Objectives and Decision Criteria for Infrastructure Investment

An NCHRP Digest on the research findings of an application of the analysis approach described in NCHRP Project 2-17(1), "Methodologies for Evaluating the Effects of Transportation Policies on the Economy." This Digest was prepared by Dr. David Lewis, President, Hickling, Lewis, Brod Inc.

INTRODUCTION

Public agencies are faced each day with the need to make decisions about the expenditure of public resources. Various procedures have been used, but many of these only address the quantitative aspects in a limited manner. Procedures for the systematic, quantitative assessment of cost and benefits associated with projects exist, but these have not been used extensively. The problem is complex for the assessment of a single project and even more involved for the assessment of multiple investment options, such as those faced by national, state, and local government agencies.

The National Cooperative Highway Research Program (NCHRP) has undertaken various research efforts to develop cost-benefit analysis techniques. NCHRP Project 2-17(1), "Methodologies for Evaluating the Effects of Transportation Policies on the Economy," developed a Primer for applying the cost-benefit techniques to analyze transportation investments considering a wide range of factors. For additional information, refer to NCHRP Report 342, "Primer on Transportation, Productivity, and Economic Development," and its supplement published by the Transportation Research Board in 1992.

This Digest describes the application of the cost-benefit procedures outlined in the Primer for the purpose of assessing transportation investment options at the national scale. Although this effort was aimed at the national level, it is believed that variations of the techniques described herein will be useful to state, regional, and local governments in making investment decisions.

This effort was prepared as a special study under NCHRP Project 2-18, "Research Strategies for Highway User Cost Analysis," to provide input to the debate on making appropriate investment decisions—using the approach previously developed in NCHRP Project 2-17(1). Information from this report was used in AASHTO testimony to Congress.

CHAPTER 1. THE PROBLEM AND ITS SOLUTION

Although deficit reduction and long-term investment have become the watchwords of any strategy for economic renewal, Congress is struggling with the question of the "correct" level of investment in public infrastructure. One concern is the efficacy of increased infrastructure spending as a means of creating a short-term economic stimulus. At the heart of the issue, however, is the fundamental debate over the rate of public capital formation needed to support the nation's return to sustained and stable long-term economic growth.

Deficit reduction is necessary to ensure an adequate supply of affordable capital for private
investment. Unless the federal government slows down the rate at which it adds to the federal debt, industry cannot be expected to pick up its rate of private investment—in plant, equipment, technical innovation and training—needed to achieve desired productivity growth, economic expansion, and improved living standards. It is recognized however, that public investment—in roads, bridges, airports and airways, and municipal services—contributes to a fundamental part of the nation’s total capital stock. Missed opportunities for sound investment in transportation networks, multimodal facilities, and congestion management mean less opportunity for industry to initiate complementary steps that boost national productivity. Such steps include improved high-speed communications and information transfer technology, just-in-time inventory control, networked truck dispatching, and a related family of investments whose introduction requires a foundation of sound and appropriate public infrastructure and whose effect is to boost competitiveness, increase real wages, and improve people’s standard of living.

NCHRP Project 2-17 seeks to provide an operational definition of “sound and appropriate infrastructure” and asks how much the nation must spend to obtain it. This project also identifies the decision criteria that investment managers need to use in order to recognize the correct volume and mix of infrastructure investment within the context of (1) the aims of deficit reduction, (2) the goal of creating the right environment for long-term economic growth and stability, and (3) the desire for a short-term economic stimulus.

Chapter 2 concludes, however, that an across-the-board increase in infrastructure spending, in itself, cannot be expected to yield the desired result of economic expansion. This is because many state and local infrastructure programs do not adopt growth-related objectives or decision criteria as the basis for project choice. A number of programs are guided by civil engineering criteria alone, without regard for economic benefits and costs. Others do adopt economic aims, but these tend to focus on the distribution of economic activity rather than on economic expansion. Only a minority of state and local programs use growth-related criteria to guide the choice of infrastructure investments.

Unless infrastructure investment is conscientiously steered to growth-oriented projects, an across-the-board increase in public capital spending will run contrary to the purposes of deficit reduction. Conversely, guiding infrastructure investment to growth-oriented projects can reinforce the goals of deficit reduction. Based on the research findings, Chapter 3 presents a framework for promoting growth-oriented public capital formation. This chapter also identifies the appropriate decision criteria and corresponding appraisal methodologies for use in identifying growth-related infrastructure projects. It then discusses ways in which the federal government can create incentives for states and localities to apply these objectives, criteria, and methodologies to ensure the optimum level, mix, and geographic distribution of public investment. The focus here is on program changes that can be achieved immediately. Chapter 4 offers a brief conclusion.

CHAPTER 2. APPROPRIATE OBJECTIVES FOR INFRASTRUCTURE INVESTMENT

Although the nation’s public works have profound economic effects, infrastructure planning has traditionally been viewed as an engineering activity more so than as an aspect of economic policy. Thus the systematic examination of infrastructure’s role in the economy is a relatively new endeavor.
2.1 ECONOMIC EFFECTS OF PUBLIC INFRASTRUCTURE

Six spheres of economic activity constitute dimensions of the economy in which the influence of infrastructure is verifiable. However, the effectiveness of infrastructure in promoting change in each sphere varies greatly. The six spheres are as follows:

1. **Distribution and structure of employment**—the geographic distribution of remunerative jobs both directly and indirectly associated with the transportation system.

