Integrating Multiple Economic Analysis Methods for More Effective Decision-making: A Three Dimensional Framework

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Prepared by:

Glen Weisbrod (corresponding author)
Telephone: +1-617-338-6775, x202
Email: gweisbrod@edrgroup.com

Chandler Duncan
Email: cduncan@edrgroup.com

Economic Development Research Group, Inc.
155 Federal Street, Suite 600, Boston, MA 02110 USA
Fax: +1-617-338-1174

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ABSTRACT

The infrastructure planning process typically requires broad consideration of the benefits, costs and impacts of proposed projects. Economists have been known to bemoan the fact that benefit-cost analysis is usually not the core of public decision-making, and that decisions are more likely to depend on judgment calls and "political considerations" to cover all of the considerations of importance to stakeholders. In fact, planners and decision-makers are often unclear about how they can use economic analysis methods to inform decision-making, and specifically how they can unsort what appear to be competing methodologies for portraying the consequences of projects: benefit-cost analysis (BCA), economic impact analysis (EIA) and financial impact analysis (FIA). The result can be inappropriate or ineffective use of economic analysis, and failure to match its capabilities to the requirements of infrastructure investment planning.

This paper critically reviews the evolving application of economic analysis techniques for transportation infrastructure investment decision-making, and identifies sources of confusion for analysts and decision-makers. It then introduces a new structure for the application of economic analysis in the planning process. The structure is built upon a unifying framework for viewing the various forms of economic analysis in terms of how they differentially cover a three dimensional universe of space, time and economy elements. The paper shows how a structural framework can be used to match economic analysis techniques to different stakeholder issues and decisions, based on spatial and temporal information requirements that are applicable at different stages of the planning and decision-making process.

Finally, it provides an example of how state agencies can use this framework to bring together information from BCA, EIA and FIA to support decisions regarding investment in a major transportation infrastructure project. This three-dimensional framework can be useful for clarifying the teaching of economic evaluation techniques, and for practical application to help analysts and decision-makers clarify the evaluation of competing projects and associated funding decisions.

1. INTRODUCTION

Overview. The field of economics has over time generated a series of distinct methods for evaluating proposed infrastructure investments in monetary terms, all of which can be applied for transportation investment planning and decision-making. The most notable methods are benefit-cost analysis (BCA), economic impact analysis (EIA) and financial impact analysis (FIA). Each method was initially developed to address a different issue concerning the efficiency, desirability and feasibility of proposed transportation investments. Yet while these methods were designed to address different issues, they have a common element -- which is that they all show the consequences of proposed transportation projects in money units. As of that is not enough cause for confusion, these three methods had also have evolved in ways that have increasingly overlapped in terms of how the breadth of cost savings and income revenue factors that they may cover. As a consequence, transportation planners can face confusion regarding when and how each of these analysis methods may be most appropriately used. It can be postulated that this situation is one reason why transportation planning practitioners do not make more use of economic analysis methods (and particularly BCA) in transportation decision-making. The relative lack of use of economic analysis in decision-making and the need for more systematic analysis has in fact been noted in the economic literature (Thompson, 2008; Sullivan et al, 2008; Eliasson, 2015).

This paper explains how and why overlap among economic analysis methods has evolved, and introduces a unified framework for unsorting the confusion – by laying out how they each method addresses the dimensions of space, time and elements of the economy in different ways, which can then be matched to specific stages in the process of transportation planning and investment decision-making. The framework is a new addition to the field, and it is intended to provide transportation planners with guidance regarding how they can systematically use economic analysis to better inform planning and decision-making at each stage in the transportation planning process. By showing how the different lines of economic analysis can be used together, the framework can also be used by analysts to communicate a broader and more complete "story" regarding the distributional consequences of proposed projects and their implications for public policy. The remainder of this paper has five parts.

- Part 2 discusses the evolution of BCA, EIA and FIA in terms of their differences and overlaps, and how that has led to both greater confusion and greater insights for transportation planners.
- Part 3 lays out the core framework for distinguishing economic analysis methods, by showing how they differ in coverage of a three dimensional universe of space, time and elements of the economy.
- Part 4 shows how the framework can be applied by matching properties of the three economic analysis methods to stages of transportation decision-making, and how this process affects the economic valuation of impacts.
- Part 5 then presents an example of real world uses for this framework, to show how BCA, EIA and FIA can be used together and in a consistent manner to provide a more robust set of findings that can also strengthen the case for planning decisions.

