Technical Memorandum for Transportation: an Investment in Florida's Future

CUTR
Technical Memorandum

for

TRANSPORTATION: An Investment in Florida’s Future

Prepared for:

Florida Transportation Commission

and

Floridians for Better Transportation

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1.0. Introduction

This memorandum describes the methodologies used in "TRANSPORTATION: An Investment in Florida's Future." That report describes research into the economic value of transportation infrastructure conducted by the Center for Urban Transportation Research for the Florida Transportation Commission and Floridians for Better Transportation.

The next section of this memorandum discusses general issues regarding transportation investments. The third section describes the various methodologies that were considered for the study and the ones that were selected. The final section describes the application of the methodologies.

2.0. Investments in Transportation and Economic Development

Investments in transportation infrastructure, whether highways, rail, seaports, or airports, promote economic development by lowering transportation costs. There are two initial groups of beneficiaries of these reduced costs: (1) individual users who enjoy travel time savings, and (2) business firms whose goods are more efficiently transported. But a word of caution is required. The changes in real income and the changes in asset values (i.e., increased property values that result from reductions in transportation costs) are overlapping manifestations of the same basic benefits. In some cases, increases in real income may be capitalized into asset values. For example, the asset value of real property may be increased as a result of improved highway access. Therefore, it is important to avoid the trap of "double counting" by including in the evaluation both the cost saving benefits and the increases in real income and asset values that are created from the cost savings.

Current research supports the assertion that transportation is a necessary but not sufficient condition for economic development. For our evaluation, economic development refers to the process by which the real income that individuals derive from economic activity increases. In this framework, increases in real income are benefits, while decreases are costs. Infrastructure improvements generate quantifiable benefits only to the extent that they lower transportation costs. The cost savings come in many forms including decreased travel time and operating costs and reduced air pollution and traffic accidents. Consequently, a transportation investment is efficient only if it lowers transportation costs such that the net benefits are positive.

The distribution of investment benefits may accrue to more than just the individuals and
businesses who use the new infrastructure. Depending on market structure, lower transportation costs can translate into lower prices for consumer goods, higher real wages for workers, or increased profits for business firms, all of which increase real income. Therefore, persons other than those who use the improved infrastructure may benefit from the investment. This may be used as an argument in favor of such investments.

3.0. Methodologies

The economic value of public capital investments, of which transportation infrastructure is a subset, is not easily or precisely measured. Current methods and models tend to measure either the benefits of only part of an investment or the benefits flowing to only part of the beneficiaries. For example, the Highway Economics Requirement System (HERS) model described later measures the benefits only of highway investments. The production function analysis described later measures the benefits of all transportation infrastructure investment but it measures only the benefits flowing to firms. It does not measure the benefits flowing directly to individual users of transportation facilities.

One common benefit of highway investments is reduced travel time. The HERS model calculates the value of this saved time to individual commuters and the value to businesses of reduced trucking costs, for instance. The production function analysis calculates the increase in productivity that results from decreases in business costs, such as trucking, and increases in productivity that result from new techniques made possible by the infrastructure investment, such as just-in-time production technologies. Therefore, the production function analysis is a more comprehensive measure of the productivity benefits realized by the business community than the simple calculation of the direct user benefits using the HERS model.

On the other hand, the HERS model gives a more complete picture of the total benefits realized by both business and non-business users of transportation facilities. It also is important to note that there is some overlap in what is measured by all of the methodologies described below. In the cases of the production function and HERS methods, for example, both measure user benefits realized by businesses, while in addition each measures other benefits. Consequently, the results achieved with one methodology cannot be added to the results achieved from another methodology; otherwise, there would be some double counting. No one methodology gives a complete picture of the value of investments in transportation infrastructure; each one looks at the question from a different perspective and gives a partial answer.

