ECONOMIC IMPACT OF PUBLIC TRANSPORTATION INVESTMENT

Prepared for:

American Public Transportation Association

Prepared by:

Glen Weisbrod
Economic Development Research Group, Inc.
2 Oliver Street, Boston, MA 02109

Arlee Reno
Cambridge Systematics, Inc.
4800 Hampden Lane, Bethesda, MD 20814

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SUMMARY

Economic Impact of Public Transportation Investment
Transit Cooperative Research Program (TCRP) Project J-11, Task 7
by Economic Development Research Group and Cambridge Systematics
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Objective. Public transportation services are important in many ways. They provide mobility, can shape land use and development patterns, generate jobs and enable economic growth, and support public policies regarding energy use, air quality and carbon emissions. All of these characteristics can be important when considering the benefits, costs and optimal investment levels for public transportation. This report focuses solely on just one aspect – how investment in public transportation affects the economy in terms of employment, wages and business income. It specifically addresses the issue of how various aspects of the economy are affected by decisions made regarding investment in public transportation.

This report updates an earlier report -- *Public Transportation and the Nation's Economy: A Quantitative Analysis of Public Transportation's Economic Impact*, prepared by Cambridge Systematics, Inc. and Economic Development Research Group, for the American Public Transportation Association, 1999.

Key findings of the report are organized in terms of three categories: (1) the effect of spending money on public transportation, which creates immediate jobs and income by supporting manufacturing, construction and public transportation operation activities; (2) longer-term effects of investment in public transportation, which enables a variety of economic efficiency and productivity impacts to unfold as a consequence of changes in travel times, costs and access factors; and (3) conclusions regarding the interpretation and policy consideration of economic impacts associated with public transportation investment.

Key Findings on Public Transportation Spending Impacts

Capital investment in public transportation (including purchases of vehicles and equipment, and the development of infrastructure and supporting facilities) is a significant source of jobs in the United States. The analysis indicates that nearly 24,000 jobs are supported for a year, per billion dollars of spending on public transportation capital.

Public transportation operations (i.e., management, operations and maintenance of vehicles and facilities) is also a significant source of jobs. The analysis indicates that over 41,000 jobs are supported for a year, for each billion dollars of annual spending on public transportation operations.

Combining investment in public transportation capital and operations within the US, the analysis indicates that an average of 36,000 jobs are supported for one year, per billion dollars of annual spending on public transportation, given the existing mix of operations (71 percent) and capital (29 percent) expenditures.

These investment impacts include directly supported jobs at manufacturers and at operators of public transportation equipment and facilities, plus additional "indirect" jobs supported by orders for other product and service providers, and "indirect" jobs supported by consumer spending of workers' wages. These overall impacts can represent *new jobs* insofar as there is an increase in public transportation spending and a sufficient number of unemployed persons to fill these jobs (so that other pre-existing jobs are not displaced).

Inflation changes the number of jobs supported per $ 1 billion of spending on public transportation. Consequently, over time, more dollars are needed to accomplish the same public transportation investment.

Other economic impacts are associated with the job impacts. Corresponding to the 36,000 jobs is approximately $3.6 billion of added business output (sales volume), which provides $1.8 billion of GDP (gross domestic product, or "value added") -- including $1.6 billion of worker income and $0.2 billion of corporate income. This additional economic activity generates nearly $500 million in federal, state and local tax revenues. [Note: these figures should *not* be added or otherwise combined, because a portion of the business output provides the worker income and other elements of GDP, which in turn are sources for tax revenues.]

Summary of the Short-term Economic Impact per Billion Dollars of National Investment in Public Transportation *(includes indirect and induced effects)*[A]

Economic Impact	**Per $ Billion of Capital Spending**	**Per $ Billion of Operations Spending**	**Per $ Billion of Average Spending**[B]
Jobs (Employment. thousands)	23.8	41.1	36.1
Output (Business Sales, $ billions)	$ 3.0	$ 3.8	$ 3.6
GDP (Value Added, $ billions)	$ 1.5	$ 2.0	$ 1.8
Labor Income ($ billions)	$ 1.1	$ 1.8	$ 1.6
Tax Revenue ($ millions, rounded)	$ 350	$ 530	$ 490

A indirect and induced effects include impacts on additional industries; they provide multiplier impacts on job creation only to the extent that there is sufficient unemployment to absorb additional jobs without displacement of other existing jobs.

B The US average impact reflects a mix of 29% capital and 71% operations spending. The study finds that the FTA federal aid impact is 30,000 jobs per billion of spending, due to a mix of 69% capital and 31% maintenance (operations). See full report for further explanation.

Key Findings on Public Transportation Productivity Impacts

Investment in public transportation expands service and improves mobility, and, if sustained over time, can potentially affect the economy by providing:

- travel and vehicle ownership cost savings for public transportation passengers and those switching from automobiles, leading to shifts in consumer spending;
- reduced traffic congestion for those traveling by automobile and truck, leading to further direct travel cost savings for businesses and households;
- business operating cost savings associated with worker wage and reliability effects of reduced congestion;
- business productivity gained from access to broader labor markets with more diverse skills, enabled by reduced traffic congestion and expanded transit service areas; and
- additional regional business growth enabled by indirect impacts of business growth on supplies and induced impacts on spending of worker wages. At a national level, cost savings and other productivity impacts can affect competitiveness in international markets.

This report presents a methodology for calculating such impacts. To illustrate the magnitude of potential impacts, two alternative scenarios are outlined for long-term US public transportation investment; a "base case" scenario that maintains long-term public transportation ridership trends, and a "higher transit investment" scenario that adds investment each year over the 2010-2030 period. The analysis estimates how travel times and costs, including effects of changes in congestion levels and mode switching, differs among the scenarios.

The results show that, per $1 billion of annual investment, public transportation investment over time can lead to more than $1.7 billion of net annual additional GDP due to cost savings. This is in addition to the $1.8 billion of GDP supported by the pattern of public transportation spending. Thus, the total impact can be $3.5 billion of GDP generated per year per $1 billion of investment in public transportation.

Potential Long-term Economic Impact per Billion Dollars of Sustained National Investment in Public Transportation *(Annual Effect in the 20th Year)*

Economic Impact	**GDP (Value Added)**
Effect of Spending	$ 1.8 billion
Effect of Transportation Changes	$ 1.7 billion
Total	$ 3.5 billion

This analysis represents the scale of potential impacts on the economy and *not* benefit/cost ratios. Specifically, economic impact studies do not account for some of the social and environmental impacts that are included in benefit/cost studies, though they do account for indirect and induced economic growth that is typically not included in benefit/cost studies.

The social and environmental impacts that are not counted within the GDP impact measure include, most notably, personal time savings and emissions impacts. The inclusion of these additional benefits would generate a larger measure of total societal benefit per billion dollars of public transportation investment. However, they were not analyzed because this report focuses specifically on how public transportation spending and investment affect the economy.

Conclusion

The analysis shows that public transportation investment can have significant impacts on the economy, and thus represent an important public policy consideration. However, economic impacts should not be equated with the value of total societal benefits associated with public transportation investment. Care should also be taken to recognize the short-term effect of public transportation spending as well as the longer-term benefits of sustained transportation investment on travel times, costs and economic productivity. Both may be useful considerations for public information and investment decisions.

1 INTRODUCTION: WHY MEASURE ECONOMIC IMPACTS?

1.1 Overview

This report discusses the nature of investment in public transportation capital investments and operations in the United States, the ways in which that investment affects the economy, and the additional impacts of public transportation investments and services on economic growth in the United States. This topic has been examined in a series of past reports, including a widely circulated APTA report published ten years ago (*Public Transportation and the Nation's Economy: A Quantitative Analysis of Public Transportation's Economic Impact*, Cambridge Systematics and Economic Development Research Group, 1999). However, the nature of public transportation investment changes over time, the structure of the economy continues to evolve and the analysis methods continue to improve. Consequently, the findings of this study differ from those of earlier works, both in perspective and results.

This report is organized into five parts.

1. ***Introduction*** - examines the objectives of economic impact analysis and compares these objectives to the broader objectives of public transportation capital investment and spending on operations.
2. ***Methods*** - presents a framework for classifying and viewing the key forms of economic impact, and summarizes the important findings from past research on this topic.
3. ***Spending Impact*** - presents a methodology and analysis of the economic impacts on money flowing through the economy as a consequence public transportation capital and operations spending.
4. ***Cost Savings and Productivity Impact*** - presents a methodology and analysis of the economic growth that result from the availability of public transportation services.
5. ***Updating*** - discusses the process for updating economic impact figures, and needs for further research to improve future studies of this topic.

There is also an ***Appendix*** that discusses the difference between economic impact analysis (which is the focus of this report) and benefit-cost analysis (which considers a very different set of impacts). It is followed by a ***Bibliography*** of sources cited.

1.2 Motivations for Economic Impact Analysis

Transportation investment affects the economy through two fundamental mechanisms: (1) *impacts of spending* -- the act of investing money in public transportation facilities and operations supports jobs and income for that industry, as well as jobs and income in supplier industries and other affected elements of the economy; (2) *costs and productivity impacts* – the public transportation services that are enabled by that investment provide enhanced mobility, time and cost savings; leading to broader economic growth occurs as a result of changes in disposable household income, business productivity and market access.

There are public policy interests in both elements of economic impact, as they can help address a variety of issues including:

Flow of Impacts. Where does the money go? Who ultimately receives the added income, the reduced costs or the other benefits from capital investments and operations?

Breadth of Impacts. Do the money benefits (in the form of added income or reduced cost) end up going to a narrow set or to a broad set of businesses and households?

Economic Stimulus and Competitiveness. Do the capital investment and operations funds stimulate job and income growth where needed most (for either short-term economic stimulus or longer-term economic competitiveness)?

Consistency with Broad Public Policy. Do the capital investments and operations activity complement or undermine other public investments? (in terms of efforts to add higher-paying jobs, support economic diversification, attract target industries and invest in target areas).

Complementing Benefit-Cost Analysis. To what extent are there economic impacts related to mobility, access, and job preservation that are not otherwise recognized in benefit/cost analysis?

Difference between economic impact and benefit-cost analysis. It is important to note that economic impact analysis is not the same as benefit-cost analysis. Economic impact analysis focuses specifically on measurable changes in the flow of money (income) going to households and businesses, including both spending and productivity effects. That is different from benefit-cost analysis, which considers the valuation of both money and non-money benefits including social, environmental and quality of life impacts. A more detailed discussion of differences between economic impact analysis and benefit-cost analysis is provided in the Appendix.

1.3 Building on Prior Research

In 1984 the American Public Transportation Association (APTA) conducted a landmark study of the employment and business revenue impacts of investment in public transportation. That study was updated in 1999 and this present study seeks to further update and expand on topics covered by those previous studies.

The key reports on this topic, conducted over the period of 1996-2008, are listed below and full citations for them are provided in the Chapter 5 bibliography.

Key Research Studies on the Economic Impacts of Public Transportation

- APTA. *Public Transportation and the Nation's Economy* (Cambridge Systematics and Economic Development Research Group, 1999).
- TCRP Report 20. *Measuring and Valuing Transit Benefits and Disbenefits* (Cambridge Systematics, 1996) .
- TCRP Report 35. *Economic Impact Analysis of Transit Investments: Guidebook for Practitioners.* (Cambridge Systematics et al, 1998)
- TCRP Report 49. *Using Public Transportation to Reduce the Economic, Social, and Human Costs of Personal Immobility* (Crain et al, 1999).
- TCRP Report 78. *Estimating the Benefits and Costs of Public Transit Projects: A Guidebook for Practitioners* (EcoNorthwest, 2002).
- VTPI. *Evaluating Public Transit Benefits and Costs: Best Practices Guidebook* (Litman, 2008).

Key Research Studies on Multi-Modal Impacts (Including Public Transportation)

- NCHRP Synthesis 290. *Current Practices for Assessing Economic Development Impacts from Transportation Investments* (Weisbrod, 2000).
- NCHRP Report 463. *Economic Implications of Congestion* (Weisbrod et al, 2001).
- NCHRP Report 456. *Guidebook for Assessing the Social and Economic Effects of Transportation Projects* (Forkenbrock and Weisbrod, 2001).
- TRB Circular 477. *Assessing the Economic Impact of Transportation Projects* (Weisbrod, 1997).
- OECD. *Assessing the Benefits of Transport* (OECD, 2001).
- OECD. *The Wider Benefits of Transport: Macro-, Meso- and Micro Transport Planning and Investment Tools* (OECD, 2007).

- UK Dept. for Transport. *Guidance on Preparing an Economic Impact Report* (Steer Davies Gleave, 2005).

The literature review, analysis methods and the findings provided in Chapters 2-5 build on these studies as well as on a range of local public transportation economic impact studies. This report presents an approach for viewing the economic impacts of investments in public transportation today and in the future.

2 METHODS: LITERATURE AND FINDINGS

This chapter discusses the methods that have been used to assess the economic impacts of public transportation in North America, drawing from a review of prior research and from analysis of recent studies. It is organized in five parts – corresponding to the three major forms of economic impacts (sections 2.1 – 2.3) plus two other categories of impacts -- representing both non-monetary impacts and alternative measures of economic impact that overlap with the primary impact measures (sections 2.4 – 2.5).

- 2.1 Spending Impacts
- 2.2 Travel Improvement Impacts
- 2.3 Access Improvement Impacts
- 2.4 Non-Monetary Impacts
- 2.5 Other Economic Impact Measures

For each category, the discussion covers their definition, the state-of-the-art analysis methods and examples of their application. Under each of these categories, there are additional levels of detail for the impacts which are discussed in this section.

2.1 Spending Impacts

Direct Spending

Definition. *Capital investment* in public transportation supports purchases of equipment and facilities (including rolling stock, tracks, other guideways, rights-of-way, control equipment, and construction of terminals, stations, parking lots, maintenance facilities and power generating facilities). *Operations* of public transportation services supports associated jobs (drivers, maintenance workers, administrative and other transportation agency workers) as well as purchases of supplies needed for continuing operations (including motor fuel, electric power, maintenance parts and materials, etc.) Thus, investment in public transportation projects and services can directly support short-term construction jobs and longer-term operations jobs, as well as purchases of products that lead to further indirect impacts on industry activity and jobs.

The source of funding (fares, government support, etc.) that pays for these investments is not relevant to how the money flows through the economy, though it certainly affects benefit/cost ratios. From the viewpoint of economic impact analysis (EIA), the investment can still lead to very real changes in the economy of some industries and areas, and that too is important to understand.

Methodology. Information on public transportation investment in the US comes directly from two sources, and there is a parallel source in Canada:

- FTA - Federal Transit Administration of the US Dept. of Transportation publishes data on federal government formula funding for replacement and rehabilitation of existing assets, and discretionary grant approvals for capital investments for new and expanded transit services (referred to as "new starts" and "small starts"). (Note that the federal government primarily funds only capital investments and preventative maintenance done in lieu of higher cost capital investments. It does not provide funding support for ongoing transit operations except in smaller communities.)_ For the annual report to Congress on new starts, see http://www.fta.dot.gov/publications/reports/reports_to_congress/publications_2618.html For statistical summaries on other aspects of FTA's funding programs, see http://www.fta.dot.gov/publications/reports/other_reports/publications_1090.html

- APTA – American Public Transportation Association represents public transportation operating agencies in the US. It publishes an annual Transit Fact Book with expenses, funding, ridership, revenue, vehicles and other aspects of capital spending and operations. http://www.apta.com/resources/statistics/Pages/default.aspx

- CUTA/ACTU – Canadian Urban Transit Association represents the public transportation community in Canada. It publishes a series of research papers and survey statistics regarding public transport usage and impacts in Canada. http://www.cutaactu.ca/en/issue_papers

This information provides a basis for studies of the total impact of public transportation spending on region-wide investment, jobs and income. Those studies are covered in the following discussion of indirect and induced impacts, which follows.

Indirect and Induced Effects

Definition. Direct investment in capital investment and operations of public transportation services leads to broader impacts on the economy. They fall into two classes:

(1) Indirect Effects – the direct investment in capital purchases (e.g., vehicles and equipment), and direct purchases for ongoing operations (e.g., fuel,

parts and other materials) lead to sales and thus support jobs in supplier industries.

(2) Induced Effects – the wages of construction workers and public transportation operations workers, as well as growth in wages at suppliers, can all lead to further retail sales (i.e., induced effects) for businesses that provide consumer goods and services.

