Assessing the Business Case ROI for Intercity Passenger Rail Corridor Investments

VOLUME 2: Methodology

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

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June 2021

Table of Contents

How to Use this Volume

This volume provides further information on analysis and measurement methods referenced in *Volume 1: Guide for Decision Makers*. Readers should consult Volume 1 for further context regarding the use of information.

Section A: Precedent for Multi-Level Benefit Perspectives

This section summarizes past precedence for recognizing a multi-level perspective for economic analysis concerning intercity rail as well as intercity highway projects. It provides further justification for the approach laid out in *Volume 1: Guide for Decision Makers*.

A-1 Evaluating Impacts from Multiple Spatial Perspectives

Measurement at Different Levels. A common misconception on the part of some transportation economists and program evaluators is that benefit-cost analysis (BCA) can consider total societal benefits in a way that captures all benefits for all parties from all perspectives. However, all forms of BCA incorporate some form of perspective. Most often, there are differences in perspective depending on whether the analysis focuses on a national view, state/regional view, or local view. This point is important because (a) some local benefits are not observed from a national level analysis, and (b) some national benefits may not be observed when viewed at a local level.

A good example of the former might be a lengthy, complex high-speed rail (HSR) corridor spanning multiple states and individual metropolitan areas. In this case, the HSR system is likely to make a corridor and its constituent metropolitan areas more productive and efficient due to the enhanced density and accessibility. The result may be that existing firms expand while new businesses are attracted to the area, increasing employment and income in the region or subareas within the region. At a national level, some of those benefits may be viewed as transferred from other areas, while others may just be missed because of the data measures used to capture national productivity effects.

A good example of the latter (i.e., national benefits not incurred at a local level) would be one in which there are significant reductions in carbon emissions due to a major mode shift from auto to rail. In that case, because carbon emissions have global impacts that cross all jurisdictional borders at all levels, the impacts within the corridor and even within a given state may be small. That is to say that reductions in carbon emissions may simply be a side issue to localities and regions, and the share of global benefits to a given area may barely factor into consideration of investment options from that perspective.

Examples of Past Studies. There has been a clear precedent of planning studies and academic studies viewing transportation corridor investments in terms of different spatial levels. ***Exhibit A-1*** provides an illustrative sampling of our overall scan of the literature as it relates to economic impact analysis at various spatial levels. It includes a few highway studies, as well as a larger and more representative sampling of HS&IPR rail studies. (Later tables break out the form of impact or benefit studied and the affected governmental jurisdictions.) It shows illustrative examples of how various studies of transportation investment impacts and benefits have focused on different spatial levels. Some have focused on national-level network efficiency benefits, while others have focused on single states or multiple-state regions. Others have focused on sub-state regions, or individual metro areas, cities and/or neighborhoods.

Exhibit A-1. Illustrative Examples of Projects where Multiple Spatial Levels of Impact were Examined

Project	Mode	Location	National	Multi-State	State	Sub-State	Metro	City	Neighborhood
California High Speed Rail BCA (1)	Intercity HSR	California, Bay to Basin	X		X				
Midwest Regional Rail System (2)	Intercity HSR	Eight states	X	X	X				
US Conference of Mayors HSR (3)	Intercity HSR	Los Angeles, Chicago, Orlando, Albany					X	X	X
NEC and the American Economy (4)	Intercity Rail	Northeast Corridor (Boston - Washington)	X	X			X	X	X
Amtrak B&P Tunnel BCA (5)	Intercity Rail	Baltimore MD and Northeast Corridor		X			X	X	X
FRA National Rail Plan (6)	Intercity Rail	U.S. and Megaregions	X	X	X		X		
WSDOT Ultra High-Speed Ground Transportation Study (7)	Intercity HSR	Portland-Seattle-Vancouver		X	X	X	X	X	
Germany HSR Economic Impact Study (8)	Intercity HSR	Cologne – Frankfurt					X	X	
Tourism Impact Study, HSR Spain-France (9)	Intercity HSR	Lleida, Spain					X	X	
North Carolina I-95 Improvements (10)	Highway	Eastern North Carolina			X	X			
Ohio River Bridges Economic Impact Study (11)	Highway	Indiana, Kentucky		X		X		X	X
Completing the Appalachian Highway System (12)	Highway	13 state Appalachian Region		X	X				

(1) California High-Speed Rail Benefit-Cost Analysis, California High-Speed Rail Authority, 2014; (2) Economic Impacts of the Midwest Regional Rail System, Midwest Regional Rail Initiative; (3) Impact of High Speed Rail on Cities and Metropolitan Areas, US Conference of Mayors, 2010; (4) The Northeast Corridor and the American Economy, Northeast Corridor Commission, 2014; (5) B&P Tunnel Project Alternatives Report , US DOT and Maryland DOT, 2015, (6) Preliminary National Rail Plan, Federal Rail Administration, 2009; (7) Ultra-High-Speed Ground Transportation Business Case Analysis, Washington State DOT, 2019; (8) From Periphery to Core: Measuring Agglomeration Effects Using High-Speed Rail, Ahlfeldt and Feddersen, SERC Discussion Paper, 2017; (9) High-Speed Rail: International Lessons for U.S. Policy Makers, Todorovich, P et al, Lincoln Institute of Land Policy, 2011; (10) North Carolina I-95 Economic Assessment, NC DOT, 2013; (11) Economic Impact Study of the Ohio River Bridges Project, Economic Development Research Group, 2014.(12) Economic Analysis of Completing the Appalachian Development Highway System, Appalachian Regional Commission, 2017.

Each of the studies in Exhibit A-1 considers at least two spatial levels in their analysis, and in many cases more. They demonstrate how rail and highway projects can effectively generate benefits and impacts when multiple levels are considered. For instance, a study of the Ohio River Bridges project in the Louisville, Kentucky metropolitan area demonstrates how economic and fiscal impacts occur at the neighborhood level in the areas surrounding the bridge landings; at the sub-state level in multiple counties; and at the metro and multi-state corridor level since the bridge connects Kentucky and Indiana.

The pattern of multiple impact levels is particularly strong for HS&IPR projects, which tend to have an even more robust set of studies of corridor-wide, regional, metropolitan-scale, and local impacts. Some HS&IPR rail proposals and lines have been studied at multiple levels within the same report, while others have had separate studies examining state, regional, and local impacts. Drawing from examples in Exhibit A-1, the Federal Railroad Administration's Northeast Corridor (NEC) Futures initiative (which considered numerous large and small extensions, enhancements and improvements to the entire northeast intercity rail system) included studies of economic impacts of many types (both BCA based and economic impact analysis based) across many spatial and jurisdictional frames, and even included service proposals that were tiered to reflect both new regional as well as new intercity routes and services. That multiple service level approach is reflected in the varying spatial levels of analysis included in the economic reports accompanying the NEC Futures battery of DEIS reports. Another example can be found in WSDOT's Ultra High-Speed Ground Transportation Business Case Analysis.

Again, on the opposite side of the spatial scale are small area studies conducted as part of larger high-speed rail initiatives. A good example of this is a city-level economic impact study conducted as part of the various Upper Midwest High Speed Rail coalition studies. That study provided a detailed impact analysis of the local economic benefits of a high-speed rail service connection to the small city of Warsaw, Indiana, a major national production hub for orthopedic implant manufacturers. Another example is the B&P Tunnel replacement project for Amtrak, in which benefit cost analysis was conducted at a national and corridor level, while also considering neighborhood economic benefits to be derived from moving the current North Baltimore Amtrak station to a location that would better support neighborhood redevelopment and provide neighborhood open space and amenities.

A study for the US Conference of Mayors calculated potential economic impacts for four cities —Albany, Chicago, Los Angeles, and Orlando. The study used a multi-level approach that considered station area impacts at the neighborhood and city level as well as metro area impacts stemming from increased visitor spending, business productivity, and labor market expansion.

> There is a history of clear interest, recognition, and study of benefits occurring at different spatial scales. They range from local neighborhoods and cities to multi-state regions and national-level study areas.

A.2 Multiple Jurisdictions: Federal, State, and Local Governments

Benefits for Different Jurisdictions. In much the same way as benefits analysis may vary at different spatial levels, benefits may also vary at different jurisdictional levels (used in this context to mean governance or taxing territories). One of the primary reasons for this is that, within a complex, lengthy HS&IPR corridor comprised of multiple jurisdictions (including cross-border international corridors involving more than one country), the beneficiaries are located in different areas and the benefits to users and businesses are incurred (or are "incident") primarily within the given jurisdictions where users reside or businesses are located. In many ways, this type of "allocation" of benefits reflects formulas used by some complex multi-jurisdictional transit agencies such as WMATA to allocate operating subsidy shares to individual constituent jurisdictions.

The Importance of Jurisdictional Perspective. The jurisdictional perspective is important for three reasons: The first and primary reason to include a jurisdictional perspective in ROI analysis relates to how transportation projects may be funded. Federal, state, county, and city governments can and sometimes do play roles in transportation project funding, regulatory approval, and supporting infrastructure, services, and development. For this reason, there is widespread interest in potential and actual impacts of highway and HS&IPR rail projects at multiple jurisdictional levels.

However, the funding for highways is often set forth by standards of federal funding formulas, with state/local matching funds. HS&IPR projects though, often have funding cobbled together from a wide range of parties since they also necessarily also involve the participation of local governments (for access and station area development) and private parties (for service operation and support) as well as state and federal agencies. For rail projects in particular, significant funding may also be obtained from station area value capture, in which case impacts at the municipal or county local levels – in terms of tax base growth - will be important.

A second reason for assuming a jurisdictional perspective in benefit and cost calculations relates to garnering stakeholder support for a project: demonstrating convincingly that productivity, employment, and income will increase in a given jurisdiction motivates and helps political leaders and other stakeholders make a strong case for a project.

A third reason relates to visitor spending: when rail projects bring visitors to an area, they typically spend money in that area, and this increases business profits and economic activity in an area. The Maine Downeaster project is a good example of this, where Maine paid for a study of intercity rail connectivity to New Hampshire and Massachusetts because of perceived increases in visitor spending that would be expected to follow. In this case, both users of the system and destination jurisdictions benefit.

Transfer Effects vs. Efficiency Benefits: Different Jurisdiction Views. As previously noted, benefit calculations and metrics can be different at the national versus the corridor, regional, or city level. A large multistate rail system is likely to make a corridor and its constituent metropolitan areas more productive and efficient due to the enhanced accessibility, and new businesses can be attracted to the area, increasing employment and income in the region or subareas within the region. At a national level, however, some of these effects, but certainly not all, may be transferred from other areas. The new businesses that move to a rail corridor or even those that expand their operations may be shifting all or some production from other parts of the country, meaning there is no net increase in benefits at a national level. However, there can indeed be net national benefits if the move enables production costs to fall relative to other areas.

A.3 Efficiency, Equity and Policy Viewed from Different Perspectives

The concept of considering ROI – assessing outcomes to justify investment in intercity transportation infrastructure and services – dates to ancient Roman highways and Phoenician ports. Yet it was only in the 1960s that economists defined a narrower notion of discounted net present value (NPV) as a measure of the aggregate "efficiency" of an investment. From this point forward, there has been a split between that narrow efficiency measure used in benefit-cost analysis (BCA) and cost-effectiveness considerations relating to other objectives such as broader public policy goals that economists refer to as distributional and inter-generational equity.

Distributional equity benefits include improvement in economic opportunity and the environment focusing on areas that have been disadvantaged or are otherwise deficient. Inter-generational equity goals include improvement in economic opportunity and the environment for future generations, which are missed by traditional discounted present value calculations. These can be central objectives of public policy and they certainly represent societal benefits and returns on investment even if they are missed by traditional BCA calculations that do not recognize spatial shifts and future generation impacts.

The federal government clearly has an interest in the efficient performance of our nation's multimodal transportation networks. It may or may not have further interest in helping finance the environmental and economic development of specific regions and local communities, but it is certainly within the purview of state and local governments to make that kind of investment. That is the fundamental reason why it is important to recognize multiple levels of benefits with multiple analysis methods.

> The conclusion from our review of studies is that there has been a history of clear interest, recognition, and study about intercity rail benefits in ways that consider multiple methodological viewpoints.

Section B. Analysis Tools

This section describes available analysis tools that can be used to measure benefits of high speed and intercity rail investments. These tools provide the means for measuring the impact and benefit measures introduced in *Volume 1: Guide for Decision Makers*. Instructions for applying these tools for specific impact and benefit measures are then provided in Section 3 of this document.

B.1 Applicable Methods

Exhibit B-1, on the next page, shows how key impact categories can be addressed by relevant methods for benefit measurement and valuation. This figure represents the basic framework for applying tools to make a broader "business case" and ROI determination.