One of the dangers of looking at a question from several different perspectives is that several partial answers may tend to confuse rather than enlighten the audience. Since we know that a precise measurement of the value of transportation investment is not possible, our goal here is to present the magnitude of the impact of such investment while being conservative in our quantification of the benefits. Our selection of methodologies, therefore, was designed to present the most comprehensive picture of the impacts, albeit incomplete and, therefore, conservative.
3.1. Input-Output Analysis

Input-output models often are used to measure the construction-period impacts of infrastructure expenditures. These benefits include increased employment and earnings, as construction workers are hired to build the infrastructure and increased output, as demand for construction materials increases.

An important characteristic of input-output models is their ability to measure the indirect as well as the direct impacts of infrastructure expenditures. For example, an increase in the demand for steel will result in increases in demand for all the inputs to the steel industry, such as coal, and all the industries supplying the steel industry will experience increases in output, employment, and earnings that can be measured by input-output models. The increased earnings will be spent on a variety of goods and services that have no direct relationship to transportation, and these effects too can be measured.

A common input-output model used for transportation impact studies is the Regional Input-Output Modeling System (RIMS II) developed by the U.S. Department of Commerce.

3.2. Production Function Analysis

A production function is a description of the relationship in an organization between its production (or output) and its inputs (typically labor, capital, and land). Production function analysis as used in this study examines how—from a statewide standpoint—the transportation infrastructure component of "capital" has changed over time and how that change has affected output, which in this case is total state output of goods and services. An important point to note is that, generally, when one of a firm's inputs is increased, output increases. For instance, if transportation capital is increased while labor is held constant, output will increase, and labor, therefore, has become more productive.

In recent times, the most important measure of productivity has been labor productivity, measured as output per hour of work time. Discussions of labor productivity have become so frequent in our current culture that "productivity" usually refers to "labor productivity."

Generally, the productivity of any input is measured as the ratio of units of output divided by the amount of the input used. Productivity is important because it is the benchmark upon which the compensation paid to inputs is based. Generally, when productivity goes up, this compensation tends to rise. Thus, the wages paid to labor, the profits earned by capital, and the rents paid toward land depend in large part on productivity. As capital is increased or improved, the resulting increase in labor productivity tends to exert upward pressure on wages, profits, and rents—three of the key components of income. As income increases, so does spending, leading to more production and more income.

Increases in productivity also have a beneficial effect on price inflation through a reduction in
unit labor costs. As long as productivity rises faster than wages, the pressure on costs and, thus, inflation, will be downward.

David Aschauer [1989] used the economic theory of production discussed above as his starting point to examine the effects of reduced levels of appropriations for public works in the 1970s and 1980s. A simplified version of his hypothesis considers the conceptual and statistical influence that public sector capital might have on private productivity. Many private industries are heavily dependent upon public infrastructure as an input to their overall production process. For example, trucking firms are dependent upon the publicly funded road and street systems, along with drivers and trucks. If the concepts discussed above apply to the labor, private capital, and public infrastructure used by truckers, then an increase in the quality and quantity of public roads and streets would tend to raise trucking productivity. Conversely, a decrease in the quality and quantity of public roads and streets would tend to lower productivity. A more efficient trucking industry would have some combination of higher profits, lower costs, and, in some cases, potentially lower freight rates. The productivity gains of trucking would rapidly spread throughout the economy, accruing to shareholders and customers first, and later to the customers of customers and so on, until the effects spread throughout the national economy.

3.3. Benefit-Cost Analysis

A traditional method used to measure the economic contribution of transportation investments is the use of benefit-cost analysis. This approach is typically used to compare the discounted economic benefits to the discounted economic costs of proposed transportation investments. If the comparison shows benefits in excess of costs, then the project is deemed desirable. The user benefits of a proposed transportation investment typically consist of time savings, vehicle operating cost savings, and accident cost savings. Stylized modeling techniques are applied to determine the travel time, operating costs, and accident costs of a no-build or base case relative to the state of affairs that would prevail if the project was actually built.

Benefit-cost analysis may be used to measure the economic impacts of transportation investments in a number of ways. Ordinarily, prospective project assessment methods that gauge the desirability of projects may be applied directly to a predefined set of proposed projects. Alternatively, retrospective analysis may be conducted by evaluating the effects of excluding existing infrastructure improvements that have already been made to the network.

