COMPARING APPROACHES FOR VALUING ECONOMIC DEVELOPMENT BENEFITS OF TRANSPORTATION PROJECTS

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ABSTRACT

COMPARING APPROACHES FOR VALUING ECONOMIC DEVELOPMENT BENEFITS OF TRANSPORTATION PROJECTS

by Glen Weisbrod and Michael Grovak

Transportation agencies are facing increasingly complex pressures for prioritizing and selecting projects. One of the most controversial and continuing issues has been the choice of alternative definitions and approaches for assessing the economic magnitude of benefits of proposed projects and programs. To shed light on the issue, this paper examines and contrasts alternative types of economic impact analysis. It focuses primarily on measures relating to economic development, which is frequently cited as a primary goal for state and local highway investment projects. Data and findings from a new highway study in Kentucky are used to explore: (1) differences in the definitions of economic benefits inherent in the various types of analysis, (2) reasons for their differing findings on the value of benefits, and (3) issues affecting their interpretation and use for decision-making.

1. INTRODUCTION

The Problem. The process of estimating potential benefits of transportation spending is important for planning in three ways: (1) establishing budgets and category allocations, (2) selecting among alternative projects (given a fixed budget), and (3) selecting design alternatives for a given project.

In the past, a variety of different approaches have been used to examine benefits of alternative projects or programs by transportation planning agencies. Various forms of transportation impacts modeling, economic modeling and/or environmental impact analysis methods have been employed. The existence of different approaches is not surprising given that motivations also vary widely. Sometimes these studies are included as part of a required Environmental Impact Statement (EIS), and sometimes as a benefit/cost requirement of federal or state agencies. Nevertheless, the result is inconsistency among highway studies in terms of the types of benefits being measured and their interpretation for policy and decision-making.

The Need. Transportation agencies need to understand implications of different approaches to measuring benefits, in terms of effects on conclusions and interpretations. This paper explores three issues:

(1) How are alternative definitions of benefits estimated in economic (money) terms?
(2) How and why do they differ in findings on project benefits?
(3) How should they be interpreted and used for decision-making?

In order to further illustrate the relevance and impacts of these alternative measurement methods, their application for a highway project in Kentucky is also discussed. The findings here can help to also assure appropriate application of benefit measures for planning purposes, for benefit-cost analysis and for other forms of analysis and decision-making. However, this paper focuses just on the above three questions in terms of benefit measurement, and not on their subsequent use for benefit-cost comparison or other applications.

2. BACKGROUND

Different Objectives and Viewpoints. Economic theory and textbooks are very clear on how to use benefit-cost analysis for project selection -- just select the choice that optimizes the net benefit. Operationalizing that approach is, however, far from straightforward. The first problem is deciding what is a benefit. Many books and articles on cost-benefit analysis note the legitimate existence of different approaches and viewpoints for defining benefits, which depend in part on how program goals and objectives are defined [1, 2, 3]. These texts lead us to consider at least four key issues concerning the definition of transportation project <u>benefits</u>:

(1) in terms of what *goals* –economic prosperity, quality of life, environment, safety, security?
(2) from what *viewpoint* –local, state, regional, national, global?
(3) for whose *welfare* –residents, businesses, travelers, others?
(4) for what *time* –in terms of value for the present, or for future generations?

To address each of these issues in practice is more complex than basic economic theory:

(1) In theory, there is no issue of how to define benefits or *goals*, for all types of benefits can be expressed in terms of consumer value (willingness-to-pay). In practice, the measurement and assignment of money values for some types of benefits are highly controversial. Attempting to transform all environmental and quality-of-life impacts into purely monetary terms can actually reduce the public acceptance of an impact analysis.

(2) In theory, there is no issue of how to select a spatial *viewpoint*, for total benefits can be measured for all of "society". In practice, there can be radically different impacts at local, state, national and global levels and the difference among those benefits can be of intense interest for decision-makers at different levels of government.

(3) In theory, impacts on subgroup *welfare* (i.e., distributional equity) need not be a concern in benefit/cost analysis, since differences in benefits among groups can be solved with compensation paid by those benefiting the most to those who are harmed, so that everyone is better off (the Kaldor-Hicks criterion). In practice, such cross-compensation usually does not occur, so it can be important to consider the distribution of benefits among subgroups.

(4) In theory, *long-term benefits* can all be calculated in terms of a net present value. In practice, there can be strategic considerations even when payback is beyond the effective range of net present value calculations. That may include investing money now to preserve rights-of-way or development options for future generations.

Alternative Perspectives on Economic Impacts. This paper focuses primarily on economic impacts in the context of one particular type of transportation project goal -- that of promoting "economic development." Since economic development is frequently cited as a primary goal for highway investment projects, it is important to understand how economic impacts can be measured and how that measurement relates to interpretations of project benefits.

One problem is that the concept of economic development is itself vague. The National Council for Urban Economic Development has recently devoted an entire report to that topic [4]. In general, economic developers seek to improve the economic opportunities and economic well-being for residents of specific areas in the face of competitive economic forces that would otherwise hold down (or reduce) them. The areas may be neighborhoods, cities, regions or entire countries. For economic developers, job growth is the most common measure of economic opportunity for workers, and income growth is the most common measure of their economic well-being.

However, a variety of other effects lead to economic development, including improvements in transportation system efficiency in serving users, increases in business productivity (and output) facilitated by transportation improvements, and improvements in other environmental and quality of life factors, which also affect business growth, property values and economic well-being. As a result, we can see economic development as an aspect of broader economic impacts. We can also understand that many different agencies have different perspectives on economic impact priorities, measures and associated analysis methods. This has helped lead to the emergence of several distinct types of economic analysis, each measuring benefits differently and each pursued by different proponents. They include:

- system efficiency (user benefit) analysis
- macro-economic simulation modeling
- productivity analysis
- strategic planning (scenario) analysis
- social welfare (full cost) analysis.

