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ENSURING PRODUCTIVE INVESTMENT IN TRANSPORTATION INFRASTRUCTURE

*by
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ENSURING PRODUCTIVE INVESTMENT IN TRANSPORTATION INFRASTRUCTURE

by David Lewis

EXECUTIVE SUMMARY

Although many are calling for increased federal investment in the nation's transportation and municipal infrastructure as a means of promoting long-term productivity growth, the federal government cannot assume that its capital resources would be directed to high-return, productivity-enhancing improvements.

Investment leads to economic growth by improving productivity, i.e., by developing ways to provide greater output from a given input of resources. Research shows that some types of infrastructure investments (typically in selected airport and highway projects) have very large economic rates of return—i.e., their economic benefits are significantly larger than their costs (including the costs of adverse impacts). But there is little relationship between aggregate spending on infrastructure and economic growth. This should not be surprising, in that most infrastructure projects are promoted in terms of “distributional” effects — e.g., the number of jobs they will create in a specific locality. Research shows that this kind of “job creation” seldom involves real economic growth; it simply redistributes resources from one use or location to another use or location.

What is missing in public-sector investment policy is a functional relationship between the quantity of capital funds available for infrastructure and the investment-quality of resulting projects. What is needed is a causal link between the demand for capital to finance sensible, high-growth infrastructure opportunities on the one hand and the supply of public capital on the other. Economic rate of return, not the number of “jobs created,” should be the criterion for project selection.

If federal infrastructure spending programs were re-designed to incorporate appropriate incentives, national infrastructure investment would automatically find a level and mix that yields a strong, growth-inducing economic rate of return. One tool for accomplishing this is privatization: using private capital for selected infrastructure projects. Investors will normally only risk their funds on projects producing an acceptable economic rate of return. For the balance of public infrastructure, the key lies in prompting state and local governments to select appropriate objectives, decision criteria and appraisal methodologies in developing capital programs. The federal government should provide incentives for states to incorporate such criteria as a condition of making use of federal transportation funds.

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I. INTRODUCTION

Although the Clinton administration has embraced deficit reduction and long-term investment as the cornerstones of its strategy for economic renewal, the 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, investment needed to achieve desired productivity growth, economic expansion, and improved living standards.

The administration recognizes, however, that investment in public infrastructure—in roads, bridges, airports and airways, and municipal services—contributes to a fundamental and necessary 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.

This paper provides an operational definition of “sound and appropriate infrastructure.” It asks how much the nation must spend to obtain it. And it examines 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.

II. APPROPRIATE OBJECTIVES FOR INFRASTRUCTURE INVESTMENT

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 are:

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

2. **The distribution of personal income**—the share of total output and income obtained by groups at different levels of disposable income;
3. **The distribution of regional output and income**—the share of production and economic output obtained by different geographic regions;
4. **The 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 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:
 - a. **Growth in productivity**—growth in the production of goods and services per labor-hour worked; and
 - b. **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. “Economic welfare” is distinguished from “output” in that economic welfare includes commodities like safer roads, cleaner air, less congestion and other factors that have economic value but that 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 economic welfare if the value of output growth exceeds the value of those economic resources consumed in achieving it.

Two frequently cited economic objectives—“improved living standards” and “economic development”—must be defined within the framework of the six objectives outlined above.

A. Improved Living Standards

The term “standard of living” relates to all aspects of daily life that individuals value. This includes both the goods and services people buy (and whose 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). Improving living standards thus equates to objective 6 above, namely growth in economic welfare.

B. Economic Development

The term “economic development” cannot be assigned a fixed definition, but rather depends upon how the decision maker chooses (implicitly or explicitly) to weigh the relative importance of each of the six objectives, how they are prioritized, and the minimum conditions 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. If, however, 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 which acquires meaning only in terms of the choice of specific objectives and the priorities they occasion.

To be sure, we often identify infrastructure investment with the goal of “economic development.” But scarcity in the amount of capital available for investment makes it critical that the specific economic objectives we assign to infrastructure programs be selected and balanced wisely. As shown in the next section, relative to other policy instruments, the influence of infrastructure investment is weak in advancing some objectives and potentially strong in advancing others. The subsequent section indicates, however, that infrastructure investment programs today are not directed to their relative strengths. The remainder of the paper discusses ways in which this situation can be corrected.

