Economic and Community Benefits of Urban Fixed-Route Transit in Florida

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FDOT Project Manager

Diane Quigley

Transit Planning Administrator

Florida Department of Transportation

605 Suwannee Street, MS 26

Tallahassee, FL 32399

Phone: 850-414-4520

E-mail: diane.quigley@dot.state.fl.us

Prepared by

Sisinnio Concas, Ph.D. Senior Research Associate

Xuehao Chu, Ph.D. Senior Research Associate

Steve Polzin, Ph.D. Program Director

Center for Urban Transportation Research

University of South Florida

4202 E. Fowler Avenue, CUT 100, Tampa, Florida, 33620

Website: www.cutr.usf.edu

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Executive Summary

Many urban areas of Florida provide fixed-route transit services. Fixed-route services include motor bus available in 29 of Florida's 67 counties, automated guideway in Miami and Jacksonville, commuter rail in south Florida, heavy rail in Miami, and streetcar in Tampa. Fixed route transit directly supports 9,442 jobs and provides more than 134 million vehicle revenue miles of service with more than 255 million passenger boardings resulting in 1,336 million passenger miles of travel annually in recent years.

To provide input for the update of its Transit Strategic Plan the Florida Department of Transportation (FDOT) decided to analyze the benefits of urban fixed-route transit in Florida. This study updates an analysis of annual economic benefits of fixed-route transit conducted in 1997 and expands the analysis to include an estimation of community impacts. The economic benefits estimated here are traditionally called economic impacts, and the community impacts are traditionally called transportation benefits.

Fixed-route transit is an essential service. It fulfills many community needs, and helps the State meet a number of important public policy objectives. In addition to these community benefits, spending out-of-state funds (i.e., from sources outside Florida) on transit contributes to economic activity.

This study found that fixed-route transit makes significant economic contributions to the state of Florida and fulfills many community needs. While most of these economic and community benefits accrue to transit users and users of roadways affected by transit, additional economic and community benefits extend to the general population.

Economic Impacts

In the absence of fixed-route transit, approximately $186.2 million in capital expenditures and $83.1 million in operating expenditures from the federal government would not have come to Florida annually.[1] To the extent these federal funds would not have come to the state in the absence of transit in Florida, these funds are equivalent to an injection of new dollars into the state economy to purchase capital goods (rolling stock, construction of terminals, stations, equipment, and other facilities) and to purchase goods and services to maintain and improve the current system (driver payroll, purchase of fuel and tires, and other support services). When this spending across industries is considered, the cumulative impact to the Florida's

[1] All monetary amounts are reported in 2009 dollars unless otherwise indicated.

economy is $463.5 million in total economic output, 4,041 jobs, and $192.2 million in labor income per year.

Passengers who choose fixed-route transit over alternative modes (e.g., driving) enjoy the benefit of reduced travel costs. In the absence of fixed-route transit, transit patrons would have to choose to travel by other means (or not travel at all), facing increased travel costs, including vehicle ownership and operating costs, or costs associated with alternative modes. This study estimates that fixed-route transit generates about $537.1 million in passenger cost savings to transit users. These out-of-pocket cost savings are equivalent to an increase in household disposable income, which positively impacts the overall state economy. At the same time, these savings also reduce the demand for gasoline, tires, and other services, and this reduction in demand contributes to a reduction in overall economic activity. The net impact of these two opposite effects to the economy is a net increase of $159.7 million in total economic output, 250 jobs, and $64.1 million in labor income per year. Spending federal money on fixed route transit services in Florida has an impact on economic activity of approximately 2.3. This means that for every dollar invested economic activity increases by $2.30.

Fixed-route transit also provides congestion relief to highway users. The provision of fixed-route transit in Florida saves highway users about 3.84 million gallons of gasoline annually. This is equivalent to $12.7 million in reduced fuel costs. This is because in the absence of transit service many transit trips would be shifted to passenger vehicles, increasing congestion and excess fuel consumption. These savings in fuel costs represent money that can be used on other household expenditures, which contributes to the state economy. The net impact of fuel cost savings is estimated to generate $9.3 million in total output, 127 jobs, and $5.3 million in labor income per year.

These economic impacts represent the increased economic activity in the state due to federal spending on transit and cost savings to transit and highway users. These impacts do not include potential increases in long-term economic activity in the state due to the many transportation-related benefits of fixed-route transit. These include changes in accessibility that increase productivity levels or changes that lower the cost of doing business in certain areas of the state.

Community Benefits

In addition to affecting the flow of dollars in the State’s economy, the provision of fixed-route services produces benefits to users and the general population in terms of reduced travel delays, improved reliability, improved traffic safety, and reduced emission of air pollutants. Annually, fixed-route transit in Florida:

- Saves highway users 6.6 million hours in congested travel conditions.
- Saves 42.9 million gallons of petroleum oil. These savings are equivalent to fuel used by 72,600 passenger vehicles traveling 12,000 miles annually at 20.3 mpg.
- Saves $146.1 million for transportation disadvantaged (TD) programs as trips are shifted from paratransit to fixed route transit. In the absence of these savings annual operating expenses of these TD programs in Florida would need to increase almost 39 percent to meet demands.
- Reduces traffic fatalities by 66 and traffic injuries by 2,599 for all roadway users annually by shifting trips to transit and reducing automobile trips. These reductions are equivalent to 2.1 percent of all traffic fatalities and 1.2 percent of all traffic injuries annually in Florida.
- Reduces carbon monoxide (CO) emissions by 9,980 tons, volatile organic compounds (VOCs) emissions by 284 tons, and carbon dioxide (CO_2) emissions by 254,556 tons.

Fixed-route transit represents an essential means of transportation for the transit-dependent population. Consisting primarily of low income individuals and persons with disabilities, the transit-dependent population represents two thirds of the urban fixed-route transit market. This study finds that:

- Fixed-route transit meets a three times larger share of the mobility needs of the transit-dependent population than the rest of the general population.
- The transit-dependent population makes 27.7 percent of their transit trips for shopping and errands.
- The transit-dependent population makes 10.4 percent of their transit trips for medical and dental services.
- Fixed-route transit is three times as important as all other modes combined in helping the transit-dependent population travel to work and work-related locations.
- Fixed-route transit is twice as likely to be used to access medical and dental services by the transit-dependent population as the rest of the general population.

Finally, this study finds that fixed-route transit directly contributes to improving the health conditions of Floridians. Transit users walk or bike to and from transit walk and bike for 128 minutes weekly, which is close to the minimum 150 minutes per week of moderate to vigorous physical activity recommended by the U.S. Surgeon General.

These benefits accrue even though transit use in Florida is only about 1 percent of person trips. Greater use of transit in Florida could provide opportunities to realize increased benefits.

Additional benefits not quantified in this study include:

- Providing mobility for the general population.
- Providing travel choices for residents and visitors.
- Increasing property values due to transit oriented development.

1. Introduction

1.1 Background Information

Many urban areas of Florida provide fixed-route transit services. Fixed-route services include motor bus operations in 29 of Florida's 67 counties, automated guideway in Miami and Jacksonville, commuter rail in south Florida, heavy rail in Miami, and streetcar in Tampa. These services provided more than 134 million vehicle revenue miles with more than 255 million passenger boardings resulting in 1,336 million passenger miles of transit travel annually in recent years.

Table 1.1 summarizes the amount of services provided (vehicle revenue miles) and services consumed (boardings and passenger miles traveled) during 2006-2008.

1.2 Study Objectives

To provide input for the update of its Transit Strategic Plan and to support the FDOT Districts and transit agencies with marketing, advertising and promoting transit nationally and locally, the Florida Department of Transportation (FDOT) decided to analyze the benefits of urban fixed-route transit in the state.

1.3 Report Organization

The following chapters report the results and the methods, data, and estimation procedures used for each of the economic and community benefits estimated in this report. Chapter 2 discusses the estimation approach. Chapter 3 details the estimation method, data and results of the economic impact of federal spending and the highway and transit users' savings. Chapter 4 discusses the methods, data sources and results of the community benefit analysis. Chapter 5 summarizes the results and compares Florida's estimate to national figures.

Table 1.1 Fixed-Route Services Provided and Consumed in 2006-2008

Company Name	*Vehicle Revenue Miles*	*Boardings*	*Passenger Miles Traveled*
Bay County Transit (*Bay Town Trolley*)	1,318,608	1,100,623	6,173,188
Board of County of Commissioners (*PalmTran*)	21,227,526	29,288,527	169,081,037
Broward County Transportation Department (*BCT*)	49,997,383	122,347,480	534,076,920
Central Florida Regional Transportation Authority (*LYNX*-Orange, Osceola, and Seminole Counties)	42,651,124	76,374,285	448,120,178
City of Ocala (*SunTran*)(1)	745,255	645,372	2,119,602
City of Tallahassee (*StarMetro*)	5,265,058	12,682,713	23,658,315
Collier Area Transit (*CAT*)	3,175,623	3,399,041	12,319,657
Council on Aging of Martin County, Inc. (*Community Coach*)	74,736	63,506	257,619
Council on Aging of St. Lucie, Inc. (*Treasure Coast Connector*)	647,741	282,917	2,088,555
County of Volusia, dba: *VOTRAN*	7,671,739	9,333,565	43,517,161
Escambia County Area Transit (*ECAT*)	4,358,306	3,352,028	16,034,702
Gainesville Regional Transit System (*RTS* - Alachua County)	8,315,751	26,506,546	83,844,217
Hernando County Board of County Commissioners (*THE Bus*)	930,971	987,338	3,140,453
Hillsborough Area Regional Transit Authority (*HART*)	21,633,813	38,744,724	191,778,159
Indian River Transit (*GoLine*)	733,941	329,312	236,133
Jacksonville Transportation Authority (*JTA* - Duval County)	29,830,381	32,709,094	176,484,435
Lake County Board of County Commissioners (*LakeXpress*)(2)	380,424	138,281	697,738
Lakeland Area Mass Transit District (*Citrus Connection* - Polk County)	4,255,555	4,667,560	24,501,419
Lee County Transit (*LeeTran*)	8,985,612	8,988,005	46,473,308
Manatee County Area Transit (*MCAT*)	3,265,450	4,736,832	20,254,894
Miami-Dade Transit (*MDT*)	134,087,227	329,847,567	1,635,703,912
Okaloosa County Board of County Commissioners (*The Wave*)	1,348,138	489,123	2,348,418
Pasco County Public Transportation (*PCPT*)	3,022,893	2,874,637	19,103,623
Pinellas Suncoast Transit Authority (*PSTA*)	26,973,734	35,163,067	170,406,883
Polk County Transit Services Division	2,139,429	1,761,030	5,835,982
Sarasota County Area Transit (*SCAT*)	6,328,307	6,398,269	32,458,118
South Florida Regional Transportation Authority (*Tri-Rail*-Broward, Miami-Dade, Palm Beach Counties)	8,523,986	10,877,085	317,556,598
Space Coast Area Transit (*SCAT* - Brevard County)	3,513,525	3,156,578	16,487,276
St. Johns County Transit (*Sunshine Bus*)	768,941	257,417	1,853,621
2006-2008 Total	***402,171,148***	***767,626,239***	***4,008,151,746***
Annual Average	***134,057,049***	***255,875,413***	***1,336,050,582***

Source: Tabulated from the National Transit Database through the Florida Transit Information System.

(1) Ocala/Marion County SunTran did not report to NTD for 2008, as it received a reporting waiver from NTD.

(2) Lake County Express transit service did not report to NTD until 2007.

2. Study Approach

2.1 Introduction

The term *economic impact* is used extensively by public and non-profit sector organizations to describe and quantify the economic activities attributable to an organization and its investments. To fully appreciate the term economic impact, it is important to differentiate between economic value and economic impact. In simple terms, economic value is created when a product or service is consumed within a specific region's geographic boundary; however, an economic impact occurs when products or services consumed are produced wholly or partially by labor and industries located within this geographic boundary.

Investment in transportation infrastructure can affect a region's economy in two ways: 1) through the spending pattern of the purchases of goods and services, and 2) through cost savings and business productivity changes that might be realized as investments improve the current transportation network. These impacts can be estimated using input-output (I-O) accounting tables. These tables, developed to track interrelationships within the economy, produce multipliers that are used to compute the total direct, indirect and induced effect on jobs, output, and income impacts generated per dollar spent in the respective area.

While economic impacts encompass a wide range of effects across many sectors of a region's economy, there are other factors that, although not directly affecting the flow of dollars in the economy, could have a relevant contribution in fostering economic growth. These benefits include travel time savings, and changes in health and safety costs, such as pollution emission costs and accident costs. While some travel time savings can impact the flow of income generated in the economy depending upon the purpose of travel (business versus personal), the reduction of pollution emissions and accidents creates a value that does not directly affect the economy. This study estimates the value to the users and distinguishes it from the economic impact analysis results. These benefits are usually directly incorporated into other assessments, such as in a benefit-to-cost ratio project prioritization or evaluation.

The following sections detail the study's approach to estimate economic impacts and community benefits.

2.2 Analysis Approach

This study updates the analysis of the annual economic benefits of fixed-route transit conducted in 1997, "An Analysis of the Economic Impacts of Urban Transit Systems on Florida's Economy," which estimated the impacts of:

- federal spending,
- savings to transit users, and
- savings to highway users.

In addition, this study expands the 1997 analysis to include estimates of transit's community benefits, including:

- reduced delays to highway users,
- reduced emission of air pollutants and CO_2,
- reduced fatalities and injuries,
- savings in petroleum oil,
- savings to transportation-disadvantaged programs,
- increased level of physical activity to transit users, improved mobility for the transit-dependent population

It also comments on other benefits not included in the estimation activities in this work:

- Improved mobility for the general population
- Increased travel choices
- Increased property values from Transit Oriented Development

The evaluation of transit investments traditionally focuses on specific individual projects. Increasingly, however, evaluation is done at the aggregate level. One example at the national level is “Economic Impacts of Public Transportation Investment" conducted for the American Public Transportation Association by Weisbrod and Reno [1]. An example of a state-level evaluation is the 1997 CUTR study mentioned above. Another recent example of state-level evaluation is “Economic and Community Benefits of Local Bus Transit Service (Phase Two)” for the Michigan Department of Transportation by HDR|Decision Economics [2]. At a regional level, the study for Hillsborough Area Regional Transit in Florida is a recent example [3].

It is common for such studies to estimate transit's gross benefits without considering the possible benefits of alternative uses of public funds spent on transit. An example at the national level is the Weisbrod and Reno study [1]. An example of gross benefits calculated at the state level in Florida is the 2009 version of “Economic Impacts of Florida's Transportation Investments - A Macroeconomic Analysis” for FDOT. Nonetheless, estimates of net benefits provide highly useful input to the public decision-making about transit investments.

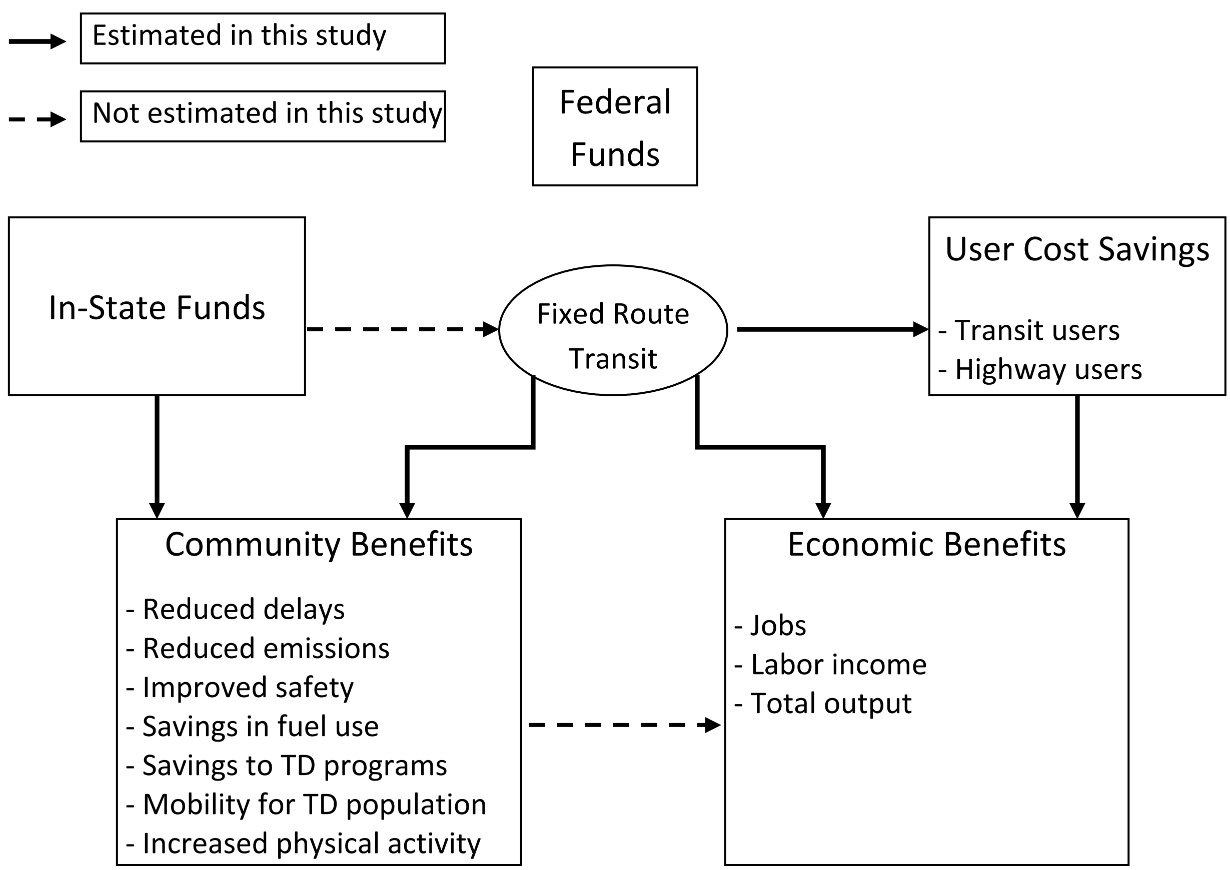
Many of the previous studies estimated the benefits of public transit in terms of planned investment programs for new services or expanded services for a period of years in the future. For example, the 2009 version of “Economic Impacts of Florida's Transportation Investments - A

Macroeconomic Analysis" focuses on a five-year work program. A number of previous studies, however, estimate the benefits of public transit in terms of actual investment during an historical period, typically one year. The 1997 CUTR study mentioned above is an in-state example and a recent out-of-state example is the HDR|Decision Economics study [2].