The rows represent categories of stakeholder benefit: user benefits, operator impacts, spillover impacts, accessibility elements, risk mitigation effects and land values. The columns represent six major analysis methodologies that can play a role in ROI assessment:

- BCA: benefit cost analysis – a methodology for assigning "net present value" to a stream of facility costs and user impacts. It is often applied in processing results of travel models, safety impact models and emissions impact models, as well as facility risk assessments.
- EIA: economic impact analysis – a methodology for calculating future regional economic impacts of projected changes in household/business costs and productivity related to transportation access. It can also provide diagnostic information for calculating changes in equity, future economic risk, and sustainability.
- MCA: multi-criteria analysis – a methodology that can develop qualitative ratings of hard-to-quantify (but still important) impacts such as community quality of life, comfort, and wider availability of travel mode choices.
- WTP: willingness to pay valuation – a methodology that utilizes survey or expert panel information to derive valuation for MCA qualitative ratings and EIA equity and risk measures.
- FFA: financial feasibility analysis – a methodology for accounting of revenues and expenditures of an organization (such as a rail service operator); its application for government agencies is commonly referred to as "fiscal impact analysis."
- LVA: land value analysis – a methodology for calculating current trends and expected future changes in land value and development around HS&IPR stations.

The cell entries indicate when and how the various analysis methods are used in an ROI assessment. The figure "D" represents methods used for "diagnostic measure" of impact (which may be qualitative or quantitative), while "M" refers to the setting of a monetary valuation for that impact. For example, "passenger hours of time saved" is a diagnostic measure for the value of time savings, while the value of that time is the monetized equivalent. In some instances, only diagnostics are readily derivable, as monetization is difficult. However, a "willingness to pay" approach can be used to derive implicit monetary values for some impacts.

It is important to recognize that while the tools shown in **Exhibit B-1** *can* be applied to address the issues listed in the first column, in many cases they *are not* commonly being applied in these broad ways. Specifically, the accessibility, risk, and land impact measures are often missed or only partially covered in studies assessing the benefits of HS&IPR proposals. The reason is often a lack of sufficient data to establish the impact measurement or its valuation. However, they can contribute significantly to a much broader assessment of HS&IPR return on investment and for that reason this guide recommends further effort to capture the benefit value of these impacts.

Exhibit B-1: Methodologies for Business Case Analysis

(*D = diagnostic assessment, M = measurement/monetization of value*)

	BCA	EIA	MCA & WTP	LVA	FFA
1. User Benefits					
Travel Time Savings	D/M				
Travel Time Reliability	D/M				
Travel Cost Savings	D/M				
Induced Travel	D/M				
2. Societal Spillover Benefits					
Emissions	D/M				
Safety	D/M				
3. Spatial Connectivity Benefits					
Regional Integration		D/M			
Intermodal Access to Broader Markets		D/M			
Equity		D	M		
4. Risk Reduction					
Resilience/Redundancy		D	M		
Sustainable Economic Future		D	M		
5. Local Land Impacts					
Land Development				D	M
2. Operator Impacts					
Operator Revenues					D/M
Life Cycle Costs					D/M

- BCA = Benefit Cost Analysis (using predefined valuation factors)
- EAI = Economic Impact Analysis
- MCA = Multi-Criteria Analysis (Ratings)
- WTP = Willingness to Pay valuation
- LVA = Land Value Analysis
- FFA = Financial Feasibility Analysis (including fiscal impacts for government)

B.2 Benefit Cost Analysis (BCA)

In the context of transportation planning, BCA is most often applied to results of travel demand models (to capture user impacts), as well as safety impact and emissions impact models (to capture spillover impacts). The results of those models are projected for a series of future years, and then BCA works by applying monetary unit values to those results to calculate a discounted "present value" of future cost and benefit streams. BCA results represent a measure of investment efficiency.

In some cases, travel demand models themselves can directly yield generalized user costs within a utility maximizing framework. For broader applications of user benefits and spillover benefits, there are existing spreadsheet templates, including those defined and used in applications for federal grants. They often need to be customized to represent the full range of modes involved in HS&IPR projects, which can include air, rail, bus, and car travel. Details of BCA methods are specified in various guides (see box).

Guidance on Transportation BCA

Benefit-Cost Analysis Guidance for Discretionary Grant Programs, US Dept. of Transportation, 2020, https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf ;

Benefit-Cost Analysis Guidance for Rail Projects, Federal Railroad Administration, US DOT, 2010; User and Non-User Benefit Analysis for Highways, American Association of State Highway and Transportation Officials, 2010, https://railroads.dot.gov/elibrary/benefit-cost-analysis-guidance-rail-projects

Transportation Benefit-Cost Analysis, TRB Committee on Transportation Economics, http://bca.transportationeconomics.org/

The user benefit and spillover benefit categories shown in **Exhibit B-2** are well established analytically, as are the tools and data needed. In general, the derivation of user benefits requires a multi-modal form of travel model analysis that can consider shifts among air, rail, bus, and car modes of travel. The derivation of emissions and safety spillovers comes from models that utilize the travel impact measures.

Exhibit B-2: Analysis Measures Relying on BCA

Element of User Impact	Measurement/Monetization	Diagnostics
Travel Time Savings	Hourly value of time from guidance or research	Person hours saved from travel demand modeling
Travel Cost Savings – Car and Bus Travelers Diverted to Rail	Vehicle operating cost savings from guidance or research (VOC data)	Vehicular trips and VMT savings (auto)
Travel Cost Savings – Air Travelers Diverted to Rail	Cost of air operation per passenger from FAA or other data and propagated delay savings	Air trips saved (aviation)
Travel Cost Savings - Reduced Roadway Congestion Delay	Cost of congestion studies (e.g., INRIX)	Excess travel time under congested conditions
Travel Cost Savings - Reduced Aviation Congestion Delay	FAA or other aviation cost studies	FAA passenger delay data
Travel Time Reliability	Hourly value of buffer time from research	Buffer time index, other measures of time variance for projected trips
Induced New Trips by Rail	Willingness to pay from surveys or travel modeling; also indicated by regional economic growth impact	Induced travel shown in travel demand modeling
Element of Societal Spillover	**Measurement/Monetization**	**Diagnostics**
Emissions (car, bus, air)	Pollution emissions models (EPA), DOT guidance for value/ton	Reduced auto VMT
	Carbon emissions model (e.g., ICAO, DOT guidance for value/ton or carbon “cap & trade” prices	Reduced air travel (trips, departures, plane miles)
Safety	Crash rates per VMT, USDOT value of life, injury, property damage	FHWA safety data and Crash Modification Factors

Note - Theoretically BCA can also be applied for other types of benefits and costs if they can be expressed in terms of a monetary value and a time stream. However, current approaches to BCA are not well suited for addressing broader public policy concerns about equity, inter-generational equity or economic sustainability -- which can be addressed through other analysis methods discussed in subsequent parts of Section B. Specifically, traditional BCA implicitly assumes income is equally distributed, ignoring inequity. An efficient investment is defined as one in which gains to winners are larger than losses to losers, since those who gain could in theory pay off those who lose out, still coming out ahead. However, there is no further requirement for any such payoff to occur. Thus, equity benefits (i.e., reduction in income disparities) are addressed separately.

Another limiting aspect of the principle of net present value is that a discount rate is applied to a stream of benefits over a defined lifetime of the investment. In the case of environmental and economic sustainability, though, the period for analysis extends to future generations. One approach suggested by some BCA economists is to utilize a lower discount rate for benefit categories that are more future-oriented; for instance, current USDOT guidance allows a lower discount rate for carbon emissions. A graduated discount rate might also be applied over time. However, even those approaches would not work for truly multi-generational sustainability impacts, for as the discount rate is reduced to zero, an untenable situation is created whereby any project could be made to pass or fail depending on the number of future years that one chooses for calculating benefits.

B.3 Economic Impact Assessment (EIA)

Economic impact analysis calculates expected future economic conditions for a defined area under alternative future scenarios. This methodology is usually applied at a regional level that represents the area of influence surrounding a transportation facility or corridor. Dynamic regional economic simulation models (e.g., REMI, TREDIS) incorporate "new economic geography" to capture the economic gains associated with improving connectivity between places along a corridor, which makes them particularly valuable for showing the economic returns from accessibility improvements enabled by HS&IPR projects. They can also portray future scenarios to support further risk analysis. See **Exhibit B-3**.

Regional economic simulation models can also serve a second purpose, which is to provide further detail on spatial, industrial, occupational, and wage impacts that are a basis for evaluating equity effects. By forecasting effects on economic growth patterns for alternative future scenarios, economic simulation models can also provide a basis for evaluating project impacts on enhancing the future sustainability and resilience of HS&IPR projects.

Exhibit B-3: Analysis Measures Relying on EIA

Spatial Connectivity	Measurement/Monetization	Diagnostics
Regional Integration	Productivity, GRP impacts	More balanced economic structure (more self-supply, less import dependence) Greater productivity and growth from expanded markets (scale economies)
Intermodal Access to Broader Markets	Cost savings	More frequent connections for air-rail transfers Reduced uncertainty in transfer schedules
Equity	*See Willingness to Pay (Exhibit B-4)*	For economically depressed areas: higher wage jobs, access to more surrounding area jobs
Risk Reduction	**Measurement/Monetization**	**Diagnostics**
Resilience/ Redundancy	Value of avoided loss, and cumulative failure risk	Incidence of severe weather and climate events Failure rates for aging infrastructure
Sustainable Economic Futures	*See Willingness to Pay (Exhibit B-4)*	Corridor transportation capacity (e.g., peak period directional trip capacity) Benefits for future horizon years (e.g., benefits in year 20 or 30 after operation commences)

B.4 Multi-Criteria Analysis (MCA) and Willingness to Pay (WTP)

Multi-criteria analysis develops ratings rather than monetary value metrics for those impacts that are difficult to monetize. It can utilize impact measures that can be quantified but not expressed in dollar terms (such as equity) as well as qualitative measures or measures pertaining to achievement of public policy goals (such as sustainability and growth of economic opportunities). A form of multi-criteria rating is used by many State DOTs for prioritizing proposed transportation projects. This usually involves assigning scores for various project attribute or impact factors, and then applying agreed-upon weights to arrive at a weighted score. Some states include economic equity or distress measures as well as economic prosperity or sustainability measures in their rating systems alongside travel benefits, economic impacts, and financial indicators. There have also been some efforts to combine MCA with BCA in hybrid approaches for project evaluation (see box).

Further Research on Applying MCA with BCA to enable a broader view of the benefits

(a) Clintworth, M., et al. (2018) Combining multicriteria decision analysis and cost–benefit analysis in the assessment of maritime projects financed by the European Investment Bank. Maritime Economic Logistics, 20, 29–47, https://link.springer.com/article/10.1057/s41278-017-0072-x

(b) Gühnemann, et al. (2012) Combining cost-benefit and multi-criteria analysis to prioritise a national road infrastructure programme, Transport Policy, 23: 5-24, https://www.sciencedirect.com/science/article/abs/pii/S0967070X12000753

(c) Barfod.et al. (2011). Composite decision support by combining cost-benefit and multi-criteria decision analysis, Decision Support Systems, 51(1), 167-175, https://www.sciencedirect.com/science/article/abs/pii/S0167923610002381

(d) Jensen, A. (2008). Multi-dimensional project evaluation: Combining cost-benefit analysis and multi-criteria analysis with the COSIMA, https://orbit.dtu.dk/en/publications/multi-dimensional-project-evaluation-combining-cost-benefit-analy

In the context of establishing a business case for HS&IPR projects, multi-criteria scoring systems are useful as the weights assigned to scores for these various factors can also provide a way to "infer" an implied value of investing in equity and economic development improvements.

It is also possible to derive monetary valuation for MCA rating factors by utilizing "willingness to pay" (WTP) methods – either "revealed preference" methods in which a monetary value can be derived from observations of spending patterns, or "stated preference" methods that are based on surveys of residents or statements of intent by community leaders. The WTP methodology provides a way to assign values to (a) economic impact scenarios in which there are improvements in equity, and (b) measures of expanded travel choices to support more sustainable long-term economic futures. See **Exhibit B-4**.

Exhibit B-4: Analysis Measures Relying on MCA and WTP

Element of Spatial Connectivity	Measurement/Monetization	Diagnostics
Equity	Societal willingness to pay for reduction in income disparities, based on stated or revealed preference (implied value)	Increase in job opportunities and income growth for residents of economically depressed areas
Element of Risk Mitigation	**Measurement/Monetization**	**Diagnostics**
Sustainable Economic Futures	Societal option value based on stated preference to meet needs for future generations	Access to additional transportation choices (depends on future regional growth needs)

B.5 Land Value and Real Estate Impacts (LVRE)

While many HS&IPR projects focus on funding from federal and state levels of government, they often also require financial, regulatory, and in-kind support from local governments and landowners. This support can be vital for development of stations, parking, and train maintenance/operations facilities, as well as for the development and operation of feeder transit services. Real estate market studies provide the data foundation for assessing potential impacts of new HS&IPR service on increasing local land prices as well as the rate and density of land development around rail stations and in surrounding areas served by rail stations.

