when they are carried out by smaller agencies or the users themselves.

The truncated analysis that is implicit in the presumption that centralized, governmental arrangements are necessary for infrastructure provision and production is illustrated in Table 6.4. If this truncated analysis adequately represented the institutional options, the full array of activities associated with infrastructure, the full set of costs, and actual practice with regard to free riding, then the policy prescriptions of the past would be appropriate. However, their inadequacy has been repeatedly demonstrated in major reports that have stressed the unexpected costs of exclusive reliance on centralized governmental agencies (Uphoff, 1986; Chambers, 1988; Cernea, 1985; Esman and Uphoff, 1984). These unexpected costs include many of the other intermediate performance criteria identified in the prior sections of this chapter, including coordination costs, lack of time and place information, rent seeking, on-the-job shirking, and corruption. Furthermore, the presumption of economies of scale, which is frequently correct in regard to the design and construction of large-scale projects, is frequently incorrect in regard to the O&M of these same projects. And, most importantly, the assumption that central government provision and production is best implies that the options for institutional arrangements are limited to a choice between "the market" and "the state." This is decidedly *not* the case; as we will discuss in Chapter 8, a wide variety of institutional options are available.

Table 6.4.
A Truncated Analysis of Institutional Performance Related to the Design and Construction of Large-Scale Infrastructure

	Central Government	Private Arrangement
Production Costs	L	H
Scientific Knowledge	L	H
Free Riding	L	H

KEY: L = low, H = high

For some rural infrastructure projects, a careful analysis of all performance criteria and a variety of possible institutional arrangements would generate the conclusion that both provision and production by large, centralized bureaucratic agencies is the most efficient and equitable institutional arrangement available. In other instances, a similar analysis would generate recommendations for central government *provision*, but *production* by private or other public agencies arranged for by the central government. In many other instances, however, complete analysis would indicate that a diversity of noncentralized government provision and production arrangements would result in lower intermediate costs and increased overall performance.

Does Administrative Decentralization Improve the Performance of Centralized National Governments?

Proposals for decentralization have been the most common policy response to the weaknesses associated with highly centralized national governments. These proposals argue that investments of huge sums in infrastructure facilities that are later determined to be poorly suited to the needs of a particular community and/or poorly maintained can occur because the officials in the best position to know about local circumstances have too little influence in decision-making processes within the ministries. In addition, decisions regarding any single infrastructure investment are too far removed from local political processes and therefore do not reflect community preferences. Residents of a community have no means

of directly shaping the nature of infrastructure development that takes place in their community.

These problems have led to proposals that employees should be physically relocated and decision-making authority within ministries be rearranged in order to give employees working in regional or subregional offices a larger role in deciding the character of infrastructure development and maintenance in their jurisdictions. In some instances, local representative councils have also been created as advisory bodies for ministry employees. In those cases in which very limited law-making authority is exercised by councils, ministries of local government often have veto power over legislation. Because local councils are not intended to be independent governments with law-making or law-enforcing authority, structural changes associated with administrative decentralization are essentially changes in the *production side* of the original, centralized national government. Employees are shifted from headquarter locations to field locations within production agencies. Figure 6.5 could be used to represent most decentralized as well as most centralized agencies.

The creation of dispersed administrative offices inevitably places a larger number of officials in closer physical contact with the communities in which infrastructure development will be undertaken. The time and effort required of officials who wish to learn more about local circumstances is reduced. These officials are also necessarily brought into closer physical contact with residents of smaller jurisdictions and with members of local councils. Administrative reorganization could be expected to improve the performance of an official who is assigned to the same area in which he was raised and in which the principal economic interests of the official or his immediate family are located. It would, in this case, be in the interest of the official to provide infrastructure facilities appropriate for his own interests. Such facilities might or might not be considered appropriate by the membership of a local advisory council or by most residents of the jurisdiction. Some developing countries purposely post employees outside their home areas to prevent officials from using their positions to promote their own economic interests or those of autocratic, local, traditional leaders within their jurisdictions.

Administrative reorganization does not, however, substantially alter the nature of the career track within the ministries. Lower-level officials are still concerned about how senior officers assess their performance with respect to promotions or disciplinary action. Reorganization does not alter the fact that the best schools and hospitals are located in the capital city. It also may not substantially alter the information that officials bring to bear on their decision making.

Although the village where a new road or irrigation system is to be built is located nearby, an official must still make some effort to learn something about the area. If the official is convinced that local people know nothing of consequence about economic development or knows what senior officials strongly prefer, the proximity of the village may still not encourage effort to obtain information in the village.

Because local advisory councils rarely have an effective veto on infrastructure decision making, officials need not take their opinions too seriously. Farmers in the Philippines did have an effective veto on the experimental participatory program described in Chapter 3. They had to agree to accept responsibility for a rehabilitated system once constructed. Once engineers were rewarded for the rate of successful turnovers completed, farmers gained a much more effective voice. But as later evaluations illuminated, the tradition of sharing authority did not carry over to other Philippine projects.

Members of a local council with connections to senior officials or political leaders are, however, in a position to make local-level public service employees take their views into account. They, in turn, are not likely to have the interests of others at heart when they exert their influence, but, rather, will act to advance their own interests. Thus, patron-client links between public officials at different levels and between local and national leaders, and not a local consensus, may determine the allocation of funds among projects.

Although some experimental decentralization projects have involved temporary shifts of substantial joint authority to local-level officials and to the citizens involved in a project, few of these shifts have been retained after the experimental projects have ended. Most decentralization efforts have involved little more than shifting personnel from headquarter

offices to field locations. If information obtained in the field is not taken more seriously than it was previously, the shift is unlikely to affect substantially any of the intermediate costs involved in either construction or maintenance of a large-scale irrigation system. Thus, the performance of decentralized agencies is likely to be similar to that of centralized agencies, unless major structural changes assuring considerable joint autonomy and responsibility for lower-level officials and the citizens they are servicing are effected.

The Role of Donor Agencies

In the above discussion, we have not considered the role of bilateral or multilateral donor organizations in the different institutional arrangements we have analyzed. Any discussion of institutional arrangements for infrastructure development in the developing world, however, would be inadequate without recognition of the importance of donor agencies in affecting the incentives of all participants in infrastructure development in ways that may exacerbate the problems of rent seeking, corruption, and accountability. Foreign aid programs have been severely criticized for overinvesting in large, capital-intensive projects, for the use of inappropriate technology, for their pursuit of donor government interests, and for the high levels of corruption that have frequently been associated with donor-financed projects (see, for example, Wall, 1973; Rockefeller, 1969; Asher, 1970; Hayter, 1971; and Levinson and de Onis, 1970). At times, the criticism presumes conspiratorial motivation. Donor agencies are presented as fronts for a new form of conscious imperialism.

Anyone who has observed infrastructure projects in operation, however, is struck by the number of extremely hard-working, highly motivated individuals, employed in both the host governments and in the donor agencies, whose principal goal is clearly to improve the well-being of those living in countries receiving foreign aid. And, yet, realistic assessments of many projects designed by donor and host government staff repeatedly show that they increased or reinforced the overcentralization of recipient countries' governments, were poorly designed given local circumstances, and generated inappropriately large debt burdens for the recipient countries. How is it possible for highly motivated, hard-working people, who sincerely want to improve conditions in the

recipient countries, to be repeatedly involved in the design and implementation of projects that do not accomplish these goals?

This question has been the subject of several careful studies (see Nelson, 1968 and Tendler, 1975) and we cannot fully address it within the confines of this volume. But identifying the incentives facing actors in the donor agencies as they relate to public officials and private enterprises in the host countries, however, begins to indicate how these consequences could be generated. Some of these incentives are present in most large-scale bureaucratic agencies. Others are unique to the foreign aid domain or even to particular agencies such as USAID.

USAID continues to face the apparently contradictory problems of creating an enduring constituency in support of foreign assistance, while seeking appropriate ways to spend the large amount of foreign aid money mandated by Congress. The legislative mandate to allocate a proportion of foreign assistance to the purchases of U.S.-made equipment was an important initial source of considerable bias in project designs toward very large and capital-intensive projects. The notorious need to "move money" faced by all government agencies, in which next year's funding depends on the agency's efficiency in spending this year's budget, reinforced the likelihood that projects requiring large expenditures for major capital goods were more likely to be funded than labor-intensive projects and using small-scale and locally manufactured equipment. This pressure to cope with a gushing "pipeline" continues at the same time that economy measures have severely reduced the numbers of agency personnel. Fewer people are now available to oversee the spending of more money.

The design of a \$31.5-million highway maintenance equipment project in Brazil poignantly illustrates the potential incentives for donor agencies. The initial proposal included an equipment import list of \$35.5 million that would produce an equipment-per-mile ratio that was higher than the average equipment-per-mile ratio in the U.S. at the time (Tendler, 1975: 68). In early discussions of this project, several proposals were made by Brazilian firms to reduce by two-thirds the U.S.-made equipment that would be imported to undertake capital-intensive repair strategies and, instead, substitute equipment that

could be purchased locally. Because any shifting of equipment from the import list to the domestic list represented an equivalent drop in the amount of funds available through USAID, mission personnel realized that such a shift to local technology would place a large financial burden on the three southern states of Brazil where the project would be located (Tendler, 1975: 69). Because such a shift represented a real threat to the likelihood of *any* project funding, major technical questions regarding the basic design of the project were not raised. Tendler summarizes some of these missing questions:

Needless to say, the technical logic of the solution excluded other important considerations. For example, was "optimum maintenance" a desirable goal in a country with much less capital than the United States, where this standard was formulated? Also, would faltering maintenance divisions in highway departments with a penchant for construction be able to absorb such a massive dose of new equipment and such a spurt in the intensity of their maintenance? Or would some of the abundant equipment be siphoned off into highway construction, as had happened in other maintenance loans, thus reinforcing the vicious circle of construction-without-maintenance? (Tendler, 1975: 68-69).

According to Tendler, these questions were largely ignored not because of malicious intent to design a poor project, but because all of the incentives facing the engineers in both the USAID mission and in the relevant government offices focused the attention of the personnel involved on equipment. For everyone involved, "the more equipment, the better" (*ibid.*). For the engineers working in the recipient agency, "the larger the equipment list, the better the chances for getting financing" (*ibid.*). For USAID personnel, "the chances for 'producing' a given amount of capital transfer would be greater with a larger equipment list" (*ibid.*).

Fear of external criticism about lack of control and corrupt practices also leads donor agencies to favor project funding that appears to give project monitors greater control over what is happening. This usually means funding a few large projects rather than several small ones.

The concern for monitoring of performance, particularly to overcome the possibilities of corruption, may require project performance criteria that can easily be measured. Although it cannot be dismissed as baseless, this concern is likely to lead to a focus on project inputs, rather than on outputs.²⁰ This concern may even alter the nature of certain development activities solely in hopes of being able to measure project effort. For example, in Bangladesh nearly all observers recognize that successful rural road construction requires great attention to compaction of the embankment. Yet, donor-financed support of road building has focused almost exclusively on the movement of earth, because it is easy to measure the amount of earth moved but very difficult to measure the extent to which that soil has been compacted. The unintended outcome has been that many, many miles of earthen embankments have been constructed over the past decade but, due to lack of concern for compaction, few of these roads remain passable to vehicles after one year of monsoon floods.

Similar concerns for easy monitoring and tendencies favoring equipment-intensive projects are present within large-scale bureaucratic agencies; hence, the incentives facing donor personnel and host government personnel are similar and tend to be reinforcing. As a result, the types of projects that receive the most funding by external donors can be explained by sets of incentives facing individuals inside both the donor and host government agencies that are extremely difficult to overcome, rather than by conspiracy theories.

This discussion has identified the continuing tension that characterizes donor financing of projects in the developing world. Fiscal responsibility will always require that institutional arrangements provide

²⁰The same is, of course, true in most evaluations of public sector undertakings in developed countries where, due to the vagueness of public sector outputs and difficulties of measurement, analysts commonly assess governmental activities by focusing on inputs or expenditures.

adequate oversight to ensure that limited assistance resources are not misspent. To this end, it is unlikely that any one optimal arrangement can ever be crafted. Hence, there will always be tradeoffs between the most desirable project design from the standpoint of the recipient country and the need for financial oversight.

Conclusion

In the last three chapters, we have stressed that efforts to finance, design, construct, operate, maintain, and use rural infrastructure facilities confront costs associated with coordination, information, and strategic behavior beyond those associated with finding the most efficient production technologies. Some of the specific problems discussed in these chapters—the need for time and place information, shirking, rent seeking, and corruption, for example—do not receive much attention in reports that focus on the lack of infrastructure sustenance in developing countries.²¹ So long as these problems are not incorporated in analyses and recommendations, projects will continue to be planned, financed, and constructed that generate such unintended consequences as high levels of corruption, overinvestment in large-scale projects, and underinvestment in smaller projects and in operations and maintenance. With a more complete set of intermediate performance measures illustrated in this chapter, the unintended consequences of past institutional arrangements for infrastructure development can be seen as expected outcomes, given the incentives of the various participants.

Instead of ignoring the problem of corruption, analyses should point out that civil servants are going to be seriously tempted to accept illegal payments when:

- official salaries are steadily eroded by inflation;
- educational facilities are limited to the capital city, so that officials assigned outside this city

must keep two households in order for their children to get a good education;

- promotion and/or transfer is only tangentially tied to on-the-job performance and strongly tied to connections with political figures;
- no competitors exist to show that a particular activity could be undertaken more efficiently and without corruptions;
- it is difficult for citizens or other public officials to gain information about what is happening; and
- they control a service (or contract) that has immense marginal value to the wealthier individuals in their territory.

Similarly, rent-seeking behavior should be expected when little connection is made between the collection of taxes and the distribution of benefits, such that the common treasury is perceived to be someone else's money (and, to a large extent actually *is*, as in those countries receiving large sums of external funds). And, it should be expected that facilities that are not designed with substantial inputs by the eventual beneficiaries are less likely to be sustained than those that can draw on meaningful input.

Recognition of these problems does not imply that there are cost-free ways of solving them. To reduce the errors associated with a lack of information, resources must be expended to obtain more information. Attempts to reduce the costs associated with one strategic problem—such as free riding—can establish institutional incentives that create opportunities for individuals to engage in other strategic behaviors, such as rent seeking and/or corruption. In other words, tradeoffs exist among the intermediate costs we have been discussing. The optimal solution attempts to guard against excessive costs of one type without expending more resources or opening the possibility for even worse problems of a different order.

²¹ See General Accounting Office (1983) for example. Major exceptions are Ascher and Healy (forthcoming); Chambers (1988); and Repetto (1986).

Within the constrained set of performance criteria (production economies, need for technical knowledge, and control of free riding) and of institutional arrangements (markets versus national government) that have been the focus of prior attention, the tendency to presume that the need for “public sector involvement” translates into a need for reliance on a central government is understandable. However, when the set of intermediate performance criteria to be examined is widened, some of the tradeoffs that exist among performance criteria become clear. No one institutional arrangement will perform better than all other arrangements for all performance criteria. And, we have only begun to elucidate the array of institutional arrangements that can be used in relation to infrastructure development. In Chapter 7, we will examine a broad array of financial instruments that need to be considered in regard to the financing of infrastructure development. In Chapter 8, we discuss the principles of polycentric organization that provide an alternative to sole reliance upon central provision and production of rural infrastructure.

Financing Infrastructure

THE PREVIOUS chapter focused on the costs of designing, constructing, operating, and maintaining rural infrastructure, arguing that institutional arrangements significantly affect the costs associated with errors resulting from a lack of appropriate information and strategic behavior. Overcoming these information and strategic costs may be accomplished by a simple change in institutional relationships; however, it is also likely that additional direct costs of producing services or coordinating the actions of multiple actors would accompany such a change. For example, additional resources may have to be expended on efforts to collect adequate time and place information or additional resources may have to be allocated for auditing to discourage corruption.

What must be addressed now is how these additional resources, along with those necessary for the construction, operation, and maintenance of infrastructure facilities, might be made available. Although we strongly contend that the availability of resources alone is not a sufficient condition to ensure that facilities will be maintained, resources are obviously a necessary condition. Resource mobilization issues must, therefore, be considered along with issues related to institutional arrangements. Throughout this chapter, mobilized resources include nonmonetary resources such as labor and materials as well as the more familiar monetary resources.

In the simple and differentiated markets for housing infrastructure outlined in Chapter 6, resources must be made available in the form of materials and

labor to design, construct, and maintain the house. Likewise, resources are required to support both the intermediary institutions (financial institutions and contractors) that help reduce the production and coordination costs noted in Table 6.1 and the monitors necessary to reduce strategic costs. Finally, while not noted explicitly in the figures of Chapter 6, resources are necessary to provide the rule of law required to ensure the enforcement of contractual arrangements among the various parties. Except for maintaining the rule of law, the bulk of the costs can be and are borne directly by the ultimate users of the houses. Thus, questions of finance in the case of privately provided and singly consumed goods such as housing are less problematic than for jointly consumed goods, particularly those provided by the public sector.

The issue of finance becomes more complex in the case of user groups. Mechanisms must be crafted to mobilize the resources necessary to design, construct, operate, and maintain the infrastructure facility. The task is complicated by the joint consumption of services provided by user groups, e.g., a small-scale irrigation system. Unless appropriate safeguards are instituted, members of the group may be able to derive irrigation benefits without contributing to the costs. Still, small groups have managed to establish the necessary arrangements, as was discussed in Chapter 6.

When authorities in highly centralized or administratively decentralized governmental institutions are responsible for infrastructure development,

they are likely to have to rely on the formal, statutory power of taxation to mobilize the necessary resources. Likewise, as will be discussed in more detail in Chapter 8, similar powers of taxation or other formal, legal means may be necessary to mobilize resources under noncentral regimes. This chapter will evaluate those fiscal instruments commonly available to accomplish this type of resource mobilization.

The focus here is on the financing of infrastructure facilities that provide local benefits. Because the benefits are localized, we concentrate on local mobilization of resources; however, we do not presume that the institutional arrangements are fully decentralized. The special issues associated with the financing of noncentralized decision making will be discussed in Chapter 8.

As was discussed in Chapter 1, meeting recurrent costs is a key concern throughout the developing world. Hence, even though infrastructure development requires resources for the design and construction phases, the focus here is on mobilizing resources for meeting the recurrent costs associated with operation and maintenance.

We begin the evaluation of resource mobilization instruments by considering the objectives commonly sought for revenue devices by public finance economists and relating them to the evaluation criteria discussed in Chapter 1. We then present a set of alternative sources of revenue, concentrating on their theoretical applicability for financing different types of rural infrastructure development activities and their practicability within a developing country environment. Because mobilization of resources is only a necessary condition for funds to be made available for operation and maintenance of a capital facility, the chapter closes by considering budgetary issues associated with ensuring the flow of resources to maintenance.

Evaluation of Fiscal Instruments

The fiscal instruments available in developing countries to derive the resources necessary to fund infrastructure development, operation, and maintenance are diverse and numerous. The appropriateness and applicability of each specific instrument depend greatly upon the attributes of the services provided and the institutional environment in which

they are used. For example, certain instruments are feasible only when the services being provided allow easy exclusion of nonpayers and the amount of the service is readily measured. Likewise, some instruments are more appropriate for national levels of government, while others are best suited to a polycentric institutional setting.

An evaluation of the various types of resource mobilization instruments potentially available for financing rural infrastructure requires some set of evaluation criteria. The public finance literature commonly includes the following, each of which is discussed below: revenue adequacy and growth; economic efficiency; equitable treatment of payers; reasonable administrative and compliance costs; and, at least in the case of public-sector-supported infrastructure, political acceptability (see Davey, 1983). In fact, other than the first and last of this list, each was implicitly or explicitly used in the preceding discussion of institutional arrangements. That is, we have already noted the crucial role of economic efficiency and equity in any evaluation of institutional designs; and the costs of tax administration and compliance are components of the transaction costs associated with mobilizing resources. The other two criteria, however, are also related to the previous discussion of institutional arrangements. Revenue adequacy must be evaluated in light of the transformation and transaction costs necessary for the construction, operation, and maintenance of infrastructure. Political acceptability is partially contingent on the costs of administering a revenue instrument; in the case of resource mobilization, political acceptability may be a function of the political costs incurred by leaders who attempt to impose particularly unpopular resource mobilization policies.