The 1997 CUTR study and a number of other previous studies include a particular benefit called changes in consumer's surplus for transit users. When measured appropriately, this benefit of public transit includes not only out-of-pocket savings and time savings in monetary terms, but also the positive value of reduced emission of air pollutants, improved traffic safety, increased physical activity, and other benefits to transit users. Since FDOT desires to have these community benefits estimated separately, this study does not include changes in consumer's surplus for transit users as a measure of transit benefits to avoid double counting.

Figure 1.1 provides a description of the study's approach. The report looks at economic benefits with capital and operating expenditures and community benefits associated with changes in travel behavior by existing and new public transit users. Travel behavior changes, to the extent that they affect the flow of dollars in the economy (i.e., user cost savings), can produce additional and ongoing economic impacts.

Figure 1.1 Study Approach



2.2.1 Estimation of Economic Impacts

Impacts of Federal Spending

This report estimates the economic impact of capital investment and operation spending on urban fixed-route transit in Florida. Economic impacts are measured in terms of job creation and contributions to gross domestic product growth due to the direct investment in capital purchases and direct purchases for ongoing operations. Impact estimates include indirect and induced effects. Indirect effects refer to all impacts associated with industries supplying goods and services to all other industries producing transit vehicle and capital equipment. Induced effects refer to the impacts associated with income generated by the workforce employed in the public transportation sector. Direct, indirect and induced effects are estimated using input-output (I-O) multipliers. In this report, the input-output multipliers for Florida come from the IMPLAN model of the Minnesota IMPLAN Group [4].

There are two approaches to estimate the impacts generated by spending. The first approach, defined as *gross impact analysis*, assumes that all capital and operating expenditures (federal, state, and local) would not occur if fixed-route transit services were not available to the state. These unspent resources would not be diverted to other sectors of the economy, resulting in a loss of economic activity. The second approach, defined as *net impact analysis*, considers the sources of funds used for capital and operating expenditures and assumes the possibility the spending and economic activity in the absence of deployment in one area may be diverted to other areas or sectors of the economy. This study follows the latter approach, the net approach, and only considers the portion of funds that are assumed to not come to the state in the absence of fixed-route services. The methodology assumes state and local funds (or in-state funds), if not spent on transit, would still be spent in other sector of the state economy sustaining jobs and economic activity. Therefore, the analysis only considers the effects of federal funds spent on transit in Florida.

Savings to Transit and Highway Users

This study estimates the direct and induced impacts of reduced household vehicle operating costs produced by a reduction in workers' commute travel times. Public transportation can reduce congestion and allow households saving on out-of-pocket costs to operate and maintain vehicles. These savings are equivalent to a reduction in the cost of living (i.e., an increase in household disposable income) that can result in direct and induced impacts on the flow of dollars within the area.

2.2.2 Estimation of Community Benefits

The impact of public transportation investment spans beyond the contribution to the local economic dynamics produced by capital and operating expenditures. In the absence of public transportation services and without changes in terms of capacity expansion and improvement to roads, highway users would be negatively affected by spending excessive amounts of time in congested conditions resulting in potential income losses. Thus, public transportation provides relief to the transportation network, saves time during congested periods, and reduces vehicle operating expenses. This study considers the following community benefits:

- Travel time savings (commute)
- Vehicle operating costs
- Accident cost savings
- Emission cost savings
- Savings to coordinated transportation disadvantaged programs
- Mobility benefits to the transit-dependent population
- Benefits generated by increased physical activity.

Except the savings to coordinated transportation disadvantaged programs, these travel benefits are also defined as direct user benefits, since they measure gains in personal utility associated with improved travel conditions. The utility associated with these benefits can be given a monetary value, which is usually referred to as willingness to pay. In the case of travel time, the willingness to pay measures the amount of money an individual would be willing to pay to avoid spending one additional minute in traffic. To the extent that community benefits generate a change in the flow of dollars in the local economy, their economic impact is not assessed in terms of contribution to economic growth. Most importantly, these benefits enhance the quality of life in Florida, which is beneficial in attracting new businesses, residents and visitors to the state and creating additional economic benefits.

2.2.3 Other Economic Benefits

This study does not consider the long run impact stemming from travel time improvements, in terms of changes in labor and capital productivity, and does not consider impacts due to increased market accessibility.

Changes in business productivity stem from travel time improvements affecting the movement of goods and services in the impact area. In an urban area, worsening congestion can lead to substantial increases in commercial vehicle travel time. This can induce businesses to reallocation of resources between capital and labor, loss of competitiveness, and in some cases, relocation outside the congested area. Transportation investments directed at reducing congestion can result in increased market accessibility and can also have agglomerative effects.

An improved transportation network might affect business and household relocation decisions. Improved travel time and reliability of travel might incentivize new businesses to locate within the impact area and existing businesses to reap the benefits of improved market accessibility. Lower commuting travel time might influence households' decisions to relocate from other areas, thus affecting labor and real estate markets.

A theoretical and empirical framework to evaluate additional benefits from congestion reduction has been formalized by the National Cooperative Highway Research Program (NCHRP) Project 2-21 [5]. This project sought to develop a framework to estimate the cost of congestion to businesses in U.S. cities and urban areas. The framework goes beyond the usual method of accounting for user expense and travel time cost savings. The research effort produced Report 463, which provides a framework to account for the direct and indirect productivity costs associated with travel time variability, worker time availability and all effects that congestion imposes on freight travel, just-in-time production processes, and market accessibility.

As part of the direct costs, the framework recognizes that businesses absorb part of the direct travel costs of all business-related travel, including the value of time for drivers. All other costs related to congestion that do not directly affect the cost of doing business are defined as indirect costs. This includes the effect that congestion might have on the attractiveness of an area that can reduce business activity. This can include increased emissions levels generated by increased congestion, which can undermine the livability of an area and affect labor force participation. Congestion, by negatively affecting freight travel time and travel time reliability, induces business to substitute between labor and capital inputs. Report 463 provides a framework for the empirical estimation of the relationship between business activity and congestion levels by applying the concept of elasticity of substitution with respect to travel time changes. These elasticities measure the extent to which businesses might be willing to pay a premium for specialized goods, services, and labor.

Tailoring the approach to business productivity impact estimation detailed in Report 463 would require detailed freight traffic data at a highly disaggregated level that is beyond the scope of this study.

2.2.4 Other Community Benefits

There are other benefits from transit that are beyond the scope of this study effort. Some of these benefits are indirect benefits or secondary benefits resulting from the accessibility provided by transit and others are subtle or involve complex and difficult to quantify impacts. Among the more commonly cited other benefits are:

- Improved mobility for the general population
- Increased travel choices
- Increased property values from Transit Oriented Development

Each of these benefits is briefly described in detail in this report.

3. Economic Impacts

This chapter describes in detail the methods, data, and estimation procedures used for each of the economic impacts estimated in this report. The following benefits are considered:

- Impacts of federal spending
- Impacts of savings to transit users
- Impacts of savings to highway users

3.1 Impacts of Federal Spending

This section describes the analytical approach used for estimating the impacts associated with spending of federal funds that would not have come to the state in the absence of fixed-route transit services. The assumption that these federal funds would be lost to Florida is because they are formula funds based on service and existing ridership. Also, discretionary funds would presumably not be received in the absence of fixed route service. If all states eliminated transit, and the federal funds to support transit were no longer collected, Florida would have a large net benefit as it is a significant donor state to the public transit account.

3.1.1 Methodology

The net impact analysis follows the approach developed in the CUTR 1997 study to estimate the economic impact of new federal funds [6]. The first step is to estimate the portion of federal funds (including capital and operating funds not coming to the state in the absence of fixed-route transit service. Then, the estimated federal capital and operating funds are disaggregated by expenditure type and entered into an input-output (I-O) model. The I-O model estimates how the flow of these dollars in the state economy has an impact on employment, output, and income levels.

Economic impacts relate to changes in economic activity resulting from changes in local spending brought about by investing in public transit services. Thus, the direct impact of capital and operating expenditures is defined as the initial change in output, or gross sales that would occur in the impact area as a result of spending these dollars. To be considered as an impact, the change must occur within boundaries of the impact area and result solely from federal funds expenditures.

The injection of federal dollars into the state economy can directly support jobs in construction, specialized services required for planning, and maintenance services. It also stimulates the purchase of other products and services that lead to further impacts on economic activity.

This study employs four measures of economic impacts:

1. Employment. This type of impact represents the creation (or support) of jobs in the impact area. Total employment consists of annual average full-time and part-time employees working in a given sector of the local economy.
2. Total output. Total industry output measures the value of production of goods and services by businesses in the local economy. Generally, total industry output is equivalent to total business sales plus what businesses place into (or remove from) inventory. Total output measures how the region's economy would be affected by the direct impacts generated by the federal expenditures.
3. Value added. Total value added is equivalent to Gross Domestic Product. It is a subset of total output as it measures total output minus the cost of labor and materials. Total output is analogous to the definition of Gross Domestic Product, as identified by the Bureau of Economic Analysis [7], and measures only the value of final goods and services. In economic analysis, value added is the preferred impact measure of contribution to economic growth generated by investments.
4. Labor income. Total income includes employee compensation and other income. Total employee compensation represents the total payroll costs, including wages and salaries, paid to workers by employers, as well as benefits such as health and life insurance, retirement payments, and non-cash compensation. Total other income includes income generated by self-employed individuals, corporate profits, payments for rents, royalties and dividends, as well as profit generated by corporations. Labor income represents an important share of a region's total income.

The concepts of direct and indirect impacts are widely used in this study. Direct investment in capital infrastructure results in a demand for spending in the economy directly affecting the demand for goods and services of businesses. These businesses rely on other businesses to purchase inputs. Indirect impacts measure the economic activity of the businesses involved in the production of goods and services due to the first businesses' production of goods and services. The wages of construction and other sector workers of primary and secondary businesses generate additional retail sales for businesses, resulting in additional induced impacts. Indirect and induced impacts can also be generated by changes in household spending patterns spanning from improvements in the transportation network (i.e., household cost savings).

This study makes use of the IMPLAN Input-Output model to generate I-O tables and multipliers. IMPLAN and the associated datasets are supported by the IMPLAN Group, based in Minnesota [4]. IMPLAN is a widely used, nationally recognized input-output economic impact model that has been used to evaluate the impact of public transportation at the national level [1] and in other studies evaluating transit economic impacts at the local and regional levels [8].

The IMPLAN I-O model estimates changes in the total local economic activity caused by some economic change in the area. In this analysis, the economic activities associated with the expenditures of new federal dollars require the purchase of goods and services from the local economy. The purchases of goods and services cause changes in the overall economic activity. The I-O model provides estimates of this new level of overall economic activity. As an example, when a business purchases goods from a second business, the first business is helping support the second. The I-O model can estimate all levels of activity supported by the first business.

3.1.2 Data Sources

The National Transit Database (NTD) provides information on capital and operating expenditures by federal sources for each of the 28 fixed-route transit operators [9]. Given yearly variation of these expenditures, a three-year average of capital and operating expenses covering the period 2006-2008 was estimated.

Capital Expenditures

NTD Table 07 reports capital funds for each fixed-route transit agency for the following categories:

- Capital Program
- Urbanized Area Program
- Other FTA
- Other USDOT
- Other Federal

In line with the assumptions of the 1997 study, this analysis assumes that only funds received under the Federal Transit Administration (FTA) and from other USDOT grant programs would not come to the state in the absence of fixed-route service. All other federal sources are assumed to still come to the state and are not considered to have an impact on the flow of dollars of the economy.

The annual average of capital expenditures from 2006 through 2008 amounts to $186.2 million (in 2009 dollars). The capital expenditures must be disaggregated by expenditure type for purposes of applying appropriate multipliers. NTD Table 11 provides a breakdown of capital expenditures in the following categories:

- Guideway
- Stations

- Administrative Buildings
- Facilities
- Rolling Stock
- Other Vehicles
- Fare Revenue Collection Equipment
- Systems
- Other

To obtain expenditure shares for the above categories, three-year average expenditures were obtained and then applied to the $186.2 million in federal capital expenditures. Table 3.1 shows the breakdown of capital expenditures by spending category.

Table 3.1 Average Annual Capital Expenditures of New Federal Dollars

(Thousands of 2009 dollars)

Expenditure Category	Amount ($, 000)	*Share*
Guideway	48,447	0.26
Stations	19,472	0.10
Administrative Buildings	3,799	0.02
Facilities	23,302	0.13
Rolling Stock	69,545	0.37
Other Vehicles	1,303	0.01
Fare Revenue Collection Equipment	7,768	0.04
Systems	8,802	0.05
Other	3,743	0.02
Total	**186,181**	**1.00**

Source: Tabulated from National Transit Database for 2006-2008.

Before using these figures for impact estimation, some assumptions and restrictions about their use must be made because not all of the above expenditures generate an impact in the state. Some of the planned expenditures to purchase goods, such as rolling stock and other vehicles, are sourced from outside the state and will not generate an impact in Florida. Table 3.2 reports the total expenditures that are assumed to have a direct impact in the state.

Table 3.2 Capital Expenditures Considered for Impact Analysis

(Thousands of 2009 dollars)

Expenditure Type	*Amount*
Guideway, Stations, Administrative Buildings and Facilities	$ 95,020
Fare Revenue Collection Equipment	7,768
Systems	8,802
Other	3,743
Total	***$ 115,333***

Source: Table 3.1.

Operating Expenditures

Estimates of federal operating expenditures were obtained using NTD Table 03 (Federal Government Sources for Transit Operating Funds Applied). In the calculation of the three-year average, funds from the FTA Urbanized Area Formula Program are considered as new federal dollars that would not come to the state under the no-transit services scenario. All other funds are assumed to come to the state in the absence of transit services and are not included in the three-year average estimate of $83.1 million. Using expenditure breakdowns from NTD Table 13, the federal portion of operating expenditures were disaggregated by spending category, as shown in Table 3.3.

Table 3.3 Average Annual Operating Expenditures of New Federal Dollars

Expenditure Type	*Expenditures (thousands)*	*Share*
Operator Wages	$ 16,019	0.19
Other Salaries & Wages	15,628	0.19
Fringe Benefits	13,767	0.17
Services	7,459	0.09
Fuel and Lube	7,346	0.09
Tires and Other	6,293	0.08
Utilities	1,450	0.02
Casualty and Liability	1,706	0.02
Services Purchased	12,156	0.15
Other	1,264	0.02
Total	***$ 83,089***	***1.00***

Source: Tabulated from the National Transit Database for 2006-2008.

3.1.3 Estimation and Results

This study uses the 2008 IMPLAN accounting tables to build the I-O model to reproduce the economic activity of the entire state of Florida. The accounting tables provide the baseline model upon which to estimate changes in the demand for goods and services generated by the federal funding expenditures. Before running the model, the dollar figures of Table 3.2 and Table 3.3 were adjusted to constant 2008 dollars (same year as the IMPLAN dataset).

Using the 2008 North American Industrial Classification System (NAICS), expenditures are assigned to specific industry sectors and then matched to the corresponding IMPLAN I-O model industry sector.

Table 3.4 summarizes direct, indirect, induced, and total impacts in terms of output, income and employment. Total impacts on output are about $463.5 million and represent the total production of goods and services in the state produced by the total expenditures of new federal dollars. Total industry output measures the value of the production of goods and services by businesses in the local economy. Generally, total industry output is equivalent to total business sales plus what businesses place into (or remove from) inventory.

Table 3.4 Cumulative Impacts by Type

	Impact Category			
Impact Type	*Employment*	*Labor Income (thousands)*	*Value Added (thousands)*	*Output (thousands)*
Direct	1,980	$ 102,526	$ 116,078	$ 198,422
Indirect	539	26,851	40,185	77,325
Induced	1,522	62,849	109,065	182,337
Total	***4,041***	***$ 192,225***	***$ 265,328***	***$ 463,460***
Multipliers	20.4	1.0	1.3	2.3

Source: CUTR analysis using 2008 IMPLAN for Florida.

Notes: The multipliers are derived as follows:

- *Employment: 4,041 jobs /$198.422 million = 20.4 jobs per million dollar*
- *Labor Income: $192,225/$198,422= $0.97 per dollar invested; rounded to $1.0*
- *Value Added: $265,328/$198,422= $1.34 per dollar invested; rounded to $1.3*
- *Total Output: $458,084 (based on revised total: see below)/$198,422= $2.34 per dollar invested; rounded to $2.3*

The total impact on value added (or GDP) is $265.3 million. Value added measures the value of gross profits and is a measure of wealth created by the injection of transit federal funds. Federal funds spent on capital and operating expenditures also will generate about $192.2 million in wages and other income and support a total of 4,041 jobs.