2. HISTORICAL EVOLUTION OF TECHNIQUES AND CONFUSION AMONG THEM

Evolution of Three Techniques. Three key forms of economic analysis are most commonly used in the evaluation of proposed transportation projects, programs and policies:

- Benefit-cost analysis (BCA) measures the *economic efficiency of spending*, in terms of whether the total benefits of a project, program or policy exceeds total costs when compared on a consistent, money-denominated basis. BCA was first introduced as part of infrastructure investment evaluation following the U.S. Federal Navigation Act of 1936, which required formal comparison of benefits and costs for waterways. Over the next twenty years, standards by BCA were more fully developed in terms of social welfare benefits (including valuation of user benefits, externalities and discounting procedures) – an evolution documented by Hufschmidt (2000). By the 1960's, BCA became more widely recognized as part of a broader effort to promote overall efficiency in government, as reflected in the Red Book on road user benefits (AASHTO, 1960). Since that time, there have been continuing efforts to make BCA more complete by incorporating "hard to quantify" and "wider" economic, social and environmental benefits (UK Dept. for Transport, 2005; Weisbrod et al, 2009).

- Economic impact analysis (EIA) measures the pattern and extent to which a project, program or policy leads to *changes in the development of the economy* of a specified area, as measured in in terms of income and employment effects on elements of the economy (industries, households, etc.). The impacts are calculated relative to a counter-factual or "no build" base case. Interest in EIA dates back to the first canals and roads in America, which were justified as strategic investments to extend markets and enable economic growth for specific industries and regions (North, 1961). Formal modeling methods to forecast economic development impacts date to the 1950's as the field of regional science and concepts of inter-regional economic shifts were developed (Isard, 1956), the 1960's when input-output analysis models were refined to portray inter-industry impacts (Leontief, 1966) and 1970's when regional impact forecasting models became available to predict price and cost response impacts based on general equilibrium concepts. (Weisbrod, 2008 provides an overview of these models).

- Financial impact analysis (FIA) measures the *economic feasibility* of investing to develop and then continue operation of a major infrastructure facility or service, as measured in terms of revenues, expenditures, net cash flow and return on investment over time. FIA is important because a project that shows positive BCA and EIA outcomes may nonetheless may be infeasible to build and operate if money cannot be raised to build a facility, loans cannot be repaid to investors, or cash flow cannot be sustained for maintenance of the facility and operation of services on it. Fiscal impact analysis is a subset of FIA that focuses on government revenues and expenses. FIA considerations for infrastructure investment date back to ancient times; the Roman road network was financed using a combination of tolls, taxes and private donations. Use of FIA today has become increasingly important as reliance on privatization, PPP and tolling schemes has grown (FHWA, 2011).

Overlap among techniques. While the calculation methods and objectives of these three analysis techniques are quite distinct, their applications have not always been distinct. Economic development --stimulating regional job and income growth -- was a primary objective of inland waterways, irrigation and flood control investments during the Great Depression. Consequently, early BCA studies during the 1930's included secondary benefits on local and regional economic growth (Hufschmidt, 2000). The Appalachian Development Highway System was similarly motivated by regional economic development objectives, so BCA studies were conducted to consider both the national efficiency benefits and the regional economic development benefits of completing that system (Wilbur Smith, 1998).

After the "Manual on User Benefit Analysis" (Red Book) was updated in 1977, it helped transportation agencies justify investment in those highway projects that provided significant time savings to travelers on high traffic routes. (See AASHTO, 1977.) However, it did little for rural projects intended to attract economic investment and induce economic growth by reducing isolation and better connecting markets. This lead a number of US states (including Wisconsin, Indiana and Montana) to implement state-level BCA evaluations that incorporated wider economic development (income or GDP) growth in place of user benefits for business-related travel (Weisbrod and Beckwith, 1992; Kaliski et al, 1999; Wornum, 2005). More recently, the UK's Transport Appraisal Guidance added "wider economic benefits" (WEB) into its cost benefit calculation, though this was done by identifying additional aspects of GDP impact that can be added to user benefits (UK Dept. for Transport, 2005). While the advantages and limitations of these various approaches may be debated, the fundamental point here is that EIA and BCA considerations can and do intersect. In addition, FIA results are also driven in part by EIA projections. With growing use of toll and value capture methods for financing projects, revenue projections within FIA are increasingly being driven by analysis of regional economic growth impacts.

Overlap in use of technical jargon used for transportation evaluation has also grown, particularly blurring the distinction between measurement of economic *benefits* in BCA and economic *impacts* in EIA. Some researchers use term "economic impact analysis tools" to apply to what have were traditionally known as "benefit cost analysis tools." (Iacono and Levinson, 2009). More recently, the UK guidance substituted the term "wider impact" (UK, 2014) to apply to the GDP elements of a BCA – that were previously known as "wider economic benefits" (UK DfT, 2005). The literature has responded to the overlapping terminology concerning benefits and impacts with additional warnings. BCA guides warn analysts not to incorporate EIA concepts such as input-output multipliers and spatial transfers of activity into BCA calculations (US DOT, 2003; US DOT, 2015). EIA guides warn analysts not to assume that BCA concepts such as travel time and business cost savings can be equated with GDP growth impacts (Cambridge Systematics, 2006; Weisbrod and Reno, 2009). Other researchers have clarified the relation of BCA and EIA in primers that explain how both work (Thompson et al, 2008).