Revenue Adequacy and Growth

Because the ultimate objective is mobilization of resources to meet infrastructure maintenance needs and produce net benefits, revenue instruments must be capable of generating revenue yields that are sufficient to meet the direct transformation and transaction costs at rates that are not expropriative. Achieving this objective will depend on the breadth of the base of the revenue instrument and the limits, if any, to the rates that may be applied. Second, service demands are likely to increase over time as the population being

served and its income increase. Maintenance costs are also likely to increase in the face of inflation and the aging of the facility. Hence, a related objective is that the revenue instrument must be able to produce additional financial revenue and/or other resources in response to increases in the demand for public services. If revenues are to respond to changes in prices or to income- and population-induced changes in demand, it is generally desirable that they do so automatically, rather than exclusively through discretionary changes in rates and revenue bases. This avoids the need for explicit policy changes that can occur so slowly that resource mobilization lags behind changing expenditure needs. Revenue growth that is regular and not prone to random fluctuations from year to year is also preferable. Unfortunately, the public sector revenue structures in many developing countries suffer from wide annual fluctuations that can greatly impede rational fiscal planning and effective spending (Schroeder and Duncombe, 1988).

Two caveats are in order regarding the concern for revenue adequacy. First, at least theoretically, any economically efficient infrastructure will, by definition, generate a stream of benefits in excess of the costs (at least over the lifetime of the facility). If a facility is incapable of generating such net benefits, it should not be sustained. Thus, the real issue is a more practical one of designing a set of instruments capable of transforming the stream of benefits into useable revenues. Second, because the term "adequate" is often nebulous, estimating what constitutes a sufficient amount of revenue is fraught with difficulties. Whereas engineers can estimate the costs of maintaining capital, optimal maintenance will depend upon the benefits it yields. Therefore, any estimate of the adequacy of revenues for operating and maintaining facilities should be based on the benefits of such activities and the costs of achieving these levels of maintenance.

Economic Efficiency

The economic efficiency criterion, discussed briefly in Chapter 1, concerns the effect of a revenue instrument on the allocation of resources. Except for lump-sum levies that are not affected by specific actions, such as a head tax, all revenue instruments alter relative prices and, therefore, are expected to affect individual behavior. These induced changes in behavior are called nonneutralities. For example, a tax on labor income can discourage work effort; taxes on sales can discourage consumption of the taxed items; and property taxes on capital improvements may discourage new investments.

Because such nonneutralities can affect the allocation of resources, they may improve or worsen the general level of welfare in a society and, hence, affect economic efficiency. For example, greater economic efficiency can result where taxes are used to discourage activities that produce undesirable externalities or side effects, as might be deemed the case with taxes on the consumption of alcohol. On the other hand, if prices accurately reflect the costs to society of particular activities, tax-induced changes in these prices which in turn alter consumers' or producers' decisions can result in a net loss in social welfare.¹ Much of the attention concerning the efficiency effects of revenue instruments focuses on alternative, equal-yield levies and the effects that different sources of revenue would have on behavior. For example, if equal revenues could be earned from either a tax on improvements to property or a tax on land, the tax on land is predicted to have a less adverse effect on resource allocation (because the supply of land is fixed) than the tax on improvements, which would discourage investment in such activities.

The extent of the allocative effects of revenue instruments depends on the market conditions that hold and the rates that are imposed. Although market

¹ For further discussions of the welfare costs of taxation, see public finance textbooks such as Stiglitz (1986).

conditions in developing countries are seldom such that prices reflect marginal costs, it is generally important to ascertain the degree to which different revenue instruments alter economic choices and the implications that these changes will have on the allocation of resources in an economy.

Equity

The equity criterion concerns the “fairness” of the resource mobilization system. The equity concept that underlies an exchange economy holds that those who benefit from the service should bear the burden of financing that service, with those who derive greater benefits expected to pay more. This essentially expresses a concern for a “fiscal equivalence” between the benefits derived from a service and the costs of providing that service—those who benefit should pay; those who do not benefit should not pay.² An alternative concept of equity bases fairness on ability to pay—persons having greater abilities to pay are expected to pay more than those with lesser abilities.

These two views can lead to different conclusions regarding the equity of a financing mechanism. For example, if a water pump provides benefits to all users, the benefit principle would hold that everyone using the pump should be required to pay the marginal costs associated with their use of the facility. Under the ability-to-pay principle, such fees may be deemed inappropriate because they would reduce the accessibility of the pump for low-income persons. This view would suggest that the service be subsidized through other means (which would have equity implications of their own).

Because it is a value-based judgment, there is, unfortunately, no simple solution to the dilemma of choosing an appropriate equity criterion. Still, analysis of who actually uses the service should be undertaken prior to choosing appropriate policies. For example, health services may be highly subsidized under the presumption that they yield substantial

redistributional effects in addition to the social or external benefits that such services provide. One must exercise caution, however, in presuming that it is primarily the poor who benefit from highly subsidized services. In fact, it has been asserted that “...it is often the middle class and the rich, not the poor, who benefit most from free services” (Akin, Birdsall, and de Ferranti, 1987: 27). The objective of income redistribution is often used by those engaging in rent-seeking behavior to legitimize public sector activities that, in reality, disproportionately benefit those with lesser needs.

The actual distributional effects of financing instruments also may be quite different from the distribution of remittances of funds to the public purse. Taxes and charges may be shifted forward onto consumers of goods and services through higher prices or may be shifted backward onto suppliers of factors of production—land, labor, or capital. For example, it is generally felt that sales-based taxes are ultimately borne by purchasers of the goods or services and that taxes on land are borne by the owners of that land. Analyses of the market supply and demand and of the income distributional characteristics of consumers and factory owners are needed to address this issue adequately. There are, unfortunately, relatively few studies of the income distributional implications of taxes or other forms of resource mobilization for public purposes in developing countries, particularly regarding local taxes in rural areas. There is a great need for future research in this area.³

Administration

Perhaps the most difficult practical problem associated with resource mobilization in developing countries involves administration. A revenue mechanism is of little relevance if it cannot be administered fairly and efficiently. Administration requires the determination of the amounts that must be paid, the effort necessary to collect these amounts, and

² The fiscal equivalence principal, per se, has most commonly been applied to the question of assigning public service responsibilities to different governments, especially within a federal governmental framework. See, for example, Olson (1969), where the term appears to have first been used. A similar concept of fiscal correspondence was used by V. Ostrom, Tiebout, and Warren (1961) and by Oates (1972).

³ For discussions of the incidence of property taxes in developing world cities, see McLure (1979) and Linn (1979b).

the recording of who has and has not complied. Because these activities require the expenditure of resources, they constitute a portion of the coordination costs outlined in Chapter 6. In addition, these administrative activities may largely determine the extent to which individuals can shirk or free ride by not contributing resources. If assessments of amounts due are improperly made, if efforts are not made to collect those amounts, or if accurate records are not maintained, some individuals may be able to avoid contributing to infrastructure maintenance. But improving the effectiveness of each of these activities will likely require additional resources, thereby adding to administrative costs.

The full cost of administering a resource mobilization instrument also includes the costs of complying with that instrument. Although public policymakers may be primarily concerned with the costs that the public sector must bear in collecting a revenue, different administrative arrangements can also impose considerably different costs on payers of the tax or fee. For example, if taxes must be paid at a district office, the costs of transportation can add enough to the total burden of the tax that they discourage compliance with the levy.

The costs of administering a resource mobilization instrument are closely linked to the nature of the infrastructure being financed. As such, administrative costs are a primary determinant of the feasibility of using different instruments. For example, when non-payers cannot be excluded without considerable effort, user charges will be infeasible because the costs of administering the fee exceed the revenue yield.

The economic and physical environment in which the instrument is being administered also affects the feasibility of different revenue instruments. For example, the costs of administering taxes such as a retail sales tax or an income tax in an environment where there are many small retailers who keep few formal records or where it is difficult to trace transactions can preclude efficient, wide-scale use of these instruments.

Administrative costs, including compliance costs, also greatly influence whether a resource mobilization instrument can feasibly be imposed at the local level. For example, while localities might impose taxes on

the sale of gasoline within the jurisdiction, it will likely be much cheaper to administer such a levy at the wholesale level or, if the country imports all of its petroleum, at the point of entry.

Political Acceptability

No one likes to pay taxes, and, as was emphasized in Chapters 4 and 5, it should be anticipated that persons will attempt to avoid paying such levies, either legally or illegally. Different revenue instruments as well as the environment in which such payments are made can, however, affect the willingness of individuals to comply with a levy and, in turn, influence its political acceptability. A portion of this willingness is motivated by the degree of coercion that is used to ensure payment. If a potential taxpayer knows with certainty that he or she will be penalized if taxes are not paid, compliance is much more likely than where such penalties may or may not be imposed. The imposition of penalties, however, increases the costs of administering the tax. As Levi (1988: 52) notes, these costs can be reduced through "quasi-voluntary" compliance. "It is *voluntary* because taxpayers choose to pay. It is *quasi-voluntary* because the noncompliers are subject to coercion—if they are caught."

Revenue instruments can differ greatly in the degree to which they encourage quasi-voluntary compliance. User fees paid in return for services rendered are much more likely to be acceptable to the payer than are general taxes where there is no clear relationship between payments and benefits. In the same manner, taxes spent on facilities that the taxpayer recognizes will yield direct benefits are likely to be more acceptable than taxes that are paid into a general fund controlled by distant bureaucracies, the benefits of which are not clear to the payer. For this reason, locally imposed and used taxes may, *ceteris paribus*, be preferred to centrally imposed levies.

The visibility of taxes can also influence their acceptability and compliance. Taxes imposed as a part of another transaction, such as sales taxes or income taxes withheld at the time income is earned, are likely to be more acceptable than are levies imposed in lump-sums, such as property taxes. Furthermore, acceptability is strengthened when changes (particularly increases) in the taxes paid are automatic, as is the case for taxes levied on rising incomes or *ad valorem* retail

sales taxes, than when the increase in tax burden is based on discretionary actions by tax administrators or political leaders.

The political and administrative environment in which public revenues are imposed and their proceeds used can also significantly affect voluntary compliance and political acceptability of a resource instrument. Levi (1988: 53) argues that this depends on the confidence payers have that "(1) rulers will keep their bargains and (2) the other constituents will keep theirs." She emphasizes that taxpayers do not want to be "suckers" as would occur if they made tax payments and received no services in return or if they made payments with which others did not comply. In essence, the revenue system must be considered fair if quasi-voluntary compliance with revenues is to result.

The fairness aspect of revenue administration in developing countries cannot be overemphasized. For example, in situations where elected and administrative officials are considered corrupt, taxpayers may rightly view the revenue system as an unfair transfer of resources from themselves to such officials and refuse to comply. Because corrupt practices may be much more difficult to carry out when the resources mobilized are in the form of real commodities or services rather than money, the use of in-kind resource mobilization techniques may be more acceptable to participants than monetary instruments, despite the diminished efficiency with which nonmonetary resources can be used. Efforts to assure payers that corrupt practices are not occurring can also improve compliance.

The effect of distrust of officials on resource mobilization is dramatically revealed in a case study of the Magat River Irrigation System (MRMP) in the Philippines (Bautista, 1987). Because a previous farmers' cooperative association had gone bankrupt due to fund mismanagement, the farmers involved in the MRMP strongly distrusted the new irrigation system management. When the president of one irrigators' association was observed to have purchased a residential lot after a considerable sum of money had been accumulated by the association, participation in the association began to decline. It was

only after a meeting was held in which the association's bankbook was passed around to all members that participation increased again. As Bautista (1987: 27) notes, members interviewed by the Association Manager after the meeting "thought that their money had already gone with the wind because nobody told them where their money was." Once they had been assured that the money was still there and that the lot had been personally purchased by the president to provide an area that the members could use to dry their grain, they were quite willing to participate in the association and to assist in maintaining the system.

Quasi-voluntary compliance and political acceptance are also strengthened when taxpayers are convinced that a levy is being administered equitably. If one payer feels he or she is significantly overtaxed relative to others in similar circumstances, there is less willingness to comply. But, when taxpayers observe that some of their neighbors are not complying with a levy, they too may decide not to comply, thereby resulting in lower and lower tax compliance.

Again, making information about the taxing process public, for example, by publicizing tax assessments and tax compliance, can diminish the tendencies to free ride, particularly in smaller taxing jurisdictions. This is also why in-kind contributions of labor, which can be easily observed by all potential contributors, can be more successful in overcoming tendencies to free ride than monetary instruments. Tax administrators who are responsible to persons other than local political leaders also help to assure taxpayers that political influence does not have an impact on tax assessments and compliance. One example of such an arrangement that has become increasingly popular at the local level in many developing countries is some form of tax sharing or "piggybacking" of local taxes onto taxes administered by other, broader-based jurisdictions, such as the central government. Such arrangements take advantage of economies of scale in revenue administration while simultaneously lessening local political influence. One practical constraint of piggybacking taxes is the broader-based jurisdiction's potential perception that such an arrangement erodes its revenue base. That is,

if a four-percent central tax and a one-percent local tax can be collected, a fiscally pressed central government may argue that because there is obviously the ability to pay a five-percent tax, it should have access to all of these funds.

Performance Criteria and Tradeoffs

The five revenue mobilization performance criteria relate closely to the list of criteria discussed in Chapter 6. The list of criteria already includes the concerns for economic efficiency, equity (either based on fiscal equivalence or ability to pay), coordination costs, and strategic costs. Since the previously discussed criterion of political acceptability relates closely to the costs of overcoming certain strategic costs, the one item missing from our list is an explicit recognition of the need to have revenue sources that mobilize adequate revenues to meet transformation and coordination costs.

As is the case for alternative institutional arrangements, no single resource mobilization instrument can simultaneously fulfill all of the multiple performance objectives. Tradeoffs are always necessary. For example, a tax on the increased value of land attributable to a new capital facility is economically efficient and equitable on grounds of fiscal equivalence because the tax revenues reflect the capitalized value of benefits associated with the facility. However, such a tax may be very costly to administer. Furthermore, if the capital facility is located adjacent to land owned by politically more powerful persons, it may be difficult to convince local leaders to impose such a levy.

The subsequent discussion of specific resource mobilization instruments will address several more of these tradeoffs. Given the importance of conflicting objectives that relate explicitly to maintenance finance, however, it is useful to discuss one issue more fully here. This issue concerns the objective of economic efficiency as it relates to the funding of infrastructure maintenance within a developing economy.

Economically efficient pricing of the use of an existing facility, such as a road, should reflect only the incremental maintenance costs associated with use of the road and any congestion costs that an additional user may impose on others. Since the latter cost is likely to be zero in the case of rural roads, economically efficient user charges should equal only the marginal maintenance costs associated with each additional user (assuming that it is feasible to administer such charges). Imposition of charges in excess of the marginal cost of maintenance restricts use of the road below that which would be economically efficient, to a point at which benefits would be suboptimal.⁴

Total maintenance costs, however, may be considerably greater than the costs of maintenance due solely to traffic, since some maintenance is required to slow road deterioration caused by the natural forces of aging and weather. Rural roads in developing countries are especially vulnerable to weathering because the road surfaces are seldom paved. This means that charging efficient prices (prices equal to the marginal use-related maintenance costs) will yield revenues that fall short of the total amount needed to maintain the road. Hence, efficient prices result in inadequate revenues; adequate use-based prices result in inefficiently low road utilization. If efficient prices are imposed, some alternative incremental revenue source must be found to generate the additional resource needs.⁵

In spite of the potential for efficiency losses to the economy, we would argue that there are good reasons for user prices sometimes to be set at levels greater than use-related marginal maintenance costs. First, from a practical standpoint, user fees do have the potential of linking payments to benefit; this is extremely important to improve compliance with the revenue instrument, and when charges approximate benefits, they are likely to be deemed fair and equitable. Second, from a purely theoretical perspective, one must recognize that insisting on marginal cost

⁴ Walters (1968: 18) provides a simple numerical example that illustrates the losses involved if prices greater than the marginal costs of use-related maintenance are imposed.

⁵ A recent paper by Newberry (1989) illustrates how, by imposing road-use charges that reflect the external social costs of congestion (primarily in urban areas) in England, sufficient resources could be mobilized to yield revenues adequate to maintain the entire system while using economically efficient prices.

pricing in one portion of an economy does not necessarily mean that the overall allocative efficiency of the economy will be improved. This concept, known as the "theory of the second best" (Lipsey and Lancaster, 1956), limits the generality of theoretical conclusions concerning economic efficiency in an economy characterized by numerous market failures, such as many administered prices, extensive sectoral subsidies, and substantial noncompetitive factors. The theory suggests that "piecemeal (single-sector) analytic work cannot confidently rely upon the first-best allocative rules or the observed prices in the rest of the economy to evaluate efficiency consequences in the sector or area under study" (Friedman, 1984: 415).

Given these important tradeoffs, we would suggest the following pragmatic counsel. If the benefits of maintaining an infrastructure facility exceed the costs, one should first determine whether a resource mobilization instrument or combination of instruments is capable of generating resources adequate to meet the costs after accounting for administrative costs. If that criterion is satisfied by several instruments, those instruments that most closely link the resources generated with benefits received should be considered most appropriate because they are equitable on benefits-received grounds. This standard of fairness is also likely to make them politically acceptable. Concern for economic efficiency should not be ignored, but can often be of secondary importance, particularly for local governments in developing countries where generally low rates are used for most revenue instruments (see Davey, 1983). Evaluation of a revenue instrument should nevertheless consider what incentives it might create for individual behavior and then consider whether alternative instruments might create more desirable incentives. For example, property taxes on improvements, such as buildings and machinery, are likely to discourage investment in these pursuits and therefore diminish their supply. Property taxes on land, which is in fixed supply, do not have such supply effects. Hence, if a choice must be made between taxing land or improvements more heavily, taxes on land would be more consistent with economic efficiency objectives. Ultimately, however, it is the policymaker who must choose from the various instruments available to mobilize the resources necessary to support the development, operation, and maintenance of rural infrastructure.

Fiscal Instruments

Mobilizing resources to develop and maintain infrastructure can be accomplished in a variety of ways. A service may be most appropriately organized, managed, and financed as a purely private enterprise. In such cases, private financing, such as through direct user charges in the form of prices paid for services and, perhaps, private capital financing, is appropriate, particularly to achieve economic efficiency. Such cases are relatively rare within the set of rural infrastructure activities of interest here; hence, in what follows we focus on facilities that yield services provided within the public or quasi-public sectors. We emphasize again that this does not necessarily mean that production of these services must be undertaken by the public sector. Indeed, private contractors may very well "produce" the services in the sense that the process of combining inputs to produce outputs is under the control of private entrepreneurs, even though financing such services involves the public sector.

One convenient and important distinction concerning revenue instruments is whether the source of the funds is external or internal to the organization that controls the infrastructure facility. In the former case, the amount of local control of the use of the resources is, obviously, much less than when the organization itself mobilizes and administers the resources. Public sector resources can be mobilized internally through some combination of (1) charges imposed on users of the service; (2) more general taxes; and (3) contributions or in-kind payments. Externally mobilized resources are derived either from grants from other authorities or in the form of loans.

User Charges

Fees imposed on users of services provide the most direct link between benefits received from and payment for the service. This has several advantages. When individual users are willing to pay for a service, it reveals that the value they place on it meets or exceeds the price they pay, i.e., that the perceived benefits exceed their costs. If the price imposed reflects the additional costs of operation and maintenance of the facility, the resulting level of use will be economically efficient. Such an allocation can be viewed as equitable on the basis of the benefit prin-

ciple of equity, and noncompliance problems are lessened because the payer derives benefits from the service only if the fee is paid.

The assumption that prices are feasible is, of course, a strong one for many of the services under consideration here. For the price mechanism to work, nonpayers must be excluded from enjoying the benefits of the service. Although exclusion may be possible in some cases, it may be very costly to accomplish. For example, tolls can be imposed on users of rural roads; however, the costs of collecting the toll and restricting access to the road throughout its length would probably exceed the revenues derived by such a measure. On the other hand, where access is limited due to the physical characteristics of the road, tolls are administratively feasible. For example, tolls have been imposed on some roads in rural Bangladesh where the road embankments were raised considerably above the surrounding land. In this case, expensive fencing was not required to limit access by vehicles (see Schroeder, 1983). Similarly, tolls have been imposed in hill areas of rural Nepal where the mountainous terrain limits access (see Schroeder and Wozny, 1987).

Strictly speaking, subtractability is also necessary for economically efficient user charges; but as argued in the previous section, we hesitate pushing this criteria too far. Subtractability means that an additional user cannot use the service without diminishing the amounts available to others. If there is no subtractability, the marginal cost of additional services is zero; economic efficiency is therefore obtained if prices, and hence, revenues, are zero. A problem with this argument is that it can be pressed to extremes with rather absurd results whenever the type of infrastructure under consideration already exists and is in use. For example, once a plane is known to be flying from point A to B, the marginal costs of an additional passenger are close to zero (the cost of a cup of coffee or soda and perhaps a stale sandwich together with a minuscule amount of fuel expended constitute the main additional costs associated with an extra passenger). The economic efficiency argument suggests that in such instances, an extra passenger on an unfilled plane should be charged only these small marginal costs for a socially efficient allocation of resources to result. Although profit-maximizing airlines recognize this principal and consequently provide for

such arrangements as flying "standby" at considerable cost savings to passengers, the strict logical implication of this result is that nearly zero prices should also be charged to every passenger once it is known that the plane will be flying from A to B and will not have all seats filled.