The corresponding impacts can be observed in terms of both land use (development) and land values, as shown in **Exhibit B-5.** Additional land development impacts can lead to further growth of jobs and income as reflected in EIA (section B3), and that can also drive increases in local government revenues (from property and sales taxes) section B6). Value capture mechanisms may also be utilized to provide revenue support for the HS&IPR project (section B7).

Exhibit B-5: Analysis Measures Relying on LVRE

Element of Land Impact	Measurement/Monetization	Diagnostics
Land Value $	Land value increases that can be estimated from hedonic housing and commercial real estate price studies (see e.g., Victoria Transport Policy Institute)	Increased land value within pre-set distances around stations
Land Development Revenue $	Increased rental or sale prices of commercial and residential property, respectively Capitalized value of rental increases based on cap rates (e.g., from Zillow)	Increased investment in building development, increasing land use density (e.g., sq. ft. commercial development)

B.6 Financial Feasibility Analysis (FFA)

FFA portrays the streams of annual revenues, expenditures, and net cash flow generated by a project over a period of years. This is of direct relevance to private operators of HS&IPR services, public agencies that support capital investment and operations support funds for HS&IPR services, and PPP arrangements for HS&IPR project development and implementation. It provides a way to portray the relative financial exposure and risks for those parties – all of critical importance to make the business case for all public and private organizations that may invest in HS&IPR projects.

Exhibit B-6: Analysis Measures Relying on FFA

Element of Operator Impact	Measurement/Monetization	Diagnostics
Revenues	Demand forecasting: Fares and fees based on price elasticity of demand (from research or modeling)	Ridership forecast and fare scenarios
Life Cycle Costs	Asset management/replacement cost models	National Transit Data; individual transit system asset data

Section C: Benefit Measurement

This section describes benefit categories and metrics that represent elements of the business case ROI. It provides a brief definition of each type of benefit and discusses how it may be affected by HS&IPR projects. It also provides sources of information and steps for calculating the value of benefit for each of these categories.

1. Transportation System User Benefits
   - Time Savings
   - Cost Savings
   - Reliability Savings
   - Induced Travel
2. Societal Spillover Benefits
   - Environmental Spillover Benefits
   - Safety Spillover Benefits
3. Spatial Connectivity Benefits
   - Regional Economic Integration
   - Intermodal Access to Broader Markets
   - Regional Equity
4. Risk Reduction Benefits
   - Resilience/ Redundancy Benefits
   - Sustainable Economic Future
6. Local Land Impacts
   - Local Land Value
   - Local Land Development
7. Operator Financial Impacts
   - Revenues
   - Life Cycle Costs

This is a substantially broader range of benefit metrics than is considered in traditional benefit-cost analysis as practiced by transportation agencies in the U.S. Some of these benefit categories have traditionally been assessed in qualitative terms, or addressed in environmental impact statements. However, for them to be recognized in the business case ROI calculation, it is necessary to quantify these benefits and assign them a $ value using the best available methods.

There are many different types of HS&IPR projects and many different settings for them, so not all benefit categories are necessarily relevant for all HS&IPR projects. There may also be additional factors to be considered that are not listed here. Thus, it may be appropriate to modify the measures described in this section, for some projects.

C.1 Transportation System User Benefits

Overview. The traditional form of benefit-cost analysis, as promulgated by the USDOT and FRA, is based on benefits to travelers, who represent the "users" of the transportation system. There are five key aspects of user benefits for HS&IPR services.

(1) User benefits are realized by travelers, and are based on changes in passenger-trips or passenger miles of travel by mode.

(2) The key elements of user benefits are travel time savings, travel cost savings, and reliability savings.

(3) User benefits may affect other modes of travel (including air travel, car travel, and bus travel) in addition to rail travel.

(4) Traveler time, travel cost, and reliability changes should be measured for not just in-vehicle travel between cities, but also travel by local feeder services, parking, and in-terminal time.

(5) Changes in mode of travel may be reflected by a combination of positive and negative time and cost factors, though the net $ value of all benefits will always be positive (or else travelers would not have been predicted to switch to rail in the first place).

<u>Notes – User Benefits</u>

Effect on Other Modes. Passenger rail service can be a complement to and a substitute for commercial road and/or air travel within the same corridor. For highway users, rail can reduce the number of vehicles on roads, easing congestion delays and delaying the need for road capacity increases. It can also reduce airport road traffic, airport passenger queues, and air traffic. For example, in the Northeast Corridor where the Acela and Northeast Regional train services both operate, Amtrak has more share of trips between the major city pairs (Boston, New York, Philadelphia, Baltimore, and Washington DC) than air travel.

Role of Travel Purpose. The value of time savings is also affected by trip purposes. USDOT recognizes that business travel has a higher value of time than personal travel and fast intercity business travel (via air or high-speed train) has an even higher value of time. It is also notable that high-speed rail can have a distinct trip purpose profile separate from other intercity rail service. This is demonstrated in *The Northeast Corridor and the American Economy* (Northeast Corridor Commission 2014, p. 17) which noted that *"over three-quarters of all Acela passengers are business travelers, while over 40 percent of travelers on its Regional services are making business trips."*

Tourism travel benefits can also be significant in the profile of HS&IPR. This is particularly true where long distance rail services enter a downtown core. Unlike air travel, where airports tend to be peripheral, HS&IPR can deliver visitors from outside a region efficiently to tourism sites, which tend to be centrally located.

<u>Calculation Steps – User Benefits</u>

Step 1. Develop *scenarios* including a "base" (current or no build) case and a future "new service" case. For each scenario, identify values or develop assumptions regarding distance, speed, travel cost, and facility capacity. This should be done for a given out-year (after project completion).

Step 2. Apply travel demand models for *trip generation, distribution, destination choice, and/or mode split* to the scenarios (from step 1) to generate estimates of daily and annual passenger volumes by train, air, bus, and car. For some intercity travel, strategic and direct demand models or other planning tools may provide comparable estimates of volumes between origins and destinations based on statistical methods rather than the simulation methods employed by agent-based and trip- or tour-based travel demand models. If possible, break out estimates by trip purpose (splitting business and personal/recreation trips).

Forecast induced new trips (i.e., person trips by rail that would not have occurred without the new train service). This may or may not be included in the modeling tools being used for analysis but should not be overlooked. If not explicitly broken out by the tool, it may be possible to assume that induced trips are represented as the increment in demand between scenarios.

Step 3. Apply travel demand models for *trip routing* to calculate per traveler averages for volumes, trip length, travel time, and travel cost by route and mode (train, air, bus, and car). Travel demand models used for analysis may only offer *traffic assignment* modules for highway modes (cars). Analyzing this mode is valuable to identify co-benefits for travelers that do not switch to rail but still benefit from decreased congestion. Information from other model components such as trip distribution, destination choice, and mode choice may provide sufficient information to measure the characteristics of non-highway modes. Decreased congestion benefits on the highway network may also be assessed using The Texas Transportation Institute/INRIX annual Urban Mobility Report.

For non-highway modes, besides time and cost averages for in-vehicle travel, it is important to include measures of local access time and cost (including both parking and/or local feeder transit) for both origin and destination ends. Also include average for terminal security processing and wait time for origin terminal and transfer terminals, as applicable. In some circumstances, it may also be appropriate to include time and cost penalties for parking in the analysis of the highway mode.

Step 4. Develop estimates of *reliability factor* (average additional buffer time allowance to account for schedule reliability) for each mode under each scenario case. To do this, first look up *average terminal delay* for airports and rail lines under current (base case) conditions. These factors reflect a combination of system performance conditions and weather factors. Then apply travel demand models for *volume/capacity ratios* as a basis for calculating future changes in congestion that lead to further impacts on reliability, as measured in terms of changes in average delay per trip. (Typically delay rises as congestion increases and vice versa). Note that the volume/capacity ratios are derived from changes in volume of passengers at each terminal (from step 3) and assumed facility (road or terminal) capacity (from step 1).

Step 5. Calculate *aggregate benefits* for shifts in travel time, travel cost, and reliability. To do this, apply travel demand estimates (from step 2) to calculate change between the base case and new service case in terms of total passengers by mode - distinguishing those that shift mode, remain in the same mode, or are induced into new trips attributable to the new service. Multiply total passengers in each category by the applicable change in per person travel time, travel cost, and reliability (from step 4). (Note: It is also possible to account for Improvement in the productivity of travel time associated with rail travel vs car or air travel bb, through adjustments in the value of time.)

Step 6. Calculate *$ valuation of traveler benefits.* To do this, first calculate an aggregate $ value of time and reliability savings by mode, by applying standard unit ($/person-hour) valuations (from USDOT) to the aggregate hours of travel time savings and reliability savings by mode (from step 4). Then add in the aggregate $ value of cost saving by mode (from step 5). Note that the unit value of time can vary by trip purpose and mode (distinctions established in step 1).

(If valuing intercity air and rail traffic at a higher hourly amount in accordance with guidance documents, remember than any user switching from car or bus must have also experienced that higher value on their previous mode. Otherwise, it will appear that they are penalized for moving to their preferred mode.)

For induced new rail trips, there is no corresponding time, cost, or reliability savings since the trip would not have occurred without rail service. For these cases, the value of the new trip is based on the "rule of one-half," which values new trips at ½ of the valuation of time and cost involved for making the trip. (See box below for further information.)

For trips changing to rail, it may be appropriate to measure a reduction in the disutility of travel time. For existing rail passengers, travel time saved should be valued at the full Value of Travel Time Savings amount. However, when a train option becomes available, some travelers may choose this mode because of its increased comfort relative to alternative modes as well as the ability to use travel time for productive purposes such as working on a laptop. The amount of this comfort and productivity discount factor can be identified in the literature, previous studies such as past California High Speed Rail benefit cost studies, or via corridor- or region-specific stated or reveal preference analysis.

Step 7. Develop a *time series for annual $ savings* by year, based on the estimates for the selected out-year that were developed in step 5. Interpolate earlier years and extrapolate later years as appropriate to represent a period of at least 30 years following completion of the new or improved rail service. These results can then be portrayed in terms of a net present value of user benefits. For more effective communication with stakeholders, they can also be entered into a regional economic impact model to show their broader economic growth implications.

Data Sources – User Benefits:

For benefit cost guidance: *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, US Dept. of Transportation, 2020, https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf ; *Benefit-Cost Analysis Guidance for Rail Projects*, Federal Railroad Administration, 2010, https://railroads.dot.gov/elibrary/benefit-cost-analysis-guidance-rail-projects*; Airport Benefit Cost Analysis Guidance*, Federal Aviation Administration, 2020, https://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/

For comparison of corresponding air, rail, marine and road mode costs, see web site: http://bca.transportationeconomics.org/parameters

For explanation of the "rule of one-half" for induced travel benefit, see web site: http://bca.transportationeconomics.org/benefits/induced-travel

For more detailed instruction on the calculation of user benefits, see web site: http://bca.transportationeconomics.org/benefits

There are systems that can calculate multimodal user benefits spanning intercity rail, highway and aviation systems and assess wider effects on economic growth. They include REMI (https://www.remi.com); RENTS (http://www.temsinc.com/rents.htm); TREDIS (https://tredis.com)

Summary of Metrics – User Benefits

Travel Time
$ value of time saved by existing rail travelers
$ value of time saved by car travelers who shift to rail
$ value of time saved by intercity bus travelers who shift to rail
$ value of added rider comfort and productivity on rail compared to other modes
$ value of time reduced for air travelers who shift to rail
$ value of time saved for remaining air travelers who can now use rail for access or egress from the airport
$ value of time saved by remaining car travelers due to road congestion reduction
$ value of time saved by remaining bus travelers due road congestion reduction
$ value of time saved for remaining air travelers due to air/terminal congestion reduction
Total Travel Time Benefits
Reliability
$ value reduced buffer time (reduction in 95th percentile travel time), intercity car travelers
$ value reduced buffer time (reduction in 95th percentile travel time), intercity bus travelers
$ value reduced buffer time (reduction in 95th percentile travel time), intercity air travelers
Total Travel Time Reliability Benefits ($)
Travel Cost
$ value of cost change for existing rail travelers
$ value of cost changes for car to rail mode shift
$ value of cost changes for bus to rail mode shift
$ value of cost changes for air to rail mode shift
Economic Value of Induced New Rail Trips
Total Travel Cost Savings ($)

C.2 Societal Spillover Benefits

Overview. Shifts in intercity travel movements to rail from road or air can yield benefits that "spill over" and hence accrue to non-travelers as well as travelers. These include *environmental* and *safety* benefits. (Other benefits such as access, equity, and sustainability benefits are based on service improvement rather than changes in traveler movements; they are covered in sections C3, C4, and C5.) There are five elements of societal spillovers from HS&IPR:

(1) The key spillover benefits are reductions in emissions and improvements in safety. They are caused primarily by changes in vehicular activity (as opposed to user benefits that are driven by changes in passenger volumes). But for benefit measurement purposes, they are measured in terms of savings per passenger-mile.