Benefit-cost analysis is widely accepted and well understood. Although it is heavily dependent upon the assumptions regarding the value of time, the value of the discount rate, and the presumed value of a human life, such analysis can provide compelling evidence of the impact of the transportation system on citizen’s lives. In the absence of local area data sufficiently rich to demonstrate the linkage between transportation investments and economic well being, benefit-cost analysis can be interpreted as an estimate of the value-in-use of the transportation system. As such, it is an intermediate step between transportation expenditures and ultimate macroeconomic impact.

The most serious limitation on the use of benefit-cost analysis to gauge the effects of
transportation investments upon the Florida economy is the lack of data and concise analytical techniques for assessing non-highway modes, such as aviation, intercity rail, and seaports. Consequently, the user benefits calculated in this study are for highway investments only.

4.0. Application of Methodologies

Because of the danger discussed earlier of using too many methods to describe a particular phenomenon, such as the economic return on a transportation investment, it was decided to limit the quantitative part of the study to the analysis of productivity benefits and user benefits. Benefit-cost analysis using the HERS model to calculate user benefits gives perhaps the most comprehensive picture of the long-term benefits of investments in transportation infrastructure. The productivity benefits calculated using production function analysis duplicate to some extent user benefits but they help explain the impact of transportation investments on the business community. Other benefits could be presented, such as construction-period benefits calculated using the RIMS II input-output model, but it was felt that additional numbers would be more confusing than enlightening. In addition to the quantitative analyses conducted, case studies were developed to provide a qualitative feel for the impacts of transportation investments.

Relevant details of the production function and benefit-cost analyses are presented below.

4.1. Production Function Analysis

Several methods were used to estimate the relationship between public capital stock and the productivity of private capital in Florida using the following equation model:

\[
\frac{\text{GSP}}{\text{KP}} = \alpha_0 + \alpha_1 \frac{L}{\text{KP}} + \alpha_2 \frac{\text{KG}}{\text{KP}} + \alpha_3 \text{CU} + \epsilon
\]

where \(GSP/KP\) is the logarithm of the ratio of gross state product in year \(t\) and private capital stock in year \(t\); \(L/KP\) is the logarithm of the ratio of private sector labor in year \(t\) and private capital stock in year \(t\); \(KG/KP\) is the logarithm of the ratio of public and private capital stocks in year \(t\); and \(CU\) is the logarithm of the capacity utilization rate in year \(t\).

The dependent variable \(GSP/KP\) can be interpreted as the amount of private sector goods and services that can be obtained from the current stock of private plant and equipment. This is a proxy for private sector productivity. Economic theory suggests that the productivity of private capital should be positively related to the following variables:

- the amount of labor services per unit of private capital supplied by households;
- the amount of public capital per unit of private capital made available to the firm;
- the capacity utilization rate during times of economic prosperity (the relationship should be negative during economic downturns.)
The highest and lowest estimated impacts using the above equation are shown in the tables below:

### “High” Regression Results for Output per Unit of Private Capital in Florida

<table>
<thead>
<tr>
<th>Overall F = 3622.91</th>
<th>R² = 0.998</th>
<th>Ordinary Least Squares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanatory Variable</td>
<td>Coefficient</td>
<td>Standard Error</td>
</tr>
<tr>
<td>Constant</td>
<td>9.06542</td>
<td>0.867550</td>
</tr>
<tr>
<td>Labor/Private Capital</td>
<td>0.871515</td>
<td>0.080182</td>
</tr>
<tr>
<td>Public Capital/Private Capital</td>
<td>0.270697</td>
<td>0.149112</td>
</tr>
<tr>
<td>Capacity Utilization Rate</td>
<td>0.049137</td>
<td>0.056664</td>
</tr>
</tbody>
</table>