C. The Relative Performance of Infrastructure Investment in Achieving Alternative Objectives

The issue of relative performance can be reduced to two questions:

- How effective is infrastructure investment in promoting distributional versus growth objectives? and
- 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 micro economic analysis indicates 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—see earlier). Whereas the studies of MIT economist 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),¹ the importance of capital investment to productivity growth has been established by Harvard economist 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 micro-economic 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 National Cooperative Highway Research Program³ found that infrastructure investments can yield rates of return that are very high—in some cases up to 10 times the yield, in comparison to 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 to 40 percent),⁶ new highway construction in urban areas (10 to 20 percent),⁷ and modernization and expansion of the air traffic control system (20 to 25 percent).⁸ 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.”⁹

This and the 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, savings that 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, faster deliveries to factories and thus more output per hour, less fuel consumption per hour of productive work, and a range of other ways in which business and industry translate transportation improvements into higher hourly production. Compared to the life-cycle costs of such improvements, the economic returns of carefully chosen projects can be very strong indeed.

Moreover, an emerging body of evidence suggests that present methods of assessing the economic rates of return on certain infrastructure investments can *understate* their true productivity effects quite sharply. Research into the relationship between infrastructure and industry logistics, for example, indicates that rather than taking the productivity gains of a transportation investment in the form of time savings, some firms will reduce inventories and warehousing facilities instead, so that the same total distribution territory can be served in about the same total travel time and within required delivery schedules. Since the logistics costs of industry represent fully 11 percent of GNP,¹⁰ reductions in inventory and related distribution, packaging and other overheads can yield greater business benefits than time savings alone. Newly emerging techniques designed to measure these effects suggest that rates of return from certain kinds of infrastructure improvements are even higher than previously thought.¹¹

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 redistributive 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 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.*¹²

It is true that transportation infrastructure and other public works are a necessary part of a well-developed and dynamic regional economy, one 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 be found to exceed the costs of achieving them—(see Section III).¹³

Exceptions to this conclusion will arise in situations where the transportation network is not mature in relation to emerging patterns of economic growth. The absence of a superhighway link between the termination of Interstate 17 in Flagstaff, Arizona and I-15 in Utah to the north could limit Arizona's ability to capture emerging North-South trade-related growth stemming

from the North American Free Trade Agreement with Mexico and Canada. But such cases will be the exception rather than 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.

The Appropriate Objectives for Infrastructure Investment in Promoting Economic Growth

The taxonomy of objectives presented earlier establish 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.

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. This is something the Clinton administration recognizes very well indeed. 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 transportation infrastructure investment occur typically in the form of delays or (alternatively) 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 socio-economic groups. The regional magnitude of these gains is rarely sizeable enough to justify the capital expense of achieving them.

A recent example is the appraisal of a plan to construct three new runways at Toronto's Pearson International Airport. Macroeconomic simulations indicated that all employment and related multiplier effects would dampen economic activity in other sectors with no net gains in employment growth. This was in spite of the project's very strong economic rate of return.¹⁴

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—factors such as these account for most of the gains from transportation infrastructure investments.

Refining the Output Objective with Consideration for Minimum Rate of Return

A public investment which 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 Clinton administration's overriding goal of creating 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 six percent after inflation—see later).

Tempering the Output Objective with Welfare Considerations

Since 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.¹⁵ 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 were 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.¹⁶ The gains were thus more than sufficient to compensate losses and mitigate environmental problems.¹⁷

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 deny 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.

D. Public Investment Objectives Today

The choice of economic objectives for infrastructure policies and investments establishes the nature of what is designed and built. A capital program designed to bolster a state's attractiveness to prospective employers relative to that of a neighboring state will differ in the kind of projects it contains compared with a program whose purpose is 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 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 result in more high-yield infrastructure projects. The underlying distributional objectives inherent in most of today's infrastructure programs, however, means that pursuit of the quantity objective will not generate the desired results.

The Dominance of Distributional Objectives in Public Investment Policy

At the state and local level, where most infrastructure investment programs are developed, the objectives are distributional, not growth-oriented, in character. In plain language, state and local policy makers usually justify projects in terms of the number of jobs they will "create" in their locality, ignoring the fact that the same funds would have produced other jobs elsewhere. Hence, there is often no *net* growth in employment from such projects. Research indicates that the majority of projects are assessed with appraisal methodologies and decision criteria that signal *only* their distributional ("job-creating") attributes. As a result, today's infrastructure capital programs are *not designed to promote economic growth* in any of its manifestations.

A national survey conducted in 1990¹⁸ found that in 87 percent of infrastructure investment appraisals, distributional objectives are stated as their principal purpose. For example, the economic appraisal of most airport and transit capital investments over the past two decades, including the new Denver International Airport scheduled to open in 1993 and extensions to the BART transit system in San Francisco, were appraised in relation to distributional, not growth-related aims. Only 13 percent of investment appraisals, on the other hand, mention growth or growth-related aims as project or program objectives.

