Economic Impact
of Public Transportation Investment

2014 UPDATE

APTA
AMERICAN
PUBLIC
TRANSPORTATION
ASSOCIATION

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AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Executive Summary

Economic Impact of Public Transportation Investment

for American Public Transportation Association
by Economic Development Research Group, May 2014

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 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 – *Economic Impact of Public Transportation Investment*, prepared by Cambridge Systematics, Inc. and Economic Development Research Group, for the American Public Transportation Association, 2009.

Key findings are organized in terms of three categories: (1) 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; (2) the effects of spending money on public transportation, which creates immediate jobs and income by supporting manufacturing, construction and public transportation operation activities; and (3) conclusions regarding the interpretation and policy consideration of economic impacts associated with public transportation investment.

Overall Findings

Increased public transportation investment can lead to significant economic growth, as a consequence of both the short-term stimulus impact of public transportation outlays and a longer-term, cumulative impact on economic productivity. The latter is enabled by increasing investment to improve our nation's urban transportation systems and sustaining the investment over time. While the total impact will depend on the level and distribution of investment, the magnitude of potential impact can be illustrated by considering a scenario of enhanced investment sustained over 20 years.

Under such a scenario of sustained higher investment in public transportation, the impact by the end of the 20-year period would represent a ratio of more than $3.7 billion per year of additional GDP per $1 billion invested annually. This includes $2.0 billion due to the productivity effect of cost savings in the economy and $1.7 billion supported by the pattern of public transportation investment spending. At current wage rates, this is equivalent to a ratio of approximately 50,731 jobs per $1 billion invested in public transportation.

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

Category of Economic Impact	Value of Economic Impact	Wage Equivalent	Job Equivalent	Corresponding Tax Revenue
Investment Spending Effect	*$ 1.7 billion*	*$1.3 billion*	*21,800*	*$432 million*
Long Term Cost Savings Effect	*$ 2.0 billion*	*$1.5 billion*	*28,931*	*$310 million*
Total Economic Impact	**$ 3.7 billion**	**$2.8 billion**	**50,731**	**$642 million**

**Difference in impact between the "Base Case" scenario and "higher transit Investment" scenario, expressed as a ratio per $1 billion of added annual investment in public transportation. See full text for interpretation of wage and job equivalents.*

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 expanded public transit service areas and reduced traffic congestion; and
- additional regional business growth enabled by indirect impacts of business growth on suppliers 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 each of these impacts by examining the effects of two alternative scenarios for long-term public transportation investment in the United States: a "Base Case" investment scenario that maintains long-term public transportation ridership trends, and a "higher transit investment" scenario that adds $14.2 billion per year of investment over the next 20 years. The analysis calculates how travel times and costs, including effects of changes in congestion levels and mode switching, differ between the scenarios. Results are then presented in terms of total impact and impact per $1 billion invested.

Spending Impacts

Capital investment in public transportation (including purchases of vehicles and equipment and the development of infrastructure and supporting facilities) are a significant source of jobs in the United States. The analysis indicates that nearly 15,900 jobs are supported for a year per $1 billion of spending on public transportation capital.

Public transportation operations (i.e., management, operations and maintenance of vehicles and facilities) are also a significant source of jobs. The analysis indicates that more than 24,200 jobs are supported for a year per $1 billion dollars of annual spending on public transportation operations.

Combining investment in public transportation capital and operations within the United States, the analysis indicates that an average of 21,800 jobs are supported for one year, per $1 billion dollars of annual spending on public transportation, given the existing mix of operations (71 percent) and capital (29 percent) expenditures.

All of the above job numbers include "direct" jobs associated with manufacturing, construction and operation of public transportation equipment and facilities, plus additional "indirect" jobs supported at parts, materials and service providers, and "induced" 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).

Other economic impacts are associated with public transportation spending. Corresponding to the 21,800 jobs is approximately $3 billion of added business output (sales volume), which provides $1.7 billion of GDP (gross domestic product, or "value added") – including $1.3 billion of worker income. This additional economic activity generates approximately $432 million in federal, state and local tax revenues.

Care should be taken in use of these impact measures. Specifically, they 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. It should also be noted that while all of these numbers are in real (constant) dollars, the ratio of jobs supported per $1 billion of spending will fall over time due to future changes in wages per worker.

Conclusion

The analysis shows that public transportation investment can have significant impacts on the economy, and thus represent an important public policy consideration. These impacts include (1) supporting American jobs and industry with spending on public transportation and (2) providing savings for households and businesses due to improvement of transportation system performance. In the long term, a program of enhanced investment sustained over 20 years can have a total effect on the economy in the range of 3.7 times the amount being spent annually.

Public transportation is a cost-efficient industry for several reasons:

- Capital investments have a long lifetime. As a result, capital costs are as low as $1.52 per trip, accounting for trips served over the full lifetime of an asset.
- Transportation investments support cost savings for both public transit users and non-users. With sufficient investment, improved public transportation may enable more households to reduce multiple car ownership. Relinquishing a car and transitioning to transit use can save approximately $10,103 per year.

Ultimately, public transportation investment can increase both business productivity and household disposable income. Increasing productivity can mean more income for workers and/or more jobs created. The sum of these two effects that is supported by the higher transit investment scenario (including both spending and productivity impacts) grows over time. By the end of a 20 year period, it represents 3.7 times the annual investment. This is equivalent to the value of 50,731 jobs per $1 billion spent (at current wage rates). Actual national job growth impacts will depend on how national economic competetiveness, workforce availability and unemployment rates are affected.

It is important to stress that this analysis examines the scale of potential impacts on the economy and does not purport to show 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, although they do account for indirect and induced economic growth that is typically not included in benefit-cost studies.

The social and environmental impacts are not counted in this economic impact study. They include, most notably, personal time savings and emissions impacts. Additionally, public transportation can play an important societal role in providing mobility for those without cars, along with backup mobility for those who do have personal vehicles. 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.

1 Introduction

1.1 Context and Background

Context. There are many reasons for investment in public transportation. These include social, environmental and economic considerations. Public transportation provides mobility for those who do not have access to a car. For other riders, it provides a way to avoid parking and fuel costs, or traffic congestion delays and aggravation. For those who continue to travel by car, there is a benefit insofar as public transportation reduces traffic growth and thus congestion delays (compared to what might otherwise occur). There can also be air quality and neighborhood development impacts that are considered beneficial for communities. All of these factors may be relevant as agencies prioritize transportation investments.

Investment in public transportation can also affect the flow of money and generation of jobs in the economy. Given the above context, the economic impact should be seen as just one aspect of a much broader story of impacts on society. Yet there can be a particularly compelling interest, for both public discussion and agency decision-making, in better understanding how investment in public transportation leads to wider effects on the economy. That is the purpose of this report.

Background. 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 and expanded in 1999 and again in 2009. Each subsequent study has revised the numbers from the prior study, expanded the range of types of impacts covered, and further refined measurement and computational methods. The 2014 study continues this progression.

The analysis methods that are laid out in this report focus on national-level impacts, but also provide guidance for local and regional studies. However, it is important to note that the nature of public transportation investment has continually changed, over time the structure of the national economy has continued to evolve and our analysis methods have continued to improve. Consequently, the findings of this study differ from those of earlier works, both in perspective and results.

1.2 Why Measure Economic Impacts?

Transportation investment affects the economy through two fundamental mechanisms: *(1) costs and productivity impacts* – the services that are enabled by investment in public transportation facilities and operations provide enhanced mobility, time and cost savings; this leads to broader economic growth, which occurs as a result of changes in disposable household income, business productivity, and market access; and *(2) 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.

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 financial benefits (in the form of added income or reduced cost) end up going to a narrow or broad set of businesses and households?
- *Economic Stimulus and Competitiveness.* Do the capital investments and operations expenditures 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?

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 productivity and spending 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. Therefore, the effect on the economy, which is the subject of this report, should be seen as just one aspect of broader public policy considerations.

1.3 Report Organization

This report is organized into four parts.

(1) Introduction - discusses the objectives of economic impact analysis and describes the facets of economic impact that are relevant to public transportation investment.

(2) Processes Impact - presents a framework for classifying and viewing the different ways that public transportation investment can lead to broader economic consequences.

(3) Travel Cost Reduction Impacts - presents a methodology and an analysis of the economic growth that results from an increase in the availability, and use of, public transportation services.

(4) Spending Flow Impacts - presents a methodology and analysis of the economic growth impacts that occur as a result of money flowing through the economy, which is triggered by public transportation capital and operations spending.

Together these parts represent updates of material that existed in the prior 2009 study, although chapter 2 presents a significantly enhanced classification of impacts and chapters 3 and 4 present substantially different results as a consequence of both shifting economic patterns and more refined economic modeling processes.