(2) Air emissions reductions occur because intercity trains – and especially electric propulsion trains – generate less emissions per passenger-mile than most cars, buses, and aircraft. This includes pollutants with localized impact (e.g., particulates), pollutants with regional impact (e.g., sulfur and nitrogen oxides), and greenhouse gas emissions that have global impact.

(3) Safety improvements occur because intercity trains have a track record of fewer injuries and deaths per passenger-mile than cars and buses. Upgrades to equipment and systems may also add to safety benefits.

(4) Other environmental impacts may include noise, water quality, and habitat. These impacts are often localized and context sensitive. They are most often treated in qualitative terms in the US but are monetized in some European studies.

(5) Changes in mode of travel are typically reflected by a combination of benefits associated with the reduction in car and aircraft use, which more than offset the impact of added train activity. Thus, results may reflect a combination of positive and negative impacts, though the net value of spillover benefits associated with mode switching will normally be positive.

Notes – Societal Spillover Benefits.

Emissions impacts are derived primarily from changes in vehicle-miles of travel among modes, combined with assumptions of fuel types and propulsion technologies by mode. The change in emissions benefit per passenger-mile is further affected by vehicle occupancy and vehicle-miles of travel. The $ valuation of emissions reduction is based on established monetary values per pound of emissions, derived from market trade prices and "willingness to pay" studies.

Other Environmental Spillover Benefits including effects on noise, groundwater, and habitat may also occur due to changes in vehicle-miles of travel among modes. In addition, there can be negative effects ("disbenefits") associated with the taking of land for transportation corridors if they preclude or reduce agricultural or other uses of that land. All of these types of impact are commonly covered in environmental impact statements; they can also be considered in a business case ROI if desired. These types of effects have also been included in benefit cost studies of high-speed rail investment for the European Commission.

Safety impacts are associated with travelers switching modes (primarily from reducing highway traffic), or operators upgrading right-of-way, equipment, or operating control technologies that enhance rail safety such as Positive Train Control. This benefit is typically dominated by car crash reductions attributable to fewer vehicle miles traveled by car. However, a complete analysis will also consider changes in vehicle-miles of travel for all modes, and then apply typical injury/fatality/damage rates for those modes. The $ valuation of safety benefits is established by USDOT based on detailed studies of injury and fatality costs.

Calculation Steps – Societal Spillover Benefits.

Step 1. Use data on trip generation and mode split for base case and new service scenarios (from the previous section) to represent the *change in passenger miles* by mode within the study area.

Step 2. Calculate the change in *vehicle-miles of travel* by mode within the study area. To do this, divide the change in passenger-miles by mode (from step 1) by vehicle occupancy (average passengers per car, bus, train, and aircraft). In the long-term, it may be safe to assume reductions in bus and air traffic if ridership shifts to trains. Reductions in car emissions occur immediately as trips are avoided.

Step 3. Calculate the *change in annual tons of emissions* by type within the study. To do this, identify average rates of emissions (including CO2, NOx, SOx, PM2.5) per vehicle-mile for each mode and multiply these rates by the change in vehicle miles by mode (from step 2).

Step 4. Calculate the *change in total annual injuries, deaths, and crash* damage occurring within the study area. To do this, identify average rates of injury, deaths, and crash damage per vehicle-mile applicable for each mode or type of highway, and multiply these rates by the change in vehicle miles by mode (from step 2).

Step 5. Calculate *$ valuation of spillover benefits.* There are four sub-steps.

- Calculate an aggregate $ value of emissions reduction by mode by multiplying changes in total annual tons of emissions (from step 3) by corresponding unit valuation rates ($/ton).

- Calculate an aggregate $ value of safety (injuries, deaths, and property damage) improvements by mode (from step 4) by multiplying change in total annual injuries, deaths, and damage crashes (from step 4) by unit valuation rates.
- Calculate the additional $ value of any other benefits (or disbenefits), if any, associated with the use of land and effects on the environment.
- Add the aggregate $ value of emissions, safety, and other societal spillover effects across all modes.

Step 6. Develop a *time series for annual $ value of emissions, safety, and other spillover benefits* by year, based on the estimates for the selected out-year that were developed in step 5. Interpolate earlier years and extrapolate later years as appropriate to represent a period of at least 30 years following completion of the new or improved rail service.

Data Sources – Societal Spillover Benefits:

Emissions and safety factors for ground transportation (car, truck, bus, rail), see: Benefit-Cost Analysis Guidance for Discretionary Grant Programs, Appendix A, US DOT (2020). https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf ; also Federal Railroad Administration, (2010). Benefit-Cost Analysis Guidance for Rail Projects. https://railroads.dot.gov/elibrary/benefit-cost-analysis-guidance-rail-projects.

For emissions and safety for air and marine modes (and comparison to road and rail), see http://bca.transportationeconomics.org/parameters

The AFLEET Tool from Argonne National Laboratory provides emissions damage factors that can be tailored to specific counties, https://greet.es.anl.gov/afleet .

Summary of Metrics – Societal Spillover Benefits.

$ value of changes in pollutants	change in car + bus vehicle-miles of travel (VMT):	from reduced air enplanements:
CO2 (carbon, greenhouse gas impact)		
NOx (nitrogen dioxide)		
SOx (sulfur dioxide)		
PM2.5 (particulates)		
Total Emissions Benefit ($)		
$ value of reduced highway crashes		
reduction in fatal crashes		
reduction in injury crashes		
reduction in property damage crashes		
Total Highway Crash Reduction Benefit ($)		

C.3 Spatial Connectivity Benefits

Overview. Besides creating user and societal spillover benefits that are both related to *travel movements* (covered in the prior two sections), the existence of HS&IPR *service* can also enhance regional access and connectivity among communities. That, in turn, can create regional economic development opportunities that represent benefits in the form of expanded productivity, income growth and equity. There are three key elements of regional access and connectivity benefits.

(1) Regional Economic Integration. Rail service linking between communities and metropolitan areas that have specialized economies can enhance connections between complementary industries and enlarge their effective markets. This can also create "scale economies" that enable higher productivity clusters to develop in those areas and enable the entire regional economy to grow more income and jobs than would otherwise occur.

(2) Intermodal Access to Broader Markets. New intermodal transfers between airports and passenger rail lines can enhance the frequency and reliability of travel to and from smaller communities within a region, expanding business travel and tourism activity for those areas and the overall region.

(3) Regional Equity. New rail services, by improving connectivity to smaller cities within the region, can help enable job centers to thrive outside of expensive central city areas. That can improve the affordability of housing and improve access to better paying jobs for low-income residents within the region. Ultimately, these changes can generate more paths to higher paying jobs for lower paid workers and reduce income disparities among communities.

Notes - Spatial Connectivity Benefits.

Regional Economic Integration Benefits incorporate both (a) "agglomeration" or scale economy benefits and (b) mega-region (integration) benefits. These benefits are most applicable when high-speed rail is introduced to enable travel faster than via existing roads, thus effectively expanding labor and business markets.

- *Agglomeration benefits* have been widely recognized and estimated for intercity rail evaluations in the UK. The idea is that regional connectivity improvements increase productivity by effectively enabling access to areas outside the large metro areas, increasing labor pools and access to ideas and information exchange. The productivity gain comes from "scale economies" associated with larger effective markets. Economists sometimes use the term "effective density" as a measure of economic agglomeration, reflecting the mass of economic activity reachable relative to travel times from zones in an area. If locations within an urban area are more accessible from a broader area within a given travel time due to HS&IPR, it would be said that the urban area has achieved a greater effective density of economic activity (even though there is not necessarily an increase in the physical density of activities).
- *Mega-region (integration) benefits* reflect an additional effect: strengthening spatial complementarity among the economies of cities within a broader region. These benefits are based on the concept that cities within a larger region of the US often have clusters of specialized industries that generate income flows between them because of their complementary specializations. High-speed rail connections can support growth of inter-city business cluster synergies within a region, in ways that can further productivity gains and attract new industry growth.

  As noted in the Business Case report for the 2019 Ultra-High-Speed Ground Transportation Study (UHSGT) in the Portland-Vancouver Cascadia Corridor, *"a key to understanding the benefits of UHSGT relates to how modern knowledge-based economies compete and grow. Instead of focusing on individual firms, growth increasingly depends on the development of business clusters. These are characterized by complex networks and synergies among industries and institutions, involving a range of interrelated activities such as research and innovation,*

> *financing, production, management, public policy, and infrastructure. Harvard Business School's Michael Porter – the world's leading academic expert in economic clusters – has consistently noted the importance of transportation links as one of the contributors to cluster growth and competitive advantage."*
>
> This is indicative of developing regional economic ecosystems. For example, a metro area economy may be heavily concentrated in the hospitality sector but could gain from broader access to financial business services and their workers – a situation that can apply for Las Vegas and a proposed high-speed rail connection to Los Angeles. As another example, large companies may benefit from dispersing their operations such that satellite enterprises flourish in a second major city where housing is less costly and real estate more readily available. The Northeast Corridor, in fact, exemplifies the way in which the specialized economic roles of Washington, New York, and Boston (as government, business, and academic research centers) are knit together into a larger mega-region.

Intermodal access to broader markets. Benefits of HS&IPR services can be significantly enhanced when they are well connected and coordinated with other modes of transportation (particularly airports) to create more seamless access to/from smaller cities. Of particular interest is the ability of HS&IPR to complement and supplement air travel, by connecting major airports with HS&IPR lines. Examples of air-rail code sharing arrangements in Europe include "Lufthansa Express Rail" between Lufthansa and Deutsche Bahn, "SBB Flightrain" between Swiss Airlines and Swiss Federal Railways, and "TGV Air" between Air France and TGV trains.

This benefit is possible because air travel service networks are optimized for long-range travel between major cities, while connections to smaller cities may be difficult, impossible, or available only via infrequent and high-cost service using small aircraft. However, unlike air travel, HS&IPR is usually set up to provide intermediate stops and thus can potentially serve small and medium size cities more effectively (i.e., more frequently and at lower cost) than airline services. The benefits of integrating air and rail services show up in the form of higher frequency, reliability, and lower cost for access to/from intermediate cities and their surrounding regions. The net effect is to provide those small and medium size cities with broader access to national and international markets.

HS&IPR transfers to airports can also lead to effects beyond enhancing market access. Potential additional impacts can include (a) operator cost savings for airlines if the rail connections reduce the need to maintain lower profit, short distance flights, and (b) expansion of the airline customer base at major airport cities. These impacts are in the category of operator impacts, discussed in section C6.

Regional Equity. Societal inequity is defined as disparities among racial, ethnic, income and various socio-economic groups. In the specific context of HS&IPR, rail service improvements provide an opportunity to *reduce* disparities in access and economic well-being among the communities or areas along the corridors that it serves. In particular, it can generate and support nodal development of housing and business activity in smaller communities outside of major cities. That can improve access to employment. As long as the HS&IPR serves residents of communities that suffer from low income and high unemployment, it can improve equity by enhancing their employment and income opportunities. (Of course, improved rail access can also raise land values, so care must be taken to ensure that there is a net gain in housing affordability and net income.)

Both the previously discussed regional integration and intermodal transfer connectivity benefits support achievement of this goal, but the reduction of income disparities among areas remains a separate form of benefit. There is a clear value assigned to achievement of this benefit, as evidenced by state and federal funding of targeted public programs to reduce poverty and unemployment, and programs to improve economic vitality and prosperity in economically depressed areas.

There can be additional equity benefits in terms of quality of life. For instance, there is just the issue of some people not having any intercity travel options. Specifically, some low-income residents can be trapped in small communities without car access to visit family, get enhanced health care, etc. For them, HS&IPR can provide opportunities to accomplish those desired activities. Those types of benefits are in addition to the more measurable income improvement benefits.

<u>Calculation Steps - Spatial Connectivity Benefits.</u>

To better explain the calculation steps, the box below presents a protype for analyzing the connectivity benefits of rail service within a mega region.

MEGA REGION TRAVEL CORRIDOR

- A typical mega-region is anchored by large cities that are 200 – 380 miles apart (A, C), with one or more medium size cities in between (B in this case). In between are various smaller communities (regions 1, 2 in this case).
- Nonstop air service is frequent between the two major cities (A,C). The smaller city (B) may have no air service, or it may have infrequent and relatively expensive service via small planes that connect to one of the large city airports.
- Now high-speed intercity rail service is introduced between large cities A and B to compete with the nonstop air service, though high -peed rail service (unlike air service) typically offers intermediate stops in medium size cities such as B, better connecting it with both major cities.
- Local train service may also be offered to connect smaller communities along this corridor with its closest large city (e.g., connecting region 1 with city A, or region 2 with city C).
- The high-speed line (and possibly also local train service) may be configured to serve one or more of the large city airports, offering transfers from long distance air routes to regional rail destinations.

Calculation of Regional Economic Integration Benefits

Regional Economic Integration benefits are most applicable for high-speed rail (i.e., cases where the new rail service is competitive with air travel between large cities, while also adding service to smaller communities located between the large cities).