As suggested in the previous section, we would argue that, because of the general paucity of good resource mobilization instruments particularly at the local level in developing countries, if user charges are feasible, they should be used even if there is little subtractability. Thus, although user fees on uncongested highways that are not prone to damage by additional vehicles may be economically inefficient, they can provide the means to improve the transport system. Such fees should be totally rejected only if they lower the use of a facility so significantly that it has an adverse effect on overall economic activity.

User fees are often rejected by policymakers on the grounds that such charges are inequitable, at least in terms of ability to pay. This creates a difficult dilemma. On one hand, if no alternatives to user fees are available to generate revenues, a project yielding benefits in excess of its costs may have to be foregone due to lack of funds, thereby creating efficiency losses. On the other hand, a user-fee-financed project may exclude those unable to pay for the services.

Considerable effort has been made to develop mechanisms that can overcome the undesired equity implications of user charges while charging fees that reflect marginal costs (Linn, 1983). Particularly important in this regard is the use of full marginal cost pricing for the higher income portion of the population and prices that reflect the externalities associated with provision of some "basic need" level of services for the poor. Although the theoretical model is reasonably simple, devising mechanisms that can be administered cheaply and fairly in a developing country context may be difficult. For example, sliding scale fees may be one way to allow higher income users to subsidize use by the poor; however, implementing such fees can be problematic, since distinguishing among income groups may be difficult. These implementation problems can be less severe in smaller communities where the purveyors of the service are likely to know consumers sufficiently well to be able to impose equitable fees.

Close relationships between those administering and those paying fees, however, can also create problems. In an evaluation of fees for health services, Buzzard (1987: 28) notes that community health workers are often "pressured to give free treatment to the poor and to the influential" and as a result may overcharge paying clients. The evaluation also found that health workers in at least one project did not collect fees from their relatives. Hence, even when the nature of the service is such that exclusion of non-payers is feasible, ensuring that it occurs can be problematic within societies where intense local pressures are placed on collectors.

Nevertheless, user fees are administratively feasible in developing countries, particularly where the service being provided yields obvious benefits to the users and the institutional arrangements are such that there are strong incentives against shirking and free riding. Such incentives are generally the strongest when the users themselves organize to provide the service and the number of users is not so large as to make monitoring overly costly. One infrastructure investment that is likely to exhibit such characteristics is irrigation.

In the previously discussed examples of successful irrigation schemes in the Philippines (both the *zanjeras* in Chapter 2 and the NIA experiment in Chapter 3), farmers' labor contributions constituted the principal forms of resources mobilized from users. (This type of resource mobilization is discussed further below.) However, there are also instances in which farmers make direct payments, either in-kind or cash, for operation and maintenance services. For example, Taylor (1979) documents payments made by farmers using irrigation services in the Pikalen Sampean Irrigation Project (PSIP) in East Java, Indonesia. He concludes that, whereas many commentators on irrigation cost-recovery efforts in Indonesia have reported that farmers are not paying for irrigation water, in the project investigated "farmers are already paying more for irrigation water than what is being spent on operations and maintenance in the project" (*ibid.*, 111). Although some payment is through contributions of labor, payments (both in the form of crops produced or in cash) are also made to local ditch tenders. Furthermore, even though payments to the water tenders are based on a traditional system of gratuity or "feeling" payments that supposedly

depend on the feelings of the individual farmers, the actual amounts paid reflect the costs associated with different amounts of effort required by the tenders. When the required tending effort is greater, as is the case for irrigation of tobacco and soybeans relative to that of maize, comparably higher payments are made to the tenders. Thus, indigenous systems can reflect the normative principals of establishing user prices.

In summary, there are solid arguments for the use of fees and charges to mobilize resources to finance the recurrent costs of operation and maintenance of rural infrastructure. Of particular significance is that such fees can be designed to ensure that users pay for what they get. At the same time, the fees will not always work well. Only some services are amenable to pricing; measurement difficulties can be considerable; and equity and political considerations may limit the feasibility of such charges. In spite of these limitations, the advantages of user fees to cover at least some portion of maintenance costs of rural infrastructure can be significant and the evidence suggests that they can work for such facilities as irrigation systems.

Local Taxes

When infrastructure facilities are provided by local governmental units, taxation constitutes an alternative to user charges as a method for mobilizing resources. Although there is a wide range of possible local tax instruments, the linkage between benefits received and payments for services is generally less direct for tax instruments than for user charges. Because of the equity and compliance implications of a linkage between liabilities and benefits, we focus here on local taxes that are most likely to provide such linkages.

When infrastructure facilities yield benefits that are highly location-specific, such as improvements to a rural road, a local well and pump, or an irrigation system, market forces are likely to increase the value of the land in that locality. For example, the summary evaluation of USAID road projects concluded that "New rural roads generally led to increases in land values, with land nearest the road increasing in value the most" (Anderson and Vandervoort, 1982: .5). If a tax instrument can capture these increments to land value associated with the infrastructure investment, the resulting allocation of resources will be no different than in the absence of the tax; that is, the tax

will be neutral, and equity in the form of benefit-based taxation will result. In fact, betterment levies have been advocated as a particularly desirable method to mobilize resources for financing location-specific facilities (Rhoads and Bird, 1969; Doebele, 1975; and Doebele, Grimes, and Linn, 1979). However, because they are borne primarily by landowners, such taxes can be susceptible to political opposition by more powerful groups within a community. The major practical problem with such taxes is that the tax may be difficult to administer fairly as it requires rather sophisticated estimates of land value increments, a task that may be beyond the skills of property tax administrators.

It was noted in Chapter 5 that in order for infrastructure facilities and their maintenance to yield benefits, related inputs generally must be used. For example, road maintenance requires traffic if benefits are to be produced. Taxes imposed on these complementary inputs can therefore be used to mobilize maintenance resources. In the case of roads, the problem is primarily one of finding a tax base that is linked closely to local road use; the problem is complicated by the numerous types of vehicles commonly found plying roads in developing countries. In addition, however, it is also desirable on efficiency grounds that the tax instrument discriminate according to the degree to which different vehicles create the need for road maintenance; for example, a steel-wheeled cart should be taxed more heavily than a similar, but rubber-tired, cart. Annual license fees can be imposed on vehicles; their weakness is that they do not differentiate between vehicles as to the amounts they use the road (and therefore create the need for maintenance). For motorized vehicles, taxes on inputs, e.g., fuel, tires, or lubricants, can be used; such levies do reflect differential usage (and, hence, serve as a proxy for benefits derived from road maintenance).

Among the many other forms of resource mobilization techniques currently in use in local areas of developing countries, however, broad-based taxes are not particularly well-suited to provide a close linkage between development and maintenance of specific infrastructure facilities. At the same time, if the maintenance under consideration is of a general type, such as maintenance of a village well used by all villagers or maintenance of the street lighting system, general taxes are quite appropriate. Although it is not

necessary to consider the strengths and weaknesses of all available forms of local taxes, a brief review of the general types of revenue instruments available is useful.

Among the general forms of taxation available are taxes on property, income, sales, and businesses. General property taxes (unlike the property-value-related betterment taxes noted above) may be the most extensively used local tax in the developing world. There are several reasons for this. One reason is that the benefits of localized services are reflected (capitalized) in the market value of property. Also, land and buildings are spatially immobile and are therefore particularly suited to local taxation; most other forms of tax bases can move to avoid local levies. A final, pragmatic reason is that property taxes are often assigned to local governments by central governments, which reserve more easily administered, broader-based taxes for themselves.

Because of its widespread use, the property tax has been extensively analyzed (see, for example, Bahl, 1979a; or Strasma, Alm, Shearer, and Waldstein, 1987). Although there are significant administrative problems associated with the tax as it is imposed throughout the world, the theoretical basis of a property tax, at least those taxes on land or other property in fixed supply, is extremely sound. It can yield significant revenues; it need not create major economic inefficiencies; and it is equitable if property wealth is a reasonable reflection of the benefits derived from local services or if property wealth is associated with ability to pay. Its weaknesses are primarily associated with its administration; furthermore, these administrative weaknesses have the effect of creating inefficiencies and inequities and restrict the yield of the tax.

Taxes on incomes are not extensively used in rural areas of developing countries primarily because of the administrative difficulties in doing so. A variant on income-based taxes, termed the personal tax, has however, been used quite extensively throughout Africa (Wozny, 1984). The tax, as most commonly administered, is a hybrid of a flat poll tax and a graduated tax related to individual (or family) income or wealth. Such levies can be reasonably equitable and neutral when administered locally, because those administering the tax are likely to be familiar with the particular circumstances of those paying it. Although use of the

personal tax has declined in many countries as it was displaced by more "modern," centrally administered taxes, it has recently been revived in Kenya and is apparently under discussion in Tanzania.

Property and income taxes are each considered *direct taxes* since there is a direct linkage between the taxpayer and tax collector. *Indirect taxes*, on the other hand, are generally levied as a part of a transaction, for example, at the time a good or service is sold. The absence of a direct exchange between taxpayer and tax collector can reduce the "pain" of paying the tax and may, therefore, be more acceptable politically than direct levies. On the other hand, indirect payment methods weaken the linkage between tax payment and benefits from the services they finance, so that taxpayers may be less diligent in ensuring that the tax proceeds are spent in ways that produce maximum benefits.

Local sales taxes are often difficult to administer in rural areas of the developing world where informal markets predominate and where few businesses maintain records. Where other levels of government tap these same sources, tax sharing may, however, be possible. Excise taxes on particular consumer goods, such as movies or beer, may be more easily administered than general taxes on all retail sales as there are fewer establishments engaged in selling these goods. However, the narrowness of the tax bases in rural areas will limit the amounts of revenues these taxes can yield.

One type of indirect tax used particularly in South Asia is a tax on goods imported or exported from a locality. Import taxes, termed the *octroi*, are especially predominant in urban areas of India, Pakistan, and Nepal where the tax is imposed at entry points into a city; rural districts in both Pakistan and Nepal have also been observed to impose taxes on goods exported from the taxing district. In each instance, taxes are not to be imposed on goods simply being transported through the taxing jurisdiction. Although these levies yield significant revenues, the tax administration process results in inefficiencies by impeding the flow

of goods and increasing transportation costs. Its equity implications are quite uncertain since they depend crucially on the rate structures used and the consumption patterns associated with the taxed goods.⁶

Businesses too can be the object of taxation at the local level in developing countries and, at least in urban areas of Latin America, are quite productive in terms of revenues generated. A wide variety of tax bases are used throughout the developing world. Different Colombian cities use a variety of business tax bases including business turnover, value of gross business assets, value of fixed assets only, or flat charges based only on the type of business (Gillis, 1971).

Another type of local business tax used extensively in francophone Africa is the patent. It consists of a two-part levy: a fixed amount based solely on the type of business activity and an *ad valorem* rate based on the annual rental value of the business's real estate. The latter portion provides for some equity across different-sized establishments, while the former portion can potentially account for different ratios of capital to profitability.

A full evaluation of these various local tax sources is beyond the scope of this analysis; however, if infrastructure sustenance is to be ensured, it is likely that some forms of local taxing instruments are necessary to provide a flow of revenues necessary to meet the needs of maintaining and operating local public facilities. No single tax instrument can meet the varied evaluation criteria listed above. Locally imposed taxes may not be particularly elastic in their response to increases in prices, local incomes, and population; still, local taxation can assist in providing some of the much needed revenues. Other than taxes on land and head or poll taxes, all taxes result in some nonneutral reallocations of resources; however, the generally low rates imposed limit the extent of any resulting inefficiencies. General taxes are not particularly well-suited for linking payments of taxes and benefits received; yet, certain activities of local governments, e.g., street lighting, can yield sufficiently broad-based benefits to overcome this limitation. Taxes can also

⁶ One study of this in Karachi, Pakistan determined, however, that the efficiency costs of the tax were minimal and that the tax was not unfairly borne by the poor (see Bengali, et al., 1988).

be structured to overcome regressive burdens. Administration, however, is likely to provide the greatest impediment to fairly imposed, effective local taxation. Hence, policy reforms that go hand-in-hand with improvements in the administrative capacity of localities are generally required to ensure that any local levy results in additional resources that have been mobilized in a fair and efficient manner.

Other Locally Mobilized Resources

In addition to user charges and local taxes, several other resource mobilization instruments are used in rural areas of the developing world. Some of these are formal mechanisms, such as fees and charges associated with minor services provided by the public sector. These cannot, however, be expected to yield considerable revenues because their base is so narrow. A second type of revenue is the sale of publicly owned assets, such as land. Given their nature, such sales cannot be relied upon as a regular local revenue source even though they may produce large periodic flows of resources into the local treasury.

A third source of nontax revenue is the sale of the proceeds of assets held and controlled by public institutions. Examples include proceeds from sale of forest products from public forests, as carried out by some localities in Nepal, or the proceeds of renting local market facilities owned by local governments, as is practiced in many developing countries. Although such facilities can provide a constant flow of revenues, they are not without potential problems.

In the case of natural resources such as forests, considerable efforts must be undertaken to ensure that these renewable assets are used economically. The incentives to use the assets economically are greater when they are controlled locally than when they are controlled by highly centralized bureaucracies. If local residents realize they can derive the benefits from these assets either by directly using the forest products or by selling them on the market with the proceeds used to finance other public infrastructure facilities, they are much less likely to allow this common property resource to be overconsumed.

Public markets and shopping centers may be operated directly by the public sector, as is the case in the Philippines (Greytak and Diokno, 1983), or they may be leased to private interests, as is the case in

Bangladesh (Schroeder, 1989). A potential problem with public ownership of assets such as markets and shopping centers is that the assets could be owned and controlled by private interests. As such, the public sector may "crowd out" private sector initiative in these activities. Furthermore, where publicly owned assets are leased to private interests, they can become targets for considerable rent seeking by private entrepreneurs who attempt to use the facilities at highly subsidized rates with the subsidies borne by the general public.

A final, extremely important, resource mobilization technique used at the local level in many developing countries is nonmonetary contributions. Such contributions were significant in the Nepal bridges, Malawi water systems, and Philippines irrigation cases discussed in Chapters 2 and 3. In low income, rural areas where the informal economic sector still predominates, resource mobilization in the form of labor or locally available materials, such as land and fill dirt for road and canal embankments, can be significant. Just as user charges and certain local taxes can create a direct link between infrastructure benefits and payments made, so can contributions of nonmonetary resources. The principal advantage of nonmonetary payments is that they permit an effective way of mobilizing resources from service recipients in a cash-poor location. Furthermore, as noted in the previous discussion of quasi-voluntary compliance, real resources, being more visible, can lessen the ability of officials to engage in corrupt practices. The principal disadvantage of in-kind resources is that they are less fungible than monetary resources so they can be used less efficiently. Furthermore, it may be more difficult to ensure that the burdens are equitably distributed.

A considerable literature has developed on the subject of local participation in development (see Uphoff, 1986a; Blair, 1985a and 1985b; Uphoff, Cohen, and Goldsmith, 1979). In fact, any sort of local participation in decision making is itself a form of resource mobilization, since the time devoted to these activities has alternative uses. We are interested here, however, in the direct contributions of time and effort directly in the preparation, operation, and maintenance of infrastructure facilities. It is possible for public, communal, or voluntary organizations to develop and maintain capital infrastructure while

mobilizing resources in a self-help manner from among the beneficiaries.

Although the term "voluntary" is commonly attached to many in-kind contributions of resources for infrastructure development and maintenance, the degree to which such contributions are noncompulsory can differ considerably across organizations using this resource mobilization technique. Many non-governmental organizations such as cooperatives or communal irrigation systems have highly structured rule systems that govern the assessment and collection of in-kind contributions. For example, indigenous irrigation systems often require members to remit some proportion of the crops produced to reimburse those tending the irrigation ditches.

The *zanjera* irrigation institutions discussed in Chapter 2 provide a good example of an indigenous institution that has been immensely successful in mobilizing extensive labor and materials for the construction and maintenance of the system. The rights and duties of membership in the groups are very clearly specified and understood by all participants. Considerable efforts are made to ensure that all members contribute the required inputs or pay a fine to the *zanjera* that covers the cost of hiring a replacement laborer. Many of these efforts involve social pressure, and the methods used to organize the work enhance the effectiveness of social pressure. These social pressures, however, are backed by very substantial sanctions. In some instances, it is possible to suspend members from the association and confiscate their land.

Other local organizations rely more exclusively on moral suasion and a sense of community to encourage compliance. When such arrangements are imposed from higher-level authorities, they are seldom successful. But when users have organized from the grass roots and when local leadership fosters strong cohesiveness within the group of users, such voluntary forms of resource mobilization may be more successful than the more formal instruments of taxes and user charges.

One national-level, self-help arrangement that apparently has mobilized considerable local resources is the *harambee* in Kenya. Under this strategy, local communities contribute labor, materials, and cash to

support the construction of development projects, with additional resources provided by the government and external donors. One study has estimated that about US\$50 million were contributed at the community level (mainly in the form of cash) during the 1967-1973 period, supporting 70,000 projects throughout the country (Orora and Spiegel, 1981). An early evaluation of the movement concluded that, as might be expected, the success of individual projects was influenced greatly by the perceived local benefits of the project, the cohesiveness of the community, the judicious use of social pressures, and the willingness of local leaders to accept responsibility for the project, which, in turn, depended on the benefits that the leaders, themselves, could realize from the project (Bolnick, 1974).

The importance of community cohesiveness to the success of self-help projects is emphasized in the general lack of success of the *swanirvar* movement initiated by the government of Bangladesh in 1975. This nationwide self-reliance movement was expected to build rural roads, irrigation canals, school buildings, and other forms of rural infrastructure with labor inputs provided from the local community. An evaluation of projects in three districts in 1978 shows that labor contributions did not materialize, in great part because of factionalism within the local communities and lack of effective support from government officials (Hossain, et al., 1982). The authors also argue that, given the wide disparities in income and wealth within the localities of Bangladesh, self-help schemes that rely primarily on direct labor contributions are likely to be perceived as unfair which, in turn, more or less guarantees the failure of such initiatives. The perceived unfairness of pure labor contributions stems from the fact that wealthier individuals are expected to contribute no more labor than are the poor, hence the criterion of differential taxes according to ability to pay is not satisfied. Similar concerns can arise when individuals have the option of providing either direct labor contributions or hiring someone else to carry out their obligation. Again, wealthier individuals may opt for the latter alternative, which other participants may deem to be unfair.

Using voluntary labor for facility maintenance is particularly difficult, especially if the institutions do not have sanctions against free riders and shirkers. The nature of the service and ease of discovery of

shirking will affect the success of such efforts. It is likely to be much easier to get all farmer-users to assist in cleaning irrigation ditches where the benefits of such efforts will obviously accrue to the participants, than it is to mobilize all villagers to fill potholes in a road used by villagers and nonvillagers alike. Furthermore, where deterioration is slow and the fruits of maintenance are much harder to recognize, local participation may be difficult to mobilize (Uphoff, 1986b: 247).

The relative costs of maintenance versus reconstruction will also play an important role in determining the degree to which local participants are willing to assist in the maintenance effort. Lazaro, Taylor, and Wickham (1979: 7) indicate that some participants in a Seminar on Policy and Management Issues in Irrigation Systems in Southeast Asia noted that:

. . . money for rehabilitation [of local irrigation systems] is quite readily available and on favorable terms. Under these conditions, a country may be well advised not to concentrate its scarce annual operating budget on recurring maintenance, but to take advantage of periodic cheap sources of credit for rehabilitation.

This same rationale extends to decision making at the local level where, if resources for rehabilitation are expected to be made readily available from outside the community, fewer voluntary contributions for maintenance will be forthcoming. Uphoff (1986b: 253) reports several instances in which infusions of money or food from external sources had severe disincentive effects in that they discouraged localities from undertaking road and irrigation maintenance efforts they had traditionally carried out. No longer self-sufficient, the localities developed a dependency on external infusions of resources.