So where do we go from here? The thesis of this paper is that it is not particularly productive to argue about treatment of overlaps among various economic analysis techniques that were never even meant to be addressing the same issues. Rather, it can be far more useful to exploit their differences and establish how each can contribute to better decision-making when applied in the right context. The context is, of course, the formal stages of transportation project planning, funding, prioritization and alternatives analysis – each of which has its own sets of stakeholders and issues. The rest of this paper focuses on how to sort out the decision stage differences and match economic analysis techniques to their address their differing needs.

There is precedence in this approach. For instance, the (US) Environmental Protection Agency has a document, *Guidelines for Preparing Economic Analyses*, which states that "For most practical applications, therefore, a complete economic analysis is comprised of a BCA, an

EIA, and an equity assessment." (EPA, 2010, p.1-5). It further states that "For any regulation, it is essential to ensure consistency between the EIA and the benefit cost analysis (BCA). If a BCA is conducted, the corresponding EIA must be conducted within the same set of analytical assumptions." (EPA, 2010, p. 9-2). That approach is the inspiration for this paper, for it suggests that transportation analysts can also conduct thoughtful analysis that spans multiple analytic techniques. However, in the case of transportation planning, there is a need to consider the relevant decision steps in the transportation planning process, in place of the decision-making steps applicable for evaluating environmental regulations.

3. Three Dimensional Framework for Distinguishing Economic Analysis Methods

To sort out the relationships among these three economic analysis methods, we introduce a framework that highlights differences in how they treat three dimensions of variation in economic activity: (a) space -- i.e., measurement of areas over which effects occur, (b) time -- i.e., measurement of how effects play out over a period of years, and (c) the incidence of effects among elements of the economy – i.e., allocation of effects on households, private businesses and government.

A second part of this framework then matches the dimensional differences to decision requirements occurring at each stage of the transportation planning process. The importance of this approach is two-fold. First, there are a number of stages in the transportation planning process where distributional equity is important and hence there is interest in the allocation of benefits, costs and other impacts across location areas (space) and across segments of society. Second, there are stages in the planning process where achievement of achievement of strategic policy goals (such as future economic development) becomes a consideration, and hence there is also interest in the timing of impacts and their incidence among segments of the economy.

The starting point is developing this framework is a portrayal of dimensional differences among economic analysis techniques, as summarized in Table 1. Key differences and their implications are discussed below, considering each dimension separately. The matching to planning stages is discussed in the next section.

Table 1. Differences in How Economic Analysis Tools Address the Three Dimensions

Time Dimension			
Tool	**Treatment of Time Effects**	**Outcome Metric**	**Interpretation of View**
BCA	Discounted $ *(future year values are diminished by the time value of money)*	Present Value for Net Benefit (B-C) or Benefit Cost Ratio (B/C) *(sum of stream over time)*	Efficiency of Investment *(reflecting roll-up of all benefits and costs over time, space and elements of the economy)*
EIA	Constant $ *(reflects today's $)*	Change in GVA or GDP (and associated jobs, wages) *in specific target years*	Strategic Goal Achievement *(in terms of economic growth for specified areas, times and elements of the economy)*
FIA	Nominal $ *(future year values are increased by inflation growth over time)*	Annual Cash Flow and Return on Investment (ROI) *by year over facility life*	Feasibility of Financing *(in terms of expenditures required and revenues achieved over time)*
Spatial Dimension			
Tool	**Treatment of Spatial Effects**	**Outcomes Covered**	**Excluded Effects**
BCA	Normally "all inclusive" *(but dependent network breadth)*	Total of user benefit plus direct benefit for non-users *located anywhere*	Productivity from economic reorganization *(shifting spatial flow of investment & trade)* (A)
EIA	Specified Study Areas	Effect on economic activity (income and jobs) *within specified areas*	Effects on activity outside of specified areas *(e.g., external trip ends)* (B)
FIA	Specific Facilities or Services	Revenues generated and expenditures made *at specified facilities*	Revenues and expenditures outside of specified facilities
Elements of the Economy (and Society)			
Tool	**Effects on Elements of Society**	**Outcomes Covered**	**Excluded Effects**
BCA	User Benefit (Traveler Benefit) (Transportation System Efficiency)	Total value of user (time, cost, and safety) benefit *for all classes of travelers*	Benefits to non-travelers
BCA	Social Welfare Gain (Societal Benefit)	Total value of user benefit plus non-user benefit *for all households + businesses*	Unmeasured effects *(e.g., productivity from technology adoption and reorganization shifts* (A)
EIA	Economic Impact (Economic Development Impact) (Growth of the Economy)	Effect on economic activity (income and jobs) generated *by business type*	Household cost savings *(spending shift, not income)* and non-money impacts (B)
FIA	Owner or Operator Finances	Net cash flow (revenue - expenditure) *for facility owners and operators*	Non-paying uses, plus cash flow for others *(not owners or operators of specified facilities)*