The output multiplier value of 2.3 is calculated by dividing total output ($463,460) by the sum of total capital expenditures of Table 3.2 ($115,333) and total average annual operating expenditures of Table 3.3 ($83,089). The output multiplier relates the changes in sales to final demand by one industry to total changes in output (gross sales) by all industries within the local area. This means that for every dollar invested in transit capital and operating expenditures, economic activity, as measured in gross industry sales, increases by $2.30. The employment multiplier measures the total number of jobs supported for each $1 million dollar of federal capital and operating expenditures.

A breakdown of job impacts by major industry group is shown in Figure 3.1 and Figure 3.2. The impact on jobs depends on the mix of capital and operating expenditures. Given that 58 percent of the expenditures are dedicated capital and 42 percent to operating expenditures, the impact on employment differs in terms of industry sectors.

Figure 3.1 Capital Expenditures Employment Impact by Industry

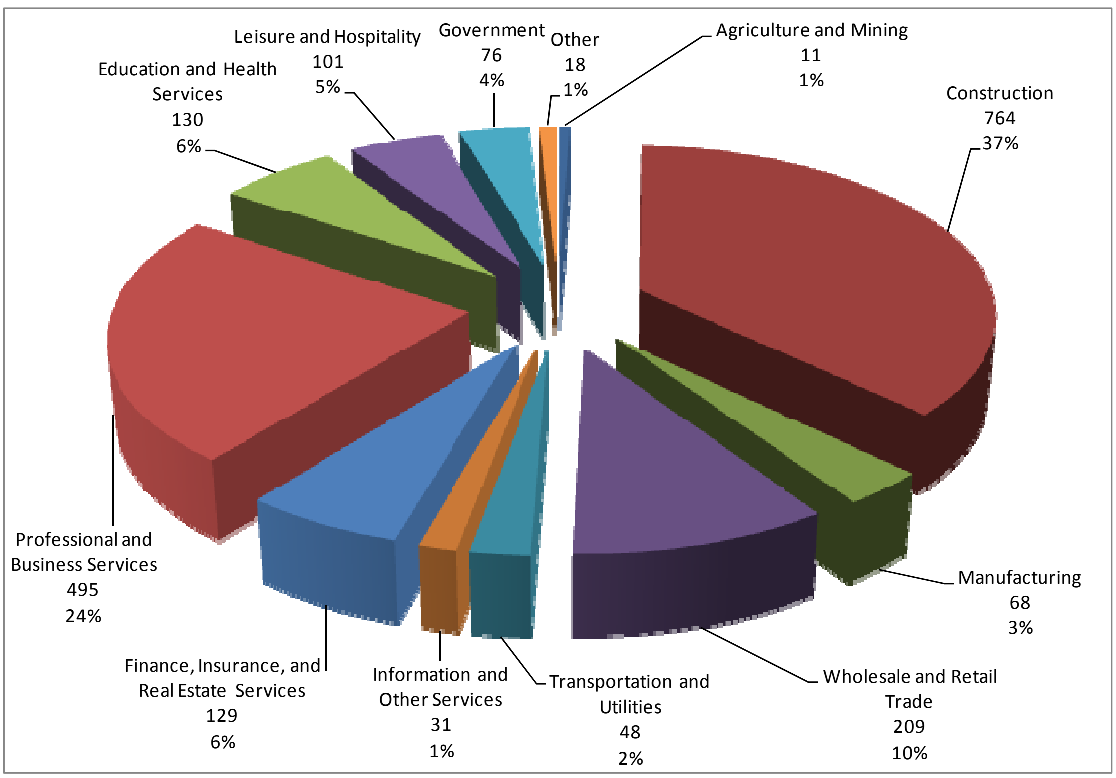
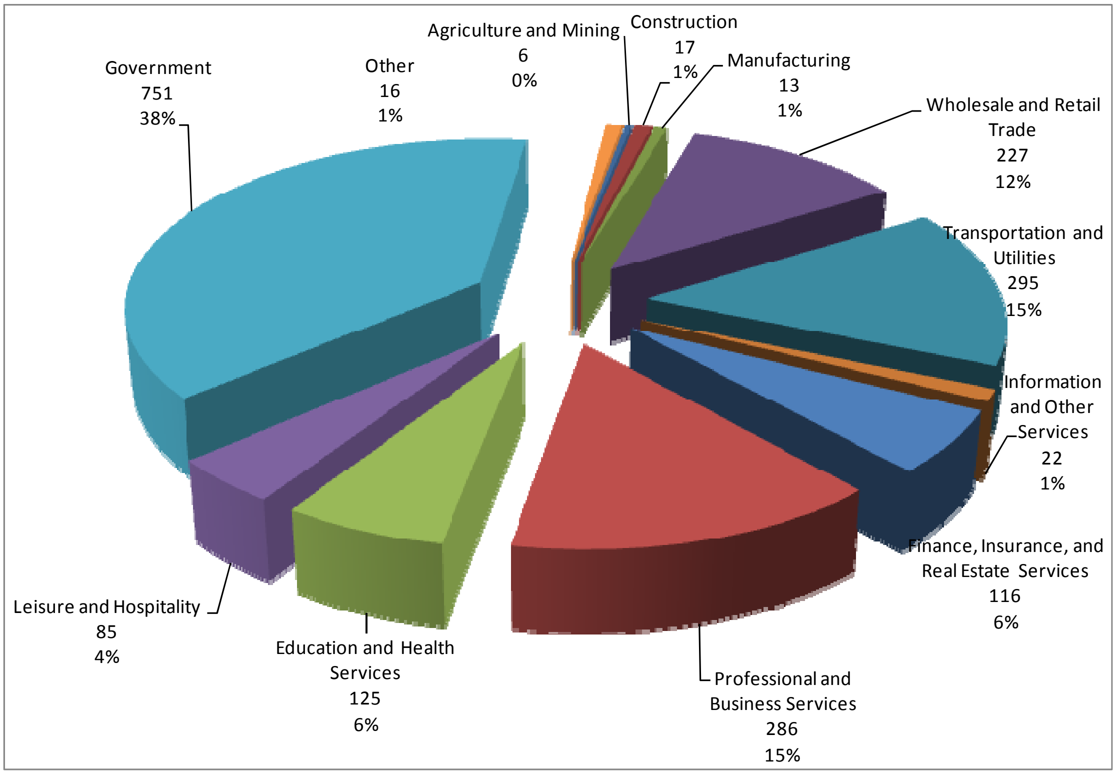


Figure 3.2 Operating Expenditures Employment Impact by Industry



The economic impact of capital expenditures spills over mainly to the construction sector, with direct and induced effects that support employment in other industries, such as professional and business services, wholesale and retail trade, and finance and insurance services. The impact of operating expenses is mainly concentrated in the government sector (public transportation), with indirect and induced effects in the profession and business service, wholesale and retail sectors and the transportation sector. This is because public transit agencies allocate a sizable component of their operating expenditures to the purchase of third-party transportation services.

3.2 Impacts of Savings to Transit Users

Passengers who choose public transportation over alternative modes enjoy the benefits of reduced travel costs. In the absence of public transportation, these passengers would choose to travel by other means and face increased travel costs, including vehicle ownership and operating costs, and/or costs associated with other alternative modes of travel. Out-of-pocket cost savings directly translate into economic impacts as the money saved is spent on other goods and services leading to overall increased economic activity. Economic input-output (I-O) modeling techniques are used to estimate direct, indirect, and induced impacts related to out-of-pocket cost savings. This section details the estimation method used to determine the impact of passenger cost savings, the source of data, and relevant assumptions.

3.2.1 Methodology

This analysis defines cost savings as the difference between the cost of using public transportation and the cost of using other alternative modes. These include the cost of using automobiles, the cost of carpooling, and the cost of using paratransit services and other purchased transportation such as taxicabs. The amount of these savings can be considered as an increase of disposable income that can be used to purchase goods and services. The portion of this purchase of goods and services that impacts the flow of dollars within the state's economy generates indirect and induced impacts.

Total passenger cost savings (*CS*) are equal to

$$CS = \sum_{i}^{k} (P_i - P_T) Q_i$$

where $i, \ldots, k$ is the alternative mode, P_i is the per trip cost of using mode i, P_T is the per-trip cost of public transportation, and Q_i the number of shifted trips by mode made in the absence of transit. The difference between the cost of using an alternative mode and the cost of using transit $(P_i - P_T)$, produces the cost saving per trip made. Multiplying the cost savings per trip made by the total number of trips made by each mode *i*, produces the total cost savings of public transportation. Summing the cost savings across all alternative modes produces the total cost savings (*CS*).

The calculation of passenger cost savings depends on how travelers would change mode in the absence of transit service, by switching to car, carpooling, or other forms of motorized travel, bike, and walking. Alternative mode share estimates are first obtained and then applied to the total number of 2006-2008 unlinked passenger trips to obtain the number of shifted trips by mode.

Multiplying the unit trip cost savings by the total number of shifted trips by mode produces the total household cost savings. The above equation relies on the assumption that trips made by transit and trips made by alternative modes in the absence of transit have equal distance.

Finally, the total cost savings are allocated within the economic impact I-O model to produce estimates of indirect and induced impacts. Relevant assumptions related to how cost savings are treated within the I-O model are discussed in the estimation section.

3.2.2 Data Sources

Data for this analysis comes from several sources. Data on the total number of unlinked passenger trips and average trip length were obtained from the 2006-2008 National Transit Database (NTD). For the 28 fixed-route transit agencies considered in this analysis, the 2008 NTD reports a total of 263,441,596 trips and an average passenger trip length of 5.31 miles for their fixed-route services.

Mode shifting estimates are usually obtained by asking transit passengers what alternative they would choose in the absence of transit services. This analysis uses on-board travel survey data. Given that the surveys cover different periods, data were weighed using the 2008 NTD unlinked passenger trips as weights. Table 3.5 reports these results.

Table 3.5 Mode Shift Estimates from On-Board Survey Data

	Mode Shift (percent)						
Mode	*Drive*	*Ride*	*Bike*	*Walk*	*Taxi*	*No Trip*	*Other*
Weighted Average	18.9	30.9	7.7	15.9	8.4	15.7	2.5

Source: CUTR analysis of tabulated on-board survey data from individual transit agencies in Florida.

Driving costs were obtained from the American Automobile Association [10]. Table 3.6 reports the cost breakdown. To estimate the cost of wear and tear, the AAA annual ownership cost estimates were divided by the 2009 NHTS average total annual vehicle miles of travel per private vehicle (10,710 miles). Average vehicle occupancy rates were obtained from the Florida sample of the 2009 NHTS.

Table 3.6 Automobile Cost Estimates

Driving Costs†	*Cost ($/mile)*	*Share*
Operating Costs		
Gasoline	0.11	15.66%
Maintenance	0.05	6.26%
Tires	0.01	1.14%
Ownership††		
Full coverage Insurance	0.10	13.27%
License, registration, taxes	0.05	7.53%
Depreciation	0.33	45.75%
Finance charge	0.08	10.38%
Total	***0.73***	***100.00%***

† *Source: AAA," Your Driving Costs," 2009.*

††*Assuming 10,710 annual VMT per vehicle.*

The cost of using a taxi was estimated by using maximum chargeable fares set by county and city ordinances in major urban areas across the state. Most cities in Florida regulate taxicab services in terms of supply and prices. City and county ordinances regulate the total number of taxicab permits to be issued at regular intervals, as well as the minimum and maximum fares that can be charged to customers. Some cities set fixed rates for certain destinations (usually between airport and central business district). The fare consists of a fixed amount the customer pays to enter the taxicab (initial flag), which covers a portion of the initial mile traveled. Charges are then applied to a mile portion. Using a sample of regulated locations in the state, Table 3.7 reports the estimated $15.94 cost per trip that public transportation users would pay in the absence of transit services, assuming a 5.31 mile-long trip.

Table 3.7 Trip Cost Estimates of Using Taxicabs

Location	*(Initial Flag)*	*Initial Distance (Mile)*	*Mile Portion*	*Additional Portion of Mile*	*First Mile*	*Additional Mile*	*Per Trip*[†]
Broward County	$2.50	1/6	1/6	$0.40	$4.50	$2.40	$16.23
Orlando	$3.75	1/4	1/4	$0.45	$5.10	$1.80	$13.65
Tampa	$2.00	1/5	1/5	$0.45	$3.80	$2.25	$14.74
Miami	$2.50	1/6	1/6	$0.40	$4.50	$2.40	$16.23
Sarasota	$2.25	1/10	1/10	$0.22	$4.19	$2.15	$14.59
Tallahassee	$2.50	1/5	1/5	$0.50	$4.50	$2.50	$16.77
Jacksonville	$1.75	1/10	1/10	$0.30	$4.45	$3.00	$19.37
						Average	***$15.94***

[†]Based on a 5.31 mile-long trip.
Source: CUTR analysis.

3.2.3 Estimation and Results

Cost savings were obtained by subtracting the unit trip cost of transit from the unit trip cost of each of the alternative modes. Table 3.8 reports these estimates and the parameters used in the calculation. For example, using an average trip length of 5.31 miles, the unit trip automobile cost is equal to $3.85. The rideshare trip cost of $1.38 is obtained by dividing the auto trip cost for single occupancy by the 2.78-person average vehicle occupancy rate for multi-occupancy.

Table 3.8 Per Trip Cost Estimates

Parameters	*Unit*
Average Transit Trip Length (miles)	5.31
Taxi Trip Cost	$15.94
Auto Trip Cost (single occupancy)	$3.85
Rideshare Occupancy (number)	2.78
Rideshare Trip Cost (multi occupancy)	$1.38
Average Transit Fare ($/trip)	$0.68
Total Unlinked Passenger Trips	255,875,413

Source: CUTR analysis.

Table 3.9 reports the cost savings per trip as the difference between the cost of using an alternative mode and the cost of using transit. Total passenger cost savings are obtained by multiplying per-trip savings by the estimated shifted trips.

Table 3.9 Total Passenger Cost Savings Estimates

Mode	*(1)* *Share*	*(2)* *Trips*[†]	*(3)* *Trip Cost*	*(4)* *Savings per Trip*	*(5)* *Total Savings (2) x (4)*
Auto	18.90%	48,362,761	$3.85	$3.17	$153,431,269
Rideshare	30.92%	79,123,040	$1.38	$0.71	$56,053,205
Taxi	8.39%	21,459,279	$15.94	$15.26	$327,571,880
Bike	7.65%	0	$0.00	$0.00	$0
Walk	15.89%	0	$0.00	$0.00	$0
No Trip	15.74%	0	$0.00	$0.00	$0
Other	2.48%	0	$0.00	$0.00	$0
Total	***1.00***	***148,945,081***			***$537,056,354***

[†] *Based on 255,875,413 unlinked passenger trips (NTD, 2006-2008)*

Next, the estimated $537.1 million in passenger cost savings are treated as a change in disposable income within the economic input-output (I-O) model. Before running the I-O model, the following issues were taken into consideration:

- allocation of cost savings to households
- reduction in demand for goods and services due to passenger cost savings
- treatment of taxicab trip savings

In this analysis, household cost savings are distributed among households based on their transit usage levels by income level obtained from the 2006-2008 American Community Survey. Table 3.10 reports the allocation of the $537.1 million cost savings to households within the I-O model.

Table 3.10 Passenger Cost Savings Allocation

Income Level	*Transit Use*[†]	*Household Cost Savings*
(<$10k)	28.16%	$151,239,404
($10-15k)	19.67%	$105,661,102
($15-25k)	26.91%	$144,543,194
($25-35k)	11.28%	$60,598,154
($35-50k)	7.46%	$40,058,591
($50-75k)	3.73%	$20,041,162
($75k+)	2.78%	$14,914,747
Total	***100.00%***	***$537,056,354***

[†]*Source: U.S. Census Bureau, 2006-2008 American Community Survey*

This approach takes into account that households with higher incomes spend their income differently than lower income households (i.e., marginal propensity to consume differs).

Relevant to the analysis is the consideration that while passenger cost savings are usually considered an increase in disposable income, the current practice for economic impact analysis of public transportation does not explicitly consider that passenger cost savings produce a reallocation of expenditure patterns within an economy (see, for example, Weisbrod and Reno [1]). Savings in automobile operating and ownership costs should be treated not only as an increase in disposable income, but also as a reduction in the demand for goods and services within an economic impact model. When passengers save in gasoline, tires, and other services, they are demanding less of those goods and services within the impact area, contributing to a reduction in overall economic activity. If not explicitly accounted for, this results in an overestimation of economic impacts of passenger cost savings.

The issue becomes more relevant in the case of the cost savings associated with taxicab services. Table 3.9 shows that 61 percent of the passenger cost savings are generated by transit users who, in the absence of transit, would be riding a taxi. This means that in the absence of public transportation taxicab services would be facing an increase in demand with ripple effects on the overall economy. The impact is even more relevant considering that taxicab services are assumed to be fully reaped locally (i.e., a 100 percent direct reduction in the economic activity associated to $327.6 million).

This study assumes that in the absence of public transportation, the taxicab industry would not be able to fully absorb the increase demand of shifted trips. This study treats the taxicab industry as a regulated industry with a relatively inelastic supply and assumes that the industry would be able to absorb two thirds of the shifted trips in the absence of transit.

This assumption is consistent with the nature of the taxicab industry. In Florida, major urban areas regulate both market supply and prices. Usually, the supply of taxicab services is regulated by fixing the maximum allowable number of permits based on population ratios. Hillsborough County, for example, sets the number of taxi permits at 1 for every 1,900 inhabitants. Any change to this cap would go through the Public Transportation Commission, making natural market adjustments very difficult, at least in the short term.

Following the previous assumptions, Table 3.11 reports the estimated reduction in the demand for goods and services faced by each industry sector.