Since each type of analysis has a different objective, these various approaches can be seen as essentially complementary rather than competing. Depending on the specific analysis goals, some or all may be appropriate.

Project Application. To illustrate how project benefits can be measured in different ways, this paper examines selected findings from the economic impact study conducted for the Kentucky Transportation Cabinet (KYTC) for Kentucky Highway 69 (KY 69) [5]. The existing highway segment is a 37-mile segment of 2-lane road connecting from US 60 to the William H. Natcher Parkway in Northwest Kentucky. The economic impact analysis focused on assessment of potential impacts associated with replacing the existing 2-lane road with a 4-lane facility. Impacts were analyzed in terms of effects on the highway network, residents, and businesses for a primary impact study area of 8 counties, the rest of Kentucky, and all out-of-state areas.

The rest of this paper examines similarities, differences and complementarities among the five above-cited types of economic benefit analysis. Each type of analysis is discussed in terms of: (1)

measurement definitions, (2) analytic methods used for the KY 69 study, (3) results for the proposed KY 69 project and (4) issues concerning its appropriate application. As in any real world example, it was decided that not all of the alternative types of analysis were equally applicable and relevant for this particular project. However, the comparison of results among the different types of analysis, and the reasons why some of them were not fully applied in this case, are both of interest and value to help guide future project evaluations.

3. SYSTEM EFFICIENCY (USER BENEFIT) ANALYSIS

Measure. System efficiency is the traditional measure of benefit for transportation investment projects. It measures benefits in terms of the improvement in travel time, travel expense and safety for travelers, all expressed in terms of a money value. This method is described in detail in the AASHTO Red Book [6] and HERS Manual [7].

Analysis. For this study, traffic network models were developed to represent origin-destination patterns and levels of daily traffic for other roads (network links) within the study area, the rest of the state and external areas. Trips were distinguished in terms of truck and automobile trips, and between work and non-work trips. The models were used to estimate total vehicle kilometers of travel (VKT) and vehicle hours of travel (VHT) for KY 69 and for other roads in the study area or elsewhere in Kentucky.

In this case, the proposed highway improvements were forecast to have the following effects: (1) there would be a 3% shortening of the highway length, which would reduce travel time and cost; (2) there would be an increase in average speeds from 50.4 to 63.2 mph on KY 69, which would further reduce travel time but increase vehicle operating costs due to lower fuel economy and higher operating costs at higher speeds; and (3) some trips would be attracted from other parallel routings to the improved KY 69, reflecting reduced travel times, although causing some offsetting increases in distances and operating costs.

Results. A summary of the user benefits is shown in Table 1. In this particular case, the greatest system efficiency benefits were in terms of improved safety, associated with replacing a curving 2-lane road (without passing lanes) with a 4-lane road (with passing lanes). The modest benefits in terms of travel time and operating cost reflect the usage levels of the road. For cars, the value of time savings is roughly offset by costs of fuel consumption at higher speeds. However, for trucks there are additional cost savings due to the reduction in stops, speed changes and grade changes.

Overall, trips with at least one trip end originating or ending in the study area accounted for 60% of the VKT (travel distance) savings and 55% of the VHT (travel time) savings. The Rest of State was forecast to receive 30% of the VKT and 38% of the VMT savings. The remainder of the benefits were allocated to out-of-state (primarily Indiana) origins and destinations. For the planning year (year 25 after completion of the road), total annual user benefits for KY-based trips is projected to be nearly $13 million.

Table 1. Value of User Benefits for Year 25 Due to KY 69 Improvement

Trip Type	Benefit	Study Area	Rest of State	Total State
Auto: Work	Safety	$1,015,000	$3,821,000	$4,836,000
	Time	$1,247,000	$603,000	$1,850,000
	Oper Cost	-$391,000	-$1,472,000	-$1,863,000
Auto: Non-Work	Safety	$1,196,000	$4,548,000	$5,744,000
	Time	$1,365,000	$661,000	$2,026,000
	Oper Cost	-$491,000	-$1,867,000	-$2,358,000
Truck: Work	Safety	$352,000	$1,341,000	$1,693,000
	Time	$263,000	$127,000	$390,000
	Oper Cost	$127,000	$482,000	$609,000
TOTAL	---	$4,683,000	$8,244,000	$12,927,000

Note: Value for vehicle operating costs were based on AASHTO [6]; values of time and safety costs were based on HERS [7]. All values were updated to 1996 dollars based on applicable consumer and producer price indexes.

Issues. It is important to note that this methodology includes direct estimates of the full value of user benefits for all trips on the highway network --including KY 69 users, trips that may be diverted from elsewhere to KY 69, and trips remaining off of KY 69. This approach of directly estimating the full system-wide user benefits using a network model is preferred over the more approximate approach of approximating "consumer surplus" by assigning diverted trips a benefit that is one-half of the benefit of improvement enjoyed for existing trips. The latter approach is most applicable when the valuation of user benefits for diverted trips cannot be directly estimated.

The advantage of this type of analysis is that it is straightforward. The disadvantage is that it values only direct benefits to highway system users, and the level of those benefits reflect only a limited set of factors – direct costs, traveler time and accident costs. The incremental values of any additional benefits to users as well as non-users (e.g., environmental improvement from reduced vehicle emissions or business value from improved network connections, intermodal linkages, logistic opportunities or business scale expansion) are typically not accounted for. It should also be noted that in this type of study, benefits to out-of-state residents passing through Kentucky and benefits to those living in Kentucky are both counted as traveler benefits occurring within Kentucky.

4. MACRO-ECONOMIC SIMULATION MODELING

Measure. Regional macro-economic simulation models can be used to estimate the economic impact of transportation projects as a consequence of cost savings and other productivity benefits. Economic simulation and forecasting models allow us to estimate impacts on "cost competitiveness of business," "cost of living" and shift in business growth and location factors over time. This approach measures impacts in terms of effects on employment, income and value added (Gross Domestic Product). It has the advantage that it can reflect economic benefits to non-users, although it also ignores other types of benefits which do not affect flows of money.