(A) denotes effects not normally captured in BCA but often captured in EIA
(B) denotes effects that by definition are not captured in EIA but are captured in BCA

The Time Dimension. The three forms of economic analysis differ dramatically in how they measure and portray impacts over time, and this is reflected in their units of measurement. BCA results reflect *discounting of future dollars*, EIA portrays future effects in terms of *constant dollars*, and FIA portrays future effects in terms of *nominal (inflated) dollars*. There are, of course, good reason for these differences which are noted below, along with the assumptions underlying them.

The discounting of future year effects within BCA is fundamental to its interpretation as a measure of investment efficiency, which evaluates benefit streams and cost streams that occur at different times and turns them into a net present value. Inherent in that measurement view is an assumption that there are no cumulative timing effects of concern, i.e., we are indifferent between a smaller benefit occurring in the near term and a larger benefit occurring further in the distance, as long as they lead to the same present value.

The use of constant dollars in EIA reflects its typically use as a means of portraying the cumulative achievement of effects in future target years, relative to today's (constant) dollars. That portrayal of effects in that way reflects its typical use as a means for assessing relative achievement of strategic goals for economic development under alternative future scenarios. Inherent in that measurement view is an assumption that the time path in which changes unfold and their cumulative future impact are a matter of concern.

The use of nominal dollars in FIA is necessary to accurately portray the effect of a project on cash flows for affected parties (e.g., investors and operators of transportation facilities and services). Both the feasibility of obtaining initial project financing and the financial viability of ongoing operations require consideration of how different factors (including inflation) may affect revenue in-flows and expenditure out-flows over time. Inherent in that measurement view is the assumption that the timing of effects matters, since project feasibility and viability depend on the extent to which parties must raise funds to ride out periods of net money outflows, and wait to obtain payback and return on that investment.

While there are good reasons for the difference in measurement units which incorporate different treatments of time, the end result is nonetheless notable – longer term outcomes are given a larger relative weight in FIA (as later year revenues and costs are likely to be inflated) and a smaller relative weight in BCA (where later year benefits and costs are discounted). In the middle is EIA (which utilizes constant dollars without inflation or discounting of future years).

The Space (Spatial Area) Dimension. The three forms of economic analysis also differ in terms of how they rely on defined study areas, and how the specification of those areas affects measurement of project effects. Specifically, BCA is usually applied with the intent to cover benefits *without defined spatial boundaries*, while EIA is applied to measure effects within *predefined study areas*, and FIA is applied to measure effects for *specific facilities* or services. For this dimension, we consider these differences and how the measurement of their effects changes as the spatial coverage of analysis is modified.

The total societal perspective that is typically adopted for transportation BCA means there is no intentional spatial boundary for defining beneficiaries or measuring effects, so benefits may be counted for all users as well as all affected non-users (externality effects). In practice, though, there are boundaries of transportation networks being modeled and hence some impacts on external parties may not be captured. This problem diminishes, and hence the measured benefits of a project may increase, as the transportation network coverage is spatially extended.

The specification of explicit study area boundaries in EIA is fundamentally required to enable analysis of changes in the spatial location and flow patterns of trade, capital investment, jobs and income generation. The smaller a study area is defined around a transportation improvement, the more likely it is to observe inflows of jobs and income into that area. As the study area is enlarged, the more likely it is that some of those job and income shifts will be re-characterized as shifts within the study area that bring little or no net gain.

The focus on specific stakeholder parties (investors, owners and operators) means that FIA may represent effects on parties who can be located anywhere (i.e., with no formal impact area). However, projections of toll and fee revenues fees are typically based on user forecasts for the affected infrastructure, which are based on trip generation and distribution forecasts for defined networks that are driven (in part) by economic forecasts for a primary affected region.

While there are also good reasons for the differences in spatial treatment of study areas, the end result is still notable as a systematic change in both data analysis and impact measurements. Specifically, as the transportation network and impact study area is expanded, the BCA measure of net benefits is likely to grow, while the EIA measure of net economic impacts is likely to shrink. There may not necessarily be a corresponding systematic change in FIA results.