2. **Distribution of personal income**—the share of total output and income obtained by groups at different levels of disposable income.

3. **Distribution of regional output and income**—the share of production and economic output obtained by different geographic regions.

4. **Distribution of sectoral output and income**—the share of total production and output attributable to particular industrial and service sectors.

5. **Growth in economic output**—increased total production valued at market prices (namely, Gross National Product [GNP] or the gross product of a specified state or region). The two principal sources of output growth (and thus sub-objectives in and of themselves) are

   - **growth in productivity**—growth in the production of goods and services per labor-hour worked; and

   - **growth in employment**—the number of jobs, or labor-hours worked.

6. **Growth in economic welfare**—increased economic benefits to society that exceed the increased economic costs of achieving them. "Welfare" is distinguished from "output" in that welfare includes commodities like safer roads, cleaner air, less congestion, and other factors that have economic value but are not included in the normal accounting definitions of economic output and gross product. Gains in productivity and employment (namely, output growth) yield gains in welfare if the value of output growth exceeds the value of those economic resources consumed in achieving it.

The two frequently cited economic objectives—"improved living standards" and "economic development"—must be defined within the framework of these six spheres outlined.

2.2 IMPROVED LIVING STANDARDS

The term "standard of living" relates to all aspects of daily life that individuals value, and it includes both the goods and services people buy. Its value is measured by the volume of gross output, and broader economic goods, such as time savings, safety, and reduced pollution—items that do not show up in the national accounts but for which people are nonetheless willing to pay. To achieve an increase in the standard of living, it is necessary to achieve an increase in the availability of things people desire (more refrigerators, less congestion) whose value to them exceeds the value of any economic resources used up to achieve the increase (such as steel, highway construction materials, labor, and clean air). Thus, improving living standards equates to Objective 5 above, namely growth in economic welfare.

2.3 ECONOMIC DEVELOPMENT

The term "economic development" cannot be assigned a fixed definition, but rather depends on (1) how the decision maker chooses (implicitly or explicitly) to weigh the relative importance of each of the six objectives; (2) how these objectives are prioritized; and (3) what minimum conditions are established for their achievement. If increased employment in a particular region is valued for its own sake, regardless of the economic costs of achieving it, then an infrastructure investment that fosters employment in the region (Objective 1) can be considered a catalyst of economic development. However, if significant weight is assigned to better
living standards as well, then the impacts of alternative employment-generating policies on economic welfare (Objective 6) must be taken into account before finalizing a plan to promote economic development.

In summary, each of the objectives outlined above relates to either growth in economic activity or to the distribution of economic resources among regions, sectors, and people. "Growth" refers either to expansion in output (gross product) as an end in itself, or to growth in economic welfare (living standards) whereby increased output is viewed as the means to an end. Growth in output per se is achieved through better productivity and higher rates of employment. Gains in these two factors thus represent possible sub-objectives of the output goal. Finally, the term economic development is a broad goal that acquires meaning only in terms of the choice of specific objectives and the priority they occasion.

To be sure, infrastructure investment is often identified with the goal of economic development. But scarcity in the amount of capital available for investment makes it critical that the specific economic objectives assigned to infrastructure programs are selected and balanced wisely. As shown in the next chapter relative to other policy instruments, the influence of infrastructure investment is weak in advancing some objectives and potentially strong in advancing others. The subsequent chapter indicates however that infrastructure investment decisions today are not made with a view to maximizing their economic effectiveness. The remainder of this Digest discusses ways in which this situation can be corrected.

2.4 THE RELATIVE PERFORMANCE OF INFRASTRUCTURE INVESTMENT IN ACHIEVING ALTERNATIVE ECONOMIC OBJECTIVES

The issue of relative performance can be reduced to two questions: 1) How effective is infrastructure investment in promoting distributional versus growth objectives? 2) What components of economic growth are influenced measurably by infrastructure investment?

Distributional Versus Growth Objectives as the Basis of Infrastructure Investment

Although the distribution of economic resources represents a legitimate and vital concern of governments at all levels, both macro- and microeconomic analyses indicate that infrastructure investment is more effective in promoting economic growth than it is as an instrument of redistribution.

Evidence Regarding the Growth Effects of Public Investment

Using macroeconomic models of the U.S. economy, researchers have found that the principal effect of capital investment is to spur growth in productivity (and thus output). Whereas the studies of Professor Robert Solow attribute up to 85 percent of past growth in GNP to productivity increases (as distinct from net increases in employment or the quantity of capital per se) the importance of capital investment to productivity growth has been established by Professor Dale Jorgenson. His studies suggest that the productivity of labor is pivotally affected by the per-worker rate of capital formation—the amount of money spent in building up the nation's capital stock.²

The evidence cited above relates specifically to the effects of private capital formation and only by implication to the impacts of public capital. There is no theoretical reason to suspect a fundamental divergence in the consequences of rational private and public investments, however. Moreover, direct evidence drawn from the microeconomic analysis of actual infrastructure projects indicates that sound public investments have their principal impacts on productivity growth, output growth, and economic welfare.