Step 1. Set up a *multi-regional economic impact forecasting model* with separate regions representing each city or metro area (A, B, C) and areas between them (1,2). It should provide sufficient industry detail to distinguish specialized industry clusters (e.g., finance, tourism, biotech, computer, government) and import/export sectors. This typically requires industry detail at the level of 3-digit NAICS codes (99 industry sectors) although 4-digit (312 sector) detail will provide more accurate results. A dynamic simulation and forecasting model (or other form of general equilibrium model incorporating economic geography) is required to capture mega-region integration effects.

Step 2. Analyze *labor market expansion benefits* by measuring how new rail service (from City A to region 1, or from City C to region 2) affects the labor force accessible within a normal commuting travel time (e.g., 45 or 60 minutes of each major city). Rail service adds to effective labor market size when it either (a) can go faster than peak period average car or bus speed, or (b) can serve a population that would not otherwise be able to commute by car or bus.

Step 3. Analyze *business market expansion benefits* by measuring how new rail service (across the entire corridor) enlarges the base of business activity accessible for same day travel. This is typically estimated by measuring employment within 1, 2, 3, and 4-hour one-way travel time from each major city.

Step 4. Calculate *the productivity gain and added GRP.* This can be done by running the multi-regional economic model set up in Step 1, using information from steps 2 and 3 as inputs to represent changes in labor market and business market access (as measured in terms of effective distance, effective market size, or effective density of business activity). The multi-regional model results should reflect gains to the intermediate areas (using the prior example, city B and regions 1, 2) as they become more economically integrated with the large metropolitan areas (city A and city C). (This can include the development of satellite business clusters in smaller cities that are economically supportive of technology clusters in larger cities.)

An alternative approach is to make an approximation of direct effects on GRP by applying impact elasticities from the academic literature on agglomeration economies. (This will not capture spatial economic integration effects or their interaction with agglomeration effects.)

Data Sources –Regional Economic Integration:

Step 1 and 4 requires a multi-regional economic impact forecasting model such as REMI (https://www.remi.com), TREDIS (https://tredis.com), or equivalent. These models forecast long-term GRP impacts as a function of changes in travel times, costs, and market access (economic geography) effects, while also calculating changes in inter-industry and inter-region income flows. F

Alternatively, statistically derived GRP impact elasticities can be applied. They are available from NCHRP 786, *Assessing Productivity Impacts of Transportation Investments,* pp.124-127, https://www.nap.edu/cart/download.cgi?record_id=22294; also see Graham and Gibbons: Quantifying Wide Economic Impacts of Agglomeration for Transport Appraisal, Center for Economic Performance, 2018, http://eprints.lse.ac.uk/91682/1/Graham_Quantifying-wide-economic-impacts_Author.pdf.

Steps 2 and 3 require a travel model with sufficient spatial scope to span 4-hour travel times as may be relevant for high-speed train times between major cities.

Calculation of Intermodal Access to Broader Markets.

The user benefit analysis (previously covered in Section C1) calculates benefits for each mode (including transfer time) but does not cover the additional market access benefits associated with connections from long-distance air routes to final destinations in smaller cities, which may also be improved though connectivity with HS&IPR service at airports.

Step 1. Identify pre/post change in location of intermodal connections. Identify current or planned train stops located at airports. Use the FAA Intermodal Passenger Connectivity Database (IPCD) to identify the set of relevant rail stations and airports.

Step 2. Identify savings in time due to more frequent service options and less time uncertainty enabled by adding transfers to rail service at airports (as opposed to reliance on transfers of air service to the final destination). Rail service may reduce the need for schedule buffers associated with air terminal transfer requirements and buffer time to allow for aircraft departure/arrival delays. (Note that air service to smaller cities often has greater rates of cancelation and delay than many long-distance routes).

Buffer time is typically defined as the added time allowed by travelers to ensure a 95% probability of arriving at the final destination by a desired time. Information on late arrival/departure times and cancelled flights is available for each US airport and origin-destination pair via the FAA's Carrier On-Time Performance Database (OTPD).

Step 3. Calculate the addition to business productivity from new or improved air-rail transfers affecting business, customer, and workforce access. The GRP gain is the macroeconomic income growth enabled by expanding the base of business activity accessible for same day travel. This is calculated by applying the results of step 2 into the productivity calculations of "Mega-region Integration", step 4.

Data Sources –Intermodal Transfer: Benefits of Access to Broader Markets:

USDOT Intermodal Passenger Connectivity Database (IPCD): https://data-usdot.opendata.arcgis.com/datasets/intermodal-passenger-connectivity-database-ipcd?selectedAttribute=AIR_SERVE

Airline Routes: On-Time Performance Database, https://www.transtats.bts.gov/Fields.asp?gnoyr_VQ=FGJ

Airport Security Lines and Delays, e.g., see https://www.insuremytrip.com/research/united-states-airport-research/#worst-airports-for-hurricane-related-delays-and-cancellations

Intercity Passenger Rail Routes On-Time Performance: For conditions with improved rail service, refer to proposed system performance expectations; for past Amtrak performance, e.g., see https://juckins.net/amtrak_status/archive/html/home.php

Calculation of Regional Equity Benefits

These instructions refer to "areas" served by HS&IPR lines, which are compared to assess economic disparities and equity impacts. These areas may be counties or smaller areas such as townships, municipalities, or other aggregations of census tracts.

Step 1. Baseline profile. Identify the areas through which the rail line travels (or otherwise define the service areas around each station). Identify areas of economic need that will be served by the HS&IPR line. This can be done by drawing upon public data sources to develop a profile of each area in terms of its relative level of prosperity or economic distress, including factors such as:

- % of households in the area with low/medium/high income (relative to state average)
- % of jobs in the area paying low/medium/high annual wages (relative to state average)
- % of residents in the area commuting to outside areas (commonly defined as the corresponding county or metro area)
- Adjacency to a designated "opportunity zone" or equivalent zone of economic need

Step 2. Calculate the economic impact on income generation for residents of each area by applying a multi-regional economic impact forecasting model (as described in Mega-Region Integration, step 4). Calculate the impact of new or improved rail service on the creation of jobs and wages in each area, with results disaggregated by industry and occupation with associated income levels. This information can be generated by a regional economic model that considers the effect of cost savings from user benefits as well as productivity gains from regional integration benefits. The results should be presented in terms of changes over a period of 10 and 20 years.

Step 3. Develop pre- and post-profiles of areas to portray the rail service economic impact in each area (building on impact forecasts from step 2) by showing how these profiles change from the baseline in terms of job growth rate, household income levels, and wage rates. Identify the extent to which the jobs are to be generated in higher-wage occupations and provide for further growth in household income. Also identify the extent of labor market access expansion, in terms of jobs accessible within 45 or 60 minutes from each county. Compare changes between (1) areas of economic need and (2) other areas (from step 1) to determine the extent to which income disparities and unemployment are forecast to be reduced.

Step 4. Assess $ valuation of reducing income disparities. There is no straightforward way to place a value on the benefit of reducing income disparities in society. However, for purposes of calculating an ROI for infrastructure investment, there are two sources of information that can be used to indicate the implied value of current public efforts to address income disparities. One approach is to identify whether the state DOT recognizes economic distress or need in any of its project prioritization processes, such as a multi-criteria scoring system. In that case, it may be possible to infer how economic need is being considered by the DOT relative to more traditional travel time and travel cost considerations. The other approach is to identify the extent of state spending on unemployment and low-income assistance programs. That represents de facto evidence of current public "willingness to pay" for equity improvement. These two measures can be used to place a value on associated equity improvement benefits within the ROI calculation for investment in HS&IPR. It is important to note that the valuation of equity benefits within this ROI calculation is on top of the already-calculated value of additional income being created by cost saving and access improvements for area residents.

Data Sources – Equity Benefits:

Household Personal Income by county – US Bureau of Economic Analysis (BEA): https://www.bea.gov/data/income-saving/personal-income-county-metro-and-other-areas

Worker Wages by county – US Dept. of Labor (DOL): https://www.dol.gov/general/topic/statistics/wagesearnings

Housing Cost by county – https://www.nar.realtor/research-and-statistics/housing-statistics/county-median-home-prices-and-monthly-mortgage-payment, also https://www.census.gov/topics/housing.html

County to County Commuting - https://www.census.gov/topics/employment/commuting/guidance/flows.html

Location Affordability Index (HUD Exchange), https://www.hudexchange.info/programs/location-affordability-index/

H+T Affordability Index (Center for Neighborhood Technology), https://htaindex.cnt.org/

Summary of Metrics - Spatial Connectivity Benefits.

Mega-Region Integration Benefits
$ GRP productivity gain from labor market connectivity
$ GRP productivity gain from expanded business connectivity (industry integration)
Total $ GRP gain
Intermodal Connectivity Benefits: Access to Broader Markets
$ GRP gain due to enhanced access to small cities (or cost savings for transfers)
Total $ value of rail transfer benefit
Equity Benefits
$ disposable income variation from differing access to higher paying jobs
Total valuation of equity improvement benefit

C.4 Risk Reduction Benefits

Overview. HS&IPR investments are notably different from many other transportation investments because they depend on major investment in the development and maintenance of a tracked right-of-way that is separate from highways. This means that they can provide value not only for travelers who depend on rail service, but also provide capacity as a backup alternative for car, bus, and air travelers in cases where there are closures or major delays on highways or at airports. In addition, investment in maintaining rail service and rail corridors can broaden longer-term options for improving future regional connectivity and enabling future economic growth. This can be especially relevant as economies evolve, land capacity for further road expansion becomes more limited, and train propulsion technologies advance. Thus, there are two distinct elements of risk mitigation benefits.

(1) Resilience/Redundancy – Investment in improving passenger rail infrastructure and service also provides a backup alternative for intercity car, bus, and air travel. This backup role can be particularly beneficial as roads and air systems are more likely than railroads to experience closures or significant congestion delays due to severe weather events or equipment failures. Investing in rail facilities now can facilitate longer term savings by avoiding the higher costs of later replacement or expansion of bridges, tunnels, viaducts, and stations that may also be shared with freight rail or roads.

(2) Sustainable Economic Futures (Option Value) – Investment in improving HS&IPR corridors and facilities now can also enable longer-term options for increasing speed and expanding capacity for rail service in the future (also potentially benefitting freight as well as passenger movement). That can further support longer-term economic growth and diversification for the regions it serves.

Notes – Risk Reduction Benefits.

Transportation resilience is usually defined as the ability of a transportation system to continue moving people despite obstacles that would otherwise prevent that continuation, such as extreme weather events, safety failures, or equipment failures. There are two major ways to achieve resilience: (a) fortify existing facilities and systems to withstand those failures, or (b) develop redundancy or other recovery mechanisms that can compensate for those obstacles. In this context, rail service can be viewed as providing beneficial redundancy – an alternate means for air travelers when airports are closed or severely constrained and an alternate for car and bus travelers when roads are closed or severely constrained by unexpected events. (Of course, this assumes the passenger rail system maintains capacity to meet additional demand.)

The extent of risk (infrastructure susceptibility to closures and failures) varies systematically by location, type of infrastructure, and its level and form of use. This can be calculated via documented historical records and models of projected future changes that reflect the aging of infrastructure facilities, growth in use of that infrastructure, and shifts in climate, weather, sea level, and ground surface conditions. Those factors cause cumulative risk (of both short-term and catastrophic failures) to rise over time.

The benefit value of avoiding failure risk can be viewed from an engineering perspective as the avoided cost of having to strengthen aviation or road infrastructure, as well as the avoided costs of temporary disruptions when these other modal systems fail. However, that is a vast underestimate, as catastrophic infrastructure failure can bring a far greater economic cost because it can threaten the economic livelihoods of people and communities. Even temporary closures can cause business failures (especially among small businesses, which can be an equity concern for underrepresented business owners). These effects can be assessed through use of regional economic impact models that consider local and regional economic reliance on various transportation modes for commuting, tourism/recreation, and business operations. In some cases, catastrophic road and air system failures can be economically devastating for a community or region, so the availability of alternate systems like HS&IPR can be of critical importance.

Option Value. Investment in intercity passenger rail may be made not just for immediate payoffs, but rather to reserve transportation corridors and right-of-way to provide (rather than close out) options for future generations. This can address desires both to (a) provide capacity to serve the travel needs of future generations and (b) provide a basis for further land development and economic development by future generations. Land development and economic development goals are also widely seen as enhancing future potentials for further revenue collection.

In this respect, it is notable that public support for HS&IPR services often exceeds current demand for use of those services. The term “option value” refers to the (willingness to spend) value that people place on maintaining options for future generations to have use of public assets such as HS&IPR corridors and services, even if there is little or no likelihood of they themselves using those resources. There is significant academic literature documenting the existence and validity of option value, particularly in terms of environmental preservation. In the context of HS&IPR, option value may reflect both personal future needs and future generations’ potential desire for high-speed rail service and associated development patterns.

