CUTR

CENTER for URBAN TRANSPORTATION RESEARCH

Economic Contribution of THEA to Hillsborough County's Economy – 2016 Update

FINAL REPORT

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Tampa Hillsborough Expressway Authority

TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY

CUTR

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Economic Contribution of THEA to Hillsborough County's Economy – 2016 Update

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Final Report

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Disclaimer

This research was conducted under a grant from the Tampa Hillsborough Expressway Authority. The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Tampa Hillsborough Expressway Authority.

Executive Summary

The Tampa Hillsborough Expressway Authority (THEA) owns and operates the Lee Roy Selmon Expressway. THEA's vision is to provide a transportation system that "ensures a balanced network of transportation choices that support community livability and economic development."[1] Since its establishment, THEA has been responsible for numerous roadway projects in Hillsborough County that have contributed to increased mobility for its patrons and the county as a whole.

Objective

THEA retained the Center for Urban Transportation Research (CUTR) at the University of South Florida (USF) to estimate the economic impacts and benefits of its operations and infrastructure investments.

Key Findings

THEA's capital infrastructure investments and operations contribute substantially to economic growth in Hillsborough County and the state of Florida. Since its inception, THEA's strategic investment planning decisions have generated $1.2 billion in local and state gross domestic product and a combined 13,200 jobs.[1] Authority operations provide a significant contribution toward area employment by supporting jobs in the most relevant industries of the region.

Impact on Business Activity

Increased transportation accessibility promotes the clustering of business and residential units in proximity to expressway points of access. This leads to a larger pool of workers and customers, which in turn positively affects business firm location decisions, sales, and employment levels. Currently, there are about 14,400 businesses operating within one mile of the Selmon Expressway. These businesses employ approximately 137,000 workers and represent 23.3 percent of all establishments operating in Hillsborough County.

This study found that by improving business and residential accessibility, THEA's strategic investments increased business clustering and specialization, resulting in 14.1 percent more business establishments than in comparable areas within Hillsborough County over the past 10 years. Increased specialization resulted in a 5.4 percent higher employment growth rate than comparable locations for the same time period.

[1] All monetary amounts are reported in 2015 dollars unless otherwise indicated.

Impact on Urban Mobility

THEA's Selmon Expressway produces substantial benefits in terms of travel time reductions, increased safety, and a decrease in harmful emissions. This study finds that the Selmon Expressway saves its users $274 million annually.

Each person saves on average 3.8 hours in travel time per year. This represents a 7.4 percent reduction in the 52 hours of travel time spent annually in congested conditions. Households save $16.2 million per year in out-of-pocket transportation costs due to reduced vehicle fuel and operating expenditures. Savings on fuel and vehicle operating costs represent money available for other household expenditures. These savings benefit households at the lower ranges of income, representing a consistent gain in purchasing power. Businesses also benefit from improved travel conditions through savings of about $9.8 million in congested travel time and in fuel and operating costs.

A considerable number of the state's motor vehicle accidents occur in the Tampa-St. Petersburg metropolitan statistical area (MSA), accounting for a significant number of injuries and fatalities. In 2015, more than 54,000 motor vehicle crashes occurred in the Tampa-St. Petersburg MSA. This amounts to approximately 14.6 percent of the total crashes in the state. This study finds that THEA's Selmon Expressway contributes to increased safety by reducing the number of crashes, which also decreases property and injury damage by about $89.7 million annually.

Impact on Urban Development

Urban economic theory suggests that highway improvements influence urban growth patterns through land prices. The improved accessibility offered by highways generates higher property prices. Since its inception, THEA has generated mobility benefits for a relevant share of commuters by improving accessibility for households living and working in both the western and eastern areas of Hillsborough County. The Authority engaged in several capital infrastructure projects that added capacity to the system and made home and work locations more accessible. During this period, the areas around the Selmon Expressway experienced rapid growth in business and residential establishments.

Through an extensive analysis of the changes in residential and commercial parcels, this study found empirical evidence that improved transport accessibility positively affected the property prices of both residential and commercial parcels located in proximity to the Selmon Expressway. During the period 2002-2016, single-family residential units exhibit on average 14.9 percent higher property sale prices than comparable parcels not located in proximity to the Selmon Expressway. Commercial properties exhibit 16.2 percent higher sale prices than comparable parcels located in the control areas.

Accessibility improvements on the Selmon Expressway also increased tax revenue on commercial and residential properties by about $22.9 million, or 8.9 percent of the total estimated 2015 tax revenue of $290.8 million for the entire study area.

Conclusions

This study estimated THEA's contribution to local economic growth and the mobility benefits associated with its Selmon Expressway. Through its operations and strategic investments, THEA supports key industries, increases mobility, reduces business costs, and expands local business opportunities, ultimately leading to economic growth and improved standards of living.

Summary of Impacts and Benefits

- ***$1.2 billion*** *in Gross Domestic Product (GDP)*
- ***13,200 Jobs*** *in high-impact industry sectors*
- ***$37 million*** *in sales and other business taxes*
- ***Increased business activity***
  - ✓ 14 percent higher growth in establishments
  - ✓ 5 percent higher growth in local employment
- ***$274 million in travel benefits***
  - ✓ $90 million in accident cost savings
  - ✓ Reduced environmental impact
  - ✓ $142 in travel time and out-of-pocket cost savings per household
- ***Increased property values***
  - ✓ 15 percent increase for single-family homes
  - ✓ 16 percent increase for commercial properties
  - ✓ $23 million in property tax revenue

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List of Acronyms

AET	All-Electronic Tolling
CBD	Central Business District
CO	Carbon Monoxide
CPI	Consumer Price Index
CUTR	Center for Urban Transportation Research
DID	Difference-in-Differences
EIA	U.S. Energy Information Administration
FE	Fixed-effect
FIRES	Florida's Integrated Report Exchange System
FTE	Florida's Turnpike Enterprise
GIS	Geographic Information Systems
GDP	Gross Domestic Product
HCPA	Hillsborough County Property Appraiser
HHI	Herfindahl-Hirschman Index
I-O	Input-Output
ITS	Intelligent Transportation System
LQ	Location Quotient
MDX	Miami-Dade Expressway Authority
MSA	Metropolitan Statistical Area
NAICS	North American Industrial Classification System
NHTSA	National Highway Traffic Safety Administration
NOx	Nitrogen Oxide
NO_2	Nitrogen Dioxide
OLS	Ordinary Least-Square
PD&E	Project Development and Environment Study
PM	Particulate Matter
QALY	Quality-Adjusted Life Year
REIS	Regional Economic Information System
REL	Reversible Express Lanes
ROW	Right-of-Way
SOx	Sulfur Oxide
TAZ	Traffic Analysis Zone
THEA	Tampa Hillsborough Expressway Authority
TMC	Transportation Management Center
TOP	Transportation Outreach Program
USF	University of South Florida

VHT	Vehicle Hours of Travel
VMS	Variable Message Sign
VMT	Vehicle Miles of Travel
VOC	Volatile Organic Compound

Chapter 1
Introduction

Project Background

The Tampa Hillsborough Expressway Authority (THEA) is the owner and operator of the Selmon Expressway. THEA's mission is "to provide safe, reliable and financially-sustainable transportation services to the Tampa Bay region while reinvesting customer-based revenues back into the community."[1] Since its establishment, THEA has been responsible for numerous roadway projects in Hillsborough County.

Investments in highways and other types of transportation system improvements are recognized as important means to achieve economic growth and development at the local, state, and national levels. Infrastructure investments increase mobility, reduce business costs, and expand business opportunities, ultimately leading to economic growth and improved standards of living.

Study Objectives

The objective of this study is to assess the economic contribution of THEA to the local community by evaluating the Authority's residential, business, and developmental impacts to the Hillsborough County economy.

Study Methodology

The term *economic impact* is used extensively by public and nonprofit organizations to describe and quantify the economic activities attributable to an organization and its investments. To fully appreciate the term, 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* by industries located within this geographic boundary.

Investment in transportation infrastructure can affect a region's economy in two ways: (1) through the spending pattern produced by the purchasing of goods and services, and (2) through cost savings and business productivity changes that might occur as investments improve the current transportation network. These impacts can be estimated using input-output (I-O) accounting tables. These tables produce multipliers that compute the total direct, indirect, and induced effects on jobs, output, and income impacts generated per dollar spent on the transportation infrastructure.

While economic impacts encompass a wide range of effects across many sectors of a region's economy, other factors may significantly contribute to economic growth even though these factors do not directly affect the flow of dollars. 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 of these benefits to the users and distinguishes them from the economic impact analysis results. These benefits are usually incorporated directly into other assessments, such as in a benefit-to-cost ratio project prioritization or evaluation.

The following chapters detail the study's approach to estimate the economic impacts and benefits of the Tampa Hillsborough Expressway Authority.

Chapter 2
Economic Impact of Capital Infrastructure Investments and Operations

This chapter describes the analytical approach to estimating the impacts associated with the capital asset and infrastructure investments of the Selmon Expressway since its inception. The following sections provide a historical perspective of THEA infrastructure investments and present estimates of their impact on the local economy.

Capital Assets and Infrastructure Investments

The Selmon Expressway consists of a 14.2-mile, four-lane, limited access toll road connecting Gandy Boulevard in southwest Tampa to I-75 in east Hillsborough County. It also consists of a 9.1 mile, three-lane (six-lane equivalent) reversible express lane facility from the Tampa Central Business District (CBD) to the Brandon area east of I-75, and 3.2 miles of parkway and feeder roads extending from the terminus of the Selmon Expressway to the east, north, and south into the Brandon community.

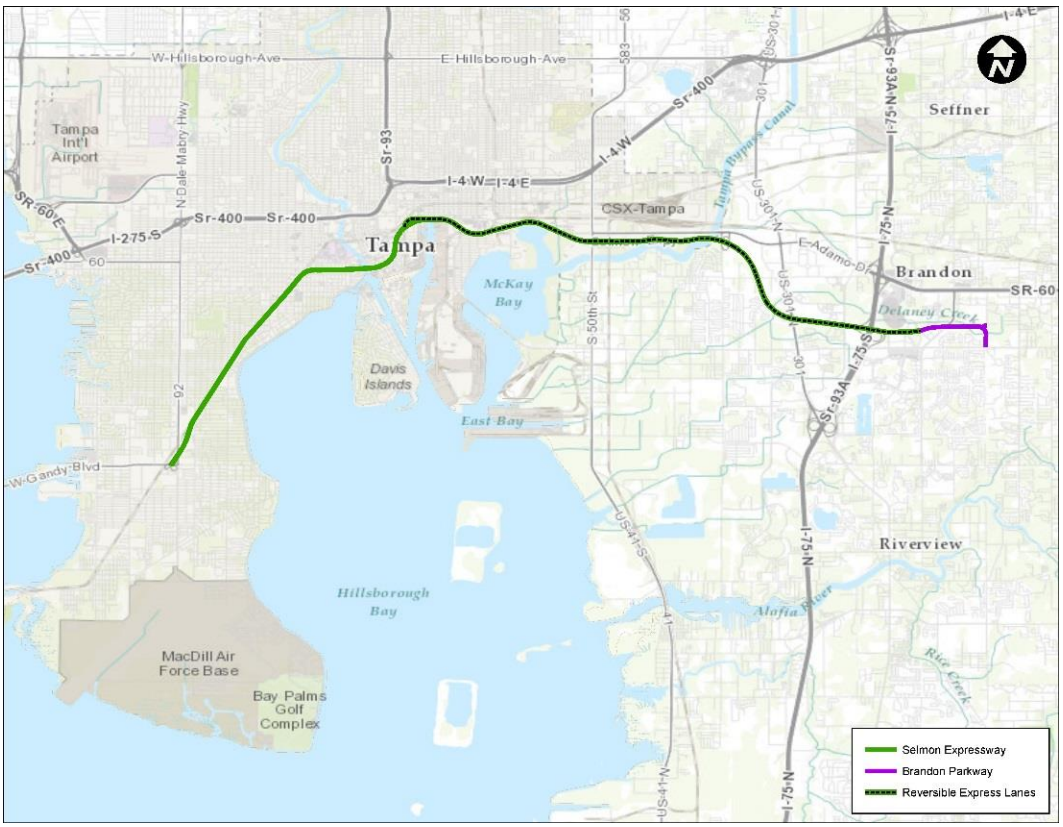

Figure 2-1. THEA System Map

Selmon Expressway

The Selmon Expressway was initially conceived as part of a system of expressways in the Tampa Bay Area. The network was built in stages, with the first five-mile-long western section completed in 1975 and the final section completed in the 1980s connecting to I-75 in the Brandon area.

