

Is There a Shortfall in Public Capital Investment? An Overview

Anation can use its current output to provide for the future in numerous ways: it can undertake private capital investment, add to the stock of public capital, enhance income-producing assets abroad, invest in human capital through education and health programs, conserve natural resources and the environment, and invest in science and technology. During the 1980s none of these approaches were pursued vigorously and most of the country's increase in output went for consumption rather than the enhancement of future production; the adverse effects of debt-financed consumption on private investment, net foreign investment, and human capital have been well documented.

In the past few years, however, academic work, commission reports, and natural disasters have highlighted the fact that the nation has also been neglecting its stock of public capital. Stories abound of deteriorating roads, bridges, and sewer systems, which have often led to serious collapses or other disasters. Almost everyone has experienced the frustration and delay of congestion on overburdened roads and airports.

Political developments have also raised the importance of public capital investment on the national agenda. At the federal level, dissolution of Cold War tensions has spurred debate on the reallocation of spending from military to other uses, although this has been mitigated somewhat by recent developments in the Persian Gulf. The impending re-authorization of the federal highway bill also has sparked a great deal of interest. Fiscal problems at all levels of government have led policymakers and citizens to rethink spending priorities.

This conference aimed to determine the extent to which the United States may be underinvesting in public infrastructure, explain the potential economic consequences, and suggest mechanisms to help alleviate any adverse trends. The conference focused on public investment in physical capital only to make the topic manageable, and should

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not be interpreted to mean that investment in human capital is in any way less important.

The conference consists of six sessions: The first three sessions discuss various topics related to the importance of infrastructure, while the last three tackle some practical policy issues in this area. The first session addresses the broad question of why infrastructure is important by discussing the impact of public capital on quality of life, the environment, and output. The second introduces a new data set on state-level public and private capital stocks to examine the impact of public capital on output, invest-

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ment, and employment growth at the state level. The third session explores directly the question of whether public infrastructure is undersupplied.

In the second, policy-oriented set of papers, the first explores the extent to which the private sector can compensate for the lack of public investment. The next two papers focus on incentives. One addresses the issue of the efficiency of current infrastructure investment and pricing, specifically as related to highways and airports. The other analyzes the optimal financing of public infrastructure and investigates the incentives imbedded in existing federal programs for public capital investment.

All conference participants agreed that public capital investment plays an important role in enhancing both the quality of life and private economic activity. All concurred that public capital, like private capital, belongs in an economic production function, and that the decline in public capital investment may have played some role in the productivity downturn. A sharp disagreement arose over the estimated economic importance of public infrastructure. The great majority of participants rejected the estimates of the marginal productivity of public capital in the range of 50 percent to 60 percent that emerge from the time series analysis.

Despite the general acceptance of the economic and social importance of public capital investment,

two quite different perspectives on the need for more infrastructure investment emerge from the discussion. On one side are those who see a strong link between public capital investment and economic and social well-being; they view the current stock of public capital as inadequate and believe that additional investment is required. On the other side are those who are primarily concerned with the efficient use of existing infrastructure; they basically oppose increasing investment until the engineering, pricing, and financing of infrastructure are closer to the optimum.

Why Is Infrastructure Important?

David Aschauer sets the stage for subsequent discussion and much controversy by laying out the case for the importance of infrastructure to the quality of life, the environment, and private economic activity.

In the first part of his paper, Aschauer presents an informal discussion of the linkages between public capital investment and various aspects of well-being, such as the human habitat, economic opportunity, and leisure time. The major point of this section is that many observers question the ability of existing and projected infrastructure facilities to adequately support quality-of-life requirements; their apprehensions are most pronounced in the areas of the environment and transportation.

As evidence on the environmental front, Aschauer notes that, despite large-scale expenditure following the passage of the Clean Water Act in 1972, many streams and lakes in the United States remain incapable of supporting their designated commercial or recreational uses. The problem rests, in large part, with municipal wastewater treatment facilities, which account for about one-third of the use impairment of the waters. These treatment facilities also raise the toxicity levels of lakes and rivers. The Environmental Protection Agency (EPA) says that many municipalities have yet to construct sewage treatment facilities to meet permanent requirements.

A second area where inadequate infrastructure has an adverse impact on both health and aesthetics is the treatment of solid waste. Garbage is being generated at unprecedented rates, while the number of facilities to handle the waste is shrinking. Between 1978 and 1986, the number of operating landfills declined from 20,000 to 6,000. Forecasts predict that by 1993 more than 2,000 of the remaining landfills will be closed due to inadequate safety and environ-

mental practices or capacity constraints. These trends suggest increased health risks to residents and damage to the environment.

In the area of transportation, inadequate public transportation poses a serious barrier to employment for those without cars. Aschauer notes that disabled citizens cite a lack of transportation as the primary obstacle to obtaining jobs and being fully productive members of society. Moreover, in many cities job opportunities in the suburbs remain unfilled because of the lack of transportation from the urban core.