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 mistaken 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.¹⁹ This resource-“sharing” philosophy is evident today as the federal government begins to ponder the infrastructure investment implications of the North American Free Trade Agreement, particularly in relation to alternative north-south transportation corridors in the Western states.

Distorting the Policy Agenda: The Misleading Polemic About the Right Level of Investment

A major debate which materialized early in 1989 has seriously misdirected the policy agenda regarding infrastructure spending. This is because the debate, which focuses on the extent to which aggregate national spending on infrastructure stimulates productivity and economic growth, is radically out of step with the simple yet profound reality that productivity and growth are rarely adopted as the aims of public investment projects. Unless the policy agenda shifts from quantity to quality of investment, no amount of aggregate spending will serve to help revitalize the economy.

The Debate

Sparked principally by the work of David Aschauer,²⁰ the last five years have given rise to considerable pressure from some economists and political leaders to expand the quantity of infrastructure investment as a means of maximizing economic growth and development. Using econometric analysis of time-series data, economist David Aschauer concluded 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 Bank economist Alicia Munnell²¹ reached similar conclusions, though their findings have been disputed by a number of other economists.

As noted by Munnell in a recent review,²² advocates of infrastructure spending seized on her analysis as support for sharp increases in public investment. Then- transportation Secretary Samuel Skinner and New Jersey Gov. 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 five-year, \$80-billion infrastructure spending package a central focus of his proposed economic plan.

More recently, however, enthusiasm among policymakers for the conclusions of Aschauer and Munnell has been tempered by growing doubts about their findings from 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 (i.e., higher growth may permit and lead to greater infrastructure spending) and that, even if the historical empirical relationships were estimated correctly, they provide no clear indications for current policy.²³

One major review was conducted by the Congressional Budget Office. After a year-long examination of the Aschauer findings, including the econometric analysis, the 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.²⁴

The Federal Highway Administration has also published a review of recent research on the relationship between infrastructure investment and productivity.²⁵ H. J. Aaron of the Brookings Institution and J. A. Tatom of the St. Louis Fed independently performed statistical tests on Aschauer's work, and found that public investment was no longer related to output in a statistically significant manner. M. Nienhaus of the Volpe National Transportation Systems Center performed other statistical tests on both the Aschauer and Munnell data and found that the relationship is unsupported for the critical period (1970 to 1987) when both output growth and productivity declined. Other researchers looked more closely at state- and regional-level data (as opposed to aggregate national data) and broke the data down by categories of infrastructure. As summarized by FHWA, their findings are that overall public investment has either a small positive or insignificant effect on economic output. Moreover, only in the highways and water/sewer categories had significant positive relationships. For other categories, the relationships were either insignificant or negative.

Fallacies in the Debate

The methodological and theoretical debate outlined above misses the mark in two key respects. First, given the evidence presented above regarding the nation's traditionally non-growth-oriented objectives in choosing infrastructure projects, it must follow that today's policy framework leaves the federal government with no assurance whatsoever that spending on public works, *at any level*, is directed to productivity or growth-oriented capital investments. Indeed, it seems quite likely that results reported by CBO and FHWA, in which no evidence is unearthed of a positive correlation between across-the-board infrastructure spending and output growth, stem from the simple fact that *growth of any sort has not been the operative goal of most infrastructure projects*. It certainly seems unlikely that infrastructure projects, or any other kind of investment, public or private, would be consistently well-performing by virtue of serendipity, however many money managers might wish it were so.

What is missing in the institutional framework of public-investment planning is a functional 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 which 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 basically sound, growth-oriented investment as well. This is also a reason why privatization of public works, where feasible, can provide a way to direct investment to productive infrastructure projects.

Most infrastructure investment dollars, however, will continue to be managed by public-sector decision makers who at present have adopted neither a growth-oriented mandate nor the tools by which to account for prospective returns-on-investment in choosing among their spending alternatives.

The second problem with the recent debate is its focus on output growth and productivity as if these were the ultimate aims of public investment. As discussed earlier, only the criterion of growth in economic welfare reflects the standard that the objective of public policy should be improved living standards.

III. A POLICY FRAMEWORK FOR PROMOTING GROWTH-ORIENTED INFRASTRUCTURE INVESTMENT

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, the federal government needs to establish incentives for states and localities to apply growth-oriented decision criteria and related appraisal methodologies. Since 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.

A. Appropriate Decision Criteria and Appraisal Methodologies For Obtaining Federal Investment Funds

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 has often been the technique of choice, since it reflects the underlying employment-oriented objective of most current infrastructure programs.