Reversible Express Lanes

In the early 1990s, THEA and the Florida Department of Transportation (FDOT) entered into agreements to jointly plan and finance the eastern expansion of the Selmon Expressway and the construction of a 1.1-mile limited access connector between the Selmon Expressway and Interstate 4 to the north. The initial planning efforts were based on the Tampa Interstate Study [2]. This plan called for adding one lane in each direction on the Selmon Expressway to serve both future traffic growth and additional traffic resulting from the I-4 Connector. Recognizing the highly directional nature of traffic on the Selmon Expressway, THEA's transportation planners developed the Reversible Express Lane (REL) concept. Under this concept, a two-lane elevated expressway would be constructed in the median of the existing expressway. The elevated expressway would carry peak hour traffic into and out of downtown Tampa, thereby freeing up capacity on the Selmon Expressway for the additional traffic generated by the I-4 Connector. In addition to rendering the Connector project feasible, this approach would allow for the future construction of an at-grade lane in each direction if needed. The REL system opened to traffic in 2006.

Brandon Parkway

In the 1980s, THEA studied an extension of the Selmon Expressway into the Brandon community. But in 1996, the Authority undertook an alternative approach of extending the Crosstown Expressway over I-75 into Brandon by adding a series of feeder roads, as well as realigning and widening existing roadways. The project was designed in coordination with Hillsborough County transportation and economic development officials to provide for a future "Brandon Downtown," which would include a satellite office complex to consolidate government operations. Construction started in 2002, was completed a year later, and included the 3.5-mile Brandon Parkway. In addition to providing much needed local roadway capacity and direct access to the Selmon Expressway, the Brandon Parkway features a heavily landscaped park-like setting with urban architectural amenities and a recreational trail.

Meridian Avenue

Improvement of Meridian Avenue was conceived as part of the REL project to merge traffic into the existing facility and to bring traffic to the Tampa CBD.

THEA's transportation planners developed a concept plan to use Meridian Avenue, a little-traveled road in the Channelside warehouse and industrial district just east of the Tampa CBD, as an entrance and exit point. The existing Channelside district was effectively cut off from the CBD by a set of railroad tracks leading to an operating industrial location by the Kennedy Boulevard overpass, which carried traffic over both Meridian Avenue and the railroad tracks.

THEA and the City of Tampa transportation planners recognized that the creation of additional access points between Channelside and the CBD would likely alter the area's use from warehouse to urban residential. Furthermore, the Channelside Bay Plaza at the southern end of Meridian Avenue was emerging as a cultural, entertainment, and cruise ship destination center. Accordingly, the Meridian Avenue project was designed with significant urban features, such as urban-width sidewalks, pavers, and upgraded landscape and lighting fixtures. Further, designers widened the street from two to six lanes to accommodate the additional Crosstown and urban traffic.

The Meridian Avenue Gateway project was completed in 2006 and has served as a catalyst for extensive urban residential investment within the Channelside district. Over 2,750 apartments and urban residences have been built to date, with an additional 700 units under construction. This residential development has in turn enhanced the economic viability of the commercial and entertainment venues within the CBD, Channelside, and the adjacent Ybor City districts.

Transportation Management Center and Intelligent Transportation System

The Transportation Management Center (TMC) houses the administrative and operation offices of THEA, the traffic management operations of the City of Tampa, and the regional toll collection operations of Florida's Turnpike Enterprise Office of Toll Operations. This facility was completed in 2005 at a cost of $6 million.

The RELs use intelligent transportation system (ITS) technology to ensure that traffic movements are reversed safely and on schedule. This includes ITS devices and components such as variable message signs (VMS), lane protection gates and systems, video monitoring equipment, fiber-optic cables, communications and control hardware and software, and other related devices and components required to operate the reversible lanes. The ITS components were completed in 2007 at a cost of $13 million.

Staffing is needed to operate the ITS and monitor the REL facility for safety purposes. THEA determined that operational efficiencies could be achieved by combining the REL and ITS operational responsibilities with existing local government traffic management operations. THEA originally looked into the feasibility of developing a unified transportation management center where the traffic operations of THEA, the City of Tampa, Hillsborough County, HART, and FDOT District IV could be co-located. While this could not be accomplished, THEA and the City

of Tampa reached an agreement on the creation of a TMC to combine their respective traffic management responsibilities. This agreement resulted in administrative and operating cost savings for THEA and the City of Tampa, as well as improving operational efficiency and expertise.

In addition, THEA approached Florida's Turnpike Enterprise (FTE) Toll Operations Office about the feasibility of locating the regional tolling operations with the TMC and THEA's administrative offices. An agreement was reached prior to the design of the TMC building, which allowed the Toll Operations Office to ensure that the facilities were designed to meet their personnel, equipment, and storage requirements. Conference and meeting rooms were included to accommodate the requirements of both organizations. THEA applied for and received a $9 million Transportation Outreach Program (TOP) Grant, which paid a portion of the TMC and ITS costs.

All-Electronic Tolling

In 2011, THEA implemented an All-Electronic Tolling (AET) revenue collection system, which provides the economic benefits of reduced travel time, lower fuel consumption, and improved customer satisfaction. The Selmon Expressway was the first toll facility in Florida to adopt AET, which was subsequently implemented by FTE in Dade County and on three of the five expressways operated by the Miami-Dade Expressway Authority (MDX).

The I-4/Selmon Expressway Connector

The I-4–Selmon Expressway Connector was conceived to divert commercial traffic from historic Ybor City and represents a major addition to THEA's transportation network. The Connector improves the movement of people and goods, offers exclusive truck access to the Port of Tampa, and serves as an additional hurricane evacuation route–all this, with the time-saving, money-saving convenience of all electronic tolling. The Connector was developed in partnership with the Florida Department of Transportation and Florida's Turnpike Enterprise. Planning was completed in 2008 and construction at the end of 2013. After opening, the Connector traffic grew from an estimated 13,000 vehicles per day in its first month of operation to about 30,000 per day in the first 10 months of operation.

Selmon Downtown Viaduct Widening Improvements

In conjunction with the I-4/Selmon Connector project, THEA widened the section of the downtown viaduct from Florida Avenue to South 22nd Street from four lanes (two in each direction) to six lanes (three in each direction). The improvements were intended to sustain the increased traffic volumes generated by the opening of the strengthen the I-4/Selmon Connector.

Capital Projects Asset Value

Table 2-1 reports the value of the infrastructure investments, converted to current (2015) dollars, discussed above. The total value of the investments is about $1.4 billion.

Table 2-1. Capital Assets and Infrastructure Investments ($, Thousand)

Project Description	*Year Completed*	*Consultant Fees & Other Professional Services*	*Right of Way*	*Construction*	*CM / CEI*	*Capital Asset Value*	*% of Total*
South Crosstown Expressway	1975	19,038	82,398	219,921	21,992	343,350	23.91%
East Crosstown Extension	1980	22,760	91,868	204,873	20,487	339,989	23.68%
East Toll Plaza Improvements	2000	854	0	5,146	0	6,000	0.42%
Brandon Parkway	2003	18,020	19,224	44,014	9,217	90,475	6.30%
Tampa Downtown Gateway	2005	3,764	36,523	29,900	3,549	73,736	5.13%
THEA / City of Tampa TMC / ITS	2005	2,839	0	20,758	1,094	24,691	1.72%
WEST Toll Plaza Improvements	2005	1,419	0	1,788	309	3,516	0.24%
I-75 Operational Improvements	2005	295	0	795	133	1,223	0.09%
Reversible Express Lanes*	2006	17,030	112	376,259	25,174	418,575	29.15%
Selmon Bridge Rehabilitation	2009	55	0	8,557	717	9,329	0.65%
AET Conversion	2011	4,357	0	14,888	1,447	20,693	1.44%
Selmon I-4 Connector	2013	3,145	0	20,397	4,067	27,608	1.92%
Selmon Viaduct Widening and Rehabilitation	2014	1,494	0	69,201	6,181	76,876	5.35%
Total		*95,071*	*230,125*	*1,016,498*	*94,368*	*1,436,062*	*100.00%*

Source: Expressway Authority/CUTR Aggregation

** Includes $85 million in covered repairs*

Covered repairs consist of insured repair costs that are not reflected in the capital asset value of the project as booked in the financial statements

Economic Impact of Capital Infrastructure Spending

THEA capital infrastructure investments since its inception have contributed to the growth of the local economy. To assess the extent of this contribution, the above infrastructure investments are considered as expenditures in the local economy that have ripple effects through several industries.

This study makes use of the IMPLAN model and 2013 accounting tables to generate input-output (I-O) tables and multipliers. IMPLAN and the associated datasets are supported by the IMPLAN Group LLC [3]. IMPLAN is a widely used, nationally recognized input-output economic impact model. Appendix A provides a more detailed explanation of the IMPLAN model and I-O analysis.

The approach is based on a multi-regional analysis, which considers Hillsborough County as the primary impact area and all remaining counties in the state of Florida as the secondary impact area receiving spillover effects.

Before proceeding to use 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 study area. Some of the planned expenditures to purchase goods and services,

such as new toll equipment, will occur outside the impact area and will not generate an impact in the county. For example, not all construction expenditures will go to the purchase of local goods and services. Part of the capital and labor inputs necessary in the construction of the infrastructure come from outside the impact area. An assumption that all capital infrastructure expenditures are spent locally would result in overestimation of impacts. The IMPLAN input-output model is capable of differentiating the use of local versus non-local goods by supplying default regional purchase coefficients.[2]

Furthermore, this study treats expenditures to purchase land under right-of-way (ROW) acquisition as a transfer of resources among parties within the impact area that does not have a bearing on business activities or create jobs. Only the component of ROW expenditures that pays for real estate appraisal services (10% of ROW) and legal services (10% of ROW) is considered as having an impact. Table 2-2 reports the total expenditures that are assumed to have a direct impact in the area. Using the 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 A-1 in Appendix A describes the NAICS industry sectors with the corresponding IMPLAN industry codes.

Table 2-2. Capital Expenditures Considered for Impact Analysis ($, Thousand)

	Industry Sector					
Expenditure Type	*NAICS*	*IMPLAN*	*Gross Total*	*% Local Purchase*	*Net Total*	*% of Net Total*
Engineering, Administration, and Legal (EAL)	5413330	449	189,439	96.2%	182,145	14.7%
Construction*	23	56	1,016,498	99.8%	1,014,363	81.6%
Right of Way						0.0%
Real Estate Services (10%)	531	440	23,013	100.0%	23,013	1.9%
Legal Services (10%)	5411	447	23,013	100.0%	23,013	1.9%
Total			*1,251,962*		1,242,534	*100.0%*

Source: Expressway Authority/CUTR Aggregation

** Includes additional $85 million Reversible Express Lanes foundation repairs*

The capital expenditures of Table 2-2 directly support jobs in heavy construction, specialized services required for planning (architectural and engineering), and maintenance and landscaping services. It also stimulates the purchase of products that lead to further impacts on economic activity. This study employs the following measures of economic impacts:

- Total output
- Value added
- Labor income

[2] Default IMPLAN regional purchase coefficients were adopted to differentiate between local and non-local production.

- 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.

Total Output

Total industry output measures the value of goods production and of business services 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 direct impacts generated by capital expenditures affect the region's economy.

Value Added

Total value added is equivalent to Gross Domestic Product, as identified by the Bureau of Economic Analysis. It is a subset of total output that measures only the value of final goods and services. Therefore, value added equals total output minus the cost of labor and materials. In economic analysis, value added is the preferred impact measure of contribution to economic growth generated by investments.

Labor Income

Total income includes employee compensation and other income. Total labor income 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.

Table 2-3 summarizes direct, indirect, induced, and total impacts in terms of output, income, and employment. The total impact in terms of value added (or GDP) is about $1.2 billion, of which about 86 percent is realized in Hillsborough County and 14 percent in all adjacent counties. Value added measures the value of gross profits and is a measure of wealth created by the capital expenditures.