Increased congestion in the ground and air transportation networks both impairs people's leisure and raises business costs. The Federal Highway Administration forecasts a 436 percent increase in urban freeway congestion by the year 2005 if improvements to the interstate system are not forthcoming. Similarly, the Federal Aviation Administration forecasts a significant increase in the number of airports suffering serious delays during the next decade. In short, transportation is another area requiring additional investment, or else inadequate infrastructure likely will continue to detract from the quality of life.

In the second part of the paper, Aschauer shifts from quality-of-life issues to the impact of infrastructure on economic activity. He cites previous studies demonstrating the positive effect of public capital stock on output, both within this country and across countries. He further notes that public capital increases the rate of return to private capital, thus stimulating private investment; at the same time it substitutes for private investment, thus discouraging private initiatives.

Aschauer assembles these various forces into a simple model to simulate the effect of higher public investment on the aggregate economy. Specifically, he assumes that public investment during the period 1970 to 1988 remained near the average for 1953 to 1969, thereby eliminating most of the actual decline. The results suggest that the increased public investment would have raised the rate of return to private capital from 7.9 percent to 9.6 percent and the rate of productivity growth from 1.4 percent to 2.1 percent for the 1970-88 period. The impact on private investment is more complicated; initially higher public investment crowds out private investment, but eventually the higher rate of return dominates and simulated private investment exceeds actual levels. Aschauer emphasizes the tentative nature of these results and goes on to address criticisms that have been raised about his empirical work: that public investment is endogenous, that the estimated coeffi-

cient on public capital is too large to be reasonable, and that the model is too simple.

Aschauer then attempts to provide new evidence showing how public sector capital affects private sector productivity. This time he explores the relationship between private productivity and public capital investment across states, by including government capital as an intermediate input in a generalized Cobb-Douglas production function. To work around the lack of state capital stocks, Aschauer rewrites the production function so that the estimate of the relationship requires data on only the capital-output ratio, rather than the level of capital stocks. He then assumes, based on cross-country comparisons, that the capital-output ratio is constant over time. As a result, individual state capital-output ratios can be expressed as the ratio of investment to output times the rate of growth of output plus the depreciation rate, which Aschauer sets at 5 percent.

Aschauer estimates the production function using data averaged over the period from 1965 to 1983. His results show that state output per worker is positively and significantly related to public investment in core infrastructure, although the coefficient on the public investment variable (representing the marginal product) is extraordinarily high. More precisely, while the marginal product of private capital in his equations ranges between 9 and 12 percent, the

Aschauer's results suggest that increased public investment would raise the rate of return to private capital, the rate of productivity growth, and even the return to private investment.

marginal product of public capital exceeds 200 percent. Again, Aschauer addresses likely criticisms of this empirical exercise and attempts to demonstrate the robustness of his results by varying the assumed depreciation rate and using instrumental variables.

Aschauer concludes that given the importance of infrastructure, both for quality of life and economic competitiveness, and the dissolution of Cold War tensions, the time seems ripe for a reorientation of government spending priorities.

Henry Aaron, in commenting on Aschauer's work, notes that although Aschauer has made an important contribution to the productivity slowdown debate by including public capital as an explanatory factor, several serious questions surround his empirical work. Aaron cautions that if a result fits with our hopes and appears too good to be true, it probably is, and should be subjected to careful scrutiny.

Most fundamentally, Aaron rejects the estimates of the productivity of public capital in both Aschauer's earlier work and the paper presented at this conference. In the case of the earlier results, which show a productivity of public capital around 60 percent, Aaron attributes the implausible estimates to the pitfalls of time series analysis. Aggregate time series analysis based on variables expressed in levels is dominated by trend, and produces marvelous fits that do not really explain much of the relevant variance. Thus, unless the results are robust to estimation using other functional forms, the hypothesis should not be considered to have been proven. Another problem is that the production function model assumes competitive factor markets. Public capital, however, does not pass any market test in which productivity is balanced against a cost measure.

In terms of the current paper, Aaron attributes the startling results to an incredible list of assumptions required to estimate the model, and argues that more tests should have been run to assess the sensitivity of the results to other assumptions. He also raises another oft-cited criticism—reverse causation, whereby rapid output growth and high productivity lead to greater public investment, rather than public capital investment causing greater output per hour. While Aschauer attempts to treat this issue with instrumental variables, Aaron notes that he should have examined it through direct modeling and testing.

In a different vein, Aaron also questions much of the informal reasoning in Aschauer's argument about quality-of-life effects. He sees much of the advocacy for more infrastructure as a reflection of the vested interests of those agencies and organizations that gain from greater capital spending. Furthermore, while Aaron believes that government spending can improve the quality of life, this claim does nothing to support the thesis that infrastructure contributes to national output as conventionally measured.

Richard Musgrave also questions Aschauer's high estimated coefficient on public capital and wonders about reverse causality, but focuses his efforts on trying to identify the unique characteristics of infra-

structure and other issues. He concludes that infrastructure as an intermediate good is distinguished by its joint and cross-industry use, and then speculates whether these characteristics could lead to high productivity.