2 How Public Transportation Affects The Economy

Public transportation investments lead to impacts on job and income growth in American communities through several paths. This chapter provides an overview of the following:

- *2.1 Travel Time/Cost Impacts:* Both public transit riders and car travelers save time and cost because of the existence of transit services.
- *2.2 Access Impacts:* Worker income and business productivity are increased by the expanded job market access and business clusters that public transit enables.
- *2.3 Spending Impacts:* Transit capital investment and operations spending stimulates the economy.
- *2.4 Other Economic Impacts:* Transit service can affect property values.

For each category of impact, the discussion covers its definition, available methods for analysis, and examples of application.

2.1 Travel Time/Cost Impacts

Overview. While the short-term stimulus effects of public transportation investment can be of significant interest (see Section 2.3), longer-term travel benefits clearly reveal that public transportation investment can ultimately lead to greater and more lasting impacts on the 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 four types of benefits can provide monetary savings for both public transportation passengers and 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.Those values however, 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 have been the primary factors considered as the benefits of public transportation projects. This mindset has changed significantly in recent years, 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 other aspects of business productivity.

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

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

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

- Business trips (sometimes referred to as "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 US DOT recognizes the value of business travel time as the hourly cost of average labor -- including wages, taxes and fringe benefits. From the viewpoint of economic impact analysis, that is a direct productivity cost to business. [1]
- "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, and a line of research 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.[2]

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1 *Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis, US DOT, 2011. http://www.dot.gov/sites/dot.dev/files/docs/vot_guidance_092811c.pdf*

2 *NCHRP Report 464, Economic Impacts of Congestion, Transportation Research Board, 2001, pp. 46-47.* http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_463-a.pdf *(first half) and* http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_463-b.pdf *(second half).*

- "Personal trips" are those conducted for any other purpose. Time savings 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 do not directly affect the flow of income generated in the economy and are thus not included in the economic impact analysis of this report.[3]

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. The value of transit time (and how to generalize such a value at the national level) is an ongoing area of exploratory research. Since the current analysis seeks only to state well-documented benefits and impacts (avoiding speculative benefits), it is likely that the benefits stated in this report represent a more conservative estimate due to this effect.

Reliability Benefits. 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 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.[4]

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.

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3 *While personal trips may involve some spending (on meals, 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 not increase total household spending in the U.S.*

4 *Economic Productivity and Transportation Investment Priorities: Literature Review, NCHRP Project 02-24, 2013.* http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP02-24_Task1LitReview.pdf

There are several ways to view and assess the economic value of time savings associated with reliability improvements. A commonly accepted approach is to recognize that many travelers (including car, truck, bus and train travelers) "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 avoid 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 for schedule buffering.

Travel Cost Savings. 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 reduced depreciation, insurance and upkeep costs applicable if some former automobile users end up owning fewer automobiles in the long run.

Travel Safety Improvement Costs. 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.

The safety 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.

Impacts of Travel Cost Changes on the Economy. 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 of impacts 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 2.2, also lead to impacts on economic growth.

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

- Cost of living savings for households, leading to broader impacts on consumer purchasing patterns;
- Business productivity benefits from access to a broader labor market, with more reliable employee arrival times, increasing business competitiveness and facilitating 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. 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. Therefore, the change in economic activity may be quite pronounced for a local area, but appear smaller when observed for a wider area.

2.2 Access Improvement Impacts

Improvements in public transportation services can lead to economic productivity changes as a consequence of both expanded public transportation service and reduced traffic congestion. This can specifically include: (a) *mobility and market access* - business productivity benefits from access to a broader and more diverse labor market, and access to a wider customer market; and (b) *spatial agglomeration economies* - business productivity benefits from clustering of similar and complementary activities, enabled by public transportation services and terminal facilities.

Mobility and Market Access. In addition to time and vehicle cost savings, public transportation provides household mobility benefits in terms of access to work, school, health care and/or shopping destinations. 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 worker 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.

Spatial Agglomeration Economies. 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 costs, 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 together result in higher productivity and more economic growth.

It is possible to estimate the labor market access effects of public transportation by observing the extent to which certain industries tend to cluster or agglomerate at locations where they can obtain a higher level of labor market or customer market access. Then one can measure the extent to which employment grows and creates income faster at those cluster locations.

In fact, many large cities could not possibly provide either the road capacity or the parking spaces needed to accommodate their downtown workforces without public 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.

Total Economic Development Impacts of Public Transportation Service.
A wide range of local economic impact studies has 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 can demonstrate the substantial magnitude of impact that public transportation investment can potentially have on regional economies.

2.3 Spending Impacts

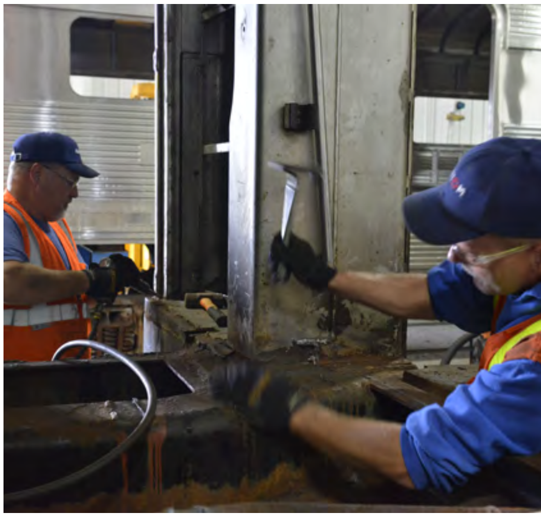
In addition to long-term travel benefits of public transportation services, the act of spending money to provide those services has an immediate effect on jobs and income.

Direct Spending Effects. *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.

Indirect and Induced Effects. Direct investment in capital and operations of public transportation services lead to broader effects 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 and parts) lead to sales and thus support jobs in supplier industries. These are industries that produce, distribute and sell those goods, as well as component materials needed to make them.

(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 for businesses that provide consumer goods and services.



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 among industries in the economy, and are constructed at a national level by the U.S. Bureau of Economic Analysis (BEA). While this report focuses on national impacts of public transportation funding, a similar type of analysis can be calculated at a regional (state or national) level. However, the indirect and induced impacts are typically smaller at a regional scale, and they must be calculated using regional input-output models that account for differences in the extent to which purchases are supplied by other firms located within or outside the region.

2.4 Other Economic Impacts

Property Values. 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 "double 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.

3 Travel Cost Reduction Impacts

Investment in public transportation facilities and systems affects the economy in two ways: (1) through long-term cost savings and business productivity benefits that accrue as a result of public transportation services, and (2) through the infusion of spending on worker wages and purchases of materials and services. This chapter focuses on the first category of impact, while Chapter 4 focuses on the latter category.[1]

This chapter implements a methodology that can be applied to connect changes in public transportation investment to ridership, mode split and cost savings for various segments of the economy. It is organized in terms of seven sections that represent a sequence of steps,

- *3.1 Public Transportation Capacity* – estimation of the cost and expected ridership impact of expanding public transportation capacity.
- *3.2 Cost of Additional Ridership* – calculation of the cost per new public transportation rider (given the cost and ridership changes).
- *3.3 Public Transportation Use and Mode Switching* – calculation of the reduction in automobile use (associated with the additional public transportation ridership).
- *3.4 Passenger Cost Savings* – calculation of the cost savings to public transportation passengers (associated with mode switching).
- *3.5 Additional Congestion Reduction Benefit* – calculation of cost savings to automobile and truck users (associated with reduced roadway congestion due to mode switching).
- *3.6 Business Productivity Benefit* – calculation of the improvement in business output per worker (resulting from worker reliability changes).
- *3.7 Calculation of Overall Economic Impacts* – calculation of 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

1 *This chapter updates analysis conducted by Arlee Reno for TCRP Project J11(7): Economic Impact of Public Transportation Investment, 2009.*

the magnitude of economic impacts likely to be associated with national spending on public transportation.

The calculation of these economic impacts is based on consideration of two alternative scenarios for long-term U.S. 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 a 20-year period. The analysis calculates the added economic impact resulting from the enhanced investment, relative to the "Base Case" scenario.

3.1 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 forecasted 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 consist of the same types of facilities and equipment.

Capital Needs. The FTA's *Condition and Performance Reports* and the TCRP project H-33B on "State and National Public Transportation Needs Analysis" (Cambridge Systematics, 2008) both forecast transit capital needs in great detail. The primary asset types and their recommended average lifetimes before replacement are:

- 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 (shelters, parking lots, etc.): 44 years
- Systems (signals, electronics, etc.): 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 20 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 that will be useful in future periods, but for which future periods will not have to incur any costs.

Capital investments are necessary in each of the asset categories to preserve existing public transportation ridership and serve new passengers. The 20-year capital needs by category have been broken down from the needs data of the most recent TCRP study as shown in Exhibit 3-1. As can be seen, many of the types of assets that are needed in the next 20 years will have value well beyond that time period.