Table 2-3. Cumulative Capital Expenditure Impacts

Impact Type	Impact Category			
	*Employment**	*Labor Income ($,000)*	*Value Added ($,000)*	*Output ($,000)*
Direct Effect	5,607	409,188	525,756	1,242,538
Indirect Effect	3,998	228,773	365,454	696,888
Induced Effect	3,427	162,246	272,248	459,830
Total Effect	13,031	800,207	1,163,459	2,399,256

THEA's capital outlays have contributed to about 13,000 jobs in several industries. The impact on jobs depends on the mix of project investment summarized in Table 2-2. Given that 14.8 percent of the expenditures went to design planning and expanding the system, and that construction expenditures amount to 81.1 percent of total expenditures, the impact is primarily concentrated in the construction and specialized services sectors. Figure 2-2 illustrates the most impacted industry sectors. The economic impact of capital infrastructure investments spill over to other sectors, showing that this type of investment also helps support employment in other industries, such as architectural, planning, and engineering services, wholesale and retail trade, and leisure and hospitality services.

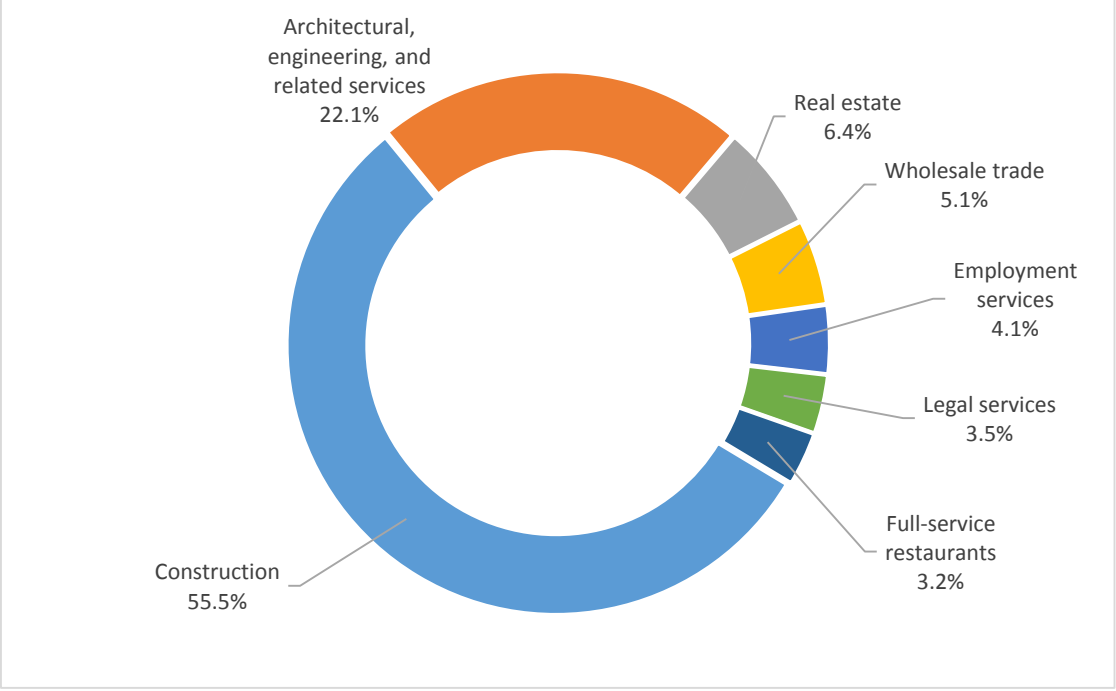

Figure 2-2. Top Industries Affected

Economic Impact of Facility Operations and Maintenance

Expenses associated with the operation of the Selmon Expressway include operations, maintenance and administration. Table 2-4 reports historical operating and routine maintenance expenses for the last three years of operations. These expenditures go toward the purchase of goods and services in the local community (landscaping maintenance, for example). Unlike capital outlays, recurring operating and maintenance expenditures have lingering effects on the local economy as they represent a continuous stream of spending.

Table 2-4. Recurring Operating and Maintenance Costs (Current FY Dollars)

Expenditure	*FY 2014*	*FY 2015*	*FY 2016*	*Average*
Operations				
Toll Operations	3,362,861	3,660,527	3,760,820	3,594,736
Roadway Operations	949,099	977,751	1,065,753	997,534
Maintenance				
Roadway and Facility	1,668,161	1,702,056	1,752,268	1,707,495
Landscape	501,999	544,137	491,045	512,394
Intelligent Transportation System	376,041	381,316	391,935	383,097
Maintenance Support Services	90,000	90,000	90,000	90,000
Bridge Inspection	274,679	285,666	408,188	322,844
Administration				
Salaries, Taxes, and Benefits	1,989,054	2,164,127	2,372,040	2,175,074
Professional Services	799,500	787,000	1,068,000	884,833
Other Expenditures	399,115	408,215	434,715	414,015
Public Communication and Marketing	280,000	395,000	425,000	366,667
Total	*10,690,509*	*11,395,795*	*12,259,764*	*11,448,689*

Source: Tampa Hillsborough Expressway Authority Operating Budget

Table 2-5 reports the resulting economic impact on Hillsborough County and the rest of the state. THEA's recurring operating and maintenance expenditures provide support to an additional 185 jobs and generate an additional $13.1 million in local GDP.

Table 2-5. Ongoing Economic Impact of Operating and Maintenance Costs

Impact Type	Impact Category			
	Employment	*Labor Income ($,000)*	*Value Added ($,000)*	*Output ($,000)*
Direct	107	5,809	7,001	11,449
Indirect	36	1,974	2,804	5,243
Induced	41	1,973	3,298	5,561
Total	*185*	*9,755*	*13,103*	*22,252*

THEA's annual expenditures affect a variety of businesses, either directly (maintenance, engineering, landscaping, professional and technical services) or indirectly. Figure 2-3 shows a breakdown by the top ten industries affected in terms of employment.

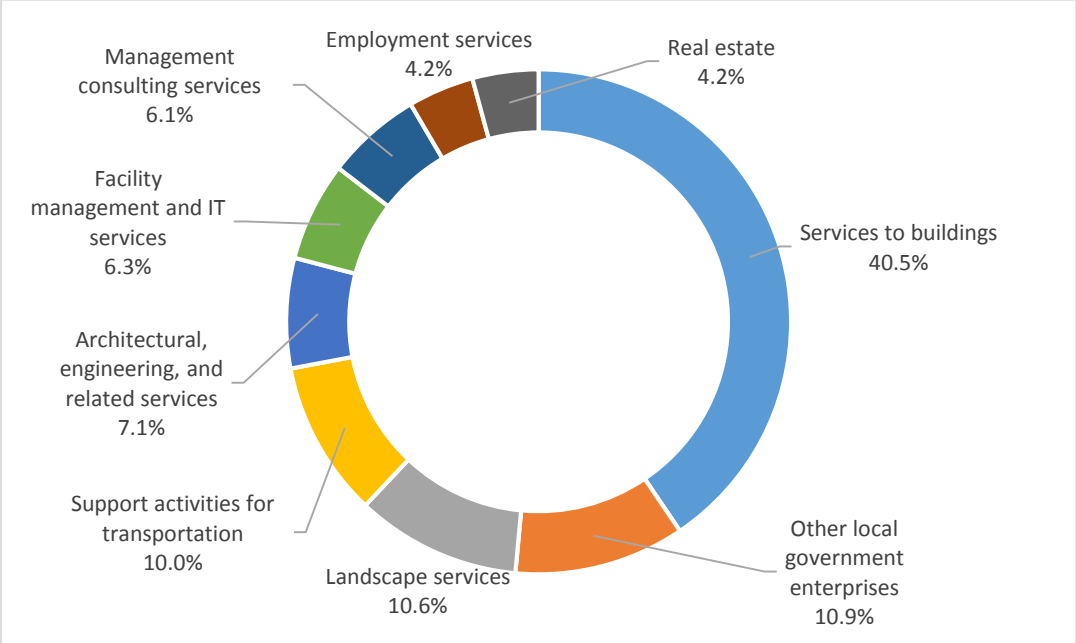

Figure 2-3. Industries Affected by THEA's Operating and Maintenance Activities

Summary of Capital Infrastructure and Facility and Operation Impacts

Table 2-6 reports the total impact of THEA's capital infrastructure and operations and maintenance (O&M) expenditures to date. The cumulative impact of THEA activities in expanding and maintaining the current system produces an impact of $2.4 billion in total output and $1.2 billion in GDP, or 1.7 percent of the county total.

Table 2-6. Total Capital Infrastructure and Operation Impacts

	Impact Category			
Impact Type	*Employment*	*Labor Income ($, million)*	*Value Added ($, million)*	*Output ($, million)*
Direct	5,714	415	533	1,254
Indirect	4,034	231	368	702
Induced	3,468	164	276	465
Total	13,216	810	1,177	2,422

Impact on State and Local Taxes

The business generated by capital infrastructure and O&M expenditures in the county contributes to increased tax revenues, as summarized by Table 2-7.

Table 2-7. Impact on Local and State Taxes

Revenue Source	Total Impact
Sales and other business related taxes†	36.7
Property taxes	17.7
Other Taxes*	11.9
Total	66.3

†Includes taxes on production and profits

** Business licenses, fishing licenses, rents and royalties, documentary and stamp taxes*

The largest impact of $36.7 million comes from sales tax revenues collected in the impact area. The collection of $17.7 million in property taxes constitutes about 27 percent of total government revenue impacts. An additional $11.9 million of taxes is in the form of business licenses and documentary and stamp taxes.

Chapter 3
Impact on Urban Mobility

According to the Texas Transportation Institute *2015 Urban Mobility Scorecard*, the Tampa-St. Petersburg urban area ranks among the most congested areas in the U.S., with each peak period traveler annually wasting about 52 hours in traffic and 24 gallons of fuel due to congestion delays [4].

The objective of this chapter is to estimate the mobility and accessibility benefits associated with the Selmon Expressway as they relate to the households and businesses of Hillsborough County. This study adopts a counter-factual approach to determine the transportation and economic consequences of eliminating the Selmon Expressway from the regional road network. The approach consists of modeling traffic changes for two scenarios: the inclusion and the exclusion of the Selmon Expressway from the regional network. The difference between the two scenarios represents the Selmon Expressway's effect on travel behavior in terms of trip-generated vehicle miles of travel and travel times.

This study considers travel improvements that directly affect user travel times, safety, and emission reductions as benefits that do not produce a flow of money into the economy. Other improvements that produce out-of-pocket cost savings to individuals and businesses are assumed to generate indirect and induced impacts on the local area. These improvements are discussed at the end of this chapter.

User Benefits

The total value of travel benefits depends on the changes in travel conditions that users would face in the absence of the Selmon Expressway. To estimate changes in travel conditions, THEA's traffic engineers ran a travel demand model with and without the Selmon Expressway. The analysis was conducted at the traffic analysis zone (TAZ) level to estimate changes in trips, vehicle miles of travel (VMT), and travel times for personal and commercial vehicles. Engineers ran the model using TAZs comprising Citrus, Hernando, Hillsborough, Pasco, and Pinellas counties.

Table 3-1 reports estimates of daily travel conditions for the selected TAZs comprising the primary market area. In the absence of the Selmon Expressway, traffic conditions would worsen and travelers would spend more time in congested traffic. Some users would travel less, but other users would have to take longer routes to reach the same destinations. For the primary market area, users would travel in excess of 508,632 VMT daily without the Selmon Expressway, wasting fuel in congested conditions and negatively contributing to the area's

increase in pollution emissions. This change in travel behavior would also translate into reduced safety (i.e., increased traffic accidents) and out-of-pocket costs, as discussed in the next sections of this chapter.