This economic modeling approach builds upon a methodology applied for Wisconsin highways, and subsequently applied in a variety of other states [8].

Analysis - Applying a Regional Model. The REMI (Regional Economic Models, Inc.) simulation model effectively combines four functions: (1) forecasting -- projecting changes in population, employment, business sales and profits over 40 years; (2) policy impact -- estimating how policies change prices and business costs in each industry and affect the competitive position and local share of national growth; (3) input-output analysis -- accounting for the inter-industry flows of dollars and the associated indirect and induced economic effects; and (4) population -- changes in population migration in response to changes in demand for labor, wage levels, living costs and amenities [9].

For this study, the long-term impacts of the improved road were specified to define the project's direct effects in terms of seven classes of input variables for the REMI model:

- Additional Spending associated with highway construction and maintenance, generating "demand" (i.e., purchases) of labor, equipment and materials for selected years;
- Shifts in Consumer Expenditures associated with highway system user impacts on vehicle speeds, miles of travel and safety -- affecting purchases of fuel, vehicle maintenance services and medical care;
- Reduction in Business Costs associated with business time and expense savings for truck and "on-the-clock" automobile travel -- increasing business productivity and improving relative competitive position for attracting a larger share of national business growth;
- Increase in Personal Disposable Income associated with household savings on fuel and vehicle maintenance -- increasing spending on other goods and services;
- Increased "Amenity Value" associated with safety improvements -- increasing the attractiveness for in-migration of population into the area;
- Additional Employment Attracted to the Area because of market expansion and logistic economies -- increasing business sales (output) in the area; and
- Additional Tourism Attracted to the Area because of improved access -- generating purchases of tourism-related goods and services, and demand for labor and materials.

Step 1: Translating User Benefits to Economic Consequences. For this study, the first step in defining economic model inputs was to translate the user benefits into effects on flows of dollars. The following factors determined the translation to REMI model inputs for this study:

- Safety. The safety benefits only affect incomes insofar as they are broad enough to affect insurance rates and hospital staffing and/or the attractiveness of locating in the region (indirectly creating income through increases in values of property sold to new residents).
- Operating Cost. Direct operating cost savings for trucks is a real cost savings for business. However, in this case there are negative overall cost savings (i.e., higher net operating costs) for car trips, due to lower fuel economy at higher speeds. That represents a loss of disposable income for residents, although it does generate more gas station sales.

- Travel Time. (1) The time savings for trucks and “on-the-clock” work trips for cars are likely to be a real cost savings for business. (2) The portion of car travel time savings associated with commuting to/from work only affects business costs when it affects employee work hours or prevailing wage rates (applicable mostly in competitive urban labor markets). (3) The portion of car travel time savings associated with non-work trips is a real quality of life benefit, but does not directly affect the flows of income and spending; however, it can increase area attractiveness for in-migration and thus affect regional income in the long-term.

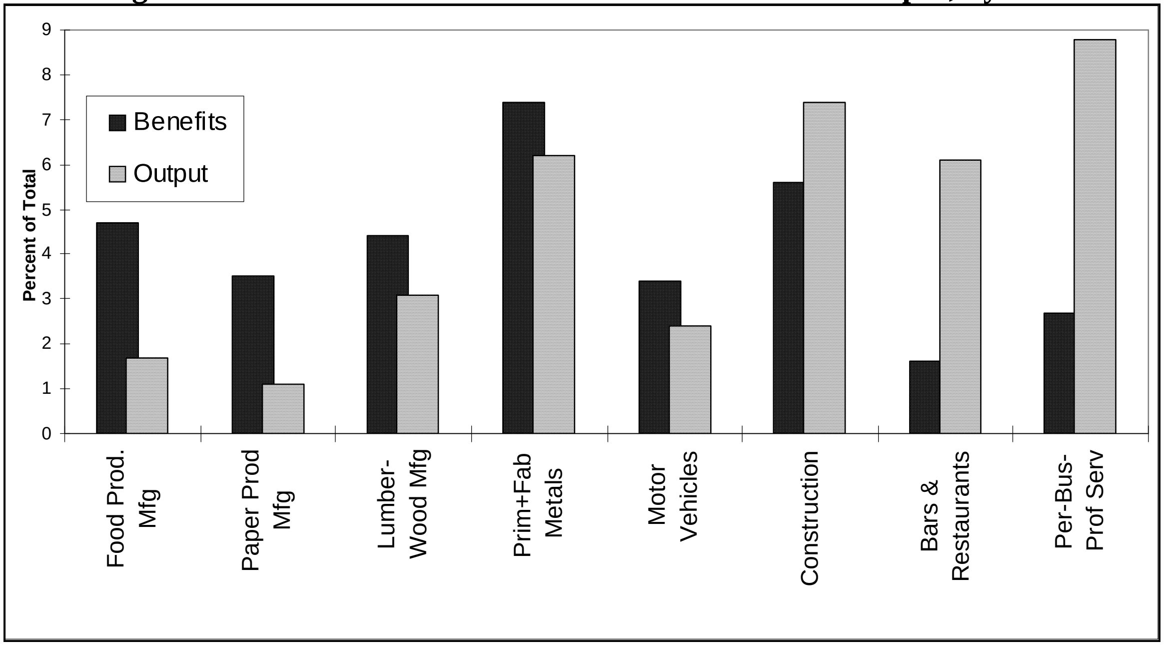
Step 2: Allocation of Benefits to Economic Sectors. The second step in preparing economic model inputs was to allocate the benefits to various types of existing businesses located within the study area or elsewhere in Kentucky. The allocation of benefits among business sectors is important because local business sectors differ in: (1) relative reliance on KY 69, (2) relative sensitivity to transportation cost changes and (3) relative competitive position and expansion potential associated with changes in that cost competitiveness.