In-kind payments can, therefore, play an extremely important role in the resource mobilization process at the local level in developing countries. In some sectors, for example, small-scale irrigation, the extent of resources mobilized by indigenous institutions for construction, operation, and maintenance is far greater than the resources mobilized by more formal governmental institutions. Success in these efforts is likely to be affected by social conditions within the

community, the quality of local leadership, the capacity of local participants to design their own rules concerning obligations to contribute, the capacity to enforce these rules either internally or in an external court of law, the types of services being provided, and the availability of alternative resources.

Grants and Other Transfers

Transfers from other levels of government currently constitute the primary source of monetary funding of infrastructure development activities in the rural areas of most developing countries for several reasons. In many of these countries, central government statutes severely limit the extent of local revenue-raising powers. Transfers of resources are then made in lieu of local resource mobilization. By collecting nearly all revenues, greater control over fiscal policy can be maintained centrally. Central-level authorities may also wish to retain control over local government spending to increase the likelihood that the funds are spent in the most effective manner as perceived nationally.

Local political leaders may also even prefer external flows of funds under the assumption that such resources are less costly than raising the funds locally. But such arrangements can discourage local initiative. Just as voluntary contributions of labor can be more difficult to mobilize where it is anticipated that other external resources will be made available, inter-governmental flows of resources help explain the apparent lack of concern for infrastructure maintenance. When local leaders anticipate that grant funds will continually be available to replace deteriorated infrastructure, they have little incentive to maintain it.

The rules and regulations governing funding mechanisms also contribute to the neglect of maintenance. Capital construction costs are commonly funded from grants. Then, once in place, the costs of operating and maintaining the facilities become the responsibility of the locality, which is prohibited from using subsequent intergovernmental grants to meet these costs. The rationale for such arrangements is that they provide an incentive to the localities to build sustainable infrastructure. But, obviously, such arrangements can be successful only if the resource mobilization instruments available to local govern-

ments are capable of yielding adequate revenues and the localities are willing to use those instruments.⁷

Various types of transfers are made to local areas, depending on the structure of governments. In the highly centralized structures characteristic of many francophone countries, nearly all funds are allocated through the national budget to regional agencies of central ministries. Because all tax revenues including those that remain in the communities in which they are collected, are administered by the central government, such allocations are unlikely to provide strong incentives for localities to undertake additional maintenance efforts or to attempt to mobilize additional resources on their own (see Miner and Hall, 1985).

Where local authorities operate as autonomous units and are expected to raise some resources on their own, grants can have different effects on the behavior of local governments, depending in part on the type of grant instrument used. Proceeds from unconditional block grants can be used in whatever manner the locality sees fit; funds from categorical grants are restricted to particular uses. If localities are permitted to spend their own revenues as they see fit, an increased flow of categorical grant funds may not achieve the desired, yet relative increment to spending on the grant-supported service because the locality is free to divert its own funds away from that service.

While simple transfers of funds to localities generally discourage efforts by local governments to raise additional revenues, both categorical and block grants can be designed so as to provide incentives to overcome these tendencies. Categorical grants can include a local matching requirement that compels the locality to fund some proportion of the total costs of an activity from its own resources. This arrangement is most commonly used for new infrastructure investments. A local matching requirement can encourage greater efforts to mobilize local resources in order to enjoy the benefits of the facility and, having participated directly in funding the infrastructure's construction, there may be an increased willingness

within the community to operate and maintain it. Unconditional block grants can be distributed according to formulae that base jurisdictional allocations, at least partially, on the amount of resources mobilized locally. Although both cost sharing and revenue effort requirements can encourage local resource mobilization, such provisions are sometimes unacceptable to granting jurisdictions since the arrangements may be biased in favor of wealthier localities and, therefore, fail to redistribute funds to those communities deemed most needy.

Given the revenue importance of intergovernmental transfers to localities, the actual response to grants is a significant policy question, yet relatively few empirical studies have addressed the issue in developing countries, and those that have been made have generated a variety of conclusions. One study of grants in Colombia found that a one-peso grant resulted in increased spending of only about one centavo, suggesting that localities reduced local revenue efforts (Slack and Bird, 1983). A study of finances in San Paulo State of Brazil indicated that per capita local tax revenues increased by nearly the same amount as did per capita transfers, suggesting the grants had a strong stimulative effect (Dillinger, 1981). Bahl and Pillai (1976) similarly found grants to state governments in India to be stimulative. Analysis of two different grant programs in the Philippines showed that the Bureau of Internal Revenue Allotment had a stimulative effect on total spending whereas the Specific Tax Allotment was substitutive (Bahl, Schroeder, and Wasylenko, 1987). Greytak and Mendez (1986) analyzed grants to small and large cities in Ecuador and found that the general grant program was substitutive in smaller jurisdictions but stimulative in large cities; the categorical portion of the grant program was, however, stimulative in both groups of jurisdictions. These diverse results suggest that the effects of grant mechanisms on local fiscal activity depend on the grant instrument as well as other factors. One particularly important additional factor is the degree of revenue and budgeting flexibility that

⁷ Similar restrictions are commonly attached to grants and loans made to developing countries by bilateral and multilateral donors, whereby use of the funds is restricted to infrastructure construction and technical assistance. Use of the funds for recurrent spending is prohibited or limited in order to provide an incentive for the recipient country to mobilize these resources on its own.

recipient governments have in responding to the incentives that different types of grants provide.

Grants are also sometimes designed to stimulate greater efforts at maintaining infrastructure. In some cases, the granting government specifies that some portion of available revenues must be used for maintenance purposes. As suggested in Chapter 4, such arrangements can fail because of the information asymmetry between officials in the different levels of government. For example, the Government of Indonesia has mandated that a portion of the general Inpres grants be spent for maintenance; however, one local official admitted that, in order to conform to the mandate, they simply label one or more of the local projects a "maintenance" project, even though it does not differ from others in their project portfolio (Schroeder, 1987). The Government of Bangladesh also mandated that 25 percent of the normal (non-development) budget be set aside for maintenance. Field work indicated that the mandate was not fully understood by local officials and was ineffective because it was seldom, if ever, audited (Bahl, 1983).⁸

In addition to their incentives, intergovernmental transfers can also be evaluated in terms of their revenue adequacy and growth. Although grants place greater resources at the disposal of localities, the granting jurisdiction commonly retains considerable control over the allocation of funds. As such, a heavy reliance on transfers makes the local jurisdiction vulnerable to random fluctuations in the behavior of higher authorities. Bird (1978: 75) has asserted that "fiscal transfers in many developing countries probably constitute one of the least reliable sources of local revenues." Allocation mechanisms are often *ad hoc*, with political objectives receiving considerably greater emphasis than revenue needs, and, due to other fiscal problems faced by central governments, the flow of funds may be delayed or the amounts ultimately transferred may fall far short of what was originally promised (Schroeder, 1988).

Tax sharing is one type of intergovernmental "transfer" that can help overcome arbitrary allocation mechanisms. Under such schemes a portion of centrally collected taxes is designated to remain in the locality in which they are obtained. Since such taxes are often more productive, more elastic, and more effectively administered, such arrangements help overcome the revenue uncertainties of more traditional grant allocations. And when a portion of taxes collected is retained in the localities paying the tax, there is an increased incentive for localities to encourage taxpayers to pay the tax. Tax sharing does, however, decrease the possibilities of redistributing funds from wealthier to poorer areas, since the former localities are likely to have the strongest tax bases. Furthermore, many central governments are not anxious to share directly and automatically any revenues collected from what they consider to be their own tax source.

In summary, since grants constitute an important source of revenues for localities in developing countries, the mechanisms to allocate grant funds must be carefully designed to ensure that these schemes are effective. Only when transfer instruments are carefully crafted can they ensure a growing and certain flow of resources that also provide incentives for localities to carry out resource mobilization efforts on their own.

Loans

Credit is another method whereby additional resources can be made available to localities to help develop and maintain rural infrastructure. In fact, loans constitute a very attractive mechanism to finance the initial construction of capital infrastructure designed to yield benefits over a period of time. Furthermore, the commitment to pay off a loan over time can improve the incentive of localities to operate and maintain a facility, but this is effective only if there are real penalties attached to defaulting on the loans. Without such penalties, credit simply constitutes

⁸ Mandates for maintenance have also not been found to work uniformly well in the United States. For example, the interstate highway system, which was financed primarily by the federal government, mandated that the states maintain the system. One Government Accounting Office audit of such maintenance found that many states were not allocating sufficient funds toward this effort (United States Government Accounting Office, 1981).

another form of transfer funding. Loans are not appropriate, however, for financing the recurrent costs of capital infrastructure and, therefore, are not discussed at any length here. Unless the revenue devices previously discussed are sufficiently developed to yield a flow of revenues capable of operating and maintaining the facility and also to permit the repayment of loans, credit finance cannot be viewed as a viable option.

In a recent review of experiences with credit finance in 44 developed and developing countries, Davey (1988) documents the diversity of mechanisms used to provide credit to localities and finds that, although many of the institutions have not been successful, there are notable exceptions, including some in developing countries.⁹ He argues that it is the strength of the local government that guarantees the success of municipal credit institutions, not the reverse. Davey (1988: 50) concludes that one important determinant for such success is the degree of accountability of officials to the local population, a condition arising only where officials are elected and must take responsibility for their actions. A second crucial prerequisite is a strong current revenue base such that localities have the ability to raise the necessary funds to repay the loans. Still, credit can help to strengthen local governments, primarily by providing funds that can be used to improve the local economic base and by increasing the self-confidence of localities as they take on the responsibility of deciding how to use the loans and how to repay them.

In summary, a long list of potential instruments is available to mobilize the resources necessary to finance the operating and maintenance costs of rural infrastructure facilities. Although no single instrument is likely to satisfy all of the several objectives discussed at the beginning of this chapter, combinations of instruments can be used to generate resources for different types of infrastructure. However, as we consider in the following section, for these resources actually to be used for maintenance, budgetary decisions must first be made to allocate the funds for that purpose.

Budgeting for Maintenance

Mobilization of monetary resources does not guarantee that the money will be used for maintenance. When there are competing needs, maintenance efforts constitute only one alternative use of the funds. This issue is especially difficult in the case of jurisdictions expected to provide a variety of services at the local level, e.g., roads, health services, and education as well as general administration. In such circumstances, infrastructure maintenance may be considered less important than other uses of resources.

There are several reasons for this, many of which are related to the incentives inherent in the budgeting process. First, while economic efficiency would dictate that funds be used where they yield the greatest net return, information concerning the net payoffs to alternative uses of funds is seldom available. Second, the longer-term payoffs from infrastructure maintenance may actually yield significantly lower present net benefits than utilization of extremely limited resources for alternative uses. Third, decisions to allocate funds away from maintenance can be reinforced by the political nature of public-sector budget making, in which political gains are increased by using funds for purposes yielding more immediate gratification of the electorate and elected officials. Fourth, the incentives of nonpolitical decision makers can bias choices towards new construction rather than maintenance. An engineer may find it much more challenging to design and build a new facility than to devise maintenance routines. Fifth, many observers argue that corruption is easier and more lucrative from construction activities than from maintenance efforts, since the latter are generally more labor intensive, making it more difficult to obtain kickbacks.

Finally, the nature of spending and production may limit the flow of resources into maintenance. As noted above, grant programs can preclude using transferred resources for maintenance to provide an incentive for local resource mobilization. Also, the method by which maintenance is produced can discourage a sustained maintenance effort. Although localities in many countries use their own "force account"

⁹ Additional discussions of credit finance are contained in Hubbell (1983), United Nations (1972), and Gall (1976).

employees to produce maintenance, in other locations, such as South Asia, all production is carried out as projects or schemes by contractors. Such arrangements are particularly suited for well-defined activities such as construction or reconstruction of a capital facility; they are not especially conducive to the on-going process that characterizes many routine maintenance procedures. When local bodies are required to carry out all activities in a project mode, the transaction costs of writing, tendering, and monitoring routine maintenance activities can prove to be great and may discourage routine maintenance.

Overcoming this long list of incentives is not an easy task; however, where the fruits of maintenance are obvious and accrue directly to those from whom the resources are mobilized, the bias against maintenance can be lessened. This goes far in explaining the relatively larger numbers of examples of successful maintenance of irrigation systems than of other public infrastructure facilities. Farmers who directly benefit from maintenance of their own irrigation systems are willing to contribute to such undertakings. Furthermore, direct contributions of labor for these efforts are not fungible into other activities that may yield fewer benefits to those contributing.

One institutional reorganization that has the potential to increase the flow of resources into maintenance is use of single purpose jurisdictions. This has the advantage of decreasing the budgetary choices available to decision makers. For example, unlike a general purpose government, a drainage district can use resources only on drainage. Decision makers in such districts then have the freedom to choose from a more constrained set of options, such as maintenance of the existing system and construction or reconstruction of new facilities. When the same enterprise will itself have to pay for early reconstruction if it underinvests in maintenance, greater incentives for maintenance are likely to result.

Another institutional mechanism that has the potential to increase the flow of resources to maintenance, even within general purpose governments, is earmarking of funds. Earmarked funds can be used only for specific purposes; hence, this mechanism again diminishes the budgetary freedom of decision makers and can increase the flow of funds into particular activities. For example, gasoline taxes may be earmarked for use only on road construction and maintenance.

From the standpoints of revenue adequacy, equity, and political acceptability, earmarking is likely to be seen as desirable since (if properly administered) it ensures a source of revenues that is closely linked to the benefits derived from a facility. At the same time, earmarking can result in diminished economic efficiency since society could, perhaps, benefit more greatly by utilization of the funds for other purposes, e.g., society might be better off if gas taxes were spent on education rather than on roads.

Although the theoretical arguments concerning earmarking are unresolved (see Buchanan, 1963; Johansen, 1963; or Teja, 1988), the practical concerns for ensuring an adequate flow of resources into capital infrastructure maintenance suggest that the mechanism is justified. Unfortunately, experience suggests that earmarking can fail to work without sufficient political will or when other objectives are viewed as more important. For example, Harral and Faiz (1988: 28) report failures of earmarked road funds in the Central African Republic where the central government overrode the mandate to use the resources generated for road improvements.¹⁰ In spite of these instances, we would argue that creation of single purpose districts and greater utilization of earmarking funds should be pursued more vigorously in attempts to help ensure that resources are made available for infrastructure maintenance.

¹⁰ In fact, a similar situation has arisen in the United States where, due to concerns for the budget deficit, highway trust fund monies are not being released by the federal government.

Conclusion

Although the availability of resources is not a sufficient condition to ensure that infrastructure maintenance will occur, it certainly is necessary. Designing instruments capable of mobilizing these resources while attempting to fulfill the several, often competing, objectives of revenue adequacy, efficiency, equity, political acceptability, and ease of administration is not easy, however, and requires considerable analytical effort. Generally, the task is one of trading off one objective in order to achieve another. Given the recognized need for additional resources, designing those instruments that can yield sufficient resources without creating great distortions in economic choices is the principal task of finance. To that end, the search for instruments should focus on benefit-based levies that are administrable within the environment of a developing country.

It is appropriate to close the discussion here with a consideration of the general constraints faced in ensuring that adequate resources can be mobilized. The first constraints that must be overcome are the legal restrictions that prevent localities or groups of users from mobilizing resources to finance the recurrent costs of operation and maintenance of infrastructure facilities. For example, users groups must be authorized the legal means to create rules governing contributions of labor or other resources. Similarly, local governments must be given the autonomy to use tax or nontax instruments that are capable of mobilizing necessary resources.

This issue is especially problematic for formal local governments when potential revenue instruments and even the permissible rates and bases of those instruments are prescribed statutorily by the central or state government. The list often excludes more productive and growing resource instruments since the central government wishes to reserve these sources for itself (Davey, 1983). Central governments sometimes even unilaterally decrease the revenue-raising powers of localities; Orewa (1987: 42-43) reports on such actions in both Nigeria and Zambia. Similarly, rules may not permit local governments to raise user fees without permission, thereby limiting the revenue growth potential of these instruments. If noncentralized arrangements for infrastructure

development are to be sustainable, central governments must be willing to relax such restrictions.

A second constraint that must be overcome is the unwillingness of decision makers to use those resource mobilization instruments that are available. Often local leaders are unwilling to tap existing sources, primarily due to the political costs this may entail. Or, if these sources are tapped, political supporters and kin may be treated preferentially. As has been emphasized throughout, a key to overcoming this constraint is closer links between payments and enjoyment of benefits. Benefit-based levies, e.g., user charges, direct contributions of labor, or earmarking of revenues to particular uses, have the potential to strengthen such linkages.

Finally, the inability to administer those resources that are made available constitutes a third important constraint that must be overcome if resources are to be made available for infrastructure sustenance. This is particularly important in rural areas of many low-income countries. In such circumstances, it does little good to design instruments that are potentially productive and equitable but simply cannot be collected.

Successful administration of a revenue instrument is greatly assisted if that instrument is simple and if compliance is visible. These attributes generally characterize most indigenous resource mobilization schemes. Simplicity not only allows a tax or fee to be fairly and easily administered, it also helps to ensure that the payer is aware of what is due. Visibility or knowledge of payment helps to ensure payers that they are not being "suckers" by complying with the levy. Thus, if an irrigation system requires the contribution of one day of labor per month, all members of the users group know their liabilities and also know whether or not their neighbors are also complying. And, if irrigated land is fairly evenly distributed, cross members, such simple levies satisfy equity criteria.

Simplicity and knowledge also aid the administration of more general, monetized revenue instruments. Simpler instruments can lessen the subjectivity of revenue administrators; willingness to comply is strengthened when all taxpayers know they are being treated in a roughly similar manner.

In summary, ensuring an adequate flow of resources is a complex, yet necessary task if rural infrastructure is to be sustained. The task includes crafting a revenue system that permits taking advantage of local preferences, that provides incentives to ensure a flow of resources, and that can be administered fairly.

Polycentric Institutional Arrangements for Infrastructure Sustenance

IN THE previous two chapters, we have drawn on bodies of theory from institutional economics, public finance, and institutional analysis to derive a set of intermediate performance criteria for institutional arrangements. We have already considered how well five stylized types of institutional arrangements are likely to perform the difficult tasks of developing and sustaining infrastructure facilities. These included the institutions of a pure market, a differentiated market, and a user group, in addition to centralized and decentralized governmental institutions. In this chapter we will consider a sixth category of arrangements—polycentric governmental institutions—that promises to more completely meet the performance criteria we established in Chapter 6.

Centralized provision arrangements are frequently able to forestall free riding, achieve economies of scale in production, and bring scientific information to bear on decision making. Although most administrative decentralizations have been introduced in order to reduce the cost of acquiring time and place information or the errors due to a lack of this type of information, most have not been successful in doing either. Administrative decentralization has also failed to reduce the high costs of strategic behavior—shirking, corruption, and rent seeking, in particular. An analysis of the structure of authority relationships makes it clear why centralized, and most decentralized, institutional arrangements should be considered unicentric. Decision-making authority is organized

within a single hierarchical chain of command with a single, ultimate center of authority.

In this chapter, we consider the kind of improvements a noncentral or polycentric institutional structure might provide in reducing strategic and information costs while retaining the advantages of larger-scale production agencies when economies of scale are present. Polycentric or noncentral institutional arrangements are characterized by the distribution of circumscribed but independent rule-making and rule-enforcing authority among numerous jurisdictions. All decision-making authorities have legal standing. No individual or group serves as the ultimate all-purpose authority that stands above the law.

We first consider the concept of polycentricity and how this type of institutional arrangement might be expected to lower the costs of acquiring time and place information and to reduce some forms of strategic behavior. We then discuss whether polycentric structures are appropriate and feasible for less developed countries. Because the relevance of polycentric systems has not been widely recognized by students of development administration and finance, we then address some of the more common reservations about the performance of polycentric arrangements particularly in developing countries. Finally, we consider the conditions under which privatization might serve as another means of improving the quality of decision making involved in the development and maintenance of infrastructure.