A review conducted by the NCHRP³ found that infrastructure investments can yield social rates of return that are very high—in some cases up to 10 times the yield of typical private sector investments.⁴ Fully audited benefit-cost analysis studies of new runways for Minneapolis—St. Paul International Airport and Vancouver International Airport⁵ have each reported economic rates of return in excess of 100 percent. Less startling, but nonetheless striking economic rates of return have been reported for
certain highway maintenance projects (30 percent to 40 percent), new highway construction in urban areas (10 percent to 20 percent), and modernization and expansion of the air traffic control system (20 percent to 25 percent). Recent studies by the Congressional Budget Office conclude that

Carefully chosen federal investments in physical infrastructure such as highway and aviation projects would yield economic rates of return higher than the average return on private capital.

These studies cited above draw their conclusions from the measurement of monetary benefits associated with infrastructure investment stemming from such things as reduced vehicle-operating costs and savings in travelers' and shippers' time. These savings translate directly into improved business and industrial productivity and thus gains in economic output. Time savings for business travelers and shippers mean more hours of productive work and faster deliveries to factories and thus more output per hour and less fuel consumption per hour of productive work. Compared to the life-cycle costs of such improvements, the economic returns of carefully chosen projects can be very strong indeed.

Moreover, there is an emerging body of evidence to suggest that traditional methods of assessing the economic rates of return on certain infrastructure investments can underestimate their true productivity effects quite sharply. NCHRP research into the relationship between infrastructure and industry logistics, for example, indicates that rather than taking the productivity gains of transportation investment in the form of time savings, some firms will reduce inventories and warehousing facilities instead. In this way, the same total distribution territory can be served in about the same total travel time and within required delivery schedules. Because the logistics costs of industry represent fully 11 percent of GNP, reductions in inventory and related distribution, packaging, and other overheads can yield greater business benefits than time savings alone.

New techniques developed under the NCHRP are designed to measure these effects. They suggest that productivity gains and rates of return associated with certain kinds of infrastructure improvements, particularly those that better the reliability and predictability of journey times throughout the transportation network, are even higher than previously thought. Such projects include those that a) enhance "connectivity" in a transportation network (such as interchange reconstruction to improve freeway-to-freeway access and to enhance intermodal connectivity); b) those, such as outer-beltways, that reduce the intermingling of local peak traffic and long-distance traffic on beltways and urban freeways; and c) traffic management systems that respond more quickly to accident and incident-induced congestion—the source of congestion that accounts for roughly half of all delays today.

Evidence Regarding the Distributional Effects of Public Investment

In contrast to the fact that certain categories of infrastructure investment yield significant rates of return and gains in economic output, the redistributional effects of infrastructure investment are typically small. This is particularly true in relation to the overall volume of economic activity in either the donor or recipient jurisdiction or sector. A major review published in 1991 reports that even the strongest growth-producing infrastructure investments—those earning in excess of 100 percent social rates of return—account for less employment-related income in the recipient region than the capital cost of the investment and less than a fraction of one percent of total regional output. In other words, while productivity gains alone can often justify transportation investment, this is rarely the case with employment, income, and other targets of regional redistribution.

It is true of course that transportation infrastructure and other public works are a necessary part of a well-developed and dynamic regional economy, which is capable of attracting growth industries and holding on to the ones they have. Studies find, however, that even less well-off regions in a mature economy like the United States can capture increased levels of economic activity with in-place infrastructure. It is once having done so that infrastructure improvements can become demonstrably worthwhile from a growth perspective. This is because the benefits of alleviating growth-
induced congestion with new or expanded transportation systems will often be found to exceed the costs of achieving them.\textsuperscript{13,14}

Exceptions to this conclusion will arise in situations where the transportation network is not mature in relation to emerging patterns of economic growth. For example, absence of a super-highway link between Interstate I-17 in Flagstaff, Arizona, and the I-15 in Utah could limit Arizona's ability to capture emerging North-South trade-related growth stemming from the North American Free Trade Agreement (NAFTA) with Mexico and Canada. On the other hand, the development of such a link could help persuade firms to locate in Sonora, Mexico, or Arizona—firms that would otherwise remain outside the North American trade block. Such cases need to be examined on their merits and while potentially significant, they will be the exception rather than the rule.

The promotion of growth, and not distributional objectives, represents the highest and best use of public capital for infrastructure investment. The term growth must now be defined more closely. Only then can it become an operational basis for policy and programming and investment planning.

Appropriate Objectives for Infrastructure Investment in Promoting Economic Growth

The taxonomy of objectives presented earlier establishes the following choices for defining the growth objectives of infrastructure investment:

- growth in output, or gross product;
- growth in employment, a source of output growth;
- growth in productivity, also a source of output growth; and
- growth in economic welfare, or living standards, defined in terms of all economic, social, and environmental benefits and costs that are assigned value (whether positively or negatively) by society.