Exhibit 3-1. 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 compared were:

- *"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 2008.
- *"Doubling Ridership" scenario* – assumes annual growth in ridership of 3.53 percent each year over a 20-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 $284 billion more in capital investment than would be needed for the "Current Trend" scenario. That represents an additional annual capital investment averaging $14.2 billion per year (in constant 2011 dollars).
- *"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 increment between the other two scenarios, in terms of net benefits versus net added investment costs.

The TCRP capital analysis was conducted for a 20-year period (assuming 2010-2030) and the needs for the purchase of capital assets by category were estimated for that 20-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 that 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 2.45 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 public transportation had not been forecast, 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 that can sustain 2.45 percent future annual ridership growth will likely be greater than what is shown here (from comparing the 2.45 percent and 3.53 percent public transportation ridership growth scenarios).

While the economic impact analysis considered only impacts occurring in a 20-year period, it is recognized that the useful lifetimes of many of the assets purchased within that 20-year period will extend well beyond the end of the impact analysis period. 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), a side analysis was performed to also assess how many additional public transportation trips would be served by the investments made under each asset category, both within and beyond the 20-year period used for economic impact analysis. This gives a more complete measure of the benefits of investing in these assets.

The result, shown in Exhibit 3-2, was a finding that, within the 20-year study period, 34.8 billion more public transportation trips would be served under the "Doubling Ridership" scenario than would occur under the "Current Trend" scenario. Yet this number rises to 172 billion when considering the full lifetimes of the additional assets purchased under the higher investment scenario.

It should be noted these numbers include both *new users* attracted from other modes and more frequent use of transit by *existing users* who will use transit for a *larger share* of their trips when infrastructure is newer and in better condition.

Exhibit 3-2. 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 new trips	**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, while the additional assets purchased under the higher investment scenario are associated with requirements to meet higher ridership (or to replace aging assets serving existing passengers), about 80 percent of their usefulness to future public transportation trips actually occurs beyond the 20-year economic impact analysis period. 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 20 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 2010 to 2011 were:

- Commuter rail car: $2.2 million
- Heavy rail car: $2.0 million
- Light rail vehicle: $3.6 million
- Transit bus: $0.5 million
- Articulated bus: $0.9 million

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

3.2 Net Cost of Additional Ridership

The second step is to obtain information required to estimate the total net cost per new public transportation trip. This builds upon the ridership and cost data shown in Section 3.1, plus additional information on associated fare revenue. The latter is based on data shown in Exhibit 3-3, which displays national totals for public transportation passenger and vehicle revenue miles. These represent 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 3-3. Average Passengers, Miles and Revenues

Total Data 2011					
Mode	**Vehicles**	**Passenger Trips* (Millions)**	**Passenger Miles (Millions)**	**Vehicle Revenue Miles (Millions)**	**Train Revenue Miles (Millions)**
Bus	69,175	5,235	21,414	2,083.2	–
Commuter Rail	7,139	466	11,427	316.9	51.37
Heavy Rail	11,342	3,647	17,317	636.3	87.13
Light Rail	2,257	436	2,360	92.5	44.54

Source: 2013 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*

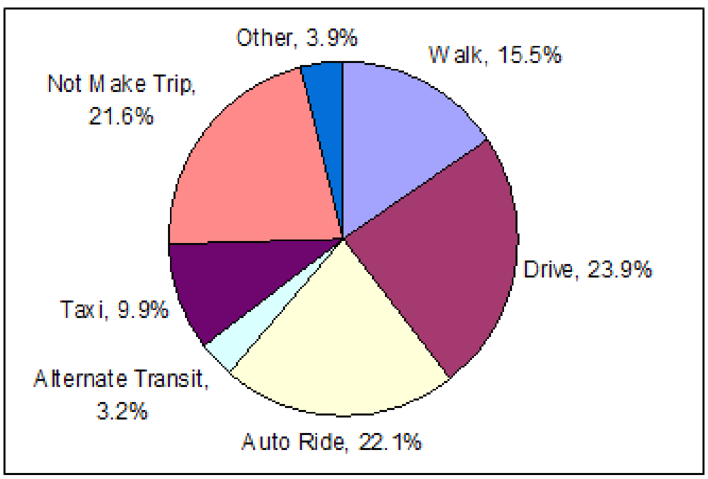
3.3 Public Transport Use and Mode Switching

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 bicycling, 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 use 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.

Exhibit 3-4 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 3-4.
Alternative Mode of Travel If Public Transportation Agency Were to Cease Operation



Source: A Profile of Public Transportation Passenger Demographics and Travel Characteristics Reported in On-Board Surveys (APTA, 2007).

The anticipated alternative choices of mode of service for bus passengers and for rail passengers could be very different if their existing service were 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 *2013 Public Transportation Fact Book*, Appendix A, the average length of unlinked bus trips is 4.1 miles compared to a 24.5-mile average trip length for commuter rail, a 4.7-mile average trip for heavy rail, and a 5.1-mile average trip for light rail. The greater likelihood of former rail passengers driving themselves and not forgoing their trips may also reflect the effect of their higher incomes when compared to the surveyed bus passengers.

These survey data can also be 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 public transit agencies. The TPMS data do not significantly differ from the On-Board Surveys Sample data (see Exhibit 3-5).

Exhibit 3-5. On-Board Surveys - Sample Alternative Mode Data Compared to Two TPMS Surveys

Sample Group	Alternative Mode							
	Walk	Drive	Auto Rider	Alternative 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 3-4; plus TPMS data from www.apta.com/government_affairs/policy/documents/tpms_summary_I_and_II.pdf and www.apta.com/government_affairs/policy/documents/tpms_summary_%20III.pdf

3.4 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 are calculated as the difference between the automobile travel costs (including parking) and public transportation fares. The U.S. average public transportation fare per trip is $1.31 (APTA *2013 Public Transportation Fact Book*, Appendix A). The American Automobile Association (2011) estimates a cost per mile of automobile operation covering gas, oil, maintenance and tires ranges from 15 cents for small sedans to 23 cents 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 Internal Revenue Service for purposes of reimbursing business travel; this rate is currently set at 55.5 cents 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 $3.00 per automobile trip, which is $1.69 over the average cost per public transportation trip. Over the course of a year, this user cost savings totals $845 per traveler. In addition, parking costs would also be added for a portion of diverted automobile trips where that factor is also applicable. 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. These savings can then be compared to the capital investment required to achieve those results. Specifically, a 2008 study for APTA and AASHTO assessed public transportation needs by developing scenarios for public transportation ridership growth and calculating the associated costs.[2] Subsequent analysis by Cambridge Systematics then compared the implementation costs of expanding public transportation to vehicle and fuel cost savings, using these same public transportation ridership growth scenarios. The results, expressed as the long-term discounted public transportation investment level in comparison to the highway vehicle and fuel cost savings, are shown in Exhibit 3-6.

Exhibit 3-6. 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

Source: Analysis by Cambridge Systematics, originally presented in Economic Impact of Public Transportation Investment, TCRP Project J11(7), 2009, Exhibit 3-7.

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).

2 *State and National Public Transportation Needs Analysis, Cambridge Systematics for AASHTO and APTA, TCRP Project H33(B), 2008. www.apta.com/gap/policyresearch/Documents/transit_needs_studies.pdf*

These findings 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 by 2030 than would otherwise occur with the "Current Trend" scenario. Multiplying by the previously-calculated cost savings of $1.69 per new public transportation traveler yields an estimated savings of $6.8 billion per year as of 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 findings shown in Exhibit 3-6, which shows total savings over the 40-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[3] on a widespread scale lead to 10-20 percent 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 3-7 shows estimates of those savings in terms of annual household cost per vehicle for a household owning one medium-size sedan. The savings would amount to $10,103 after accounting for the costs of purchasing a monthly transit pass.

3 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 U.S. cities.

Exhibit 3-7. Annual Costs of New Automobile Ownership[4]
(APTA, 2011)

Variable Cost	**Per Mile**
Gas	$0.1528
Maintenance	$0.0497
Tires	$0.0100
Total	$0.2125
Annual Miles Per Household	15,000
Annual Mileage Cost	$3,188

Fixed Cost	***Per Car***
Insurance	*$1,029*
License and Registration	*$611*
Depreciation	*$3,571*
Finance Charge	*$848*
Annual Fixed Cost	*$6,059*

Total Yearly Driving Cost	***$9,247***
+Parking Cost	*$1,863*
Total with Parking	*$11,109*
-Potential Cost of Transit Pass	*-$1,006*
Net Annual Household Savings of Relinquishing 1 Full-Size Sedan and Using Transit Instead	***$10,103***

Assumptions (auto at 22.46 mpg, gas at $4.078 per gallon)

To illustrate the effect of automobile ownership shifts, consider the impact if automobile ownership is reduced for just 10 percent of the projected new public transportation passengers who are commuters. That alone would lead to an additional savings of $5.4 billion per year as of the year 2030. This value is computed by taking the fractional portion of passenger trips and converting them into equivalent number of passengers, using a factor of 500 trips per year, and then deflating the value by an assumed vehicle occupancy factor of 1.5[5] to arrive at the affected number of vehicle owners. These 533,333 vehicle owners are assumed to experience the above mentioned household savings of $10,103 by relinquishing automobile ownership to arrive at the $5.4 billion annual 2030 figure.