### “Low” Regression Results for Output per Unit of Private Capital in Florida

<table>
<thead>
<tr>
<th>Overall F = 238.241</th>
<th>R² = 0.982</th>
<th>Cochrane-Orcutt Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanatory Variable</td>
<td>Coefficient</td>
<td>Standard Error</td>
</tr>
<tr>
<td>Rho (autoregressive parameter)</td>
<td>0.806110</td>
<td>0.158156</td>
</tr>
<tr>
<td>Constant</td>
<td>10.2997</td>
<td>0.670390</td>
</tr>
<tr>
<td>Labor/Private Capital</td>
<td>0.998862</td>
<td>0.068404</td>
</tr>
<tr>
<td>Public Capital/Private Capital</td>
<td>0.086619</td>
<td>0.103974</td>
</tr>
<tr>
<td>Capacity Utilization Rate</td>
<td>0.005305</td>
<td>0.034024</td>
</tr>
</tbody>
</table>

The shaded rows in each of the tables measure the direct relationship between public capital stock and the productivity of private capital. The “High” table shows a strong, statistically significant relationship between infrastructure and the productivity of private plant and equipment; the “Low” table shows a weak, insignificant (not different from zero) relationship. Other methods produced coefficients with values and significance levels scattered between the two extremes given above.

The estimated effect reported in the “High” table suggests that a one percent increase in public capital may increase private capital productivity and gross state product by as much as 0.27 percent, holding all other independent variables in the model constant. At the opposite extreme, the “Low” table suggests that the impact on private capital productivity and output may be as low as 0.09 percent—essentially zero. The midpoint between 0.27 and zero (a bit more extreme
than the “Low” table value) is about 0.135. Interestingly, this value is consistent with the average value reported in previous state-level studies, about 0.14, as shown below.

<table>
<thead>
<tr>
<th>Researcher(s):</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moomaw and Williams [1991]</td>
<td>0.25</td>
</tr>
<tr>
<td>Costa, Elison, and Martin [1987]</td>
<td>0.20</td>
</tr>
<tr>
<td>Munnell [1990b]</td>
<td>0.15</td>
</tr>
<tr>
<td>Munnell [1990b]</td>
<td>0.06</td>
</tr>
<tr>
<td>Garcia-Mila and McGuire [1993]</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Average of five studies:</strong></td>
<td><strong>0.14</strong></td>
</tr>
</tbody>
</table>

The results reported above deal with percentage changes only (i.e., elasticities). A final measure of the “bottom line” is the dollar-for-dollar impact of public infrastructure on gross state product—the totality of economic activity carried on within the state of Florida. That is, the actual return on investments in infrastructure is dependent on the total dollars invested and the state’s total output, as shown in the calculations below. These calculations apply the elasticity of 0.14 to Florida’s total investment in public capital and total output to determine how much that output will increase for each additional dollar invested in infrastructure.

At the midpoint value of 0.14, the following relationship is true when all other variables are held constant:

\[
\frac{\text{Percentage Change in Output}}{\text{Percentage Change in Public Capital}} = 0.14
\]

This may be rewritten as:

\[
\frac{(\text{Change in Output})/\text{Output}}{(\text{Change in Public Capital})/\text{Public Capital}} = 0.14
\]

and as:

\[
\text{Change in Output} = \frac{\text{Output}}{\text{Public Capital}} \times 0.14 \times \text{Change in Public Capital}
\]

Statistically derived results are usually converted at the average values of observable variables. Substitution of the 1969-89 sample averages for gross state product and public capital capital yields:
Change in Output = ( $101,482 million / $44,686 million ) × 0.14 × Change in Public Capital
= 0.31794 × Change in Public Capital.

The results may be extended to include the 1992 base year used for the benefit-cost analysis. Adding data for 1990, 1991, and 1992 to the 1969-89 sample averages for gross state product and public capital yields:

Change in Output = ( $122,518 million / $45,764 million ) × 0.14 × Change in Public Capital
= 0.374804 × Change in Public Capital.

The midpoint of these two figures is 0.346372, rounded to 0.35. This means that for every one dollar invested in Florida's public capital, total output will increase annually by $0.35 for the life of the investment. In other words, there is a 35 percent annual return on the investment.