Methodology. The calculation of indirect and induced (multiplier) impacts is made on the basis of input-output (I-O) accounting tables. These matrices show the pattern of purchases and sales between industries in the economy. Base tables are constructed at a national level, and tables for smaller regions are derived by regionalizing the core BEA tables to reflect inter-regional purchasing patterns. These regionalized tables thus utilize information on both the inputs used to produce a dollar of product for each specific industry and the extent that each industry's purchases are supplied by other firms located within or outside the study area. The multipliers are used to calculate the total direct, indirect and induced effect on jobs, income and output generated per dollar of spending on various types of goods and services in the study area.

Examples of specific studies that have documented the direct, indirect and induced impacts of public transportation investment and operating spending on region-wide jobs and wages are the Atlanta MARTA Economic Impact Study (Tanner and Jones, 2007), the Oklahoma Transit Impact Study (Johnson, 2003), the Wisconsin Transportation Impact Study (Cambridge Systematics and EDR Group, 2003) , Chicago Transit Economic Impact Study (EDR Group et al, 2007) and California High Speed Rail Environmental Impact Study (Cambridge Systematics and EDR Group, 2007).

At the national level, the US Bureau of Economic Analysis (BEA) produces updated national I-O tables and multipliers every five years. At a sub-national level, the IMPLAN model and the RIMS-II model are the two models which are most commonly used to estimate these impacts. RIMS was used for the Wisconsin study, while IMPLAN was used for the California study and was also a component of the broader TREDIS system used for the California and Chicago studies. Custom state-specific I-O models developed at universities were used for the Oklahoma and Georgia studies.

While I-O systems are widely used to estimate the indirect and induced impacts of public transportation spending, other types of economic models are needed for transportation studies where the changes in travel and/or access conditions will lead to broader changes in household and business costs, productivity, competitiveness and output growth. Those additional tools are discussed later in Section 2.2.

2.2 Travel Improvement Impacts

Overview. While the effects of public transportation investment can be of significant interest, longer-term travel benefits are a fundamental justification for public transportation investment that can ultimately lead to greater and more lasting impacts on an area's economy. Direct benefits for travelers fall into four core categories: (1) travel time savings, (2) travel cost savings, (3) reliability improvements and (4) safety improvements. All three types of benefits can provide monetary savings for both public transportation passengers and for travelers who continue to use other transportation modes.

User benefits are derived from valuing traveler impact measurements such as changes in person hours traveled or vehicle hours traveled (VHT), person miles traveled or vehicle miles traveled (VMT), and safety and reliability improvements. Unit costs are then applied to these metrics to derive the direct user benefits. (Examples of unit costs are the vehicle operation expenditures per mile or hour, the value of time per hour, and the costs of accidents per incident, by type.) Monetary values can also be applied to environmental impacts; however those values do not directly translate into corresponding impacts on the flow of dollars in the economy, unless prices are applied (such as through emissions fees).

Traditionally, public transportation passenger cost savings were often the primary factors considered as the benefits of public transportation projects. This mindset has changed significantly and now it is widely accepted that public transportation investment can also help reduce roadway traffic congestion, with broader benefits for commercial truck deliveries, employer labor market access and on other aspects of business productivity. These issues were raised in the APTA Report on *Public Transportation and the Nation's Economy* (Cambridge Systematics and EDR Group, 1999), the Federal Transit Administration's *Transit Benefits 2000 Working Papers* (HLB Decision Economics, 2000), the NCHRP *Economic Impact of Congestion Study* (Weisbrod, Vary and Treyz, 2001), the *Guide to Evaluating Public Transit Benefits and Costs* (Litman, 2008) and the NCHRP *Guide for Assessing Social and Economic Effects* (Forkenbrock and Weisbrod, 2001).

Thus, the *direct economic impact for travelers* can include vehicle operating cost savings (including fuel use savings) and parking cost savings for those switching from automobile to public transportation. In addition, a reduction in automobile traffic congestion due to greater public transportation use can also produce travel time savings as well as vehicle operating cost savings for highway users.

Travel Time Savings

Definition. Improvements in public transportation services may lead to three types of travel time savings:

- Time savings for the existing and new public transportation passengers due to improved services (e.g., more direct routes and/or more frequent service);

- Time savings for existing and new public transportation passengers in congested urban areas, enabled by bus or rail rapid transit that operates on exclusive lanes or right of way (thus avoiding road congestion);

- Time savings for automobile and truck travelers on congested routes, who can now travel faster due to fewer vehicles on the road (since some other automobile travelers shift to public transportation).

Methodology. In economic impact analysis, the treatment of these time savings differs depending on trip purpose.

"On-the-clock" trips include those conducted as part of a job. It is assumed that "time is money"—i.e., employers either pay directly for traffic delays by paying for the additional worker time, or indirectly through reduced employee productivity. Because of the latter effect, the USDOT's Highway Economic Requirements System (HERS) calculates that the value of on-the-clock travel time as the cost of hourly average labor -- including both wages and fringe benefits. From the viewpoint of economic impact analysis, that is a direct productivity cost to business.

"Commute trips" include those traveling between home and work. There is a broad literature of studies concerning the valuation and treatment of time savings for commute trips, which is discussed in Forkenbrock and Weisbrod (2001) and Litman (2008). There is also a line of research (Madden, 1985 and Zax, 1991) which shows that businesses ultimately end up paying a premium to attract and maintain workers in parts of urban areas where transportation costs to employees are higher. This premium is typically placed at half or more of the incremental value of time delay, and can be treated as a business productivity cost.

"Personal trips" are those done for any other purpose. Saving time on personal trips also have a clear value to travelers, which has been established by various "willingness to pay" studies. However, savings in personal travel time generally does not directly affect the flow of income generated in the economy and is thus not included in the economic impact analysis of this report.[1]

Finally, there is the possibility that travelers perceive travel via public transportation to be qualitatively different from automobile travel and thus valued differently. For instance, public transportation can provide a higher value trip to the extent that passengers can use their travel time for business or other productive activities. That is most likely to apply in situations where passengers have protected shelters and comfortable seating on express commuter bus and commuter rail lines. However, public transportation can also provide a lower value trip if passengers have to wait exposed to the elements and then stand in crowded vehicles. Since both situations currently occur, no such differences for public transportation time compared to auto time are assumed for this study. However, these could be included in analyses of specific services such as new commuter rail lines.

Reliability Benefits

Definition. Improvements in public transportation services can enhance reliability for public transportation passengers, and also for cars and trucks as a consequence of less congestion-related traffic delay.

These reliability benefits occur because rising traffic congestion can increase collision rates and also lead to longer traffic backups when there is a disabled vehicle or collision. By taking some cars off of the road, public transportation enhancements can potentially reduce delay and increase reliability for all highway users – including car, truck and public transportation drivers and passengers. NCHRP report 463 provides a detailed explanation of the definition of congestion, how it is measured, and how resulting traffic reliability issues affect passengers, businesses, and labor markets.

The reason reliability is singled out in economic impact analysis is because in addition to the direct effects on average travel time, it can also affect worker productivity, product and service delivery logistics, and market accessibility for both workers and customers. Unanticipated delays in worker arrival times (or the arrival times of product inputs and services) can hamper efforts to use just-in-time manufacturing and inventory systems, require more slack time in freight and warehouse scheduling processes, and can reduce productivity in service calls. Market accessibility to specialized labor skills can directly affect cost structures

[1] While personal trips may involve spending (on meals, entertainment, recreation, etc.), and travel speeds may affect the timing and location of that spending, it is assumed that availability of faster public transportation options for personal trips will generally not increase household spending rates in the U.S.

and therefore competitive pricing. Significant congestion can also disrupt coordination and business efficiencies.

Methodology. There are several ways to view and assess the economic value of time savings associated with reliability improvements. One is to recognize an additional value or premium placed on travel time savings for passenger and freight travel during congested periods. For instance, some studies have added a 50% premium to the average value of time delay savings during congested peak period conditions. A more intuitive way to assess the value of reliability is to recognize that many travelers (including car, truck, bus and train travelers) tend to "pad" their personal schedules to allow for the possibility of greater congestion delay. This added "buffer time" is equivalent to leaving early all of the time to avoiding arriving late at least some of the time. By reducing the travel time uncertainty caused by traffic congestion, public transportation can reduce or eliminate the need (and cost) of schedule buffering.

Travel Cost Savings

Definition. Improvements in public transportation services may lead to three types of cost savings for travelers:

- Change in travel cost to existing public transportation passengers – due to changes in fare structures associated with new services;
- Change in travel cost for those shifting from automobile use -- due to the difference between public transportation fares and previously-paid vehicle operating costs including fuel, parking, toll and maintenance expenses;
- Change in ownership cost -- potential additional depreciation, insurance and upkeep cost savings applicable if some former automobile users end up owning fewer automobiles in the long run.

Methodology. A variety of analytic tools provided by FHWA, including STEAM, HERS and BCA_NET, can be used to calculate these savings for automobile and public transportation usage.

Travel Safety Improvement Costs

Definition. Improvements in public transportation services may enhance safety by reducing collisions and associated insurance costs, personal losses and emergency response costs. The cost savings fall into four classes:

- Accident reductions for those shifting from automobiles to public transportation -- due to the significantly lower accident rates for public transportation;

- Accident reductions for those still traveling by automobile -- due to reductions in congestion and hence congestion-related collisions.

- Accident reductions for residents – to the extent that there are fewer cars on the road in the long-term, pedestrian and bicycle accidents and fatalities involving vehicles will be reduced.

- Reduced costs of traffic enforcement and emergency services.

Methodology. The cost savings associated with increased public transportation investment is calculated as the sum of two elements: (1) the difference in average occupancy and accident rates for public transportation vehicles, cars and trucks, and (2) the difference in accident rates for roadway vehicles under alternative congestion levels. For instance, the rate of fatal accidents *per transit passenger mile* was estimated by APTA (for all public transportation modes combined) to be $1/25^{th}$ the rate of fatalities *per highway passenger mile* for the years 2002 to 2006.

Impacts of Travel Cost Changes on the Economy

Definition. The travel-related impacts that have been discussed so far – including travel time, reliability, cost and safety impacts – lead in various ways to impacts on the economy. Some of the travel-related impacts translate directly into economic impacts (e.g., cost savings to households and businesses). Other travel-related impacts lead to economic impacts through additional factors (e.g., effects of worker schedule reliability on business productivity). Both types also lead to shifts in purchasing patterns and business expansion decisions.

Altogether, it is important to understand that economic impact accounting is a way of viewing and measuring effects of public transportation investment, which is meant to be neither a duplication of traveler benefit measures nor added on top of them. It is also important to note that access improvements, discussed later in Section 2.3, also lead to impacts on economic growth.

In terms of economic accounting, the previously discussed traveler impacts lead to five categories of direct effect:

- Cost of living savings for households, leading to broader impacts on consumer purchasing patterns;

- Business productivity benefits from delivery cost savings due to reduced congestion, which can lead to business expansion;
- Business productivity benefits from more reliable employee arrival times, also increasing competitiveness and business expansion;
- Indirect effects, as directly-affected businesses expand and generate additional orders to their suppliers (leading to growth of those firms);
- Induced effects, as the hiring of more workers generates a larger payroll, which is re-spent on consumer purchases (growing additional business).

It is important to note that measures of economic development impact are especially sensitive to study area definition, as noted in TRB Circular 477 (Weisbrod, 1997). Often, some (but not all) of the increase in jobs and income in a given area of public transportation improvement is due to shifts in activity from elsewhere. However, there is usually some underlying productivity benefit that is causing the shifts to occur in the first place. So the change in economic activity may be quite pronounced for a local area, but appear smaller when observed for a wider area.

Methodology. Tools that combine both I-O and cost response methods are:

- The REMI model, which emerged in the 1990's as a tool for transportation economic impact analysis, estimates how industries grow in response to changes in generalized transportation costs. It has been used for a variety of highway impact studies as well as for several studies of the economic impact of investment in public transportation. They include: Philadelphia SEPTA (Urban Institute and Cambridge Systematics, 1991), Rochester Light Rail (Wilbur Smith Associates, 1998), Hartford, CT (Carstensen, 2001) and Los Angeles MTA investments (Cambridge Systematics and EDR Group, 2001).
- The newer generation TREDIS model was initiated in 2006 as a multi-modal analysis system with added features that respond to differences in bus, rail and automobile reliability and expense costs for commuting, as well as the different impact of roads and public transportation on labor market access and associated worker productivity. It has since been used for multi-modal transportation impact studies in Portland Metro, OR (EDR Group, 2006) and Chicago, IL ("Chicago Metropolis 2020," 2007), passenger rail impact studies in California (Cambridge Systematics, 2007) and commuter rail in Massachusetts (Mass. EOT, 2009). It is also being used with Canadian model data for a series of bus and rail public transportation economic impact studies in Toronto and Durham, Ontario.

2.3 Access Improvement Impacts

Improvements in public transportation services may lead to economic productivity changes as a consequence of both expanded public transportation service and reduced traffic congestion. This may specifically include:

- Mobility and Market Access - business productivity benefits from access to a broader and more diverse labor market with a better fit of workers skills, and access to a wider customer market;

- Spatial Agglomeration Economies - business productivity benefits from agglomeration or clustering of similar and complementary activities, enabled by public transportation services and terminal facilities;

They also lead to further indirect and induced effects (previously discussed in Section 2.11) and broader productivity and cost effects on the economy (previously discussed in Section 2.2).

Mobility and Market Access

Definition. In addition to time and vehicle costs savings, public transportation provides household mobility benefits in terms of access to work, school, health care and/or shopping destinations. These impacts have been discussed in a variety of studies ranging from rural transit services (Burkhardt, 1999) to human costs of immobility (Crain et al, 1999). In the context of economic impact modeling, the work and shopping access benefits translate into increased productivity for business. This takes two forms:

(1) worker productivity enabled by access to a broader and more diverse labor market, offering better fit between desired and available workers skills, and
(2) economies of scale enabled by access to a wider customer market.

The labor market impact can be particularly notable, and is backed by public transportation passenger surveys, which measure the number of people using public transportation to travel to workplaces that they would otherwise not be able to access. The role of public transportation in enlarging labor market access was also recognized in the APTA study (Cambridge Systematics and EDR Group, 1999) and in UK reports (Eddington, 2006).

Methodology. A pioneering work examining the economic impact of public transportation on labor market access was the Philadelphia SEPTA study (Urban Institute and Cambridge Systematics, 1991). That study examined the effect of reducing commuter rail service on the movement of jobs from downtown Philadelphia across the river to New Jersey. Additional work on congestion impacts in NCHRP 463 (Weisbrod et al, 2001) also shows that different occupation and skill groups had differing commute distances and patterns. That, in turn, causes both traffic congestion reduction and public transportation policies to have distinct patterns of impacts. Further impacts of rail transport on labor markets in California (2007), Ontario and Massachusetts (2009) have also addressed the effects of public transportation services on expanding labor markets to enable business growth.

There are often disparities in access to transportation across different income, disability, gender, ethnicity, and education subgroups. Often the demographic groups more dependent on public transportation are young, elderly, and low-income individuals. A lack of personal mobility has further economic consequences which can be estimated. These include unemployment costs, reduced tax revenue and higher welfare/medical costs. In the US, over eight percent of American households do not have access to a car, though the portion rises to over twenty percent for low income households (*2001 National Household Travel Survey,* as quoted in Bureau of Transportation Statistics, 2003).

More generally, mobility benefits are defined as "benefits from transit trips that would not be made without the availability of transit" (EcoNorthwest, 2002). FTA New Starts Criteria define mobility improvements in terms of the number of public transportation dependent passengers using public transportation services and the value of benefits they gain per passenger mile (FTA, 2007). To quantify the value of access to a job, the value of missing an employment or business trip may be estimated in terms of the added cost to affected households and businesses.

Within the context of benefit-cost studies, it is also possible to calculate an economic valuation of improving mobility for medical, shopping and other classes of trips that are not business or commute-related. For instance, in the case of medical needs, the Medicare cost of a visit to the doctor may be used as a proxy. Studies have also estimated the value of a missed shopping trip to be roughly $4 per trip and a missed recreation or personal trip to be roughly $2 per tips. Combining these estimates together provides an estimate of the overall value of mobility for an individual. Factoring in the number of users that fall within this category can provide an aggregate value for mobility benefits (Crain et al, 1999). Similar types of mobility benefits for education, health care and retail trips were also calculated in a public transportation benefit-cost study for Wisconsin (HDR, 2006). It is important to note, though, that the personal valuation of a missed or foregone trip may be different from an impact on the flow of income and generation of jobs in the economy.