<u>Calculation Steps – Risk Reduction Benefits.</u>

Resilience/Redundancy

Step 1. Identify failure risk. Assemble historical information on incidences of severe and catastrophic weather events (tornados, hurricanes, floods) by county, using available NOAA and FEMA data. Assemble historical information on closures of airports, rail lines, and highways along the corridor, using available FAA, FRA, and FHWA data. Also assemble information on facility condition and age using available “state of good repair” data from US DOT. Finally, assemble information on expected future increases in weather-related risks due to climate change. Combine all of this information to develop 10-, 20- and 30-year forecasts of risks for air, highway, and rail facilities and routes serving the study corridor. Failure risks should differentiate short-term (1-7 day) closures versus catastrophic closures that may knock out access for weeks or months.

Step 2. Assess economic consequences. Utilize transportation network data to determine the extent of community reliance on specific airports and roads identified in step 1 and the extent to which alternative airports and roads are available to service those communities. Apply regional economic impact models to determine the extent to which an extended (2+ week) closure of the relevant airports or roads will lead to higher costs and loss of business and household income in communities along the study corridor.

Step 3. Rail system benefit. Determine the extent to which new or upgraded rail facilities and services can be used to maintain some or all travel affected by airport or road closures serving the corridor, thus reducing step 2 losses. Calculate this benefit by considering the cumulative risk from step 1 and the economic consequences from step 2.

Data Sources – Risk Reduction Benefits:

Seismic Hazard Data from the U.S. Geological Survey (USGS), https://earthquake.usgs.gov/hazards/hazmaps/conterminous/index.php#2014

Flood Map Data the Federal Emergency Management Agency (FEMA), https://msc.fema.gov/portal/advanceSearch#searchresultsanchor

Storm Events Data from the National Oceanic and Atmospheric Administration, Climate.gov, https://www.climate.gov/maps-data/dataset/severe-storms-and-extreme-events-data-table

Road Disruptions and Closures Data from FHWA's National Performance Management Research Data Set (NPMRDS), https://ops.fhwa.dot.gov/publications/fhwahop20028/index.htm

Railroad Incident Disruptions Data from the Federal Rail Administration, https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/on_the_fly_download.aspx

Airport Weather Delays and Cancellations from Federal Aviation Administration, as shown in https://www.insuremytrip.com/research/united-states-airport-research/#worst-airports-for-hurricane-related-delays-and-cancellations

Sustainable Economic Future (Option Value)

Step 1. Long-range growth and need - Assemble long-term (50+ year) scenarios for regional economic growth and land development goals in and around the rail corridor, considering needs for intercity travel. Also consider long-term scenarios for shifts in energy and environmental requirements affecting reliance on car and airline travel. Evaluate alternative strategies to achieve the desired economic future, development patterns, energy mix, or other environmental outcomes. Compare the prices of alternative methods including regulation, subsidies, taxes, etc. to achieve goals and whether high-speed rail offers a less costly means to achieve this future than alternatives.

Step 2. Determine Value – Use stated preference (surveys) or revealed preference (past backing for rail funding) to determine the likely range of public valuation placed in investing in HS&IPR that is beyond the current accounting value of user benefit (time and cost savings for travelers). It may be possible to identify useable values from past research on these issues published inn academic journals and for other infrastructure projects.

Data Sources – Benefits of a More Sustainable Economic Future:

Long-term economic growth scenarios (including residential and business growth) by county are sometimes generated as part of State DOT long-range multimodal planning processes. Alternative forecasts are also generated by sources including:
Moody's Analytics (https://www.economy.com/products/alternative-scenarios),
IHS Markit (https://ihsmarkit.com/products/alternative-us-global-scenarios.html),
and TREDPLAN (https://www.tredis.com/products/tredplan/economy).

Scenario planning platforms include UrbanSim, MetroQuest, Envision Tomorrow, and others.

Summary of Metrics – Risk Reduction Benefits.

Resilience (Redundancy Benefit)
Probability of severe failure events (split by short-term vs. longer-term closures)
$ Value of investing now to assure continued future functional rail capacity
Sustainable Economic Future (Option Value)
Probability of need for expanded future transportation system capacity, by type
$ Value of investing now to enable future capacity for rail system growth

C.5 Local Land Impacts

Overview. Unlike intercity roads or highways, where there are typically many intermediate intersections or interchanges (in between major cities), intercity trains tend to have fewer intermediate stops and high-speed trains have even less. This aspect of train service means that travel activity is focused on a limited number of stations. The resulting foot traffic activity at stations, together with the access advantages provided by train service at those locations, creates conditions that can make station areas attractive as locations for commercial activity, office buildings, and/or apartment buildings. The resulting growth of land prices, building development, and business investment can generate additional income for households and businesses, as well as tax revenues for local government. There are two notable aspects of this effect:

(1) Land Value – The increase in station area land value can increase income for nearby businesses and landowners, as well as generate added property tax revenue for the local government. It was once thought that the gain in value at the station area would be offset by a loss of value elsewhere in the region, but it is now understood that the concentration of activity at stations can support higher development density and provide scale economies that can represent real productive value whereas effects elsewhere in the region may be diffused and neutral.

(2) Land Development – The increase in building activity can create construction jobs and income, including jobs associated with the building process as well as those at suppliers of materials and parts. Once the building process is completed and tenants or owners move in, additional employment at those locations may also result. To the extent that this is new business activity (and not merely a relocation from elsewhere in the community), it will mean more jobs and income – both directly near the train station and at other suppliers of goods and services that may be located elsewhere in the community.

Notes – Local Land Impacts

Local land impacts can occur as a series of stages. Initially, land values increase because of increased boarding and alighting at train stops, which make surrounding land become potentially more productive and valuable for development. This creates opportunities for a higher density of development (localized agglomeration) to take place, that can use "scale economies" to increase profitability for businesses in the station area and expand local job opportunities (and hence potential earning power) for households living in the area. The result can be viewed in terms of rising land value, housing prices, and office rents, and later as increases in the level and density of new development and economic activity (reflected as increases in jobs and wage income).

The increase in land value will naturally lead to an increase in municipal property tax revenue. However, beyond that effect, it is possible to further utilize the land value increase as a source of project financing, a process referred to as "value capture." This can take the form of Tax Increment Financing (TIF), which dedicates future increases in property tax revenue around the station, or a Special Assessment District, which collects a fee per square foot of real estate development around the rail station. These sources can be dedicated for use to help fund rail operations and debt service. Value capture funds are recognized as a source of rail related revenue in the next section called "Operator Financing," so here the local land economic impact is measured as the income gain to the community *net of* (after subtracting) value capture revenue.

<u>Calculation Steps – Local Land Impacts.</u>

Step 1. Station area activity – Utilize rail travel demand forecasts to calculate the expected level and growth of passenger volume at each train station for a given future out-year. This is an indicator of future potential for passenger-serving commercial development in and around the station.

Step 2. Surrounding station area development – Assemble forecasts of regional population and employment growth, along with rail travel demand data on average time or cost savings for those who use the station. That information can be used together with research studies to estimate the expected added value of adjacent land and the potential magnitude of additional housing, commercial, and/or mixed-use development there (for the future year). Market studies can also be used, if available, to indicate the types of business activity likely to be attracted to the station area once the rail access is provided.

Step 3. Local economic growth – Translate the increases in station area development (from step 2) into increased jobs and income, by applying applicable ratios of jobs/sq. ft. (by type of development) and income/job (by type of business). Multiplier effects from a local input-output model or a regional economic forecasting model can be used to estimate additional community gains associated with growth of supplier businesses elsewhere in the community.

Step 4. Tax and value capture – Apply findings from step 3, along with local tax rates, to estimate the future year potential for added municipal-wide tax revenue. Then also calculate the additional potential for value capture for the area at and surrounding the station and calculate the municipal-wide gain net of value capture funds. These potentials should be expressed in terms of a time series of annual revenue values, with appropriate allocation to government and private operators.

Data Sources – Local Land Impacts:

Impacts on station area development and land values can be forecast by either (a) a Land Use model (or LUTI – Land Use Transportation Interaction model) if such as model is maintained by the local metropolitan planning organization, or (b) application of typical impact factors such as those listed below:

Land development impact: Evaluating Transportation Land Use Impacts, VTPI, 2019, https://www.vtpi.org/landuse.pdf

Building utilization: Typical Sq. Ft. per worker by use, as shown in https://www.cityofdavis.org/home/showpublisheddocument?id=4579

Income per added worker: Wages Earnings and Benefits | U.S. Department of Labor (dol.gov), https://www.dol.gov/general/topic/statistics/wagesearnings

Local property tax rates: use rates from the relevant community, from the Mortgage Research Center, https://www.mortgagecalculator.org/helpful-advice/property-taxes.php

Value capture rates: Financing Transit Systems Through Value Capture, An Annotated Bibliography, VTPI, 2020, https://www.vtpi.org/smith.pdf

Summary of Metrics – Local Land Impacts.

Local Land Development
$ Value of added income for businesses, land owners and municipal government (net of value capture, if applicable)
$ Value of value capture income*

** Note: value capture income is calculated as part of land development impacts, but may be used as a source of revenue for operator impacts (section C6). For that reason, the added income from land development is calculated net of value capture income (to avoid double counting of benefits).*

C.6 Operator Impacts

Overview. Private companies, public authorities, quasi-public/private entities, or PPP (public private partnerships) may be involved in owning and/or operating corridor land and buildings, track right-of-way, rolling stock, and control equipment associated with HS&IPR service. These entities typically contribute some form of investment and expect to get back some form of revenue to justify their investment. There are two key aspects of operator impacts:

(1) Life Cycle Costs include capital investment for construction and acquisition of land, buildings, facilities, and equipment. This provides the service capacity. It is typically amortized by bonds to represent an annual cost, and it may be paid as a public investment distinct from the private operator finances. There are also operating expenditures for labor, fuel, maintenance, utilities, administration, and services required to operate train service. This cost depends on ridership, frequency of service, types of equipment, and fuels used.

(2) Revenues are collected by landowners and train service operators in the form of fares and fees. Gross revenue depends on ridership and fares, and net revenue depends on how capital and operating revenues are allocated among relevant parties. Public or private operators may also gain from value capture.

<u>Notes – Operator Impacts.</u>

HS&IPR Improvement Effect. Investment to improve HS&IPR infrastructure and services can have two simultaneous benefits for operators – to reduce operating and maintenance costs and also increase revenue (as a consequence of better service). These benefits may also accrue to freight rail if there is shared use of tracks and facilities, or dependency in service operating characteristics.

HS&IPR Revenue Dependence. While passenger revenues are important to any transportation facility or system that involves fares or tolls, HS&IPR projects are (like strictly private-sector transportation systems such as the air travel system) sensitive to how much revenue can be taken in. That is because intercity rail, and particularly high-speed rail projects, require significant amounts of capital funding that may be beyond the reach of state transportation funds or available federal funds. Equally as important, HS&IPR projects may be privately developed (typically as public private partnerships). Additionally, even PPP projects may involve substantial public financing, requiring significant revenues to pay off debt service or entailing agreements in which operating subsidies are precluded and operating expenses must be balanced by passenger fares and other operating revenues (e.g., California HSR is being developed under such an arrangement).

Connection to User Benefits (section C1). When new or improved rail service is offered, it can provide opportunities for new fare structures that can change effective fares or expenses for travelers compared to their prior travel choices. In each case, it is important to note that any reduction in traveler fares, fees, or expenses – while considered a user benefit – also represents a loss of revenue for some other party. For instance, in the case where a rail service attracts former air travelers and saves them money, there is a revenue loss for the airlines but a revenue gain for the train service operator.

Connection to Spatial Connectivity Benefits (section C3). HS&IPR projects are particularly likely to affect regional productivity and economic growth when they affect spatial connectivity. In those cases, a likely impact is an increase in aggregate income being generated in the region, leading to growth of income tax revenue over time. That revenue growth may be considered as a justification for, or source of, public funding or subsidy for investment in HS&IPR (i.e., a form of public-private allocation).

Connection to Land Development Benefits (section C5). While the concentration of activity at train stations can lead to locally desirable impacts on surrounding land development, there can be a specific opportunity to define a special zone around the station that can generate "value capture" funds. These funds are typically dedicated for use to support the provision of rail service or related supporting services (such as station facilities or feeder transportation). As such, they may be counted as a source of operator revenue from public-private allocations.

<u>Calculation Steps – Operator Impacts.</u>

Step 1. Life Cycle Costs – Develop a time stream of scheduled capital investments, annual facilities operating costs, allowance for asset management and maintenance costs, and applicable other costs such as track access charges, debt service costs, risk reserves, security costs, etc. Note any spillover of benefits amongst the track owner, passenger operator and freight operators.

Step 2. Revenues – Develop a time stream estimate of annual passenger volumes and projected fare revenue. Also develop a projection of additional revenues that may be collected from rail station concessions, parking, land or air rights, value capture (special assessment or tax increment financing), and/or other fees.

Step 3. Public-Private Allocations – Designate public and private sector roles in ownership and operation of the improved facilities and services, including public and private organization allocations of fare revenue, value capture revenues (i.e., property taxes, special assessment fees, and/or rents), other non-farebox revenues (e.g., parking, terminal concession leases) and contracted subsidies if applicable.