It is a matter of fact that growth for growth's sake has never been the centerpiece of American public policy. On the other hand, growth achieved through acceptable means and at acceptable costs—such as environmental costs—is the only means available to recover and sustain ground in American living standards. The implication then is that output growth, tempered by the consideration of positive and negative "welfare effects" outside the normal accounting framework of gross product, represents the appropriate objective of infrastructure investment. Welfare effects in the case of infrastructure investment occur typically in the form of delays and time-savings safety and environmental impacts.

With output growth established as a prime objective of infrastructure investment, it is important to determine through what means infrastructure investment can help achieve it, namely employment growth, productivity growth or both.

Macroeconomic studies in mature economies indicate that new or improved transportation facilities make very little difference to net new employment and related income in a region. While transportation studies often report large numbers of jobs either directly or indirectly associated with infrastructure facilities, more in-depth investigations find that virtually all employment associated with steps to expand the transportation system would be absorbed elsewhere in the labor market if the investment were not to take place. In other words, employment gains that arise in one region draw economic activity from other geopolitical jurisdictions, industrial sectors, or socioeconomic groups. The regional magnitude of these gains is rarely sizeable enough to justify the capital expense of achieving them.

While prudent infrastructure investments can certainly promote growth, the causal factor is increased productivity—output per worker—not more workers. Time savings, better fuel efficiency, longer vehicle lives, lower inventory-carrying costs, and more productive logistics account for most of the gains from transportation infrastructure investments.

Refining the Output Objective with Consideration for Minimum Rate of Return

A public investment that seems likely to generate productivity gains is not necessarily worthwhile. At
a minimum, the annual flow of benefits should seem likely to exceed the value of investment opportunities that are foregone by not employing the capital in pursuit of other productive opportunities. In operational terms, this simply means that the investment should possess a high probability of yielding a rate of return in excess of the opportunity cost of capital. In terms of the nation's strategic need to create investment-led economic growth, this in turn means that public investments should not be undertaken unless they are likely to yield rates of return that, at a minimum, exceed the average yield on typical private sector investments (which some analysts pitch in the region of 6 percent after inflation—see later).

Tempering the Output Objective with Welfare Considerations

Because investments in public infrastructure can entail environmental and other costs that are not measured in the normal framework of accounting for gross output, it is important to account for them in rate-of-return calculations. As it happens, newly emerging methods of appraisal reveal that the productivity gains of sound infrastructure investments typically far outweigh the value that society places on the associated environmental costs. A recent appraisal of new runway options for Vancouver International Airport, for example, found that the monetary value of noise-related costs (property depreciation, nuisance and annoyance costs, and removal expenses) in neighborhoods surrounding the airport was in the region of $45 million (in present day value over 30 years). The productivity gains on the other hand were estimated in the region of $4.5 billion, mainly in the form of improvements in airline productivity and the productivity of business travelers. The gains were thus more than sufficient to compensate losses and mitigate environmental problems.

The key point here is that by quantifying the welfare losses of prospective infrastructure projects, the best investments will typically be found to offer strong economic rates of return and sustainable economic development from an environmental perspective. Taking the traditional course, whereby proponents of infrastructure investments stop short of assigning monetary value to environmental costs and denying their relative importance, is simply a recipe for endless debate and delay. Putting the welfare costs in perspective and building compensation and mitigation plans into the infrastructure investment planning process, on the other hand, offers proven rewards in terms of community acceptance and progress.

2.5 PUBLIC INVESTMENT OBJECTIVES IN USE TODAY

The choice of economic objectives for infrastructure policies and investments establishes the nature of what is designed and built. For example, a capital program designed to bolster a state's attractiveness to prospective employers (relative to that of a neighboring state) will contain different kinds of projects than one designed to promote output growth and economic welfare. It is important, therefore, to ask whether current infrastructure policies and programs in the United States tend to pursue appropriate objectives. On balance, most public investment programs today focus on distributional aims not on growth-related objectives. There is an emerging focus on productivity as the rationale for infrastructure spending, but its focus is largely on the quantity of public capital spending—on the assumption that more spending will yield more high-yield infrastructure projects. The underlying distributional objectives inherent in most of today's infrastructure programs, however, mean that pursuit of the quantity objective will not generate the desired results.

Dominance of Engineering-Based Objectives in Public Investment Planning

In many states, and certainly at the federal level, the bulk of highway, bridge, and aviation investment possibilities is identified through the application of engineering-based objectives and decision criteria. Under this approach, projects are viewed as "needs" that are defined to arise when current or projected pavement, structural, geometric, safety or service-related conditions deteriorate beneath a set of
prescribed minimum standards, such as a minimum pavement condition rating or volume-to-capacity ratio.  

Major condition and performance monitoring systems, such as the Highway Performance Monitoring System (HPMS), are used by federal and state governments to make official forecasts of highway and bridge investment needs and to simulate the life-cycle costs of achieving the prescribed minimum engineering standards. Some states and localities examine the economic rationale of infrastructure projects in addition to their engineering rational, but many rely solely on engineering-based criteria to guide infrastructure plans.