Musgrave also argues that much could be learned about the benefits of public capital through cost-benefit analysis. While this approach has its problems, it can, and should, be applied to estimate cost savings in production where public capital is an intermediate good. Musgrave also recommends that researchers attempt to quantify currently unrecorded pieces of GNP, such as quality of life indicators, and apply cost-benefit analysis to estimate the impact of infrastructure investment on these unrecorded aspects of national output.

Musgrave concludes with the thought that although it was appropriate to limit the conference to the subject of physical infrastructure, one must not forget that physical assets are only one part of the issue. Public investment in health and education is no less important and should be included in any more comprehensive analysis.

How Does Public Infrastructure Affect Regional Economic Performance?

Alicia Munnell's paper explores the impact of infrastructure investment on three measures of state-level economic performance. Since no comprehensive measures of public or private capital stocks are available at the state level, these data are constructed and used to estimate state production functions, to explore the relationship between public and private investment, and to analyze employment growth within a business location model.

The first step is to construct estimates of the public and private capital stocks by state. For public capital stocks, the perpetual inventory method is employed to generate an estimate of the net value of state and local government capital investments, which is then used to apportion Bureau of Economic Analysis (BEA) national stock estimates among the states. In the case of private capital, BEA stock estimates are distributed among states based on measures of each state's activity in various sectors of the economy. The observations show significant variation and appear to contain real information.

Munnell then introduces these stock estimates as inputs in a pooled cross-section production function based on data for 1970 to 1986. The results indicate

that public capital has a significant, positive impact on output at the state level. The regression coefficients also show rough equivalence between the marginal products of private and public capital; specifically, the coefficients imply a marginal productivity of 35 percent for both private and public capital. They also suggest slightly increasing returns to scale across the three inputs. When public capital was

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disaggregated, water and sewer systems had the largest impact on output, followed by highways, with other public capital exhibiting a very small impact.

The next section examines the relationship between public and private investment in which two opposing forces are at work. On one hand, public capital enhances the productivity of private capital, raising the rate of return and encouraging more private investment. On the other hand, public capital serves as a substitute for private capital. An attempt is made to combine these opposing influences in a stock-adjustment model, where the desired stock of private capital is related to the level of output, the stock of labor, and the stock of public capital, and also to the marginal productivity of private capital. The results, while not robust, indicate that, on balance, public capital investment stimulates private investment. Munnell notes that these results should be interpreted only as an additional bit of evidence supporting public capital's economic importance and as an invitation to future researchers.

Finally, a business location model that includes a measure of public capital stock is used to analyze employment growth. This type of model assumes that firms strive to maximize profits and will choose a location based on their profitability at alternative sites. Any characteristics of the location that affect production costs or sales will influence this decision.

The specification used by Munnell analyzes the average annual percent change in private employment in the state as a function of variables reflecting the labor market, energy costs, cost of land, market size, tax burden, and public capital stock. Munnell notes that the results are generally in line with what one would expect, with public capital having a positive influence on employment growth, all else equal.

Taken together, the results of these three exercises indicate that public capital has a positive impact on private sector output, investment, and employment. Some areas need significantly more research and refinement, but these results are another piece in the emerging picture of public capital's economic importance. Munnell concludes that more spending on public investment, which clearly would remedy serious safety hazards and improve the quality of life, may also induce greater productivity and growth.

In his comments, Charles Hulten, while finding the coefficient on public capital in the production function quite plausible, and substantially more so than the results of aggregate time series estimates, notes several problems. First, since the nation's infrastructure networks are largely complete, the estimated coefficient on public capital may overstate the benefits from *additional* public investment. Second, without resource costs one cannot discern whether the allocation of public capital is efficient. Third, only a state's own public capital stock enters into the production function, which ignores the benefits that a state may derive from the public capital stocks in neighboring jurisdictions. Fourth, the equations include no adjustment for congestion. Finally, the production function is only one equation within a simultaneous system, and thus the correlation between public capital and private output might come from other parts of the economic system, which brings up the perennial issue of the direction of causation.

Ann Friedlaender sketches out an alternative framework that could be used in this type of research, a framework that would address the problem of resource costs. She advocates estimating a cost rather than a production function. This model would incorporate input price effects into the analysis, as well as allowing analysis of the efficiency of capital allocation. While admitting that the data requirements of this approach are substantial, she offers reasonable guidelines for estimating certain data, such as the cost of private and public capital by state. Friedlaender also proposes that one could add demand effects into the analysis through the use of a benefit

function. She concludes that such an approach is feasible and could yield interesting results to supplement the existing evidence on the importance of infrastructure to regional output, investment, and employment.

Is Public Infrastructure Undersupplied?