The Concept of Polycentricity

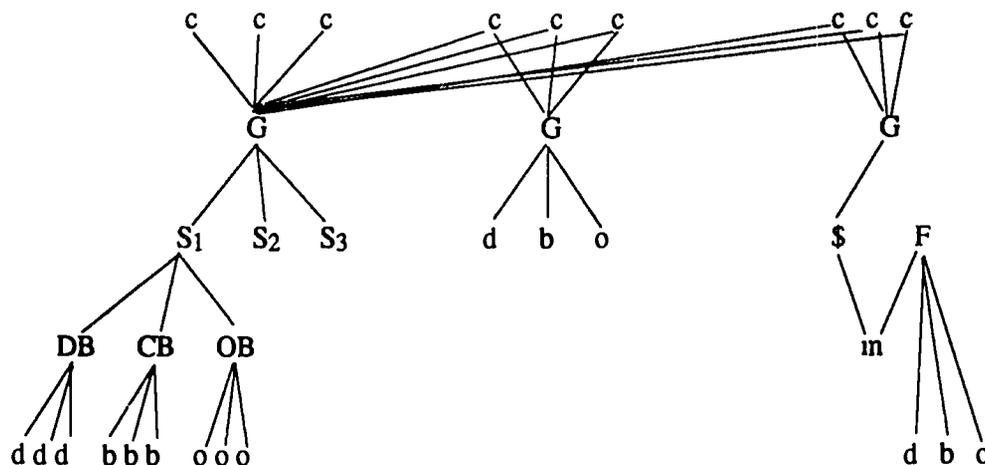
In contrast to the centralized and decentralized structures described in Chapters 2, 3, and 6, a polycentric governing structure offers citizens the opportunity to organize not one but many governing authorities. Each government may exercise considerable independent authority to make and enforce rules for a circumscribed scope of authority within a specified geographical area. Each government is first and foremost a provision unit. Some of the provision units may organize their own production bureaus, as when the Ministry of Transportation establishes a road construction bureau, or they may choose to contract with other public bureaus or private firms that produce a particular good or service. The option of choosing from among multiple producers makes it possible to take advantage of diverse economies of scale for one or more of the design, construction, maintenance, and operational services involved in infrastructure development and sustenance.

The jurisdiction of different governments in a polycentric system varies enormously. Some are

general-purpose authorities providing a wide array of public services to a community. Others may be special-purpose authorities that do nothing but provide for, operate, and maintain a single infrastructure facility such as an irrigation system or a toll road. The varied functions of these governments mean that individuals maintain citizenship in several governments simultaneously. Figure 8.1 illustrates some of the potential diversity of relationships between citizens and governments as well as between governments.

That individual governments exercise independent authority means that authorities operating in different jurisdictions all have legal standing. An official in one jurisdiction does not function as a superior to officials in other jurisdictions and thus does not control their career paths. Hierarchical relationships will exist within any one jurisdiction, but the long chains of such relationships closely associated with loss of information and control will not. Consistent with the equal legal standing of public servants in different jurisdictions, disputes between officials regarding the interpretation of laws or the limits of

Figure 8.1. A Polycentric Arrangement for Infrastructure Development



KEY: *c* = citizen-consumers, *G* = national government, *Si* = sectoral ministry (e.g., irrigation, transportation)
DB, CB, OB = Design, Construction, and Operating Bureaus within each sectoral ministry
d = designers, *b* = builders, *o* = operators-maintainers,
\$ = financial institutions (banks, credit rings, etc.), *m* = quality monitors, *F* = construction firms

jurisdiction are properly settled in courts of law instead of within an administrative hierarchy. Periodic elections provide an opportunity for persons within a jurisdiction to select governing officials they believe will provide appropriate goods and services for the jurisdiction (or at least to discipline those that have failed in the past).

Polycentric orders sacrifice few of the advantages provided by centralized governing authorities and generate advantages of their own. Governing authorities can still penalize those who attempt to free ride. Officials in a small jurisdiction can contract with production bureaus of larger jurisdictions for the production of specific services for which there are economies of scale. The opportunity to contract with the specialized employees of larger jurisdictions or with private firms is a convenient and economical way of purchasing scientific expertise as it is needed for specific projects. Coordination costs among authorities in different jurisdictions could increase because authorities can refuse to go along with proposals made by others. In reality, however, contestation over different policies between independent units is likely to simply be more open than the contestation that regularly takes place within the bureaus over policy options. Whether actual coordination costs rise depends on how diverse communities of interests are organized and whether mutually productive or zero-sum relationships are involved. If coordination costs do rise as a result of initial disagreements but result in the refinement of a policy that, in turn, produces an improved outcome, the increased coordination costs are well worth the price.

The elections by which local executive and legislative authorities are selected provide an imperfect but important means of aggregating time and place information for decision making. This is because the store of information about a particular voter's own time and place circumstances, in combination with his or her own interests, determines that voter's preference for the policy positions of one candidate over another. Once elected, officials or representatives face strong incentives to keep at least some of their constituents happy in order to secure their reelection. Retaining popularity requires that officials keep themselves well informed about changing preferences. By definition, local candidates are also likely to possess a large fund of local time and place information upon which to

draw in decision making.

Polycentric systems also provide a means of reducing the costs of opportunism. Citizens who wish to remove corrupt or lazy elected officials are not required to rely on the cooperation of senior administration officials; members of the relevant jurisdiction can accomplish this themselves through electoral or other selection and removal processes. In addition, larger numbers of officials operating independently in a larger number of jurisdictions reduce the likelihood that any one of them will monopolize control over important public goods and services.

The Possibility of Polycentricity in Developing Countries

The work of Goran Hyden (1980, 1983) provides an especially good account of the continuing strength of ethnic-group loyalties among the residents of developing countries, despite the efforts of national-level political authorities to transfer those loyalties to the nation. Even though there are multiple, ethnically defined centers of loyalty in these countries, none of the jurisdictions to which these loyalties attach overlap, and few of the leaders recognized as legitimate in each center function as authorized governors. Such situations provide individuals with the experience *not* of polycentricity as we use it here but of imperfect imperial control. Within imperial systems, however, one does find ethnic groups (the Masai and the Nuer, for example) and special-purpose groups (like the *zanjeras*) that do provide individual members with the experience of a polycentric governing system. Thus, the most important basis for optimism about the potential value of polycentric institutional arrangements in developing countries is the considerable extent to which the underlying principles of polycentric organization are already in operation in numerous contexts.

Sources of Polycentricity

Among the most intriguing contributions to the literature on decentralization are accounts of the operation of local indigenous institutions (D. Korten, 1980, 1983, 1984; Uphoff, 1982, 1986b). Some of these institutions are officially recognized as having independent, though circumscribed, authority to make and enforce local rules. Many indigenous institutions are

almost invisible to national government officials (and to many academics). Others are strictly outlawed. Invisible institutions, however, frequently provide substantial public services. The "informal economy" was an invisible part of most developing countries until quite recently, when careful observers began to realize that a substantial portion of the economic activity in Eastern Europe and developing countries was conducted by unlicensed firms (see De Soto, 1989; Jagannathan, 1987; Jenkins, 1988). In many cases, unauthorized indigenous institutions constitute the "informal polity" that governs the informal economy.

Indigenous institutions are frequently small in size and therefore able to provide services for members on either a voluntary or involuntary basis using social pressure to enforce rules that limit free riding. Some, however, also make use of authorized or unauthorized police powers to enforce the payment of fines for failing to contribute to the group effort. And some effectively organize larger-scale group efforts. In countries as diverse as Indonesia, Nepal, Japan, Taiwan, and the Philippines, large-scale irrigation works have been constructed and maintained over long periods of time by indigenous institutions (Lando, 1979; Pradhan, 1983; Beardsley, et al., 1959; Pasternak, 1972; and Bacdayan, 1974).

In regimes where indigenous institutions have no legal standing, many smaller institutions are able to survive unnoticed or unchallenged. Such idiosyncratic factors as a forbidding environment (Botswana's Bushmen) or a particularly ferocious reputation (East Africa's Masai and Nuer) provide some degree of autonomy for acephalous groups (i.e., those organized on nonhierarchical, polycentric principles) caught up in centralized systems. The problems of information and control loss endemic in hierarchically organized systems would also lead one to predict that small organizations could develop and flourish in such environments. Wade (1988) documents one case in which the leaders of an Indian village constitutionally authorized to exercise very limited taxing, spending, and police powers have purchased illegally (i.e., using bribes) the right to exercise

these powers from local government officials. With this authority, village leaders currently govern an irrigation system and provide a wide range of additional public services well-tailored to local needs. Indigenous institutions characterized by large size, significant revenue-mobilizing capacity, or active partisan political participation eventually attract the attention of recognized government authorities who may attempt to remove local leaders they discover acting *ultra vires* (see Sawyer, 1988, for a recent example from Liberia).

The extensive empirical evidence in studies of local indigenous institutions provides clear proof, if any were needed, that the self-organizing capabilities of people can survive and occasionally even flourish under repressive regimes (see Wade, 1988, and cases contained in National Research Council, 1986; Berkes, 1989; V. Ostrom, Feeny, and Picht, 1988; McKay and Acheson, 1987). The developmental impact of the social capital these organizational skills represent will remain tragically constrained or amplified exponentially throughout the entire population of each country, depending on the success experienced in: (1) limiting the authority of institutions representing larger communities of interest; and (2) finding ways of structuring complementary, rather than predatory, relationships between organizations serving larger communities of interest and these smaller organizations. All countries must be able to organize public authorities to address problems whose range of effects varies widely. Several large, comparative studies of local organization found that the nature of these complimentary relationships between authorities representing small and larger communities was central to the successful operation of the smaller units (Leonard and Marshall, 1982: 6; Uphoff and Esman, 1974: 25).

Principles versus Blueprints

The principles by which indigenous institutions are structured constitute an important body of "social capital" that could be tapped for use in the design of new institutions in developing countries. In this context, capital is used here in its broadest sense to refer

¹ Robert C. Hunt (1988: 349) examines the hypothesis that "no large canal irrigation system ought to be able to function if managed only by farmers" and concludes after a review of a large number of empirical studies: "Yet they do, and very successfully."

to those goods or ideas with which something else can be created or established. Thus, the social capital of a particular community is that body of shared knowledge about how to organize people in a productive manner. Although we have many examples of traditional or indigenous social organization in developing countries that utilize strictly hierarchical principles that are inconsistent with democratic government and productive human interaction, there are also numerous examples of polities that are acephalous. The principles underlying those non-hierarchical institutions offer a genuine alternative to political systems that rely exclusively on hierarchical decision-making arrangements. We consider these *underlying principles* to be a more general form of social capital than the *specific rules* used within any particular indigenous institution.

Although a shared knowledge of the specific rules used within an indigenous institution—the “blueprint” of that institution—is essential for its survival over time, a knowledge of the underlying principles used in the evolution or design of these specific rules is likely to be more helpful to other individuals facing similar problems in different circumstances. General principles may be transferable to other settings and used by many communities of individuals to craft particular indigenous institutions that meet their communities’ needs. Because the way rules affect the incentives of participants depends on very specific attributes of the goods involved and on the cultural and physical environment of a particular community, the specific rules developed in one indigenous institution may not work if they were adopted in a neighboring location. Thus, the blueprint may not be transferable.

At the end of his book, *Community Resource Management: Lessons from the Zanjera*, Robert Siy summarizes what he believes are the underlying design principles of the indigenous institution he studied, the *zanjera*. Siy also contends that it is an institution’s design principles that are transferable, not the highly specific blueprints that constitute any particular indigenous institution. Siy identified the following *zanjera* design principles:

- In order to discourage “free riding,” *it is necessary to develop incentives and sanctions to promote long term participation and in-*

volvement in group tasks (ibid., 153).

- It appears that organizations can best gain and maintain the commitment of members to the work of the organization if *individual obligations can be assigned in proportion to the benefits derived by each member from the group activity or project*. In other words, each members’ share of total costs should correspond to his actual share of total benefits (ibid., 155).
- In selecting the appropriate method of estimating individual benefits, several issues should be considered: the validity of the indicator in members’ eyes, the capability of the organization to collect the information accurately and reliably, and the simplicity of the indicator (ibid., 155).
- [T]he next step is to determine a procedure for assigning and assessing members’ contributions. . . . The important condition is that, in contexts where the organizational demands on labor and material resources vary from year to year, provisions must be made to have those resources available for use when the situation requires, regardless of the specific method which accomplishes this (ibid., 156).
- An irrigation organization should be considered as a going concern, as an institution with a clearly defined purpose and function. . . . It is, therefore, important for such groups to be able to generate the resources which they require for their continued operations. These resource requirements include not only the direct inputs for providing the good or service that the group offers but also the resources required to enforce agreements, procedures and regulations (ibid., 162).
- A major lesson is that particular organizational principles are practicable and appropriate only within certain types of physical arrangements. For example, maximal decentralization is not feasible within a system that requires close coordination between each sub-unit (as when water is rotated along a main canal or lateral) (ibid., 167).

These principles are consistent with the theoretical approach taken in this volume and are general lessons that can be transferred to other settings.²

Some Common Concerns about Polycentric Arrangements

Although the ability of polycentric systems to constrain national political officials and empower the most attractive of the local organizations has been appealing to academics and development professionals, many have expressed serious reservations about the value of polycentric arrangements, particularly in developing countries. These reservations are rooted in concerns about several governance and finance issues. First, we address three concerns about governing a polycentric system. These include how a coherent body of law can be maintained in a system of multiple independent lawmakers, how a legal system that protects minorities and the poor within the smaller jurisdictions can be established, and how an adequate administrative capability can be provided for many governments in countries where literacy levels are still low.

We begin the discussion of financial issues with a brief review of a portion of the economics literature devoted to the financial aspects of multi-tier systems of government. The theory propounded here also provides deductive support for noncentral systems. Related financial issues of concern include the questions of whether interjurisdictional equity can be achieved in a polycentric system where jurisdictions vary in their natural or artifactual endowments, and how the recurrent costs of multiple local governments can be contained.

Governance Issues

At least since the time of Napoleon, the process of modernizing a country has been commonly associated with the empowerment of a group of well-educated, highly motivated administrators to guide the affairs of subordinate jurisdictions. This presumably provides the means for organizing a competent administration interested in conveying new ideas to poorly educated people about how to prevent disease or increase

agricultural output while protecting them from autocratic hereditary leaders who may wish to keep their followers dependent and subservient. The idea of conferring some amount of independent law-making and law-enforcing authority on many smaller single- or multi-purpose governments generates fears of a legal chaos of incompatible rules overseen by incompetent local officials who perpetuate the continued exploitation of local populations. Defenders of polycentric organizations must be able to respond to these concerns.

How Can the Coherence of Law Be Maintained?

If many groups within a single country are authorized to make rules concerning broad or narrow aspects of public policy, will the law eventually become a jumble of incompatible rules? Certainly, the willingness of individuals to invest in any economy requires fairly high levels of predictability—the capacity to anticipate the behavior of others. Predictability, in turn, depends on the likelihood that rules governing behavior are widely understood and are likely to be enforced. The concern about a loss of coherence of law should appear less threatening, however, with the realization that many developing countries still recognize one or more bodies of traditional or religious law and maintain a special system of courts with jurisdiction over conflicts in these types of law. Such countries already have a type of polycentric system in operation.

Although a conflict between laws is bound to arise at some time in such systems as the result of conscious and unconscious choices, coherence can and often is achieved. This is accomplished by a judicial system consisting of multiple hierarchies of courts that recognize the principle of a hierarchy of law. This principle states that traditional laws are valid only if they are consistent with those of the provisions of the statute law that are, in turn, consistent with the fundamental law of the land found in the country's Constitution.

Apparent inconsistencies in the laws of two jurisdictions are evaluated in the context of a court proceeding. The court may be approached by either public officials responsible for upholding provisions

² See E. Ostrom (1990) for a further discussion of design principles derived from a much larger set of cases.

of statute law, or by a citizen who has been injured by the enforcement of a provision of the traditional law. Defenders of the traditional law must prove that the inconsistency does not exist or that the provision of the statutory law is inconsistent with the country's Constitution. The losing party has the opportunity to appeal through a hierarchy of courts. The appeals process offers the losing party further hearings in courts whose personnel are chosen from different jurisdictions by different criteria and are therefore further removed from any local prejudices that may have biased traditional court decisions.

Extending greater authority to more groups to make rules about a greater variety of problems would be likely to increase the number of conflicts of law that would have to be resolved in this way. The increased costs of greater investment in the dispute resolution services of a polity must be considered, however, in the context of the potential for increased productivity in the economy made possible by a body of law that is better fitted to the problems that people face.

A number of developing countries already recognize the multiple communities of interest associated with network-type infrastructure facilities by assigning different jurisdictions responsibility for different types of roads. Bangladesh, for example, assigns responsibility for farm-to-market roads, secondary roads, and main highways to local upazila councils, zila (district) councils, and the national Roads and Highways Department, respectively. The existence of numerous directives from central ministries that require uniform methods in the provision and production of road services are, however, inconsistent with independent efforts to provide roads in different jurisdictions. In addition, the central ministries continue to exercise considerable authority as the controllers of block grant funds and as the contracting parties with the international donors who provide a large proportion of road development funding.

How Can Competent Administration Be Developed?

Virtually all developing countries currently have subnational administrations that are inefficient and unresponsive to the residents of the jurisdictions in which they operate. In many countries, government

offices at all levels lack a sufficient number of highly trained personnel. The ranks of persons with post-secondary educations are still slim. Given this situation, would it not seriously compromise even the inadequate quality of the current administrations to create additional subnational governments and devolve to them larger amounts of decision-making authority? Although the problems of overcentralization are widely acknowledged, the problems of actually organizing an alternative administrative structure are not inconsequential. We do not question the importance of maintaining an adequate level of administrative capability in smaller general- or special-purpose jurisdictions. We do, however, question the soundness of the theory that district or provincial personnel are currently inefficient primarily because they have had so little professional training, and argue that considerably more administrative talent exists for use in local governments than is commonly recognized.

Enhancing the capacity of employees in provincial or district offices to plan and implement policy has been the objective of numerous institutional development programs, such as the PDAP described in Chapter 3. Available evidence appears to indicate, however, that a program designed to improve skill levels unaccompanied by changes in the incentives personnel face may have little or no long-term effect on performance. The history of PDAP reveals that training initially improved the skill levels and sense of professional confidence of provincial planning staff members. A recent review, however, indicates that over time the skills acquired by administrators appear to have atrophied through nonuse (see Hubbell, et al., 1989). Certainly, the level of initiative shown by provincial governors during the latter stages of PDAP has not been maintained. The longer-term effects of this program suggest that simply increasing staff skill levels may not be sufficient to increase the productivity of provincial governments.

In contrast, training programs organized in Nepal for members of farmer-managed irrigation systems have been more successful in increasing productivity (see Pradhan and Yoder, 1989). These training programs are funded by the Department of Irrigation, but are actually produced by persons farming in highly successful farmer-managed systems. In this case, the trainees have instructors who share a similar social

status and an intimate familiarity with the problems they face. Unlike PDAP's provincial planning staff trainees, these farmer trainees can hope to substantially effect changes in rules governing their systems in order to enhance productivity after the training program ends. PDAP trainees usually returned to a work environment whose rules they could not hope to alter.

Careful attention to incentives is evident in the organization of the accounting systems used by the illegal local village governments described by Wade (1988) and the *zanjeras* irrigation systems (see Siy, 1982). In one Indian village where the mutual suspicions of two factions threatened the viability of the government, two treasurers were appointed with responsibility over a portion of the net monetary income from "taxes" and fines. These men kept separate books that were examined by each other at predetermined times when their separate accounts were entered into the principal account book for the village. The secretaries of each *zanjera* kept careful records of attendance at work days and the monetary and in-kind contributions of each member. Once a year, a "settling-up meeting" was held, at which persons owing outstanding fines for missed work days were expected to pay in full. The meeting was followed by a feast. The simple accounting books of the secretaries could be examined at any time to ensure their accuracy.

Evaluations of human capital endowments that rely almost exclusively on the formal educational qualifications of its population have quite appropriately emphasized the importance of continued heavy investment in educational services. They also dramatically underestimate the extent and the nature of the existing human capital endowment in developing countries. Good administrators need information that is not taught in schools. The tragic consequences of the unfortunate choices of well-meaning officials who lack good local time and place information and access to local scientific information demonstrate the inadequacy of assessing qualifications solely on the possession of certificates. An exclusive reliance on certificates has disqualified from public service many potential candidates who have extensive experience with the specific problems facing local populations. The capacity of communities to independently finance, build, and staff schools (the *harambee* schools of Kenya are well-known examples) and to

organize private courts regarded as fairer than official courts (as described by DeSoto, 1989, in Peru) indicates the existence of an important reservoir of skills that is not currently being recognized or utilized in public administration.

The issue of trained manpower shortages for the local governments also implicitly assumes that the public sector must produce all the goods and services that are to be provided publicly. Such an assumption ignores the tremendous potential for private sector production, which may be capable of overcoming the trained labor supply issue while simultaneously aiding in the achievement of efficiency. We will provide a more general overview of possible linkages between the private and public sectors in a later section of this chapter.

How Can a General Rule of Law Be Maintained?

Perhaps the most serious reservation about devolving independent taxing and spending authority to a sub-national jurisdiction or a special-purpose authority concerns the issue of how local authorities can be held accountable for their actions. The independent selection of local officials by election or other means is inconsistent with the removal of these officials by administrative action on the part of central government officials. Provisions for the dismissal of local officials by administrative action make a mockery of the electoral process. But if officials of larger jurisdictions cannot discipline local officials as they would junior officers, how is it possible to ensure that the locally elected officials of smaller jurisdictions will faithfully enforce the law of the larger jurisdictions?