Spatial Agglomeration Economies

Definition. Public transportation supports economic growth through the concentration of economic activity and the clustering of offices, shops, entertainment centers, and other land uses around public transportation stops. Such clustering activity may provide increased efficiency through reduced labor cost, improved communication, lower infrastructure costs, and increased interaction with similar businesses. Clustering provides an opportunity for more face-to-face contact and for access to specialized labor, which result in higher productivity and more economic growth. The relationship between urban transportation and market agglomeration economies is discussed in Weisbrod et al (2001); Graham (2005); Eddington (2006); and OECD (2007).

The relationship between public transportation service and business density is widely recognized. The locations of downtown office districts, often focused on financial services and related business sectors, usually coincide with the location of greatest public transportation availability and usage. While the direction of causality may be argued, the relationship is clear.

In fact, many large cities could not possibly provide either the road capacity or the parking spaces needed to accommodate their downtown workforces without pubic transportation. In the same way, the clustering enabled by public transportation investment can facilitate economic linkages between organizations, government agencies, and workforce training institutions by providing access to labor, business networking opportunities, and suppliers.

From a municipal organization's perspective, clustering also helps to support compact patterns of development that in some cases can more effectively utilize infrastructure for electricity, water, and sewer utilities to serve new development.

In some cases, as public transportation improves the overall quality of life, both businesses and employees are attracted to the region, which supports additional growth and development. Agglomeration benefits are typically capitalized into land values and rents at locations where access to public transportation services is concentrated.

Methodology. The methods used to assess public transportation impacts on agglomeration economies center on statistical analysis, using regression techniques. These techniques relate measures of the effective labor or customer market size to measures of business concentration, output level or productivity measures. The effective market size is often measured as the population living within a given (e.g., 45 minutes) travel time of a given business center location. A variety of studies in the United Kingdom have determined measures of the agglomeration effects (e.g., Graham, 2005), and parallel studies were conducted in the US for smaller urban centers (e.g., Comings and Weisbrod, 2007). The

TREDIS economic model incorporates these same types of regression relationships (involving labor market access and agglomeration impacts) to calculate the economic impacts of planned public transportation enhancements across Canada and the US. Examples include studies for Chicago, Portland, OR and Boston ("Chicago Metropolis 2020," 2007; EDR Group, 2006, 2009).

Total Economic Development Impacts of Public Transportation Service

A wide range of local economic impact studies have estimated the regional economic impact of various alternative public transportation investment scenarios. These studies have done so by relying on regional economic models to estimate the impacts of public transportation enhancements on travel times and costs, workforce access and/or business market agglomeration. In doing so, they have demonstrated the substantial magnitude of impact that public transportation investment can potentially have on regional economies, and they have provided a basis for the generalized analysis methods that are explained in Chapters 4 and 5 of this report. Examples of these local studies include the following:

- Chicago, IL, RTA and METRA (EDR Group, 2009).
  Scenario: invest to maintain system ($1.68B cost) vs. disinvestment
  11,400 jobs, $2.0 billion in net annual business output and household cost savings gain as of 2020

- Atlanta (University of Georgia, 2007)
  Scenario: continued operation ($660 million/year) vs. disinvestment
  $1.3 – 1.5 billion of added economic growth

- AC Transit, Oakland, CA (Crain, 1999).
  Scenario: reduction in service ($4.8m) vs. continued service
  $48.1M in lost income and time.

- Los Angeles County MTA (Cambridge Systematics and EDR Group, 1999).
  Scenario: system investment with rail/bus Improvements vs. no investment
  131,200-261,700 jobs and $9-16 billion in personal income gain as of 2020

- New York MTA (Cambridge Systematics and EDR Group, 1997).
  Scenario: disinvestment vs. system investment to maintain service
  319,800 jobs and $18.9 billion in annual business sales loss as of 2016

- Danbury, CT HART (Jack Faucett Associates, 1997).
  Scenario: immediate shutdown vs. funding to maintain service
  $1.8 million loss in wages and $1.3 million loss in direct HART expenditures

- Dayton, OH, MVRTA (University of Dayton, 1995).
  Scenario: immediate shutdown vs. funding to continue operation
  985 jobs and $3.8 million in annual spending loss

- Philadelphia SEPTA (Urban Institute and Cambridge Systematics, 1991).
  Scenario: immediate shutdown of rail transit vs. funding to continue operation
  175,000 jobs , $10 billion wages and $16 billion annual business sales loss as of 2010.

2.4 Non-Monetary Impacts

While this report focuses specifically on impacts on the economy, it is also useful to recognize broader benefits that can be valued in dollar terms although they do not directly affect growth of income or productivity in the economy.

Option value

Definition. Public transportation option value is the value a non-public transportation user assigns to the ability to use public transportation as an option when a typical mode of travel is unavailable or inconvenient for a given trip. Non transit travel modes such as walking, biking, and carpooling can be assigned value. However, the option value is typically measured by the occasional need that auto users have for public transportation. The value of having an additional option for travel depends on a variety of circumstances such as extreme weather conditions, severely congested roadways, incidences of vehicle unavailability due to maintenance and repair, high gas prices or parking costs, or short term disability or financial constraints.

Methodology. The primary challenges are in estimating future auto trip costs and the number of times public transportation will be needed. Despite the potential variance in estimates, option value is an important benefit to be included as individuals make modal decisions given certain conditions. Option value is further discussed in Forkenbrock (2001) and Puget Sound Regional Council (2005).

Environmental benefits

Definition. The most often cited environmental benefit due to increased public transportation and reduced automobile miles is air quality, which can have region-wide benefits. Pollution from auto emissions contributes to a wide variety of negative health problems such as respiratory illness and lung damage. Increased ozone levels can damage plants, trees, and crops. Improving the environmental quality of a region may help to attract workers and business that support transportation systems that improve the environment. Recent attention has also been focused on greenhouse gases such as carbon dioxide in addition to the Clean Air Act criteria pollutants (e.g, SO_X, NO_X, CO, and particulates).

Methodology. A comparison of US and European methods for assessing environmental and health impacts is presented in the NCHRP study on monetizing hard-to-quantify impacts (EDR Group, 2007). Updated tables are provided in Weisbrod et al (2009).

In estimating the value of reduced air emissions, dollar values are assigned to each criteria pollution type (e.g, SO_X, NO_X, CO, particulates) according to EPA models or tradable allowances/ permits that are traded on a climate exchange. Climate exchanges such as the Chicago Climate Exchange, Regional Greenhouse Gas Initiative, or the European Climate Exchange provide current pricing on trading allowances for each type of emission. This methodology can provide a specific dollar value of reduced pollution based on current pricing even though the exact impacts on the environment may not completely be known. Including an accurate assessment of the environmental benefits for a public transportation project may require a blending of artful and scientific estimates.

2.5 Other Economic Impact Measures

Land development & property values

Definition. The increase in property values near a public transportation station essentially represents a capitalization of the access cost savings and travel time savings associated with those locations. Including this value in a regional or national economic impact study would be considered “doubling counting” since the value of time savings is already included in those other types of study. However, this form of analysis is useful both because it demonstrates the localized nature of some public transportation impacts, and because it also serves to confirm the value public transportation provides in the market. It also helps us understand how public transportation can shape development and land use changes.

Clustering of commercial business often occurs near public transportation stations because of the value of access to labor and customers. However, the influence of public transportation on local development and value ultimately needs to be examined within the context of other major influences, such as public-sector support for development and private-sector market trends which may have a stronger impact depending on current conditions.

Methodology. Market studies, direct property comparisons and regression models (that factor out location and setting influences) are helpful methods to determine the value of surrounding land. TCRP Report 35 (Cambridge

Systematics, 1998) provides methods for calculating land value impacts in the context of measuring accessibility and agglomeration benefits. TCRP Report 102 (Cervero et al, 2004) provides numerous case studies of public transportation impacts on land values surrounding rail transit stations. Some illustrative examples from that study and more recent studies are shown below:

Examples of property value impacts

- A statistical study of residential property values in Buffalo, NY, examined how values varied for properties within one-half mile of light rail transit stations. It found that every foot closer to a light rail station increased average property values by $2.31 (using geographical straight-line distance) and $0.99 (using network distance). Consequently, a home located within one-quarter of a mile radius of a light rail station can earn a premium of $1300-$3000 (Hess, 2007).

- Studies over two decades show average housing value premiums associated with being near a station (usually expressed as being within 1⁄4 to 1⁄2 mile of a station) are 6.4% in Philadelphia, 6.7% in Boston, 10.6% in Portland, 17% in San Diego, 20% in Chicago, 24% in Dallas, and 45% in Santa Clara County (Cervero et al, 2004).

- A study of experiences in the San Francisco Bay Area study found that for every meter closer a single-family home was to a BART station, its sales price increased by $2.29, all else being equal. Alameda County homes near BART stations sold, on average, for 39% more than otherwise comparable ones 20 miles from the nearest station (Cervero et al, 2004).

- A detailed study conducted by researchers at the University of Toronto in 2000 indicated that proximity to a subway station in Toronto generated approximately $4,000 in additional residential property value for a home with a value of $225,000. (Canadian Transit Association, 2003)

- A study of the DART system compared differences in land values of “comparable” retail and office properties near and not near light trail stations. The average change in land values from 1997 to 2001 for retail and residential properties near DART stops was 25% and 32%, respectively; for “control” parcels, the average changes were 12% and 20% (Weinstein and Clower, 2003).

3 SPENDING IMPACT

Investment in public transportation facilities and systems affects the economy in two ways: (1) through the injection of spending on worker wages and purchases of materials and services, and (2) through cost savings and business productivity benefits that accrue as a result of public transportation services. This chapter focuses on the first category of impact, while Chapter 3 focuses on the latter category.

This chapter is organized into five parts:

3.1 Direct, Indirect and Induced Effects

Capital investments in public transportation are made to accomplish one of three objectives:

- New system investments, with expenditures for land acquisition, engineering and all necessary system components;

- Modernization, with expenditures for replacement or rehabilitation of system components at the end of their useful lives; and

- Expansion, with expenditures for additions to existing services. The scope and range of expenditures for expansion projects vary greatly.

For all three classes of objective, capital investment is defined to include: (1) development of facilities –including project design and construction of stations, maintenance buildings, right-of-way routes, power generation plants, etc. and (2) purchases of equipment – passenger vehicles (e.g., buses, trains) and supporting control and operations equipment. In addition, there is ongoing spending on operations and maintenance of public transportation systems, including bus and train services, maintenance activities and administration.

Labeling Economic Impacts. Both capital and operations spending on public transportation lead to impacts on the economy through three categories of economic impact. They are:

(a)"***Direct effects***" on workers and businesses engaged in the manufacturing of vehicles and control equipment, construction of guideways and station facilities, and operation of public transportation services;
(b) ***"Indirect" effects*** on supporting industries, i.e., those that supply goods and services to enable the direct spending – including workers in industries supplying the engines, equipment parts, and the steel, concrete, wood and plastic materials that are needed for building vehicles, guideways and station facilities; and
(c)***"Induced" effects*** on the re-spending of worker income on consumer goods and services – including food, clothing, shelter, recreation and personal services.

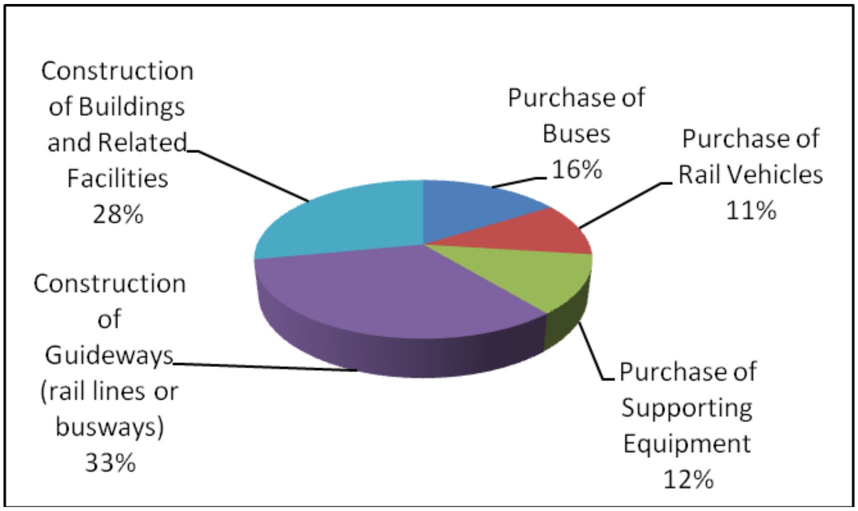
These economic "effects" can be viewed as indicators of the broader role of public transportation on a regional or national economy, as they show how investment in public transportation also helps support jobs and income in other industries. They can also show how increases in public transportation spending can increase jobs in the economy, as long as there are sufficient workers to fill the public transportation-generated jobs without the displacement of other existing jobs. When there is relatively high unemployment, as currently exists in the year 2009, then an *increase* in public transportation spending can have very real "multiplier" effects, as it leads to more jobs not only in the construction and transportation industries, but also in other industries that benefit from indirect and induced impacts.

3.2 Mix of Capital and Operations Investment

Total US Spending Mix. Investment in public transportation capital and operations lead to very different forms of job and income generation, and affect very different industries in the economy. For that reason, it is important to consider both forms of investment. Exhibit 3-1 shows the mix of products and services now being purchased as capital investment in public transportation in the US. Exhibit 3-2 also shows the mix between capital and operations at a national level. According to APTA, currently as of 2007 71% of all public transportation investment is for operations and maintenance of existing systems, while 29% is for capital investment in vehicles and equipment needed to operate and expand existing systems.

Federal Government Spending Mix. US federal authorization law focuses all federal government funding for public transportation on capital expenditures and preventive maintenance. However, the latter would actually be described as operations in the federally required standard accounting system. Accounting for that fact, in federal fiscal year 2007, 31.4% of federal assistance for public transportation was for operating expenses as defined by the standard accounting system and 68.6% was for capital expenses.

Exhibit 3-1
Components of Capital Investment in Public Transportation in the US, 2007



Source: APTA Fact Book, 2009

Exhibit 3-2.
Mix of Public Transportation Capital and Operations Spending 2007

Spending Category	**% of Capital Spending**	**% of Total Spending**
Purchase of Buses	16%	5%
Purchase of Rail Vehicles	11%	3%
Purchase of Supporting Equipment	12%	4%
Construction of Guideways (rail lines or busways)	33%	10%
Construction of Buildings and Related Facilities	28%	8%
Subtotal: Capital Spending	**100%**	**29%**
Operations and Maintenance Spending		**71%**
Total Public Transportation Spending		**100%**

Source: APTA Fact Book, 2009

3.3 Economic Impact Models

The estimates of job impact used for this study utilized a composite methodology that attempts to parallel the FHWA methodology which is used for highway related job creation, in that it tracks the pattern and mix of direct expenditures, and traces their indirect and induced impacts by utilizing a national economic model. Exhibit 3-3 shows the estimated breakdown of jobs generated in terms of direct, indirect and induced effects, for both capital and operations spending.

Exhibit 3-3. Jobs Generated in the US per Billion Dollars of Spending on Public Transportation *(National Spending Mix, with 2007 prices)*

Job Generation per $ Billon of Spending	**Capital**	**Operations**	**Blended Average**
Direct Effect	8,202	21,227	17,450
Indirect Effect	7,875	2,934	4,367
Induced Effect	7,111	16,979	14,291
Total Jobs	23,788	41,140	36,108

To verify these values, they were compared with alternative job generation impact calculations derived using two alternative economic modeling systems that offer simplified inputs to represent fixed, preset spending profiles for bus and train construction and for public transportation system operations. Both the IMPLAN model and the REMI model are built upon the US national input-output (I-O) table, reflecting 2004 inter-industry purchasing and import patterns, with 2007 prices. The core analysis, labeled as "EDRG Composite," was also adjusted for consistency with producer price index changes representing price inflation for the applicable capital investment elements. Exhibit 3-4 compares findings from these alternative calculation methods.

Exhibit 3-4. Summary of Estimated Public Transportation Spending Impact on Job Generation, Using Three Alternative Models with 2007 Prices

Job Generation per $ Billion	**Alt. A: IMPLAN model**	**Alt. B: REMI model**	**Core Analysis: EDRG Composite**
Public Trans. Capital	18,465	28,984	23,788
Public Trans. Operations	31,291	43,952	41,140
Public Trans. Overall Average	27,571	39,611	36,108

Together, the IMPLAN and REMI models show a range of low and high impact estimates that encompass our estimates. The differences between these various estimates are also understandable. For instance, the unadjusted IMPLAN estimates can be interpreted as representing a low end of the range because they do not automatically account for: (a) additional transportation spending impacts on wages and tax revenues, leading to further growth of government jobs over time, or (b) jobs associated with equipment that is assembled outside the US, but with parts that originated in the US. On the other hand, the REMI model estimates can represent a high end of the range because they incorporate forecasts of growth in technological productivity and real wages, which can include changes in US-based assembly and fuels.