The Dimension of Economy Elements. The three forms of economic analysis also differ in terms of the breadth of coverage and ways that they measure effects on various elements of society and the economy -- including travelers, other (non-traveling) residents and businesses. Specifically, BCA is applied to reflect effects on *transportation system users*, plus *non-user externalities*. In contrast, EIA focuses on *productive (income-generating) elements of the economy* --disaggregated by industry and occupation. FIA focuses on the economic position of *owners and operators* of transportation facilities and services. There are clear reasons for measuring these various effects on different parties, as noted below.

The wide coverage of BCA to encompass both user and non-user effects is theoretically capable of being all inclusive in coverage of costs and benefits for all affected parties. In practice, though, BCA is limited to impacts that can be quantified and represented in terms of a monetary valuation. Furthermore, current practice is commonly limited to cover external benefits that are direct consequences of transportation activity changes, such as pollution. That is a "partial equilibrium" perspective, and it means that productivity changes associated with reorganization of economic activities and land uses are typically not covered. Despite imperfections in coverage, BCA remains the method for evaluating the efficiency of proposed or alternative investments.

The focus of EIA on income generation and money flows in the economy makes this type of analysis narrower in coverage than BCA. In particular, it measures effects of business cost savings and productivity on growth of an area's economic activity. Cost savings for households are considered to represent shifts in spending patterns that do not necessarily lead to any further economic growth. On the other hand, EIA studies often take a dynamic or "general equilibrium" perspective, meaning that they utilize regional macro-economic models to estimate effects on competitiveness, markets and economic patterns shifts that may further add to productivity and income generation. That information, with details about distributional effects among segments of the economy, can be important if there is a strategic, long term policy interest in strengthening an area's economic growth.

The application of FIA for assessing capital financing and cash flow means that it covers effects on stakeholders who are involved in financing, ownership, leasing or operation of the project facility or its associated services. That makes it even narrower in coverage than the other analysis methodologies, yet it addresses a critical aspect of project feasibility that cannot be discerned from the other forms of analysis.

The point here is that there are good reasons for the differences among methodologies in their coverage of effects on various parties in the economy. Most notably, they reflect different aspects of investment effects in terms of economic efficiency, strategic policy achievement and financial feasibility.

Differences in Impact Coverage. Because the various economic analysis techniques cover different impact elements and vary in how they represent them over time and space, they lead to different valuations of the consequences of a project. Figure 1 shows how all three techniques draw from the very same direct transportation impact factors (travel times, distances, volumes, safety, access and reliability), though they then diverge in how their consequences are measured. Those effects shown in the box labelled "social welfare" are typically valued on the basis of "willingness to pay," determined by stated preference or revealed preference studies. Those shown in the box labelled "productivity factors" also have societal value, but their valuations typically come from analysis of business data – either business cost data (in the case of business-related travel time and travel expense) or statistical studies of wage or GDP variation among industries and locations (in the case of access and reliability effects). Broader macroeconomic consequences for economic geography and regional growth are typically determined through use of economic models.