The allocation of business cost benefits was calculated as follows: For each business sector, we define $\mathbf{A_s = B_s * C_s * D_s}$ where: $\mathbf{A_s}$ is \$ of total business benefit accruing to sector “s”; $\mathbf{B_s}$ is total \$ of business activity in sector “s”; $\mathbf{C_s}$ is % of business activity in sector “s” spent on highway-related costs; and $\mathbf{D_s}$ is % of total highway travel by sector “s” that can benefit from KY 69 improvement. Thus the portion of trucking and on-the-clock auto benefit accruing to a given business sector (s=1) is defined as $(\mathbf{A_{(s=1)} / \Sigma A_s})$.

For this study, values for $\mathbf{B_s}$ (business activity by SIC group) came from state economic data. The values for $\mathbf{C_s}$ (share of business cost spent on road travel) was the sum of two elements: (a) the portion of business cost associated with purchases of trucking services and (b) the portion of business cost spent on “in-house transportation” -- i.e., company-owned vehicles, their maintenance and fuel, and company-employed drivers and mechanics. Prior studies that ignored this second element are likely to have under-estimated transportation impacts, as recent research indicates that it can account for up to half of all trucking activities [10]. The values for $\mathbf{D_s}$ (use of KY 69) came from a survey of shipping patterns conducted for this study, paralleling a prior study conducted for Wisconsin [8].

Figure 1 illustrates the allocation of overall truck benefits to various industry sectors (values of $\mathbf{A_s}$) within the study area, and shows how they differ from the overall mix of industry output in the study area (values of $\mathbf{B_s}$). This illustrates the importance of assembling information on shipping patterns. Prior studies that lacked data on the spatial pattern of shipments are likely to have mis-allocated industry benefits, since some industries have shipping patterns that do not benefit from the highway improvement, while others can benefit substantially from it.

Figure 1. Portion of Total User Benefit and Economic Output, by SIC



Note: User benefit is here defined as the portion of work-related travel benefits shown in Table 1; economic output is here defined as the portion of business sales volume occurring in the study area.

Step 3: Estimation of Logistic and Market Effects. The third step was to estimate the additional impact on attraction of tourism and business activity resulting from economic efficiency and productivity benefits which are above-and-beyond the already-estimated direct user benefit impacts on business cost. These factors include additional industrial business attraction and tourism activity associated with the opening of access to new and more diverse suppliers, and market and transportation connections for businesses locating in the study area (which in turn can allow firms to employ new or improved ways of producing and delivering goods and services) [11]. A series of techniques were used, including: (1) market estimation models to assess opportunities for expanded market boundaries and scale economies for commerce and tourism in the study area, (2) interviews of business, economic development and tourism professionals, and (3) surveys of business expectations. The analysis led to a finding that logistic and market effects could lead to business attraction representing an increase of 0.2% of total study area business output, but up to 6% in certain industries. The additional business attraction was forecast as a result of the following factors:

- Study Area: North-South Access – Enhanced access between the Ohio River region and the southern half of the study area (W. Kentucky) would support expansion of the market for use of Ohio river port and mainline rail facilities, improved shipment and delivery access to points south for the area's aluminum plants, and further attraction of office furniture, machinery and automotive parts industries.
- South Access Extension – Enhanced access continuing southwest along the Western KY Parkway, and continuing south via the Natcher Parkway, would support access to the new "auto alley," including locations in Bowling Green, KY and (via I-65 to) TN, and further support market growth of automotive plastics and chemical-related industries.

- North Access Extension – Enhanced access from the study area to southern Indiana, if extended via IN 37, would improve access to I-64 and its connection to auto plants in IN and KY. That would create further opportunities for shipping of automotive components. Plans for developing a new multi-modal river port facility would add to the potential attractiveness of the northern study area.
- Tourism Expansion – Expansion of tourism access could expand the out-of-state market for three large music and food festivals, and increase the market for budding tourism development at the birthplace of Bill Monroe, the father of Bluegrass music.

Results. REMI model results are shown in Table 2 and Figure 2. For the study area, the forecast is for a potential economic expansion of over 400 jobs once the project is completed, slowly growing to over 500 jobs by year 25. Associated with that job growth is a net increase in personal income growing to $20 million/year.

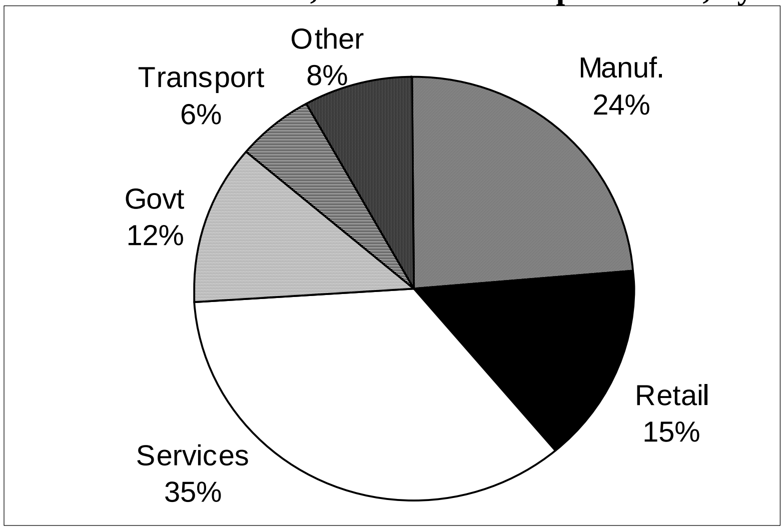
The overall statewide benefits differ from the study area benefits because statewide accounting: (1) adds trucking cost savings benefits to businesses located elsewhere in the state, (2) adds spillover benefits of study area industry attraction, and (3) deletes a portion of tourism impacts which are a redistribution of visitor trips from elsewhere in the state. The overall statewide benefits are slightly higher than the study area benefits. They represent an increase of over 550 jobs once the project is completed, growing to over 650 jobs by year 25. Associated with that is a net increase in personal income growing to as much as $36.5 million/year, which can be compared to the previously-shown user benefit estimate of $13 million/year.