Table 3-1. Forecasted Travel Changes (Annual)

Travel Changes	*Without Selmon*	*With Selmon*	*Change*
Vehicle Miles of Travel (Million)	39,316	39,186	-130.7
Vehicle Hours of Travel (Million)	989.5	982.4	-7.2
Crashes	78,288	78,028	-260.0
Injuries	82,094	81,821	-273.0
Fatalities	597.0	596.0	-1.0
Excess Fuel Consumption (Gallons, Million)			
Private Vehicles	1,578	1,573	-5.2
Commercial Vehicles	297.7	296.7	-1.0
Emissions (Tons)			
Global Warming (CO2 Equivalent)	17,371,222	17,313,474	-57,747
Carbon Monoxide (CO)	196,349	195,696	-652.7
Nitrogen Oxides (NOx)	26,988	26,899	-89.7
Volatile Organic Compounds (VOC)	19,297	19,232	-64.1

Source: CUTR calculations based on THEA traffic engineer forecasts
All figures represent yearly averages at projected 2040 conditions

Figure 3-1 illustrates the travel time savings for TAZs within the primary market area where the majority of Selmon Expressway users reside and where more than 80 percent of the toll transactions originate. These savings correspond to per trip average travel time savings from each TAZ to all modeled TAZs. The figure shows that the largest travel time savings (more than 14 minutes per trip) occur at the end points of the Selmon Expressway and the southern areas of Hillsborough County.

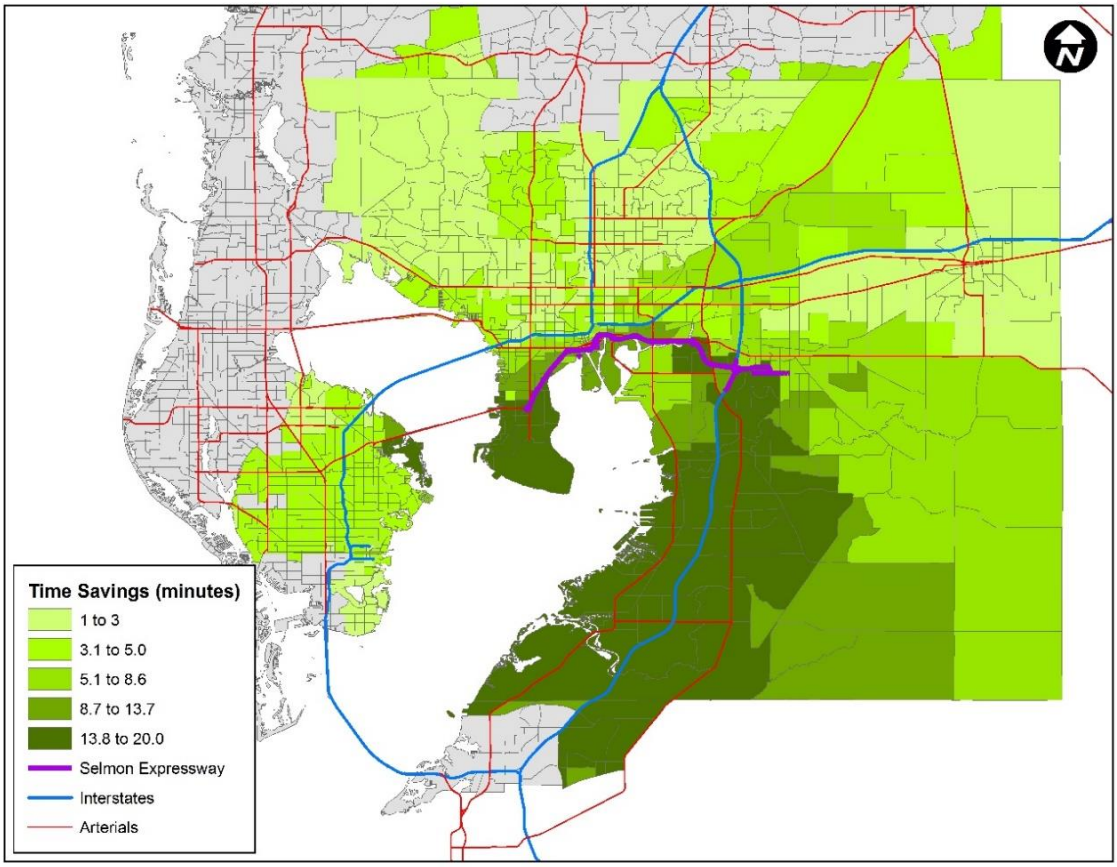

Figure 3-1. Travel Time Savings Due to Selmon Expressway

Next, these changes in travel conditions are translated into quantifiable user benefits. The benefits are assumed to occur yearly at 2040 conditions (i.e., per travel model output), under the assumption that travel occurs during 364 days. Appendix B describes in more detail the formula used to estimate user benefits and the original data sources.

Travel Time Savings

The value of 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. This study considers the cost associated with travel time spent for commuting and for other purposes, or non-work travel. It also estimates travel time savings associated with commercial travel. The value of travel time savings is the product of four values:

- Change in VHT
- Vehicle occupancy rate
- Value of time, measured in dollars per hour
- Percent of travel by trip purpose

Travel time savings for non-work purposes are valued at 50 percent of the prevailing average wage rate; for commuting purposes, at 100 percent of the prevailing average wage rate. This evaluation is consistent with recommendations by the U.S. Department of Transportation [5]. The prevailing average wage rate for the impact area is provided by the Bureau of Labor Statistics and is equal to $19.28 per hour (in 2015 dollars) [6]. This study uses the 2009 National Household Travel Survey to estimate the percent of travel for work and personal purposes [7]. These percentages are used to weight the total value of travel time savings. Table B-1 in Appendix B reports the results of this estimation.

Health and Safety

A considerable amount of the state's motor vehicle accidents occur in the Tampa-St. Petersburg MSA, accounting for a significant amount of injuries and fatalities. Table 3-2 shows that in 2015, more than 54,000 motor vehicle crashes occurred in the Tampa-St. Petersburg metropolitan statistical area. This amounts to approximately 14.6 percent of the total crashes in the state. Of these accidents, 72.6 percent reported injury, representing 16.3 percent of the state's 243,137 total injuries. Crashes with fatalities represent about 0.5 percent of the total accidents in the MSA and result in 404 fatalities, or 14.0 percent of total fatalities statewide.

Table 3-2. Accidents by Severity Type in the Tampa-St. Petersburg MSA, 2015

Category	*Tampa-St. Petersburg MSA*	*State*	*Share of State*
Total Crashes	54,660	373,808	14.6%
Total Injuries*	39,715	243,137	16.3%
Traffic Fatalities	404	2,880	14.0%

Source: Florida's Integrated Report Exchange System (FIRES)

**Includes total possible, incapacitating, non-incapacitating injuries*

Changes in health and safety costs associated with crashes represent another relevant component of the benefits associated with travel improvements. These include monetary costs, such as property and personal injury damages caused by collisions and cost avoidance activities, as well as non-monetary costs, such as pain and loss of productivity. This study estimates the changes in comprehensive health and safety costs associated with changes in the number of vehicle crashes, as a result of being part of the Tampa-St. Petersburg MSA transportation network.

Comprehensive health and safety costs associated with vehicle crashes are estimated as the total cost per accident by severity type, multiplied by the change in the number of crashes in

each severity class; the product is summed over all severity classes. The total change in accident cost is the product of three values:

- Change in VMT
- Accident rates (in million per VMT) by road functional classification and severity type
- Cost of accident by severity type

Accident cost estimates are derived from the National Highway Traffic Safety Administration (NHTSA) report on the economic and societal impact of motor vehicle crashes [8]. This report provides estimates of average economic and comprehensive costs by the KABCO injury scale. KABCO denotes injury categories as fatal (K), incapacitating (A), non-incapacitating (B), possible injury (C), and none (O).

Economic costs include loss of human capital, market productivity, household productivity, medical care, property damage, legal costs, and travel delay. NHTSA does not recommend using economic costs for cost-benefit ratios, since economic costs do not include the "willingness to pay" or intangible costs to avoid these events. Willingness to pay is included in the comprehensive cost estimates using a quality-adjusted life year (QALY) factor loss. The comprehensive cost estimates are presented in Appendix A of the above referenced report. These costs are updated in 2015 constant dollars.

Crash rates are positively related to traffic density, vehicle speeds, and roadway characteristics. For example, Kockelman [9] reports a nonlinear positive relationship between crash rates and vehicle speeds. Wang and Kockelman [10] find that crash rates vary according to vehicle type, with light-duty vehicles (minivans, pickups, and sports utility vehicles) being associated with higher crash rates. Litman [11] provides empirical evidence that crashes increase with annual vehicle mileage and that mileage reduction reduces crashes and crash costs.

This study uses estimates in accident rates from historical traffic accident data presented by Florida's Integrated Report Exchange System.[3] Table B-2 in Appendix B reports the results of this estimation.

Changes in Emission Costs

Air pollution costs are costs associated with emissions produced by motor vehicle use. Motor vehicles produce various harmful emissions that have a negative effect at local and global levels. Exhaust air emissions cause damage to human health, visibility, materials, agriculture, and forests [12, 13]. The major sources of motor vehicle pollutants include carbon monoxide

[3] https://www.firesportal.com/Pages/Public/Home.aspx?ReturnUrl=%2f

(CO), volatile organic compounds (VOCs), nitrogen oxide (NOx), sulphur oxide (SOx), and particulate matter (PM). Pollution costs are the product of three values:

- Changes in VMT
- Emission estimates, measured in grams/mile
- Emission costs, measured in $/Kg

The estimation of pollution emissions relies on emission pollution factors. Pollution emission costs are measured in damages related to health and visibility impacts, and physical impacts on the environment. This study adopts the cost estimates of Delucchi [14], who estimated costs for several impact categories for urban areas of the U.S. in 1991. Delucchi recently updated the original values to account for changes in information about pollution and its effects [15]. Delucchi customizes these estimates by using regional exposure scalars to adjust the average exposure basis in U.S. urban areas to the average exposure in each of the metropolitan statistical areas. According to Delucchi, population density is the best simple measure of exposure to air pollution. This exposure scalar is the ratio of population density in each individual area to the average urban-area population density in his original analysis of 1991 (2,150 persons per square mile). The original 1991 $/Kg are scaled to 2009 dollar values using the consumer price index (CPI). To account for cost of living geographical differences, these estimates are scaled to each individual region using the ratio of an area's median household income to the U.S. median household income. This approach to emission cost estimation is also consistent with the methodology of the U.S. Department of Transportation Highway Economic Requirement System [16]. Table B-4 in Appendix B reports the results of this estimation.

Excess Fuel Consumption

The total cost of excess fuel consumption is equal to total annual gallons of excess fuel consumed, multiplied by the cost of fuel. Changes in fuel consumption account for vehicle fuel efficiency under congested conditions. Excess fuel consumption is estimated as the product of the change in VMT and changes fuel efficiency rates generated in the absence of the Selmon Expressway. This study uses the average gasoline (for all formulations) pre-tax price for sale to end users produced by the U.S. Energy Information Administration (EIA) [17].

Vehicle Operating Costs

Changes in non-fuel operating costs are captured as changes in the cost of operating and maintaining a vehicle. Vehicle operating costs are the product of two values:

- Changes in VMT
- Non-fuel operating cost ($/mile)

This study uses the 2015 non-fuel vehicle operating cost estimates of the American Automobile Association's *Your Driving Costs* report [18]. Estimates of average operating costs for commercial vehicles come from the American Transportation Research Institute Cost of Trucking annual report [19], which provides comprehensive operating and maintenance estimates for trucks.

The average operating cost across all passenger vehicle classifications is $0.06 per mile, while the average operating cost for freight is $0.16 per mile. Table B-5 in Appendix B reports the results of the estimation of fuel and vehicle operating cost savings.

User Benefits Estimates

Table 3-3 reports the results of estimated direct user benefits. The results indicate that most of the benefits accrue due to travel time and accident cost savings.

Table 3-3. User Benefits

Cost Savings Category	*($,Million/Year)*
Travel Time	
To Households	153.4
To Businesses	6.9
Fuel and Operating	
To Households	16.2
To Businesses	2.9
Accidents	89.7
Emissions	4.8
Total	*274.0*

Source: CUTR calculations (Appendix B)

Household Travel Time Savings

Travel time savings measure the value of time that is lost due to congestion and that can be reduced by using the Selmon Expressway; time that households can dedicate to other uses, such as leisure or personal time. The Selmon Expressway saves each person on average 3.8 hours in travel times. This represents a 7.4 percent reduction in the 52 hours of travel spent annually in congested travel. When compounded to all residents of the multi-count travel demand model, this is equivalent to a savings of $153.4 million.