Use of Distributional Objectives as the Economic Basis for Public Investment Policy

Where economic objectives are considered, most infrastructure investment managers adopt aims that are distributional, not growth-oriented in character. In some instances, decision makers act in the belief that they are advancing the cause of growth because employment gains that are projected to occur as a result of interregional or intersectoral transfers are mistakenly construed as net new jobs. Even so, the majority of projects are appraised with appraisal methodologies and decision criteria that signal only their distributional attributes. As a result, infrastructure capital programs are not designed to promote economic growth in any of its various manifestations.

A national survey conducted in 1990 and reported in NCHRP Report 342 finds that in 87 percent of infrastructure investment appraisals, distributional objectives are stated as their principal economic purpose. Only 13 percent of investment appraisals, on the other hand, mention growth or growth-related aims as project or program objectives. Distributional priorities are evident, moreover, in the form of territorial competition for economic activity rather than in the desire to achieve a reasoned geographic, demographic, or sectoral distribution of economic activity over a defined region.

Infrastructure investment objectives at the federal level also reflect a long tradition of distributional aims and related decision criteria as their underlying basis. Here again, however, federal goal statements often betray a misinformed entanglement of ideas culminating in the use of distributional decision criteria in the belief that they convey signals about the growth implications of prospective public investments. The philosophy and modus operandi embedded in the major federal infrastructure programs of today were shaped largely during the post-war nation-building years marked by the geopolitical horse-trading that characterized the design and timing decisions of the Interstate Highway Program. This resource "sharing" philosophy is evident today as the federal government begins to ponder the infrastructure investment implications of the NAFTA, particularly in relation to alternative north-south transportation corridors in the Western states.

Emerging Growth Objective for Infrastructure: Weaknesses in the Debate About the Quantity of Public Investment

Sparked principally by the work of David Aschauer, some economists and political leaders have called for expanding the quantity of infrastructure investment as a means of maximizing economic growth and development. Using econometric analysis of time-series data, economist Aschauer concludes that much of the decline in U.S. productivity that occurred in the 1970s was precipitated by declining rates of public capital investment. Subsequent work by then Federal Reserve Economist Alicia Munnell reached the same conclusions.

As indicated by Munnell in a recent review, advocates of infrastructure spending seized on her analysis as support for sharp increases in public investment. Then transportation Secretary Samuel Skinner and New Jersey Governor James Florio joined traditional interest groups to argue that more public investment in infrastructure would help boost productivity and growth in economic output. Prominent economists signed a national petition for increased infrastructure spending. Several congressional committees held hearings on the topic. The U.S. Council of Mayors called for stimulative
infrastructure spending early in 1992, and Presidential-hopeful Bill Clinton made a 5-year, $80 billion infrastructure spending package a central focus of his proposed economic plan.

Aschauer’s study concluded that every dollar spent on projects such as roads, sewers, and airports yields a significantly higher rate of return than would the same amount of private sector investment in assets such as business plants and equipment. This conclusion led many political leaders to argue that more infrastructure spending would not run counter to the aims of deficit reduction, namely the need to liberate national savings for productive long-term investment.

To be sure, the enthusiasm among policy makers for the conclusions of Aschauer and Munnell has been steadied somewhat by analytic suspicion on the part of many other economists. Critics charge that the econometric methodologies employed are flawed, that the direction of causation between public investment and output growth is unclear and that, even if the historical empirical relationships were estimated correctly, they provide no clear indications for current policy. After a year-long examination of the Aschauer findings, including the econometric analysis, the Congressional Budget Office (CBO) reports that there is little basis for his conclusions and thus little evidence to suggest that substantial, across-the-board increases in infrastructure spending would be more productive on average than private investment. While the methodological and theoretical debate outlined above is important, it is weak in two key respects. First, given the evidence presented regarding the nation’s traditionally engineering- and nongrowth-oriented economic objectives in choosing infrastructure projects, it must follow that today’s policy framework leaves the federal government with little assurance that spending on public works, is directed toward productivity or growth-oriented capital investments. Indeed, it seems quite likely that investigations conducted by the CBO and others in which no evidence is unearthed of a positive correlation between across-the-board infrastructure spending and output growth stems from the simple fact that growth of any sort is not the operative goal of most infrastructure projects. It appears unlikely that infrastructure projects or any other kind of investment—public or private—would be consistently well-performing by virtue of serendipity.

What is missing in the institutional framework of public investment planning is a complementary relationship between the quantity of capital funds available for infrastructure and the quality of public investment that follows. In the private sector, such a relationship is assured by market forces that encourage managers to direct capital to productive, high rate-of-return investments and to do so at more or less the optimal time. Indeed, this is why deficit reduction can be expected to yield not only more private investment, but also sound, growth-oriented investment as well. Infrastructure investment dollars, on the other hand, must be managed by public sector decision makers who, in choosing among their spending alternatives, have adopted neither a growth-oriented mandate nor the tools by which to account for prospective returns-on-investment. The second problem with the recent debate is its focus on output growth and productivity as the ultimate aims of public investment. As discussed previously, only the criterion of welfare growth reflects the normal standard of public policy that the objective of public policy is better living standards.