Ultimately, none of these model estimates account for the potential that there can be even more jobs generated if there is a change in policies regarding "made in America" purchasing. It is estimated that currently, 76% of the public transportation vehicles, 87% of the supporting equipment and 81% of the track is made in America (based on US BEA input-output tables). If any of these percentages increase in the future, then the total US job impact of capital spending would become even greater than indicated here. Additional increases in the US job impact of operations spending would occur if incentives are put into place for further switching to biodiesel and natural gas fuels (which are primarily made in the US). As a result, all of these estimates could understate job impacts. However, for purposes of this report, it is most useful to avoid assuming that any further changes in other policies will take place. Thus, this study adopts the composite calculation of approximately 36,000 jobs per billion dollars for all public transportation spending in the US.

3.4 Overall Economic Impact of Spending

Federal Investment Impact on Jobs. The preceding estimates reflect jobs supported per billion dollars of investment in public transportation in the US, including that funded by rider-paid fares, local/state revenue sources, federal funding and other sources. To assess the number of jobs supported by *federal investment* in public transportation, it is necessary to recalculate the job figures using the specific spending mix that is applicable for federal funding. As previously noted, federal funding is focused on capital investment and preventative maintenance, but using the federal standard accounting system that would translate to 68.6% actually going for capital expenses and 31.4% going for operating expenses. That mix supports an estimated 29,236 jobs per billion dollars of federal spending on public transportation. If expenditures on right-of-way are excluded from the analysis, then the figure rises to an estimated 29,833.[2]

[2] *The purchase of land for busways and rail lines does not generate jobs, so the exclusion of those costs leads to slightly higher estimates of job generation per billion dollars of spending. For*

Job Impacts of Alternative Investment Mixes. Exhibit 3-5 summarizes these findings. The actual value of these job generation numbers will vary from year-to-year, depending on the mix of investment elements and inflation rates. Changes may include not only shifts in capital and operating investment, but also shifts in technologies used. For instance, the growth of alternative motor fuels such as biodiesel and natural gas can increase US job creation because these alternative fuels come from US-based sources which support additional jobs for their collection and processing.

Exhibit 3-5. Jobs Generated in the US per Billion Dollars of Investment in Public Transportation, for Alternative Capital/Operating Mixes (2007 Prices)

Category	(Capital / Operating) Mix	Model Calculation	Recommended Use: Rounded Value
Capital Investment Only	(100 / 0)	23,788	24,000
Operations Investment Only	(0 / 100)	41,140	41,000
Total National Investment Mix*	(29 / 71)	36,108	36,000
Federal-Aid Investment Mix	(69 / 31)	29,833	30,000

**National total includes spending by all federal, state and local public transportation agencies and companies within the US. Source: APTA.*

Other Impacts on Wages, Value-Added and Output. The economic impact of investment in public transportation occurs in the form of an increase in economic "activity" which can be measured in several different ways. They are:

- total business output (volume of business revenues or sales)
- total GDP (gross domestic product; also referred to as "value added", it represents business output minus cost of labor and materials)
- total labor income paid (i.e., wages, which is a subset of GDP)
- total jobs associated with those wages.

Job impacts are usually of most interest to the general public, partly because they are an understandable unit of measurement and the most direct goal. However, it is important to note that these are alternative units of measurement of the same fundamental economic impacts, so they can *never* be added together.

Exhibits 3-6 and 3-7 present the categories of economic impacts in terms of the results per billion dollars of investments or spending. The broadest measure is business output (sales volume), which shows an average of $3.60 of change per

this study, a figure of 2% was adopted as a reasonable estimate of the applicable portion of federal public transportation funding.

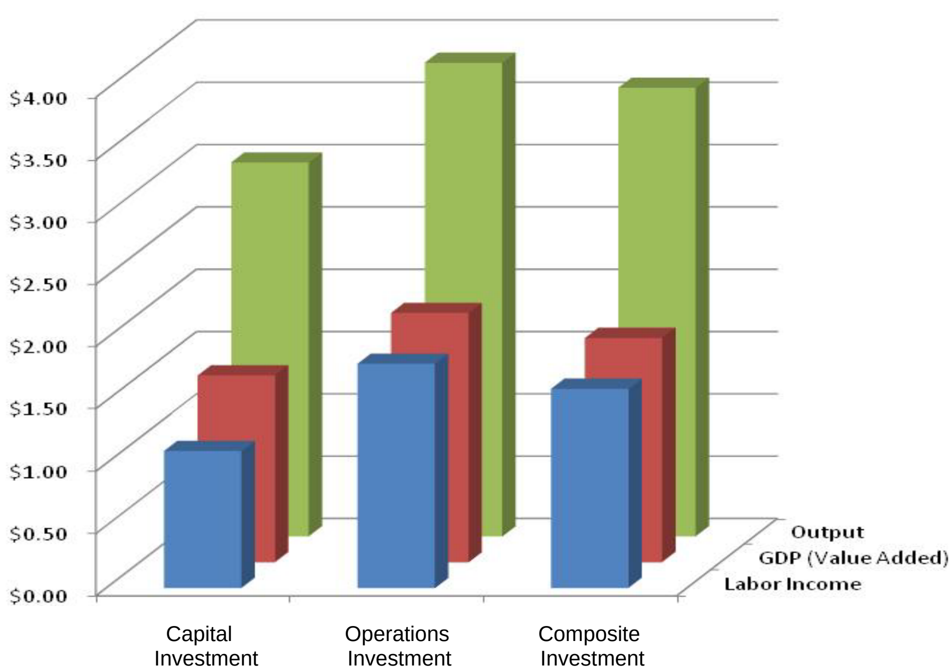
dollar of public transportation spending. The impact measure preferred by most economists is GDP (Gross Domestic Product, also referred to as "value added"), which shows an average of $1.80 of change per dollar of investment. GDP consists of labor income and net corporate profits. In addition, the jobs per billion dollars of investment is shown, which averages to 36,108. It is important to note that these numbers indicate the scale of investment impacts on the economy and are not benefit/cost ratios (which focus on long-term project benefits).

***Exhibit 3-6 Economic Impact per Billion Dollars of National Investment in Public Transportation** (includes indirect and induced impacts)**

Economic Impact	Per $ Billion of Capital Investment	Per $ Billion of Operations Investment	Per $ Billion of Average Investment
Output (Business Sales)	$ 3.0 billion	$ 3.8 billion	$ 3.6 billion
GDP (Value Added)	$ 1.5 billion	$ 2.0 billion	$ 1.8 billion
Labor Income	$ 1.1 billion	$ 1.8 billion	$ 1.6 billion
Tax Revenue (fed, state, local)	$ 350 million	$ 530 million	$ 488 million
Jobs (Employment)	23,788	41,140	36,108

** Note: indirect and induced impacts reflect effects on additional industries; they do not provide additional multiplier effects on federal investment unless there is sufficient unemployment to absorb additional jobs without displacement of other existing jobs*

Exhibit 3-7 Economic Impact per Billion Dollars of Public Transportation Investment



A breakdown of the corresponding tax revenue impacts of $1 billion of public transportation investment is shown in Exhibit 3-8. Almost three-quarters of these tax revenues are generated as a consequence of additional wages; the rest is generated as a consequence of additional business activity.

Exhibit 3-8 Tax Revenues Generated per $1 Billion Dollars of Public Transportation Investment *(in millions of 2007 dollars)*

	Federal Tax Revenues ($ Millions)	State & Local Tax Revenues ($ Millions)
Corporate Profits and Dividend Taxes	$ 9	$ 4
Personal Income Tax	$136	$ 36
Sales and Property Taxes	$ 0	$ 82
Social Security Contributions	$167	$ 0
Other Taxes and Fees	$ 17	$ 31
Subtotal	$329	$159
Grand Total	$488	

Comparisons to Other Forms of Investment. It can be useful to compare the job generation impacts of public transportation investment with other forms of investment. Exhibit 3-4 showed that federal investment in public transportation supports roughly 30,000 jobs per billion dollars, which is the same as the figure widely used by the FHWA for the impact of federal spending on highway investment.[3]

Another comparison of interest is contained in a study by economists at the University of Massachusetts-Amherst, who analyzed the magnitude of job creation associated with $1 billion of federal money spent for either tax cuts or economic stimulus (Pollin et al, 2007). It found that (1) "each billion dollars of tax revenue allocated to tax cuts for personal consumption generates approximately 10,800 jobs" while "investing the same amount in the military creates 8,500 jobs… in health care yields 12,900 jobs; in education, 17,700 jobs; in mass transit, 19,800 jobs; and in construction for home weatherization and infrastructure, 12,800 jobs." All of those figures count only the direct and indirect (supplier) jobs, so they are uniformly lower than totals including induced (wage spending) effects, which is the more comprehensive approach used in our study.

[3] *FHWA analysis for 2007 indicates that each $ billion of federal highway expenditure, in historical proportions of use, supports 27,800 jobs (allowing for inclusion of right-of-way expenses) or 30,000 jobs exclusive of right-of-way acquisition costs. Source: www.fhwa.dot.gov/policy/otps/pubs/impacts/index.htm (updated 2/12/09)*

While the methods used were not identical, the basic finding of the UMass study still holds that additional public transportation investment supports additional jobs at levels greater than many of the other categories of public spending, and nearly twice as many jobs as tax cuts. That feature can make public transportation investment particularly useful as a means of stimulating job growth when there is above-average unemployment.

3.5 Types of Jobs: Impacts by Industry and Occupation

Breakdown of Impacts by Industry. The job impacts shown earlier in Exhibits 3-5 and 3-6 can be further disaggregated in terms of industries and occupations. A breakdown of job impacts by major industry group is shown in Exhibits 3-9 and 3-10 on the next page. The mix of affected industry groups shown in those charts and tables reflects the combined outcome of four key factors:

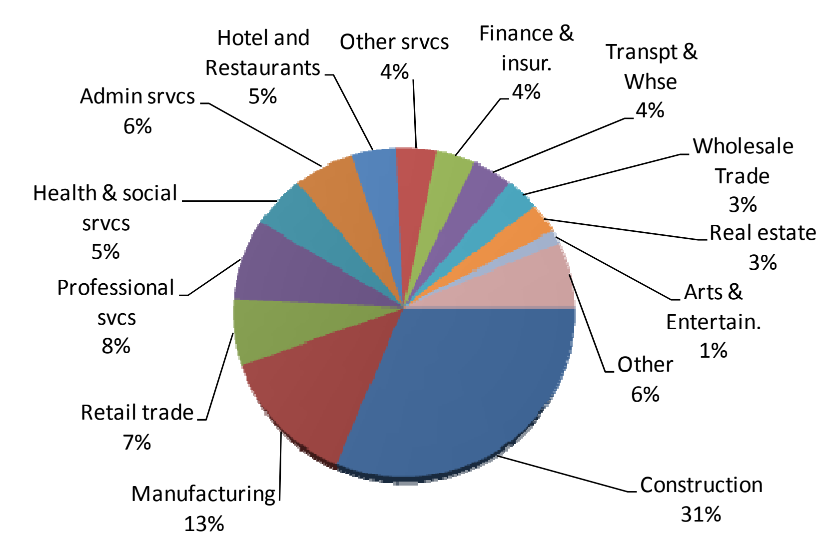
- *The direct investment mix* for capital and operations – which in this case is primarily construction services; manufacturing of buses, trains, tracks and equipment; and government-owned public transportation services (as shown in Exhibit 3-2).

- The locally-made portion of those manufactured products and services – which in this case means the U.S.-supplied portion: 100% for ongoing public transportation operations plus 76% for buses, 87% for train rolling stock, and 81% for control equipment.

- *The indirect effect* on orders to their suppliers, which the national input-output table shows are distributed across a broad range of industries. For capital investment, the indirect effects are concentrated in manufacturing of building materials and equipment, associated transportation and wholesaling, plus administrative, professional and financial services. For operations spending, the indirect effects are concentrated in professional and administrative services, vehicle replacement parts manufacturing, wholesale trade and petroleum products.

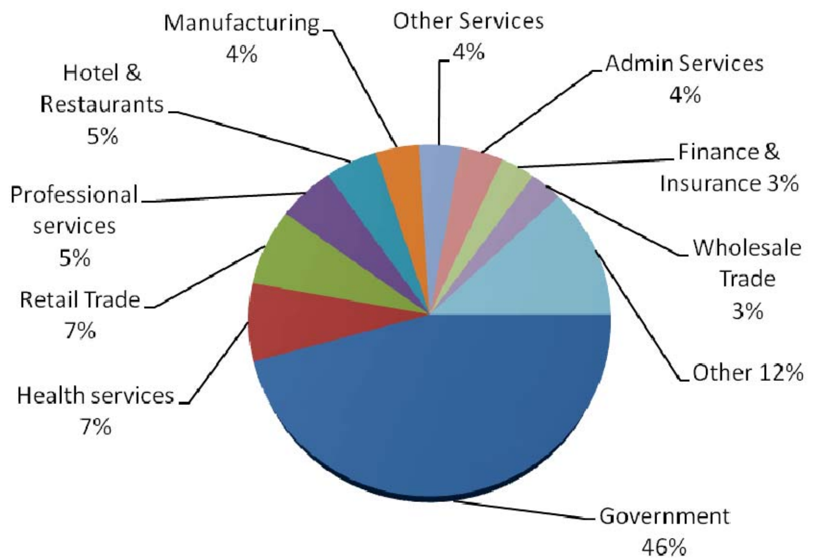
- *The induced effect* on worker spending of the additional wages, which the national input-output table shows are distributed across a very different range of industries – primarily retail trade, restaurants and lodging, personal services, health services and financial services.

Exhibit 3-9. Public Transportation Capital Investment: Jobs per $ Billion, by Industry



Construction	7,427	Health & social srvcs	1,246	Finance & insur.	905	Arts & Entertain.	324
Manufacturing	3,109	Admin srvcs	1,406	Transpt & Whse	944	Other	1,519
Retail trade	1,534	Hotel and Restaurants	1,048	Wholesale Trade	775	Total	23,788
Professional svcs	1,910	Other srvcs	938	Real estate	702		

Exhibit 3-10. Public Transportation Operations: Jobs per $ Billion, by Industry



Government/Transit	21,445	Hotel and Restaurants	1,814	Finance & Insur	1,176
Health srvcs	2,744	Manufacturing	1,359	Wholesale Trade	1,002
Retail trade	2,702	Other srvcs	1,474	Other	4,355
Professional srvcs	1,703	Admin srvcs	1,366	Total	41,140

Not surprisingly, the preceding two charts show that the largest impact of public transportation capital investment is on the construction industry and on the manufacturing sector of the economy, while the largest impact of public transportation operations spending is on the government-owned (public transportation) operations. However, the previously-discussed indirect and induced impacts are also clearly evident.

Breakdown of Job Impacts by Occupation Group. In a time of economic stagnation, the job generation impacts of public transportation investment are particularly valuable. However, the public need is not just for any type of job, but rather for jobs in those industries particularly hard hit by the economic downturn. In a time of declining blue-collar employment within the US, there is a particular need for quality skilled and semi-skilled blue-collar jobs.

The direct effects of public transportation capital and operations investment support jobs in five labor skill categories defined by the US Dept. of Labor[4]:

- *Management and Professional* – including managerial workers and technical engineers;
- *Service* – including workers providing protective services, food services and other support services;
- *Sales and Office* – including sales agents and clerical jobs;
- *Natural resources, construction, and maintenance* – including construction workers for track, terminal and right of way, plus vehicle and facility maintenance workers; and
- *Production, Transportation, and Material moving* – including drivers and , crew members.

The tables and bar charts that follow show the job mix in terms of two different views. Exhibit 3-11 shows jobs *directly* supported by public transportation investment, compared to the mix of all jobs in the U.S. Exhibit 3-12 shows for *total* supported jobs, including indirect and induced effects, compared to that same mix of all jobs in the U.S.

The results are notable. The direct effects shown in Exhibit 3-11 indicate that both capital and operations spending directly support a relatively large share of jobs in transportation service professions, compared to the U.S. average. They also show that capital spending directly supports a relatively large share of jobs in management, professional and construction occupations, compared to operations spending.