4 *http://newsroom.aaa.com/2013/04/cost-of-owning-and-operating-vehicle-in-u-s-increases-nearly-two-percent-according-to-aaas-2013-your-driving-costs-study/*

5 *The 2009 NHTS approximated occupancy factor from cars across listed purposes http://nhts.ornl.gov/tables09/FatCat.aspx*

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. And even when time savings do accrue for new public transportation passengers, they only affect the flow of dollars in the economy insofar as they affect business-related travel or the reliability of worker arrivals at businesses.[6] 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, although 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 studies comparing urban areas with differing levels of public transportation service, which suggest that sustained investment in public transportation could bring a *reduction* in automobile vehicle-miles that is substantially larger than the *increase* in public transportation passenger-miles.[7] These findings suggest that the more compact urban densities supported by transit may result in shorter and less expensive trips (hence additional transportation savings) even for non-transit users. However, those effects depend on the growth and density of the specific city, so the current national analysis does not explicitly incorporate any such impacts.

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6 *Of all public transportation trips, 59 percent are commuting to/from work, 14 percent are for educational or medical purposes, and the rest are for shopping, social or personal purposes. Source: APTA (2008).*

7 *For instance, see The Broader Connection between Public Transportation, Energy Conservation and Greenhouse Gas Reduction, TCRP Study J-11(3), ICF for the American Public Transportation Association, 2008. www.apta.com/research/info/online/documents/land_use.pdf.*

3.5 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 roadway congestion in urban areas include estimates of how much congestion reduction is attributable to current public transportation.[8] 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 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.[9]

Scenarios for Future Congestion Reduction. To estimate the future effects of public transportation (rather than the "current effects" as TTI calculates), two scenarios were considered – the "Current Trend" and the "Doubling Ridership Growth" scenarios, as previously defined in Section 3.1. The impacts of both were calculated using results from the Highway Economic Requirements System to model highway vehicle miles of travel and the resulting highway levels of service and performance that would occur in urban areas with various levels of public transportation service expansion over the next 20 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

8 *Texas Transportation Institute, Urban Mobility Report, 2012. http://mobility.tamu.edu/ums/report/*

9 *Federal Highway Administration, Highway Economic Requirements System – State Version, Technical Report, 2005. http://www.fhwa.dot.gov/asset/hersst/pubs/tech/tech00.cfm*

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 highway user costs due to changes in VMT from added public transportation investment, 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 would 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 3-8.

Exhibit 3-8. 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 Both 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 20-year investment period, compared to 5.4 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 different sets of assumptions lead to different rates of diversions of vehicle miles of travel, with a high diversion of 91 percent of VMT from highway driving 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 urban VMT associated with the "Doubling Ridership" scenario – calculated as 91 percent diversion of 24 billion passenger miles shifted from automobile to public transportation (with no change in miles per trip between public transportation and automobile trips); and
- A diversion estimate of 8 billion vehicle-miles of urban VMT associated with the "Current Trend" scenario – calculated as 37 percent diversion of 21 billion passenger miles shifted from automobile to public transportation (allowing for 15 percent longer miles trip for public transportation trips).

Findings on Cost Savings for Road Traffic. HERS analysis results were then used to calculate the operating cost savings to automobile travelers on urban highways as VMT is reduced by diversion to public transportation. The highest growth public transportation strategy would achieve a reduction in automobile VMT of 50 billion on urban 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 3-9.

It is not known how many vehicle miles of travel the added public transportation investment might decrease for each type of urban highway (Interstate, other freeway or expressway, other principal arterial, etc.). The reduction of a single VMT on an urban Interstate will result in slightly less cost savings than a reduction of a single VMT on other types of highways. Therefore, cost reductions were calculated based on the cost changes for urban Interstate travel. This provides a conservative estimate of savings, although the ability to estimate reductions more precisely by highway type would not change the results very much.

Exhibit 3-9. Estimate Impacts of Reductions in Vehicle Miles of Travel on Costs to the Remaining Highway Drivers for Urban Highways

HERS Run (Scenario)	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 629 billion miles per year of VMT on the urban Interstates at the end of 20 years, a change of user costs of 1.8 cents per mile equates to about $11.3 billion per year in reduced highway user costs for the remaining highway users due to the public transportation investment. As previously noted, diversions from other types of highways would result in slightly higher cost savings than shown here.

However, since the savings in highway user costs builds up over time, it will shift from zero in 2010 to $11.3 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 $11.3 billion per 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. 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 percent of the total cost of congestion is borne by businesses.[10] Accordingly, our analysis splits the $11.3 billion per year of congestion cost savings to households and businesses with a 55/45 split. This finding may understate the full potential congestion cost savings that may occur if transit availability is able to support development patterns with shorter overall trip lengths. As indicated previously, while such effects are the subject of current research, and are worth noting, they are not assumed as part of the congestion benefit in the current study.

3.6 Business Productivity Impact

In addition to the cost savings described above, a shift from auto to public transportation will facilitate increased economic productivity and competitiveness for cities. 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 enable scale and agglomeration economies.

The “wage premium,” originally discussed in Section 2.1, is a pass-through effect in which employers in highly-congested areas absorb some of the 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

10 *The Cost of Congestion to the Economy of the Portland Region, Portland Business Alliance, Metro and Port of Portland, 2005; also The Chicago Metropolis Freight Plan -- (Ch.7) Assessing the Economic Impacts of Congestion Reduction Alternatives, Chicago Metropolis 2020.*

the cost savings to business is effectively an increase in business productivity (which is defined as the ratio of output/cost for business operations). This impact is assumed to apply to roughly 30 percent of the congestion cost savings identified in Section 3.5.

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, as well as broader market access. Those changes, in turn, can allow a metropolitan area’s economy to become more productive. The reasons for this productivity gain are that:

- some businesses can gain access to a larger and more diverse labor market, providing them with a better capacity to find workers with the desired skills (“labor pool matching”), thereby enhancing labor productivity.
- some trade and service sector establishments can gain access to broader customer bases, allowing them to more efficiently arrange locations and resources to serve customers.
- knowledge and technology-dependent businesses can gain labor productivity as a consequence of knowledge-sharing, enabled by broader and more diverse worker and business interactions.
- some businesses can make more efficient use of space when higher density locations are enabled.

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 through a two-step process -- 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.

The first step draws on the finding of studies showing that adding public transportation capacity facilitates higher density urban development with reduced need for parking. At an urban level, public transportation ridership correlates with population density such that a 1 percent gain in public transportation’s mode capture translates to a change of roughly 400 residents per square mile over the entire city. However, that relationship can run both ways – although public transportation facilitates higher density, higher density can require more public transportation. Also, population density changes occur gradually over time, and depends on the rate of urban development. To allow for these factors, the rest of this section uses the more conservative assumption that a 1 percent change in public transportation mode capture will tend to increase population density by 100 residents per square mile.[11]

11 *The average population-weighted density of U.S. metropolitan areas is 6,321 (U.S. Census, 2010).*

The following example illustrates this effect. Adopting the scenarios defined in Sections 3.1 - 3.5, the scenario for increased public transportation investment would translate to an additional 4 billion public transportation trips per year in 2030, 59 percent 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 U.S. public transportation mode share from 5 percent to 8 percent. Extending findings cited in the preceding paragraph, this 3 percentage point increase in public transportation's mode share could (in the long run) help to boost effective urban density by 300 people per square mile.

The second step draws on findings from studies showing that increased population density enables greater economic productivity by expanding the size and diversity of labor and customer markets available to businesses. Continuing the example, a 5 percent increase in effective population density translates to a productivity growth of 0.15 percent, or more than $116 million per year. Extrapolating these results to the 50 largest U.S. cities (based on city size) yields additional U.S. productivity in 2030 of about $5 billion from increased public transportation investment.[12]

TCRP Project H-39 utilized statistical analysis of transit service, center city employment density and productivity to generate a similar type of conclusion. Results of that study indicate that a 10 percent change in transit service leads to an average of $45 million of added worker wages for the average metropolitan area. Factoring up that result for 50 metropolitan areas, and a 25 percent difference in transit ridership among the two scenarios (after 20 years), leads to an estimated long-term productivity impact in the range of $5.6 billion.[13]

3.7 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 3.4 - 3.6 to be substantial. In section 3.4, the estimate was made that the average household able to reliquish a car as a result of enhanced transit access would save $10,103 per year. This represents money returned to them for use on other household expenditures. For those with lower range of incomes, this is a very substantial benefit, providing an enormous gain in their purchasing power.