CHAPTER 3. FRAMEWORK FOR PROMOTING GROWTH-ORIENTED INFRASTRUCTURE INVESTMENT

It has been established previously that while prudent public investments can yield substantial growth in productivity, output, and economic welfare, an across-the-board increase in federal spending on public works offers no guarantee that such growth will result. Missing are the institutional linkages through which federal infrastructure spending programs can establish a complementary relationship between the quantity of capital supplied and the “growth-performance” of the specific public investments that follow.

Specifically, incentives are needed for states and localities to apply growth-oriented decision criteria and related appraisal methodologies. Because federal programs finance a large share of state and local infrastructure budgets, a shift in the incentive
structure of federal programs can be expected to shift the orientation of state infrastructure spending patterns.

3.1 Decision Criteria and Appraisal Methodologies

A decision criterion is simply a yardstick against which decision makers can gauge the performance of an investment opportunity. If regional employment growth is the decision maker's declared objective, the criterion will be the number of jobs projected to arise in the region as a result of the investment opportunity. An appraisal methodology is the technique by which the decision criterion is quantified. Economic impact analysis, for example, measures the number of direct and indirect jobs associated with a particular infrastructure facility. Not surprisingly, this analysis is often the technique of choice because it reflects the underlying employment-oriented objective of most infrastructure programs.

Economic Rate of Return as the Core Decision Criterion

Economic growth as the principal objective of infrastructure investment implies that the appropriate decision criterion is each project's (or set of interrelated projects') economic rate of return. The rate of return associated with public investment provides, in essence, the same kind of information produced by private enterprise in examining the merit of a prospective investment. Both private and public managers seek to determine whether the wealth of shareholders will expand as a result of the proposed investment—namely, whether owners will likely enjoy a return on investment greater than that available from alternative uses of the capital (including the option of leaving it in the bank).

Public and private rate-of-return calculations differ principally in the range of costs and benefits taken into consideration. The corporate manager is interested only in the private costs and benefits that influence shareholder returns, namely those expected to accrue to the firm. The public sector manager, by contrast, must consider all significant economic effects in executing the rate-of-return calculation. In effect, the shareholders are public at-large; consequently, it is the public's economic welfare, as defined earlier, that the infrastructure manager should seek to maximize.

The Enhanced Benefit-Cost Framework as the Core Appraisal Methodology

Benefit-cost analysis, enhanced with studies of industrial logistics and risk analysis, represents the appropriate appraisal framework for use in producing reliable estimates of the economic rate of return associated with prospective public investments. The benefit-cost framework comes closer than any other to reflecting the welfare objective. In practical application, it facilitates the identification of public investments that

- yield productivity and output growth;
- generate gains in the standard of living (that is, projects with net economic benefits, taking account of all effects, whether or not they are reflected in the national income and product accounts); and
- represent neither too much nor too little long-term investment from the perspective of the electorate's willingness to sacrifice current consumption in return for future rewards. Getting this trade-off right is especially important to the search for the appropriate levels of long-term public investment and related fiscal policy.

The benefit-cost framework also offers the advantage of providing information about other related decision criteria, such as net present value and first-year benefit. As given in Table 1, each of these interrelated criteria provides useful decision-support information. Net present value, for example, allows investment alternatives to be ranked in order of their contribution to economic growth.
To be sure, benefit-cost analysis is not without its shortcomings. As explained earlier, it can overlook certain kinds of benefits, specifically those associated with logistics-related benefits and industrial reorganization in response to infrastructure improvements. New techniques are emerging under the AASHTO-sponsored NCHRP research to provide state and local planners with accessible techniques of measuring these effects and accounting for them in the investment planning process. The benefit-cost analysis framework also suffers from uncertainty in the projections and assumptions that underlie its conclusions, a weakness that can lead to the suspicion that assumptions are “cooked” in order to generate a desired outcome. Modern approaches to probability and risk analysis however have gone far to resolve this problem in benefit-cost analysis. Supplemented with logistics and risk analysis where necessary, the benefit-cost framework provides the most sensible and thorough operational technique for finding growth-oriented public infrastructure investments.

3.2 Creating the Right National Incentives

If the appropriate, growth-oriented national incentives were put in place, infrastructure investment could find its appropriate level through a dynamic relationship between the supply of public capital on the one hand and the demand for sensible, high-yield infrastructure opportunities on the other. As a practical reality, one can accept that the federal capital rationing process is a political and allocational one, and as such, expect the dissemination of federal capital to reflect certain political purposes and distributional aims. But if at a minimum, programs were structured so as to target such allocations to infrastructure programs and projects that, *inter alia*, reflect economic growth objectives and exhibit at least a minimally desirable economic rate of return, the volume of demand for infrastructure investment would signal an economically appropriate level of public investment.

Adapting national investment programs accordingly means the following:

- Integrating economic growth objectives and related decision criteria into the national infrastructure planning process;
- Providing incentives for state and local programs to adopt economic growth as a principal objective for infrastructure investment and economic rate of return as a key decision criterion; and
- Providing mechanisms for state and local planners to adopt the benefit-cost analysis framework—enhanced with logistics and risk analysis—as a principal appraisal methodology in assessing individual programs and projects.