George Peterson addresses directly the question of whether public infrastructure is undersupplied. He begins by tracing the historical pattern of infrastructure spending over a longer period than previous studies. While public capital spending has indeed declined from its peak in the 1960s, this decline is only one downturn in a longer history of cyclical behavior. Moreover, the fact that infrastructure investment has declined does not in itself indicate that it is undersupplied. Thus, more information is required to determine whether there is a shortfall in public capital.

As one piece of evidence, Peterson basically accepts the Aschauer argument that the marginal productivity of public capital is extremely high compared to private capital. This suggests an undersupply even if the infrastructure has no value in providing services directly to the consumer. Peterson then looks to the taxpayer-voter for further evidence that infrastructure may be undersupplied.

Peterson obtains a partial answer through voters' revealed preferences as expressed in bond elections and other referenda. The answer is partial because only 25 percent of infrastructure spending passes through this process. Nevertheless, if public officials were trying to satisfy the median voter, as theory suggests, they would submit frequent bond proposals for consideration in order to assess voter demand. As a result, bond elections should be closely contested with bond approval rates and margins close to 50 percent. Instead, he finds that 80 percent of infrastructure bond proposals were approved between 1984 and 1989, and that the margin of approval exceeded 66 percent on average. This experience suggests an undersupply. But why? What forces could frustrate the demands of both business, which can gain as much from public capital investment as from its own investment, and the electorate, which appears disposed to approve higher levels of public capital outlays?

Peterson suggests three possible explanations. The first emphasizes spillover effects. As long as some of the benefits from public capital investment

spill over to users outside the local taxing district, and these users do not contribute to the costs of the projects, local taxpayers, who consider only their own benefit-cost trade-off, will choose to provide a suboptimal level of infrastructure capital. This problem could be solved through a user fee system, where all users, regardless of where they live, pay a fee to cover the marginal costs they impose on the network. In those instances when user fees are impractical, an alternative solution is intergovernmental matching grants.

A more innovative explanation is Peterson's notion that the undersupply might be traced to the "fear of rejection" on the part of public officials. Since the taxpayer revolts of the 1970s and early 1980s, the very act of referendum voting—and the possibility it brings of public repudiation—appears to intimidate officials. Rather than designing proposals to satisfy the median voter, they aim at garnering as large a majority as possible in order to minimize the chance of rejection. As a result, public capital spending proposals are simply not brought to the attention of voters.

Peterson's third explanation suggests that the political process systematically underweights the benefits from infrastructure that accrue to businesses.

Peterson addresses directly the question of whether public infrastructure is undersupplied, examining voting patterns on capital investment referenda.

He contends that the principle of "one person, one vote" provides no mechanism for aggregating the interests of both business and taxpayers.

Peterson concludes that infrastructure undersupply is as much a problem of politics as of economics. He argues that traditional decision-making processes are badly designed to handle joint consumer and producer demand for public goods. He also rejects the trend toward creating authorities and other institutions that can invest in infrastructure without submitting to the referendum process. Rather, he advocates the formation of business and consumer

alliances that together take the case for infrastructure spending directly to the public.

Alan Blinder, while agreeing that infrastructure is undersupplied, and that the causes include public officials' fear of rejection and externalities, questions the argument that business needs are not well represented in the political process. Each of us is both a producer and a consumer, and there is no evidence that people vote only their consumer interests. Furthermore, in an age when business has successfully lobbied to further its interests on regulatory, anti-trust, and trade protection issues, why should one believe that it is completely mute on the infrastructure front?

Because of the growth in both the economy and population that has occurred during this century, Blinder considers it inappropriate to compare only the absolute levels of capital spending across time. He notes that Peterson's median voter model implicitly assumes that the number of bond referenda proposed derives from previous approval rates. That may be a "good" model, but it does not embody rational expectations. Furthermore, while Blinder agrees that user fees are an appropriate way to deal with externalities, he cautions that user fees may not do the job if a free rider problem exists within a jurisdiction.

Joel Tarr focuses on the cyclical nature of infrastructure spending in an attempt to place the current developments in a historical context. He explains that both public and private capital spending have exhibited irregular cycles of spending bursts followed by periods of retrenchment and stability. Further, spending has shifted over time among levels of government and between private and public providers.

State governments were especially active from the 1820s through the 1840s, but curtailed their activities after depressions. Cities then assumed the role of primary infrastructure provider during the 1860s and early 1870s, after states suffered from over-investment, high taxes, corruption, and subsequent borrowing limitations.

At this point, private provision again became important, especially in water supply, as many municipal governments experienced defaults on their obligations and were hampered by spending limitations imposed by state governments. By the 1890s, however, municipalities regained their position as primary provider, which they held until World War I; after the war the states resumed the dominant role with heavy involvement in transportation investment.

The federal government was not deeply involved

in providing capital investment until the 1930s. It dominated through World War II. Since then, federal financing of capital spending has exhibited the familiar cycles of boom and bust.

Tarr then discusses the common characteristics of previous infrastructure spending bursts. Concerns over deterioration of facilities and adequacy of services have generally not been sufficient to spur investment. Earlier periods of rapid investment were characterized by a variety of demand- and supply-side conditions: major urbanization; critical technological developments, such as the automobile, the airplane, or advances in bacterial science; and new funding mechanisms, such as the gas tax.