4.1.1. Production Function Data Assumptions and Sources

The category of public capital includes not only construction and preliminary design and engineering of the state's transportation system, but also includes other public construction investments. Non-transportation public construction includes public education facilities, public communications and utilities, and public housing. However, in evaluating infrastructure investments by type, Aschauer found that transportation and public utilities have the most dramatic effect on state output. Munnell's results also found the impact of infrastructure, of which transportation is the largest part, to be stronger than that of other public investments.

Gross State Product Data
Gross state product time series data for the state of Florida were obtained from the U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, December 1991.

Employment Data
The employment series used in the model included annual data on the total number of full-time and part-time employees for the years 1969 to 1989. These data are prepared by the U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Measurement Division.

Private and Public Capital Data
The data set used for this analysis incorporates both a private capital stock and public capital stock series, covering the period 1969 to 1989. These series were developed using a modified perpetual inventory method. Initial stock estimates were obtained from Jose da Silva Costa, Richard W. Ellson, and Randolph C. Martin, "Public Capital, Regional Output and Development: Some Empirical Evidence," *Journal of Regional Science*, Fall 1987. Using data from the U.S. Department of Commerce, Bureau of Economic Analysis, Costa *et. al.* apportioned national capital stock by state. The private capital stock series for Florida was constructed by adding investment data to the published private capital stock value for Florida and then subtracting discards and
depreciation. A similar procedure was used to construct the public stock series. Data on the annual value of public and private investment were obtained from Dodge data adjusted by the Executive Office of the Governor, Revenue and Economic Analysis Unit.

Capacity Utilization Data
Capacity utilization data were obtained from the Board of Governors of the Federal Reserve System, *Federal Reserve Bulletin*. FR-1.3.

4.2. Benefit-Cost Analysis

The latest model available for the calculation of highway user benefits is the Highway Economic Requirements System (HERS) developed for the Federal Highway Administration. HERS is an analytical software system that performs highway needs analyses. Measurement of needs is based upon current highway system condition and estimated costs and benefits of candidate improvement projects. The system may be used to determine costs, benefits, and some of the economic impacts of competing highway improvement policies. HERS may be run at the national or state level to develop dollar estimates of pavement, capacity, and alignment improvement needs as a part of a long-range planning process.

HERS can estimate either the benefits derived from a given level of highway funding or the funding required to achieve specific highway system performance targets. The system includes three types of user benefits (travel time, operating costs, and accident costs) and two types of agency benefits (maintenance costs and the salvage value of improvements). HERS allows users to incorporate constraints on the allowable highway system conditions and to specify an objective for each analytic scenario. HERS uses the Highway Performance Monitoring System (HPMS) database as the starting point for all analyses. HERS and HPMS use "sample sections," which represent a large number of actual highway sections. HERS estimates of costs and benefits are obtained by analyzing individual sample sections and multiplying the results by the appropriate expansion factor (i.e., 1.0/Sampling Rate).

HERS starts with the base-year highway system conditions in the HPMS data, forecasts changes to the system, and analyzes potential improvements for each of the funding periods that comprise the planning horizon. HERS calculates changes in traffic volume and pavement condition, identifies and evaluates potential improvements to be made, selects those improvements that best meet the user-specified objectives, and simulates the implementation of these improvements. If funds are available, appropriate improvements are made to eliminate unacceptable conditions. Additional improvements to correct less-pressing deficiencies are then selected on the basis of benefit cost analysis until available funds are consumed or highway system performance targets have been met.

HERS produces an extensive variety of statistical reports for each run. These statistics describe changes in highway system performance, improvements selected by the system, and the costs and benefits of these improvements.
The calculation of user benefits using the HERS model is a straightforward matter of entering values for the variables in the model and then running the model. Based on an investment level that would maintain the current highway conditions for the next 20 years, the model indicates that each dollar invested would result in an increase in user benefits of $2.86. This includes travel time savings of $1.49, vehicle operating cost savings of $.83, and accident cost savings of $.54. The assumptions and values used in the model are outlined below.