Businesses also reap the benefits of travel time savings, valued at $6.9 million annually. Businesses might be able to convert these travel time savings to increased productivity, output, and sales.

It is relevant to differentiate between the monetary values of Chapter 2, which are defined as economic impacts, versus the monetary values estimated in this section. Benefits associated with reductions in accidents, decreased pollutant emissions, and time spent in travel (which could be dedicated to other activities) do not directly impact the flow of money into the local economy. That is, they do not directly increase business sales. These benefits are relevant for project evaluation purposes when comparing the cost of investment versus the benefits that might be produced. On the other hand, savings in out-of-pocket costs, such as fuel and vehicle operating costs, have impacts that spill over to the rest of the local economy.

Household Cost Savings

The user benefits analysis shows that the Selmon Expressway saves households about $16.2 million per year in fuel and vehicle operating costs. When adding the value of time, each households saves $141.9 annually.

In addition, savings on fuel and vehicle operating costs represent money saved to use on other household expenditures. Gasoline and out-of-pocket medical expense savings due to reduced travel times, improved travel conditions, and accident reductions make personal disposable income available for other goods and services. According to the U.S. Census Bureau, about 160,000 households, or about 13.5 percent of all households in the study area (1.19 million), earn $15,000 or less per year. To these households, out-of-pocket and travel time cost savings are relevant in terms of added accessibility and increased purchasing power.

The economic impact of these savings is equal to an additional $17.1 million in business sales, which help support 128 jobs per year. These estimates represent the additional indirect and induced effects generated by the household out-of-pocket cost savings spent back into the local economy.

Benefits to Selmon Expressway Users

The benefits listed in Table 3-3 accrue to all travelers within the counties considered by the travel demand model (Citrus, Hernando, Hillsborough, Pasco, and Pinellas). According to the 2014 American Community Survey (ACS) five-year estimates, about 1.19 million households reside in these counties. Dividing the total value of travel time and out-of-pocket cost savings by the number of households produces a benefit of $141.9 million annually per household.

To estimate the benefits to Selmon Expressway users specifically, a more precise definition of what constitutes the user market area is needed. Figure 3-2 defines the Selmon Expressway market area as the set of zip codes where more than 80 percent of the toll transactions originated during fiscal year 2015-2016.

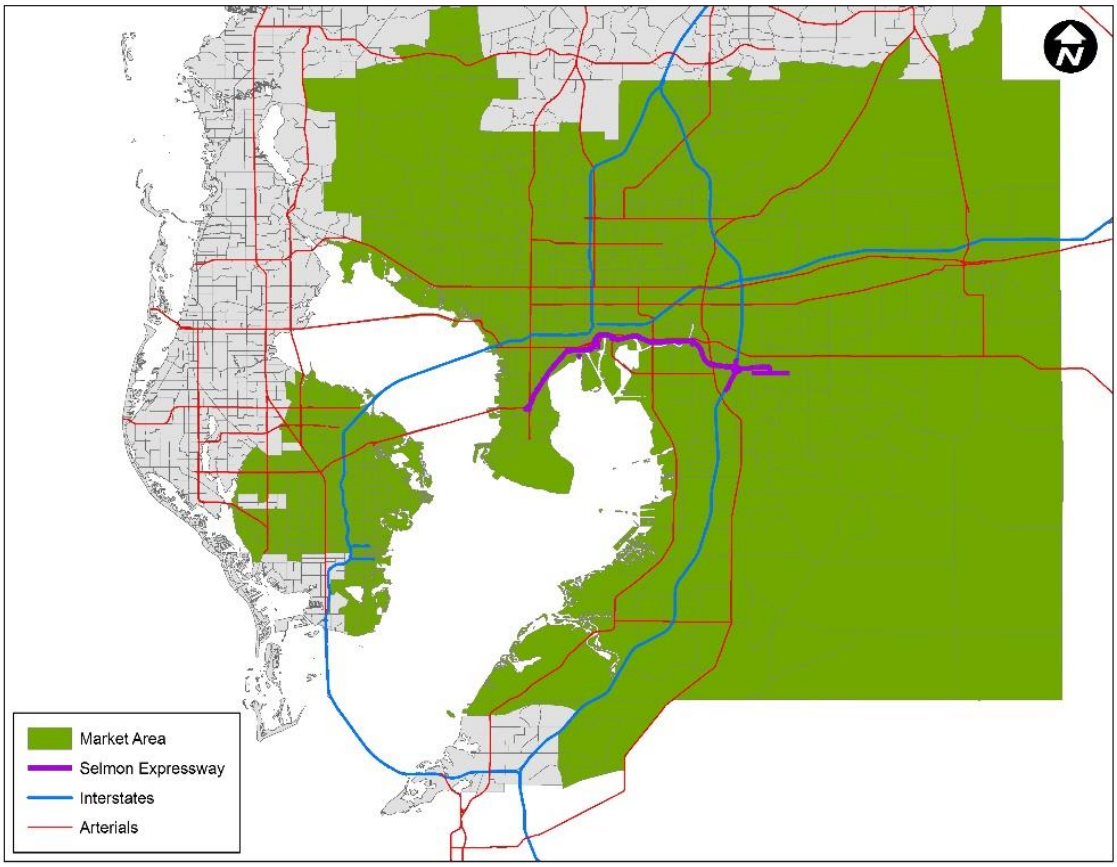

Figure 3-2. Selmon Expressway Primary Market Area

Source: THEA Toll Operation Statistics

According to the American Community Survey 2014 five-year average estimates (zip code level), about 573,800 households reside in these zip codes. Total gross toll revenue for FY 2015 is about $69.3 million, or $120.8 per household residing in the market area. Taking the ratio of $141.9 to $120.8 produces a benefit-to-cost ratio of $1.2. This means that households paying to access the Selmon Expressway save $1.2 for each dollar spent to access it, a 20 percent gain.

Chapter 4
Impact on Business Activity

Business firm location decisions are driven by spillover effects from the clustering of other firms that increase customer base and proximity to a transport network offering increased accessibility to customers, employees, and suppliers. On the other hand, employment is the result of a firm's current and past levels of product demand, firm-specific market conditions, and generalized economics trends.

The analysis of this section hypothesizes that expected accessibility gains from the Selmon Expressway, and in particular the REL and Brandon Parkway opening in 2006, affect business location decisions. Increased accessibility leads to clustering of residential units in proximity to the expressway points of access. This leads to a larger pool of workers and customers, which in turn positively affects firm location decisions, sales, and employment levels. To measure changes in the number of establishments and employment levels, the analysis employs longitudinal data from Infogroup, a provider of business and residential data.[4] Infogroup's national business database contains more than 24 million businesses, and the national consumer database has more than 265 million consumers. All records are telephone verified and updated daily. Each record in the business database is geocoded and includes business name, address, employee size, and North America Industry Classification System (NAICS) codes at the 6-digit level. Firms have unique identifiers, allowing year-over-year comparisons to analyze industry changes and general economic trends over a certain period of time. This allows constructing a panel data to conduct longitudinal inference on location patterns and employment changes.

Trends in Business Activity

As of 2014, there are about 14,400 businesses operating within one mile of the Selmon Expressway, which comprises the study area for this analysis.[5] These businesses represent 23.3 percent of all establishments operating in Hillsborough County.

Figure 4-1 displays a breakdown by industry type following the North American Industry Classification System (NAICS) 2-digit level of industry aggregation. Relative to the rest of the county (Figure 4-2), the study area is similar in terms of business composition, except that it contains a larger proportion of professional and technical services (21.3%).

[4] http://www.infogroup.com/

[5] The analysis of establishments and employment levels omits the government sector, hospitals, and public education institutions.

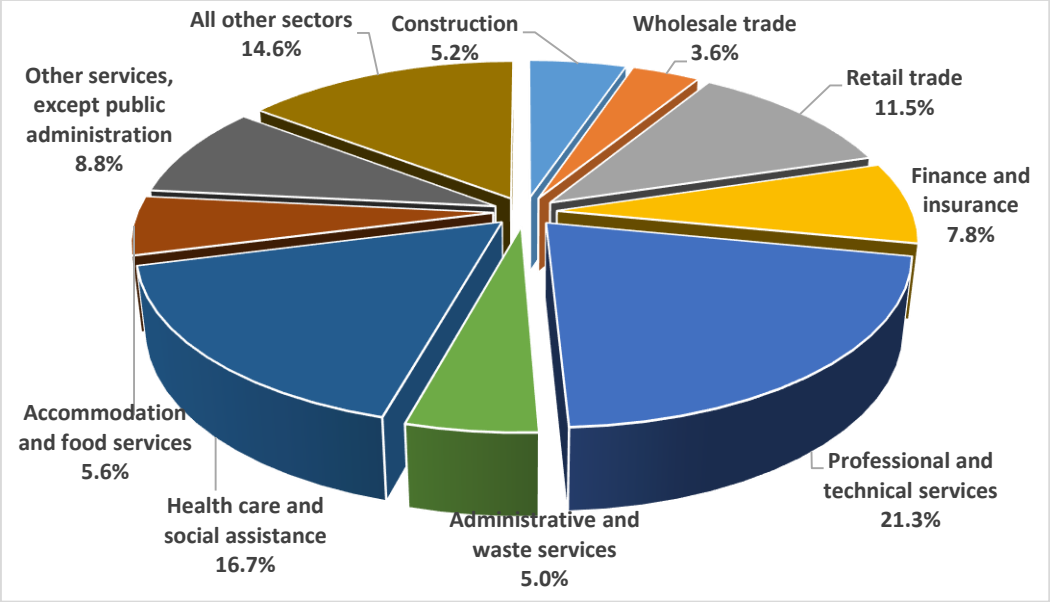

Figure 4-1. Business Composition Within One Mile of Selmon Expressway

The number of business establishments in 2014 increased by 37.5 percent over the number of establishments at the opening of the REL system and Brandon Parkway in 2006. During the same period, the number of establishments in Hillsborough County increased by 31.6 percent. The growth is spread proportionally across the different 2-digit industry sectors, leaving the composition relatively unchanged.

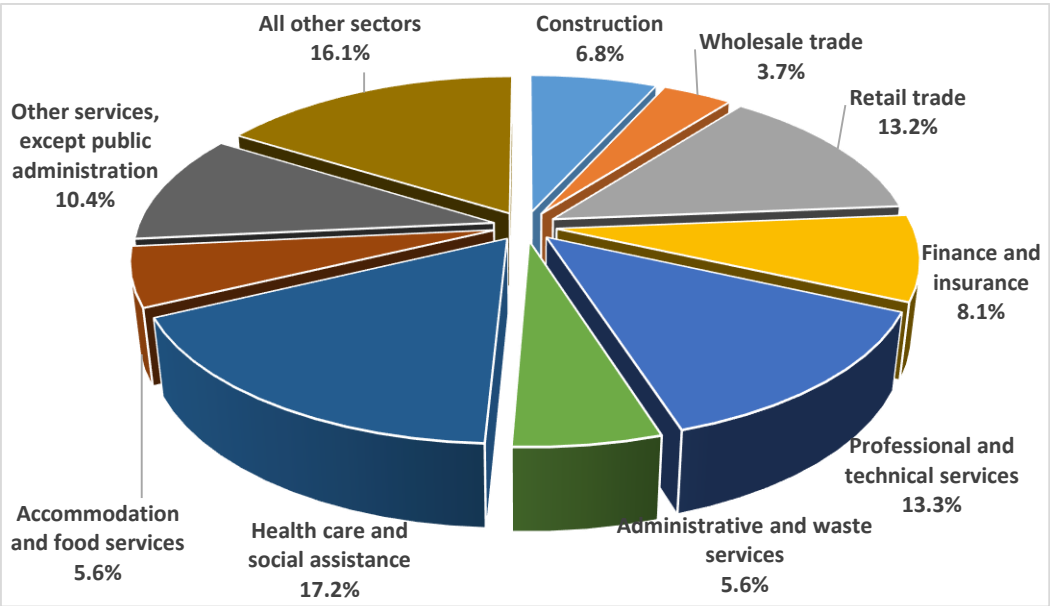

Figure 4-2. Business Composition of Hillsborough County

In 2014, businesses in the study area employed approximately 137,000 workers. About 90 percent of the businesses employed less than 20 workers. As shown in Figure 4-3, the sectors employing the largest number of employees were professional and technical services (19,900 jobs), retail trade (19,600 jobs), and health care and social assistance (16,800 jobs).