Table 3.11 Estimated Reduction in Consumer Demand

Industry	*Change in Demand*
Retail Services: Gasoline Stations	-$32,811,234
Retail Services: Maintenance and Parts	-$15,510,240
Finance and Insurance Services	-$49,540,902
License, registration, taxes	-$15,776,499
Taxicab Services	-$228,050,552
Total	***-$341,689,426***

Source: CUTR Analysis

Next, the increase in household disposable income and the decrease in demand of goods and services are distributed among households and industry sectors to produce the indirect and induced impacts.

Table 3.12 shows that the overall employment impact is 250 jobs. This is because transit services absorb part of the demand that would otherwise be satisfied by taxicab services. This is equal to a reduction in the number of direct and indirect jobs needed to support the taxicab industry sector.

Table 3.12 Economic Impact of Passenger Cost Savings

Impact Type	*Employment*	*Labor Income*	*Value Added*	*Output*
Direct Effect	-4,209	-$111,183,728	-$164,891,396	-$278,112,238
Indirect Effect	-716	-$32,471,504	-$49,929,259	-$90,870,442
Induced Effect	5,175	$207,746,642	$374,476,695	$634,443,967
Total Effect	***250***	***64,091,410***	***159,656,040***	***265,461,287***

Source: CUTR Analysis using 2008 IMPLAN for Florida

On the other hand, household savings have a positive employment indirect and induced impact on a broad range of industry sectors characterized by higher productivity per labor. Ultimately, this has a positive effect on the state gross domestic product ($159.7 million), which is greater than the decrease in economic activity faced by those industry sectors of Table 3.11. The total impact on gross business sales is about $265.5 million, with an increase in labor income of about $64.1 million, supporting 250 jobs.

3.3 Impacts of Savings to Highway Users

The provision of public transportation services in congested conditions can improve transportation capacity, producing congestion relief benefits in terms of travel time savings and other benefits, such as reduction in the amount of wasted fuel, and emission reductions. This section details the method, data, and estimation procedures used to estimate cost savings and time savings to highway users.

3.3.1 Methodology

This study defines congestion relief benefits to highway users as the change in peak-period traveler costs generated by the provision of public transportation services. Congestion benefits include the time savings accrued to existing users, as well as vehicle fuel cost savings.

The analysis adopts the methodology used in the Texas Transportation Institute's (TTI) "Urban Mobility Report" [11]. The report estimates the impact of additional traffic on the existing roadway network that would be imposed in the absence of public transportation services. The approach assigns public transportation ridership to a specific roadway functional class according to the type of service provided by that mode. Accordingly, transit vehicle-miles of travel from commuter rail are assigned to freeways, and all other modes are assigned based on the proportion that already is present in the roadway. Assignment to peak period travel is based on the percentage of transit travel occurring in the peak period. A detailed description of the methodology is presented in Appendix B of the "Urban Mobility Report."

This study assumes that the congestion benefits estimated by TTI capture most of the benefits generated by fixed-route public transportation for the state. This is because the report provides estimates of changes in congestion for seven large urban areas in Florida, capturing 92 percent of the state ridership (1.37 million passenger miles) supplied by the 28 fixed-route agencies (1.48 million passenger miles) analyzed in the present study.

Next, the TTI travel time savings and fuel cost savings estimates are monetized to quantify the total congestion relief benefits. Travel time savings include the value of personal and commercial travel. Fuel costs savings account for vehicle fuel efficiency under congested conditions.

Finally, the indirect and induced economic impacts associated with fuel costs savings are estimated. This is because fuel cost savings are treated as a change in disposable household income that can be spent towards purchasing other goods and services.

While this study estimates the impact of congestion by estimating changes in travel times and vehicle fuel costs, it does not consider the long-run impact stemming from public transportation in terms of changes in labor and capital productivity and does not consider impacts due to increased travel time reliability and market accessibility.

Changes in business productivity costs stem from travel time improvements affecting the movement of goods and services in the impact area. In an urban area, worsening congestion can lead to substantial increases in commercial travel time. This can induce businesses to capital and labor substitution, loss of competitiveness, and, in some cases, relocation outside the congested area. Transportation investments directed at reducing congestion can result in increased market accessibility and also can have agglomerative effects. An improved transportation network might affect business and household relocation decisions. Improved travel time and reliability of travel might incentivize new businesses to locate within the impact area and existing businesses to reap the benefits of improved market accessibility. Lower commuting travel time might influence households' decisions to relocate from other areas, thus affecting labor and real estate markets.

A theoretical and empirical methodology to evaluate additional benefits from congestion reduction has been formalized by the National Cooperative Highway Research Program (NCHRP) Project 2-21 [12]. This project sought to develop a methodology to estimate the cost of congestion to businesses in U.S. cities and urban areas. The methodology goes beyond the usual method of accounting for user expense and travel time cost savings. The research effort resulted in NCHRP Report 463, which provides a methodology to account for the direct and indirect productivity costs associated with travel time variability, worker time availability, and all effects that congestion imposes on freight travel, just-in-time production processes, and market accessibility.

As part of the direct costs, the methodology recognizes that businesses absorb part of the direct travel costs of all business-related travel, including the value of time for drivers. All other costs related to congestion that do not directly affect the cost of doing business are defined as indirect costs. This includes the effect that congestion might have on the attractiveness of an area that can reduce business activity and can include increased emission levels generated by increased congestion, which can undermine the livability of an area and affect labor force participation. Congestion, by negatively affecting freight travel time and travel time reliability, induces business to substitute between labor and capital inputs. NCHRP Report 463 provides a methodology for the empirical estimation of the relationship between business activity and congestion levels by applying the concept of elasticity of substitution with respect to travel time changes. These elasticities measure the extent to which businesses might be willing to pay a premium for specialized goods, services, and labor. Tailoring the approach to business productivity impact estimation detailed in Report 463 would require detailed freight traffic data at a highly disaggregated level that is beyond the scope of this study.

3.3.2 Data Sources

Estimates of changes in congestion and fuel consumption levels in the absence of public transportation services were obtained from the 2009 "Urban Mobility Report [13]." Travel time savings and fuel savings estimates may be downloaded from the TTI's Urban Mobility Report website, http://mobility.tamu.edu/ums/congestion_data/tables/ complete_data.xls.

Data on average gasoline (for all formulations) price for sale to end users were obtained from the U.S. Energy Information Administration[14].

The value of travel time delay was obtained by updating the "Urban Mobility Report" estimates for 2007 to 2009 dollars (estimated at $15.47 per hour of person travel and $102.12 per hour of truck time). Note that the value of personal travel time savings is equal to the opportunity cost of time spent in a motor vehicle for work or non-work related purposes – time that could be spent on other activities, such as leisure, family time, or more work.

3.3.3 Estimation and Results

Table 3.13 reports the estimated of travel time and fuel savings. The TTI column is directly from the TTI report, while the adjusted column results from an adjustment to the TTI values for Florida. The TTI values are based on a nationwide assumption that every 100 transit passenger miles foregone would result in 80 new vehicle miles; but the available data from transit on-board surveys and the 2009 NHTS for Florida show that 38.5 miles of new vehicle travel are likely to be created. The adjustment factor is given by the ratio of 38.5 over 80 = 0.48125.

Table 3.13 Travel Time and Fuel Saving

Category	*TTI*	*Adjusted*
Annual Delay (1,000 hours)	13,688	6,587.3
Wasted Fuel (million gallons)	7.97	3.84

Source: 2009 "Urban Mobility Report," Congestion Data for Your City.

Multiplying the 2009 unit cost of fuel of $3.31 (retail price, all grades) by the 3.84 million gallons of wasted fuel produces $12.71 million in fuel cost savings. The TTI estimates of travel time savings associated with the 6.6 million hours reduction in annual delay amount to about $102.1 million. These estimates include the value of personal and commercial travel time.

Transit services can reduce congestion and allow saving on out-of-pocket costs to operate and maintain vehicles. These savings are equivalent to a reduction in the cost of living (i.e., an increase in household disposable income) that can result in direct and induced impacts on the flow of dollars within the state. In this context, the 3.84 million gallons of fuel saved by transit are equivalent to an increase in household disposable income of $12.71 million. This is income that can be spent towards purchasing other goods and services.

Gasoline and non-fuel operating cost savings due to reduced travel times and improved travel conditions are equivalent to changes in personal disposable income for other goods and services. The reallocation of this consumer spending across all sectors within the impact area is proportionate to the baseline consumer spending on these categories of goods and services and to the proportion of transit users by income cohort. This approach recognizes that baseline consumer spending depends on household income levels. This impact is net of the reduction in gasoline sales resulting from the gallons saved due to congestion improvements discussed in this section.

Gasoline cost savings result in an estimated additional $15.9 million in annual total output and $9.3 million in additional GDP with the support of 127 jobs per year. These estimates represent the additional indirect and induced effect generated by increased household disposable income.

3.4 The Economic Contribution of the Transit Share of ARRA Funds

In response to the recent economic downturn, in February 2009 the federal government passed the American Recovery and Reinvestment Act (ARRA). The objective of the $785 billion stimulus package was to promote economic activity by increasing domestic spending on several sectors, including public transportation.

As part of this study, CUTR researchers were asked to report the contribution of ARRA funds in terms of job creation and support at the state level. These funds are not considered as part of the federal annual transit allocations received each year in Florida. ARRA funds were awarded as part of an economic stimulus package for a single instance and based on the discretion of the federal government.

Since ARRA came into effect, FTA has awarded 1,072 grants totaling about $8.78 billion, including FHWA funding, which support about 10,000 jobs nationally [15]. Between February 17, 2009 and September 30, 2010, Florida was awarded a total of $11.02 billion in contracts, grants, and loans, which funded 173 transit projects totaling $316 million [16]. Table 3.14

reports the breakdown of the FTA awarded ARRA funds by grant project type. According to the act, the ARRA funds can be used only for capital projects and no local share is required [17]. However, some funds later were allowed to be used for operations. Accordingly, table 3.14 shows that most of the ARRA funds (68.8%) go to capital investment and vehicle and equipment purchase (22.0%).

Table 3.14 Transit ARRA Funds by Grant Type (millions)

Grant Project	***Enhancement Funds***	***Flexible Funds***	***Local Funds***	***Transit Assistance & Fixed Guideway***	***Transit Systems Rural Funds***	***Total***
Capital for Fixed Route	$0	$0	$2,264	$228,806	$1,528	$232,597
Fixed Guideway Improvements	$0	$0	$0	$3,214	$0	$3,214
Operating for Fixed Route	$0	$0	$0	$1,975	$897	$2,872
Operating and Administrative Assistance	$0	$0	$0	$2,694	$180	$2,874
Public Transportation Shelter	$0	$0	$2,623	$1,250	$2,300	$6,173
Purchase of Vehicles and Equipment	$0	$0	$0	$61,242	$13,048	$74,290
Transit Facility Security	$0	$0	$0	$116	$0	$116
Transit Improvement	$0	$0	$0	$15,790	$0	$15,790
Total	***$0***	***$0***	***$4,887***	***$315,088***	***$17,952***	***$337,927***

Source: FDOT Office of Work Program
http://www2.dot.state.fl.us/fmsupportapps/workprogram/AmericanRecoveryReinvestmentAct.aspx?FILE=SUMMARY

Table 3.15 shows ARRA funds and job hours created or sustained in Florida through September 30, 2010. Recipients of ARRA funds are already required to report direct, on the project job hours sustained to the U.S. House Committee on Transportation and Infrastructure. The reported data are summarized in the monthly State and Formula Program Table available at http://transportation.house.gov/. This table summarizes statewide data as reported by individual recipients on spending and sustained job-hours during the first year of ARRA implementation and during each reporting month. The summary data in this table represent ARRA funds from the Transit Capital Assistance Program. There are three other ARRA transit programs at the national level - Fixed Guideway Infrastructure Investment, Capital Investment Grants, and Supplemental Discretionary Grants for a National Surface Transportation System. Florida will not receive any funding from the Capital Investment Grants Program. The vast majority of ARRA funds go to the Transit Capital Assistance Program.

Table 3.15 ARRA Funds and Job Hours in Florida through September 30, 2010

Measures	***Dollars***	***Job Hours***
Funds Allocated	$323,287,614	
Funds Obligated	$266,186,603	
Funds Outlayed	$89,428,275	
Funds Associated with Projects under Contracts	$145,634,724	
Funds Associated with Projects which work has began	$124,863,328	
Funds Associated with Completed Projects	$48,289,203	
Job Hours Created or Sustained		768,963

Source: State and Formula Program Table at http://transportation.house.gov/

Direct job hours include jobs provided by grant recipients, prime contractors, sub-contractors, and second-tier contractors, and are defined as all jobs billed directly to the projects. Jobs not billed directly to the projects, such as those associated with the off-site production of equipment, vehicles, or construction materials (such as steel or concrete) should not be counted. The Committee then converts these job hours to job months by assuming that every 173 job hours represent a job month. To determine the total number of job months, including direct, indirect, and induced benefits of ARRA funds, the Committee assumed that an expenditure of $7,667 creates one FTE job month ($92,000 creates one FTE job year).

4. Community Benefits

Consistent with several recent national studies, this study includes community benefits in addition to the economic impacts associated with fixed-route transit. These benefits are not easily calculated or captured, but still have significant value to the mobility and quality of life to residents and visitors in Florida. This chapter describes the method, data, and estimation procedures for each of the following community benefits:

- Energy savings
- Emission reduction
- Safety benefits
- Savings to TD programs
- Mobility benefits to the transit-dependent population
- Increased physical activity for transit users

It also comments on the following non quantified benefits:

- Improved mobility for the general population
- Increased travel choices
- Increased property values from Transit Oriented Development

4.1 Energy Savings and Emission Reduction

The United States under its current energy policies highly depends on imported oil. Geo-political instability in the various oil-rich regions in the world seriously threatens to interrupt the supply of imported oil or sharply increases its price. Fixed-route transit can potentially play a meaningful role in reducing our dependence on imported oil.

One cost of consuming energy for transportation is the emission of pollutants and greenhouse gases (http://www.epa.gov/oaqps001/urbanair/). Emission of pollutants can harm your health and the environment, and cause property damage. Volatile organic compounds (VOCs) and nitrogen oxides (NOx) combine with sunlight to form ozone. Breathing ozone can trigger a variety of health problems including chest pain, coughing, throat irritation, and congestion. It can worsen bronchitis, emphysema, and asthma. Carbon monoxide (CO) is a poisonous gas that reduces the body's ability to transport oxygen to organs and tissues, and interferes with learning. Elderly people, children and adults with respiratory conditions are particularly vulnerable. Particulate matter or PM, is a complex mixture of extremely small particles and liquid droplets. The size of PM is directly linked to their potential for causing health problems. Most harmful is those that are 10 micrometers in diameter or smaller (PM_{10}) because they are the ones that can pass through the throat and nose and enter the lungs. Once inhaled, PM_{10} can affect the heart and lungs and cause serious health effects.

In addition to potentially reducing the emission of these pollutants, fixed-route transit can also potentially reduce the emission of carbon dioxide (CO_2), a major greenhouse gas that contributes to climate change.

This section describes how this study estimated savings in oil and reductions in carbon dioxide (CO_2) and four air pollutants, including particulate matters 10 micrometers or less (PM_{10}), carbon monoxide (CO) , nitrogen oxide (NOx), and volatile organic compounds (VOCs).

4.1.1 Methodology

Fixed-route transit has the potential to reduce the use of petroleum oil and the emission of air pollutants (PM_{10}, CO, NOx, and VOCs) and CO_2 through at least the following three sources:

- Land use effect - The presence of fixed-route transit has the potential to affect the location of land uses, and these changes in land use can potentially influence travel behavior, particularly the amount of travel by private vehicles. To the extent that this land use effect of transit results in reduced vehicle travel, transit can save energy use and reduce emissions.
- Displaced VMT – The presence of fixed-route transit would like to have attracted some of the passenger miles currently traveled via transit from passenger vehicles. This shift of travel from passenger vehicles to transit saves energy use and reduces emissions.
- Congestion relief effect - The congestion relief to highway users results from the modal shift of transit users from motor vehicles. To the extent that this congestion relief reduces energy use by private vehicles, transit would save energy and reduce emissions.

Subtracting the energy used and emissions generated by transit services from the sum of the reduced energy use and emissions from these three sources gives an estimate of transit's net energy savings and emission reductions.

4.1.2 Data Sources

The main data for the analysis are emission factors (Table 4.1). Two sets of emission factors are distance-based (measured in grams per mile), while the other five sets are volume-based. Four of the five sets of volume-based factors are measured in grams per gallon and one set in grams per megawatt hour for electrical rail.

Table 4.1 Emission Factors by Base Type, Fuel Type, and Air Pollutants

Base	*Fuel Type*	PM_{10}	*CO*	*NOx*	*VOCs*	CO_2
Distance-Based	Diesel Bus (grams/mile)	0.32	3.56	12.68	0.40	2,350.50
	Gasoline passenger Vehicles	0.02	5.86	0.55	0.20	368.40
Volume-Based	Diesel Bus (grams/gallon)	1.01	11.23	40.04	1.28	7,423.46
	Diesel Rail (grams/gallon)	2.78	30.83	109.8	3.50	20,374.36
	Bio-Diesel Bus (grams/gallon)	0.91	10.00	40.84	1.02	7,423.46
	CNG Bus (grams/pound)	0.03	2.92	16.81	0.64	7,423.46
	Gasoline Passenger Vehicles	0.50	119.00	11.23	3.98	7,478.52
	Electrical Rail (grams/megawatt hour)	30.00	1,772.1	17.37	137.99	741,619.6

Source: compiled by CUTR from various sources as explained in the text.