Integrating Economic Growth Objectives and Decision Criteria into the National Planning Framework

For more than 20 years, the Secretary of Transportation has been required under Section 307 of Title 23 of the United States Code to report to Congress on the long-term (20-year) capital investment expenditures needed to maintain and improve the physical condition and operating performance of the nation’s highways and bridges. The HPMS previously discussed evolved to serve that requirement. However, based on the analysis of thousands of highway sections and bridges, HPMS has become a standard planning tool in most states as well.

Over the past 3 years, the Federal Highway Administration (FHWA) has developed an extension to the HPMS that is capable of comparing the engineering-based investment strategies that emerge from the system in relation to their economic rates of return. This innovation is important because integrated into the biennial Section 307 Condition and Performance Report, it will provide Congress with a basis for establishing infrastructure budget appropriations that are grounded in both desirable engineering and economic characteristics of highway and bridge infrastructure. The FHWA is presently developing the means by which to integrate these economic measurements into the Section 307 reporting process. Similar mechanisms are evolving in the transit and aviation fields.
Table 1

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<thead>
<tr>
<th>Measure of Worth</th>
<th>Definition</th>
<th>Interpretation</th>
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<tbody>
<tr>
<td>Net Present Value</td>
<td>Present-day value of benefits minus present-day value of costs.</td>
<td>NPV greater than zero means project is economically efficient. Projects are ranked according to NPV.</td>
</tr>
<tr>
<td>Rate of Return</td>
<td>The discount rate at which NPV = 0</td>
<td>Rate of return should exceed pre-set hurdle rate to qualify for consideration.</td>
</tr>
<tr>
<td>Benefit-Cost Ratio</td>
<td>Present value of benefits divided by the present value of costs. Indicates dollars of benefits per $1.00 of cost.</td>
<td>A ratio of greater than one means the project is worthwhile.</td>
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| Measures of Timing           |                                                                           |                                                                               |
|------------------------------|                                                                           |                                                                               |
| First-Year Benefit           | Benefits in the first year after construction divided by costs to date including interest paid during construction, expressed as a percent. | A ratio equal to the hurdle rate means the project is optimally timed. A ratio below the hurdle rate means the project is premature. A ratio above the hurdle rate means the project is overdue. |
| Pay-Back Period              | Number of years until capital recouped through the flow of benefits.      | A short pay-back period means less risk.                                       |

Providing Incentives for State and Local Programs to Adopt Economic Growth as a Principal Objective

Because the HPMS is pervasive at the state level, the rate-of-return extensions outlined above can be expected to influence the orientation of planners and political leaders at that level. In this way, the consideration of aggregate budgetary spending levels by state planning officials can be conducted with due regard for the long-term economic returns of infrastructure investment.

Multimodal extensions of these systems, now under consideration by the U.S. DOT, should be seen as mechanisms for achieving the same result in the transit, aviation, and intermodal areas.

ISTEA as the Mechanism for State and Local Planners to Adopt the Enhanced Benefit-Cost Analysis Framework

The HPMS and related systems help establish broad spending targets; however, missing from the discussion thus far is the critical question of identifying individual programs and projects with regard to economic growth. Certainly, it would not be practical to require a rate-of-return appraisal for each of the thousands of infrastructure projects that lay claim to federal financial support. For the many smaller projects, however, it would be feasible to categorize infrastructure projects into classes defined by their likely rates of return. The NCHRP, CBO, and the FHWA have each demonstrated the feasibility of such an analysis. The federal government could thus provide the basic research needed to promulgate rate-of-return guidance, by mode and class of project, on an ongoing basis.

The planning framework established by the Intermodal Surface Transportation Efficiency Act (ISTEA) could serve as an effective means by which rate-of-return guidance could be integrated into the state and local investment planning process. The ISTEA establishes the Transportation Improvement Plan (TIP) as the major planning document for securing federal financial assistance. After being subject to a specified analysis process, all highway and transit projects proposed for federal capital
assistance must be included and prioritized in the TIP. Without amending the legislation, the federal government could establish the consideration of economic rate of return as a required element in this process. This step would have the added advantage of encouraging multimodal choices and priorities to be established according to economic growth decision criteria. States that are required under ISTEA to integrate the TIPs into statewide long-range plans could be brought into the rate-of-return framework accordingly. For large projects (those with capital costs in excess of a specified amount, probably in the neighborhood of $10 million) and for projects involving highway-versus-transit modal alternatives, the federal government could require an "Economic Appraisal Process" (EAP) as part of the TIP and the statewide plan. As a companion to the Environmental Impact Statement, an EAP would establish the requirements of a benefit-cost appraisal, logistics analysis, and risk analysis bases for program and project approval. The federal government and AASHTO would provide technical guidance on the conduct of the analysis, in much the same way that the federal Office of Management and Budget publishes technical guidelines (in the Federal Register) for the conduct of benefit-cost analysis in federal departments. The "Primer on Transportation, Productivity and Economic Development" (NCHRP Report 342) is already serving this purpose informally.