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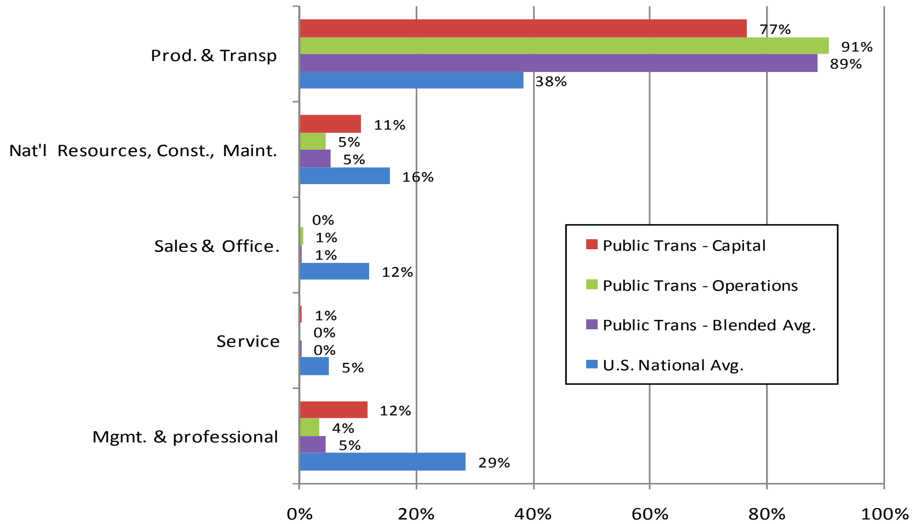
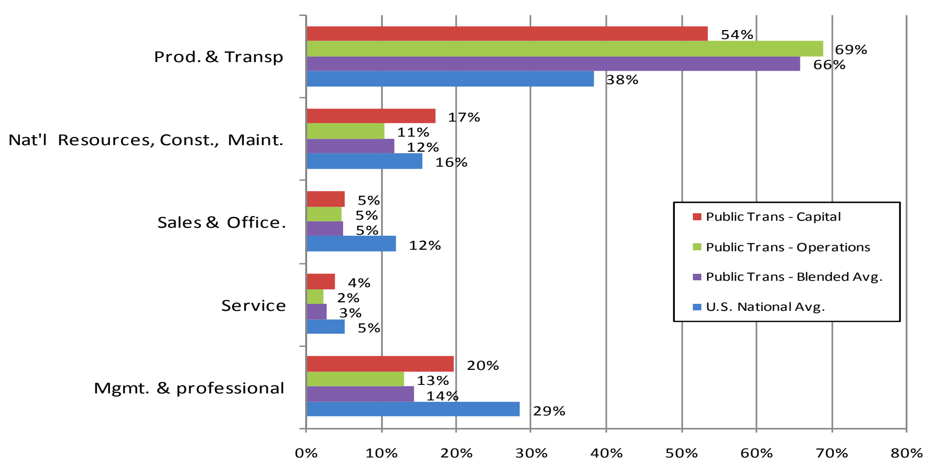
[4] White collar and blue collar job classifications were discontinued in 2007. Occupational series are presented by the aggregate groups specified in the 2000 Standard Occupational Classification manual (BLS). http://www.bls.gov/ncs/ebs/ebsm0005.htm

Exhibit 3-11. Direct Effects: Occupation Mix
(Jobs Directly Supported by Investment in Public Transportation)



	Direct Jobs ($1B spending)			
Occupation Classification	**Capital**	**Operations**	**Blended Avg**	**US Nat'l Avg.**
Mgmt. & professional	964	765	822	51,163,587
Service	50	84	74	9,378,394
Sales & Office.	15	148	110	21,589,418
Nat'l Resources, Const., Maint.	883	979	951	27,882,384
Prod. & Transp	6,291	19,251	15,493	68,542,369
Total	8,202	21,227	17,450	178,556,152

Exhibit 3-12. Total Effects: Occupation Mix
(Sum of Direct, Indirect and Induced Effects)



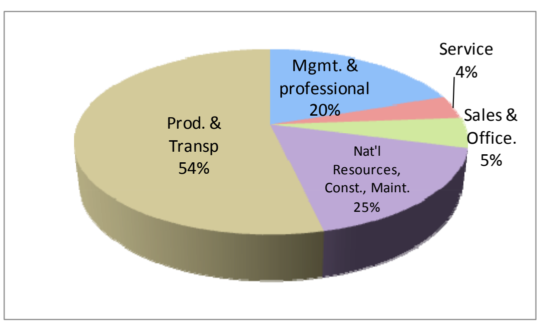
	Total Jobs ($1B spending)			
Occupation Classification	**Capital**	**Operations**	**Blended Avg**	**US Nat'l Avg.**
Mgmt. & professional	4,718	5,409	5,209	51,163,587
Service	938	1,023	998	9,378,394
Sales & Office.	1,241	2,031	1,802	21,589,418
Nat'l Resources, Const., Maint.	4,116	4,331	4,269	27,882,384
Prod. & Transp	12,775	28,346	23,831	68,542,369
Total	23,788	41,140	36,108	178,556,152

In contrast, *indirect* and *induced* effects support a wider range of occupations, generated by suppliers and vendors of goods and services as well as firms benefiting from workers re-spending their wages. These jobs can include health care workers, retail and wholesale workers, and additional professionals such as legal and financial service workers. These effects are reflected in Exhibit 3-12, which shows the occupation mix of total jobs. Not surprisingly, it still shows a relatively large concentration of jobs in transportation occupations, though the shares of jobs in all other occupation groups are larger than was the case in the prior chart (due to the inclusion of indirect and induced effects).

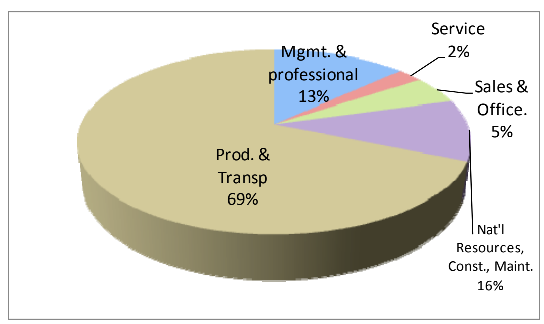
Overall, these occupational findings are important because they show how investment in public transportation supports a mix of jobs in construction, production, maintenance and transportation service professions. However, this job mix contrasts substantially with the average job mix found elsewhere in the economy, which features a greater share of jobs in professional services, business services and financial services. A further breakdown of the differences in occupational mix supported by public transportation capital spending and operations spending is provided in Exhibit 3-13.

***Exhibit 3-13. Comparison of Total Effects: Occupation Mix for Capital Investment and Operations** (Sum of Direct, Indirect and Induced Effects)*

(A) All Jobs Generated by Public Transportation Capital Investment per $1Billiom



(B) All Jobs Generated by Public Transportation Operations per $1Billion



Total Transportation Jobs	Capital	Operations
Mgmt. & professional	4,718	5,409
Service	938	1,023
Sales & Office.	1,241	2,031
Nat'l Resources, Const., Maint.	4,116	4,331
Prod. & Transp	12,775	28,346
Total	23,788	41,140

4 COST SAVINGS & PRODUCTIVITY IMPACTS

Whereas the prior chapter examined how spending on public transportation capital and operations supports transportation-related jobs, this chapter examines how the facilities and services that are enabled or created by that investment lead to the long-term effect of cost savings and productivity growth for the economy.

It implements a methodology that can be applied to link changes in public transportation investment to ridership, mode split and cost savings for various segments of the economy. It incorporates basic concepts introduced in the Chapter 3 methods review, organized in terms of seven sections that represent a sequence of steps.

- 4.1 Public Transportation Capacity –estimation of the cost and expected ridership impact of expanding public transportation capacity;
- 4.2 Cost of Additional Ridership –calculation of the cost per new public transportation rider (given the cost and ridership changes);
- 4.3 Public Transportation Use and Mode Switching –calculation of the reduction in automobile use (associated with the additional public transportation ridership);
- 4.4 Passenger Cost Savings –calculation of the cost savings to public transportation passengers (associated with mode switching);
- 4.5 Additional Congestion Reduction Benefit –calculation of cost savings to automobile and truck users (associated with reduced roadway congestion due to mode switching);
- 4.6 Business Productivity Benefit –calculation of the improvement in business output per worker (resulting from worker reliability changes);
- 4.7 Calculation of Overall Economic Impacts - to calculate the total change in disposable household income, business productivity and tax revenue (generated as a consequence of the prior steps).

Since each step requires additional data and assumptions to complete the calculations, the information presented in this chapter serves: (1) to demonstrate how the methodology can be applied, and (2) to illustrate the range and magnitude of economic impacts likely to be associated with national spending on public transportation. More data are needed to provide better information in the future, to further refine these economic impact estimates.

4.1 Public Transportation Capacity

Key Issue. The first step in assessing the long-term economic effects of investment in public transportation is to examine “What do we get in terms of capacity, service and ridership from that spending?” That issue can be addressed by first defining alternative scenarios representing different levels of public transportation investment, and then assessing their implications.

To accomplish this goal, it is necessary to assess the types and costs of public transportation capacity needed to serve the recent and forecast future growth of public transportation ridership. First, it is important to clarify that investment in public transportation capital is intended both to replace capital assets that serve existing passengers and to add new assets that can serve additional passengers. In practice, both goals require similar types of investment. Replacements for existing assets and expansion to provide new assets generally cost the same and represent the same general mix of spending categories (from engineering design requirements to purchases of facilities and equipment), except for very particular elements such as new rights of way. The capital investment needed for new passengers and the capital investment needed to serve current passengers also typically consists of the same types of facilities and equipment.

Capital Needs. The FTA’s Condition and Performance Reports and the recent TCRP project H-33B on “State and National Public Transportation Needs Analysis” (Cambridge Systematics, 2008) both forecast capital needs in great detail, but utilize specific categories of those capital assets which support public transportation. At the most generic level, the categories include these asset types, along with their recommended average lifetimes before replacement (in years):

- Bus vehicles (of various types) : 12 years
- Rail vehicles (of various types): 25 years
- Guideway (busway or rail right-of-way) elements: 96 years
- Stations: 92 years
- Facilities: 44 years
- Systems: 37 years

There are variations of asset lifetimes within these categories. But clearly, some of these categories have very long average lifetimes for the assets in the category. This means that if an existing asset in a long life category is replaced, or a new asset in a long life category is added, those assets can be very useful to public transportation passengers well beyond a normal analysis period of twenty years, which was used for the TCRP capital needs analysis. These long life assets thus have substantial value to society well past the periods for which economic analysis or economic impact analysis is traditionally done. They represent costs incurred now for assets which will be useful in future periods but for which future periods will not have to incur any costs.

In order to preserve existing public transportation ridership, and in order to serve new passengers, capital investments are necessary in each of these categories. The twenty year capital needs by category have been broken down from the needs data of the most recent TCRP study as shown in Exhibit 4-1. As can be seen, many of the types of assets which are needed in the next twenty years will have value well beyond the next twenty years.

Exhibit 4-1. Public Transportation Capital Needs by Asset Category

Asset Type	Percent of Capital Needs	Asset Lifetime (Years)
Buses	18.1%	12
Rail Vehicles	19.9%	25
Guideway Elements	20.2%	96
Stations	9.1%	92
Facilities	18.5%	44
Systems	12.5%	37
Service Vehicles, Other	1.8%	7

Source: *State and National Public Transportation Needs Analysis* (Cambridge Systematics, 2008)

Defining Scenarios. Over the course of a scenario-based needs analysis for the TCRP H-33B project, public transportation capital needs were estimated in terms of the future levels of growth in demand for public transportation. They are commonly expressed in terms of average annual rates of growth of ridership. By comparing results for alternative ridership scenarios, an estimate can be made of the cost of a new trip. By utilizing the information in the table on asset lifetimes, the evaluation of the costs of the assets needed to serve new trips can also be extended to the full expected lifetimes of each asset category.

The scenarios that were compared were:

(1) “Current Trend” scenario– assumes annual growth in public transportation ridership of 2.45 percent each year, which was the average annual ridership growth from 1997 to 2007.

(2) “Doubling Ridership” scenario – assumes annual growth in ridership of 3.53 percent each year over a twenty year period, which would nearly double the number of passengers by the end of the period. The estimated incremental 20 year capital costs to serve this higher ridership forecast is $262 billion more in capital investment than would be needed for the Current Trend scenario. That

represents an additional annual capital investment averaging $13.1 billion per year (in constant 2007 dollars).

(3) “High Growth” scenario - assumes an average of 4.67 percent ridership growth per year. While this scenario was not subjected to economic analysis, the results would be fairly similar to the results of comparing the other two scenarios, in terms of net benefits versus net added investment costs.

The TCRP capital analysis was conducted for a twenty year period (assuming 2010-2030) and the needs for the purchase of capital assets by category were estimated for that twenty year period for each of these ridership scenarios. The comparative analysis of the first two scenarios is presented in this report. The analysis calculates the incremental costs versus the incremental benefits of moving from scenario one to scenario two. This is not the only incremental comparison which could be made. For example, there is additional annual public transportation capital investment needed over and above current annual public transportation capital investment even to get to scenario one. That is, the current historical ridership growth of 2.4 percent per year since 1997 cannot be sustained at current annual levels of public transportation capital investment.

Since a “base” level of “expected” annual financial support for transit had not been forecasted, the analysis compared two specified scenarios (scenario one and scenario two) in order to conduct an incremental benefit/cost analysis. This gives a comparison of one sustainable scenario against another sustainable scenario. The incremental benefits of moving from a currently unsustainable funding level to the funding level which can sustain 2.4 percent future annual ridership growth will likely be greater than what is shown here (from comparing the 2.4 percent and 3.53 percent public transportation ridership growth scenarios).

As the useful lifetimes of the assets purchased in that twenty year period extend well beyond the end of the period, and since these assets can continue to be used during subsequent periods through the end of their useful asset lifetimes (without additional capital costs for replacement), an analysis was performed of how many public transportation riders[5] are served by the investments made under each asset category over the next twenty year period. This gives a more complete measure of the benefits of the assets to future public transportation passengers than just a shorter twenty year analysis would provide. The total additional passengers that will be served over the twenty year period are 34.8 billion more passengers under the “Doubling Ridership” scenario than would occur under the “Current Trend” scenario.

Ridership. If it is assumed that the capital investments needed for each category are proportional to their impacts in terms of new trips for either twenty years or over the entire lifetimes of the classes of assets, the annual passengers attributed

[5] Or more correctly, “ridership-years” (counting one public transportation rider for one year)

to the capital investments for each category are shown in Exhibit 4-2. Taking account of the proportionate usefulness of the additional assets purchased during the next twenty years compared to the assets purchased at the lower growth scenario, it turns out that these additional assets serve 172 billion additional public transportation trips during the lifetimes of the additional assets which were purchased under the higher growth scenario.

Exhibit 4-2. Attributable New Trips Over Full Asset Lifetimes

Asset Types	**Total Net Attributable New Trips (Billions)**	
	Twenty Years	**Asset Lifetimes**
Buses	6.3	8.6
Rail Vehicles	6.9	18.3
Guideway Elements*	7.0	67.0
Stations	3.2	28.9
Facilities	6.4	30.9
Systems	4.3	17.4
Service Vehicles, other	0.6	0.8
Total	34.8	172.0
Cost Per Trip -Total	$7.54	$1.52

** includes rail lines and bus rapid transit lines*
Source: calculated from preceding text

Thus, only about one fifth of the usefulness to future public transportation trips of the additional assets purchased to meet higher ridership growth (or to replace the overage assets serving the existing passengers) actually occurs during the twenty year analysis period itself. This also has a dramatic impact on the estimate that is commonly made of the capital cost associated with each new trip. On the basis of the new trips that occur only during the twenty years of the scenario investment period, the capital cost per new trip is $7.54, whereas that figure drops to $1.52 per new trip when the full life cycle costs of the assets are attributed to the trips that those assets will serve over their full asset lifetimes.

Capital Costs. The unit costs of vehicles and of other assets determines the numbers of each asset that can be purchased for any given level of investment. The average costs for vehicles delivered during 2007 to 2008 were:

- Commuter rail car: $1.9 million
- Heavy rail car $1.4 million
- Light Rail Vehicle $2.9 million
- Transit Bus: $0.4 million
- Articulated Bus: $0.8 million

(Note: bus rapid transit may use either regular transit buses or articulated buses.) (Source: *APTA Transit Vehicle Database*.)

Exhibit 4-3 below shows the cost per mile for the projects compiled by FTA in the 2010 New Starts Report. Averages are also shown for each mode. However, those averages include some extreme outliers, so it was necessary to select representative projects and use their values rather than simply adopting the averages.