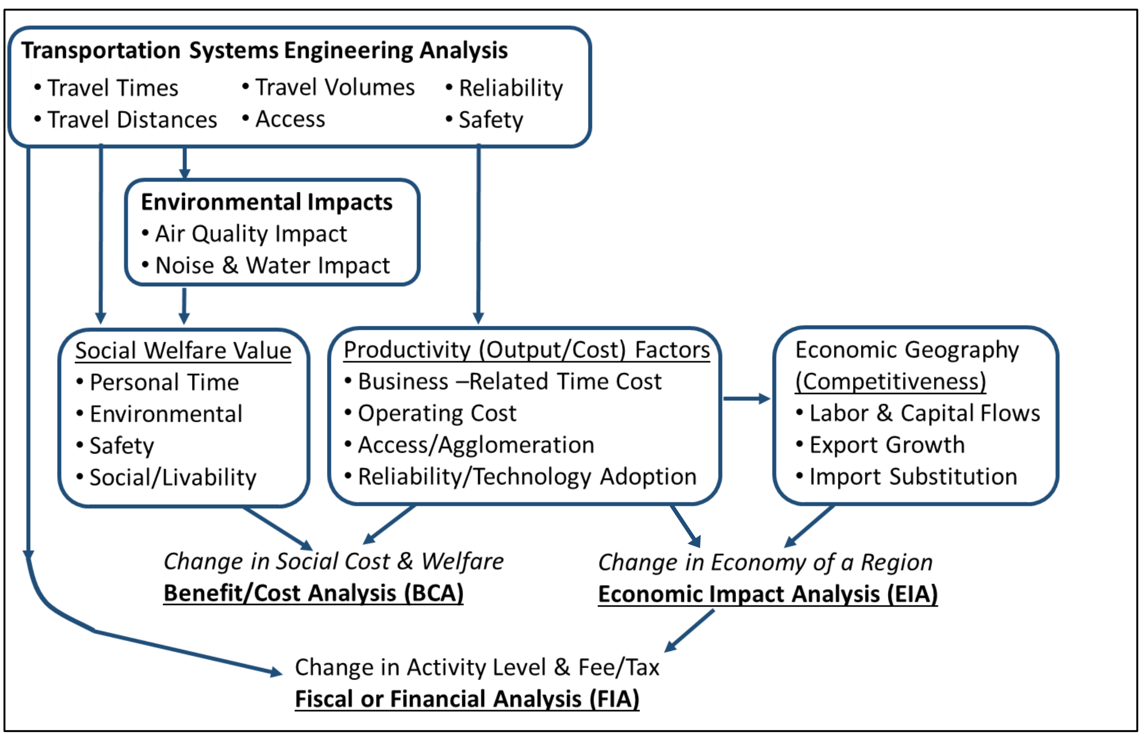

Figure 1. Flowchart: How Different Dimensions of Impact are Processed within Various Economic Analysis Methods

There are two other consequences of the flowchart in terms of coverage by economic evaluation methods. One is that social welfare factors that have no direct business productivity consequences are covered by BCA but do not typically affect EIA calculations. The other is that economic geography impacts that result from changes in relative productivity among areas are covered by EIA but not BCA.

Differences in Measurement and Valuation. Even among productivity impacts (in the center box of Figure 1), their valuations in BCA and EIA can differ. After all, BCA applies independent fixed unit valuations for each of the social welfare and productivity factors and adds them together, while EIA processes the productivity factors in terms of their joint consequences for a broader measure of economic geography outcomes in which there may be shifts in supply, demand and investment flows that affect prices and wages.

The composition of benefitting economic sectors and the definition of the study area will affect EIA outcomes in ways that may indeed be of interest to planning and funding agencies, particularly when some projects affect freight that has a higher value or greater impact on local income and job generation. The composition of the affected classes of travel and affected sectors of the economy can also affect FIA. For instance, changes in the economy will change tax revenues for government agencies and can also change travel demand forecasts underlying toll and fee revenue projections. When a multi-regional economic impact model is used, then there may also be insights into effects on different toll or fee collection schemes.

4. MATCHING DECISIONS TO ANALYSIS METHODS

The US, State DOTs and metropolitan planning organizations follow a sequence of stages in the transportation planning process, shown below. It is possible to conduct all three forms of economic analysis at each stage, though the importance of each methodology varies by stage.

Stage	EIA	BCA	FIA
Long-range vision / plan	***X***	*(s)*	*(s)*
Short-range prioritization	***X***	***X***	*(s)*
EIS / Alternatives analysis	***X***	***X***	*(s)*
Project financing / implementation	*(s)*	***X***	***X***

(Note: X denotes primary method; (s) denotes secondary method)

The planning process starts with a *long-range vision and planning stage* that involves evaluation of alternative scenarios for a specified future year, typically 25-35 years out. Scenario analysis is appropriate for long-range planning because land development evolves cumulatively over time and across space, and thus development patterns can appear different depending on the future year selected. Economies also evolve, and while they are *not* the accumulated result of all past economic activities, they are path-dependent. That means that the economic mix and location of economic growth in any given year is affected by patterns in preceding years. This makes EIA particularly useful for scenario analysis, as it can portray details about how economic growth patterns and trends can be affected over long time periods.

The subsequent stages of *project prioritization* requires a process that can rate each project on the same scale, regardless of differences in project location or time frame. BCA is commonly applied here, as it can provide an efficiency metric that encompasses all classes of travel and applies across all project locations and time scales. However, practically all State DOTs have prioritization systems that consider economic efficiency as just one part of a broader set of factors including distributional equity (among areas, time periods and/or socio-economic groups) and strategic goal achievement (including economic growth, revitalization, and environmental impacts). For that reason, some form of multi-criteria rating system is commonly utilized for project prioritization, and those rating systems (at least in the US) often include BCA and EIA elements (Weisbrod and Simmonds, 2011).

The stage of *EIS and alternatives analysis* focuses on analysis of how different siting and design features of a project will affect its impact area -- now and in the future. That can requires forms of economic and environmental analyses that are clearly tied to a specific study area, and for that reason EIA can be particularly useful in addition to BCA.

Finally, the stage of *project funding and implementation* requires consideration of financing options for project development as well as ongoing operation and maintenance. At this stage, FIA is clearly required in addition to BCA because it is possible to find project concepts that have a positive social benefit but do not produce the cash flow necessary to be financially feasible to implement.