Table 2. Overall Economic Impacts of KY 69 Improvement (Annual, Year 25)

	Study Area	Rest of State	Total State
Business Sales (Output)*	$74.7	$8.7	$83.4
Gross Regional Product*	$34.8	$6.3	$41.1
Personal Income*	$30.2	$6.3	$36.5
Population	1166	250	1416
Employment	541	117	658

Source: Forecasts by the REMI economic simulation model. All dollar amounts are in millions of 1996 dollars; personal income also reflects wage and price changes.

Figure 2. Mix of Job Benefits, due to KY 69 Improvement, by Industry



Source: year 25 economic forecasts from the REMI simulation model.

Issues. This type of analysis assesses transportation project benefits in terms of jobs and income growth. The advantage of this analysis is that it accounts for transportation effects of cost savings, productivity enhancement and market growth (scale economies), and their impacts on business expansion, competitiveness and attraction of economic activity from elsewhere. That means that -- with sufficient external analysis of spatial factors (such as logistic and market scale economies) -- it can account for the full business value of transportation system improvements.

A limitation of this analysis, though, is that it accounts only for effects on private sector business income and consumer income. It places no value on activities of individuals that do not involve wages paid, and there is little or no value placed on social, environmental and quality of life benefits (including many aspects of personal time savings and safety) except insofar as they lead to an exchange of money. Perversely, costs incurred to treat or mitigate such problems are recognized as increases in economic output. As a result, transportation projects that improve quality of life can sometimes have the effect of reducing business output (for example, when a safety improvement leads to a loss of jobs and output in medical care, insurance and public safety activities.)

It is also important to note that this type of analysis combines various types of benefits to which we can assign varying degrees of confidence and likelihood. In this case, some of the benefits -- e.g., those associated with time, cost and income effects -- are fairly sure to occur. Other types of benefits --`e.g., those associated with safety improvements -- are dependent on assumptions concerning consumer valuation of accident reductions. Yet other types of benefits -- e.g., those associated with industry and tourism market expansion and scale economies -- are likely to occur although their magnitude is also dependent on other marketing and facilities investment actions.

5. PRODUCTIVITY ANALYSIS

Measures. Productivity research examines how highway investments affect private sector productivity (level of output per dollar of inputs), and hence generated income. Impacts can be measured in terms of net business costs, business output, productivity (cost/output ratio) or implied value of (willingness to pay for) additional highway spending benefits. Unlike the other analytic approaches discussed in this paper, this approach (in its current form) does not make use of project-level transportation network analysis. Rather, it builds upon aggregate-level data to calibrate cost models (or production models) to identify typical levels of private sector business performance gains associated with highway investment.

An advantage of this approach is that it yields estimates of overall impacts on various types of business, which encompass all of the effects of logistics and market scale economies that were crudely estimated on a project-specific basis for the economic simulation modeling (previously discussed). A major limitation of this approach is that it utilizes historical data to calibrate models relating productivity increases to levels of highway inventory rather than actual accessibility improvements. As a result, the productivity factors represent average impacts of past spending on the economic performance of various industries and regions. (For reviews of studies around the world, see [12, 13].) Research to date has focused on the impacts of highway inventory expansion (usually represented as dollars of capital stock) and is not sensitive to differences in the nature of accessibility improvements provided by various projects. However, several lines of current study, including an FHWA-sponsored study of establishment-level productivity and an NCHRP study of urban congestion impacts, are seeking to develop measures of localized productivity impacts linked to changes in highway accessibility rather than levels of highway inventory.

Analysis. Productivity analysis is an area of ongoing research, in which new and more useful results are still emerging. Some of the most useful available information are research findings concerning how business benefits of highway spending (increasing the value of highway inventory) vary by state/region and by business type (SIC group). We can utilize such information to estimate a corresponding value for the study area. Recent work by Nadiri [12] provides updated U.S. estimates of the marginal benefit to business per dollar of "non-local" highway capital (i.e., excluding local streets), by 2-digit SIC group. That marginal benefit to the national economy represents the sum of what each industry would be willing to pay for an additional dollar of highway capital. The benefit is found to vary widely by industry. In general, it is greatest for manufacturing industries such as wood, chemical, and metal products, as well as machinery and motor vehicles. We can apply the SIC-specific benefit figures together with the study area's profile of business activity by SIC in order to estimate a weighted average of the expected total marginal benefit associated with highway spending in that area.

Overall, Nadiri reports that the marginal benefits to industry over the 1950-1989 period has averaged $0.23 per year for each dollar of capital stock of highways. However, the benefits of highway spending in the last decade have been more modest than in the early decades, presumably since more recent projects have been aimed at enhancing connections for the national highway system while earlier-year expenditures were building the basic Interstate system. As a result, the most recent data indicates that the marginal benefit from non-local highway capital has been slightly less than half of the 40-year average. (It is important to note that these are estimates of marginal benefit per dollar of highway capital investment, which are different from the rate of return on highway spending, since the latter also requires a significant additional adjustment for the financing of public capital. However, since this paper focuses just on benefit measurement, the nature of that adjustment is not relevant here.)

To calculate appropriate estimates of the marginal benefits for this study, we must: (1) recalculate the overall rate of marginal benefit to business using weights representing the applicable industry mix of business activity for the proposed highway in the study area, and (2) calculate the proposed highway project's contribution to the dollar value of highway capital stock.

Results. Applying marginal benefit data with the specific mix of economic activity in the highway study area (refer to Figure 1) yields a revised set of weights for calculating the rate of marginal benefits to business. The result is a regionalized estimate of 0.18, compared to the previously-discussed national average of 0.23. Adjusting this regionalized estimate to the most recent decade yields a revised value of 0.09. That means that if the proposed highway project was to add $129 million of highway capital (its construction cost) and have a typical return on its investment, then the resulting marginal benefit to business nationally would be $11.6 million per year.