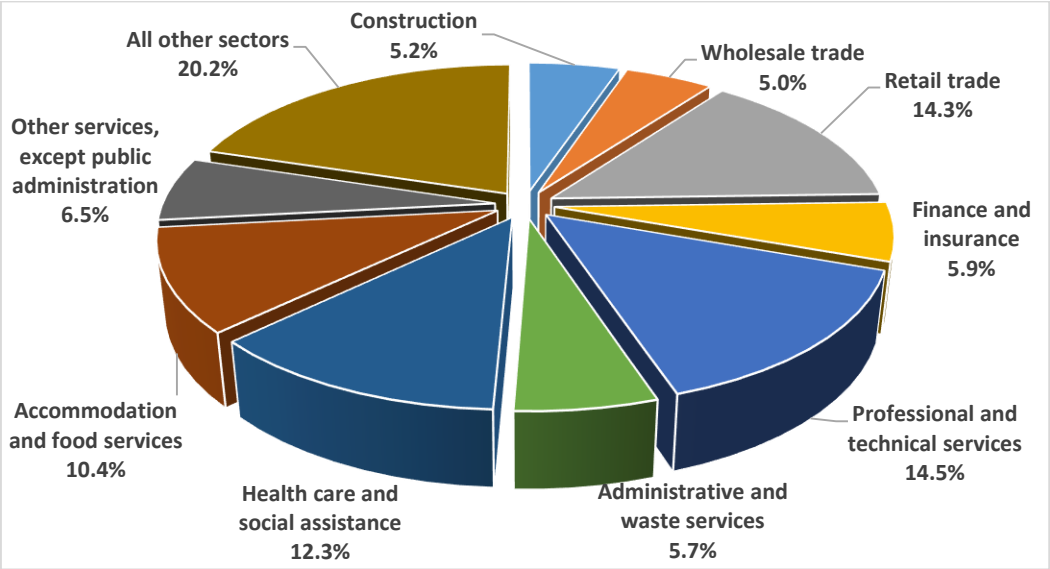

Figure 4-3. Total Employment by Industry - Within One Mile of Selmon Expressway

Between 2006 and 2014, employment within one mile of the Selmon Expressway increased by 14.8 percent (1.7% annually), while employment in the rest of the county increased by 10.2 percent (1.2% annually).

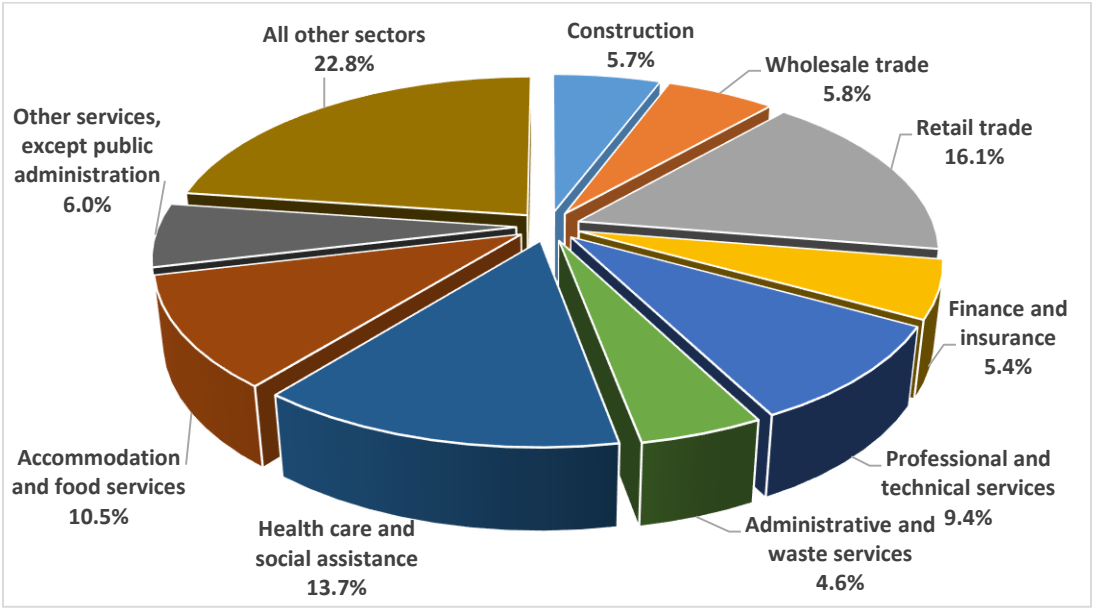

Figure 4-4. Total Employment by Industry - Hillsborough County

The location quotient (LQ) is a useful way to characterize industry concentration and employment distribution in the study area with respect to the rest of the county. The LQ is computed as

$$LQ_{i,j} = \frac{emp_{i,j}/emp_j}{emp_{i,c}/emp_c}$$

Where $emp_{i,j}$ is the employment in sector *i* in area *j* (i.e., study area or one mile buffer around the Selmon Expressway), emp_j is total employment in area *j*, $emp_{i,c}$is county employment in sector *i,* and emp_c is total employment in the county. Industries with an LQ exceeding 1.0 are relatively more concentrated in the study area, having a greater share of the local employment with respect to the rest of the county. For example, professional and technical services account for 14.5 percent of total industry employment within one mile of the Selmon Expressway, but jobs in this sector account for only 9.4 percent of total county employment. The LQ for professional and technical services is equal to (14.5/9.4)=1.5, meaning that businesses in this sector that are located in proximity to the Selmon Expressway employ 1.5 more professional and technical services employees than businesses in this sector in the rest of the county.

Figure 4-5 shows the LQ for all industry sectors (NAICS 2-Digit). The vertical line indicates an LQ equal to 1.0, meaning a given industry has the same share of employment in the study area as it does in the rest of the county.

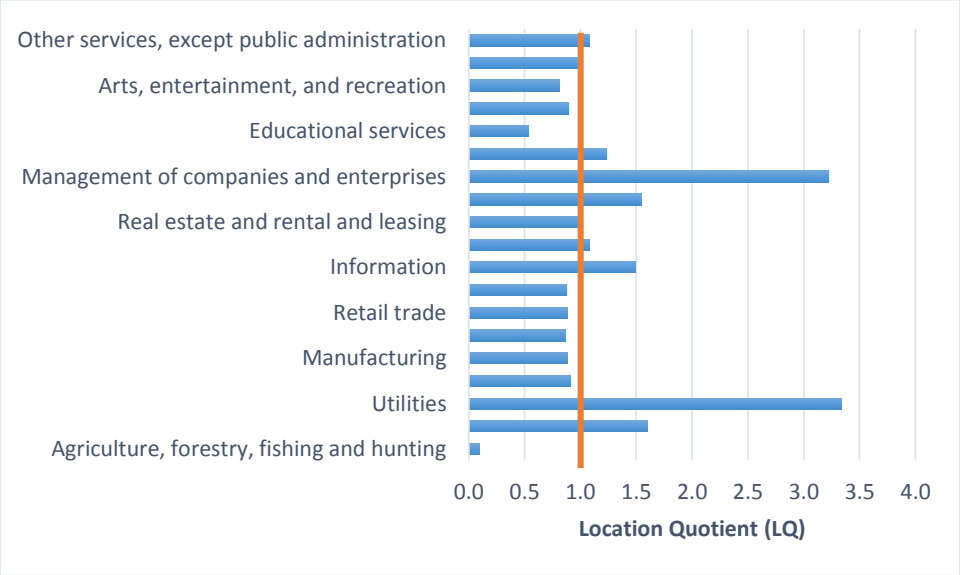

Figure 4-5. Location Quotient – NAICS 2-Digit

The next step in identifying patterns in business activity within the study area is to conduct the analysis at a more disaggregated level, by computing the LQ within subsectors of those industries in Figure 4-5 having an LQ greater than 1.0. Table 4-1 lists NAICS 3-sector industries that experienced growth in terms of number of establishments, employment, and LQ between 2006 and 2014. Businesses in these industries experienced marked growth either in number of new establishments, increased employment, and/or industry concentration.

Table 4-1. Selected Industry Sectors

	Establishments				*Employment*				
				Growth				*Growth*	
Industry	*2006*	*2010*	*2014*	*2006-2014*	*2006*	*2010*	*2014*	*2006-2014*	*Mean LQ*
Furniture manufacturing and retailing	156	130	143	-8.3%	1,432	1,095	1,484	3.6%	1.38
Merchant wholesalers	498	489	510	2.4%	7,445	8,016	6,798	-8.7%	0.94
Building material and garden supply stores	46	37	97	110.9%	1727	1426	1862	7.8%	0.84
Sporting goods, general and miscellaneous retail	393	315	447	13.7%	5,337	4,555	6,125	14.8%	1.00
Truck transportation	55	43	93	69.1%	1,097	903	1,264	15.2%	0.90
Data processing and hosting services	23	18	38	65.2%	191	143	272	42.4%	0.62

The high LQ for some industry sectors reflects the proximity of the Selmon Expressway to Tampa's downtown, industrial areas, and the port. However, for other industries, the high LQ may reflect accessibility and clustering associated with accessibility to the Selmon Expressway. In 2006, the Reversible Express Lane (REL) system was open to traffic, which provided a faster connection to businesses and employees located in proximity to the facility.

The use of spatial analysis tools can shed light on spatial clustering patterns that might be associated with the above changes in business activity in proximity to the expressway. Spatial kernel surfaces provide a useful method for evaluating changes in the distribution of businesses in space and time. Kernel methods generate density surfaces that show where point features are concentrated.

Figure 4-6 through Figure 4-10 use kernel density surfaces to evaluate changes in the spatial distribution and concentration of businesses (measured in terms of businesses per square mile) by comparing the year 2006 to 2014.

Figure 4-6 shows that in 2006 (upper map) the establishments engaged in manufacturing and retailing new furniture (NAICS 337-442) were most densely clustered along the Selmon Expressway corridor in the Brandon area. In addition to home furnishing fixed point-of-sales, establishments engaged in the manufacturing of furniture articles, such as cabinets, window blinds, and other wood and metal fixtures, are included on the map.

In 2014 (lower map), establishment density in the Brandon area declined, while it increased in other areas along the Selmon Expressway, particularly in the entry and access points along Adamo Drive in proximity to the Ikea store (red rectangle in the figure). The reduction of 8.3

establishments corroborates lower density in the Brandon area. On the other hand, the increased density around the Ikea superstore indicates agglomerative and clustering effects, supported by a 3.6 percent increase in employment during the same period. Note that the location quotient is 1.4.