One means of penalizing elected officials who ignore rules established for all citizens is for local residents to remove them from office (using recall or some other provision) or to choose not to reelect them to office. This mechanism may not be helpful, however, if it is a member of a minority group in the smaller jurisdiction that is suffering from the illegal behavior of a local official.

In the American and Swiss federal systems, the court systems are the principal control mechanism. An official of a larger jurisdiction may bring suit in court against an official of a smaller jurisdiction who has failed to enforce a law established by the larger juris-

diction. An individual who believes he or she has been harmed by a local official's unwillingness to enforce a law of the larger jurisdiction may also bring suit against this official.³ One of the principal advantages of a system of local government organized on such principles is that it produces a structure of incentives that places local executive authorities in a "double bind." The necessity of facing voters in future elections constrains them to be attentive to the concerns of local people; the threat of a court suit encourages local executives to take note of the law of the larger jurisdictions of which their local community is a part.

The *zanjera* irrigation systems provide an example of how rules that are derived from several jurisdictional levels can be integrated and enforced. The initial *biang ti daga* contract is negotiated by the set of farmers who wish to acquire *atar* shares. The contract specifies the mutual obligations of all the farmers to each other and to the owner of the plot of land. Although there is a general set of principles to be followed in drafting this type of contract, each one specifies the particular rules and obligations of their particular system and exactly how this system will be governed over the long term. Conflicts between farmers or between farmers and their elected officials would first be handled within the *zanjera*. If the conflict were not resolved at this level, and the *zanjera* were a member of a federation, the conflict would next go to the federal council for discussion and potential resolution. If a satisfactory resolution did not occur at this level, and the conflict had to do with the legal rights specified in their contract, participants could go to the Philippine court system with the conflict. In fact, conflicts between *zanjeras* over their respective water rights have frequently used the formal court system for resolution (Cruz, Comista, and Dayan, 1987). In such a nested-rule system, rules at a lower level that are not consistent with rules of a higher level are eventually eliminated. Still, there is a considerable diversity of lower-level rules that are fully consistent with the rules of other jurisdictions.

One would expect to find dispute resolution mechanisms playing an important part in controlling political officials in any polycentric system. Concerns about the ability of the poor to operate control mechanisms in any political system are significant (see Leonard and Marshall, 1982) and underscore the importance of keeping the costs of access to dispute resolution mechanisms low. In developing countries that have maintained a customary court system separate from a court system that hears cases based on statutory law, the jurisdiction of most of these courts is limited to family law and petty criminal questions, even though the costs of access to customary courts have been deliberately kept low. Containing the costs of access to courts with jurisdiction over public officials requires that all courts maintain simplified procedures.

Finance Issues

Some strong reservations about polycentric institutional arrangements are rooted in the perception that such arrangements yield serious inequities and inefficiencies. In this section, we discuss the concept of fiscal equivalence that has been central to considerations of both efficiency and equity in any polity containing multiple jurisdictions. In addition, we consider ways that many local governments could be financed in low-income countries and how equity questions may be best addressed.

How Can Fiscal Equivalence Be Achieved?

In the economics literature, decentralization issues fall within what has been called "fiscal federalism." This title is somewhat unfortunate because it implies that these issues are relevant only to a federal system of government. In reality, however, wherever multiple jurisdictions are recognized, even within a unitary system of government, the questions considered here must be addressed. Unlike the political science literature, in which the term federalism is reserved for a fairly well-defined approach to the structure of governments, the fiscal federalism literature has

³ In the Anglo-American jurisprudential tradition, provision is made for individuals to secure a court order that would force an official to act or refrain from acting, even before that individual can prove that he or she has been harmed by actions of the official. If an individual can convince a judge that the expected action or inaction of an official will produce harm that cannot be adequately compensated for after the fact, the judge can issue a writ of mandamus directing the official to act or a writ of injunction directing the official to refrain from acting until a full hearing of the issue can be heard by the court.

adopted a much looser definition, as is demonstrated by the following definition of economic federal government by Oates:

A public sector with both centralized and decentralized levels of decision-making in which choices made at each level concerning the provision of public services are determined largely by the demands for these services by the residents of (and perhaps others who carry on activities in) the respective jurisdiction (Oates, 1972: 17).

Oates goes on to note that, under this definition, the term "federal" refers equally to systems in which local decisions are based on delegated authority and to systems with constitutionally guaranteed authority.

Among the questions that must be addressed under any such polycentric or multi-tiered system is the assignment of functions to an appropriate level within the system. The traditional public finance approach assigns governments responsibility for three principal functions: allocation, distribution, and stabilization (Musgrave, 1959). The last of these functions involves designing strategies for achieving the macro policy goals of economic growth, employment, and price stability. It is quite natural that these goals be pursued by the highest level of government because usually only this level has control over the monetary, trade, and debt policies that must be consistent with fiscal policies in order to achieve stable economic growth.⁴

Distributional goals, particularly at the level of individuals or households, are also usually considered the appropriate domain of national governments, although there is little doubt that the public spending and taxation decisions of smaller units of government affect income distribution. The principal point here is that any attempt by local governments to elicit a major alteration in the distribution of income and wealth will likely be doomed to failure if interjurisdictional mobility can occur. Local jurisdictions that attempt to "soak" the wealthy and redistribute this money to the poor are likely to find that the wealthy will flee the locality, while greater numbers of poor individuals will migrate into the area.⁵

The strongest argument in favor of polycentric provision of services is that it increases allocative efficiency. In its simplest form, the argument rests on the expectation that although the demand for public services differs among individuals, there is likely to be a greater homogeneity of demand within small groups than over broad segments of society. The argument also presumes that if the central level of government were to provide these services, it would attempt to provide exactly the same levels of services to all areas, regardless of local demand.⁶ A countrywide, uniform set of services, however, is likely to result in spending that is suboptimal in some areas and excessive in others. If each locality is allowed to choose (and pay for) the level of services deemed most appropriate locally, the overall level of satisfaction in the economy can be enhanced. Hence, a polycentric decision-making process can more ef-

⁴ There is a vast amount of literature that has considered the pro- or counter-stabilizing effects of subnational governments; however, this subject is well beyond our scope of interest here.

⁵ Again, there is a substantial literature, referred to as tax and expenditure "incidence" research, that considers the redistributive effects of local fiscal actions (Bish, 1971). It is important because general local revenue instruments can impose differential burdens on persons with different incomes and wealth; likewise, expenditures may affect different segments of a local society quite differently and, therefore, will have differential distributional effects. Nevertheless, redistribution as a broad policy goal is not generally viewed as an appropriate local government activity. For an argument to the contrary see Pauly (1973) who argues that some local redistributive efforts are reasonable in the same way as is the provision of local public services.

⁶ In fact, it is quite unlikely that uniform service levels would result from central government provision of services. There is substantial evidence from the U.S. that within large local governments there is considerable variation in service levels across subareas within the same jurisdiction. In the area of education, for example, studies have shown that the quality of education is better in higher income areas of central cities than in poorer neighborhoods (Sexton, 1961; Mandel, 1975; Owen, 1972; Berk and Hartman, 1971; Katzman, 1978). Police have been unable to keep crime rates approximately equal across different neighborhoods, nor do they allocate services equally across neighborhoods (Weicher, 1971; Mladenka and Hill, 1978; E. Ostrom, 1983a). In general, studies of delivery patterns within jurisdictions have found a wide variety of patterns from those favoring the rich to those favoring the poor, including many that cannot be judged as favoring either rich or poor (Boyle and Jacobs, 1982; Levy, et al., 1974; Lineberry, 1977).

fectively determine the local demand for these goods and services than can a highly centralized bureaucracy.

Theoretical work in this area, including that by Bish (1971) and Barzel (1969), has been summarized by Oates (1972) in the following statement of a theorem:

For a public good—the consumption of which is defined over geographical subsets of the total population, and for which the costs of providing each level of output of the good in each jurisdiction are the same for the central or the respective local government—it will always be more efficient (or at least as efficient) for local governments to provide the Pareto-efficient levels of output for their respective jurisdictions than for the central government to provide any specified and uniform level of output across all jurisdictions.

The same arguments lead to the theoretical conclusion that different districts, probably of different sizes, should be established for each of the n any types of services provided by the public sector. That is, rather than have a single local government provide fire protection, street services, recreation, and education, separate fire, street, recreation, and education districts should be established to provide each service. The boundaries of each district should be drawn so as to minimize the variability of demands within the district and increase the variability of demands across districts.

Another advantage of separate provision organizations is that officials of each organization would be able to focus their attention on arranging for and monitoring maintenance and use activities for that organization alone. When officials are responsible primarily for one rather than many infrastructure facilities, they may be far more tenacious in protecting the past investments of their organization. When responsibility for the provision and maintenance of many different goods and services is assigned to a single set of officials, the temptation to increase the flow of immediate services to clients by deferring future maintenance activities may be difficult to resist.

The number of single-purpose (or even multi-purpose) local governments that can be created within a

particular area is limited by transaction costs. Allocative efficiency requires a flow of information about preferences between citizens and local government decision makers. The efforts citizens must make to select, monitor, and communicate with decision makers is not, however, costless. Indeed, ensuring high quality information flows can be extremely costly. Hence, there is a tradeoff between the economic efficiency achieved by many small, single-purpose districts and the technical efficiency of larger, multi-purpose jurisdictions. As stated by Bish (1971: 53):

While every aggregation will reduce an individual's ability to articulate his own particular preference on each of the issues involved, combining some functions in the same unit should result in sufficient savings in decision-making costs to more than offset the loss of precise demand stipulation.

While the price system and competition allow private markets to yield efficient allocations of private goods, the mechanism(s) by which polycentric governments can produce efficient allocations is more complex. In Tiebout's (1956) pioneering work in this area, mobility was the mechanism that most closely matched individual preferences and public service outcomes. Essentially, the Tiebout model relies on different localities that provide many different taxing and spending packages. Then, if mobility is costless and if perfect information is available, persons and firms will move to a locality in which their preferences are best served, in the same way that consumers will spend their incomes on different goods and services depending on their willingness and ability to do so. The basic Tiebout model was extended by V. Ostrom, Tiebout, and Warren (1961) to add the possibility of separating provision from production and allowing provision units to contract for production with their own or private production enterprises. Allowing for some competition on the production side enhances the potential efficacy of "exit" as a strategy available to citizens (V. Ostrom and E. Ostrom, 1978). There are, of course, some major limitations to the Tiebout model. Just as information is costly, so is mobility. Most property owners who wish to move from one jurisdiction to another must first find someone to buy their property (and replace them as taxpayers in this jurisdiction) before they can afford to leave. Furthermore, the production of some services by one district

provides benefits that spill over onto those residing in neighboring districts. For example, a sewer treatment system is likely to affect persons and firms outside the service district itself, particularly those downstream. If each locality is permitted to choose independently (and is forced to pay for) the level of sewage treatment services it considers optimal, downstream communities are likely to find themselves flooded with poorly treated wastewater. From the perspective of the entire population, the aggregate level of sewage treatment services will be suboptimal.⁷

Finally, while mobility may help to bring about an efficient outcome, it may also have a detrimental effect. As additional persons enter a jurisdiction to take advantage of the services being provided, the additional costs of providing these services may increase and must be borne by those already located there. That is, if additional persons enter to take advantage of a good school system, costs per pupil may rise as additional classroom space, number of teachers, and other education inputs must be purchased. Such congestion costs may exceed the efficiency gains from the polycentric decision-making process, resulting in a net decline in welfare.⁸ The conceptual solution to the problem is to charge new immigrants the full marginal costs of the services they are enjoying; however, estimating such costs and devising a workable system to capture these costs is not trivial.

How Can a Developing Country Afford Many Local Governments?

From the vantage point of persons familiar with the existing current accounts of highly centralized political systems already facing severe shortages of funds, proposals that would recognize communities of interest as local governments can appear to be a recipe for public bankruptcy. Such a suggestion is particularly frightening if one assumes that persons serving in local government might claim roughly similar salaries

and benefits as well as similar working conditions. The creation of large numbers of local governments would, in fact, require an increase in the numbers of elected officials, but the financial implications of this are less disturbing if the issue of funding local government is approached using different assumptions.

First, changes in the constitution or statute law that would enable communities to form both special and multi-purpose governments need not require that all of them do so. It should make it possible for villages to continue to contract with larger district or provincial jurisdictions for services for which economies of scale exist.

But if funds for salaries for local government officials are to be made available, why would any village choose *not* to form its own multi-purpose government and pay those officials the wages paid by other local governments? To fail to do so would be to deny local people the income from those salaries as well as the added benefits of well-tailored public services. Undoubtedly, the numbers of communities that decide they want a local government would multiply beyond all reason unless it was accepted that the salaries and working conditions of public service need not be the same for all those working in every jurisdiction, even jurisdictions with populations of the same size. The duties of small village jurisdictions would occupy officials only intermittently and could easily be undertaken on a part-time or a voluntary basis. These officials do not need elaborate office complexes in order to carry out their business effectively; elaborate offices are not only expensive but produce the wrong incentives in a developing country attempting to establish control over public officials. At present, for example, traditional headmen in Botswana carry on substantial amounts of dispute resolution and resource governance activities that are crucial to the survival of their communities with no offices nor any salary (see Odell, 1985). Similar circumstances exist in many developing countries where

⁷ We recognize that alterations in the "rules" might result in an optimal outcome, even in the context of decentralized service provision; for example, rules that required sewer outlets from a community to be placed upstream from water inlets would force each community to internalize the externalities associated with suboptimally treated sewage.

⁸ This concept has been analyzed under the general heading of the previously cited Theory of Clubs, in which a small group may find it advantageous to add members so as to decrease each member's share of total costs but, after some point, may wish to limit membership if the congestion costs associated with new members outweigh the benefits of spreading the fixed costs of running the club over a larger number of members (see Buchanan, 1965).

local leaders, some of whom have hereditary leadership status, have little or no formal legal authority.

If communities are to reach responsible conclusions about the establishment of local governments, deliberations about how many governments should be created and how much will be spent on these governments must take place in light of a budget constraint. The principles guiding the calculation of this budget assume considerable significance. Revenue transfers can be used to redistribute tax revenues collected by a central government, but this source of revenue must be considered secondary to the financial support a community provides for the creation of the services it enjoys. In such a context, citizens can decide how many officials they need and how much they want to pay them, understanding that money spent on administrative salaries leaves less to be used for other inputs into facilities.

What About Equity?

Polycentric systems have been dismissed by some analysts because high levels of local autonomy over taxing and spending are assumed to produce high levels of inequality due to regional differences in income or resource base. Differences in taxable income are assumed to result in inequalities in access to tax-supported public goods and services.

Such resource-based differences may, in fact, produce no differences in levels of services produced in two jurisdictions if the productivity of the poorer jurisdiction is much higher than that of the wealthier jurisdiction or if its residents choose to tax themselves more heavily. As was mentioned in the last chapter, empirical studies in developing countries have consistently shown that the wealthier portions of the populations tend to profit disproportionately from subsidized government services. One careful study of access to urban services shows that highly centralized governments are associated with considerable inequality of access to public services between civil servants and ordinary citizens (Cohen, 1974).

In general, equity problems in federal systems have been approached in two ways (ACIR, 1987: 13). One has been to manipulate the boundaries of local

government units so as to include a heterogeneous population. Thus, tax contributions of varying amounts can be pooled and redistributed within the unit itself.⁹ A second approach has been to rely on overlapping units to pool revenue on a larger scale and redistribute resources to units considered to be disadvantaged according to some set of criteria. Any effort to redistribute resources represents a departure from the criterion of fiscal equivalence. Arranging boundaries so as to encompass a deliberately heterogeneous community is inconsistent with fiscal equivalence and, if imposed, may kill any inclination among residents to cooperate. "Getting what you pay for and paying for what you get" is also a principle of equity, albeit not redistributive equity. The alternative approach, relying on redistribution by overlapping jurisdictions, attempts to combine the principle of fiscal equivalence, as a first-order criterion of organization, with redistributive equity as a second-order criterion. Redistribution is undertaken only when the first-order criterion generates patterns of performance that lie outside acceptable limits of resource distribution. The simple adoption of a non-central institutional arrangement does not guarantee that the different jurisdictions will always be able to reach a mutually agreeable settlement about distribution (see Hinchliffe, 1980).

Public-Private Industry Structure

Although development projects are often organized around the production of one type of facility, such as roads, village water systems, health clinics, or schools, little consideration has been given to the nature of these facilities other than the fact that they are usually public facilities. Such facilities are characterized by considerable difficulty in excluding consumers once the facility is provided, thereby requiring some form of collective organization for their provision. As we argue in Chapter 5, most of the goods and services provided by public authorities are frequently assumed to be analytically similar in kind and characterized by substantial economies of scale. Large-scale governments, thus, were presumed to be the most efficient type of institution to provide them. Central control of funding for public service provision

⁹ Although, as noted above, even in the U.S. the redistributions may not benefit the poor.

was and, to some extent still is, assumed to make it much easier to distribute services equally across the population of a country.

An alternative way of looking at the provision of public goods and services stresses the variety of different kinds of goods provided by government. In their efforts to evaluate how different patterns of interorganizational arrangements affect performance, economists have long used the concept of an industry to refer to a "group of sellers of close-substitute outputs who supply a common group of consumers" (Bain, 1959). It is assumed that the structure of an industry will vary considerably for different types of private goods and services and that given attributes of goods combined with the structure of an industry will affect how well industry participants perform.

The term "industry" is also useful for conceptualizing public sector organization in which many separate enterprises develop interdependent patterns of behavior. Some organizations in a public service industry perform provision activities while others are production agencies. We can think of the public sector as comprising many public service industries, such as the roads, education, police, and water industries. The governmental component in some industries, such as national defense or police, is proportionately larger than in other industries. The boundary of a public service industry includes those enterprises that participate in the production or provision of a related set of goods or services that share similar technologies and production methods and are jointly consumed by a defined set of individuals.

When visualizing patterns of relationships that apply to the organization of governments, scholars frequently use a pyramid. The apex of the pyramid is occupied by some center of authority that exercises sovereign prerogative and has the last say in making governmental decisions. In visualizing the interorganizational structure of public service industries, however, a matrix is a more appropriate representation.¹⁰ Collective consumption units can be arrayed as the columns in a matrix and producers as the rows. The specific type of arrangements for a par-

ticular service between providers and producers, such as a contract between a highway department and a private road construction firm, can be entered in the cells of the matrix. Once the organizational elements are arrayed in this manner, it is possible to develop a quantitative measure of the structure that can be used in predicting the incentives that industry participants will face and the likely behavior of those participants. For a rigorous comparison of the performance of public service industries that are organized differently, measures must be developed to quantify such attributes as the numbers of different providers and producers involved or the proportion of total provision or production carried out by any one firm or governmental unit in the different structures.

Privatization as a Form of Decentralization

Like the term "decentralization," "privatization" has been used to refer to different institutional arrangements for the provision and production of public goods. The generality of the concept is made clear in the following definition: "Privatization is the act of reducing the role of government, or increasing the role of the private sector, in an activity or in the ownership of assets" (Savas, 1987: 3). The term has been used to refer to such arrangements as those in which:

- Public funds are used to pay part or all of the costs for goods produced and delivered by a private firm or a nonprofit organization—known as contracting out;
- Private firms produce and sell services formerly provided or produced by public authorities (see Roth, 1987);
- Public funds are used to pay for goods or services provided for a public authority by a private firm—another form of contracting out;
- Public corporations are created to produce such goods as electric power, which are paid for by consumers (sometimes at rates that are subsidized by public monies); and

¹⁰ See E. Ostrom, Parks, and Whitaker (1974, 1978) for examples of how matrices are used to measure the structure of polycentric interorganizational structures.

- Publicly supervised cooperatives or other groups are authorized to produce a service that is paid for by consumers (sometimes at rates that are subsidized by public monies).

As Savas (1987: 58-59) points out, using this term to refer to such an array of institutional forms is misleading (and has, therefore, generated considerable misunderstanding) because, in most cases of privatization, public authorities continue to play an important role of some kind. In those cases in which public authorities pay in full or in part for the production of a good, collective action on the part of legislative and executive authorities is necessary to: (1) decide which goods are to be paid for from the public treasury; (2) decide how much of the budget is to be devoted to the production costs of a given good; (3) decide how the money is to be raised; and (4) decide what criteria are to be applied to the production of the good. In addition, public officials must be available to oversee the contracting process, monitor the production process and audit the expenditure of public funds, and evaluate the final product to determine whether the contract terms have been fulfilled.