Tarr concludes that current social, political, fiscal, and technological forces are unlike any previous period of growth in infrastructure investment, and thus suggests that those interested in expanding investment should investigate a variety of flexible approaches to achieve this goal.

What Are the Prospects for Privatizing Infrastructure?

Jose Gomez-Ibanez, John Meyer, and David Luberoff explore one alternative by investigating the prospects for privatizing infrastructure investment. Specifically, they analyze whether the private sector can do a more effective job of investing in and pricing infrastructure services. They focus on highways and wastewater treatment facilities as two areas where private participation appears most promising.

They make clear at the beginning that they would expect privatization to have little impact on the total quantity of infrastructure. In fact, they contend that the nation would probably end up with more infrastructure under public provision than under private. Their argument is that private infrastructure investment is likely to displace some other capital project, since it is financed from a limited pool of private savings. Public provision, in contrast, has some possibility of increasing total investment to the extent that the project is funded by user charges or taxes that are paid from a reduction in current consumption rather than from saving.

Rather than altering the quantity of infrastructure, privatization affects the distribution of burden between users, taxpayers, and wage earners. The conventional argument in favor of privatization is that the private sector is inherently more efficient and thus could build and operate facilities at a lower cost

than the public sector. This argument has been augmented in recent years by the concern that the public sector may be unable to finance facilities because of taxpayer resistance.

The commonly cited cost advantages of privatization are not entirely clear, the authors argue. Some of the reduction in cost reflects transfers among groups rather than real savings for society as a whole. For example, landowners may be more likely to donate rights-of-way to private road projects, but this is merely a transfer from landowners to road builders and does not change the amount of land needed for the project or the resource costs to society as a whole. On the other hand, private firms do have some real cost advantages: they have a stronger incentive and more flexibility to use resources productively, they can often build facilities more quickly, and they may be better able to exploit economies of scale, scope, and experience.

Proponents of privatization bemoan provisions of the Tax Reform Act of 1986 that restrict the use of tax-exempt financing for private projects; they claim that the higher financial costs for private providers makes it difficult for them to compete fairly with the public sector. Gomez-Ibanez, Meyer, and Luberoff argue, however, that even without tax exemption the costs of private and public providers do not differ markedly, since private providers can deduct interest payments as a business expense.

Cost, however, is often neither the only, nor the most important factor in the decision whether a particular project should be provided privately or publicly. Siting is often a major problem for highways as well as solid waste disposal facilities. Private providers may have some advantages in siting by allaying concerns of local residents and forming alliances with them before the project falls under the public spotlight, while public agencies are generally required to conduct site searches openly from the start. The private sector may also be more skilled in public relations—better able to market the benefits and minimize the risks of a project. Private involvement, however, does not eliminate the pressures or opportunities for government oversight or public involvement in siting decisions, since private facilities still require zoning permits and environmental approvals. Moreover, the public may be concerned that private firms may not take their environmental and other community responsibilities seriously. Public agencies may have an advantage simply because they have more established institutions and procedures for dealing with these issues. On balance, the authors

do not find that the private sector offers any major advantages in siting.

Other important issues are those of pricing and rate regulation. User charges seem to be appropriate financing mechanisms for both solid waste disposal and highways. While the choice of provider need not

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dictate the type of financing, the question arises whether a private firm or a public agency is more likely to charge the appropriate or socially desirable price. An argument in favor of private firms is that they are more likely to price services at marginal cost and to adjust charges to reflect the costs imposed by different types of users. The most important disadvantage of a private provider is that it may be tempted to exploit any monopoly power it might enjoy. Some states have turned to regulation to mitigate this problem; this strategy, however, may be inefficient because it could stifle market signals to increase capacity. In other words, the regulatory process, while necessary, could undermine many of the advantages of private involvement in infrastructure provision.

The authors then try to make some overall assessments about the winners and losers from privatization, with the caveat that the incidence of gains and losses depends in large part on the individual project. Organized labor and landowners are the most likely losers in private provision, due to the private firm's greater incentives to capture economic rents. The clearest winners are federal and state taxpayers. Investors might gain if they can hold onto economic rents or efficiency gains rather than passing them on to facility users; the outcome will depend on the competitiveness of the market for the particular service. Thus, privatization is a more attractive policy

for the public where the potential efficiency gains are great and the private operator faces effective competition.

The discussants find little with which to disagree. Sir Alan Walters adds that another argument for private provision is reducing the power of unions, thereby not only lowering wages but also reforming what he views as deleterious work practices. He also points out that the authors focus only on new construction and do not consider privatization of existing assets; this is probably a sensible tack since the likelihood of privatizing the Interstate Highway System is minimal. Nevertheless, an analysis of the efficacy of a completely privatized road system would have been interesting.