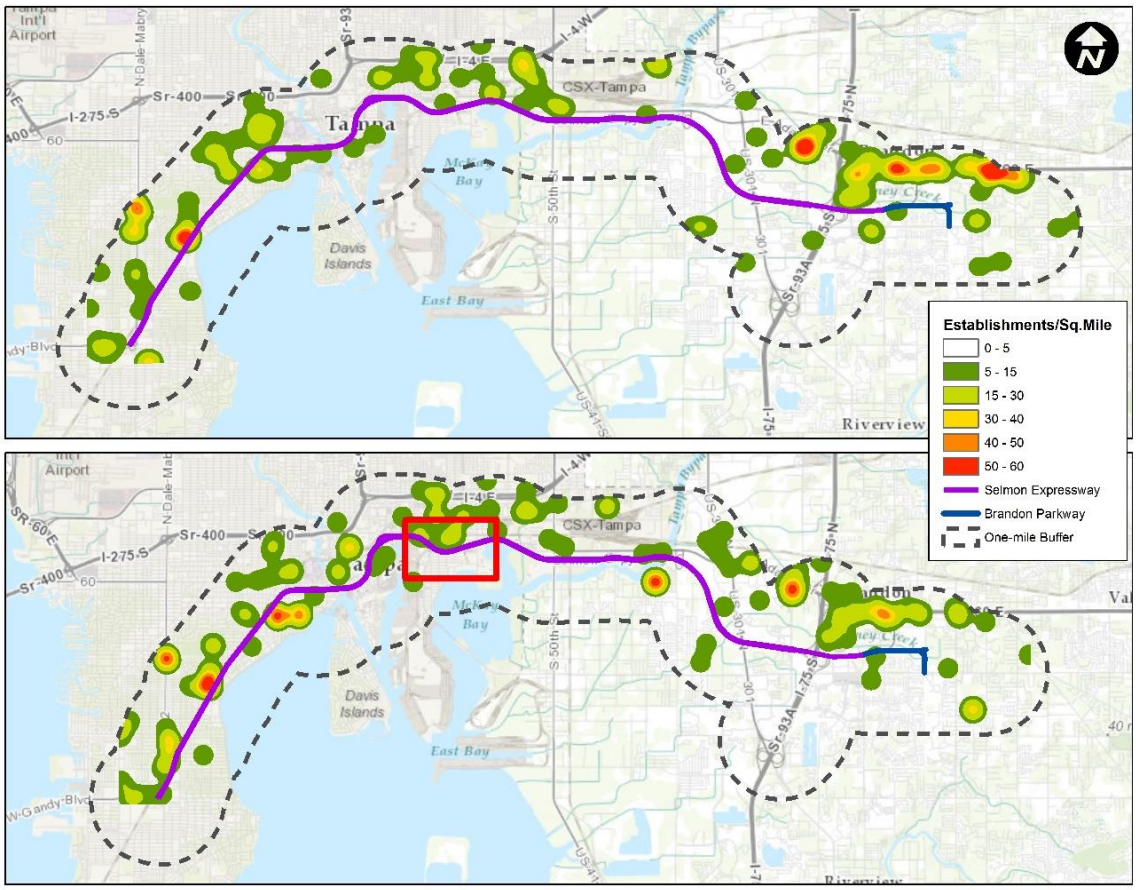

Figure 4-6. Establishment Density, 2006-2014: Furniture Manufacturing and Retailing (NAICS 337-442)

Figure 4-7 shows the spatial kernel density maps for businesses engaged in the wholesale of durable and nondurable goods (NAICS 422 and 423). Durable goods establishments are engaged in wholesaling a variety of products, such as motor vehicles, machinery, metal and minerals, appliances, and sporting and hobby goods. Nondurable goods wholesale trade establishments are engaged in wholesaling products such as paper and paper products, chemicals and chemical products, drugs, textiles and textile products, apparel, and food and farm products. The modest growth (2.4%) in the number of establishments in the Merchant Wholesalers, for example, is primarily reflected in the increased density in proximity to the Brandon Parkway (see red rectangle).

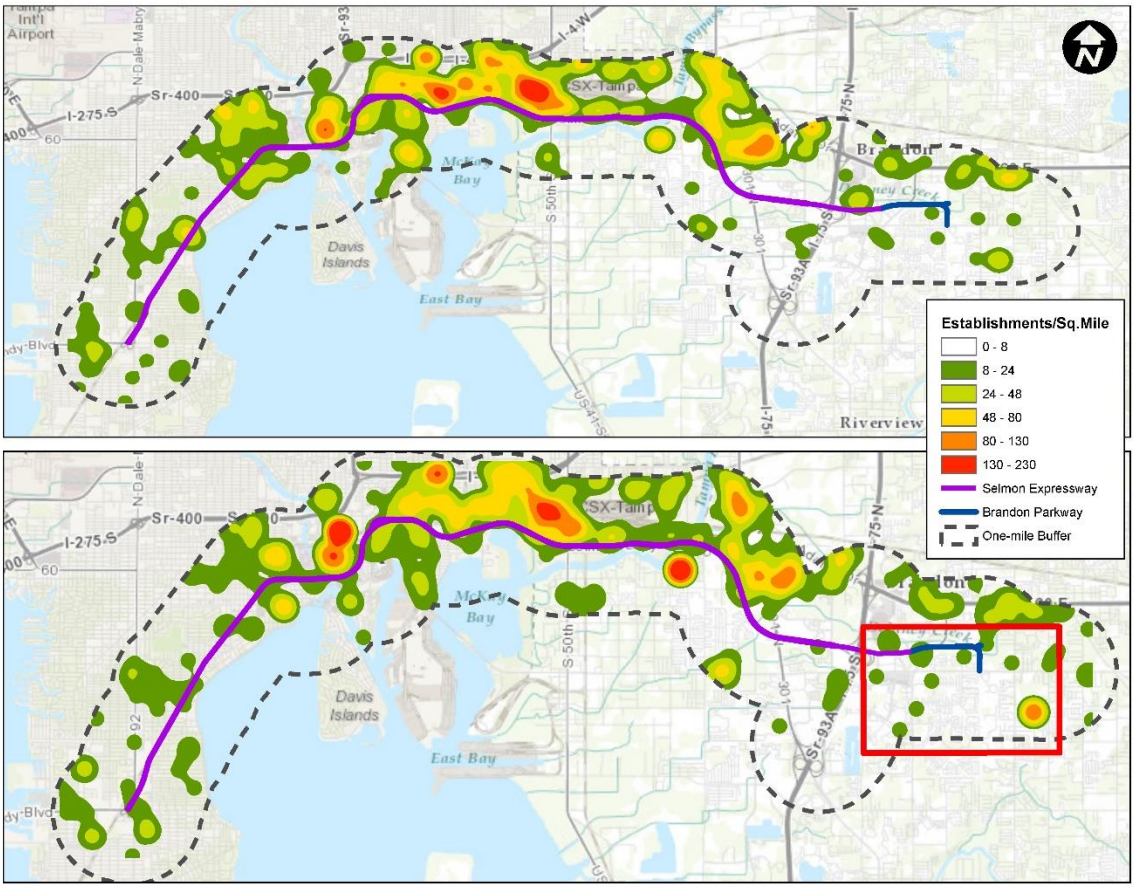

Figure 4-7. Establishment Density, 2006-2014: Wholesale Trade (NAICS 423-424)

Figure 4-8 displays the spatial density of businesses engaged in the retail of repair and maintenance material for homes and other units, and the provision of garden equipment and supplies (NAICS 444). This sector experienced rapid growth during 2006-2014. By 2014, the number of businesses more than doubled, from 46 to 97 units, and there was a 7.8 percent growth in employment over 2006 levels, employing about 1,800 in 2014.

The map shows that establishment density increased along the Selmon Expressway corridor, with the highest density spots at the Selmon entry and exit points. The clustering of these businesses might be related to ease of accessibility for customer-households, since goods and supplies sold in this industry include bulk garden and equipment supplies.

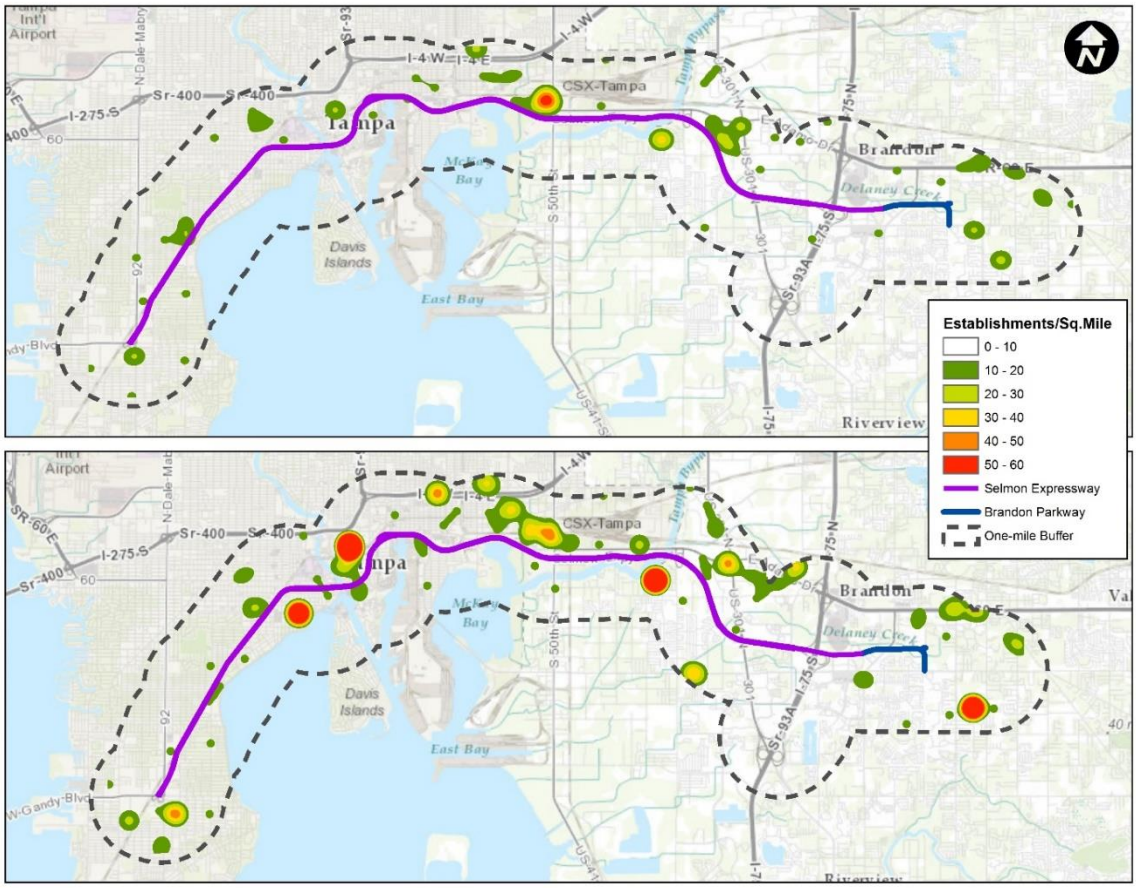

Figure 4-8. Establishment Density, 2006-2014: Building Material and Garden Supply Stores (NAICS 444)

Between 2006 and 2014, the number of sporting goods, general merchandise, and miscellaneous store retailers increased by 54 units (13.7%), resulting in a growth of about 800 jobs (14.8%). Figure 4-9 shows that establishment density increased in the Brandon area in proximity to the Brandon Parkway and Lumsden Road (red rectangle in the figure).

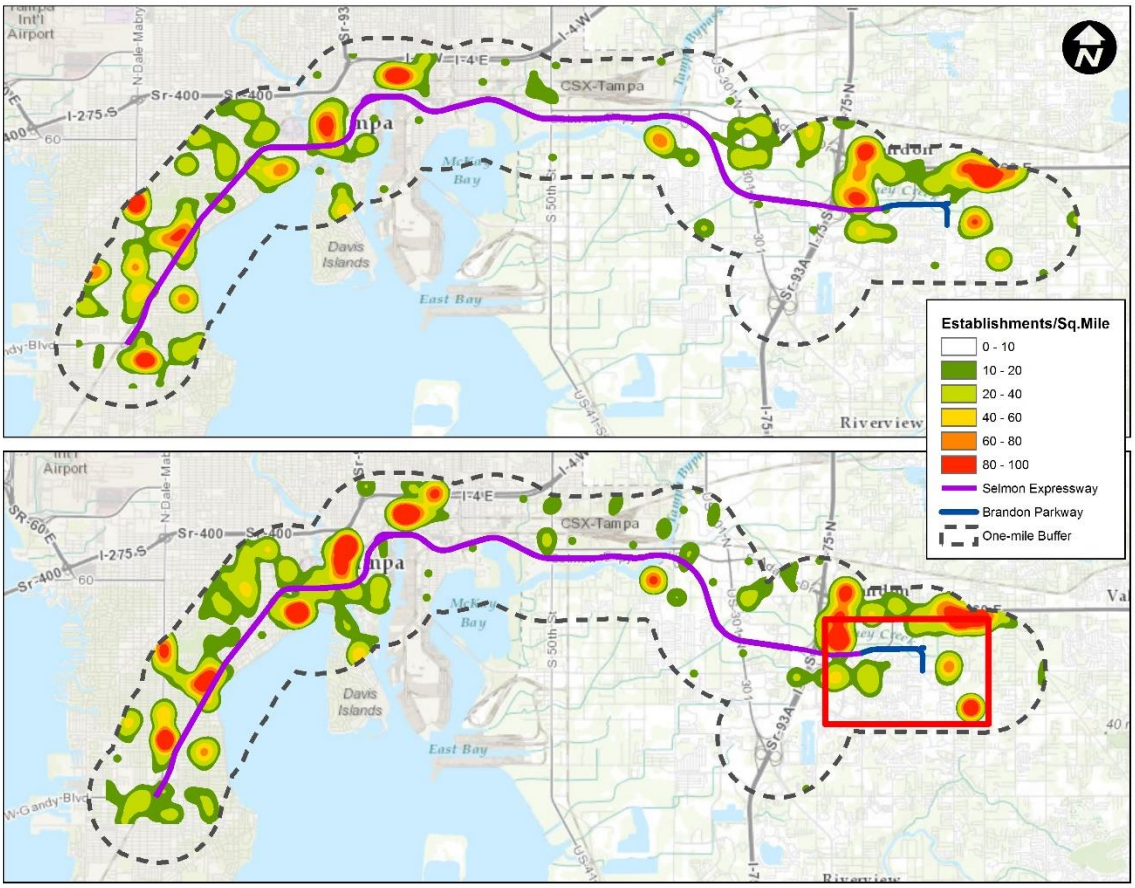

Figure 4-9. Establishment Density, 2006-2014: Sporting Goods, General, and Miscellaneous Retail (NAICS 451 to 454)