Economic Rate of Return as the Basic Decision Criterion

If economic growth is to be singled out as the principal objective of infrastructure investment, 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. The shareholders are, in effect, the public at-large, and it is the public's economic welfare, as defined earlier, that the infrastructure manager should seek to maximize.

Benefit-Cost Analysis, supplemented with studies of industrial logistics and risk analysis, represents the appropriate appraisal methodology 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 maximization objective. In practical application, it facilitates the identification of public investments:

- that yield productivity and output growth;
- that 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
- that 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 declared aims of the Clinton administration.

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 shown in Table 1, each of these interrelated criteria provides useful decision-support information. Net present

value, (NPV) for example, allows investment alternatives to be ranked in order of their contribution to economic growth.

Table 1

KEY MEASURES OF PRODUCTIVITY AND ECONOMIC GROWTH		
Measure of Worth	Definition	Interpretation
Net Present Value	Present-day value of benefits minus present-day value of costs.	NPV greater than zero means project is economically efficient. Projects are ranked according to NPV.
Rate of Return	The discount rate at which NPV=0	Rate of return should exceed pre-set hurdle rate to qualify for consideration.
Benefit-Cost Ratio	Present value of benefits divided by the present value of costs. Indicates dollars of benefits per \$1.00 of cost.	A ratio of greater than one means the project is worthwhile.
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.

To be sure, Benefit-Cost Analysis is not without its shortcomings. There can be problems in valuing the benefits and costs of environmental amenities and harms. And 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, however, that provide state and local planners with accessible techniques of measuring these effects.²⁶

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 helped to address this problem.²⁷ 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.

B. Creating the Right Federal Program Incentives

If growth-oriented federal program 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, we can accept that the federal capital-rationing process is a political and

allocational one and as such we can expect the dissemination of federal capital to reflect certain political purposes and distributional aims. But if at a minimum, federal 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 federal investment programs accordingly means:

- integrating economic growth objectives and related decision criteria into the federal government's 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.

As discussed next, accomplishing these requirements is a matter of advancing already developing trends.

Integrating Economic Growth Objectives and Decision Criteria into the Federal 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 Highway Performance and Monitoring System (HPMS) discussed earlier evolved to serve that requirement. Based on the analysis of thousands of highway sections and bridges, over time it has become a standard planning tool in most states as well.

Since 1990 the Federal Highway Administration 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 since, integrated into the biennial Section 307 Condition and Performance Report, it will provide the Congress with a basis for establishing infrastructure budget appropriations that are grounded in desirable engineering *and* economic characteristics of highway and bridge infrastructure. FHWA is presently developing the means by which to integrate these economic measurements into the Section 307 reporting process. Similar mechanisms have begun to be developed in the transit and aviation fields.

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 Decision Criterion

Since the HPMS is pervasive at the state level, the rate-of-return extensions outlined above can be expected to influence the orientation of highway 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. Multi-modal extensions of these systems, now under consideration by the federal Department of Transportation, 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 as an Appraisal Methodology for Individual Programs and Projects

The HPMS and related systems help establish broad spending targets; missing from the discussion thus far is the critical question of identifying *individual programs and projects* with regard for economic growth. Certainly, it would not be practical to require a rate-of-return appraisal for each of the literally 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 National Cooperative Highway Research Program, the Congressional Budget Office and the Federal Highway Administration 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 on-going 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 surface transportation investment planning process. The ISTEA establishes the **Transportation Improvement Plan (TIP)** as the major planning document for securing federal financial assistance. All highway and transit projects proposed for federal capital assistance must be included and prioritized in the TIP after first being subject to a specified analysis process. Without amending the legislation, the federal government could establish the consideration of economic rate of return as a required element in this process, a step that would have the added advantage of encouraging multi-modal choices and priorities to be established according to economic growth decision criteria. States, which 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 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 as a basis for program and project approval. The federal government 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** developed by the National Cooperative Highway Research Program is already serving this purpose informally.

A similar mechanism is needed for aviation infrastructure investment, and could be incorporated into legislation reauthorizing the Aviation Trust Fund.

IV. CONCLUSION AND RECOMMENDATIONS

If the federal program design requirements outlined in Section III above are met, public transportation investment capital can be guided to its highest and best use, namely high-yield, productivity-oriented projects serving economic growth objectives. In application, the appropriate objectives, decision criteria and assessment tools would signal, on an on-going basis, an appropriate level of transportation infrastructure spending both within and beyond a period of deficit reduction.

Without such a signaling mechanism, on the other hand, merely increasing the quantity of infrastructure spending will not put public investment to work in helping revitalize the nation's economy. Indeed, such expenditures could place a further burden on the economy, by displacing more productive private-sector investment.