Step 4. Multimodal Cost Impacts – Based on projected mode shifts of passengers (from road and air to rail), determine highway system and airport operating cost savings from reduced use of those facilities and the resulting savings in cost of their operation and maintenance. Also determine any potential cost savings for rail equipment and systems upgrades.

Step 5. Net Financials – Develop an annual estimate of net revenue for each year in the useful life of the facilities (if owned by the operator), or each year in the period of contracted operations (if facilities are not owned by the operator). The estimate should reflect life cycle costs, revenues, and resulting cash flow (net inflow or outflow of money).

Data Sources – Operator Impacts:

The calculations require demand, revenue, and operating cost forecasting models.

Summary of Metrics – Operator Impacts.

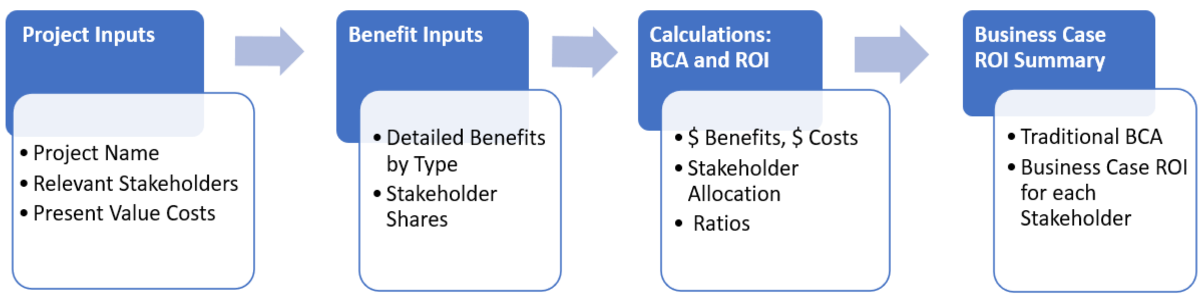
P3 Developer Impacts
Fare Revenue (private allocation)
Value Capture Revenue
Tax Credits / Loan Guarantees
$ Total Revenue to P3 Developer
Public Agency Impacts
Farebox Revenue (public allocation)
Non-farebox revenue gains (public facilities and taxes) Life cycle cost savings (multimodal) $ **Total Public Revenue Gain or Cost Savings**

Section D: High-Speed and Intercity Passenger Rail ROI Tool

To accompany this Guidance Document and the methodologies described herein, an Excel-based tool has been developed which allows HS&IPR analysts at all levels to calculate a rate of return from multiple stakeholder perspectives, resulting in a Business Case ROI for project stakeholders. Specifically, the tool 1) identifies project stakeholders at various jurisdictional levels and from public versus P3 perspectives; 2) provides "quick reference" guidance for estimating and monetizing the benefits (keyed to and described in greater depth in Section C) and for allocating those benefits to the defined stakeholders; 3) calculates ratios of benefits to costs for each stakeholder group; and 4) summarizes these results from both a traditional BCA perspective (where stakeholder differences are not observed) and from a stakeholder-based Business Case ROI perspective.

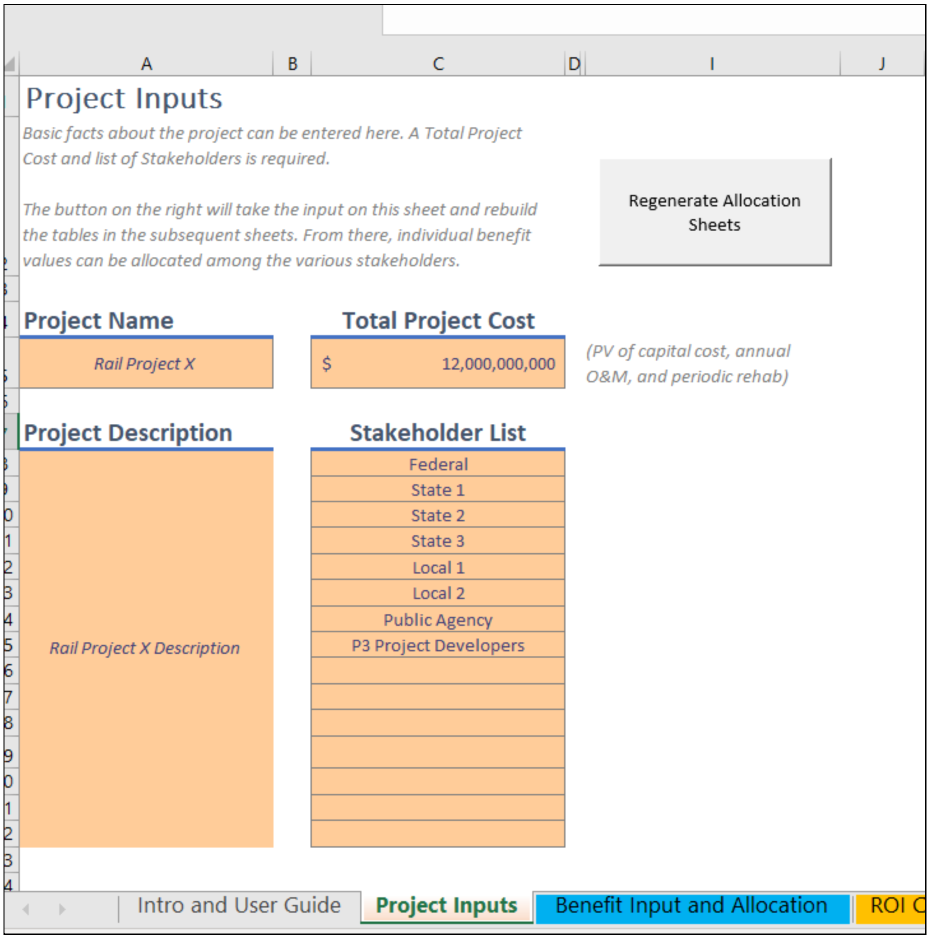
D.1 Overview of the Tool

The figure below shows the logic flow of the ROI tool, as well as key operations and functions at each worksheet/stage of the model.



The following worksheets comprise the model. For each operational worksheet, a screenshot is included below.

- ***Sheet 1: Intro + User Guide*** – This sheet provides an overview of the tool and instructions for its use. The user guidance provides sufficient detail for users to execute the tool, including where key project and benefit inputs are entered, where stakeholders are designated, where stakeholder benefits allocations are entered, and where ROI calculations are made.
- ***Sheet 2: Project Inputs (Input 1)*** – This sheet provides for entry of the discounted present value (PV) of project costs, as well as a stakeholder list which is carried through the remainder of the tool using built-in macros.



- ***Sheet 3: Benefit Input and Allocation (Input 2)*** – This sheet breaks major benefit categories into disaggregated individual metrics. The sheet provides "quick reference" guidance on methods and sources for the valuation of each metric. It also provides "quick reference" guidance for allocation of benefits to stakeholders. Present value of benefits are entered directly in this sheet, and allocation of stakeholder percentages are also entered directly here. A partial view of this sheet is shown below.

  It is important to note that the row total of allocation percentages for any given benefit metric may often be greater than 100 percent. As described in greater detail in the Guide for Decision Makers, this is a deliberate and fundamental feature of the tool – it provides for what are essentially overlap of benefits; for example, where locales are nested within states and states nested within the federal stakeholder lens. This feature allows for ROI results that are specific to different stakeholder groups. Different benefit categories will have different allocations.

  At the same time, no individual stakeholder may receive more than 100 percent of a given row allocation total; features are built into the tool to warn users when this input error is encountered.

Rail Project X - Benefit Input and Allocation

Breakdown of Benefit Types into submetrics, approaches to valuation, and Stakeholder allocation

Benefit Category	Benefit Type	Economic Value Measure	Valuation Approach	Source of Valuation (see	Stakeholder Allocation Basis	Total PV to be Allocated	Federal	State 1	State 2	State 3	Local 1	Local 2	Public Agency	P3 Project Developers
LOCAL LAND IMPACTS	Time Savings													
		$ value passenger hours saved by existing rail users	Average hourly value of travel time - intercity rail travelers	DOT, FAA guidance	reduction in annual passenger hours, by stakeholder trip origins	$ 537,000,000	46%	27%	6%	41%	74%	74%	18%	13%
		$ value passenger hours saved by car users shifting to rail	Average hourly value of travel time - intercity highway travelers			$ 3,000,000,000	80%	45%	68%	69%	66%	48%	79%	72%
		$ value passenger hours saved by intercity bus users shifting to rail	Average hourly value of time - intercity bus travelers			$ 50,000,000	42%	93%	5%	73%	16%	70%	59%	48%
		$ value person hours reduced for air travelers shifting to rail	Average hourly value of time - air travelers		national level effects only	$ 200,000,000	71%	52%	60%	96%	4%	64%	81%	6%
		$ value passenger hours saved by remaining car users	Average hourly value of travel time - intercity highway travelers		reduction in annual passenger hours, by stakeholder trip origins	$ 500,000,000	8%	35%	24%	99%	58%	83%	37%	74%
		$ value passenger hours saved by remaining bus users	Average hourly value of time - intercity bus travelers			$ 500,000,000	83%	20%	10%	86%	68%	84%	20%	48%
		$ value passenger hours saved for remaining air travelers, including propagated delay	Average hourly value of time - air travelers		national level effects only	$ 500,000,000	3%	18%	86%	88%	36%	2%	97%	0%
		Total Time Savings Benefits				**$ 5,287,000,000**	**62%**	**38%**	**53%**	**73%**	**61%**	**54%**	**65%**	**55%**
	Cost Savings													
		reduced auto vehicle operating costs from reduced VMT - auto to rail mode shift	VOC per mile for light duty vehicles	DOT, FAA guidance	reduction in annual VMT, by stakeholder trip origin	$ 100,000,000	81%	42%	25%	40%	33%	11%	79%	65%
		reduced air travel costs - air to rail mode shift	average commercial air fare		reduction in annual air passenger trips, by stakeholder trip origin	$ 300,000,000	8%	31%	61%	94%	49%	97%	85%	68%
		reduced bus travel costs - bus to rail mode shift	average intercity bus fare		reduction in annual bus passenger trips, by stakeholder trip origin	$ 25,000,000	30%	44%	80%	82%	4%	53%	36%	18%

Intro and User Guide | Project Inputs | Benefit Input and Allocation | ROI Calculations | ROI Summary

- ***Sheet 4: ROI Calculations*** – Based on the allocations in the prior worksheet, stakeholder shares are aggregated and summarized in this sheet. (If desired, it is also possible to overwrite these aggregate shares.) Based on these allocations, ROI ratios are then calculated for the project overall using traditional methods as well as by stakeholders, using a Business Case approach. To highlight important differences in results under different stakeholder allocation assumptions, the ROI is calculated in two alternative ways: one based on total benefits, and another based only on user benefits.

Rail Project X - ROI Calculations

Total Benefit values calculated from the prior sheets. ROI ratios are caclulated for the project overall using traditional methods, as well as by stakeholers, using a Business Case approach. Costs are allocated tp staljep;ders in two alterantive ways: based on total benefits and based only on user benefits.

Row		Benefit	Total Benefit (PV)	Federal	State 1	State 2	State 3	Local 1	Local 2	Public Agency	P3 Project Developers
8		Induced Travel	$ 200,000,000	43%	38%	75%	10%	15%	60%	72%	97%
9		Environmental (Emissions)	$ 248,000,000	53%	52%	62%	62%	31%	70%	71%	49%
10		Safety	$ 35,000,000	29%	73%	72%	40%	61%	50%	71%	51%
11		Regional Integration	$ 1,500,000,000	5%	90%	5%	72%	62%	25%	60%	81%
12		Intermodal Transfer	$ 2,000,000	32%	10%	63%	58%	49%	44%	43%	52%
13		Equity	$ 10,000,000	40%	45%	81%	65%	66%	5%	14%	9%
14		Resilience (Redundancy)	$ 20,000,000	73%	98%	66%	51%	91%	34%	64%	65%
15		Sustainable Economic Future	$ 1,000,000	33%	6%	9%	11%	47%	3%	21%	77%
16		Local Land Value	$ 10,000,000	23%	49%	56%	90%	13%	86%	40%	67%
17		Local Land Development	$ 10,000,000	51%	45%	80%	68%	92%	30%	58%	4%
18		Revenue	$ 1,000,000,000	52%	83%	67%	43%	17%	69%	93%	63%
19		Life Cycle Cost Savings	$ 1,000,000,000	74%	92%	75%	88%	15%	65%	86%	48%
20	Total		$ 9,948,000,000	$ 3,600,658,791	$ 5,087,141,731	$ 5,797,910,456	$ 4,852,505,280	$ 5,303,247,766	$ 6,630,948,562	$ 6,133,865,352	$ 6,287,651,174
21											
22		Total Stakeholder-based benefits	$ 43,693,929,112								
23											
24		Traditional Benefit Cost Ratio	0.83								
25											
26		Cost share based on Stakeholder-based benefits		0.082406386	0.11642674	0.132693731	0.111056739	0.121372645	0.151759036	0.140382554	0.143902169
27		Allocated Costs based on Stakeholder-based benefits		988876632.7	1397120882	1592324766	1332680868	1456471745	1821108432	1684590645	1726826029
28		Benefit Cost Ratio based on Stakeholder-based benefits		3.641160759	3.641160759	3.641160759	3.641160759	3.641160759	3.641160759	3.641160759	3.641160759
29											
31		Cost share based on User Benefits only		0.042980831	0.036698717	0.083345827	0.046200579	0.080018802	0.096160025	0.065979179	0.077691286
32		Allocated Costs based on User Benefits only		515769970.8	440384603.3	1000149926	554406947.6	960225628.5	1153920296	791750147.6	932295431.3
33		Benefit Cost Ratio based on User Benefits only		6.981133053	11.55158853	5.797041327	8.752605466	5.522918373	5.746452842	7.747223503	6.744268998

- ***Sheet 5: ROI Summary*** – This sheet summarizes the Business Case ROI in the format of a printable (in landscape) page.