Exhibit 4-3. Cost Per Mile for Fixed-Guideway Infrastructure

Mode	Miles	Dollars (Millions)	Dollars per Mile (Millions)
BRT: Bus Rapid Transit	357.5	3,692.4	10.3
BW: Busway	0.6	48.3	80.5
CR: Commuter Rail	177.7	20,493.7	115.3
HR: Heavy Rail Transit	26.3	10,121.0	384.8
LR: Light Rail Transit	179.6	19,022.6	105.9

Source: FTA: 2010 New Starts Report from 2010 FTA New Starts Report. Excludes projects for upgrades to existing rail routes
http://www.fta.dot.gov/documents/20090508_Release_FY_2010_Annual_Report.pdf

4.2 Cost of Additional Ridership

The second step is to calculate the total cost per new public transportation trip, building on the ridership and cost data shown in Section 4.1. This is based on data shown in Exhibit 4-4, which displays national totals for public transportation passengers, vehicle-miles and passenger-miles. These represent for all vehicles, as there is currently no useful national data that specify only "new vehicles." However, the National Transit Database vehicle inventory does differentiate miles per vehicle for each individual fleet, which are also identified by year delivered.

Exhibit 4-4. Average Passengers, Miles and Revenues

Total Data 2007					
Mode	Vehicles	Passenger Trips* (Millions)	Passenger Miles (Millions)	Vehicle Revenue Miles (Millions)	Train Revenue Miles (Millions)
Bus	65,249	5,413	20,976	1,987.0	---
Commuter Rail	6,391	459	11,153	297.4	53.93
Heavy Rail	11,222	3,460	16,138	638.5	94.21
Light Rail	1,810	419	1,932	82.7	48.34

Source: 2007 APTA Public Transportation Fact Book; train-miles from National Transit Database (NTD) and includes information only for agencies reporting to NTD.
**passenger trips are expressed in terms of unlinked trips*

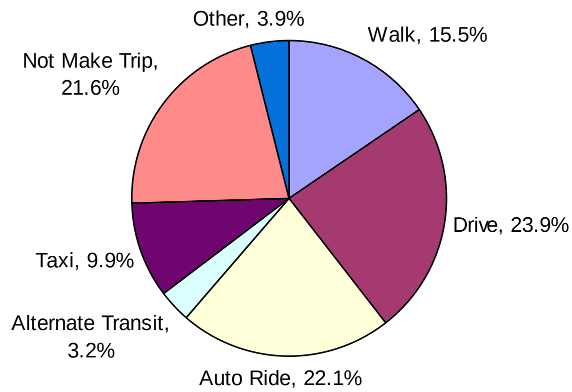
4.3 Public Transport Use and Mode Switching

The third step is to develop a profile of the mode switching associated with gains of new public transportation passengers. This is necessary because all calculations of the cost savings per new public transportation passenger depend on whether the new passenger was formerly traveling by car, by another form of public transportation service, by walking or bicycle, or not making the trip at all.

Mode switching profiles are generally compiled from survey research data. The survey research reported here asks current public transportation passengers what they would do if public transportation were not available. This is not quite the same question as who would come to public transportation services if they were to be expanded. However, it is reasonable to assume that the switching decisions would be fairly similar in both directions.

Exhibits 4-5 shows findings from the APTA report: *A Profile of Public Transportation Passenger Demographics and Travel Characteristics Reported in On-Board Surveys* (APTA, 2007). The surveys of bus and rail passengers found that if public transportation service were no longer available, roughly 24 percent would drive themselves, 22 percent would get a ride with someone else, and 10 percent would take a taxi. Besides the resulting increases in traffic, there would also be a substantial reduction in mobility, because roughly 22 percent of the former public transportation passengers would not be able to make their trip. The other public transportation passengers would walk, ride a bicycle or use other public transportation options if available.

Exhibit 4-5. Alternative Mode of Travel if Public Transportation Agency Were to Cease Operation



Supporting Data (source: APTA, 2007)

Public Transport Group	Alternative Mode							
	Walk	Drive	Auto Ride	Alternate Transit	Taxi	No Trip	Other	Total
Rail Modes	12%	40%	14%	7%	7%	18%	2%	100%
Bus Modes	18%	14%	27%	1%	12%	24%	5%	100%
Total	15%	24%	22%	3%	10%	22%	4%	100%

The anticipated alternative choices of mode of service for bus passengers and for rail passengers could be very different if their existing service was not available. This difference may reflect both shorter trip lengths for bus passengers as well as differences in private vehicle ownership and household income between these user groups. According to the APTA *Public Transportation Fact Book*, the average length of unlinked bus trips is 3.7 miles compared to a 23.5 mile average trip length for commuter rail, a 5.2 mile trip for heavy rail, and a 4.5 mile trip for light rail. The greater likelihood of former rail passengers driving themselves and not foregoing their trips may also reflect the effect of their higher incomes when compared to the surveyed bus passengers.

These survey data can also compared to *Transit Performance Monitoring System* (TPMS) data. This data was established by the Federal Transit Administration, and reports from two phases are shown below in comparison to the onboard surveys by transit agencies. The TPMS data do not significantly differ from the On-Board Surveys Sample data (See Exhibit 4-6).

Exhibit 4-6. On-Board Surveys - Sample Alternative Mode Data Compared to Two TPMS Surveys

Sample Group	Alternative Mode							
	Walk	Drive	Auto Rider	Alter-native Transit	Taxi	No Trip	Other Mode	Total
Transit On-Board Surveys Sample Values	**15%**	**24%**	**22%**	**3%**	**10%**	**22%**	**4%**	**100%**
TPMS Phases I and II On-Board Transit Surveys	18%	24%	22%	---	12%	21%	3%	100%
TPMS Phase III On-Board Transit Surveys	16%	24%	25%	---	11%	20%	4%	100%

Sources: Transit On-Board Surveys shown in Exhibit 4-5; plus TPMS data from http://www.apta.com/government_affairs/policy/documents/tpms_summary_I_and_II.pdf and http://www.apta.com/government_affairs/policy/documents/tpms_summary_%20III.pdf

4.4 Passenger Cost Savings

The fourth step is to combine information assembled from the previous tasks to calculate the economic cost savings for each public transportation market segment. These include: (1) public transportation passengers who changed from driving or riding cars, (2) those who changed from using other public transportation options and (3) those who changed from walking or bicycle modes. For the economic impact analysis, only cost savings that translate into money flows in the economy are counted, so neither the value of personal time savings nor the "consumer surplus" value of being able to use public transportation and make more trips can be counted as direct impacts on the economy.

Cost Differential: Switching from Automobile Driver to Public Transportation Passenger. For the portion of new public transportation passengers who switch from driving an automobile to riding a bus or train, the cost savings is calculated as the difference between the automobile travel costs (including parking) and public transportation fares. The US average public transportation fare per trip is $1.12 (APTA 2008 Public Transportation Fact Book). The American Automobile Association (2008) estimates a cost per mile of automobile operation covering gas, oil, maintenance and tires. The total ranges from 13¢ for small sedans to 20¢ for SUVs. However, the full cost of added automobile mileage, included adding wear and tear and associated depreciation of automobile value, is calculated by the IRS for purposes of reimbursing business travel; this rate is currently set at 58.5 ¢ per mile. These numbers must be multiplied by approximately 5 (miles per trip) to represent the total automobile operating cost per equivalent public transportation trip. That yields a total of $2.93 per automobile trip, which is $1.81 over the average cost per public transportation trip. Over the course of a year, this user cost savings totals $905 per traveler. In addition, parking costs would also be added for a portion of diverted automobile trips where that factor is also applicable apply. That figure is not estimated at a national level at this time.

Overall Travel Cost Savings to New Public Transportation Passengers. A range of other studies have also estimated the benefits of public transportation capital investment in terms of reductions in vehicle operating costs for those who switch to public transportation. Analyses recently conducted by Cambridge Systematics for APTA and other agencies compared the implementation costs of expanding public transportation to the vehicle and fuel cost savings, using the same public transportation ridership growth scenarios as were used in the TCRP H-33B Report (Cambridge Systematics, 2008). Specifically, the estimated long term discounted public transportation investment level in comparison to the highway vehicle and fuel cost savings is shown in Exhibit 4-7.

Exhibit 4-7. Net Present Value of Public Transportation Capital Investment and Vehicle Operating Cost Savings for Selected Scenarios

Scenario and Growth Rate of Ridership	**(NPV over 2010-2050, in $ billions)**	
	Public Transportation Capital Investment	**Savings in Vehicle Operating + Fuel Costs**
Current Trend Scenario: *2.45 percent growth/yr.*	$255	$136
Doubling Ridership Scenario: *3.53 percent growth/yr.*	$503	$282
High Growth Scenario: *4.67 percent growth/yr.*	$1,197	$612

Note: NPV (Net Present Value) is estimated as a discounted time stream of costs and benefits. It is calculated by first adjusting for inflation (to constant dollars), and then applying a discount rate to account for the time value of money (i.e., the reduced valuation of costs and benefits that are further out in time).

The findings previously shown (in Exhibit 4-7) are generally consistent with the preceding calculations of automobile operating cost savings For example, the "Doubling Ridership Growth" scenario leads to approximately 4 billion more public transportation trips per year as of the year 2030 than would otherwise occur with the "Current Trend" scenario. Multiplied by the previously-calculated savings of $1.81 in cost savings per new public transportation traveler, yields an estimated savings of $7.2 billion per year as of the year 2030. Actual savings will be less in earlier years and will then grow over time to be even more in years beyond 2030. That pattern of cost savings over time is generally consistent with the finding shown in Exhibit 4-7, which shows total savings over the forty year period (2010-2050) from the "Doubling Ridership Growth" scenario has a net present value that is $146 billion higher than that of the "Current Trend" scenario.

Cost Savings from Reduction in Automobile Ownership. Increases in public transportation ridership brought on by incremental increases in public transportation investment and services do not necessarily lead to reductions in automobile ownership. However, the availability of quality public transportation services[6] on a widespread scale lead to 10-20% lower rates of automobile ownership in cities where such services are provided and used. The cost savings associated with lower automobile ownership rates are substantial and are in addition to the automobile operating cost savings that were previously noted. Exhibit 4-8 shows estimates of those savings in terms of annual cost per vehicle, which varies from $4,232 to $6,901/year depending on the type of vehicle.

Exhibit 4-8. Annual Costs of New Automobile Ownership
(excluding insurance and operating costs)

Cost Category	**Small Sedan**	**Medium Sedan**	**Large Sedan**	**Average**
License & registration	$410	$562	$690	$554
Depreciation	$2,332	$3,355	$4,275	$3,321
Financing	$541	$770	$903	$758
Ownership costs/year	*$4,232*	*$5,594*	*$6,901*	*$5,570*

Source: American Automobile Association, Your Driving Costs 2008
www.aaaexchange.com/Assets/Files/20084141552360.DrivingCosts2008.pdf

To illustrate the effect of automobile ownership shifts, consider the impact if automobile ownership is reduced for just 10% of the projected new public transportation passengers who are commuters. That alone would lead to an additional savings of $2.5 billion/year as of the year 2030. However, automobile ownership changes are likely to occur over a long period of time and are dependent on sustained investment to improve the level and quality of public

[6] Cities where peak period public transportation is widely available with 15 minute headways and land use is conducive to walking to and from public transportation stops or stations; this currently includes major US cities.

transportation services provided in cities. Accordingly, the analysis assumes that only half of the potential savings ($1.25 billion) are realized by the year 2030.

Potential Additional Savings In Travel Time. Increased public transportation investment can lead to time savings for travelers who switch from slower mode options including those traveling by automobile on congested routes and those traveling via slower public transportation services. However, other travelers switch to public transportation from automobile travel despite a longer total travel time, because the longer time is more than offset by parking and/or automobile operating cost savings. Overall, the net savings in time for new public transportation passengers can vary widely among urban areas. It is also important to note that even when time savings do accrue for new public transportation passengers, it only affects the flow of dollars in the economy insofar as it affects business-related travel or the reliability of worker arrivals at businesses[7]. While these impacts are very real, their magnitude and national implications are not well understood at this time.

Potential Additional Reduction in Automobile Mileage. There is a further potential for additional savings to new public transportation passengers associated with secondary reductions in automobile VMT. The current analysis assumes that those switching from driving an automobile to using public transportation have a reduction in automobile VMT that is nearly equivalent to the length of the added public transportation passenger-miles. However, for those switching to public transportation from riding in an automobile driven by others, the current analysis assumes no further reduction in automobile VMT. In reality, there is likely to be some additional VMT reduction associated with decreases in two effects: (1) ridesharing trips in which drivers need to travel extra miles for passenger pickup and drop-off, and (2) chauffeured trips in which the driver returns without passengers. In both cases, the switch from automobile rider to public transportation passenger would result in some further VMT savings, though the extent of that savings is not estimated at this time.

In addition, the provision of public transportation services on a widespread scale can in the long run lead to greater reductions in automobile vehicle-miles due to broader changes in urban density and driving reliance. This is indicated by a studies comparing urban areas with differing levels of public transportation service, which derive an inverse statistical relationship between differences in public transportation passenger-miles and automobile vehicle-miles.

The findings of these studies, summarized in Exhibit 4-9, suggests that sustained investment in public transportation can lead to long term impacts on automobile vehicle-miles that are 3 to 4 times the increase in public transportation passenger-

[7] Of all public transportation trips, 59% are commuting to/from work; 14% are for education or medical purposes, and the rest are for shopping, social or personal purposes. Source: APTA (2008).

miles. While all of these effects are very real, they depend on the growth and density of the specific city. Thus, the current analysis does not add these impacts.

Exhibit 4-9. Automobile VMT Reductions Due to Public Transportation Use

Study	Cities	VMT Reduction per Public Transport Passenger-Mile
Pushkarev-Zupan	NY, Chicago, Phil, SF, Boston, Cleveland	4
Newman-Kenworthy	Boston, Chicago, NY, SF, DC	2.9
Newman-Kenworthy	23 N. American, Australian, European cities	3.6
Litman 2004	50 largest U.S. cities.	4.4
ICF 2008	U.S. cities	3 to 4

4.5 Additional Congestion Reduction Benefit

The fifth step is to calculate the additional economic cost savings accruing to automobile and truck travelers who also benefit when public transportation leads to reduced traffic congestion growth. This step only applies to urban areas where (current or projected future) traffic congestion during peak hours causes additional delay costs that can be reduced by diverting more commuting trips to public transportation.

Estimates of Congestion. The Texas Transportation Institute's (TTI) annual estimates of urban roadway congestion in urban areas include TTI's estimates of how much congestion reduction is attributable to current public transportation (TTI, 2009). The congestion estimates developed by TTI are based on average volume to capacity ratios weighted by vehicle miles traveled for the interstate highway facilities and the other principal arterial roadways in the urban areas. TTI also estimates what congestion levels would be if the current public transportation services were not available and were not taking vehicles off of the roadways.

TTI's congestion estimates are based on data available from the Highway Performance Monitoring System (HPMS). The HPMS database includes statistics on highway condition, extent and usage. Each state submits HPMS data to the Federal Highway Administration (FHWA) annually according to prescribed reporting guidelines.

To fully assess alternative futures for public transportation investment and their impacts on the economy, it is also necessary to examine how additional future capital investments and additional operations spending will affect highway performance levels and associated costs borne by highway users. The Highway Economic Requirements System (HERS) is a decision support system designed to analyze the effects of alternative funding levels on highway performance. HERS uses the HPMS data which are from an extensive sample of the nation's highway system as the basis for its analyses of the benefits and costs of alternative scenarios of highway improvements.

Scenarios for Future Congestion Reduction. In order to estimate the future effects of public transportation (rather than the current effects as TTI does), two scenarios were considered – the "Current Trend" and the "Doubling Ridership Growth" scenarios, as previously defined in Section 4.1. The impact of both were run using the Highway Economic Requirements System, to model the highway levels of service and performance that would occur in urban areas with various levels of public transportation service expansion over the next twenty years. The HERS model estimates the total user costs per mile of travel and the delay in hours per 1,000 vehicle miles of travel for various classes of highways. This includes (1) urban Interstates, (2) other urban freeways and expressways, and (3) urban principal arterials. These are the highway types for which the diversion of automobile travel (vehicle miles of travel) to public transportation is expected to occur.

In calculating the increase in public transportation, alternative assumptions were made about the proportion of the new public transportation passengers that would represent diversions from the highway system. For the high diversion assumption, it was assumed that all public transportation diversions will occur from automobile travel at an auto occupancy rate of 1.1. For the low diversion assumption, on the other hand, estimates of diversion were derived from on-board surveys of public transportation passengers, which asked about their former modes of travel. Further details associated with the low diversion rate are shown in Exhibit 4-10.