CHAPTER 4. CONCLUSIONS AND RECOMMENDATIONS

If the criteria outlined in Chapter 3 are met, public investment capital can be guided to its highest and best use—namely high yield, productivity-oriented projects serving the growth objectives. In application, the appropriate objectives, decision criteria, and assessment tools would signal, on an ongoing basis, an appropriate level of infrastructure spending both within and beyond a period of deficit reduction.

Without such a signaling mechanism, however, merely increasing the quantity of infrastructure spending will not put public investment to work in helping to revitalize the nation's economy.

The analysis presented in this submission also has implications for the use of infrastructure spending as a means of short-term economic stimulus. Although ready to go, high-rate-of-return projects cannot be expected to contribute significantly to growth in net new employment. This is not to say that infrastructure investment ought to be dismissed from the list of near-term priorities; indeed, it should not. It is simply that such investment should be tailored to the achievement of productivity and growth-related objectives, not to the creation of new employment.

NOTES


4. This comparative phenomenon should not be taken as an indictment of private-sector investment performance. Rather, it is a revealing statement about the overdue nature of many public works projects. Had private industry behaved like governments and overlooked reasonable, growth-oriented investment opportunities for the past two decades (see Chapter 3), it too would be facing the chimera of phenomenal rates of return due to pent up earning potential.


7. Ibid.


10. Unpublished working paper prepared for NCHRP Project 2-17(4), “Measuring the Relationship Between Freight Transportation and the Economy” (Hickling Corporation, Sept. 1992). This finding is based on current research, which has yet to be published or endorsed by the research sponsor, the National Research Council.

11. Unpublished Working Paper prepared for NCHRP Project 1-17(4), “Measuring the Relationship Between Freight Transportation and the Economy” (Hickling Corporation, September 1992). This finding is emerging in ongoing research, which has yet to be published or endorsed by the research sponsor, the National Research Council.


13. Some studies report a statistical relationship between total employment and the advent of highway improvements. There is no evidence in these studies however that the transportation investments did not follow from the growth in employment. See for example, Jesse L. Buffington and Dock Burke, *Employment and Income Impacts of Highway Expenditures on Bypass, Loop and Radial Highway Improvements*, Federal Highway Administration, Washington, D.C. (1989).

14. Economist Randall Eberts supports this conclusion in stating that, “Public infrastructure is not a stimulus necessary for economic growth. It accommodates economic growth. You have to have another stimulus in order for public investment to have a contribution.” Cited in Research Symposium: Transportation Infrastructure as Public Investment Strategy, p.3, Hubert H. Humphrey Institute for Public Affairs (Oct. 1-2, 1992).

15. This is not all that different from rate-of-return computations made in private firms because federal environmental regulations tend to force companies to internalize, if imperfectly, the cost of mitigating significant environmental costs.


17. Some economists would argue that compensation and mitigation should not be financed by taxing the project’s beneficiaries because doing so reduces their use of the new facilities and thus diminishes somewhat the productivity gains. Instead, they argue that compensation should be financed in an economically more neutral way, such as lump sum taxes and transfer payments. In the end, this debate boils down to practical politics versus economic optimality. In the Vancouver case, for example, noise advocates had to concede the low relative magnitude of “their” costs compared with overall economic gains; satisfying their sense of fairness however led to a policy solution that taxed beneficiaries in order to finance noise mitigation and compensation measures. In Phoenix, Arizona, on the other hand, where residents adjacent to the newly constructed Squaw Peak Freeway suffered noise costs and losses in amenity, homeowners were intent on receiving compensation, but showed little concern about the source of compensation funds.


23. Ibid.

24. Op. Cit., Michael Deich. This is not to be confused with CBO's conclusion that some "carefully chosen" public investments can out-perform typical private investments.

25. See also, Douglas Holtz-Eakin, "Public Sector Capital and the Productivity Puzzle," (National Bureau of Economic Research, Working Paper No. 4122, 1992). Holtz-Eakin analyzes how various factors contributed to growth in private sector output in the 48 contiguous states during 1969-1986. He finds that a 10 percent increase in a state's work force increased private sector output by 7 percent; a 10 percent increase in private capital increased output by 3 percent; but a 10 percent increase in public capital investment had essentially no effect on a state's output during the period studied.

26. This is also a reason why the "privatization" of public works, where possible, can be desirable.

27. These techniques are being developed under National Cooperative Highway Research Program, Project 2-17(4), "Relationship Between Freight Transportation and Industrial Productivity." See also op. cit., NCHRP Report 342, "Primer on Transportation, Productivity and Economic Development."

28. Interestingly, new guidelines published by the Federal Office of Management and Budget require the use of risk analysis in the conduct of benefit-cost studies at the federal level.

ACKNOWLEDGMENTS

The research summarized herein was performed as a special study under NCHRP Project 2-18, "Research Strategies for Highway User Cost Analysis," by Dr. David Lewis, President, Hickling Lewis, Brod Inc. Grateful acknowledgment is made to the chairman and members of the project panel for NCHRP Project 2-17(1), which resulted in NCHRP Report 342, "Primer on Transportation, Productivity, and Economic Development," and provided the basis for this analysis.