Rail Project X - ROI Summary

Rail Project X Description

A	B	C	D	E	F	G	H	I	J
Traditional Benefit Cost Ratio	0.83								
		Federal	State 1	State 2	State 3	Local 1	Local 2	Public Agency	P3 Project Developers
Stakeholder Allocated Benefits		$ 5,520,079,116	$ 4,325,640,756	$ 5,434,837,996	$ 5,091,327,891	$ 4,947,722,794	$ 5,576,224,620	$ 4,894,827,451	$ 5,925,623,666
Benefit Cost Ratio (costs allocated by total stakeholder benefits)		3.48	3.48	3.48	3.48	3.48	3.48	3.48	3.48
Benefit Cost Ratio (costs allocated by user benefits only)		5.57	5.23	5.58	6.05	6.36	6.95	7.68	5.90
Benefit Cost Ratio (optional alternative cost allocation process)									

- ***Sheet 6: Present Value Calculator (optional sheet)* -** As an added option, the tool includes a discretionary sheet that may be used to calculate the 50 year Present Value of annual cost and benefit streams. This tool is useful when a Present Value has not been estimated but an annual target year value is available. The sheet permits gradual phasing in of benefits as a project ramps up, and permits different discount rates to be applied to individual benefit categories.

D.2 Illustrative Case Study Scenarios

As noted in the Guide for Decision Makers (p. 14-15), three scenarios were introduced to illustrate how different configurations of stakeholders with varying stakeholder interests can result in different ROI results. The three scenarios, each of which are public sector or P3 projects, are:

1. ***Three State Project:*** A HS&IPR line encompasses three adjacent states, and where benefits do not overlap among the states. No federal or private sector participation in the development or financing of the project is assumed.
2. ***Federal/Local Sharing Project***: There are both federal and local jurisdictions involved, with distinct benefits recognized by each stakeholder entity in different proportions. While local stakeholders have some interest in more general benefit categories such as user benefits and safety improvements, the local stakeholder interest is heavily weighted toward economic develop benefits, which are not directly relevant to federal decision making.
3. ***Overlapping Benefits with Value Capture***: This is a scenario where federal, state, and local jurisdictions are all involved in funding, and all levels have varying levels of interest across the board in most benefit categories, including economic development and value capture.

Note that inputs used in these scenarios are not derived from any specific HS&IPR project or previous studies of proposed rail projects. However, while hypothetical, they are indicative of the general magnitude of relative benefits seen in some prior high-speed rail studies.

Example 1: Three State Project. In this hypothetical case, there is a $10 billion project for a rail line running through three states. Most but not all benefits accrue to these three states, which is why the total of benefits across all three states (sum of the state column totals) is less than the total benefits shown in the first column of numbers.

Some of the benefit allocation percentages vary by states, as use of the rail line, user cost savings, environmental impacts, and economic development (regional integration) impacts have different distributions among the states.

In the final accounting, each state's share of cost is allocated consistent with its share of total benefits, so all three states end up with the same ROI. These state ROI numbers are smaller than the Global ROI because there are some benefits occurring to parties outside of the three states.

Case Study 1: Three State Project - ROI Calculations

Total Benefit values calculated from the prior sheets. ROI ratios are calculated for the project overall using traditional methods, as well as by stakeholders, using a Business Case approach. Costs are allocated in two alternative ways: based on total benefits and based only on user benefits.

Benefit	Total Benefit (PV)	State 1	State 2	State 3
Time Savings	$ 5,287,000,000	31%	31%	31%
Cost Savings	$ 850,000,000	30%	30%	30%
Reliability Savings	$ 200,000,000	37%	27%	37%
Induced Travel	$ 200,000,000	33%	33%	33%
Environmental (Emissions)	$ 380,000,000	22%	22%	22%
Safety	$ 35,000,000	33%	33%	33%
Regional Integration	$ 1,500,000,000	40%	30%	30%
Intermodal Transfer	$ 2,000,000	40%	20%	40%
Equity	$ 10,000,000	33%	33%	33%
Resilience (Redundancy)	$ 20,000,000	33%	33%	33%
Sustainable Economic Future	$ 1,000,000	33%	33%	33%
Local Land Value	$ 10,000,000	33%	33%	33%
Local Land Development	$ 10,000,000	33%	33%	33%
Revenue	$ 1,500,000,000	33%	33%	33%
Life Cycle Cost Savings	$ 1,000,000,000	33%	33%	33%
Total	**$ 11,005,000,000**	**$ 3,598,490,000**	**$ 3,428,090,000**	**$ 3,448,490,000**
Total Stakeholder-based benefits	**$ 10,475,070,000**			

Case Study 1: Three State Project - ROI Summary

Example case study with three state stakeholders only

		State 1	State 2	State 3
Global ROI	1.10			
Stakeholder Allocated Benefits		$ 3,598,490,000	$ 3,428,090,000	$ 3,448,490,000
Stakeholder ROI (with costs allocated by total stakeholder benefits)		1.05	1.05	1.05
Stateholder ROI (with costs allocated by user benefits only)		1.08	1.04	1.03

Example 2: Federal/Local Sharing Project. In this example, there is a $10 billion project that is supported by the federal government and three localities (city or metropolitan areas). The federal government's definition of benefits encompasses essentially all of the travel-related (time, cost, safety) benefits, some (but not all) of the environmental and equity benefits, and none of the local land development benefits. On the other hand, the localities definition of benefits includes land development and value gains occurring within each of their own areas as well as much of the resilience, economic sustainability, and equity effects. Also, the localities in this example only value travel savings for their own residents.

Taken together, each party values some benefits that are not recognized by the others. However, some benefits are valued by both parties, creating an overlap of benefit coverage. While that overlap is natural and reasonable, those benefits can only be counted once for the total of all benefits. For this reason, the benefits recognized by all stakeholders (column totals) sum to a number larger than the total of all benefits (represented by the first column of numbers below). Ultimately, the ROI seen by various individual stakeholders appear larger than the Global ROI because these stakeholders share costs yet both recognize some common benefits as well as benefits not recognized by others.

Case Study 2: Federal/Local Sharing - ROI Calculations

Total Benefit values calculated from the prior sheets. ROI ratios are calculated for the project overall using traditional methods, as well as by stakeholders, using a Business Case approach. Costs are allocated in two alternative ways: based on total benefits and based only on user benefits.

	Benefit	Total Benefit (PV)	Federal	Local 1	Local 2	Local 3
	Time Savings	$ 5,287,000,000	97%	18%	18%	18%
	Cost Savings	$ 850,000,000	100%	20%	20%	20%
	Reliability Savings	$ 200,000,000	100%	20%	20%	20%
	Induced Travel	$ 200,000,000	100%	20%	20%	20%
	Environmental (Emissions)	$ 380,000,000	50%	9%	9%	9%
	Safety	$ 35,000,000	100%	20%	20%	20%
	Regional Integration	$ 1,500,000,000	100%	40%	40%	40%
	Intermodal Transfer	$ 2,000,000	100%	20%	20%	20%
	Equity	$ 10,000,000	60%	33%	33%	33%
	Resilience (Redundancy)	$ 20,000,000	80%	33%	33%	33%
	Sustainable Economic Future	$ 1,000,000	80%	25%	25%	25%
	Local Land Value	$ 10,000,000	0%	33%	33%	33%
	Local Land Development	$ 10,000,000	0%	33%	33%	33%
	Revenue	$ 1,500,000,000	30%	33%	33%	33%
	Life Cycle Cost Savings	$ 1,000,000,000	32%	22%	22%	10%
Total		**$ 11,005,000,000**	**$ 8,906,300,000**	**$ 2,574,450,000**	**$ 2,574,450,000**	**$ 2,459,450,000**
	Total Stakeholder-based benefits	**$ 16,514,650,000**				

Case Study 2: Federal/Local Sharing - ROI Summary

Example case study with Federal and 3 local stakeholders only

		Federal	Local 1	Local 2	Local 3
Global ROI	1.10				
Stakeholder Allocated Benefits		$ 8,906,300,000	$ 2,574,450,000	$ 2,574,450,000	$ 2,459,450,000
Stakeholder ROI (with costs allocated by total stakeholder benefits)		1.65	1.65	1.65	1.65
Stateholder ROI (with costs allocated by user benefits only)		1.40	2.14	2.14	2.04

Example 3: Overlapping Benefits and Value Capture – This example includes elements of both prior examples, with again a $10 billion project and but this time including both (a) a split of state-level benefits among contiguous states as in example 1 plus (b) federal and local agencies that have varying definitions of recognized benefits that are different from each other and the states, as in example 2.

With this expanded scenario, the ROI calculation distributes costs among all parties in proportion to the benefit that are applicable for them, including some benefits that are common among multiple parties and some benefits that are applicable to some parties but not others. The result is that each party perceives benefits exceeding their allocated costs and each sees a rate of return that is significantly higher than the global ROI. This result is not erroneous or incorrect; rather it shows the value of viewing projects with a positive global ROI by allocating costs among parties and allowing each party to view benefits relevant to itself.

Case Study 3: Overlapping Benefits with Value Capture - ROI Calculations

Total Benefit values calculated from the prior sheets. ROI ratios are calculated for the project overall using traditional methods, as well as by stakeholders, using a Business Case approach. Costs are allocated in two alternative ways: based on total benefits and based only on user benefits.

Benefit	Total Benefit (PV)	Federal	State 1	State 2	State 3	Local 1	Local 2	Public Agency	P3 Project Developers
Time Savings	$ 5,287,000,000	97%	30%	26%	40%	18%	28%	10%	0%
Cost Savings	$ 850,000,000	93%	30%	23%	40%	14%	20%	10%	0%
Reliability Savings	$ 200,000,000	85%	35%	20%	30%	15%	30%	10%	0%
Induced Travel	$ 200,000,000	90%	40%	30%	20%	30%	30%	10%	0%
Environmental (Emissions)	$ 380,000,000	40%	13%	15%	12%	9%	9%	2%	0%
Safety	$ 35,000,000	100%	30%	25%	45%	30%	30%	0%	0%
Regional Integration	$ 1,500,000,000	40%	30%	40%	30%	50%	50%	0%	0%
Intermodal Transfer	$ 2,000,000	100%	30%	25%	45%	30%	30%	10%	0%
Equity	$ 10,000,000	50%	30%	20%	20%	30%	25%	0%	0%
Resilience (Redundancy)	$ 20,000,000	100%	30%	25%	45%	40%	40%	0%	0%
Sustainable Economic Future	$ 1,000,000	90%	50%	30%	10%	30%	30%	17%	0%
Local Land Value	$ 10,000,000	10%	30%	20%	30%	50%	50%	50%	0%
Local Land Development	$ 10,000,000	10%	30%	20%	30%	50%	50%	50%	30%
Revenue	$ 1,500,000,000	10%	10%	10%	10%	30%	30%	20%	50%
Life Cycle Cost Savings	$ 1,000,000,000	10%	10%	10%	10%	30%	25%	80%	0%
Total	**$ 11,005,000,000**	**7353903775**	**2770035249**	**2617556213**	**3332400000**	**2737800000**	**3271049641**	**1772689622**	**753000000**
Total Stakeholder-based benefits	**$ 24,608,434,500**								

Case Study 3: Overlapping Benefits with Value Capture - ROI Summary

Project X Description

		Federal	State 1	State 2	State 3	Local 1	Local 2	Public Agency	P3 Project Developers
Global ROI	1.10								
Stakeholder Allocated Benefits		$ 7,353,903,775	$ 2,770,035,249	$ 2,617,556,213	$ 3,332,400,000	$ 2,737,800,000	$ 3,271,049,641	$ 1,772,689,622	$ 753,000,000
Stakeholder ROI (with costs allocated by total stakeholder benefits)		2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46
Stateholder ROI (with costs allocated by user benefits only)		1.88	2.24	2.49	2.10	3.76	3.00	4.37	NA