4.2.1. Benefit-Cost Assumptions

- The average hourly values of time by vehicle type used in the HERS model are the USDOT rather than FDOT default values because they provide a more complete list of values for the HERS model. They differ somewhat from FDOT’s values but are generally comparable:

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>HERS</th>
<th>FDOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Autos</td>
<td>$9.59</td>
<td>$N.A.</td>
</tr>
<tr>
<td>Medium Autos</td>
<td>9.59</td>
<td>$N.A.</td>
</tr>
<tr>
<td>All Autos</td>
<td>N.A.</td>
<td>11.12</td>
</tr>
<tr>
<td>4-Tire Trucks</td>
<td>10.87</td>
<td>$N.A.</td>
</tr>
<tr>
<td>2-Axle, 6-Tire Trucks</td>
<td>20.42</td>
<td>$N.A.</td>
</tr>
<tr>
<td>Pick-up Trucks</td>
<td>13.53</td>
<td>11.12</td>
</tr>
<tr>
<td>3+-Axle Single-Unit Trucks</td>
<td>23.34</td>
<td>16.13</td>
</tr>
<tr>
<td>3- and 4-Axle Combinations</td>
<td>25.94</td>
<td>20.13</td>
</tr>
<tr>
<td>5+-Axle Combinations</td>
<td>26.09</td>
<td>22.35</td>
</tr>
</tbody>
</table>

- The value of time was updated to 1992 dollars with the U.S. Bureau of Labor Statistics Consumer Price Index. The 1988 to 1992 update factor used was 1.193.

- The cost values for fuel, vehicle depreciation, and vehicle maintenance used in the HERS calculations are based on 1988 prices. Operating cost characteristics are based on statistical models developed by FHWA based on the 1982 vehicle fleet.

- Vehicle operating cost figures were updated to 1992 dollars through the use of U.S. Department of Commerce price indices for Consumer Expenditures on Motor Vehicles and Parts, Fuel, and Transportation Services.

- The 1988 dollar values of accidents (the preferred term is "crashes") by type were obtained from FHWA:
  - $2,723,000 for fatal crashes
  - $229,000 for incapacitating injury crashes
  - $48,000 for non-incapacitating injury crashes
  - $4,500 for property damage only crashes

- The dollar values of crashes were updated to 1992 dollars with the U.S. Bureau of Labor Statistics Consumer Price Index.
The discount rate used in the analysis was seven percent per year. FDOT currently uses the seven percent rate for its analysis activities. The rate is slightly inconsistent with FHWA's accident costs, which were calculated with a four percent rate.

Nationwide construction costs, adjusted for state differentials, were used to measure improvement costs rather than FDOT-specific costs due to a lack of uniformity between improvements tracked by the HERS model and those tabulated by FDOT. In addition, FDOT has no embedded estimate of right-of-way cost in its analytical estimates, but HERS does.

5.0. Principal Research Team Members

CUTR assembled a team of experienced transportation economists to undertake this study. The team included CUTR's experts in economic impact studies and nationally prominent economists from other research organizations. The team members from the research firms of Hickling Lewis Broad Inc., and Apogee Research, Inc., are especially versed in the relationship between transportation investments and business productivity. They have published numerous articles on the subject and have performed studies for such clients as the American Association of State Highway and Transportation Officials, Army Corp of Engineers, Federal Highway Administration, Federal Transit Administration, and Transportation Research Board.

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6.0. Bibliography


*Exploring the Application of Benefit/Cost Methodologies to Transportation Infrastructure Decisionmaking*, Department of Transportation, Transportation Research Board, American Society of Civil Engineers, Tampa, FL, May 14, 1995.


Mudge, Richard R., Apogee Research, Inc., *Statement of Principles and Guidelines: Improving the Quality of Infrastructure Investments*, for Advisory Commission on Intergovernmental Relations.


Perera, Max H., *Framework for Classifying and Evaluating Economic Impacts Caused by a Transportation Improvement*, Transportation Research Board, Record 1274.