In addition to the economic gains to public transportation passengers (estimated in section 3.4), the analysis in section 3.5 indicated a further net gain to remaining automobile drivers. That gain averages $2.90 per one-way

12 *The 3 percent elasticity of productivity with respect to population market size and density is the low end of the 3 percent to 7 percent range found in past studies (Melo, et al., A Meta-Analysis of Estimates of Urban Agglomeration Economies, Regional Science and Urban Economics, 39, 2009).*

13 *Chatman, et al., Methodology for Determining the Economic Development Impacts of Transit Projects, TCRP Web Document #56, 2012.*

public transportation trip, or about $1,433 per year. (This is based on 250 round trips, or 500 one-way trips, per user per year.) Thus, each additional person traveling by public transportation saves costs to themselves plus costs to remaining automobile travelers, averaging $2,278 per year. Of course, the preceding effects are just those accruing to travelers. Additional impacts discussed in Section 3.6 can further increase business productivity and enhance the nation's cost-competitiveness, leading to greater income growth.

Broader Long-Term Effects on Income and Productivity. The long-term access and cost savings for travelers 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.
- 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 U.S. 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 (supplier) and 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 economic impacts were calculated using the TREDIS economic impact model to trace how changes in household spending patterns and business costs flow through the economy. The analysis 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 3.1 (and continued in Sections 3.2 – 3.5):

(1) A "Base Case" ("current trend" scenario) in which public transportation ridership grows at an average rate of 2.4 percent per year over the next 20 years, based on continuation of recent investment levels to support modest growth, and

(2) A "Doubling Ridership" scenario in which annual expenditures on public transportation are increased by an additional $14 billion per year (in constant 2012 dollars), raising public transportation ridership growth to an average rate of 3.53 percent per year over that time period.

The difference between these two scenarios increases over time and accumulates, so that the doubling ridership scenario leads to 4 billion more public transportation trips per year in the twentieth year (and up to 22 billion less automobile VMT in that year) than would exist with the "Base Case" scenario.

To calculate these broader, long-term impacts, the economic impact model accounts for transportation cost reductions accruing to 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 U.S.-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 long-term economic impacts on income and productivity are shown in Exhibit 3-10. They reflect changes in household disposable income and business income that are a direct consequence of greater public transportation availability. Those changes can lead to even broader impacts on the economy insofar as they spur shifts in business investment and location decisions, affecting labor markets and resource use. However, the broader consequences are more speculative and are not estimated here.

The long-term impacts shown in Exhibit 3-10 are based on constructed scenarios and thus should be interpreted as illustrative of the magnitude of potential long-term economic impacts that can be enabled by a major increase in public transportation investment. Since they are built on a series of assumptions described in Sections 3.2 – 3.5, the results should be interpreted as a reasonable estimate given the limitations of currently available data. They can also be viewed as a demonstration of a broader methodology that can be applied in the future as improved data sources and improved scenario forecasts become available.

Altogether, the long-term changes in disposable income total $28.5 billion per year by the year 2030. That represents more than double the assumed annual investment of $14.2 billion per year. The economic impact achieved in the twentieth year is equivalent to 410,820 more jobs. However, the actual job creation will depend greatly on how these changes affect national business competitiveness in global markets, as well as future rates of unemployment, labor force growth and changes in real wage rates.

The estimated economic impacts presented in this chapter represent the economic efficiency and productivity benefits available under a long-term enhanced investment scenario for public transportation. These performance effects are only part of the story. Section 4 estimates the more immediate stimulus effects associated with spending on public transportation capital and operations expenditures.

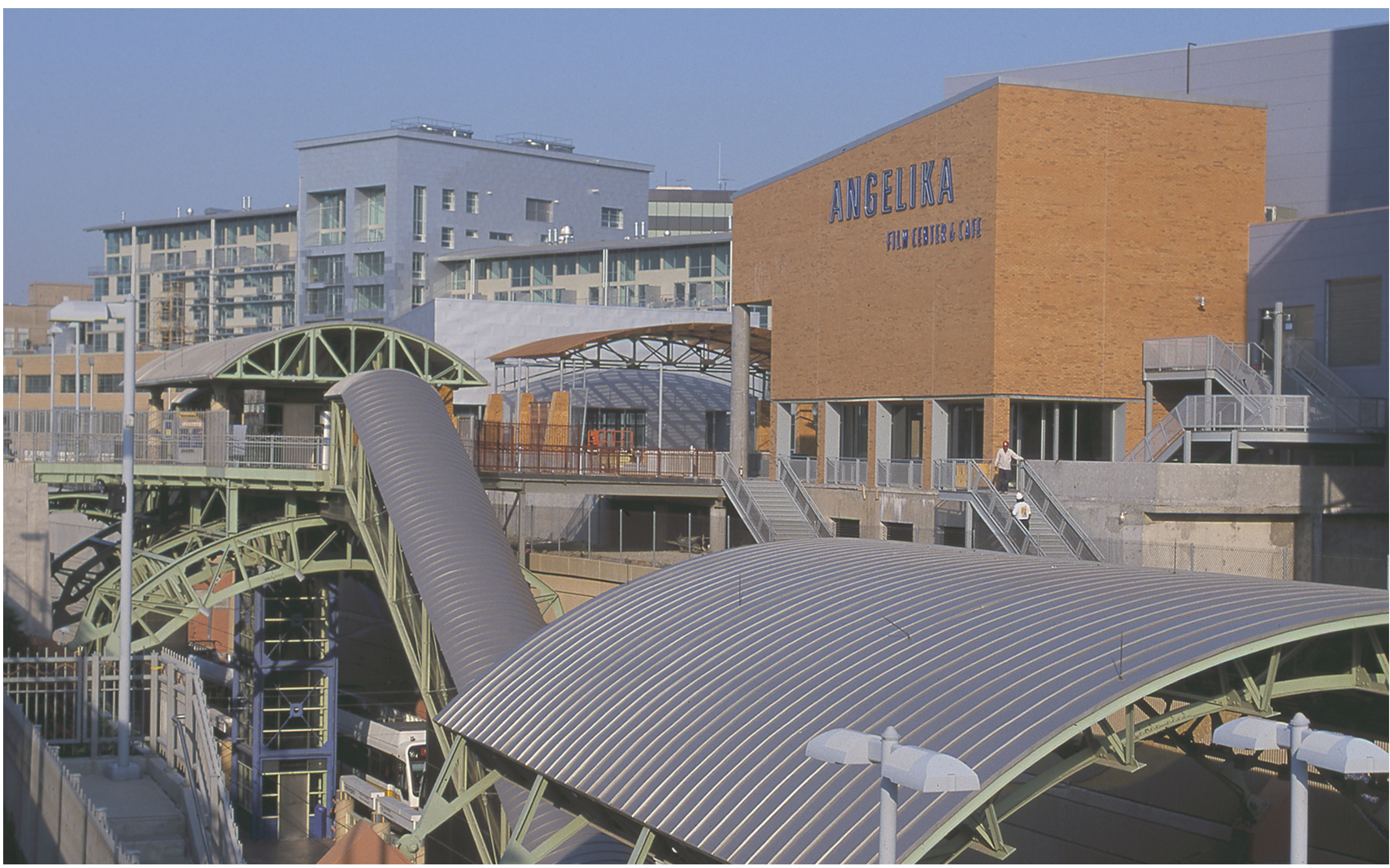


Exhibit 3-10. Estimate of Scenario Impacts on the Economy, 2030
Difference between "Current Trend" Scenario and "Doubling Ridership" Scenario
(effect of investing $13 billion per year)

Form of Impact	Annual Magnitude of Change After 20 Years*	Notes
Households: Disposable Income	**+18.4 billion**	
from cost savings to public transportation passengers	*(+ $6.8 billion)*	*(A)*
from savings in auto user operating costs	*(+ $6.2 billion)*	*(B)*
from savings in auto ownership costs	*(+ $5.4 billion)*	*(C)*
Business: Productivity	**+ $10.1 billion**	
from labor market access enhancement	*(+ $5.0 billion)*	*(D)*
from auto/truck operating cost reduction	*(+ $5.1 billion)*	*(E)*
Tax Impacts	**+ $4.4 billion**	
from Federal Tax Revenue	*(+ $3.3 billion)*	*(F)*
from State & Local Tax Revenue	*(+ $1.1 billion)*	*(F)*
Economic Impact		
Total Household and Business Impact	*+ $28.5 billion*	*(G)*
Equivalent Job Benefit	**410,820**	*(H)*

** All future-year dollar amounts are expressed in constant 2012 dollars.*
(A) Cost savings to public transportation passengers is calculated in section 3.4.
(B) Of the total congestion reduction benefit calculated in section 3.5, the household benefit is estimated to be 55 percent and the rest of that benefit is allocated to business productivity.
(C) Auto ownership costs are calculated in section 3.4; the figure shown here assumes that only half of the potential calculated benefit is realized.
(D) The labor market scale/agglomeration effect on productivity is estimated in section 3.6.
(E) The business cost reduction benefit includes both business travel cost savings and reduction in worker wage premium; it is conservatively estimated to be 45 percent of the total congestion reduction benefit calculated in section 3.5.
(F) Tax impacts are likely to be significantly offset by reductions in sales of gasoline, cars, tires and taxable services associated with auto use.
(G) Calculated as the sum of household disposable income and business productivity cost savings.
(H) The actual realization of jobs and associated wages will depend on future workforce growth, unemployment rates and business competitiveness in global markets.