5. APPLICATION EXAMPLE

The Ohio River Bridges project illustrates how BCA, EIA and FIA can come together to inform decision-making for a proposed project.. The project is a joint effort of the States of Indiana and Kentucky to replace and upgrade bridges across the Ohio River in the Louisville area. It includes a variety of road system improvements, most notably:

- a new "Downtown Crossing" bridge intended to replace the asset of an existing but aging bridge, while also providing the benefits of improving safety and reducing congestion;
- a new East End bridge, intended to increase the amount of accessible land for industry development, while potentially reducing downtown congestion by providing a bypass route for pass-through traffic between Indiana and Kentucky; and
- a new connector route tying the East End bridge to I-265, thus completing a circumferential highway network.

The latter two elements also link new industrial development areas to the "River Ridge" complex on the Indiana side of the river. River Ridge is one of the largest industrial development sites of its kind in North America, and increasing its access and connectivity was one of the primary economic development objectives of the entire project. Predicated on anticipated accessibility provided by the East End Bridge to Louisville, River Ridge developers had already secured commitments for from several new businesses including a planned new distribution center for Amazon.com, which would then have highway access to the UPS "WorldPort" freight hub at Louisville International Airport.

To address the investment decision stage, the states funded a BCA study, which supported a federal TIGER grant application. The results, shown in Table 2, show that the project has a positive expected net benefit of $530 million. However, the BCA table does not show the financing plan, which called for local residents to face additional tolls of over $100 million/year, which would also rise over time. While economists could readily explain that tolls are a transfer among parties in the economy, this type of analysis was not appropriate for addressing the concerns of residents and businesses in the region who were reasonably interested in the trade-off between toll costs (which they saw as an added cost of doing business) and the River Ridge economic development opportunities (which some of them saw as a significant employment and income opportunity).

To address the issue of localized impacts, specifically for Indiana's households and businesses, Indiana statute requires a separate EIA and FIA study. In the EIA study, an economic impact model calculated productivity improvements associated with both reduced congestion in the downtown area and enhanced access for labor markets, business delivery markets and connectivity to the airport. The results, shown in Figure 2, show that the project would increase jobs and wage income across many elements of the regional economy, with nearly 23,000 additional jobs and over $1.4 billion/yr. of additional wages in the region within 30 years (net of any adverse tolling effects). This finding enabled agencies to demonstrate how the toll cost to users would be eventually offset by additional income growth and potentially greater job opportunities in the region.

Table 2 Benefit Cost Analysis for Ohio River Bridges Project

Traditional BCA	**NPV $Billions**
	(@ 7% discount rate)
Time Savings Benefit	$2.692
Operating, Safety and Environmental Cost	-$163.7
Total Benefit	**$2.529**
Construction Cost	$1.549
Operating Cost	$0.448
Total Cost	**$1.998**
Net Benefit	**$0.530**
Benefit/Cost Ratio	**1.27**

(source: The Louisville-Southern Indiana Ohio River Bridges Project, TIGER Discretionary Grant Application, 2012)

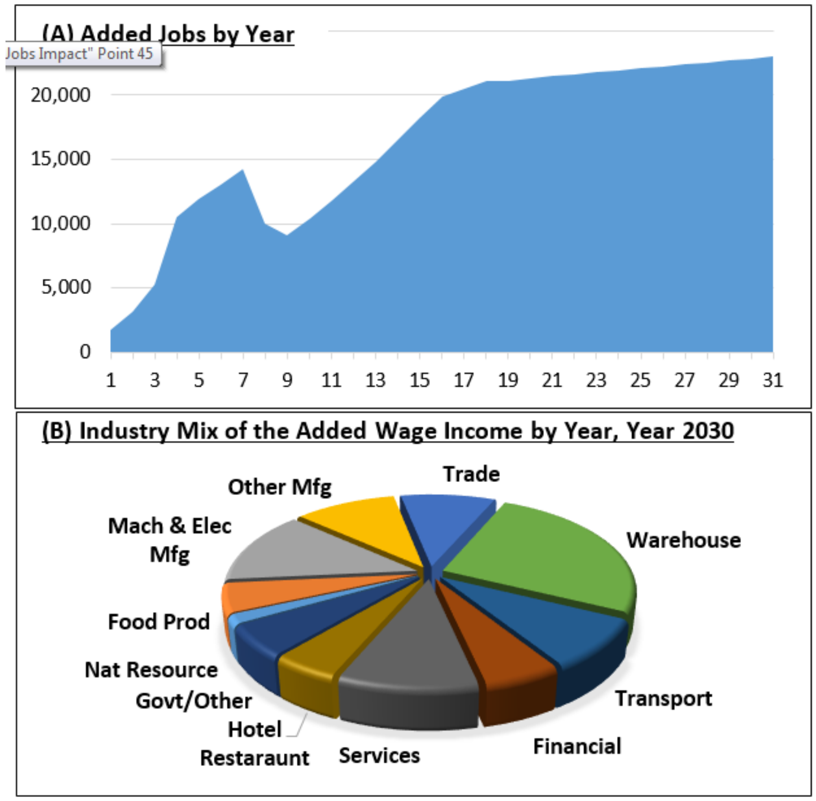

Figure 2 Economic Impact Analysis for Ohio River Bridges Project
(Source: Economic Impact of the Ohio River Bridges Project, 2014 Update)