There are many additional factors that would have to be accounted for, in order to appropriately complete this analysis for the KY 69 project. While current expectations are that the KY 69 project would cost $129 million for construction (not counting costs of engineering, right-of-way and utility work), the project's actual contribution to highway capital stock (and hence its benefit to business) will depend on whether there is further spending in subsequent years at a rate which maintains its quality and functionality up to the standard of the new road. In the national study discussed above, a "perpetual inventory" approach was used to calculate highway capital stock. That approach accumulates the value of highway spending over time, and depreciates it over the typical useful life of highway projects. The depreciation factor is supposed to reflect decay in the economic performance of highway stock over time, except insofar as that decay is offset by new spending to maintain the facilities. Additional factors, such as assumptions regarding economic efficiency factors (assumed to be 90% in the national study), can also affect the calculated economic benefit of highway spending.

Thus, we find that by crudely applying the indices discussed above, we derive estimates of business benefit that could be as much as $11.6 million, depending on a variety of assumptions, including the extent to which there is subsequent spending to maintain highway performance. This benefit differs from the other economic benefit measures discussed in this paper in the following ways:

- It is merely a "benchmark," representing the average business benefit achieved by *past* highway spending around the country rather than the actual business benefit likely for this particular case.
- It accounts only for private sector business benefits and excludes the additional consumer economic benefits of highway improvements (which are included in the user benefit and

macro-economic simulation approaches). Other benefits not affecting the flow of dollars (which are also included in user benefit measures) are also excluded here.

- It accounts for national-level benefits, which means that it includes benefits to out-of-state businesses (which are missed in the other statewide benefit measures). However, benefits for businesses moving into the state are valued only in terms of their net value to business rather than their gross contribution to regional income (as counted in the regional application of the macro-economic modeling approach).
- It measures business willingness-to-pay for highway spending, which reflects effects on net business income rather than effects on personal income. (In general, businesses pass on some but not all of their cost savings or additional income to customers and workers).

If we take these differences into account, then two findings emerge: (1) The level of business productivity benefit estimated by this benchmark is roughly double the value of the user benefit measure attributable to work-related trips. (That is plausible, given that the user benefit measures, shown in Table 1, counted only direct traveler-related impact). (2) The level of business productivity noted here would be consistent with the GDP impact forecast by the macro-economic modeling approach if we assume that 15% of the inter-state shifts associated with industry attraction into Kentucky reflect net productivity benefit at the national level. (That, too, is plausible although at this juncture the development of productivity benefit estimates for this specific highway is very imprecise).

Issues. The definition of benefits under this type of analysis is typically narrower than that used for macro-economic modeling, as most productivity studies to date have focused just on private sector (production) impacts and ignored consumer economic benefits. That definition of benefits could eventually be broadened. At present, findings from productivity research have primarily been used as a means of testing the return on broad highway spending programs. As such, this approach is most useful to help inform policy-level decision-makers regarding the allocation of public funds to transportation improvements. A possible further use, demonstrated here, could be to customize and apply those findings for specific types of highway projects in specific areas. Further research on highway accessibility and highway capital stock accounting is needed to make this additional use applicable for localized planning and evaluation. Eventually, such research could be useful to provide "benchmarks" for comparing economic returns from alternative spending options. However, this approach currently has very limited application for individual project evaluation.

6. STRATEGIC PLANNING (SCENARIO) ANALYSIS

Measures. Transportation projects are sometimes justified as an element of economic development strategies, which seek to achieve either offensive economic goals (to improve the competitive position and economic well-being of an area form its current position) or defensive goals (to protect the competitive position and economic well-being of an area from loss). A fundamental aspect of economic development strategies is the determination of the most appropriate strategies given an assessment of current and potential future scenarios. In theory, strategic factors can all be considered in the framework of a benefit-cost analysis that considers the net present value of all possible future alternative scenarios. In practice, it can be more useful for decision-making to separately consider alternative scenarios, their upside opportunities and downside risks, their probabilities and their own preferences for risk aversion. This type of approach is sometimes referred to as "risk analysis" or "risk/benefit" analysis. It can also be important for considering project effects on land use or development options for future generations -- benefits that may start beyond the effective range of net present value calculations.

Analysis. The development of scenarios is typically based on "SWOT Assessment" -- considering current and anticipated future competitive strengths, weaknesses, opportunities and threats facing the area's economic position. Alternative scenarios can then be constructed that represent actions by competitors that may shift the competitive balance, as well as more global economic and technology changes. For each scenario, its likelihood and contingent factors affecting that likelihood (including whether or not the highway project is completed) can then be considered. The responses of competing areas can also be considered, in terms of the following questions:

- What if we *do invest* in the project to increase our area's competitive economic position?
  …Is it likely to succeed in improving or protecting our competitive position?
  …Will competing areas initiate their own investments to counteract any advantage to us?
- What if we *do not invest* in the project?
  …Is our economy likely to grow less or decline more, or will it remain the same?

The KY 69 study considered the effects of exogenous factors on future results, but did not assume that there would be any changes in the plans of other states or regions. As previously discussed in the context of logistic and market effects, it was recognized that the highway's long-term (35-40 year horizon) economic impacts could be affected by a variety of factors, including:

(1) whether or not there is eventual upgrading of the Indiana highway connection from the northern terminus of KY 69 to the Interstate highway system,

(2) whether or not there is continuation of the emerging pattern of developing automobile parts industries assembly activities within the currently-defined 5-state "auto alley",

(3) whether or not a country music tourist site (Bill Monroe's birthplace) is further developed as a tourist destination, and

(4) whether or not major planned river port improvements are completed.

The number of combinations of assumptions concerning these types of factors can become quite large; for example, there are 16 combinations of the above four contingencies.