Exhibit 4-10. Percentage Of Urban Passenger Miles Diverted From Driving On Highways, Based On Public Transportation On-Board Surveys

Mode	Percent Diverted From Driving on Highways	Percentage of Public Transport Passenger Miles	Percentage of Passenger Miles Diverted From Highway VMT
Rail Modes	47%	52%	24%
Bus Modes	26%	48%	13%
Total Modes	35%	100%	37%

Note: Highway driver diversion includes auto drivers and taxis.

The analysis also allowed for alternative assumptions regarding passenger-miles of travel. In one case, public transportation passengers are estimated to have an average trip length of 6.0 miles at the end of the twenty year investment period, compared to 5.2 miles average per trip for all unlinked public transportation trips as currently measured. For the other case, the current rate of passenger miles per trip is assumed to remain unchanged.

The differencing sets of assumptions lead to different rates of diversions of vehicle miles of travel, with a high end diversion of 91 percent of VMT from highway driving (including adjustment for the difference in car and public transportation mileage per trip) and a low diversion of 37 percent of VMT from highway driving (based on the on-board surveys).

Since the difference between the “Current Trend” scenario and “Doubling Ridership Growth” scenario is 4.0 billion public transportation trips per year in the twentieth year of each scenario (representing 24 billion passenger-miles), the diversion of passenger miles of travel in that year can vary between:

- A diversion estimate of 22 billion vehicle-miles of travel (VMT) associated with the “Doubling Ridership” scenario -- calculated as 91% diversion of 24 billion passenger miles shifted from automobile to public transportation (with no change in miles/trip between public transportation and automobile trips); and

- A diversion estimate of 8 billion vehicle-miles of travel (VMT) associated with the “Current Trend” scenario -- calculated as 37% diversion of 21 billion passenger miles shifted from automobile to public transportation (allowing for 15% longer miles/trip for public transportation trips).

Findings on Cost Savings for Road Traffic. HERS analyses were then performed for alternative scenarios, in order to calculate the operating cost savings to automobile travelers on urban interstate highways as VMT is reduced by diversion to transit. The highest growth public transportation strategy would achieve 50 billion of automobile VMT reduction on urban interstate highways; estimates were also made for intermediate scenarios representing the previously calculated scenarios involving 8-22 billion of VMT reduction. The results are shown in Exhibit 4-11.

Exhibit 4-11. Estimate Impacts of Reductions in Vehicle Miles of Travel on Costs to the Remaining Highway Drivers for Urban Interstates

HERS Run	**Year 20 Results**		
	Urban Interstate VMT (Billions)	**Average User Cost/Mile**	**Change In User Cost/Mile**
Baseline VMT	651	92.8 cents	--
Current Trend Scenario	643	92.1 cents	0.7 cents
Doubling Ridership Scenario	629	91.0 cents	1.8 cents
Very High Growth Scenario	601	88.6 cents	4.2 cents

Note: User cost includes all monetary costs, safety costs, and travel time costs. VMT diverted run was set to take 50 billion per year maximum VMT off of the urban Interstate System

Applied to the roughly 600 billion miles per year of VMT on the Urban Interstates at the end of twenty years, a change of user costs of 1.8 cents per mile equates to about $11 billion per year in reduced highway user costs for the remaining highway users due to the public transportation investment.

However, since the savings in highway user costs builds up over time, it will shift from zero in 2010 to $11 billion per year as of 2030. The cost savings will be less during interim years, but even greater than the 2030 value in subsequent years as the number of public transportation passengers will continue to grow over time.

The $11 billion/year of congestion cost savings will be split among households and businesses in the economy. In general, the savings associated with non-business travel will accrue to households, while the savings associated with business travel (via truck and car) will accrue to businesses. Cost savings for commuting trips are a special case – while they are realized by households, they can also lead to some business operating cost reductions, especially when businesses in congested areas have been compensating their employees with higher pay to make up for the higher costs of travel to/from their congested locations (as previously discussed in Section 4.2). Taking all of these factors into account, studies of urban congestion in other cities (e.g., Chicago, IL and Portland, OR) indicate that at least 45% of the total cost of congestion is borne by businesses (EDR Group, 2006; Weisbrod et al, 2001). Accordingly, our analysis splits the $11 billion/year of congestion cost savings to households and businesses with a 55/45 split.

4.6 Business Productivity Impact

In addition to the cost savings described above, a shift from auto to public transportation would facilitate increased productivity and competitiveness within cities (as discussed in Section 4.3). This benefit stems from two factors: (1) reduction in wage premiums paid to attract workers to more-congested areas with higher travel times and costs, and (2) enhancement of access to labor and customer markets, which bring scale and "agglomeration" economies.

The "*wage premium*," originally discussed in Section 4.2, is a pass-through effect in which employers in highly congested areas absorb some of excess costs of worker commuting (rather than having households bear the full cost) in order to attract and maintain quality workers. Congestion reduction diminishes the need for businesses to pay such a premium, and the cost savings to business is effectively an increase in business productivity (which is defined as the ratio of output/cost ratio for business operations). This impact is assumed to apply to roughly 30% of the congestion cost savings identified in Section 4.5

The effect of "*agglomeration economies*" comes from the fact that widely-available public transportation service can facilitate higher levels of metropolitan population and employment density, which, in turn can allow a metropolitan area's economy to become more productive. The reasons for this productivity gain are that:

- some businesses will have access to a larger and more diverse labor market, providing them with a better capacity to find workers with the desired skills, thereby enhancing labor productivity;

- some trade and service sector establishments will be able to access broader customer bases, allowing them to more efficiently arrange locations and resources to serve customers;

- specialized knowledge spreads more quickly through social networks, enhancing human capital and labor productivity in technology and skill industries that benefit from such interaction; and

- greater diversity in economic activity and labor force skills breeds creativity and innovation.

These benefits, while occurring at a metropolitan level, can also translate into greater national level productivity if they take place across a broad spectrum of metropolitan areas. In the context of the present study, the magnitude of this effect is estimated by first by considering the extent to which higher public transportation usage stimulates higher metropolitan density, and then by assessing the extent to which higher effective density translates into economic productivity.

Many studies have shown that adding public transportation capacity facilitates higher density development – particularly near public transportation stations, but also in downtown centers (through reduced need for parking). At the metropolitan level, public transportation ridership (as % mode capture) correlates with total metropolitan density such that a 1% change in public transportation's mode capture translates to a change of roughly 650 people per square mile over the entire city. However, to be conservative, the rest of this section uses the much lower assumption that a 1% change in public transportation mode capture increases metropolitan density by 100 people per square mile. This lower assumption also allows for the fact that correlation runs both ways – i.e., that although public transportation facilitates higher density, higher density *requires* more public transportation).

The following example illustrates this effect. Adopting the scenarios defined in Sections 4.1 - 4.5, the scenario for increased public transportation investment would translate to an additional 4 billion public transportation trips per year in 2030, 59% of which occur during commuting periods. Converting this to daily trips yields roughly 4.6 million commuters per workday switching from auto to public transportation, thereby boosting the US public transportation capture from roughly 4.9% to 7.9%. From the above figure, this 3% increase in public transportation's mode share could boost effective metropolitan density by 300 people per square mile. For a typical moderately sized city such as Milwaukee, which is in the middle range of affected urban areas, this would in the long-run increase total metropolitan area workforce by roughly 5% as compared to the scenario of less public transportation investment.

Continuing the example, a 5% increase in effective density translates to an increased productivity of 0.09%, or roughly $70 million per year. Extrapolating these results to the 50 largest US cities (based on city size) yields additional US productivity in 2030 of about $5 billion from increased public transportation investment. To allow for uncertainty regarding the exact magnitude of this labor market access effect on business productivity, the current analysis assumes that only two-thirds of this benefit is actually realized.

4.7 Overall Economic Impact of Cost and Productivity Changes

Direct Economic Impact. The impact of public transportation investment on both new public transportation passengers and continuing automobile travelers was shown in Sections 4.4 - 4.6 to be substantial. In section 4.4, the estimate was made that the average public transportation user who did not have to drive an automobile would save about $905 per year in costs (in 2008 dollars), assuming 250 roundtrips per year. This represents money returned to them for use on other household expenditures. The lowest quintile of households by income (one fifth of all U.S. households) had an average of only $10,500 of income in 2007, and has of course declined since then. For those at the lower range of incomes, this is a very substantial income benefit, providing an enormous gain in their desperately needed purchasing power.

In addition to the economic gains to public transportation passengers as estimated in section 4.4, the analysis in section 4.5 of the economic impacts on the remaining automobile users indicated that on a per trip basis, the net gain to the remaining automobile drivers due to an added public transportation trip would be from $1.20 to $3.10 per public transportation trip, or about $600 to $1,550 per year depending on calculations about the proportion of diversions, and also assuming 250 round trips per user per year. Thus, each additional person traveling by public transportation saves costs to themselves plus costs to remaining automobile travelers in the range of $1,505 to $2,455 per year.

Of course, the preceding effects are just those accruing to travelers. Additional impacts discussed in Section 4.6 can further increase business productivity and enhance the nation's cost competitiveness, leading to further income growth.

Total Effects on the Economy. Chapter 4 discussed how continued spending on public transportation can affect manufacturing orders for American-made vehicles and equipment, as well as jobs for public transportation vehicle operators and agency staff – all of which are largely blue collar jobs. In addition, the long-term access and cost savings for travelers, which are addressed in this chapter, lead to further impacts on the economy through six mechanisms:

- New public transportation travelers who switch from automobile travel can receive some savings in travel expenses and car ownership costs, which they can use to purchase other consumer products and services as they desire.

- Travelers who continue to commute to and from work by automobile can also benefit from reduced peak period traffic congestion, which leads to direct savings in automobile operating costs. Households can use the savings to purchase other consumer products and services as desired (and have more leisure time).

- Businesses that pay higher wages to attract workers in congested areas can potentially save on that labor cost premium as traffic congestion (or at least the growth of that congestion) is reduced. The net effect is a reduction in the cost of doing business. This represents an improvement in business productivity (i.e., the output/cost ratio), which can make affected businesses more cost competitive in global markets. However, the reduction in wage premium also offsets part of the household savings in commuting cost.

- Businesses in urban areas benefiting from faster and less congested commuting periods can also gain productivity as a result of gaining access to larger labor markets with more diverse and specialized skills. (This is sometimes referred to as "agglomeration economies.") That too can make affected businesses more cost competitive in global markets (without any necessary change in wage rates).

- At a regional level, business growth may occur insofar as the greater productivity and changes in consumer spending lead to more business sales and attraction of new business activity that sells products to elsewhere within the US and abroad. However, at a national level, business growth can only occur insofar as businesses with enhanced productivity are able to serve a larger export market (due to enhanced cost competitiveness) or a larger domestic market (resulting from higher disposable income levels, as a consequence of productivity increases).

- At a regional level, business growth due to cost savings may lead to further economic impacts through indirect (suppler) an induced (worker re-spending) effects. However, at a national level, business growth can only occur insofar as businesses are able to increase productivity or sell to international markets

These broader impacts were calculated using TREDIS (Transportation Economic Development Impact System) – an economic impact analysis system used for transportation studies. The system incorporates an input-output model to trace how changes in household spending patterns and business costs flow through the economy. It also incorporates econometric equations to represent industry growth responses to price and cost changes ("elasticities"), and effects of regional changes in travel time reliability and labor market access on business productivity over time. However, the model is not able to estimate how improved business cost competitiveness will affect growth of international exports in a rapidly changing global economy.

The economic impact analysis process was conducted by comparing the two scenarios that were introduced in Section 4.1 (and continued in Sections 4.2 – 4.5):

(1) a base case ("current trend" scenario) in which public transportation ridership continues to grow at a rate of 2.4% per year from 2010 through the year 2030 with continuing investment following recent trends, and

(2) a "doubling ridership" scenario in which annual expenditures on public transportation is increased by an additional $13 billion/year (constant 2008 dollars), raising public transportation ridership growth to a rate of 3.53% per year over that time period.

The difference between these two scenarios increases over time and accumulates, so that the public transportation investment scenario leads to 4 billion more public transportation trips in the year 2030 (and up to 22 billion less automobile VMT in that year) than would exist with the base case scenario.

To calculate total economic impacts, the economic impact model accounts for transportation cost reductions accruing to both public transportation passengers and peak period automobile travelers, as well as additional business productivity achieved as a result of expanded labor market access and reduction in worker wage premiums. It also accounts for reduction in demand for US-made petroleum products and tires under the public transportation investment alternative. In addition, the model accounts for effects on business suppliers and income re-spending, but assumes that indirect and induced effects of cost changes lead to reallocations among industry sectors at a national level (rather than further multiplier effects on growth), since total employment is fixed by the available labor market.

The estimated economic impacts are shown in Exhibit 4-12. They are built on a series of assumptions described in Sections 4.2 – 4.5. Due to the large number of assumptions that were necessary, these results should be interpreted as a reasonable estimate given the limitations of currently available data. However, they can also be seen as illustrative of a broader methodology that can be applied again in the future as improved data sources and improved scenario forecasts becomes available.

Altogether, the economic impact estimates indicate a potential increase in GDP that would be over $23 billion/year by the year 2030. That represents 1.8 times the assumed annual investment of $13 billion/year. It could be even higher insofar as higher business productivity (and as lower businesses costs) can make some American products more cost-competitive in global markets, generating even more income from further growth of exports.

Future GDP increases can also mean more income for workers and/or more jobs created. At current wage rates, the GDP increase by the year 2030 is equivalent to approximately 400,000 more jobs. However, the actual amount of job creation will depend greatly on future rates of unemployment, labor force growth and changes in real (inflation-adjusted dollar) wage rates, as well as business competitiveness in global markets.

Exhibit 4-12. Estimate of Scenario Impacts on the Economy, 2030
Difference between "Current Trend" Scenario and "Doubling Ridership" Scenario (effect of investing $13 billion/year)

Form of Impact	Magnitude by Year 2020*	Notes
Households: Disposable Income	**+15.0 billion/yr.**	
from cost savings to public transportation passengers	+ $7.6 billion/yr.	(A)
from savings in auto user operating costs	+ $6.1 billion/yr.	(B)
from savings in auto ownership costs	+ $1.3 billion/yr.	(C)
Business: Productivity	**+ $8.4 billion/yr.**	
from labor market access enhancement	+ $3.4 billion/yr.	(D)
from auto/truck operating cost reduction	+ $5.0 billion/yr.	(E)
Total Value Added (GDP Equivalent)	**+ $23.4 billion/yr.**	(F)
Estimated Tax Revenue Impact (fed, state, local)	**+ $3.4 billion/yr.**	(G), (I)
Equivalent Wage Income Benefit	**+$18.4 billion/yr.**	(H), (I)
Equivalent Job Benefit	**400,000**	(H)

Notes:
* *All future-year dollar amounts are expressed in constant 2008 dollars*
(A) *Cost savings to public transportation passengers is calculated in section 4.4*
(B) *Of the total congestion reduction benefit calculated in section 4.5,the household benefit is estimated to be 55% and the rest of that benefit is allocated to business productivity*
(C) *Auto ownership costs are calculated in Section 4.5; the figure shown here assumes that only half of the potential calculated benefit is realized.*
(D) *The labor market access and scale/agglomeration effect on productivity is estimated in section 4.6; the figure shown here assumes that only 70% of the potential calculated benefit is realized*
(E) *The business productivity benefit includes both business travel cost savings and reduction in worker wage premium; it is conservatively estimated to be 45% of the total congestion reduction benefit calculated in section 4.5*
(F) *Calculated as the sum of household disposable income and business productivity cost savings*
(G) *Calculated as the sum of federal, state and local taxes, including taxes on household income that depend on assumptions regarding wage income growth (as discussed under "H" below).*
(H) *The actual realization of jobs and associated wages will depend on future workforce growth, unemployment rates and business competitiveness in global markets*
(I) *Impacts on taxes and wages cannot be added to each other or to other value added measures since the wage impact represents a portion of value added, and the tax revenues are paid for out of the value added benefits.*

Interpretation. The preceding analysis shows the nature of economic growth impacts that can be realized over a long period of time as a result of increased public transportation ridership growth. In interpreting those findings, it is important to note four issues:

- First, these term impact estimates include only the effect of long-term transportation changes, which are in addition to the effect of ongoing transportation capital investment and operations spending discussed in Chapter 3.

- Second, these estimates may be regarded as conservative since they do not include impacts of likely additional cost savings associated with reduced parking costs or possible additional reductions in automobile VMT, and they only include a portion of the potential impacts on automobile ownership and business labor markets.

- Third, the benefits of increased public transportation use and reduced automobile traffic congestion grow over time, so that longer-term impacts will be even greater than those shown here for the year 2030.

- Fourth, this analysis counts only impacts on the flow of money in the economy. It does not include environmental benefits, social benefits for carless households, or any other classes of benefit that do not directly affect the flow of money in the economy. A full benefit analysis would be needed to also assess and include those additional impacts.