The distance-based emission factors for both diesel bus and gasoline passenger vehicles are derived from MOBILE6.2.03 for Florida as a whole. MOBILE6 is an emission factor model for predicting grams per mile emissions of Hydrocarbons (HC), Carbon Monoxide (CO), Nitrogen Oxides (NOx), Carbon Dioxide (CO2), Particulate Matter (PM), and other pollutants from cars, trucks, and motorcycles under various conditions. All VMT is assigned to the arterial/collector roadway type for all hours of the day and all vehicle types. An average speed of 25.5 mph is used for all hours of the day. In addition, average temperatures and default parameters under low altitude are used. The MOBILE model was US Environmental Protection Agency's official model for estimating air pollution emissions from cars, trucks, and motorcycles until it was replaced by its new model called MOVES.

The volume-based emission factors are obtained as follows:

- *Diesel Bus* - The volume-based emission factors for diesel buses were converted from the distance-based emission factors for diesel bus using an average fuel efficiency of 3.16 mpg in Florida. The average fuel efficiency is derived from 2006-2008 data in the NTD. Because the NTD contains fuel use by fuel type but only total bus miles traveled for all fuel types, the fuel efficiency is based on data on diesel fuel used and bus miles traveled for transit agencies that used diesel only for their bus services.
- *Diesel Rail* - The volume-based emission factors for diesel rail were extrapolated from the volume-based emission factors for diesel bus using the ratio of fuel efficiency values between diesel bus and diesel rail. Tri-Rail was the only agency that operated diesel rail from 2006 to 2008. The 2008 NTD data for Tri-Rail indicate an average fuel efficiency of 1.1507 mpg, which gives a ratio of 2.7446.
- *Bio-Diesel Bus* - The volume-based emission factors for bio-diesel buses were extrapolated from the volume-based emission factors for diesel bus using information

on percent reduction. Figure 2 and Table 2 of Schiavone [18] show percent reduction for PM, CO, and NOx. The CO_2 emission factor is assumed to be the same as for diesel bus, while the VOCs emission factor is assumed to be 80 percent of that for diesel bus.

- *CNG Bus* - The volume-based emission factors for CNG buses were extrapolated from the volume-based emission factors for diesel buses using information on percent reduction. Percent reduction over diesel bus for PM_{10} (97%), CO (84%), and NOx (58%) is derived from Table A6.1 in World Bank [19]. A 50 percent reduction is assumed for VOCs. In addition, it is assumed that the fuel economy for CNG is 25 percent lower than that for diesel, based on Table 9 of Chandler et al. [20]. Finally, the CO_2 emission factor for CNG is the same as for diesel.
- *Gasoline Passenger Vehicles* – The volume-based emission factors for gasoline passenger vehicles were converted from the distance-based emission factors for passenger vehicles using an average fuel efficiency of 20.3 mpg for passenger vehicles from the U.S. Environmental Protection Agency [21].
- *Electrical Rail* - The sources of emission factors for electrical rail vary for CO_2 and across the air pollutants. For CO_2, it is converted from an average factor of 1,635 pounds per megawatt hour from Florida [21]. For PM2.5, it is based on an assumed factor of 30 milligrams per kWh from the University of California Energy Institute [22], which is then converted to 30 grams per MWh. The same factor is used for PM_{10}. For the other air pollutants, it is from Table 16b in Shapiro et al. [23].

4.1.3 Estimation and Results

The estimation for each of the four components described in the method section is discussed separately below.

Land Use Effect

To capture the land use effect of fixed-route transit, this analysis uses the estimated indirect effect of fixed-route transit on daily vehicle miles traveled per household from Bailey et al. [24]. This analysis is based on the following steps:

1. Availability of rail and bus in Florida. Bailey et al. [24] measure rail availability and bus availability as follows, where distance is to the closest station for rail and to the closest line for bus:

$$\text{Rail Availability} = \frac{1.223}{1 + e^{2\cdot(\text{distance}-0.75)}}$$

$$\text{Bus Availability} = \frac{1.135}{1 + e^{8\cdot(\text{distance}-0.25)}}$$

Based on the Florida sample of the 2001 NHTS, average rail availability = 0.0267 and bus availability = 0.3549.

2. Daily reduction in VMT per household. Bailey et al. [24] estimate that the indirect effect of transit on daily household VMT is -5.185 for rail and -0.764 for bus. Applying these estimates to the availability values for rail and bus, respectively, gives an estimated average daily reduction of 0.41 vehicle miles traveled per household.

3. Annual VMT reduction. The estimated number of households in Florida is 7,080,705 from the 2006-2008 dataset of the American Community Survey. Applying the average daily reduction to the total number of households and multiplying by 365 give an estimate of the annual VMT reduction of 1,058,550,043.

4. Emissions from the reduced VMT. Multiplying the annual VMT reduction by the distance-based emission factors for passenger vehicles in Table 4.1 gives the annual emissions associated with the land-use effect in row 1 of Table 4.2.

5. Fuel used. Multiplying the annual VMT reduction by the fuel efficiency of 20.3 mpg for passenger vehicles gives 52,145,322 gallons of gasoline shown in row 1 and column 6 of Table 4.2. The average fuel efficiency of 20.3 mpg is from EPA [21].

Table 4.2 Reduced Emissions and Energy Savings

Components	*Air Pollutants (short tons)*				*CO_2 (short tons)*	*Petroleum Oil (gallons)*
	PM_{10}	*CO*	*NOx*	*VOCs*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
(1) Land use effect	28.6	6,840.0	645.3	228.7	429,868.2	52,145,322
(2) Displaced VMT	13.9	3,325.1	313.7	111.2	208,973	25,349,606
(3) Congestion relief	2.1	503.3	47.5	16.8	31,632	3,837,185
(4) Fuel used by transit	49.9	688.5	1,867.8	72.3	415,918	38,417,234
(5) Net benefits	***-5.3***	***9,979.9***	***-861.4***	***284.4***	***254,556.3***	***42,914,879***

Source: CUTR analysis.
Note: A positive value in row (5) represents a reduction or a benefit, while a negative value represents an increase. These estimates suggest that fixed-route transit reduces emission of CO, VOCs, and CO_2, but increases emission of PM_{10} and NOx. However, transit agencies in Florida have been actively replacing older diesel vehicles by vehicles that use cleaner fuel technologies such as electric hybrid, bio-diesel, clean diesel, and other green technologies. As these diesel buses are replaced, it is expected that the emissions of PM_{10} and NOx from fixed-route transit would decrease, thus yielding a net reduction in emissions of these pollutants.

Displaced VMT

Some of the passenger miles currently traveled via transit would shift to travel by passenger vehicles in the absence of transit. The following steps are used to estimate the amount of VMT and associated emissions and energy use: 1,336,050,582

1. The NTD indicates that users of fixed-route transit annually traveled an average of 1,336,050,582 passenger miles during 2006-2008 in Florida.

2. To estimate the amount of displaced VMT, this analysis adopts the approach as part of APTA's Recommended Practice on quantifying greenhouse gas emissions from transit [1]. This approach is based on a frequently asked question by transit agencies on their on-board surveys: "If transit had not been available, how would you have made this trip?" As described previously, the modal shift factor based on tabulated data from on-board surveys from individual transit agencies is estimated to be 38.5163 percent.

3. VMT. Multiplying the total passenger miles traveled by the modal shift factor of 38.5163 percent results in 514,597,004 VMT. It is important to note that these passenger miles account for in-vehicle miles but do not include person miles traveled by transit users for access to and egress from transit vehicles. As a result, these miles understate the total door-to-door miles. On the other hand, this estimate of VMT does not account for any degree of circuitry in travel by transit relative to travel by passenger vehicles. Circuitry in travel by transit can exist because transit routes may not connect any given pair of origin and destination as directly as travel by passenger vehicles in most cases, especially for bus services. Assuming that these two opposite effects would cancel each other out, this analysis does not explicitly deal with either of these two factors.

4. Emissions from the displaced VMT. Multiplying the annual VMT reduction by the distance-based emission factors for passenger vehicles in Table 4.1 gives the annual emissions associated with the displaced VMT shown in row 2 of Table 4.2.

5. Fuel used. Dividing the displaced VMT by the fuel efficiency of 20.3 mpg for passenger vehicles gives 25,349,606 gallons of gasoline shown in row 2 and column (6) of Table 4.2. The average fuel efficiency of 20.3 mpg is from EPA [21].

Congestion Relief

The detailed data for the "2009 Urban Mobility Report" show fuel savings to highway users because of the presence of public transit in major urbanized areas in Florida. For 2007, the savings are 7.97 million gallons. This estimate assumes that 80 percent of all transit passenger miles traveled would shift to vehicle miles traveled, which significantly overstates the likely percent of shift at 38.5163 percent as measured in Florida and described above. This estimate must be adjusted to correct this overstatement.

To account for this overstatement in the original estimate, this analysis uses the ratio of 38.5163 percent over 80 percent to adjust the original fuel savings to 3,851,628 gallons shown in row 3 and column 6 of Table 4.2.

The final estimated saving of 3,851,628 gallons is multiplied by the volume-based emission factors for passenger vehicles results in the estimates of emissions associated with the energy savings to highway users due to congestion relief shown in row 3 of Table 4.2.

Energy Use by Transit

Table 4.3 shows energy use by fuel type and mode, respectively, from the 2006-2008 NTD data. Multiplying these volumes of energy by the volume-based emission factors in Table 4.1 gives the estimated emissions in row 4 of Table 4.2.

Table 4.3. Annual Energy Usage by Fixed-Route Transit in 2006-2008

Fuel	*Bus*	*Rail*
Diesel (gallons)	34,999,257	2,482,339
Bio-Diesel (gallons)	417,900	
Gasoline (gallons)	27,022	
CNG (gallons)	114,523	
Electricity (Kh)		84,908,970

Source: 2006-2008 NTD through the Florida Transit Information System.

To determine total gallons of fuel used by fixed-route transit, one needs to determine gallons of fuel used in generating the electricity used for rail service. This takes several steps:

1. Share of electricity used for rail service. Table 1990 - 2008 Net Generation by State by Type of Producer by Energy Source (EIA-906) in *Electric Power Annual 2008 - State Data Tables* at http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html shows that 222,934,833 megawatt hours were generated annually in Florida in 2006-2008. The electricity used for rail service represents 0.0381 percent of the total electricity generated by all energy sources.

2. Petroleum fuel used for electricity generation. Table 1990 - 2008 Fossil Fuel Consumption for Electricity Generation by Year, Industry Type and State (EIA-906) in *Electric Power Annual 2008 - State Data Tables* at http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html shows that 30,676,463 barrels of petroleum oil were used annually in electricity generation in 2006-

2008 in Florida. Using a conversation factor of 42 gallons per barrel, this is equivalent to 1,288,411,425 gallons.

3. Petroleum oil used in generating the electricity used for rail service. Multiplying the share of electricity used for rail service (0.0381 percent) by the total gallons of oil used for electricity generation gives an estimate of petroleum oil used for rail service at 490,716 gallons.

4. Total gallons of petroleum oil used by fixed-route transit service. Showing in row 4 and column 6 of Table 4.2, adding up the gallons of diesel (both bus and rail), bio-diesel, and gasoline in Table 4.3 and the 490,716 gallons used for electrical rail service gives an estimate of 38,417,234 gallons of petroleum oil that fixed-route transit consumed annually in 2006-2008.

Net Benefits

Subtracting row 4 from the sum of rows 1-3 of Table 4.2 gives an estimate of transit's net annual energy savings and emission reductions during 2006-2008. These estimates suggest that fixed-route transit reduces emission of CO, VOCs, and CO_2, but increases emission of PM_{10} and NOx. However, transit agencies in Florida have been actively replacing older diesel vehicles by vehicles that use cleaner fuel technologies such as electric hybrid, bio-diesel, clean diesel, and other green technologies. As these diesel buses are replaced, it is expected that the emissions of PM_{10} and NOx from fixed-route transit would decrease.

4.2 Safety Benefits

Providing a safe transportation system for residents and visitors is the top priority of FDOT in Florida and USDOT at the national level. While the numbers of traffic fatalities and injuries have declined significantly in recent years, they still represent a significant cost to our residents, visitors, and society as a whole. Continued improvement in the safety of transportation system is the primary goal. This section describes the method, data, and estimation procedures for analyzing the net safety benefits of urban fixed-route transit.

4.2.1 Methodology

This study estimates transit's safety benefits as the difference between the sum of those from two potential sources for transit to reduce traffic fatalities and injuries and those resulting from the provision and usage of transit services. The two potential sources are:

Land use effect - The presence of fixed-route transit has the potential to affect the location of land uses, and these changes in land use potentially can influence travel behavior, particularly the amount of travel by private vehicles. To the extent that this land use effect of transit results in reduced vehicle travel, transit may reduce traffic fatalities and injuries for passenger vehicles.

Displaced VMT – The presence of fixed-route transit would like to have attracted some of the passenger miles currently traveled via transit from passenger vehicles. This shift of travel from passenger vehicles to transit reduces traffic deaths and injuries for passenger vehicles.

Traffic fatalities and injuries can result from the provision and use of transit services in two ways: 1) those that occurred to transit users as passengers of transit vehicles and to other roadway users involved in transit accidents and 2) those that occurred to transit users as they access to or egress from transit vehicles.

4.2.2 Data Sources

The Florida sample of 15,884 households in the 2009 National Household Travel Survey (NHTS) is the major source of data. Since 1969, the NHTS series has been the only authoritative source of the nation's inventory of household travel. The 2009 NHTS collects data from a given sample household on all daily trips taken in a 24-hour period by persons age 5 years or older for all purposes by all means of transportation. The sampled households cover all areas of the state, urban, and rural and the 24-hour period for different sampled households varies throughout the 13-month period from April 2008 to April 2009. The data include weights to expand the sample to state annual totals. Details about this survey can be found at http://nhts.ornl.gov/.

The 2009 NHTS collected data on the one-way trips that the sampled persons and households made on their designated travel days. A one-way trip is defined as any time a subject went from one address to another for purposes other than changing the mode. Travel data were collected through telephone interviews on the basis of pre-mailed travel diaries.

The 2009 NHTS data include many characteristics for each one-way trip in the survey. These include trip distance, trip duration, and the modes of transportation among other things. If more than one mode is used on a one-way trip, the mode that covered the most distance is designated as the main mode for that trip; the other modes are designated as the access modes if used before the main mode and as the egress modes if used after the main mode. A total of 24 specific modes are recognized in the survey. The data include information on the specific mode for each of up to five access segments and on the specific mode for each of up to five egress segments. However, the data do not include the access or egress duration for each access or egress segment; rather the data include only the combined total access time for all access segments and the combined total egress time for all egress segments.

Crash Statistics

The second main source of data is the summary information for 2006-2008 in the "Traffic Crash Statistics Report" from the Florida Department of Highway Safety and Motor Vehicles. This annual report shows the number of pedestrians, bicyclists, occupants of passenger cars, sports utility vehicles, light trucks, and motorcycles who died from traffic crashes. In addition, it shows the number of pedestrians, bicyclists, and motorcyclists who were injured from traffic crashes.

Safety Data from NTD

The third main data source is the 2006-2008 safety and security data as part of the NTD. On a monthly basis, transit agencies are required to report detailed information on fatalities and injuries to transit passengers, transit agency employees, and other roadway users that are involved in transit accidents. FTA has made the safety and security data available to the public in a spreadsheet format at its NTD website at http://www.ntdprogram.gov/ntdprogram/data.htm.

Fatality and Injury Rates

The data from the 2009 NHTS and the traffic crash statistics are used to derive fatality and injury rates as shown in Table 4.4. The derivation of these fatality and injury rates is described below.

Table 4.4 Exposure and Traffic Fatality and Injury Rates

Measure	*Severity*	*Private Vehicles*	*Bike*	*Walk*
Exposure	(1) Person Time (millions, minutes)	385,933	5,040	29,780
	(2) Person Miles (millions, miles)	181,606	535	1,376
	(3) VMT (100 millions)	127.4		
Number of Fatalities and Injuries	(4) Fatalities	2,436	121	526
	(5) Injuries	193,110	4,303	7,720
Time-Based Rates per 100 Million Person Minutes	(6) Fatalities	0.63	2.40	1.77
	(7) Injuries	50.04	85.39	25.92
Distance-Based Rates per 100 Million Person Miles	(8) Fatalities	1.34	22.61	38.23
	(9) Injuries	106.33	804.21	561.14
Distance-Based Rates per Billion VMT	(10) Fatalities	19.12	0.95	4.13
	(11) Injuries	1,515.88	33.78	60.60

Source: CUTR analysis.

1. Determine the amount of annual exposure in terms of person minutes and person miles that users of the Florida highway system had as reflected in the 2009 NHTS. Exposure is estimated for passenger vehicles, biking, and walking, respectively. Rows 1 and 2 of Table 4.4 show the results.
2. Determine the annual amount of exposure to bicyclists and pedestrians in terms of VMT by private vehicles as reflected in the 2009 NHTS. Row 3 of Table 4.4 shows the results.
3. Determine the annual number of traffic fatalities and injuries during 2006-2008 on the Florida highway system. The “Traffic Crash Statistics Report" shows the numbers of fatalities and injuries for drivers and passengers of motor vehicles but not by vehicle type. The national data for 2006-2008 on traffic injuries estimated from the General Estimates System in the “Traffic Safety Facts Report” are used to determine the share of injuries to occupants of passenger vehicles to occupants of all vehicle types. This share is 98.08 percent. A similar share for fatalities is 95.81 percent. Rows 4 and 5 of Table 4.4 present the result for fatalities and injuries, respectively.
4. Determine time-based fatality and injury rates by calculating the ratio of the number of fatalities or injuries over time-based exposure. Rows 6 and 7 of Table 4.4 show the time-based rates result for fatalities and injuries, respectively.
5. Determine distance-based fatality and injury rates per person mile by calculating the ratio of the number of fatalities or injuries over distance-based exposure. Rows 8 and 9 of Table 4.4 show the distance-based rates for fatalities and injuries, respectively.
6. Determine distance-based fatality and injury rates per VMT for biking and walking by calculating the ratio of the number of fatalities or injuries for biking and walking, respectively, over VMT in row 3 of Table 4.4. Rows 10 and 11 show the distance-based rates for fatalities and injuries, respectively.