In interpreting Exhibit 3-10, it is important to note four issues:

(1) These term impact estimates include only the effect of long-term transportation changes; they do not include the effect of ongoing transportation capital investment and operations spending as discussed in Chapter 4.

(2) 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 implications of changes in automobile ownership and business labor markets.

(3) The benefits of increased public transportation use and reduced automobile traffic congestion grow over time, so that longer-term impacts (beyond year 20) will be even greater than those shown here for year 20.

(4) This analysis counts only impacts on the flow of money in the economy. It do not include environmental benefits, social benefits for carless households, or any other class of benefit that do not directly affect the flow of money in the economy. A full benefit analysis would be needed to assess those additional impacts.

4 Spending Impact

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

This chapter is organized into five parts:

4.1 Definitions: 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 (tracks and special lanes) 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.

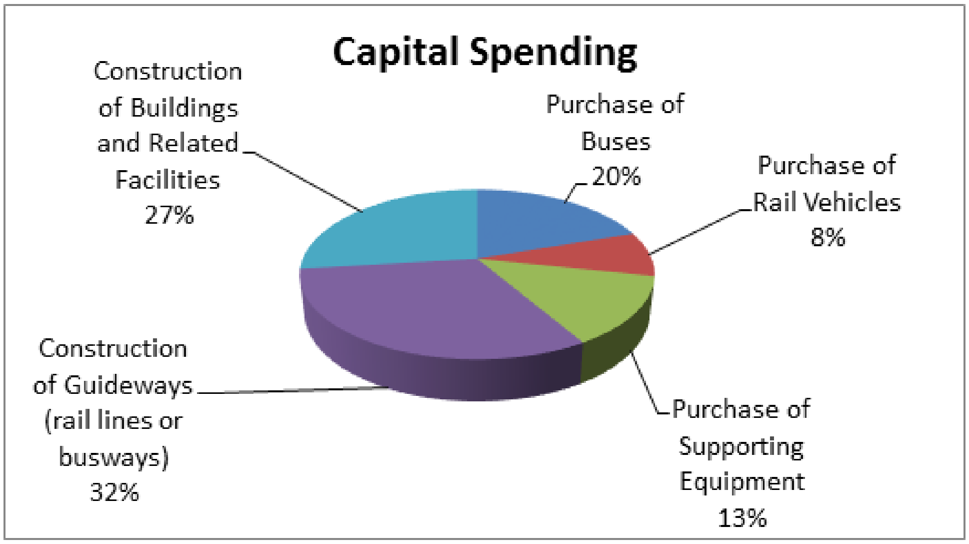
These economic "effects" can be viewed as indicators of the broader role of public transportation in a regional or national economy, as they show how investment in public transportation also helps support jobs and income in other industries. They can also show how increased public transportation spending can accelerate job growth in the economy, as long as there are sufficient workers to fill the new jobs without the displacement of other existing jobs. And as long as there are workers available for new jobs, 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.

4.2 Mix of Capital and Operations Investment

Total U.S. 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 4-1 shows the mix of products and services now being purchased as capital investment in public transportation in the U.S. Exhibit 4-2 also shows the mix between capital and operations at a national level. The most recent data from APTA (as of 2011) indicates that 71 percent of all public transportation investment is for operations and maintenance of existing systems, while 29 percent is for capital investment in vehicles and equipment needed to operate and expand existing systems.

Federal Government Spending Mix. U.S. authorization law focuses most 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 2011, 31 percent of federal assistance for public transportation was for operating expenses as defined by the standard accounting system and 69 percent was for capital expenses.

Exhibit 4-1.
Components of Capital Investment in Public Transportation in the U.S., 2011



Source: 2013 APTA Fact Book, Appendix A.
www.apta.com/resources/statistics/Documents/FactBook/2013-Fact-Book-Appendix-A.pdf

Exhibit 4-2.
Mix of Public Transportation Capital and Operations Spending 2011

	% of Capital Spending	% of Total Spending
Purchase of Buses	20%	6%
Purchase of Rail Vehicles	9%	2%
Purchase of Supporting Equipment	13%	4%
Construction of Guideways (rail lines or busways)	32%	9%
Construction of Buildings and Related Facilities	27%	8%
Subtotal: Capital Spending	100%	29%
Operations and Maintenance Spending		71%
Total Public Transportation Spending		**100%**

Source: 2013 APTA Fact Book, Appendix A
http://www.apta.com/resources/statistics/Documents/FactBook/2013-Fact-Book-Appendix-A.pdf

Compared to the earlier 2009 study, these newer data shows a small increase in the share of spending going to buses (from 16-20 percent), and a small decrease in spending shares for the other categories.

4.3 Economic Impact Modeling

Calculation of Overall Impact on Jobs. The estimates of job impact used for this study utilize a methodology similar to that commonly used to calculate the job impacts of highway construction and airport operations. The methodology uses a national economic model to: (1) track the pattern and mix of direct expenditures, (2) assess the portion of purchased products and services that are produced within the nation, and (3) trace indirect impacts on suppliers and induced impacts of worker spending. The current analysis is based on estimates that 76 percent of the content of public transportation vehicles, 87 percent of the content of supporting equipment, and 81 percent of the track material is made in America.

Exhibit 4-3 shows the estimated breakdown of jobs generated in terms of direct, indirect and induced effects, for both transit capital and operations spending. The lower end estimate comes from national accounts of the IMPLAN input-output model, while the higher end estimate includes consultant estimates of added effects caused by: (a) dynamic impacts of added transportation spending on increasing wages and tax revenues over time, and (b) jobs associated with equipment that is assembled outside the U.S., but with parts that originated in the U.S.

Exhibit 4-3.
Jobs Generated in the U.S. per Billion Dollars of Spending on Public Transportation

Job Generation per $ Billon of Spending	Capital Spending	Operations Spending	National Average
Direct Effect	5,063 – 5,822	11,364 – 13,069	9,551 – 10,984
Indirect Effect	3,679 – 4,231	1,863 – 2,142	2,385 – 2,743
Induced Effect	5,117 – 5,885	7,826 – 9,000	7,047 – 8,104
Total Jobs	13,859 – 15,938	21,053 – 24,211	18,983 – 21,830
Recommended Value for Use	15,900	24,200	21,800

Source: Calculations by EDR Group based on IMPLAN model, 2011 prices.

The findings shown in Exhibit 4-4 show that transit investment is more than competitive with other types of policy areas, including not only highway operations, but also defense, energy, water, and tax reductions in terms of stimulus for the overall economy.

Exhibit 4-4
Comparative Job Creation of Different Types of Public Outlays

Expenditure Type	Jobs per $Billion Outlays	Source	Year	Notes
Highway operations	17,810	FHWA - Freight Management and Operations	2000	(A)
Defense	8,555	Department of Economics and Political Economy Research Institute, Umass Amherst	2007	(B)
Tax cuts for personal consumption	10,779	Pollin and Garret-Peltier, Department of Economics and Political Economy Research Institute, UMass Amherst	2007	(B)
Energy	11,705	Heintz, Pollin and Garrett-Peltier, cited by Victoria Transport Policy Institute	2009	(C)
Water	14,342	Heintz, Pollin and Garrett-Peltier, cited by Victoria Transport Policy Institute	2009	(C)

(A) Highway Operations Spending as a Catalyst for Job Growth, available at http://ops.fhwa.dot.gov/freight/freight_analysis/highway_ops/hiway_ops2.htm

(B) The U.S. Employment Effects of Military and Domestic Spending Priorities, available at http://www.ips-dc.org/reports/071001-jobcreation.pdf

(C) How Infrastructure Investments Support the U.S. Economy: Employment, Productivity and Growth, Political Economy Research Institute (www.peri.umass.edu) for the Alliance for American Manufacturing, available at www.americanmanufacturing.org/wordpress/wpcontent/uploads/2009/01/peri_aam_finaljan16_new.pdf referenced at http://www.vtpi.org/econ_stim.pdf

Variation in Economic Impacts Over Time. The estimated ratios of jobs generated per billion dollars of spending that are shown here differ from prior studies. In general, these ratios tend to decrease over time for two reasons:

- The cost of paying workers tends to rise as worker productivity increases and as the buying power of the dollar is eroded by inflation over time. Increased productivity also means that fewer workers will be needed to provide the same services.
- The use of advanced equipment and material technologies – which affect the non-labor share of total costs – continues to rise over time. As spending on automated fare collection and control systems increase, the need for workers to manually provide these services is reduced.