Results. The economic impact simulation model results reported previously were based on an assumption that (1) the Indiana highway improvement will not occur, (2) auto parts growth will continue with current trends, (3) some modest river port improvements will occur and (4) Bill Monroe's birthplace will expand modestly (but below the maximum potential identified in the KY 69 report). Other scenarios could lead to higher or lower levels of economic benefits to the study area and the state. To examine the range of possible impacts, the KY 69 study separated out economic impacts of the basic traveler benefits (i.e., those associated with time, cost and income effects) from the economic impacts of logistic and market effects on industry and tourism growth.

Results are summarized in Figure 3. It is notable that the economic impacts of user time and cost benefits are realized immediately, whereas the economic impacts of further business attraction (which is more sensitive to scenario assumptions) phase in over a long time period. Further extension of the study could be done to examine alternative scenarios as illustrated in Figure 4.

Figure 3. Economic Impacts of Various Factors Due to KY 69 Improvement

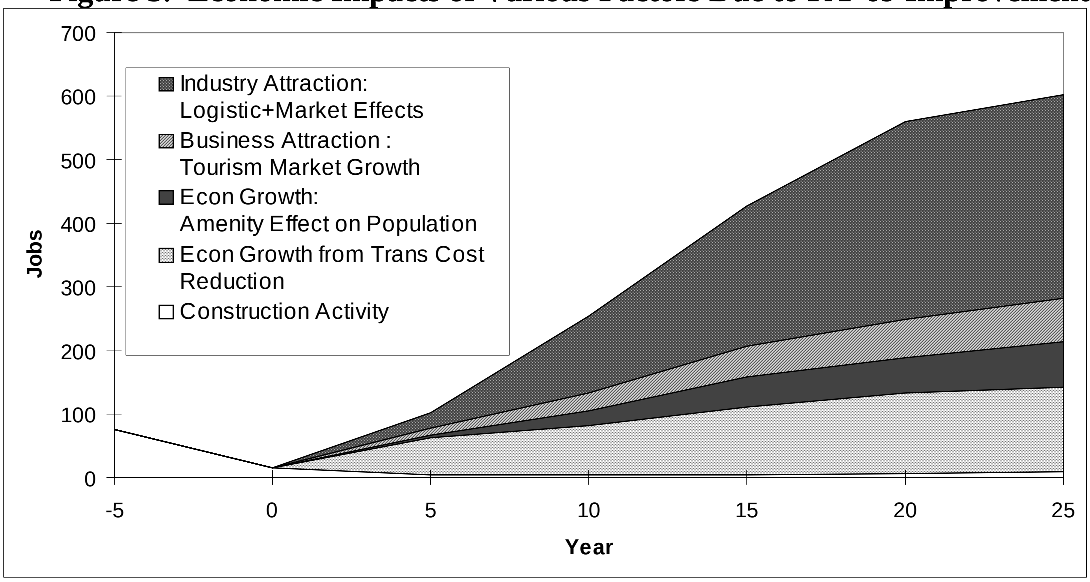
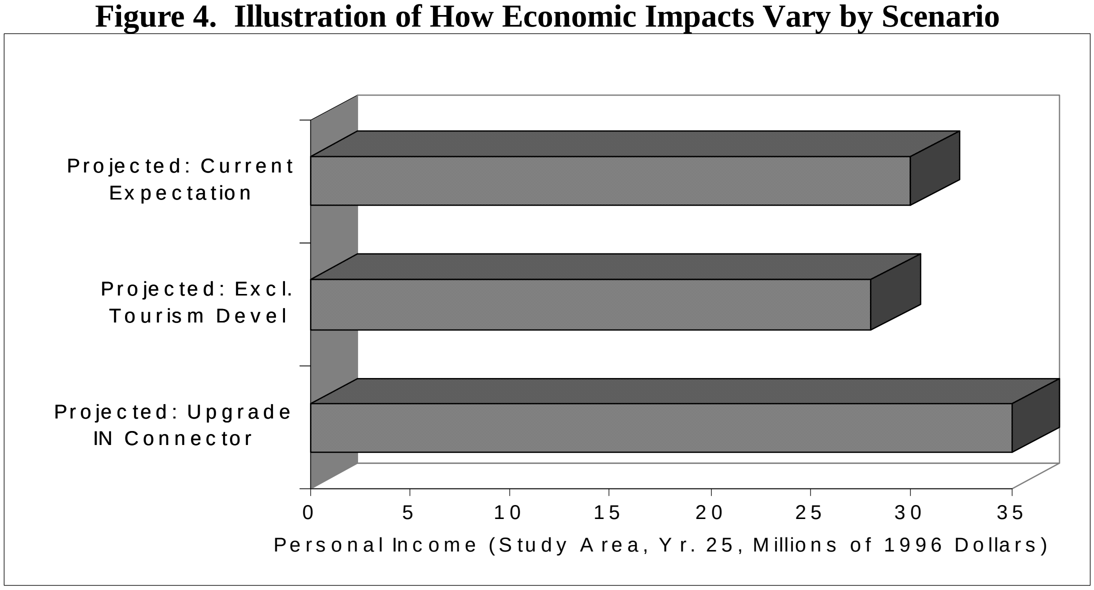


Figure 4. Illustration of How Economic Impacts Vary by Scenario



Issues. Scenario analysis is not an alternative method for measuring impacts, in that it still relies on previously-discussed macro-economic modeling methods to represent the job, income and output impacts of transportation improvements. In that sense, all of the limitations and distortions inherent in measuring economic impacts through economic models remain. However, it does provide an opportunity for identification of external contingencies and competitive strategy factors that may not otherwise be explicitly recognized. Most important, it can be a useful way of identifying upside possibilities and downside risks affecting the economic impacts of projects, and that can be useful for decision-making. Risk factors are typically obscured by simple calculation of net present values for analyzing project benefits. Care must be taken, however, to reasonably define scenarios and avoid a proliferation of too many scenarios that can confuse decision-making. The World Bank is an example of an organization which explicitly considers risk factors and the balance of multiple economic development objectives in its transportation investment decision-making [14].