4.2.3 Estimation and Results

As described in the method above, this study estimates the net reduction in the number of traffic fatalities and injuries that result from the availability of urban fixed-route transit.

Land Use Effect

1. Determine the reduced amount of exposure of passenger vehicles as a result of transit's land use effect. This amount is already determined in estimating transit's benefits on emission reduction and energy savings. Row 1 of Table 4.5 shows the result.
2. Determine the number of fatalities and injuries avoided as a result of the reduced exposure of passenger vehicles due to transit's land use effect. Multiplying the exposure in row 1 of Table 4.5 by the distance-based rates in rows 10 and 11 of Table 4.4 gives the result for fatalities and injuries in rows 5 and 6 of Table 4.5, respectively.

Table 4.5 Estimation of Safety Benefits

Components	*Severity*	*Private Vehicles*	*Bike*	*Walk*	*Transit*	*Total*
(1) Reduced Exposure (millions)		1,055.0				1,055
(2) Shifted Share		58.2%	15.9%	7.7%		
(3) Shifted Passenger Miles (millions)		778	103	212	N/A	1,093
(4) Access/Egress (minutes, millions)		40	57	3,192		3,288
Land Use Effect	(5) Fatalities	20.2	1.0	4.4		26
	(6) Injuries	1,599.3	35.6	63.9		1,699
Displaced VMT	(7) Fatalities	10.4	23.3	81.2		115
	(8) Injuries	826.8	827.3	1,192.0		2,846
Service Effect	(9) Fatalities	0.2	1.4	56.4	16.0	74
	(10) Injuries	19.8	48.8	827.4	1,050.0	1,946
Safety Benefits	***(11) Fatalities***	***30.4***	***22.9***	***29.2***	***-16.0***	***66***
	(12) Injuries	***2,406.4***	***814.1***	***428.6***	***-1,050.0***	***2,599***

Source: CUTR analysis.

Displaced VMT

1. Determine the number of passenger miles traveled currently by transit that would be shifted to passenger vehicles, biking, and walking, respectively, if transit were not available. According to the 2006-2008 data from the National Transit Database, transit users traveled 1,336,050,582 passenger miles on the fixed-route systems in Florida in 2008. Rows 2 and 3 of Table 4.5 show the shifted shares and shifted passenger miles, respectively.
2. Estimate the number of fatalities and injuries for each mode. This is accomplished by multiplying the shifted passenger miles in row 3 of Table 4.5 by the distance-based rates in rows 8 and 9 of Table 4.4. Rows 7 and 8 of Table 4.5 show the result.

Provision of Transit Service

1. Tabulate the number of fatalities and injuries as a result of transit accidents as reported in the safety and security data in the National Transit Database as made available at http://www.ntdprogram.gov/ntdprogram/data.htm. Rows 9 and 10 in the Transit column in Table 4.5 show the tabulated fatalities and injuries, respectively.

Access and Egress

1. Determine exposure of transit users as a result of them needing access to or egress from transit vehicles as reflected in the 2009 NHTS. Recall that the 2009 NHTS has information on the specific mode but not the separate amount of time spent for each

segment of access or egress. This analysis excludes access and egress for transit trips that also involved access and egress modes other than passenger vehicles, walking, or biking. Row 4 of Table 4.5 shows the result.

2. Determine the number of fatalities and injuries associated with exposure to vehicle traffic by transit users in access or egress. Multiplying the access and egress exposure in row 4 of Table 4.5 with the time-based rates in rows 6 and 7 of Table 4.4 gives the results in rows 9 and 10 in Table 4.5 for private vehicles, biking, and walking.

Safety Benefits

The estimated reduction in fatalities and injuries as a result of fixed-route transit service is calculated as the difference between the sum due to transit's land use effect and displaced VMT, and the number of fatalities and injuries associated with the provision and usage of fixed route transit . Rows 11 and 12 of Table 4.5 show the result. The presence of fixed-route transit in Florida is estimated to have reduced 66 traffic fatalities and 2,599 traffic injuries annually during 2006-2008.

4.3 Mobility Benefits to the Transit-Dependent Population

Transit serves a basic mobility function for the transit-dependent population, including children, older adults, persons with disabilities, adults who do not drive, people whose households do not have any vehicles available, and people whose household income is low. The transit-dependent population with access to basic mobility enjoys the benefits of social interaction, entertainment and education which in turn influence their contribution to society and the economy. An individual’s level of mobility greatly influences the quality of life they experience. And basic mobility extends the opportunities for employment to the adult segment of the transit-dependent population who, without this access may otherwise be unable to be employed. These characteristics of basic mobility, taken together, make a positive contribution to the economy.

4.3.1 Methodology

To know the net mobility benefits of transit for the transit-dependent population, would require estimating what trips transit users in the transit-dependent population would forego as a result of transit not being available. Summary information from tabulated data of on-board transit surveys from individual transit agencies in the state indicates that current transit users would not make 15.7 percent of the trips they currently make by transit if transit were not available. However, these tabulated data do not show the trip purposes of these likely foregone trips or such foregone percentages for the transit-dependent population. Thus, this study examines the role of transit and the degree to which transit is used in the daily lives of the transit-dependent population.

For this analysis the transit-dependent population consists of the following six segments:

- Young children: persons 5 to 15 years old
- Older adults: persons 65 years or older
- Persons with disabilities: having at least a medical condition that makes it hard to travel
- Zero-vehicle households: living in households with no vehicles available
- Non driver: adults who do not drive
- Low income: living in households with annual household income no greater than $15,000.

The analysis estimates transit usage by the transit-dependent population by exploring the following:

- Characteristics of the transit-dependent population in terms of whether they traveled on the travel day and whether they used transit if they traveled.
- Degree to which the transit-dependent population used transit on the travel day, including their share of all linked trips relative to the rest of the general population and transit's share of all trips they made on the travel day.
- Purposes of the transit trips that the transit-dependent population made on the travel day.

4.3.2 Data Sources

The analysis uses the Florida sample of 15,884 households in the 2009 NHTS. The 2009 NHTS collected data on the personal and household characteristics and on the one-way trips that the sampled persons and households made on their designated travel days. A one-way trip is defined as any time a subject went from one address to another for purposes other than changing the mode. The travel days were assigned to all days of the week and all seasons from April 2008 through April 2009. The travel day started at 4:00 AM of the day assigned and continued until 3:59 AM of the following day. Personal and household data were collected through telephone interviews, while travel data were collected through telephone interviews on the basis of pre-mailed travel diaries.

The 2009 NHTS data include many personal characteristics. Relevant to this analysis are person age and gender, whether a person was a driver, and whether the person had any medical conditions that made travel difficult. It also has data on many household characteristics. Relevant to this analysis are annual household income and vehicles available for the use by household members.

4.3.3 Estimation and Results

As part of developing the estimates of transit use for the transit-dependent population, it is necessary to analyze the NHTS data to determine the target population and determine their mode use and trip characteristics. First, data on the available personal and household characteristics in the 2009 NHTS allows one to determine whether a person in the sample is in the transit-dependent population, as defined earlier. Next data on the use of transit (which includes five of the modes in the NHTS, including local public transit bus, commuter bus, commuter train, subway/elevated train, and streetcar/trolley) is extracted. Once these are determined, it is possible to estimate the mobility characteristics on an average day, the degree to which transit is used, and the purposes of the transit trips.

Mobility Characteristics of the Transit-Dependent Population

With the basic information identified as above, it can be determined whether a person in the sample ventured out of home by any mode during the travel day assigned to the person's household. If a person did not travel at all on the travel day, this person may be considered immobile on an average day. If a person traveled on the travel day, it can be determined whether this person used transit for any of the trips this person made. As a result, the entire population can be grouped into three mobility categories for an average day: did not travel, used transit, or did not use transit. Table 4.6 shows the mobility categories of the transit-dependent population in two different ways.

Table 4.6 Mobility Characteristics of the Transit-Dependent Population on an Average Day

Mobility modes on Average Day		*Distribution Across Populations*			*Distribution Across Mobility Characteristics*	
		Transit-Dependent	*Rest of General Population*	*Total*	*Transit-Dependent*	*Rest of General Population*
Did not travel		70.2%	29.8%	100%	21.7%	8.3%
Did travel	used transit	66.8%	33.2%	100%	2.4%	1.1%
	did not use transit	42.8%	57.2%	100%	75.9%	90.7%
All		***47.2%***	***52.8%***	***100%***	***100%***	***100%***

Source: CUTR analysis of the Florida sample of the 2009 NHTS as made available by FHWA to CUTR in August 2010.

The middle three columns under the heading of Distribution Across Populations show the shares of the population within each mobility category for the transit-dependent population and the rest of the general population. Relative to its share of the entire population (47.2 %), the transit-dependent population is significantly over-represented in the population who did not travel at all (70.2 %) and in the population who did travel and used transit (66.8 %), but is under-represented in the population who did travel but did not use transit (42.8 %).

The two columns on the right show the distribution across the three mobility categories for the transit-dependent population and rest of the general population, respectively. For the transit-dependent population, 21.7 percent were immobile versus only 8.3 percent for the rest of the general population on an average day. Similarly, 2.4 percent of the transit-dependent population used transit versus only 1.1 percent for the rest of the general population on an average day.

Degree of Transit Usage

Table 4.7 examines the degree to which transit is used by the transit-dependent population. The transit-dependent population makes two-thirds of all linked trips by transit. On the other hand, transit's share of all linked trips made via all modes is 1.7 percent for the transit-dependent population versus 0.6 for the rest of the general population.

Table 4.7 Degree of Transit Usage by the Transit-Dependent Population

Degree of Transit Usage	*Transit-Dependent*	*Rest of General Population*	*All Population*
Linked Transit Trips	66.9%	33.1%	100%
Transit's Share of All Linked Trips by All Modes	1.7%	0.6%	1.0%

Source: CUTR analysis of the Florida sample of the 2009 NHTS as made available by FHWA to CUTR in August 2010.

Trip Purpose

The data indicate transit is far more important in the daily travel of the transit-dependent population than the rest of the general population. Table 4.8 estimates the distribution of transit trips (linked) across seven major trip purpose categories in column (1). Transit is most important to the transit-dependent population for travel to work and shopping destinations, with about one quarter of transit trips for each of these purposes.

Table 4.8 Purpose of Link Trips by Mode and TD Population

Purpose Categories	*Transit Trips by Transit Dependent (1)*	*Transit Trips by Rest of General Populatio n (2)*	*Non-Transit Trips by Transit Dependen t (3)*	*Non-Transit Trips by Rest of General Populatio n (4)*
Work and work-related	23.3%	28.8%	7.8%	24.9%
School and church activity	10.5%	21.5%	15.1%	5.0%

Medical and dental services	10.4%	1.2%	5.2%	2.0%
Shopping and errands	27.7%	6.5%	24.4%	19.8%
Social/recreational	13.6%	9.9%	29.9%	24.3%
Family & personal business and obligations	8.4%	24.8%	15.5%	21.0%
Others	6.2%	7.3%	2.2%	2.9%
All	***100%***	***100%***	***100%***	***100%***

Source: CUTR analysis of the Florida sample of the 2009 NHTS.
Note: Detailed purposes within each category are listed in Table 4.9.

Comparing this distribution (column 1) to the same distribution but for the rest of the general population (column 2) shows the importance of transit to the transit-dependent population. While transit is important to the transit-dependent population for travel related to shopping and errands, this comparison also shows that fixed route transit is critical to them for travel to medical and dental services and for travel to social and recreational activities. The transit-dependent population makes 27.7 percent of their transit trips for shopping and errands versus 6.5 percent for the rest of the general population; they make 10.4 percent for medical and dental services versus 1.2 percent for the rest of the general population; and they make 13.6 percent for social and recreational activities versus 9.9 percent for the rest of the general population.

Additional insights are gained by comparing the purposes between transit trips (column 1) and non-transit trips (column 3) by the transit-dependent population. Transit is three times as important in percentage terms (23.3 percent versus 7.8 percent) as all non-transit modes combined to help the transit-dependent population get to work and work-related locations. In addition, transit is twice as important in percentage terms (10.4 percent versus 5.2 percent) as all non-transit modes combined to help the transit-dependent population for medical and dental services.

Table 4.9 Detailed Trip Purposes by Category

Category	*Detailed Purposes*
Work and work-related	• Go to work • Return to work • Attend business meeting/trip • Other work related
School and religious activity	• Go to school as student • Go to religious activity • Go to library: school-related • –Go to day care/before or after school care
Medical and dental services	• Medical services • Dental services
Shopping and errands	• Buy goods: groceries/clothing/hardware store • Buy services: video rentals/drycleaner/post office/car service/bank • Buy gas
Social and recreational	• Go to gym/exercise/play sports • Rest or relaxation/vacation • Visit friends/relatives • Go out/hang out: entertainment/theater/sports event/go to bar • Visit public place: historical site/museum/park/library
Family personal business and obligations	• Use professional services: attorney/accountant • Attend funeral/wedding • Use personal services: grooming/haircut/nails • Pet care: walk the dog/vet visits • Attend meeting: PTA/home owners association/local government
Other	• Transport someone • Pick up someone • Take and wait • Drop someone off • Meals • Social event • Get/eat meal • Coffee/ice cream/snacks • Other reason

Source: Questionnaire Extended Interview for the 2009 NHTS at http://nhts.ornl.gov/2009/pub/ExtendedInterview.pdf.

4.4 Savings to Transportation Disadvantaged (TD) Programs

Fixed-route transit serves a basic mobility function for the transportation disadvantaged population as defined in Chapter 427, Florida Statutes:

> "those persons who because of physical or mental disability, income status, age are unable to transport themselves or purchase transportation and are, therefore, dependent on others to obtain access to health care, employment, education, shopping, social activities, or other life-sustaining activities or children who are handicapped or high-risk or at risk as defined in Section 422.202, Florida Statutes."

The TD population with access to basic mobility enjoys the benefits of social interaction, entertainment and education which in turn influence their contribution to society and the economy. An individual's level of mobility greatly influences the quality of life they experience. And basic mobility extends the opportunities for employment to the adult segment of the TD population who, without this access may otherwise be unable to be employed. These characteristics of basic mobility, taken together, make a positive contribution to the economy.

The Florida Commission for the Transportation Disadvantaged coordinates transportation services to the transportation disadvantaged in the state. Currently, all of Florida's 67 counties have coordinated transportation services managed by 49 community transportation coordinators. The Community Transportation Coordinator is the agency or organization in each county responsible for ensuring that coordinated transportation services are provided to serve the transportation disadvantaged.

One benefit associated with fixed-route transit is the opportunity for the Florida Commission for Transportation Disadvantaged (CTD) through its community transportation coordinators to encourage its clients to use fixed-route transit provided by public transit agencies rather than the paratransit services provided by these coordinators. In 2008, an estimated 64.3 percent of TD trips were made on fixed-route transit. Fixed-route transit has proved to be a lower-cost alternative compared to TD paratransit modes of transportation such as taxicabs and shared vans. In response to this cost difference, many sponsoring agencies of TD trips are encouraging clients to use fixed-route transit.

4.4.1 Methodology

This study estimates the cost savings of providing TD trips by fixed-route transit to community transportation coordinators as the difference between in the total cost of providing these TD trips between paratransit at the average operating cost and fixed-route transit at the average fixed-route fare cost for TD passengers.

The methodology assumed that due to local funding limitations not all of the paratransit trips could have been provided on fixed-route transit. Therefore, to be conservative, this study assumes that if fixed-route transit were not available, only 30 percent of the fixed-route trips would be made on paratransit. This percentage was used in the 1997 study (CUTR 1997) and was consistent with the historical growth in the provision of paratransit services.

This current study adjusts down the reported number of TD trips made on fixed-route transit. Individual counties do not appear to actually count the number of such trips. Rather, they mostly estimate this number based on the number of transit passes distributed by type (daily, weekly, and monthly) and an assumed number of one-way trips for the pass period (day, week, or month). Specifically, the following is assumed:

- 1 trip for a daily pass
- 10 trips for a weekly pass
- 40 trips for a monthly pass

The assumed usage rates for weekly and monthly passes may seem to be reasonable for people who go to work or school on a daily basis, but seems to be high for some TD clients. To be conservative and consistent with the assumed usage rate for daily passes, this study assumes that only 50 percent of the reported number of fixed-route trips via weekly and monthly passes were actually made on fixed-route transit. This assumption reduces the total number of fixed-route trips from the reported 33,223,983 to 19,333,576.

4.4.2 Data Sources

To determine fixed route fares, data were derived from two sources for fiscal years 2006-2008. One data source is the NTD. For individual transit operators, the NTD data provided information on total passenger fare revenues and the number of boardings for each fixed-route mode. This information is used to derive the average fixed-route fare for all fixed-route modes for all transit operators in each county. However, services provided by the South Florida Regional Transportation Authority are not considered in determining the average fixed-route fare for Broward, Miami-Dade, and Palm Beach counties which Tri-Rail serves. These fares are not considered as Tri-Rail is a commuter rail service which differs from average costs and fares associated with fixed-route motorbus.