There are several additional factors that also cause these job generation ratios to vary over time:

- Increasing globalization of trade tends to introduce more options for foreign-sourced parts and materials (which do not generate jobs in the U.S. economy). However, that trend can be mitigated through policies encouraging "made in America" purchasing.
- The job generation ratio for operations spending goes down as fuel cost takes a greater share of the money spent, particularly when the fuels are foreign-sourced petroleum products. However, job impacts can be increased if there is further switching to biodiesel and natural gas fuels (which are primarily made in the U.S.).
- Economic impact models are gaining precision and detail about parts and material purchasing over time, which have tended to reduce job impact estimates as the models incorporate greater recognition of needs for highly specialized parts that may not be manufactured locally.

Variation in Economic Impacts by Region/Area. The job generation ratios shown in Exhibit 4-3 represent national impacts of public transportation spending. The corresponding impacts for any given state, region, metro area or city will be lower than the national figures because smaller shares of purchased equipment, parts and materials are typically produced within the geographically smaller area of study.[1]

4.4 Overall Economic Impact of Spending

Job Impacts of Alternative Investment Mixes. Exhibit 4-5 shows how the job generation ratios vary depending on spending mix. A given level of operations spending generates more jobs than equivalent spending on capital investment because operations is more labor-intensive, while capital investment requires more purchases of manufactured equipment. However, the two go hand-in-hand; it makes no sense to buy equipment without operating it, and it is not really possible to continue operations in

1 *Regional economic models such as IMPLAN and RIMS-II, or broader economic analysis systems such as REMI and TREDIS, may be used to calculate impacts for smaller, sub-national regions.*

the long term without upgrading or replacing some equipment and facilities. Combined, public transportation spending in the U.S. is estimated to generate around 21,800 jobs per $1 billion of spending (or 21.8 jobs per $1 million of spending).

Federal Investment Impact on Jobs. Public transportation in the U.S. is funded by a combination of rider-paid fares, local/state revenue sources, federal funding and other sources. To assess the number of jobs supported just 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 preventive maintenance, but using the federal standard accounting system that would translate to 64.3 percent actually going for capital expenses and 35.7 percent going for operating expenses. That mix supports an estimated 18,900 jobs per billion dollars of federal spending on public transportation.

Exhibit 4-5.
Jobs Generated in the U.S. per Billion Dollars of Investment in Public Transportation, for Alternative Capital/Operating Mixes (2011 Prices)

Category	Spending Mix (Capital / Operations)	Job Impact per Billion Dollars of Spending
Capital Investment Only	(100% / 0%)	15,900
Operations Investment Only	(0% / 100%)	24,200
National Total Investment*	(29% / 71%)	21,800
Federal-Aid Investment Mix	(64% / 36%)	18,900

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

Source: Calculations by EDR Group based on IMPLAN model, 2011 prices.

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 profit and personal income generated).
- Total labor income paid (i.e., wages and benefits, which are a subset of GDP).
- Total jobs associated with that labor income.

Job impacts are usually of most interest to the general public, partly because they are an understandable unit of measurement and often the most direct objective. 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.

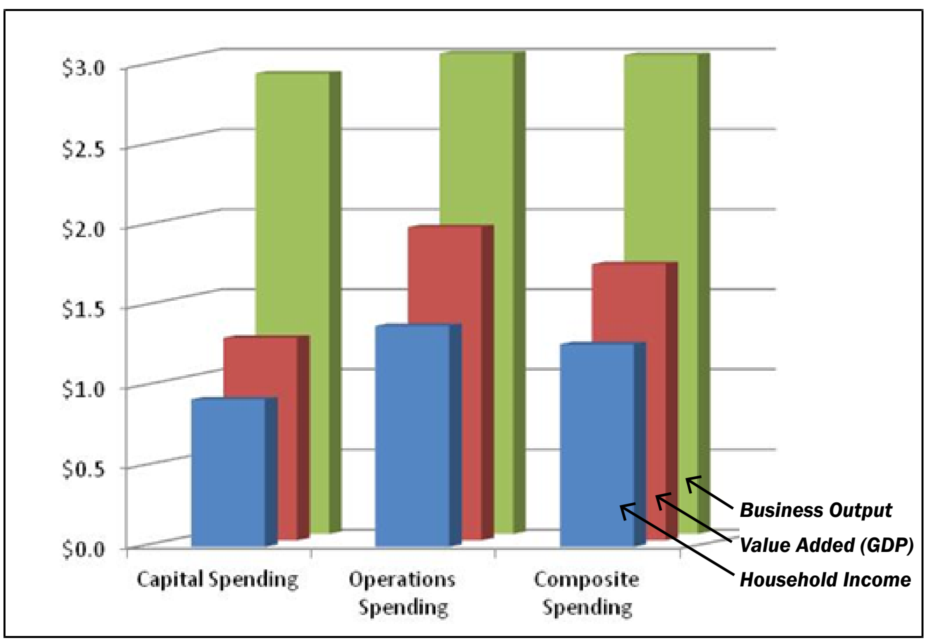
Exhibits 4-6 and 4-7 present the categories of economic impacts in terms of the results per billion dollars of investments or spending. The broadest measure is business output (sales volume), which shows an average of $3.00 impact per dollar of public transportation spending. The impact measure preferred by most economists is GDP (Gross Domestic Product, also referred to as "value added"), which shows an average of $1.70 of change per dollar of investment. GDP consists of labor income and net corporate profits. In addition, an average of 21,800 jobs are generated in the U.S. per billion dollars of investment. It is important to note that these numbers indicate the scale of short-term spending impacts on the economy and are not benefit-cost ratios (which focus on long-term project benefits).

Exhibit 4-6. Economic Impact of Spending on Public Transportation (includes direct, indirect and induced impacts per $1 Billion of spending)

Economic Impact	Per $ Billion of Capital Investment	Per $ Billion of Operations Investment	Per $ Billion of Average Investment
Output (Business Sales)	$2.9 billion	$3.1 billion	$3.0 billion
GDP (Value Added)	$1.3 billion	$2.0 billion	$1.7 billion
Labor Income	$0.9 billion	$1.4 billion	$1.3 billion
Tax Revenue (fed, state, local)	$266 *million*	$500 *million*	$432 *million*
Jobs (Employment)	15,900	24,200	21,800

Source: Calculations by EDR Group based on IMPLAN model, 2011 prices.

Exhibit 4-7. Ratios of Output, Value Added (GDP) and Income Impacts per Dollar of Public Transportation Investment



Source: Exhibit 4-6.

Tax Revenue Impacts. A breakdown of the corresponding tax revenue impacts of $1 billion of public transportation investment is shown in Exhibit 4-8. Almost three-quarters of these tax revenues are generated as a consequence of additional labor income; the rest is generated as a consequence of additional business activity.

Exhibit 4-8 Tax Revenues Generated per $1 Billion of Public Transportation Investment (in millions of 2011 dollars)

Tax Revenue Type	Federal Tax Revenues ($ Millions)	State & Local Tax Revenues ($ Millions)
Corporate Profits and Dividend Taxes	$ 31	$ 14
Personal Income Tax	$ 100	$ 40
Sales and Property Taxes	$ 0	$ 61
Social Security Contributions	$ 129	$ 26
Other Taxes and Fees	$ 12	$ 20
Subtotal	$ 271	$ 161

Grand Total Tax Revenues ($ Millions) **$ 432**

Source: Calculations by EDR Group based on IMPLAN model, 2011 prices.