The analysis presented here also has implications for the use of infrastructure spending as a means of short-term economic stimulus. While "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 the creation of new employment.

ABOUT THE AUTHOR

David Lewis earned a Ph.D. in Economics from the London School of Economics. During his seven years with the Congressional Budget Office, he served as a Principal Analyst in the Natural Resources and Commerce Division conducting policy analysis in surface transportation, aviation and risk management. As Chief Economist for Canada's Office of the Auditor General, Dr. Lewis conducted a range of investigations into the efficiency of cost-recoverable government programs. Since 1985, he has been Chief Economist and Partner-in-Charge of U.S. Operations of the Hickling Corporation. He is recipient of the Saltzman Prize awarded by Harvard's *Journal of Policy Analysis and Management* and the Elmer B. Staats U.S. Comptroller General Medal awarded by the *International Journal of Government Auditing*. This paper draws on his work at the Congressional Budget Office and subsequent research commissioned by the American Association of State Highway and Transportation Officials in cooperation with the Federal Highway Administration. A portion of the research reported here was conducted by Dr. Lewis under the Cooperative Research Programs Division of the Transportation Research Board of the National Research Council. The opinions and conclusions are those of the author.

ENDNOTES

1. For a useful review, see Robert Solow, et al., "U.S. Economic Growth," *Scientific American* (June 1988).
2. Cited in David Lewis, Daniel Hara, and Joseph Revis, "The Role of Public Infrastructure in the 21st Century," in *A Look Ahead: Year 2020* (Transportation Research Board, 1988).
3. David Lewis, *Primer on Transportation, Productivity and Economic Development*, (National Cooperative Highway Research Program, Report 342, September 1991).
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 Section III), it too would be facing the chimera of phenomenal rates of return due to pent-up earning potential.
5. *Airport Adequacy Study*, prepared for the Metropolitan Council of the Twin Cities, (Hickling Corporation, September 1988) and *An Assessment of Airside Capacity Expansion Options*, prepared for the Canadian Department of Transport (Hickling Corporation, March, 1991).
6. Congressional Budget Office, using Federal Highway Administration data.
7. *Ibid.*
8. David Lewis, *Improving the Air Traffic Control System: An Assessment of the National Airspace System Plan* (Congressional Budget Office, April 1983—later revisited by the Mitre Corporation, September, 1987).
9. Michael Deich, *How Federal Spending for Infrastructure and Other Public Investments Affects the Economy* (Congressional Budget Office, July, 1991).
10. Unpublished Working Paper prepared for National Cooperative Highway Research Program, Project 1-17(4), "Measuring the Relationship Between Freight Transportation and the Economy," (Hickling Corporation, September 1992). This finding is emerging in on-going research which has yet to be published or endorsed by the research sponsor, the National Research Council.
11. *Ibid.*
12. *Op. cit.*, *Primer on Transportation, Productivity and Economic Development*.

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, 1989).
14. *Macroeconomic Analysis of Capacity Enhancement at Lester B. Pearson International Airport*, (Hickling Corporation, 1990). Later follow-up analysis suggested some employment gains during the region's recession of 1991/1992. These were seen to be short-lived, however.
15. This is not all that different from rate-of-return computations made in private firms since federal environmental regulations tend to force companies to internalize, if imperfectly, the cost of mitigating significant environmental costs.
16. *Op. cit.*, *An Assessment of Airside Capacity Expansion Options*.
17. Economists would argue that compensation and mitigation should not be financed by taxing the project's beneficiaries since 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.
18. *Op. cit.*, *Primer on Transportation, Productivity and Economic Development*.
19. David Lewis, *The Interstate Highway System: Issues and Options* (Congressional Budget Office, June, 1982).
20. David Alan Aschauer, "Is Public Expenditure Productive?" *Journal of Monetary Economics* (March 1989), 23, pp. 177-200.
21. Alicia H. Munnell, "Why has Productivity Declined? Productivity and Public Investment," *New England Economic Review* (Federal Reserve Bank of Boston, January/February, 1990).

22. Alicia H. Munnell, "Infrastructure Investment and Economic Growth," *Journal of Economic Perspectives*, Volume 6, Number 4 (Fall 1992), pp. 189–198.
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 (see earlier).
25. *Assessing the Relationship Between Transportation Infrastructure and Productivity; Searching for Solutions*, A Policy Discussion Series, Number 4, Washington, D.C.: Federal Highway Administration, August 1992.
26. These techniques are being developed under a research program sponsored by the National Academy of Sciences (National Research Council) and managed by the Transportation Research Board. See also *op. cit.*, *Primer on Transportation, Productivity and Economic Development*.
27. 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.