Walters does question the authors' argument that while privately provided infrastructure is likely to displace other private investment, publicly provided infrastructure, if funded by user charges or tax revenues rather than debt, is likely to generate additional investment. Walters believes that while the form of finance will affect the timing of savings, total investment will remain unchanged.

Gail Fosler states that the authors provide a useful discussion of the advantages and limitations of privatization; this effort adds an important perspective to the work of those advocating privatization as the solution to America's infrastructure problem. She notes the fact, implicit in their selection of highways and solid waste disposal facilities as examples, that privatization of infrastructure investment and public services generally has not progressed very far.

This raises the question: If private provision of infrastructure is such a good idea, why is it not done more frequently in the United States? Fosler concludes that the incentives required for private participation are extremely high. History shows that infrastructure activities are provided privately only when they are very profitable, and that they are often profitable when they enjoy significant noncompetitive market advantages. As a result, the efficiency gains from private provision are limited.

Fosler also reaffirms the authors' point that siting is a critical issue, and speculates that even if funding were available for all infrastructure spending it would probably not all be spent because of the politics of development. Fosler closes with the point that beyond providing infrastructure, the private sector has an important role in helping to shape the political process, so that the required levels of public spending and taxation are forthcoming from the government with as little economic distortion as possible.

How Efficient Is Current Infrastructure Spending and Pricing?

Clifford Winston argues that the focus of the current policy debate should be shifted from the question of how much to increase infrastructure spending—be it public or private—to a discussion of efficient pricing and investment guidelines. He believes the nation does not need to increase public capital outlays as much as it needs to price and spend more effectively. Users of infrastructure impose costs on themselves and others by increasing congestion and by wearing out the infrastructure. Thus, an efficient infrastructure policy will maximize the gap between social benefits and costs, including the costs that users impose on others, through pricing specifications that regulate demand and investment guidelines that specify design.

Winston lays out an efficient spending policy for both highways and airports. Current policy finances highway construction and repair through the fuel tax; this levy does not accurately reflect the pavement damage and congestion caused by different types of vehicles. Pavement damage varies with weight per

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axle, and thus users should be charged according to this measure. The current fuel tax provides the opposite incentive, because it encourages the use of small, fuel-efficient engines. Smaller engines, however, cannot pull as many axles as their larger counterparts. Thus, the fuel tax indirectly encourages shippers to use the least number of axles, and the most weight per axle, to transport a given load, thereby creating the most pavement damage per haul.

Pavement damage also depends on the thickness of the pavement. Previous analysis conducted by Winston found that optimal thicknesses are significantly higher than current thicknesses. Increasing pavement thickness would reduce annual mainte-

nance expenditures and, by lowering the marginal cost of a standard axle load, would soften the impact of taxes promoting efficient pavement wear.

Winston also examines the problem of congestion and finds that while congestion pricing has been advocated by economists for many years, it has been ignored or dismissed by policymakers. He addresses critics of congestion pricing by arguing that equity objections can be overcome if revenues are used properly and by citing existing systems that implement congestion pricing without disrupting travelers.

Winston then turns to airports and discusses the need for efficient pricing and investment in this area. Many observers argue that airport congestion and flight delays stem from capacity constraints. If increasing capacity through construction is the only method used in addressing the congestion problem, Winston claims that society will face a difficult and expensive task. Building new airports involves enormous costs and long lead times, and the predicted growth of air traffic volume is tremendous. He argues that efficient pricing and investment can provide immediate, low-cost relief.

Currently the most common method of assessing landing fees is by aircraft weight. This fee is inefficient, since the principal cost imposed by an aircraft takeoff or landing is the delay it causes other aircraft. Instead, Winston argues, congestion pricing should be implemented and runway capacity of existing airports should be expanded to the point where the marginal cost of an additional runway is equated with the marginal benefit of reduced delay. While less empirical work has been done on the effects of efficient policies on other infrastructure areas, the available information suggests that significant benefits could be derived.

In the final section of the paper Winston addresses common criticisms of efficient pricing and investment—technological infeasibility and the political difficulties of implementation. He also assesses the alternatives to efficient infrastructure policy—traditional approaches, privatization, and significantly increasing infrastructure spending. He cites evidence that efficient policies can be implemented with existing, proven technologies and believes that political hurdles could be overcome. In comparing efficient policies with the alternatives he finds efficient pricing and investment clearly preferable.

Alan Altshuler responds that despite the merits of the efficient pricing and investment argument, he does question the political feasibility of implementing this kind of policy. Winston's evidence in support of

his claims is only mildly suggestive, he says. Moreover, Winston does not carefully weigh the evidence contrary to his premise.

Altshuler judges that congestion pricing of roadways is still a political nightmare, and he will continue to view it as such until toll-road authorities have replaced commuter discounts with peak-period surcharges. Business, labor, and civic groups have consistently been hostile and quite vocal about proposed policies of this nature, and very successful in fighting their implementation. Altshuler also disputes Winston's claim that user fee systems can be structured to avoid regressivity, and to calm the ruffled feathers of vested interests.