The principal reason for contracting out the actual production of public goods is to increase the efficiency with which goods are produced. Contracting mechanisms provide a means of capturing the advantages of market competition in the production of public goods. Contracts are awarded on the basis of bids as well as on some estimation of dependability. Private firms operating in a competitive market situation are assumed to have a greater incentive to keep costs low than does a public bureau that has a monopoly on the rights to produce particular services.

Public Concessions as a Buttress for Centralization

There is no necessary connection between privatization and the distribution of authority in a polity; it is possible for either highly centralized or noncentral political systems to carry out extensive privatization. Privatization can also be carried out by either democratic or authoritarian regimes.

Various types of privatization such as contracting out, however, can be expected to produce quite different outcomes depending on the nature of the political system in which they occur. Contracting out in a

highly centralized polity probably will not increase the efficiency of the production of public goods. This is because in a highly centralized political system, the executive authorities who award contracts and monitor performance are difficult to control. Competition between prospective contractors therefore will likely be minimal. Government contracts become lucrative awards to cronies whose production efficiency is likely to be as low or lower than that of a public producer. Similarly, the ownership of natural resources by the government provides political leaders with lucrative concessions to award to foreign or domestic firms. Awardees, in turn, can be expected to support the tenure of the leadership at the apex of authority.

Monopolies versus Competitive Markets

The concentration of political and economic authority that characterized the traditional political institutions of many developing countries has been preserved or increased since colonial control ended. This means that many ideologically capitalist economies maintain no competitive markets (De Soto, 1989), and few of these capitalist economies support a dependable capital market or a stable currency. The extensive control of central government authorities over access to import licenses and foreign currency ensures that only the politically well-connected are able to get the materials necessary to maintain a productive enterprise of any complexity.

In such an environment, privatization efforts that involve the sale of public corporations frequently result in neither a wider distribution of control over valuable assets nor an increase in productive efficiency. Sales of large firms often end up transferring the ownership of public firms into the hands of persons who hold political office or who are closely connected to persons who do. This occurs because, in the absence of a dependable capital market, only the wealthy and well-connected can afford to purchase such enterprises. Political authority can be used to protect the new private enterprise from competitive pressures.

High concentrations of executive authority also often mean that the judiciary has little independence. In such circumstances, the security of the rights of less well-connected persons in property is uncertain. In the absence of a stable currency, a capital market, and an

independent judiciary, competitive markets are untenable.

Privatization Is Not a Panacea

The point of this argument is to warn against wholesale efforts to privatize the production of publicly provided services in developing countries without first considering overall consequences. We are skeptical of *any* institutional option that is accepted as a panacea for a wide variety of problems.¹¹ While additional research is needed, a combination of polycentric provision and privatized production may prove to be an efficient approach in many developing countries. With polycentric provision, there are multiple consumers of services rather than a single, centralized agency with monopsonistic power that can quite easily be abused. Privatization of production can, in at least some instances, provide for competition which, again, will foster increased production efficiency. Understanding the options available for the organization of production, however, should be conducted systematically within the special environment of a developing country.

Conclusion

Consistent with the work of other scholars interested in development, we see indigenous institutions as an important source of social capital for the development of effective noncentral (or polycentric), public-private, institutional arrangements for infrastructure sustenance. Indigenous institutions represent a community's social "know-how" about how to get things accomplished that involve collective benefits. In many developing countries, the successful effort to eliminate this social capital has created a substantial lacuna in effective organization. Where indigenous institutions are still operating effectively to construct, operate, and maintain rural infrastructure, it is important to study the *design principles* that create a structure of incentives leading to infrastructure sustenance, because this information is transferable to assist other populations with similar infrastructure concerns. Earlier efforts to devise an optimal blueprint for the specific rules organizing public sector activities have produced little knowledge that is transferable.

We have introduced polycentric, or noncentral, organization as a distinctly different way of distributing decision-making authority. Although we do not want to say that hierarchical principles have no place in organizing any public sector activities, noncentral principles have much to contribute to the provision and production of sustainable facilities. This assertion is reinforced by documented evidence of noncentral principles in some of the more effectively governed irrigation systems, such as the *zanjeras*.

We have also examined some of the more common reservations about the applicability of noncentral institutional arrangements for developing countries. This discussion emphasized the crucial role an independent court system plays in maintaining both the coherence of law and a rule of law in a noncentral polity. Together, the rule of a hierarchy of law and a hierarchy of courts selected by independent jurisdictions can resolve contradictory law in the absence of a single, ultimate center of law-making authority. Courts are also the key to ensuring that a general law can be maintained throughout a country, even though law enforcers are not subject to the administrative control of a central authority.

Although further training will be needed to improve systems of public administration, training in the absence of improved incentives for administrators is not likely to yield increased productivity. Current administrative organization also fails to take full advantage of the manpower resources that currently exist in developing countries.

Polycentric organization is often criticized for fostering both inefficiency and inequity. Our discussion has highlighted the allocative efficiencies associated with a primary reliance on the rule of fiscal equivalence, a rule that does not exclude the possibility of redistributing revenues if a polity finds the outcomes of a strict adherence to fiscal equivalence unacceptable. A primary reliance on the principle of fiscal equivalence also guards against the creation of unnecessary governments in a polity in which groups are authorized to form governments in order to carry out joint projects.

¹¹ Skepticism concerning decentralization as a panacea is also strongly articulated by Gow and Van Sant (1985: 109).

A view of the development and maintenance of public facilities that is not narrowly confined to the public sector has led us to examine public-private industry structures as one form of polycentric organization. The privatization of the production of public facilities, in which genuine competition is maintained among producers, can enhance efficiency substantially but should not be viewed as a panacea for all the ills of overcentralization. The independence of the adjudication services provided in any polity is critically important to the maintenance of competition among producers. In addition, public sector actors play a crucial role in funding, contracting, and monitoring function, even when production is organized privately. How well these functions are carried out strongly influences the sustainability of the public facilities produced.

Institutional Incentives and Policy Implications

IN THIS volume we have examined one of the most puzzling questions facing public officials, citizens, donors, and scholars working to improve the economic and social well-being of individuals living in developing countries: the problem of sustaining rural infrastructure.¹ Providing sustainable infrastructure is a key step toward achieving higher levels of economic development. Rural infrastructure facilities, such as roads, water systems, community buildings, and irrigation systems, when designed, financed, constructed, operated, maintained, and used in a sustainable manner, enhance the productivity and incomes of rural agricultural workers. And, as we briefly summarized in Chapter 1, increases in farm production and incomes may generate further multiplier effects that lead to higher incomes for other nonfarm, rural workers.

Investments in rural infrastructure, however, entail allocating resources that could otherwise be spent on immediate consumption goods, such as food, medicine, and clothing, or on other capital investments, such as construction of urban housing or manufacturing establishments. In resource-poor countries, the waste of resources that occurs when investments in infrastructure projects are not sustained is particularly tragic. During the past several decades, massive expenditures have been allocated to

construct rural infrastructure projects throughout the developing world. These investments have frequently enhanced productivity, but as we have documented, many have not proved to be sustainable. This dissipation of needed capital has agitated donors, host governments, development scholars, and the intended beneficiaries of these investments. In recent years, donors have begun to require that host governments commit themselves in advance to bear the recurrent costs associated with donor-assisted infrastructure projects. However, these paper requirements have not proved to be effective instruments for improving the likelihood of infrastructure sustenance.

The Central Question Addressed in this Volume

Multiple causes, which are deeper than a simple disregard for the formal maintenance requirements in international aid contracts, are responsible for failing to invest in the recurrent costs associated with sustainable infrastructure. The challenge presented to the authors of this report was to answer the question: How can the likelihood of maintaining rural infrastructure facilities be increased in developing countries so that these facilities are sustained over time rather than allowed to deteriorate long before their expected useful lives are completed? Given the

¹ It is also a problem facing public officials and citizens living in developed countries. We were asked to examine this question in the developing world and thus have focused our attention there, but we are well aware that the problem is not restricted to the developing world.

multiple factors that contribute to the lack of infrastructure maintenance, solving this problem is extraordinarily difficult.

In previous chapters, we have drawn on three traditions—the new institutional economics, institutional analysis, and public finance economics—to analyze successful and unsuccessful efforts to sustain different types of rural infrastructure facilities. In this last chapter, we draw the threads of our analyses together. Although we do not present a specific blueprint for action—in fact, we argue that such a blueprint is bound to fail—we do discuss specific policy implications derived from our analysis. We turn first to a brief synopsis of this mode of analysis.

The Proposed Analytical Approach

The diverse characteristics of the different types of rural infrastructure, in addition to the significance of the compatibility of infrastructure facilities and the specific natural and social contexts in which they are built, make it impossible to suggest any one particular strategy in support of infrastructure sustenance. However, we can recommend a more general approach to the problem:

- Examine the particular incentives of participants—donors, higher civil servants, lower-level officials, users, contractors, and elected officials—to ascertain why particular types of infrastructure, once constructed, are allowed to deteriorate so fast.
- Identify the sources of the perverse incentives leading to massive investments in the construction of infrastructure facilities and paltry investments in their maintenance.
- In light of this analysis, experiment with changes in various aspects of institutional structure related to rural infrastructure.

However, public officials and legislators should not expect formal legal changes to make much difference in long-term sustenance unless most major actors understand and support the reasons for the changes and are willing to work within a new set of rules. Even so, no change will occur rapidly. Considerable adjustment will be needed as participants learn how to work with (and sometimes around) new ways

of structuring their relations with one another. Some institutional changes will relate directly to the infrastructure development process. Others will relate more generally to the governance of the public sector, including the role of a court system in enforcing contracts.

Such a general strategy produces no panacea. But it can eliminate the disappointment that inevitably occurs when the latest quick-fix does not produce noticeable results. Instead of applying a single policy reform, we recommend a mode of analysis to develop optimal solutions to the problem of infrastructure sustenance on a case-by-case basis.

In Chapter 1, we began with a simple proposition:

Individuals who are expected to invest resources (including their own time and labor) in the maintenance of rural infrastructure must perceive that the benefits they obtain exceed the costs of the resources they devote to maintenance.

In application, this means that lower-level public officials, who are expected to brave the mud and dust to carefully monitor the work of road contractors, will not exert much effort (or any effort at all) unless the rewards received, in terms of pay, status, and benefits from the road, are greater than the cost of shirking or not working at all (including any sanctions that can be imposed). Farmers served by a government-owned and -operated irrigation system cannot be expected to organize themselves to operate a rotation system and clean canals unless the benefits they receive from this activity (including more and predictable water) exceed their costs. Before lower-level public servants or the users themselves engage in the hard work associated with the operation and maintenance of most rural infrastructure facilities, net positive benefits must be expected. Contracts between donor agencies and host governments that do not eventually change the benefit-cost calculations of those who are expected to do the day-to-day work will have little effect on infrastructure sustenance.

However, the mere existence of aggregate benefits that exceed aggregate costs is not enough to elicit individual efforts at a sufficient level to obtain these aggregate benefits. This is particularly true when individuals may obtain some portion of the benefits

produced without much individual effort to obtain them. The free-rider problem is now well accepted as characterizing a large number of situations in which individuals can withhold contributions toward the production of joint benefits but cannot be excluded from enjoying the benefits once they are provided. However, if all potential beneficiaries follow the free-rider strategy, everyone receives fewer net benefits overall.

We are certainly not the first to notice the pervasiveness of free riding in the provision of infrastructure and other types of public or common-pool resource goods and services. Prior analyses have focused on free riding plus two additional challenges characteristic of infrastructure provision: (1) that lower costs may be achieved when projects are constructed by enterprises that can realize substantial economies of scale; and (2) that the design and construction of major infrastructure projects can be substantially improved if technical expertise is made available for these tasks. Consideration of all three of these problems is included in our analysis.

As we pointed out in Chapter 6, however, truncated analyses that focus exclusively on these three problems frequently have been used to support policy recommendations to "strengthen" institutions in developing countries. Strengthening institutions is frequently interpreted as training civil servants in technical and managerial skills and helping to increase the power of the central government in relation to

competing interests. The intended consequences of such policy reforms include enhanced design and construction technologies, improved agency budgeting and managerial skills, and firmer commitments to fund the recurrent costs of operation and maintenance.² One of the practical effects of such policies is to help increase the power of central governments in relation to competing interests without much impact on the sustainability of rural infrastructure.³ The recognition of the perversities of relying exclusively on strong, central governments has generated recommendations for decentralization.

Reforms based on truncated analyses frequently produce counterproductive outcomes. Among these is the potential for rent seeking that occurs as soon as the free-rider problem is solved through coerced financial contributions to a common, public treasury. Once taxes are imposed, they become a fixed cost for everyone, except those who are willing to risk exposure and punishment for illegal tax avoidance strategies. Individual net benefits can be legally enhanced, however, by lobbying for special entitlements or other forms of disproportionate benefits supported by the common treasury. Wealthy and powerful individuals or groups are likely to have the necessary resources to influence the allocation of public funds that will allow them to obtain economic rents from large-scale infrastructure projects. Thus, highly concentrated benefits can be generated that far exceed the costs expended in rent-seeking activities. The resultant costs are spread across many individuals who are

² The U.S. Government Accounting Office, for example, made the following recommendations in an effort to solve the recurrent cost problem:

We believe AID should strengthen the project planning, loan agreement, and . . . certification process as a serious mechanism for establishing recipient country capability, willingness, and commitment to operation and maintenance. To do this AID, in conjunction with other donors, should work with recipient countries to:

- build necessary institutional capability through O&M projects (management, technical training, and equipment maintenance);*
- estimate annual life-of-system O&M costs, including personnel, training, and equipment requirements;*
- establish O&M funding sources with the ultimate objective of recipient countries, including system users, assuming all O&M costs; and*
- provide necessary monitoring and early warning of O&M shortfalls (GAO, 1983: 21-22).*

³ Obviously, investments in training civil servants in technical and managerial skills can be of long-term value in developing human capital. We do not object to training as a potentially worthwhile investment. Our concern is with the focus on strengthening the power of national institutions rather than strengthening the capabilities of national, regional, and local agencies as well as those of courts, inter-agency arrangements, and private associations.

less motivated, and usually less able, to prevent the disproportionate allocation of government funds and entitlements.

Elected officials and higher-level civil servants may also participate in these activities with or without conscious awareness of the consequences. Elected officials in all countries seek ways of obtaining benefits for their constituents that are likely to generate further electoral support. For national officials, getting the potholes fixed in a local road does not significantly increase their probabilities of being reelected. In contrast, getting potholes fixed or a water supply system repaired can be very important for locally elected officials. For civil servants, particularly those trained as engineers, construction of large-scale civil works is where professional status and promotions within the civil service are achieved. Extra-legal opportunities for income are sometimes also present. For these reasons, we urge that the principles of polycentric governance systems be seriously studied for their applicability in developing countries.⁴

The absence of institutional arrangements that facilitate and encourage beneficiaries of localized, rural infrastructure facilities to find ways of financing, constructing, operating, and maintaining their own facilities exacerbates the problem. If few legal instruments exist to enable individuals to make firm commitments to financing the construction and maintenance of a local infrastructure project, potential beneficiaries must seek national government support for facilities that have only local benefits. Furthermore, when everyone else in a country seeks national government support, beneficiaries are apt to feel that the national government should provide certain kinds of facilities even though their benefits are highly localized. If these types of infrastructure facilities have been provided by the national government elsewhere, local beneficiaries may argue, why not here?

Incentives to engage in rent seeking exist in all countries with large, public treasuries. These incentives are compounded in some developing countries by two factors: (1) the availability of large sums of donor assistance devoted to infrastructure development;⁵ and (2) the absence of local and regional, general-purpose or special-purpose governments to whom beneficiaries can turn for expressing local preferences and aggregating resources related to infrastructure.

Another intermediate performance criterion that we have stressed is the availability of local time and place information to complement the technical information needed to design many infrastructure projects. Projects that are designed without extensive knowledge of physical and hydrological site characteristics and without serious discussions with current or potential infrastructure users about use-patterns and constraints rarely operate well once constructed. Maintaining such projects costs far more than maintaining projects that have been designed with an appropriate blend of technical or scientific knowledge with local time and place knowledge.

General Policy Implications of Our Approach

In Chapter 6 we presented several detailed analyses using 15 intermediate performance criteria for evaluating the production and provision of infrastructure facilities. These criteria focused on the transaction costs associated with coordinating actions of multiple actors in situations of less than perfect information where the actors can be expected to engage in strategic behavior. We strongly recommend that analyses of particular infrastructure issues in specific settings consider the full array of relevant characteristics of goods described in Chapter 5 and the full array of intermediate and overall performance criteria described in Chapter 6. However, by considering only

⁴ Elected officials rarely expect to be in office for as long as the expected life-of-system for most infrastructure facilities within their jurisdictions and will usually derive more personal benefits by constructing new facilities than maintaining old ones. Locally elected officials, however, frequently rely on the same infrastructure facilities as those they serve, can be voted out of office for indifference to maintenance and repair issues, and have to face their angry constituents on a daily basis.

⁵ These large sums are readily available as a result of perverse incentives in operation inside many donor agencies. These incentives are generated by performance evaluation criteria that reward officers in part on the basis of their ability to design projects that absorb large amounts of money. Donor agencies regard these criteria as necessary evils if they are to comply with legislative mandates to spend the large sums appropriated for foreign assistance.

six additional criteria along with the three criteria stressed in the truncated analyses discussed in Chapter 6 (scientific information, economies of scale, and free riding), we can suggest particular policies that donors and central governments might undertake to improve the sustainability of rural infrastructure. Specifically:

- To the already perceived need of gaining **scientific information**, we add a recognition of the importance of blending *time and place information in provision and production* with scientific information;
- To the already perceived benefits of gaining **economies of scale** in production, we add a recognition of the problems of controlling *shirking and corruption in production* and the role of monitoring and reward structures; and
- To the recognized potential for **free riding**, we add a recognition of the additional strategic behaviors of *rent seeking and corruption in provision*.

Given these additional transaction costs, when the design, construction, operation, and maintenance of infrastructure facilities are predominantly organized within a single, national government and largely financed by external funds, we can predict with some confidence the following results:

- overinvestment in poorly designed and poorly constructed large-scale infrastructure projects;
- underinvestment in the operation and maintenance of these projects;
- rapid deterioration of infrastructure; and
- excessive investment in repair and rehabilitation of previously constructed projects.

This is a rather grim picture, but it is also an aggregate of numerous working parts. Once the working parts are identified, the chances of change and improvement are enhanced considerably.

An understanding of this dynamic also helps explain why temporary deconcentration of authority from central bureaucratic offices to regional offices and the creation of user groups that lack sufficient autonomy are not likely to have a strong, long-term impact. It may be that some officials recognize that such deconcentration results in more effectively designed, constructed, and operated infrastructure. But such changes are also likely to create additional burdens for lower-level civil servants, to diminish their opportunities to enhance their incomes through corrupt practices, and to reduce the powers of most central bureaucrats. Thus, when a project is completed, few officials are likely to wish to retain these institutional changes.⁶ If the beneficiaries of the changes—primarily the users of the infrastructure facility—have little voice in the matter, such institutional changes have little chance of survival. This is even more likely when the user groups created and supported by national governments under these programs are frequently not given formal recognition and the right to mobilize their own resources. Consequently, they have difficulties even surviving once the source of their support has been withdrawn, let alone undertaking active opposition to a return to earlier practices.

The most successful decentralization projects, as we learned in Chapter 3, do have many positive (albeit sometimes short-lived) effects that are quite consistent with the theoretical argument developed here. Projects are better designed and constructed at lower costs when well-trained engineers must take the ideas and local knowledge of users into account. Projects are better maintained when users are able to mobilize high levels of resources to undertake operation and maintenance activities themselves. When the users themselves must pay the costs of constructing or rehabilitating a facility, they are highly motivated to keep original costs as low as possible and to monitor the activities of producers to avoid corrupt practices. Users are also highly motivated to devise formulae that fairly distribute the costs of paying for design and construction as well as operation and maintenance

⁶ Although not retaining these institutional changes may appear unfortunate in the immediate context, they may have provided an educational benefit for their participants that will prove of value in the long term. When future opportunities for institutional reform again arise, the lessons learned from previous experiments with institutional change may ultimately contribute to the creation of institutions that are both productive and enduring.

activities. Keeping an open set of books that everyone can inspect ensures that no one gets away with free riding and that public officials can be held accountable. Furthermore, mobilizing revenues in the form of labor and materials, rather than cash, makes it far more difficult to divert public resources to private ends.