The other data source for information on TD trip costs is the Florida Commission for Transportation Disadvantage's Annual Performance Report of TD services in Florida. For individual counties, the 2006-2008 reports provide information on a variety of data items, including:

- total number of TD trips
- number of TD trips on fixed-route transit
- number of TD trips on fixed-route transit by pass type (daily, weekly, monthly)
- total operating expense for all TD trips
- average operating cost for paratransit trips

These data items can be used to derive the average operating cost for TD trips on fixed-route transit:

1. Subtracting the number of TD trips on fixed-route transit from the total number of TD trips gives the number of TD trips on paratransit.
2. Multiplying this derived number of TD trips on paratransit by the average operating cost for paratransit trips gives the operating expenses for paratransit trips.
3. Subtracting the derived operating expenses for paratransit trips from the total operating expenses for all TD trips gives the operating expenses for TD trips on fixed-route transit.
4. Dividing the derived operating expenses for TD trips on fixed-route transit by the number of TD trips on fixed-route transit gives the average operating cost per TD trip on fixed-route transit.

This average cost could have been used to replace the average fixed-route fare in estimating the cost savings in this study. Unfortunately, the results are inconsistent and unreasonable for many counties. For example, the average operating cost for TD trips on fixed-route transit is negative for several counties, while is extremely large for some other counties. As a result, the average cost derived in this way was not used in this study and is not shown in Table 4.10.

The data for Orange, Osceola, and Seminole counties are combined to determine information comparable to the average fixed-route fare for LYNX.

4.4.3 Estimation and Results

Table 4.10 shows the calculations. The average fare for a fixed-route trip was $0.75. This average fare per fixed-route trip compares with an average operating expense per paratransit trip of $25.93, a $25.18 difference. With TD clients taking fixed-route transit in lieu of paratransit, sponsoring agencies reduced costs for those fixed-route trips by $487.1 million annually during 2006-2008, as shown in the total row of column (6) of Table 4.10. This amount of cost savings could be realized only if all of the TD trips can be provided on fixed route service. Due to budget limitations, however, that is unlikely. Assuming 30 percent of the fixed-route trips made on paratransit, the cost saving is $146.1 million (i.e., 487.1 million x 30 percent).

Table 4.10 Annual Savings of Transferring TD Trips from Paratransit to Fixed-Route Transit

County	(1) Adjusted TD Fixed-Route Trips	(2) Fixed-Route Average Fare	(3) Paratransit Average Operating Expense per Trip	(4) TD Agency Cost if by Fixed Route (1) x (2)	(5) TD Agency Cost if by Paratransit (1) x (3)	(6) Potential TD Agency Cost Savings (5) - (4)
Alachua	42,007	$0.99	$24.13	$41,599	$1,013,464	$971,865
Bay	720	$0.64	$11.03	$460	$7,942	$7,482
Brevard	129,142	$0.41	$8.95	$52,482	$1,155,240	$1,102,757
Broward	1,438,476	$0.52	$21.24	$748,576	$30,554,469	$29,805,893
Collier	61,508	$0.79	$29.32	$48,469	$1,803,298	$1,754,829
Duval	32,340	$0.76	$35.61	$24,523	$1,151,732	$1,127,209
Escambia	20,132	$1.11	$20.10	$22,260	$404,610	$382,350
Hillsborough	313,866	$0.86	$17.20	$271,034	$5,397,558	$5,126,525
Lee	63	$0.62	$24.48	$38	$1,530	$1,492
Leon	57,285	$0.78	$24.54	$44,882	$1,405,612	$1,360,731
Manatee	43,280	$0.35	$8.96	$15,193	$387,810	$372,617
Miami-Dade	14,118,336	$0.81	$27.74	$11,426,036	$391,696,894	$380,270,858
Okaloosa	17,815	$0.32	$15.75	$5,755	$280,506	$274,751
Orlando	604,942	$0.77	$19.62	$464,612	$11,866,138	$11,401,526
Palm Beach	1,130,267	$0.72	$26.07	$811,135	$29,469,821	$28,658,685
Pasco	109,897	$0.48	$13.24	$53,170	$1,454,948	$1,401,778
Pinellas	567,601	$0.89	$13.03	$504,547	$7,398,521	$6,893,974
Polk	73,198	$0.52	$20.65	$38,183	$1,511,825	$1,473,642
Sarasota	319,932	$0.42	$30.24	$133,448	$9,673,375	$9,539,927
Volusia	275,427	$0.70	$19.38	$191,748	$5,337,733	$5,145,985
Total	***19,356,233***	***$0.75***	***$25.93***	***$14,898,154***	***$501,973,029***	***$487,074,874***

Source: CUTR analysis.

4.5 Increased Physical Activity for Transit Users

Overweight and obesity have become a serious health problem in Florida and the nation. One part of the solution is increased physical activity by the general public. However, a significant portion of the adult population in Florida and the nation do not meet the U.S. Surgeon General's recommended minimum 150 minutes per week of moderate or vigorous physical activity [25]. A key to meeting a regular level of physical activity on a daily basis would be to build physical activities into a person's daily routine. Since using fixed-route transit typically involves walking or biking for access to and egress from transit stops, the role of transit in increasing physical activity and improving health in the public is widely recognized [26-29].

4.5.1 Methodology

This analysis estimates the impact of urban fixed-route transit on the weekly amount of physical activity for transit users who walk or bike to and from transit in association with their transit usage. It measures the amount of physical activity in terms of time spent on walking and biking. It measures the impact as the difference in the amount of physical activity between the actual conditions and the hypothetical scenario without urban fixed-route transit in Florida. Under actual conditions, transit users typically walk or bike as part of their access to and egress from transit. Under the analysis scenario where fixed-route transit was not available, current transit users are likely to walk or bike more in lieu of taking transit trips. To avoid overestimation, it is important to subtract the amount of walking and biking under the analysis scenario from the amount of walking and biking for access and egress under current conditions.

4.5.2 Data Sources

The major data source is the Florida sample of 15,884 households in the 2009 NHTS. The 2009 NHTS data include many characteristics for each one-way trip in the survey. These include trip distance, total trip duration, and the modes of transportation, among other things. If more than one mode is used on a one-way trip, the mode that covered the most distance is designated as the main mode for that trip; the other modes are designated as the access modes if used before the main mode and as the egress modes if used after the main mode. A total of 24 specific modes are recognized in the survey; fixed-route transit in this analysis is defined to cover five of these modes, including local public transit bus, commuter bus, commuter train, subway/elevated train, and streetcar/trolley. The data include information on the specific mode for each of up to five access segments and on the specific mode for each of up to five egress segments. However, the data do not include the access or egress duration for each access or egress segment; rather the data include only the combined total access time for all access segments and the combined total egress time for all egress segments.

The other source of data for this analysis is the information on modal shifts from fixed-route transit to other modes if transit were not available. As described before, the information on such modal shifts was obtained from tabulated data by individual transit agencies in Florida from their on-board surveys. The modal shares from individual agencies were weighted by their respective ridership to get such modal shifts for the state as a whole.

4.5.3 Estimation and Results

The analysis applies the above method to the data to estimate the impact of urban fixed-route transit on the weekly amount of physical activity for transit users in association with their transit usage in the following five steps:

Step 1 - Access and Egress Time

This step estimates the amount of time spent by current transit users via walking and biking for access to or egress from transit. Recall that the 2009 NHTS has information on the specific mode but not the separate amount of time spent for each segment of access or egress. This limitation in the 2009 NHTS data understates the true amount of physical activity associated with transit use. This analysis excludes walking and biking as part of access and egress for transit trips that also involved access and egress modes other than walking and biking.

The degree of understatement is likely to be small. The access and egress time included in this analysis already represents 82.2 percent of total access and egress time associated with all transit trips. The remaining 17.8 percent includes three components: access and egress time by modes other than walking and biking; time spent waiting for transit vehicles when a transit mode is involved in access or egress; and time spent on walking and biking. The last component is the source of understatement and is likely to be a small portion of the 17.8 percent.

The result from Step 1 is in row 1 of Table 4.11. Transit users in Florida walked over 53 million hours for access and biked just under 1 million hours for access to or egress from transit in 2009.

Table 4.11 Annual Health Benefits of Transit (Hours of Walking and Biking)

Row	*Measures*	*Walking*	*Biking*	*Walking + Biking*
1	Access and egress time for current transit trips	53,192,246	953,319	54,145,565
2	Travel time for shifted trips	10,757,815	4,848,091	15,605,906
3	***Net benefits (1 - 2)***	***42,434,432***	***-3,894,772***	***38,539,659***

Source: CUTR analysis.

Step 2 - Modal Shifts to Walking and Biking

This step estimates the amount of time that current transit users would spend on walking and biking for some of their trips currently made with transit if transit were not available. Row 2 of Table 4.12 shows the result. If transit were not available, current transit users would shift some of their transit trips to walking and biking. They would spend close to 11 million hours on walking and close to 5 million hours via biking for these shifted transit trips. Table 4.12 shows how these estimates are obtained in 6 sub-steps:

1. Based on the summary information on modal shifts from transit if transit became unavailable, 15.9 percent of the current transit trips are expected to be made via walking and 7.7 percent via biking.

2. Based on the 2009 NHTS, urban fixed-route transit served a total of 228,376,647 linked trips in 2009. Applying the above shares of shifted transit trips to walking and biking to this total number of transit trips gives 36,311,887 walking trips and 17,585,002 biking trips shifted from transit.
3. To determine the average distance of these shifted walking and biking trips, this analysis assumes that the 15.9 percent of walking trips would shift from the shortest 15.9 percent of the current transit trips and the 7.7 percent of biking trips would shift from the next shortest 7.7 percent of the current transit trips. Based on the 2009 NHTS data, the distance is 1 miles for the 15.9 percentile of transit trips and is 2 miles for the 23.6 (= 15.9 + 7.7) percentile of transit trips. The average distance is 0.67 miles for the shifted transit trips to walking and is 1.84 miles for the shifted transit trips to biking.
4. Combining the number of shifted transit trips and the average distance gives the total distance of the shifted transit trips for walking and biking, respectively.
5. Based on the 2009 NHTS, the average speed is 2.26 mph for current walking trips under 1 mile and is 6.67 mph for current biking trips that are at least 1 mile but shorter than 2 miles.
6. Combining the total distance of the shifted transit trips with the average speed gives the total walking and biking time as a result of the shifted transit trips.

Table 4.12 Walking and Biking Time from Shifted Transit Trips

Row	*Measures*	*Walking*	*Biking*
1	Share of shifted transit trips	15.9%	7.7%
2	Number of shifted transit trips	36,311,887	17,585,002
3	Mean distance of walking trips under 1 mile and biking trips of 1-2 miles long	0.67	1.84
4	Total distance of shifted transit trips (miles)	24,290,360	32,355,144
5	Mean speed of walking trips under 1 mile and biking trips of 1-2 miles long (mph)	2.26	6.67
6	Total time of shifted transit trips (hours)	10,757,815	4,848,091

Source: CUTR analysis.

Step 3 - Total Annual Impact

This step estimates the total annual impact of transit on physical activity of transit users. It is estimated by subtracting the total time of making the shifted walking and biking trips from transit from the access and egress time for the current transit trips. Row 3 of Table 4.11 shows the result. Overall, the total annual impact of transit is an increase of over 38 million hours of physical activity for current transit users.

Step 4 - Average Weekly Impact per User

This step estimates the average weekly impact of transit on physical activity per transit user who walk or bike for access to and egress from transit. It is estimated as the ratio of the total weekly impact over the number of transit users who did not use modes other than walking or biking for access to or egress from transit. The total weekly impact is the total annual impact from Step 3 divided by 365 and multiplied by 7, resulting 739,117 hours. Based on the 2009 NHTS, the number of transit users who did not use modes other than walking or biking for access to and egress from transit is 345,521. Combining these estimates gives the estimated weekly impact of transit on physical activity at 128 minutes per transit user who walk or bike for access to and egress from transit.

4.6 Benefits of Fixed-Route Transit Not Measured

The following sections provide brief descriptions of the nature and characteristics of some of the other benefits of fixed-route transit.

4.6.1 Improved mobility for the general population

Transit provides enhanced mobility, particularly for persons without ready access to alternatives. Mobility is fundamental for access to employment, healthcare, education, various services, socialization, and recreation. By providing mobility, transit improves the quality of life of individuals and aids employers and businesses by providing access for employees and customers. Mobility is fundamental to both social and economic interactions, thus, transit aids in the fundamental relationships that impact the quality of life.

4.6.2 More Travel Choices

Economic theory indicates that consumer choices have value to individuals and that choices therefore, increase overall consumer satisfaction. In light of the variation in consumer values and contexts, the optimal choice varies across individuals. As applied to transit, some share of the population prefer transit as a mode of travel and their situation is improved by having the choice of transit. Even individuals, who might normally use other means of travel, might find certain conditions where the presence of transit benefits them. This might occur when personal vehicle reliability, health, weather, or other considerations make transit the preferred mode. Discussion of the economic value of offering product choices in the case of transportation is discussed in Chu and Polzin [32].

4.6.3 Increased Property Values from TOD

There is a growing body of literature that is exploring the relationship between accessibility and the subsequent impact on land values. In the case of transit this has resulted in a growing interest in the ability of transit to influence the location of development and the values of land adjacent to quality transit services. Thus, for locations that are able to benefit from transit-induced land value increases, it provides a benefit to the local community.

Over the past few decades several studies have explored this issue [30-37]. The industry continues to learn more about the nature and magnitude of impacts and the conditions under which they can be achieved. A growing interest in leveraging this relationship and the increasing body of evidence being developed will provide assistance in quantifying and valuing this impact in the future.

All of these considerations are important in improving the quality of life for Florida’s citizens.

5. Conclusions

Many urban areas of Florida provide fixed-route transit services. Fixed-route services include motor bus in 29 counties, automated guideway in Miami and Jacksonville, commuter rail in south Florida, heavy rail in Miami (i.e., the Metromover), and streetcar in Tampa. These services provided more than 134 million vehicle revenue miles with more than 255 million passenger boardings traveling 1,336 million passenger miles annually in recent years. Fixed-route transit is an essential service. It fulfills many community needs, and helps the State meet a number of important public policy objectives. In addition to these community benefits, spending on transit contributes to economic activity.

To provide input for its updated Transit Strategic Plan the Florida Department of Transportation (FDOT) determined a need to analyze the benefits of urban fixed-route transit in Florida. This study updates an analysis of annual economic benefits of fixed-route transit conducted in 1997 and expands it to include an analysis of community benefits. The economic benefits estimated here are traditionally called economic impacts, and the community impacts are traditionally called transportation benefits.

5.1 Summary of Results

This study found that fixed-route transit makes significant economic contributions to the state of Florida and fulfills many community needs. Some of these economic and community benefits fall on users of fixed-route transit and users of roadways that are affected by transit. Other economic and community benefits, however, extend to the general population.

5.1.1 Federal Spending Impacts

In the absence of fixed-route transit, $186.2 million in capital expenditures and $83.1 in operating expenditures from the federal government would not have come to Florida annually (these and other dollar amounts in this report are represented in 2009 dollars). To the extent that these federal funds would not have come to the state in the absence of transit, these funds are equivalent to an injection of new dollars into the state economy to purchase capital goods (rolling stock, construction of terminals, stations, equipment, and other facilities) and to purchase goods and services to maintain and improve the current system (driver payroll, purchase of fuel and tires, and other support services). When this spending across industries is considered, the cumulative impact to Florida’s economy is $463.5 million in total economic output, 4,041 jobs, and $192.2 million in labor income per year. Spending federal money on fixed route transit services in Florida has an economic activity multiplier of approximately 2.3. This means that for every dollar invested economic activity increases by $2.30.

5.1.2 Impacts of Savings to Transit Users

Passengers who choose fixed-route transit over alternative modes enjoy the benefit of reduced monetary travel costs. In the absence of fixed-route transit, transit patrons would have to choose to travel by other means (or not travel at all), facing increased travel costs, including vehicle ownership and operating costs, and/or costs associated with purchasing alternative modes. This study estimates that fixed-route transit generates about $537.1 million in passenger cost savings to transit users. These out-of-pocket cost savings are equivalent to an increase in household disposable income, which positively impacts the overall state economy. At the same time, these savings also reduce the demand for gasoline, tires, and other services, and this reduction in demand contributes to a reduction in overall economic activity. The net impact of these two opposite effects to the economy generates a net increase of $159.7 million in total economic output, 250 jobs, and $64.1 million in labor income per year.

5.1.3 Impacts of Savings to Highway Users

Fixed-route transit provides cost savings to highway users. As passenger vehicle trips are shifted to transit, highway users may reduce fuel consumption based on the reduction in VMT and congestion. According to the "2009 Urban Mobility Report" by the Texas Transportation Institute [11], the provision of fixed-route transit in Florida saves highway users about 3.84 million gallons of gasoline annually. This is equivalent to $12.7 million in reduced fuel costs. These savings in fuel costs represent money that can be used on other household expenditures, which contributes to the state economy. At the same time, these savings in fuel costs also reduce the demand for fuel, and this reduction in the demand for fuel reduces economic activity. The combined impact of these two opposite effects is estimated to generate $9.3 million in total output, 128 jobs, and $60.9 million in labor income per year.

5.1.4 Energy Savings and Emission Reductions

Fixed-route transit has the potential to reduce emissions of air pollutants, including particulate matters 10 micrometers or less (PM_{10}), carbon monoxide (CO), nitrogen oxide (NOx), and volatile organic compounds (VOCs), and emission of carbon dioxide (CO_2), through at least the following three sources:

1. Land use effect – The presence of fixed-route transit has the potential to affect the residential location decisions and land-use mix, and travel behavior, particularly the amount of travel by private vehicles. To the extent that the land-use effects result in reduced vehicle travel, transit may reduce emission of air pollutants and CO_2.
2. Displaced VMT – With the availability of transit, some of the passenger miles currently traveled via passenger vehicle would shift to travel by transit. This shift of travel from passenger vehicles to transit reduces emissions.