He believes, however, that a shift in truck taxation from number of axles to axle weight is quite plausible, since it would entail only a minor revision of a long-standing arrangement. Airport congestion pricing policies are increasingly being implemented, according to Altshuler, but he doubts that they will be sufficient to alleviate airport congestion in the face of rapid predicted traffic growth, even if used in conjunction with runway expansion and air traffic control improvements. In sum, although specific initiatives may be feasible, Altshuler sees little reason to believe that economic efficiency will triumph in infrastructure policy; the values on which our political system is grounded routinely conflict with efficiency.

Michael Bell's comments begin by highlighting what he sees as the value in Winston's approach. Bell believes Winston takes an important step by considering not only the condition of the infrastructure but also its performance, since it is the services rendered by the facility that are important, and not the facility itself. Winston also explicitly links spending on new construction with operation and maintenance requirements, a very important, but often neglected, approach. Finally, Bell says that Winston raises legitimate questions about privatization, which is often seen as a panacea.

Bell believes that Winston's analytic approach could be extended in the following ways: expanding the definition of the output or product of public infrastructure spending, and including environmental costs as part of the social costs and thus incorporating these costs into the efficient pricing scheme.

Bell ends his discussion by raising two concerns about efficient pricing strategy. One is the same point made by Altshuler—however theoretically reasonable or technically feasible an idea may be, the public may not accept it. This applies especially to congestion pricing. Second, even if technically feasible

means of pricing were accepted and implemented for roads and airports, the task still remains of adapting these types of fees to environmental projects. This could be difficult because of distributional issues, the costs of administering such policies, and the weakening of economic tools as they are implemented through the political process.

How Should Public Infrastructure Be Financed?

Edward Gramlich further pursues the issue of getting the incentives right by evaluating the various mechanisms for funding public investment. He concentrates on state and local government spending, since the federal government undertakes little direct capital investment. The federal role in providing grants to states and localities for capital investment is central to the discussion, however.

Gramlich discusses three types of public capital investment and the appropriate funding schemes for each category. He begins with public capital investments that serve local needs with minimal spillovers to other communities and have no distributional implications. Here he argues that services should be financed by user fees; these fees apportion payment in accordance with benefits received and ensure efficient use. Some exceptions to this rule may arise in cases where, on equity grounds, officials want even those unable to pay to have access to, say, a park; the guiding principle, however, is that services that are enjoyed locally should be paid from a local revenue source.

Gramlich then discusses the second category of government investment, the case where spillovers occur, such as in national roads, wastewater treatment, or air pollution control. If feasible, the user fee is again the preferred funding mechanism. If user fees are costly to assess or inequitable, other options include the creation of a regional authority or the introduction of matching grants from the federal government. In the case of federal grants, the federal matching rates should correspond to the share of benefits accruing to out-of-jurisdiction users.

While many federal grant programs were designed with this principle in mind, their matching rates are much higher than appropriate, with the consequence that they must be capped to limit use. Gramlich proposes revamping the programs by reducing the matching rates significantly, while at the same time removing the caps. Changing the structure

of these programs would go a long way toward providing proper subnational government spending incentives and reducing federal grant spending.

The final category of investments entails both spillovers and long-run distributional considerations; the primary examples are public schools and higher education systems. These types of investments require different funding mechanisms. User fees are not appropriate for local schools, since education is a fundamental right of citizenship. Moreover, states have frequently been instructed by the courts to offset variations in the revenue-raising capability of communities in order to ensure that children in low-income communities are not educationally disadvantaged. The federal government currently has a limited grant program to assist poor school districts, again characterized by a cap and a high federal matching share. Gramlich notes that the problem

Gramlich suggests that uncapping federal grant programs and reducing matching rates would go a long way toward providing proper state and local spending incentives.

created by variations in community wealth is exacerbated by the federal deductibility of local property taxes. Thus, to improve schooling for children in underprivileged areas requires strengthening state equalization grants for education, reforming federal grants to poor school districts by removing existing caps and lowering the matching rate, and eliminating the federal tax deduction for property taxes.

Higher education is another area where long-run distributional implications come into play. In this case it is possible to impose user fees—tuitions—to cover the full cost of the service. This happens in some states, but typically only out-of-state students are charged the appropriate fee. Whether or not user fees cover the full costs, higher education has become very expensive, thus altering the issue somewhat: if fees do not cover the full cost, how can states afford

the programs, or if fees are full cost, how can families afford it?

After examining the issue of who should pay for which facilities, Gramlich then addresses timing questions. He emphasizes that in financing any project the cohort that reaps the benefits should pay the costs. Thus, capital expenditures should be financed by long-term bonds with maturities close to the life of the asset purchased. User fees or taxes should then pay annual depreciation plus interest and principal on the bonds. The good news is that, for the most part, this is already happening.

At both the federal and state levels much infrastructure investment is financed through dedicated trust funds. Trust funds are a useful way to link marginal benefits and costs when dedicated taxes or user fees can be assessed and when no externalities are present. Gramlich offers some suggestions for reform of the trust funds to best meet their intended purposes.