7. SOCIAL WELFARE ANALYSIS

Measures. Social welfare measures attempt to reflect the value of all impacts of transportation projects -- including user impacts, non-user impacts, environmental impacts and social impacts. They attempt to combine the best of system efficiency (user benefit) analysis and economic simulation modeling (business impact), and add other externality impacts (including environmental and social effects) which are not considered in any of the other methods. Negative externality impacts may be considered to be "disbenefits" (i.e., negative factors that reduce benefits) or "hidden costs" (i.e., additional aspects to be added to derive "full costs"). Either way, care must be taken to avoid double-counting of benefits and costs, as some externality impacts may ultimately be reflected in economic measures through changes in property values or population and business attraction to an area. In theory, this approach can lead decision-makers to a more complete analysis of net project costs and benefits. In practice, its usefulness is limited by lack of consensus on the appropriate valuation of non-economic effects.

Analysis. Overall social welfare may include many factors including:

- for travelers: the full value of their time, cost and safety impacts
- for businesses and employees: the additional value of productivity changes which are over-and-above the already-counted traveler impacts
- for residents and users of affected areas: the value of environmental quality changes including air, water and land use conditions, plus social factors including the distribution of income and economic advancement opportunities.

In money terms, the appropriate valuation of these effects are observed or estimated "willingness to pay" to achieve positive benefits and avoid costs or "disbenefits." This is done in one of two ways:

- For some types of impacts, such as traveler expenses and business productivity changes, the valuation of effects can be directly observed or predicted in terms of changes in disposable income. (For example, travel expenses diminish disposable income and productivity changes create additional jobs and associated disposable income.) Thus, those impacts can be directly related to economic development.

- For other types of impacts, such as environmental quality, the valuation of effects may be reflected in property value changes, depending on market conditions. Otherwise, they have to be inferred from other analyses of willingness-to-pay or calculations of their net effects on disposable income. To the extent that these values are not reflected in changes in personal money income or wealth, then they are social benefits but not economic benefits.

A wide variety of studies -- beyond the scope of this paper -- have examined the value of externality benefits and costs associated with transportation projects. These include studies of broader social values and costs associated with air pollution, energy depletion, loss of undeveloped land, etc. They are discussed in several reviews of the "full costs" of transportation [15, 16, 17].

The remaining category of impacts are social impacts, including the distribution of income and opportunities. Distributional factors may not affect the sum total of project benefits, but they may nevertheless be of importance for decision-making. For economic developers, there may be interest in issues of job types, tax and income redistribution, and visibility in improving depressed areas. While these factors have typically not been included in benefit-cost analysis, a composite methodology developed for Chicago shows how they can be considered. That "mid-level methodology" weights the value of benefits by income class and adds a composite scoring system within a broader implementation of benefit-cost analysis [18].

Results. Analysis for the proposed KY 69 project explicitly focused on economic and not social welfare benefits. Data were assembled on the breakdown of economic benefits to consumers and businesses, valued in terms of willingness-to-pay or income equivalent. Benefits to businesses were valued in terms of their impacts on disposable income for Kentucky residents. Non-business benefits to individuals were counted in terms of their net effects on disposable income, or else in terms of their effects on the flow of income from increasing population inflow (in the case of the amenity factors). However, no additional analysis was done to monetize or analyze the value of environmental or social factors for this particular study. In this case, that decision can be attributed to a particular interest in encouraging more economic development (job and income creation) in the affected part of the state, with no immediately obvious environmental sensitivities at stake.

Issues. This type of analysis has the advantage that in its full application, distortions present in other benefit measurement approaches (including under-counts and biases) can theoretically all be corrected. For instance, the omission of additional economic benefits attributable to logistic and scale economies -- which are typically ignored in user benefit studies --can here be accounted for. Likewise, the distortions in national macro-economic accounting -- in which safety problems, environmental cleanup and fuel consumption act as positive factors creating jobs -- can here be offset by their negative values to consumers. The major limitation with this type of analysis is that the appropriate valuation of environmental externalities remains a point of considerable contention, and that acts to limit the broad acceptability of social welfare impact assessment measures for decision-making. In the minds of some decision makers, as well as segments of the public, an issue remains as to whether it is philosophically appropriate to estimate a monetary value for certain environmental or social factors (e.g., habitat changes which do not significantly affect human activity).

8. CONCLUSIONS

The types of analysis discussed here reflect differences in terms of: (1) definition of the beneficiary (e.g., travelers, businesses or residents), and (2) breadth of benefits included (e.g., varying degrees of coverage of business operating economies, quality of life and environmental factors). They also require different analytic methods (e.g., traffic network models, economic simulation models and/or statistical ratio factors), involving different levels of cost, complexity and accuracy.

In general, the more comprehensive types of analysis attempt to capture factors which are less certain and harder to quantify in monetary terms. The most straightforward type of analysis – system efficiency modeling of traveler impacts – is most common, and is applicable for evaluation of individual transportation projects. In practice, however, it is narrow -- the valuations of travel time and travel cost savings commonly used for such analysis ignore some elements of business efficiency and quality of life factors which are captured by the broader approaches of macro-economic modeling and social welfare analysis. The tradeoff is that these broader approaches require more data and more assumptions, which can then limit the confidence and precision of their results.

As a consequence, system efficiency measurement can be applicable for nearly any transportation project, while macro-economic modeling is most applicable for large-scale projects with significant city/county or larger scale economic impacts. The broadest possible definition of impacts – the social welfare measure – is also that with the least precision, and the inclusion of environmental impacts also leads it to be applied most frequently for policies and programs with broad societal (e.g., national or global-level) impacts. The other two approaches – strategic planning analysis and productivity analysis – can be best viewed as methods for addressing special purposes (the former for recognizing contingencies in decision-making and the latter for more general public investment prioritization). The appropriate selection among these various types of analysis must be made by considering the type and purpose of the transportation project, the intended use of the analysis results, and the scale of the impact to be studied.

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