3. Congestion relief effect – The congestion relief to highway users resulting from the modal shift of transit users from motor vehicles. To the extent that congestion relief reduces energy use by private vehicles, transit would reduce emissions.

Subtracting the emissions generated by transit vehicles from the sum of the reduced emissions from these three sources gives an estimate of transit's net reduction of emissions. Table 5.1 summarizes transit's net effect on annual emissions. These estimates suggest that fixed-route transit reduces emission of CO, VOCs, and CO_2, but increases emission of PM_{10} and NOx with current mixes of transit technology and energy sources.

Table 5.1 Transit's Benefits of Annual Reduced Emissions

Components	*Air Pollutants (short tons)*				*CO_2*
	PM_{10}	*CO*	*NOx*	*VOCs*	*(short tons)*
(1) Transit Vehicles	49.9	688.5	1,867.8	72.3	415,918
(2) Three Sources	44.6	10,668.4	1,006.4	356.7	670,474.1
(3) Net Reduction	***-5.3***	***9,979.9***	***-861.4***	***284.4***	***254,556.3***

Source: CUTR analysis.
Note: A negative value in row (3) indicates an increase in emissions.

Reduced CO emissions are equivalent to 128,000 passenger vehicles traveling 12,000 annually; the reduced emission of VOCs is equivalent to 117,000 passenger vehicles travelling 12,000 annually; and the reduced emission of CO_2 is equivalent to 52,000 passenger vehicles traveling 12,000 annually. On the other hand, the increased emission of PM_{10} is equivalent to 16,500 passenger vehicles travelling 12,000 miles annually; and the increased emission of NOx is equivalent to 110,000 passenger vehicles traveling 12,000 miles annually. However, transit agencies in Florida have been actively replacing older diesel vehicles by vehicles that use cleaner fuel technologies such as electric hybrid, bio-diesel, clean diesel, and other green technologies. As these diesel buses are replaced, it is expected that the emissions of PM_{10} and NOx from fixed-route transit would decrease.

Fixed-route transit is estimated to save 42.9 million gallons of petroleum oil annually, net of the energy used for operation. Gross savings come from three sources:

- Land use effect – The effect of fixed-route transit on land use and travel behavior is estimated to save 52.1 million gallons.
- Displaced VMT – The modal shift of transit users from private vehicles is estimated to save 25.3 million gallons.

- Congestion relief effect – The congestion relief to highway users resulting from the modal shift of transit users from private vehicles is expected to save 3.8 million gallons.

These three sources of gross savings total 81.3 million gallons annually. Transit's net saving of petroleum oil (after debiting its use) is estimated to be 42.9 million gallons annually.

5.1.5 Safety Benefits

Fixed-route public transit has the potential to reduce traffic fatalities and injuries through its impact on land-use and residential location decisions, and by displacing VMT from passenger vehicles. At the same time, fatalities and injuries are also associated with the operation of transit services. These fatalities and injuries not only result from those directly involved in transit accidents but also from accidents that involve transit users during transit vehicle access and egress. Taking into account both positive and negative safety impacts, the presence of fixed-route transit is estimated to produce a net reduction in 66 traffic-related fatalities and 2,599 traffic-related injuries each year.

5.1.6 Mobility Benefits to the Transit-Dependent Population

Transit provides basic mobility for the transit-dependent population that may not have an option of traveling whenever they need. An individual's level of mobility greatly influences his or her quality of life. Having access to basic mobility also helps the transit-dependent population and the general population make a positive contribution to the economy.

Ideally, one would want to estimate the net impact of transit on the mobility of the transit-dependent population in terms of the type and number of trips transit users would forgo as a result of transit not being available. Due to unavailability of data to develop such an estimate, this study uses data from the Florida sample of the 2009 National Household Travel Survey (NHTS) to estimate the importance of transit usage for the transit-dependent population.

Relative to its share of the entire population (47.2 %), the transit-dependent population is significantly over-represented in the population who did not travel at all (immobile, 70.2 %) on an average day and in the population who did travel and used transit (mobile, 66.8 %) on an average day. Within the transit-dependent population, 21.7 percent were immobile versus only 8.3 percent for the rest of the general population. Similarly, 2.4 percent of the transit-dependent population used transit versus only 1.1 percent for the rest of the general population.

Two-thirds of fixed-route transit trips in Florida are made by the transit-dependent population. Transit's share of all linked trips made via all modes is 1.7 percent for the transit-dependent population versus 0.6 for the rest of the general population. Transit is particularly important to the transit-dependent population for three travel purposes: work and work-related, shopping and errands, and medical and dental services. The transit-dependent population makes about 25 percent of their transit trips for work and work-related destinations. The transit-dependent population makes 27.7 percent of their transit trips for shopping and errands versus 6.5 percent for the rest of the general population, and they make 10.4 percent of their transit trips for medical and dental services versus 1.2 percent for the rest of the general population.

5.1.7 Savings to TD Programs

Fixed-route transit provides the opportunity for the Florida Commission for Transportation Disadvantaged through its community transportation coordinators to encourage their clients to use fixed-route transit provided by public transit agencies rather than the more expensive paratransit services provided by these coordinators. This study defines the cost savings of providing TD trips as the difference between the average operating cost of providing TD trips by paratransit and the average fare on fixed-route transit. This study estimates 5.8 million TD trips are shifted to fixed-route services in Florida. This is roughly 17.5 percent of the total number of reported TD trips that are shifted to fixed-route transit. This study provides a conservative estimate of $146.1 million annually in cost savings to TD programs through the provision of fixed route services.

5.1.8 Increased Physical Activity for Transit Users

Overweight and obesity have become a serious health problem in Florida and the nation. Since using fixed-route transit typically involves walking or biking for access to and egress from transit stops, fixed-route transit can help transit users achieve the minimum weekly 150 minutes of physical activity recommended by the U.S. Surgeon General. This study defines the increase in physical activity among transit users as the difference in the amount of walking and biking by current transit users for access and egress, less walking and biking if transit were not available because the current transit users are likely to walk or bike more frequently for some of their current transit trips. Data for this analysis was derived from the Florida sample of the 2009 National Household Travel Survey (NHTS). Additional data was derived from transit on-board surveys from individual transit agencies in Florida. It is estimated that individual transit users who walk or bike for access to and egress from transit walk and bike an additional 128 minutes weekly when using fixed-route transit.

5.1.9 Benefits of Fixed-Route Transit Not Measured

As noted in Section 4.6, there is growing appreciation of and an interest in quantifying and valuing some of the additional benefits of transit to the users and the broader community. Transit improves the quality of life of individuals and aids employers and businesses by providing access for employees and customers. It provides travel choices and influences land development and land values and, as such, can be a tool for communities to use to encourage economic development.

5.2 Comparison with National Studies

As with any economic impact study of public transportation benefits and impacts, these results were derived from the application of commonly used methods to a select body of data and should be interpreted within the framework of the methodology used. Nonetheless, the results of the impact analysis of federal expenditures can be compared to national studies.

In recent years, the American Public Transportation Association (APTA) sponsored several studies that estimate the benefits of public transit on the economy, the environment, and on energy savings at the national level as shown in Table 5.2.

Table 5.2 APTA Studies by Benefit Type

Benefit Type	*APTA Studies*
Economic Impacts	Weisbrod and Reno [1]
Environmental Benefits	
CO	Shapiro et al.[23]
VOCs	Shapiro et al. [23]
CO_2	Shapiro et al. [23]; Bailey et al. [24]
NOx	Shapiro et al. [23]
Energy Benefits	Shapiro et al. [23]; ICF International [38]

5.2.1 Economic Impacts

The 2009 APTA economic impact study estimates the economic impacts and benefits associated with government expenditures in public transportation capital and operating costs [1]. The report focuses on the relationship between public transportation investment and employment, wages and business income growth resulting from increased levels of investment.

The APTA approach to estimate the economic impact of capital and operating expenditures is comparable to this study. Using the federal standard accounting system, the APTA study estimated that 68.6 percent of all public federal transportation expenditures are for capital and 31.4 percent are for maintenance of the current system. Weighting the job impact estimates by this expenditure breakdown produces a job multiplier of 30 jobs per million dollar of investment. Using the same approach, this study estimates a Florida job multiplier of 22 jobs per million dollar of investment.

The lower multiplier is due to the different size of the impact area between the two studies. The APTA study is conducted at the national level, where most of capital expenditures related to the manufacturing of public transit vehicles have an impact in terms of job creation (assuming vehicles are manufactured within the U.S.), whereas this study assumes that the share of federal spending to purchase vehicles does not have direct, indirect and induced impacts (i.e. vehicles are not manufactured in Florida).

5.2.2 Environmental Benefits

Shapiro et al. [23] summarized the environmental benefits of public transit at the national level for 1998 as follows:

- Public transportation is reducing annual emissions of the pollutants that create smog, volatile organic compounds (VOCs) and nitrogen oxides (NOx), by more than 70,000 metric tons and 27,000 metric tons respectively.
- Public transportation is reducing emissions of carbon monoxide (CO) by nearly 745,000 metric tons annually.
- Public transportation is also reducing emissions of carbon dioxide (CO_2), which contributes to global warming, by more than 7.4 million tons a year.

Bailey et al. [24] summarize the environmental benefits of public transit at the national level for 2007 as follows:

- The total effects reduce greenhouse gas emissions from automobile travel by 37 million metric tons. This consists of 30.1 million metric tons reduced from secondary effects and a net savings of 6.9 million metric tons from primary effects and the effects of transit induced congestion reduction.

5.2.3 Energy Benefits

Shapiro et al. [23] summarizes the energy benefits of public transit at the national level for 1998 as follows:

- Public transportation saves more than 855 million gallons of gasoline a year, or 45 million barrels of oil.

Bailey et al. [24] summarize the energy benefits of public transit at the national level for 2007 as follows:

- The total energy saved, less the energy used by public transportation and adding fuel savings from reduced congestion, is equivalent to 4.2 billion gallons of gasoline

5.2.4 Summary

The provision of fixed route transit services in numerous Florida metropolitan areas enables Florida to leverage federal resources available for the provision of transit services. As detailed in this report, these federal resources produce positive economic impacts for Florida. In addition, the absence of transit might be a loss of choice for some travelers and an inconvenience for others but for many Floridians it would be the difference between being able to productively contribute to the economy through employment or visit doctors, socialize with friends, worship, attend school, or carry out other activities that many take for granted. The annual economic and other benefits of that mobility have been quantified in this document as:

- 4,418 jobs annually
- $632.5 million in total economic output
- $261.6 million in labor income per year
- $12.7 million in reduced fuel costs.
- A saving of 6.6 million hours in congested travel conditions
- 42.9 million gallons of petroleum oil saved. These savings are equivalent to fuel used by 72,600 passenger vehicles traveling 12,000 miles annually at 20.3 mpg.
- $146.1 million savings to transportation disadvantaged (TD) programs as trips are shifted from paratransit to fixed route transit
- Avoidance of 66 traffic fatalities and 2,599 traffic injuries by shifting trips to transit and reducing automobile trips. These reductions are equivalent to 2.1 percent of all traffic fatalities and 1.2 percent of all traffic injuries annually in Florida.
- A reduction of 9,980 tons of carbon monoxide (CO) emissions, 284 tons of volatile organic compounds (VOCs) emissions, and 254,556 tons of carbon dioxide (CO_2) emissions.

Other benefits including: Improved mobility for the general population (particularly for the transit-dependent population), increased travel choices, and increased property values from Transit Oriented Development are briefly acknowledged and described but not quantified in this work.

References

1. Weisbrod, G. and A. Reno, *Economic Impact of Public Transportation Projects*, 2009, American Public Transportation Association.
2. HDR, *Economic and Community Benefits of Local Bus Transit Service (Phase Two)*, I. HDR Decision Economics, Editor 2010: Silver Spring. p. 64.
3. *Economic Impact of HART: Existing and Future Expansions*, 2010, Cambridge Systematics: Tampa.
4. *IMPLAN.com*. 2010; Available from: www.implan.com.
5. Weisbrod, G., D. Vary, and G. Treyz, *Economic Implications of Congestion*, in *NCHRP Report 463*, N.C.H.R. Program, Editor 2001: Washington, D.C.
6. Jones, F.R., X. Chu, and R.T. Statsiak, *An Analysis of the Economic Impacts of Urban Transit Systems on Florida's Economy*, C.f.U.T. Research, Editor 1997, Center for Urban Transportation Research: Tampa.
7. BEA. *Relation of GDP by state to U.S. Gross Domestic Product*. Bureau of Economic Analysis, Regional Economic Accounts 2010.
8. HDR/HLB, *The Socio-Economic Benefits of Transit in Wisconsin*, I. HDR/HLB Decision Economics, Editor 2006: Silver Spring. p. 64.
9. FTA, *National Transit Database*, 2006-2008, Federal Transit Administration.
10. *Your Driving Costs*, 2009, American Automobile Association.
11. Schrank, D. and T. Lomax, *2009 Urban Mobility Report*, in *Urban Mobility Report*2009, Texas Transportation Institute: College Station, Texas.
12. Weisbrod, G.E., et al., *Economic implications of congestion*. NCHRP report,2001, Washington, D.C.: National Academy Press. 1 v. (various pagings).
13. Schrank, D. and T. Lomax, *2009 Urban Mobility Report*, 2009, Texas Transportation Institute.
14. *Gasoline Prices by Formulation, Grade, Sales Type*, 2009, Energy Information Administration.
15. FTA. *The American Recovery and Reinvestment Act (ARRA)*. 2010 December 2010; Available from: http://www.fta.dot.gov/index_9440.html.
16. FDOT. *Federal Economic Stymulus Update*. 2010 [cited 2011 January 2011]; Available from: http://www.dot.state.fl.us/planning/economicstimulus/status.pdf.
17. FTA. *ARRA Transit Programs*. 2010 December 2010; Available from: http://www.fta.dot.gov/news/news_events_12039.html.
18. Schiavone, J., *Use of biodiesel in transit fleet*, in *TCRP Synthesis 72*2007: Washington, D.C. .
19. Faiz, A., C. Weaver, and M. Walsh, *Air Pollution from Motor Vehicles: Standards and Technologies for Controlling Emissions*, 2004, The World Bank: Washington, DC.
20. Chandler, K., E. Eberts, and L. Eudy, *New York City transit hybrid and CHG transit buses: Interim evaluation results*, 2006, National Renewable Energy Laborator: Golden, CO.
21. *Emission factors - Calculating Emissions of Greenhouse Gases: Key Facts and Figures*, 2005, U.S. Environmental Protection Agency: Washington, DC.

22. Heath, G.A., et al., *Quantifying the Air Pollution Exposure Consequences of Distributed Electricity Generation*, 2005, California Energy Policy Institute, University of California.
23. Shapiro, R., K.A. Hassett, and F.S. Arnold, *Conserving energy and preserving the environment: the role of public transportation*, 2002.
24. Bailey, L., P. Mokhtarian, and A. Little, *The Broader Connection Between Public Transportation, Energy Conservation and Greenhouse Gas Reduction*, A.P.T. Association, Editor 2008.
25. *Physical activity guidelines for Americans*. [cited September 3, 2010]; Available from: http://www.health.gov/paguidelines/guidelines/default.aspx.
26. Bresser, L.M. and A.L. Dannenberg, *Walking to public transit - steps to help meet physical activity recommendations.* American Jounal of Preventive Medicine, 2005. **33**(4): p. 273-280.
27. Brown, B.B. and C.M. Werner, *A new rail stop tracking moderate physical activity bouts and ridership.* American Jounal of Preventive Medicine, 2007. **33**(4): p. 306-309.
28. Edwards, R., *Public Transit, Obesity, and Medical Costs: Assessing the Magnitudes.* Preventive Medicine, 2008(46): p. 14-21.
29. Stokes, R.J., J. McDonald, and G. Ridgeway, *Estimating the effect of light rail transit on health care costs.* Health and Place, 2008(14): p. 45-48.
30. Gatzlaff, D.H. and M.T. Smith, *The Impact of the Miami Metrorail on the Value of Residences Near Station Locations.* Land Economics, 1993. **69**(1): p. 54-66.
31. Chen, H., A. Rufolo, and K. Dueker, *Measuring the Impact of Light Rail Systems on Single-Family Home Values: A Hedonic Approach with Geographic Information System Application.* Transportation Research Record, 1998(1617): p. 38-43.
32. Landis, J., S. Guhathakurta, and M. Zhang, *Capitalization of Transit Investments into Single-Family Home Prices: A Comparative Analysis of Five California Rail Transit Systems*, 1994, Institute of Urban and Regional Development, University of California: Berkely.
33. Cervero, R. and M. Duncan, *Transit's Value-Added: Effects of Light and Commuter Rail Services on Commercial Land Values*, 2001, Department of City and Regional Planning, University of California, Berkeley, CA.
34. Weinberger, R. *Light Rail Proximity: Benefit or Detriment? The Case of Santa Clara County, California*. in *80th Annual meeting of the Transportation Research Board*. 2001. Washington, D.C.
35. Garrett, T., *Light-Rail Transit in America: Policy Issues and Prospects for Economic Development*, 2004, Federal Reserve Bank: St. Louis.
36. Chu, X. and S. Polzin, *The Value of Having a Public Transit Travel Choice.* Journal of Public Transportation, 1998. **2**(1).
37. Weisbrod, G., D. Vary, and G. Treyz, *Economic implications of congestion*. NCHRP report,2001, Washington, D.C.: National Academy Press. 1 v. (various pagings).
38. ICF, *Public transportation and petroleum savings in the U.S.: reducing dependence on oil*, 2007: Fairfax, VA.