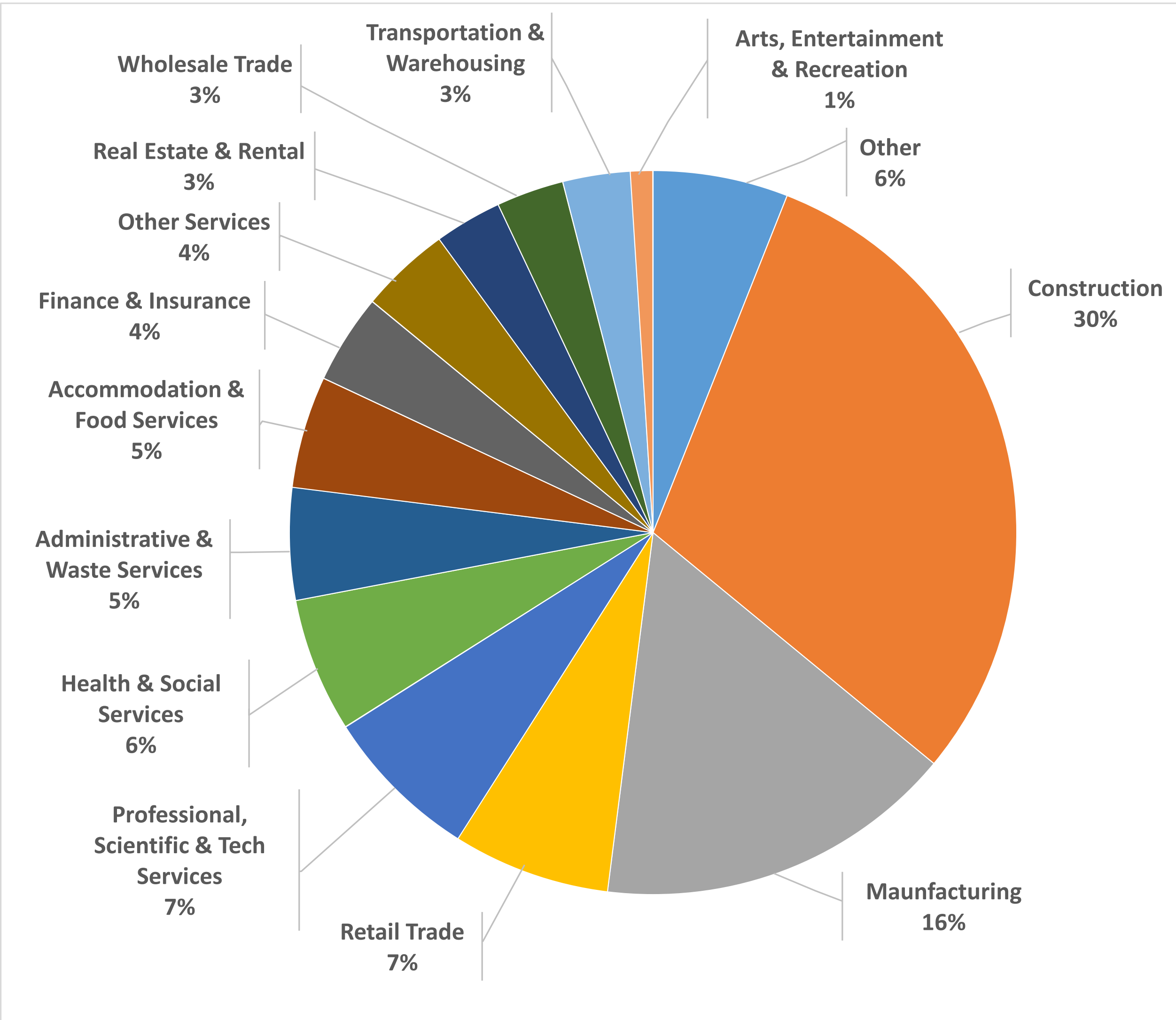
4.5 Impacts by Industry

Breakdown of Impacts by Industry. The job impacts shown earlier in Exhibits 4-6 and 4-7 can be further disaggregated in terms of industries and occupations. A breakdown of national job impacts by major industry group is shown in Exhibit 4-9 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 4-2). This has changed since the last APTA impact update study.
- The locally-made portion of those manufactured products and services – which in this case means the U.S.-supplied portion: 100 percent for ongoing public transportation operations plus 76 percent for buses, 87 percent for train rolling stock, and 81 percent 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. This effect changes from year to year as the average labor compensation per worker in each U.S. industry changes, and the input-output models reflect such changes.

Exhibit 4-9.
Jobs per $1 Billion of Public Transportation Capital Investment: by Industry



This chapter quantifies the economic effect of spending money on public transportation capital needs and operating expenses. To offer a more complete picture of total impacts on the economy, the final chapter of this report presents these stimulus effects along with the cost savings and productivity impacts calculated previously in Chapter 3.

5 Conclusion

Total Impacts on the Economy

Together, the results presented in Chapters 3 and 4 of this report show that there is significant economic gain available from increased transit investment, both from stimulus effects and from long-term effects on national productivity. Exhibit 5-1 presents the total impact of a scenario of enhanced public transportation ridership. These impacts are derived from two processes: (1) the effect of enhancing transportation system performance which affects household and business operating costs (portrayed in Exhibit 3-10), and (2) the effect of spending on purchases of vehicles, materials and construction activities (portrayed in Exhibit 4-6). The combined effect indicates that the impact on U.S. annual GDP can exceed $52 billion by year 20. That is over 3.7 times the annual investment in that year. The impact will be smaller in earlier years and potentially greater in later years.

It is important to note thatthe analysis in this report, including Exhibit 5-1, show the potential effect of additional investment in public transportation compared to not making any additional investment. These impact numbers do not incorporate any guess regarding how the money could otherwise be spent, though that must ultimately be a consideration in decision-making.

Exhibit 5-1. Total Scenario Impact (Annual Effect of Spending and Transportation Enhancement)
Difference between "Current Trend" Scenario and "Doubling Ridership" Scenario

Scenario Impact (Added investment of $14.2 billion per year)*	Impact of Investment Spending (A)	Impact of Transportation System Change (B)	Total
Value of Economic Impact	+ $23.8 billion/yr.	+ $28.5 billion/yr.	+ $52.3 billion/yr.
Wage	+ $18.2 billion/yr.	+ $21.8 billion/yr.	+ $ 40.0 billion/yr.
Job Equivalent (see note C)	+ 309,560	+ 410,820	+ 720,380
Corresponding Tax Revenue (see note D)	+ $6.0 billion/yr	+ $4.4 billion/yr	+ $10.4 billion/yr

* *All future-year dollar amounts are expressed in constant 2012 dollars*

(A) Calculated from Exhibit 4-6 effect per $1 billion of spending, factored up to reflect $14.2 billion
(B) From Exhibit 3-10
(C) The equivalent job benefit reflects the number of jobs typically associated with the change in business activity. At a national scale, actual job growth impacts will depend on the how the economic impacts lead to shifts in demand, cost-competitiveness, workforce availability and unemployment rate.
(D) Tax impacts are likely to be partially offset by reductions in sales of gasoline, cars, tires and taxable services associated with auto use.

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 by city and state. They include passenger fares, use of gas tax funds and various other local and state tax mechanisms including income and sales taxes. These costs may also 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 not 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.

Summary of Findings

Overall, investment in public transportation infrastructure and services can be expected to create economic efficiencies and job growth in the U.S. economy, both from the stimulus of transit outlays and the more efficient economic conditions associated with transit use. Moreover, the long-term economic payoffs for public transit investment exceed many other policy areas, including the likely effects of reduced taxation. Some of the specific findings of the current study include:

- The rate for federal funding of public transportation reflects a specific mix of capital investment and preventive maintenance funding as allowable by law. Under current federal law, an estimated 18,900 jobs are supported per billion dollars of spending.
- The national rate can vary from 13,859 to 24,211 jobs per billion dollars of spending, depending on the spending mix. The lower figure holds for spending on capital investments (vehicles and facilities), while the higher figure holds for spending on transit system operations. In reality, it is not logical to spend money on vehicles and not use them, nor is it logical to operate vehicles forever without any purchases of new equipment. For these reasons, the average rate is a more meaningful number.

- Looking across the total outlays for public transportation in the U.S. each year, there is an average rate of approximately 21,800 jobs per billion dollars of public transportation spending (i.e., 22 jobs per million dollars of spending). This figure is based on the national mix of public transportation spending as of 2011. It includes a direct effect of spending in transportation-related manufacturing, construction and operations, as well as orders to suppliers or by re-spending of worker income on consumer purchases.

- The rate of jobs supported per billion dollars of spending will continue to change every year, as prices change and technologies evolve.

- Public transportation is a cost-efficient industry, with capital costs of $1.52 per trip—when accounting for the trips that assets will serve over their full lifetimes.

- Households that are able to relinquish a car and transition to transit use in lieu of auto ownership can save approximately $10,103 per-year.

The findings show that the national economy needs dependable, efficient mobility options to continue a growth trajectory. They also show that there is significant economic gain available from a scenario of increased transit investment. In the long term, a program of enhanced investment sustained over 20 years will lead to an accumulation of significant benefits. These include:

- An economic impact (change in investment spending and long-term cost savings) that by the twentieth year is 3.7 times the amount being spent annually.

- An increase in income that, at current wage rates, is the equivalent of 50,731 additional jobs per $1 billion invested. Actual national job growth impacts will depend on the workforce availability and unemployment rate.

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