Gramlich's first discussant, Rudolph Penner, finds little with which to disagree and expands on the problem of capped grants. Many federal grants provide large windfalls to someone who would have engaged in the same activity regardless of the subsidy, rather than affecting the individual's marginal decision. This action, while irrational by textbook standards, is quite pervasive and thus deserves some attention. If the design of grant systems is fundamentally flawed, it severely limits the ability of higher-level governments to induce lower-level governments to provide optimal levels of public capital investment.

Penner has found that many phenomena that appear perverse to economists are often quite understandable and reasonable to legislators and others. He offers as an explanation of the popularity of these capped grants the fact that they convey a great deal of power to the bureaucracy and to the appropriate subcommittees. They also reduce the uncertainty facing politicians about the total amount required to fund a grant program. While the current situation is far from perfect, Penner believes it can improve. In large part improvement requires educating non-economists to the principles of economics (such as marginal decisions and horizontal equity). These issues are not intuitive to many people, but they need to be understood since they form the theoretical underpinnings of the proposed changes.

James Poterba, while generally agreeing with Gramlich's position, believes that some of his recommendations are open to debate. He begins by noting

that reforms of infrastructure finance are not merely accounting conventions; changes in financing mechanisms will also directly affect the level of spending. For example, one study showed that transit workers in urban mass transit systems with earmarked taxes received higher wage increases than those in systems without earmarked taxes. Similarly, Poterba's own work revealed that states with capital budgets spent 15 percent more on capital investment than states where capital and operating outlays were combined.

Poterba makes the same point as Penner: something must be going on to explain the pervasiveness of capped grants in the face of all the evidence of their inefficiency. He agrees with Penner that political factors are at work, but believes that the most important of these is the perceived need for equitable treatment of different jurisdictions. With open-ended grants, rich areas may contribute several times as much as their poorer neighbors to matching programs; the result is that absolute transfers from the federal government to the richer areas will be larger than those to poorer areas, thereby widening the inequities.

Poterba argues that capped grants may actually be efficient, citing literature from regulatory economics as evidence. For example, if federal grant-givers envision a minimum threshold of highway spending in each jurisdiction, then high subsidy rates on expenditures up to some level will ensure that most areas will take advantage of the program up to that point. Even if closed-ended grants are an efficient way to achieve an objective, Poterba emphasizes that this does not automatically imply that existing grant programs are well designed.

Poterba also raises a point about the applicability of user fees in certain situations. Regarding Gramlich's recommendation of user fees for solid waste disposal, for example, Poterba notes that user charges are generally more successful when levied at the time a consumer purchases a good than when charged to someone disposing of it. Finally, Poterba believes that calls for more efficient infrastructure financing will receive serious attention, especially given the current climate of fiscal austerity at both the federal and state levels.

Conclusion

Infrastructure is important for the environment, the quality of life, and economic performance. The United States has cut back sharply on infrastructure

investment in recent years. At the same time, few of the incentives that affect the decision to invest in new public capital or to use infrastructure services appear consistent with those advocated by economists. The

Resolving the infrastructure debate will be essential in order to determine the manner and appropriate level of capital spending in the 1990s.

question is what government officials should do now. Here opinion is sharply divided.

Those worried about the incentives to spend, the efficiency of design, and the appropriateness of the prices charged, want all efforts focused on elim-

inating current distortions and inefficiencies. They tend to believe that once the perversities in the existing system are removed, the present stock of infrastructure may meet most of the nation's needs. Additional investment at this time will divert attention and alleviate pressure to make the needed reforms.

While acknowledging the inadequacies in current funding, pricing, and design, other observers still see a need for more immediate investment. Dilapidated bridges and roads, large wastewater treatment requirements, and other needs make additional public capital investment essential. The positive impact of infrastructure on output and economic growth provides a further spur. Moreover, many question the likelihood that efficient pricing mechanisms will be adopted in the near future.

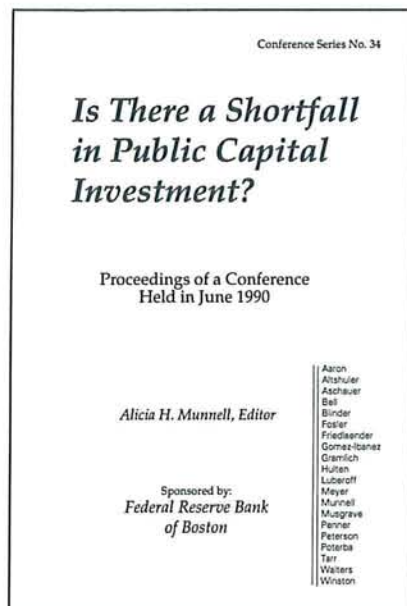
Resolving this infrastructure debate will be essential in order to determine the manner and appropriate level of highway and other capital spending during the 1990s.

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