It is also important to note that the economic impacts shown here apply to a set of illustrative scenarios, which are useful to demonstrate the substantial economic stakes associated with future investment in public transportation. Looking to the future, there is a clear need to consider additional scenarios for public transportation investment, and to also examine the economic impacts of alternative funding options.

Other Classes of Benefit and Cost. It is important to recognize that public transportation has a wide range of other costs and benefits that are not addressed in the analysis of economic impacts. They include the following:

- **Finance: Public Transportation Fares and Operating Subsidies.** Public transportation capital investments and operating costs are paid for through a series of mechanisms that vary from city to city. They include passenger fares, use of gas tax funds and various other local and state tax mechanisms including income and sales taxes. These costs must be considered in benefit-cost studies. The different options for raising funds also have widely divergent impacts on various economic sectors and population groups, which can also be studied. However, those issues are <u>not</u> addressed in this study, because it is important to isolate how public transportation investment and spending affect the economy separately from the issue of how the funding is raised.

- **Full Societal Benefits.** Public transportation capital investments and operations can also lead to a wide range of social benefits that are also valued by residents of affected areas. These may include impacts on energy use, air quality, carbon emissions, health, equity, and public costs associated with land use and development patterns. All of these various types of impact, often referred to as external impacts, can be assigned values and then considered in benefit-cost studies. However, it is important to note that many or most of these external impacts are valued by "willingness to pay" because they do not directly affect the flow of income in the economy. Accordingly, these broader impacts are not addressed in this study, as this study seeks to focus on a separate issue of how public transportation investment and spending affects the generation of jobs and flow of income in the economy.

5 CALCULATION & UPDATING PROCESS

5.1 Need for Updating

The values shown in this report represent the estimated US national impact of public transportation spending on jobs and economic growth as of 2008. These values may also be applied for the year 2009. For subsequent years, it is necessary to update the numbers. There are two basic reasons why these values should not be used in future years without updating:

- First, the ratio of dollars per job continues to increase over time, as the buying power of the dollar is eroded by inflation in both wage levels and costs of materials. This same pattern of change holds for any kind of spending; it means that as salaries rise due to inflation, a million dollars will support fewer jobs. The result is that job impacts will differ depending on the year that the study is conducted.

- Second, the use of advanced technologies – which affecting the non-labor share of total costs –continues to rise over time. For instance, spending on automated fair collection and automated control systems continue to rise, while the need for workers to manually provide these services continues to fall over time. This trend further changes job impact estimates, and also causes them to differ depending on the year that the analysis is conducted.

The values shown in this report rely primarily on 2007 prices for goods and services purchased by public transportation capital and operating expenditures. To update the analysis for future years, it is necessary to apply Producer Price Indexes (PPI) for the applicable cost elements. Currently, PPI series exist for the following categories:

- Heavy truck and bus manufacturing;
- Railroad rolling stock manufacturing;
- Electrical equipment (used as the closest available measure of inflation for bus and train control systems);
- Highway and street construction (used as the closest available measure of inflation in cost of right-of-way and guideway construction);
- Commercial building construction (used as the closest available measure of inflation in cost of terminal and maintenance building construction).

The PPI series can be used in two ways. First, they provide a basis for adjustment of the ratio of jobs created per dollar of spending in each of these categories. Second, they provide a basis for comparison between (a) general income and consumer price inflation, and (b) increases in cost of construction and capital equipment. In past years, the latter has tended to rise faster than the former.

5.2 Future Research Needs

This report presents a methodology and shows how it can be used to estimate national economic impacts of public transportation capital investment and operations spending. The general approach can also be applied for local and regional impact studies with the following differences: (1) applicable regional economic impact models need to be applied in place of the national economic impact model; (2) applicable local or regional data on changes in mode split, usage, travel times and costs need to be applied in place of the national totals; and (3) impacts on automobile ownership should not be included unless (or until) public transportation options become sufficiently ubiquitous so as to facilitate a drop in automobile ownership.

There is also a remaining need for further research at the national level, to improve available data and pursue future studies of these issues. For instance, to make a more balanced comparison of the relative economic impact of investing in alternative transportation modes, it may be useful to consider how transportation spending affects jobs by considering all relevant investment and spending -- including that is initiated by federal agencies, state agencies, private businesses and households. After all, most federal and state funds originates as tax and fee revenues collected from households and businesses, so ultimately the money for all of these various types of spending come from the nation's workers and residents. This recalculation can be done by considering the average number of jobs supported per dollar of spending on each mode, where that average covers all forms of public and private spending.

If this approach is taken, then it recognizes that road building also supports public transportation by enabling better bus services and train station access. Auto and truck fuel purchasing patterns also affect total job impacts from road building. The approach further recognizes the potential for expanded public transportation to shift needs and household savings associated with automobile purchases, and redirect those savings into other forms of purchases. These additional issues remain to be addressed in later research studies.

A APPENDIX: DEFINITION OF ECONOMIC IMPACT

A.1 Clarifying Economic Impact Analysis vs. Benefit-Cost Analysis

Definition - What is Economic Impact Analysis?

In the context of transportation planning and policy, economic impact analysis (EIA) analyzes how a program or a project affects the economy of a given area. The economic impact area may be as small as a neighborhood or as large as the nation, depending on the scale of the program or project. Different measures of economic impact work at different spatial areas. At a neighborhood or corridor level, economic impacts may be measured in terms of the change in demand for locations– as reflected by increased property values, increased investment in new construction activity or increased density of development. At a regional or state or national level of analysis, the measures of economic impacts are in terms of changes in business output or gross state product (GSP) or gross domestic product (GDP), and the associated changes in jobs and in wage income.

Difference in Definitions

Within the broad field of transportation economic impact research, there are overlapping concepts of (a) the economic value of program or a project's net benefits, and (b) the effect of a transportation program or project on the economic growth of a region (also referred to as the economic development impact).

The *economic value of benefits* may be presented just in terms of "traveler benefits" (also referred to as "transportation system user benefits") or in terms of wider "societal benefits" (also referred to as "social benefits"). Either way, some benefits reflect real monetary cost or income changes, while others have a value to people, though no actual transfer of money may take place. Major benefit categories for which the monetary transfers may not take place include travel time benefits, safety benefits, environmental quality benefits, and increases in choices of destinations or of travel modes or of the times at which travel can occur. Travel time benefits may occur due to reductions in travel times, and due to reductions in the uncertainty of travel times (reliability benefits).

In contrast, *economic impacts* refers more strictly to the effects on the economic activity in a given region, as reflected by a change in the flow of money (output, GDP or the income generated in the region). It may be presented as "the direct economic impacts" on costs and revenues, or in terms of broader "economic impacts."

Differences in Coverage.

Exhibit A-1 illustrates the basic differences in coverage of the analysis approaches. The various measures are thus different and yet in many ways they are also complementary. While EIA excludes non-money impacts that are included in BCA, it includes indirect and induced impacts on business growth that are not included in BCA.

Exhibit A-1. Difference in the Coverage of Impacts Between Benefit Cost Analysis and Economic Impact Analysis

Form of Impact	**Benefit Cost Analysis**	**Economic Impact Analysis**
Business and household cost savings	Yes	Yes
Business-related time savings that generate cost savings	Yes	Yes
Personal time savings (not affecting money flows)	Yes	--
Environmental impacts (not affecting money flows)	Yes	--
Attractions (relocations) of business activity into area	--	Yes
Income generated by transit operations & suppliers	--	Yes

Source: Drawn from Weisbrod (2008)

EIA also reflects the impacts of changes in business productivity that result when transportation improvements enhance labor market access, business agglomeration (density) and other factors that tend to be ignored in the traditional use of BCA. While these productivity impacts can theoretically be included in BCA as well, in practice they are seldom recognized. The need to recognize these productivity benefits in transportation policy and decision-making was made clear in a widely circulated discussion of BCA shortcomings that is contained in the United Kingdom's *Eddington Transport Study* (2006).

The Eddington report identifies seven micro-economic drivers through which transport investment drives economic performance and which are beyond the parameters of benefit-cost but can be included in economic impact analysis. These are summarized as:

- Increasing business efficiency through time savings and improved reliability for business travelers, freight, and logistic operations;
- Increasing business investment and innovation by supporting economies of scale or new ways of working;
- Supporting clusters and agglomerations of economic activity;
- Improving the efficient functioning of labor markets, increasing labor market flexibility and the accessibility of jobs;

- Increasing competition by opening up access to new markets;
- Increasing domestic and international trade by reducing the costs of trading; and
- Attracting globally mobile activity by providing an attractive business environment and good quality of life.

There has also been a line of US-based research regarding the wider economic benefits of transportation investment, including many of the same types of economic productivity, market access and agglomeration economies affecting GDP (e.g., see Weisbrod and Treyz, 1998 and Weisbrod et al, 2001). However, a major aspect of the Eddington report is its further elaboration of three rather than two types of economic analysis that can be conducted. Eddington evaluates these three types of overall analysis:

- The conventional benefit-cost ratio which refers to the measure conventionally used;
- The wider benefit-cost measure which would add on to traditional b/c the “missing” gross domestic product (GDP) productivity impacts on the economy, as identified above; and
- The value for money (VFM) assessment which adds in the missing GDP impacts plus the monetized estimate of the environmental costs and some social costs.

The report concludes that the last and broadest measure can be the most appropriate to use in evaluating transportation investments, and it shows how that measure can be used to evaluate a wide range of projects across modes and across investment purposes. Recommendations of the Eddington report are now being implemented in the UK. They have also received significant attention by transportation professionals in the US, and this TCRP report is intended to help further that discussion by showing how the GDP impacts of public transportation investment can be assessed in the US.

A.2 Generators of Economic Impacts

Classification. Public transportation capital investment and operations spending leads to impacts on the overall economy as a consequence of three processes:

- *Spending* creates jobs and income through expenditures on wages for workers and spending on orders for materials and services that are needed to construct and develop transportation facilities, and to provide their ongoing operation.

- *Traveler Impacts* associated with an improvement in public transportation services or the increased availability of service can include savings in travel time, savings in travel costs, and savings in accident costs. The travel cost savings for public transportation passengers may include savings on tolls or fares, and for those formerly traveling by automobile--savings on vehicle costs, fuel and parking costs, and less peak period congestion delay. The opportunity may also exist to reduce the number of personal vehicles owned by a household. The cost savings for those who remain as automobile travelers may include less traffic delay due to the shift of some of the former automobile travelers to public transportation. Access improvements are also clearly travel-related, though in practice they are generally estimated as broader economic development impacts.

- *Broader Economic Development Impacts* include increases in jobs and income resulting from the growth of activity at suppliers of goods and services to serve the expanding construction of public transportation facilities, vehicles, and other equipment, and the expanding operations of public transportation services. They can also include induced economic growth associated with additional workers spending their income throughout the economy. In addition, though, there can also be household and business cost savings enabled by public transportation availability, reduced road congestion, and increased access to employment, education, health care and shopping opportunities. Particular attention has been given in to the effect on business productivity enabled by factors such as a larger scale of customer markets, improved access to a greater diversity of labor market skills, and the business agglomeration (cluster) economies associated with enhanced public transportation access.

All of these elements of economic impact can also be classified as one of two classes: “generative” and “distributive.”

- *Generative economic impacts* are true personal or business productivity gains due to some combination of: (1) traveler benefits -- such as the value of time or expense savings, and (2) external benefits affecting non-travelers -- such as increased business productivity from access to broader labor markets, more reliable worker arrivals, or greater scale or density of development. Any or all of these generative impacts may, in turn, also affect investment and income levels.

- *Redistributive economic impacts* include the effects of spatial shifts in land development (not counting the effects of density changes), spatial shifts in business location patterns, and any resulting shifts in activity among industries or in income among population groups.

While both types of impact can lead to economic growth in a given study area, only the generative impacts remain when economic impacts are viewed from a national or global perspective. (For further information, see TCRP 35, Cambridge Systematics et al, 1998).

Finally, there are other related economic indicators that are affected as a result of economic development. They include property values, land use/development (capital investment), tax revenues and government expenditures. These other indicators are usually seen as a reflection of the "capitalization" of the above-cited user and non-user benefits, i.e., they are generated as a consequence of those direct benefits and hence they provide supplementary evidence of their value. As such, they are of interest to observe and measure, but they cannot be added to the calculation of total economic impacts due to the risk of double counting. These alternative impacts thus often serve as a confirmation of the other impacts that are exhibited within the economy.

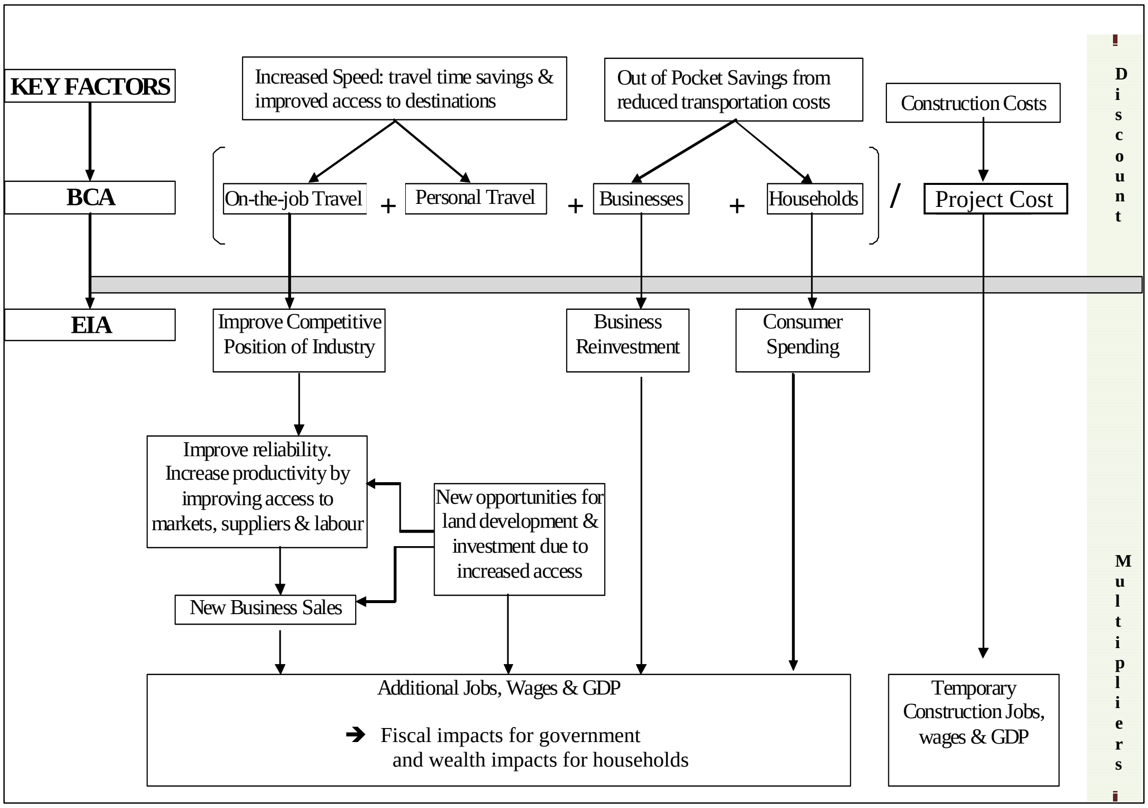
A.3 Direct, Indirect & Induced Economic Impacts

Broader economic development impacts are generated and estimated through a series of steps. First, direct impacts are identified as the portion of direct spending and/or transportation improvement benefits that lead to the expansion of business activity in the study area. The increase in business activity for directly affected businesses leads to yet more growth as it: (1) requires more supplies to be purchased, and (2) requires additional workers to be hired and paid. That in turn, leads to (3) yet more growth as the suppliers increase their purchases of materials and workers. In addition, (4) the additional worker income is spent on consumer purchases. The stimulated economic activity related to the suppliers is referred to as the "indirect effect" and the stimulated economic activity related to the worker re-spending on consumer purchases is referred to as the "induced effect."

Summing together the direct, indirect, and induced effects provides a comprehensive picture of the economic activity associated with the growth of business activity due to transportation spending. The total impact on economic growth in any given region may be measured in terms of the regional output (business sales), the gross regional product (value added), wages (personal income), and/or jobs (employment).

Exhibit A-2, shows how these various forms of spending patterns, travel time and cost savings, economic productivity and competitiveness all interact to affect the economy. That graphic also distinguishes elements included in benefit/cost analysis as distinguished from economic impact analysis.

Exhibit A-2: Factors in Benefit-Cost Analysis and Economic Impact Analys



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