From an efficiency perspective, it may be reasonable to seek an estimate of the real marginal income increase that would actually go to existing residents (as opposed to income flowing to new residents who will take some of the future new jobs). However, from a broader social and economic development perspective, the perceived benefits of economic growth are broader than that definition. Public discussions show that many residents desire living in a growing local economy because that tends to expand their future occupational and cultural opportunities. The valuation of that broader outcome has not been determined, but the reported EIA outcome did appear sufficiently useful to help inform public discussion.

Finally, also pursuant to the Indiana law, there were separate FIA studies that considered both the project's cash flow impact and its fiscal impact on local government. Those results are shown in Table 3. They show how the tolls make the project financially feasible (by paying off bonds), while there would also be additional tax revenues from projected economic growth.

Table 2: Fiscal Impact Analysis for Ohio River Bridges Project

A. Table of Major Cash Flows ($ millions)

Year	State + Fed Funds	Toll Bond Funds	Construction Cost	Toll Revenue
2010	$206	$0	$193	$0
2011	$38	$0	$42	$0
2012	$109	$0	$45	$0
2013	$122	$702	$422	$0
2014	$318	$315	$768	$0
2015	$100	$259	$720	$0
2016	$221	$149	$440	$0
2017	$278	-$151	$144	$34
2018	$1	$0	$17	$79
2019	$0	$0	$0	$98
2020	$0	$0	$0	$110
2021	$0	$0	$0	$117
2022	$0	$0	$0	$123
2023	$0	$0	$0	$126
2024	$0	$0	$0	$130
2025	$0	$0	$0	$134
2026-2030	$0	$0	$0	$742
TOTAL	$1,393	$1,274	$2,791	$1,694

B. Fiscal Impact Analysis (Local Government) - Year 2030

+ Property Tax from pop & emp growth	+ $11.65
- Property Tax from acquired property	- 0.04
+ Other Taxes & Fees	+ 2.55
= Total Revenue (Local Governments)	+ 14.16
- Cost of Added Local Services	- 12.53
= Net Fiscal Impact (Local Governments)	+ 1.63

Sources: Louisville - Southern Indiana Ohio River Bridges Project, Financial Plan: 2014 Annual Update; Traffic and Revenue Study, 2013; Economic Impact Report, 2012

The effect of using all three economic analysis techniques was to establish the following:

- *Efficiency Effect* - The bridge investment appears to be an economically efficient investment.
- *Incidence Effect* – The added toll cost has a different incidence than general public taxation, and that cost was perceived by travelers to be an offset against the time savings.
- *Reservation Effect* – Further industrial development and land use would be enabled by the circumferential (bypass) and connector route.
- *Strategic Effect* – For residents, the cumulative effect of enabling more inward investment (creating job growth) was seen as a factor justifying the project despite the toll concern.

6. CONCLUSIONS

The Ohio River Bridges case illustrates how financing, selection and implementation decisions can be informed by a combination of BCA, EIA and FIA studies. It shows the value of a structured framework that applies these techniques as informational complements rather than competing measurements. It also illustrates the concept of applying the same basic transportation project data to simultaneously drive BCA, EIA and FIA calculations. (Another example spanning BCA and EIA in Australia is provided in Weisbrod, Mulley and Hensher, 2015).

This multi-perspective approach can have significant value, insofar as it can validate the local benefit perceptions of communities and the narrow impact concerns of stakeholders, while still sorting out the net broader impacts at a broader state or national level. In fact, this type of accounting approach also makes it possible to inform decisions regarding who should pay for transportation improvements -- by distinguishing cases where a project in one state actually supports broader inter-state commerce or national interests, or alternatively cases where a state agency is being asked to support projects with purely localized benefits for specific communities or industries.

However, there are barriers to broader adoption of multiple perspective economic analyses. They include institutional and political forces that seek the largest possible impact or benefit numbers from economic analysis, sometimes with little regard as to the appropriate interpretation of economic analysis findings. Another barrier is the limited level of training of transportation planners and engineers regarding use of the three forms of economic analysis covered in this paper. There is clearly room for further refinement in methods and applications of this structural framework, but a logical next step would be to expand the teaching of economic analysis for transportation planners and engineers so that future planning decisions can more fully draw insight from the complementary features of these economic analysis methodologies.

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