Designing institutions that motivate all the actors involved in infrastructure development to keep transformation, coordination, and information costs down, while trying to counteract potential strategic behaviors, is a substantial challenge. The evolution of polycentric provision and production arrangements adapted to local history and circumstances is a long-term strategy well worth serious consideration. Enabling potential beneficiaries of infrastructure facilities and other types of public goods to organize themselves into special-purpose enterprises with circumscribed governmental authority at local and regional levels is essential to accomplish the needed resource mobilization without the immediate threat of massive rent seeking that is involved when large funds are clustered in national, general-purpose treasuries. Some level of autonomy is needed if citizens and officials are to treat these units of government as their own and to allocate the resources they mobilize with considerable care and thought.

If various-sized production enterprises are also established over time, smaller governments can choose among larger enterprises with diverse skills and expensive, specialized equipment to undertake aspects of infrastructure design and construction while deciding whether to retain full responsibility for operation and maintenance themselves. Devising appropriate rules for using facilities so as to reduce the rate of deterioration can also be accomplished more effectively by those who see the adverse consequences of some use-patterns firsthand.

Developing polycentric governance systems is not something that can or should be done from the outside. This is not to say that "outsiders" cannot function constructively as conduits for ideas that support this type of development. In this report, we recommend institutional reforms that are consistent with a polycentric system of governance, not as purveyors of a new quick fix but as analysts suggesting an alternative way of organizing the public sector that is fundamentally different from that used in the past to

organize so many governments in the developing world. Our confidence in the applicability of this approach derives from evidence of polycentricity productivity at work in developing countries. As "discovered" by De Soto (1989) in Peru, a vigorous, constructive, informal economy exists in many developing countries. Organizational principles similar to those involved in constructing polycentric systems are evident in dispute resolution mechanisms and other informal public institutions. Many indigenous institutions that have proved highly successful over time are also organized using polycentric principles. Because institutions are typically designed to cope with a particular array of circumstances, it is not always possible or advisable to preserve indigenous institutions unchanged over long periods of time. When circumstances or the nature of the task they must perform change, these institutions must also change. What is critically important about indigenous institutions that did or still do provide ways of effectively organizing difficult tasks are the underlying *principles* on which they were (or still are) organized.

For example, as we point out in Chapter 8, the Philippine *zanjeras* demonstrate a variety of mechanisms to cope with free riding, to assign obligations to members in proportion to the benefits they receive, and to measure benefits in a way that was considered valid by participants. As change occurs, such as with the construction of more permanent diversion works, some of the tasks people must perform will change. Rules created to avoid free riding in the maintenance of a brush dam must be adapted to prevent free riding in the maintenance of a concrete dam. Farmers who are familiar with how their institutions work now can use the underlying principles as a foundation for new institutional arrangements that reflect the new circumstances.

All too frequently, however, irrigation development projects that are intended to involve farmers instead create centrally designed "user group organizations" imposed by official organizers who travel from site to site. While the membership of the user group organizations and farmer organizations such as the *zanjeras* is the same (i.e., local farmers), the major difference between these groups is that the former are created and managed by central government officials whereas the latter are self-organized and self-governed. No explanation of institutional

arrangements that takes place in a user group organizational meeting lasting at most a few hours can convey the same depth of understanding of how to make an institution work that members of the *zanjeras* have derived from their own experience with rule forming and reforming over time.

External advisers can provide more effective assistance by learning how some of the better operating user groups have solved the problems that many face. The International Irrigation Management Institute (IIMI) in Nepal, for example, has held a number of meetings on irrigation practices and institutions. Some of these meetings present reports by scholars concerning the operation of different types of systems and what can be learned from these (see, for example, Pradhan and Yoder, 1989); some involve site visits by farmers to some of the more successfully managed local irrigation systems; and others are seminars at which farmers exchange information about how they cope with various types of problems. The more successful farmer organizations become the model for others to study, rather than some abstract, printed charter.

Because indigenous institutions in developing countries often evolved during an era in which most relationships were not monetized, many such institutions do not have mechanisms that are as effective at enhancing the financial accountability of local officials as they are in ensuring that individual farmers provide their fair share of labor contributions. Devising new rules concerning the appropriate use of funds is a challenge that the participants in many indigenous institutions face. External advisers can be helpful in providing information about options that others have tried and found helpful.

Although indigenous institutions may form the foundation for the evolution of a locally adapted polycentric system for infrastructure development and maintenance, the effective operation of such a system also relies on the effective operation of institutions in the wider political system. For example, no polycentric system can be very productive without monitoring, sanctioning, and conflict resolution

mechanisms that enable individuals to enter into enforceable agreements. Without assurance that others involved in an agreement will perform as agreed, many potentially beneficial ways of organizing infrastructure development must be foregone. In any long-term arrangement, conflicts arise. Without fair and low-cost conflict resolution mechanisms, unresolved disputes fester and increase the likelihood that individuals will refuse to join in maintenance activities.⁷ Thus, any effort to increase the diversity of provision and production units needs to pay careful attention to various ways of enhancing conflict resolution mechanisms—both at a local level and as among major providers and producers of infrastructure services.

Immediate Policy Implications of Our Approach

Are there no shorter-term strategies that national governments and donor agencies could adopt that would enhance the likelihood that infrastructure facilities, once constructed, would be maintained? While we offer some proposals that could be implemented immediately, we must do so in terms of general principles rather than specific designs. The application of these general principles must account for the specific attributes of (1) the infrastructure facility involved; (2) the individuals who are likely to be beneficiaries and their resources; and (3) the governance system within which a project is located.

In analyzing what could be done to improve the performance of infrastructure projects, we must first consider the type of joint use that is involved. As we discussed in Chapter 4, all infrastructure facilities are jointly used to some extent by a set of beneficiaries. Individuals directly consume the services (e.g., the transportation service or the water) generated by a facility rather than the facility itself, but they do so jointly. Gradually, individuals also wear out the facility itself. It is therefore important to identify the users of a facility, how large a set they comprise, how localized they are, and how homogeneous their preferences, use-patterns, assets, and general ways of life are. It is also important to examine how sub-

⁷ Water allocation disputes, for example, can undermine mutual trust and willingness to cooperate in the maintenance of an irrigation system.

tractable the flow of services is given the patterns of use that exist (see Chapter 4 for a more extended discussion of joint use).

Two types of rural infrastructural facilities need to be distinguished: (1) facilities that are used by an identifiable, localized group that obtains substantial, highly salient benefits from that facility; and (2) facilities that are used by a larger and more dispersed population, many members of which do not experience in the short-term a substantial, readily identifiable improvement in their lives from an improvement of those facilities. An example of the first type of facility is a small-scale irrigation system or a rural water supply system. An example of the second is the main trunk of a national highway system or some of its heavily travelled branches. Central government officials and donors can adopt more stringent project design principles in the first case than in the second.

Small-Scale Infrastructure Sustainance

Consider, as an example, the principles that could be used to design small-scale irrigation projects in a developing country. We advise donors and national governments interested in enhancing investments in sustainable, small-scale irrigation projects to invest in the financing and construction of infrastructure projects *only* when firm evidence exists that those who are supposed to benefit from a facility:

1. Are aware of the potential benefits they will receive.
2. Recognize that these benefits will not fully materialize unless facilities are maintained.
3. Have made a *firm commitment* to maintain the facility over time.
4. Have the organizational and financial capabilities to keep this commitment.
5. Do not expect to receive resources for rehabilitating the facility if they fail to maintain it.

This can be accomplished by investing in infrastructure projects that meet the following conditions:

1. The direct beneficiaries are willing to invest some of their own resources up-front.
2. The direct beneficiaries are willing to pay back a substantial portion of the capital costs (at low interest and over a long time, if necessary) and to undertake maintenance.
3. The direct beneficiaries are assured that they can:
 - participate in designing the project;
 - monitor the quality of the work performed;
 - examine the accounts that form the basis for their financial responsibilities;
 - protect established water rights; and
 - hold contractors accountable for inferior workmanship that is discovered after the system is in operation.
4. The granting agency is assured that:
 - farmers' commitments to repay costs will be enforced by appropriate legal action, if necessary.
 - farmers have an effective organization with demonstrated capabilities to mobilize resources, allocate benefits and duties, and resolve local conflicts.
5. All donors and the host government are firmly committed to the above principles and will not provide funds to bail out those beneficiaries who fail to perform their responsibilities.⁸

Individuals who are willing to make initial investments to obtain capital goods demonstrate that they expect to enjoy future benefits. Furthermore, the higher the proportion of the capital investment that

⁸ In light of the imperative that donor agency officers "move" money and the temptations of rent seeking for government officials, this is a particularly difficult commitment for donors and host governments to make. It may require the major donors to work together with the host government on a joint funding strategy. Both donors and host governments may want to provide funds in case of major disasters to help rebuild structures destroyed by earthquakes, floods, and avalanches. This is a form of "insurance" that does not destroy incentives to undertake routine maintenance unless the definition of an externally caused disaster is interpreted too broadly.

beneficiaries are willing to repay, the higher the likelihood that the beneficiaries are not rent seeking but rather are attempting to make economically feasible investments to enhance productivity. If an infrastructure facility is really going to increase the well-being of the supposed beneficiaries, they will have increased resources to devote to the repayment in the future. Furthermore, if they know that they have to repay capital costs, the beneficiaries are likely to insist (if they have the institutional autonomy to do so) that the project have a high likelihood of producing net benefits in the future. Under these conditions, donor or central government funds are thus enhancing projects that are considered to be of real value to the participants.

This means that direct beneficiaries or their representatives must be involved in the design and financial planning of an infrastructure producing highly localized benefits, and must have the right to say “no” to a project that they do not think is worthwhile. If they cannot say “no,” they cannot make a commitment that is considered binding because they can always assert that they were forced to agree. In addition, to make enforceable commitments, the beneficiaries need to be:

- organized in a legally recognized form prior to the creation of financial and construction arrangements. Beneficiaries can then participate in the design and financing of the project, as well as in the approval of a contract to eventually assume ownership of the facility and responsibility for its maintenance.
- confident that government officials are also making enforceable contracts—that beneficiaries can hold public officials accountable as well as being held accountable.
- assured that future conflicts over contract enforcement will be resolved fairly and that impartial conflict resolution arenas exist if needed.

The policy implications of our analysis in regard to small-scale infrastructure projects are relatively straightforward:

- Encourage the beneficiaries to organize themselves into provision units that can mobilize

resources to acquire ownership of small-scale infrastructure facilities over time and assume full responsibility for operation and maintenance; and

- Invest in general institutional facilities that enhance the capabilities of such provision units.

Some readers may respond that we are simply recommending privatization. Such an observation, however, does not capture the essence of our analysis. Strictly private provision involves individuals or family units interacting with firms to finance, design, construct, operate, and maintain a facility. In Chapter 6, we examined both simple and differentiated market arrangements involved in an investment in housing. These arrangements can appropriately be called private or market arrangements. However, if a simple or differentiated market is to function efficiently or fairly, there must be clearly demarcated property rights, fair and low-cost court systems, and effective police systems to enforce these rights. Therefore, *public* institutions play a crucial role in the operation of markets in what is called the private sector.

When groups of beneficiaries organize to provide a joint benefit by specifying mutual obligations for resource mobilization and for joint decision making, some type of governing authority must be created to ensure that mutual obligations are met. Such an authority is often created even in those cases in which the organization technically remains a private rather than a public organization. The *zanjeras* are an example of a provision unit that is legally recognized as a private corporation. If, however, we were to list the powers of the officers of the *zanjeras* to mobilize resources and sanction persons for noncompliance with rules, the list of powers would closely resemble the list of powers of many organizations, such as special districts in the U.S., that are formally recognized as public governmental units.

Large-Scale Infrastructure Sustenance

The task of enhancing investments in facilities such as roads, which yield benefits to a set of less easily identifiable beneficiaries scattered over a larger spatial area, is much more difficult. It is further complicated by the fact that the benefits generated by a road that are enjoyed by any one individual are often quite small relative to the benefits enjoyed by the set of all

road users. Even when the principal beneficiaries are local residents, the incremental benefit of decreased transportation costs for a single user may be sufficiently small to substantially weaken the incentives of individual users to contribute to road improvement efforts. Under these circumstances, it is difficult to rely on efforts by individual or small groups of consumers to maintain a road.

Our advice to donors and national governments facing such conditions remains similar to that given above: opportunities to assist in such investments should be foregone until firm evidence exists that the intended beneficiaries of the infrastructure facilities will contribute substantially toward the costs of developing and maintaining such investments. However, in this instance, it is much harder to specify a set of principles that should guide project design. There are several reasons for this.

When the beneficiaries of a road project form a large, relatively amorphous group, mobilizing and allocating resources so that free riding is forestalled is extremely difficult. The relatively small observable current benefits enjoyed by local residents as a result of maintenance efforts may make it difficult to rely on contributions of in-kind resources to finance maintenance. Instead, monetary resource mobilization instruments are likely to be necessary. But monetary instruments are commonly accompanied by considerably greater opportunities for rent-seeking activities and corruption. Furthermore, the services generated by rural roads are such that charges directly linking payment with benefits received are likely to be impossible to implement; instead, broader resource mobilization tools must be used. In such cases, the degree of accountability that can be exercised by beneficiaries over service provision is minimal.

This suggests that increasing the accountability of the actors involved in the provision and production of road services is a key to improved sustainability. In this regard, we concur fully with Harral and Faiz (1988:32) in their review of road deterioration in developing countries, when they concluded that:

Inadequate maintenance in developing countries has various causes, but only institutional failure can explain the extent of the inadequacy. At the heart of this failure is the absence

of public accountability. All activities to strengthen institutions, enhance incentives, and improve the internal workings of road agencies should be judged by their ability to increase accountability.

While we do not presume to have *the* solution to the accountability problem, we do believe that the approach to institutional analysis proposed in this volume is a powerful means of generating appropriate solutions. At the heart of any institutional reform must be a concern for increasing the competitiveness of both providers and producers and ensuring that commitments are credible.

First, with respect to the provision of such facilities as roads, provision units should be organized in ways that facilitate the communication of preferences between users and providers. Multiple provision units for different types of roads (e.g., localized units for minor collector roads primarily serving local residents, larger units for roads connecting market centers, and even larger units for regional highways) permit more efficient preference aggregation.

Again, decisions as to funding infrastructure investments should be contingent on up-front investments by users who are also required to repay at least some portion of the capital costs. But the requirement to repay loans implies, as well, that the provision units must have some general revenue-raising powers of their own. At the local level, such revenues can be mobilized by using local fees and taxes that reflect the benefits received from having passable roads, e.g., property-based levies or local marketing fees. Where roads are provided by regional or national authorities and predominantly serve motorized vehicles, indirect taxes associated with vehicle inputs such as petroleum and tires are more likely to be feasible. Where such taxes are already imposed by central governments, tax sharing based simply on use-level differences, such as vehicle miles based on accurate traffic counts, may be most appropriate. Again, specific mobilization techniques must be tailored to the particular situation.

Although the availability of revenues is necessary for local or regional road provision units to arrange for road services, their commitments must be credible as well. If local units soon learn that if they do not maintain the roads, deteriorated roads will be replaced

by additional grant/loan funds, maintenance is unlikely to result. This means that the national government must hold them to their commitments; at the same time, the national government must also be credible in its commitments to transfer revenues to local jurisdictions.

Finally, on the provision side it is necessary that those who are using and paying for an infrastructure facility, e.g., through indirect taxes on vehicle use-related activities, have the wherewithal to communicate their preferences to the providers and to hold the providers accountable for their decisions. This requires an open decision-making process at all levels, such that taxpayers realize that they are contributing resources that should be made available to road services and have some ability to influence decisions that affect the quality of those services. Interest groups such as bus and truck owners' associations and even groups of localities served by regional roads must therefore be given the opportunity to voice their preferences in allocation decisions. When multiple groups are allowed to participate in open arenas to determine outcomes and when multiple jurisdictions control decisions about their own revenues, the ability of any single group to seek out rents can be limited. Similarly, when public sector decision makers are forced to compete for their positions of leadership, the quantity and quality of services can be expected to rise as these decision makers respond in ways that will increase their likelihood of remaining in positions of power.

Competition and the ability to enter into credible commitments are also necessary for effective production of road construction and maintenance services. Again, production contracts are only likely to result in well-built facilities if producers can be held accountable both directly by provision units and as directly as possible by users. Although competition can be facilitated by multiple private producers, nothing should preclude public bodies or private voluntary organizations from also engaging in the competitive process. Thus, for example, one road provision jurisdiction may contract with another to produce particular road construction or maintenance services. Some provision jurisdictions may appropriately resemble a special-purpose jurisdiction, such as a bridge authority where capital is invested in a particular facility and tolls can be collected to repay

capital costs and finance recurrent costs. The key is that the process is competitive; the exact legal structure of all units that participate in the surface transportation industry is less important.

However, the preceding chapters (especially Chapter 4) also suggest that the competitive process will work efficiently only if contracts between providers and producers permit both parties equal access to independent dispute adjudication services. Contractors must be unequivocally informed that failure to carry out the promised work will result in penalties that will harm them both in the present and in the future (through decreased likelihood of winning subsequent contracts). However, public decision makers must also recognize that actions on their part that impede the ability of contractors to carry out the promised tasks effectively will also make them liable for some type of penalty or punishment, as determined by an independent judicial body.

Because the results of inadequate construction or maintenance may not show up for a long time, one institutional device that deserves greater attention is some form of independent insurer that derives small payments from all contractors or even from provision units. In the event of system failures that can be traced to contractor negligence, the insurance company would be held liable. Such an arrangement creates a third body that would find monitoring road service production in its own best interest, and that could act as an independent source of information in helping adjudicate contractual disputes. Thus, as we have emphasized throughout this volume, careful crafting of appropriate institutional arrangements that provide an opportunity for actors to ensure their own best interests can lead to results that serve the best interests of all.

Conclusion

Analysts agree that simple market arrangements, without any opportunity for public provision, will fail to provide adequate rural infrastructure. In addition, we conclude here that simple hierarchical arrangements, without local public provision, will also fail. The costs associated with market failure are different from the costs associated with bureaucratic failure, but the end result is much the same: inadequate infrastructure that dampens development.

We know from empirical observation that it is possible for individuals to craft complex institutional arrangements that are highly successful in counteracting perverse incentives in infrastructure provision and production. Successful institutional arrangements take into account specific provision and production problems in a particular economic, technological, and cultural setting. Rarely, however, can successful institutional arrangements be characterized simply as part of "the market" or "the state." Nor is there a single blueprint that can be used to construct successful institutions for maintaining all types of rural infrastructure in all settings. We can assert, however, that successful institutional arrangements are usually complex rather than simple, and polycentric rather than single-centered. But beyond that, the variety of complex, polycentric institutions that perform relatively well for some types of rural infrastructure have not been successfully fitted into a simple typology.

No single institutional arrangement, regardless of how complex or simple its operation is, can solve the

problem of infrastructure sustenance without incurring substantial costs. When we refer to institutional arrangements that counteract perverse incentives, we do not mean to suggest that perverse incentives are eliminated. Successful institutions for sustaining rural infrastructure will continue to face some combination of transformation, coordination, information, and strategic costs. Even in an idealized model of an institution that ignores transaction costs, some fault can be found with even relatively successful operating institutional arrangements because their operation will have been influenced by these costs. What is most relevant from an analytical and policy perspective is a realistic appraisal of the entire array of costs associated with alternative institutional arrangements. The preceding chapters have illustrated the nature and source of these costs and have shown how a consideration of them can guide analysts and policymakers in their quest for institutional reforms leading to improved sustainability of rural infrastructure in developing countries.

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ACRONYMS and ABBREVIATIONS

ACIR	Advisory Commission on Intergovernmental Relations
ADCC	Agricultural Development Coordinating Council
ADT	average daily traffic
ARD	Associates in Rural Development, Inc.
BRBDP	Bicol River Basin Development Program
CO	Community Organizer
DFM	Decentralization: Finance and Management [Project]
FAO	Food and Agriculture Organization
GAO	Government Accounting Office
ha	hectare
HMG	His Majesty's Government of Nepal
IA	Irrigation Association
IIMI	International Irrigation Management Institute
ILO	International Labor Organization
MOWS	Ministry of Works and Supply (Malawi)
MRMP	Magat River Multipurpose Project
NIA	National Irrigation Administration
O&M	operation and maintenance
PDAP	Provincial Development Assistance Program
PDS	provincial development staff
PRMPP	Palsiguan River Multi-Purpose Project
PSIP	Pikaler Sampean Irrigation Project
Rs	Sri Lankan rupees
UNDP	United Nations Development Program
USAID	United States Agency for International Development