Industries in the truck transportation sector (NAICS 484) provide over-the-road transportation of cargo using motor vehicles, such as trucks and tractor-trailers. This sector is further subdivided into generalized (NAICS 4841) and specialized (NAICS 4842) freight trucking to reflect differences in equipment used, type of load carried, and scheduling and terminal services. General freight transportation establishments handle a wide variety of commodities, typically palletized and transported in a container or van trailer. Specialized freight transportation includes cargo that, because of size, weight, shape, or other inherent characteristics, requires specialized equipment for transportation. Each of these industry groups is further subdivided based on distance traveled. Local trucking establishments primarily carry goods within a single metropolitan area and its adjacent nonurban areas. Long distance trucking establishments carry goods between metropolitan areas.

The number of truck transportation businesses located within one mile of the Selmon Expressway increased by 69.1 percent (or 38 businesses) during 2006-2014, with employment rising by 15.2 percent to about 1,200 workers. The largest growth occurred in the generalized

trucking subsector (71% of the growth in businesses) engaged in long-distance freight transportation.

Figure 4-10 shows that between 2006 and 2014 this growth was localized to areas in close proximity to the Selmon Expressway entry/exit ramps, in particular in proximity to U.S. 301 (highlighted red rectangle).

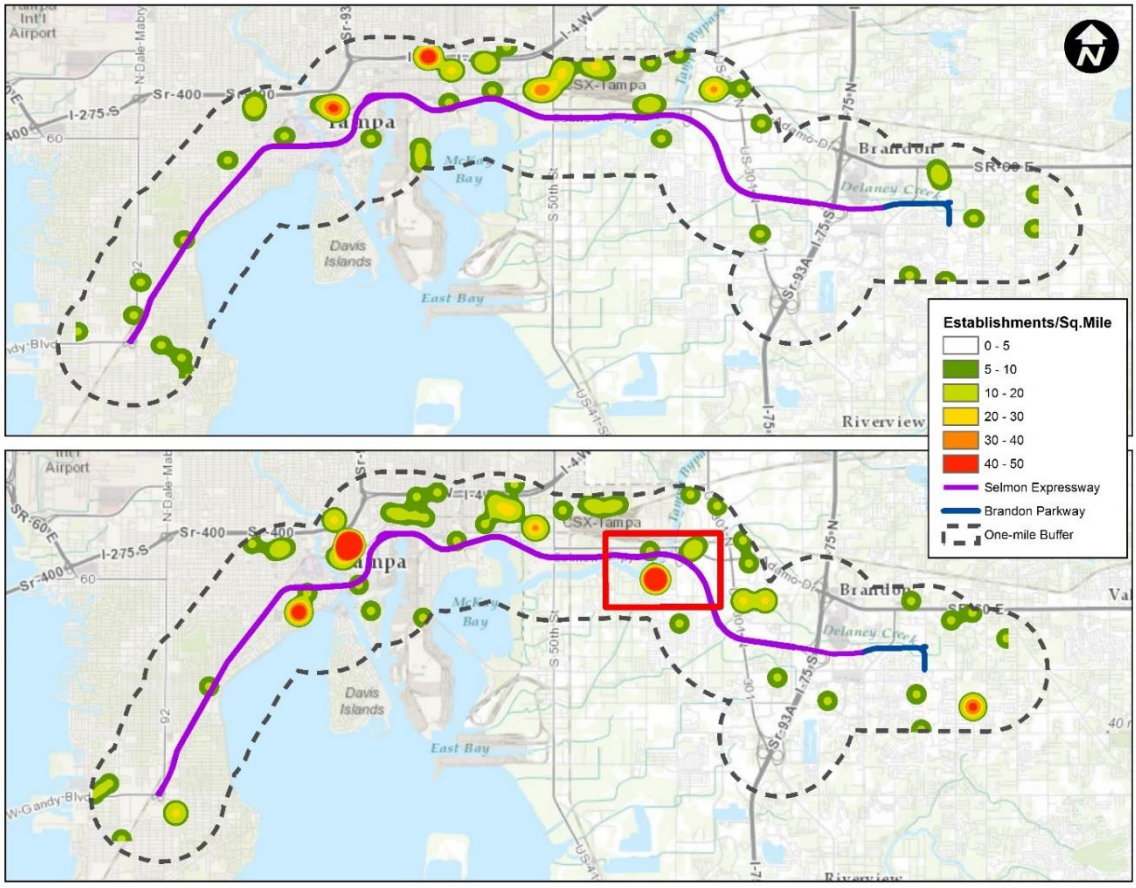

Figure 4-10. Establishment Density, 2006-2014: Truck Transportation (NAICS 484)

The increased economic activity within one mile of the Selmon Expressway of specialized industry sectors and the increased clustering around the facility's main access points provide preliminary evidence of expected and realized accessibility gains realized by strategically locating in proximity to an efficient transportation network. This preliminary evidence is subject to further analysis to test the statistical evidence of proximity to the Selmon Expressway and increased business activity levels.

Changes in the Number of Establishments

As shown in the previous figures, the number of establishments located in the study area changed during 2006-2014. The analysis attempts to estimate whether the Selmon Expressway affected business growth during this period. The test is carried out by regressing the number of establishments at the NAICS 3-digit level using difference-in-differences (DID) technique (Appendix C details the methodology). DID regression is done by comparing changes in the number of establishments located within one mile of the Selmon Expressway to a selected subsample of establishments located within one mile of toll roads and/or interstates in Hillsborough County.

Figure 4-11 shows a map of the study area, highlighting the selection of establishments for statistical analysis. The map shows that overlapping between businesses located within one mile of the Selmon Expressway and the nearby interstate is avoided by omitting observations that are within a half mile of the outer edges of the Selmon Expressway study area.

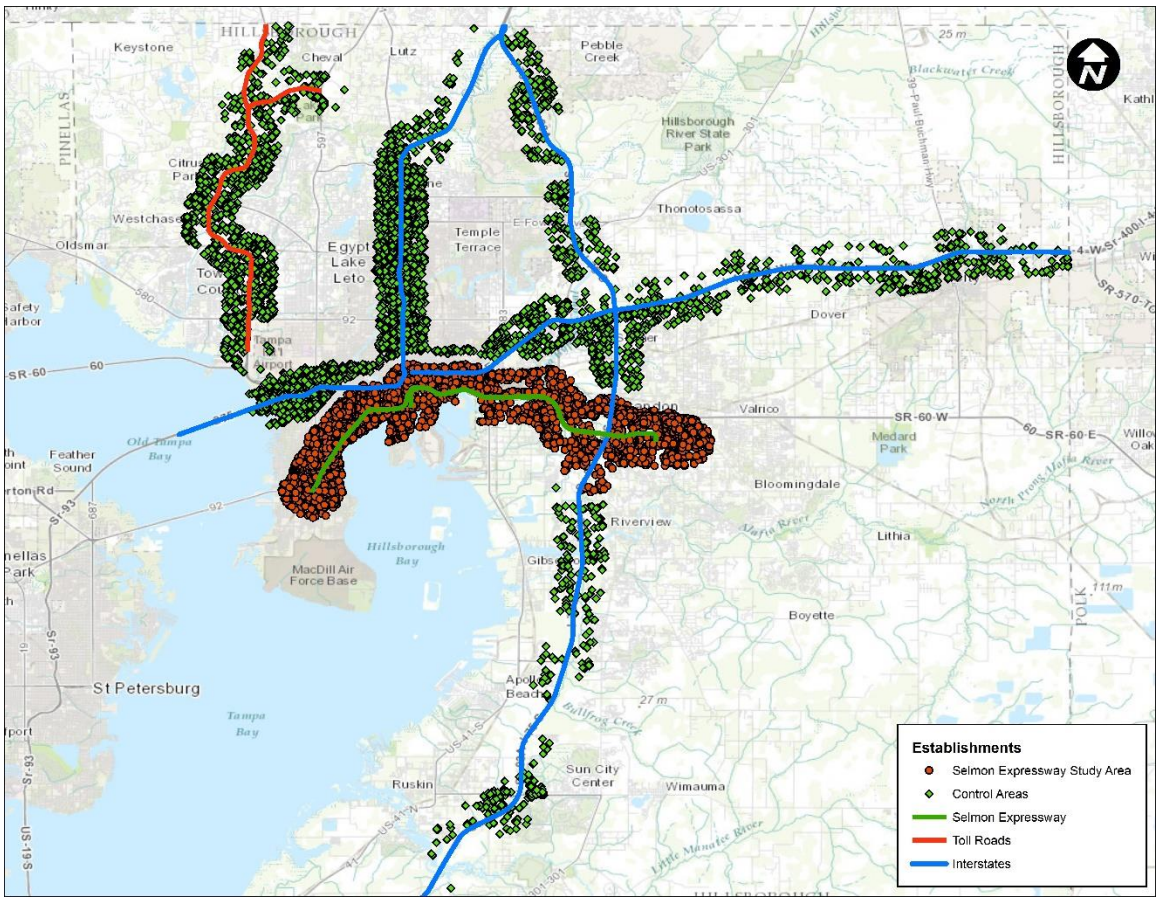

Figure 4-11. Sample of Establishments Selected for Statistical Analysis

Table 4-2 reports sample descriptive statistics. The total number of establishments in the study area is similar to the control areas, while total employment and average firm size is greater in the control areas. The study area shows increasingly greater market concentration compared to the control areas. Market concentration is measured by the Herfindahl-Hirschman index (HHI), defined as the sum of the squares of the market shares (calculated in terms of gross sales) of each business within each industry sector. The HHI ranges from 0 to 100 to indicate increased market concentration.

Table 4-2. Establishment Characteristics

Study Area						
Year	*Establishments*	*Total Employment*	*Average Employment*	*Sales/ Employee ($,000)*	*Industry Concentration Index (%)*	*Location Quotient*
2006	10,498	119,451	11.4	207.9	7.5	1.13
2010	10,720	116,092	10.8	205.5	9.0	1.05
2014	14,431	137,118	9.5	255.2	10.3	1.04
Control						
Year	*Establishments*	*Total Employment*	*Average Employment*	*Sales/ Employee ($,000)*	*Industry Concentration Index (mean)*	*Location Quotient (mean)*
2006	11,558	153,569	13.3	217.0	5.5	0.98
2010	11,611	154,028	13.3	210.1	7.8	1.02
2014	14,862	169,344	11.4	279.7	8.2	1.05

Note: The sample excludes government and unclassified establishments, and establishments employing more than 900 workers.

The econometric model uses fixed-effect regression (FE) to control for time-invariant, industry-specific, unobservable characteristics that may affect establishment location decisions. Productivity, as measured by the sales per employee ratio, is useful for comparing productivity across businesses within the same industry. This variable is obtained by dividing the total gross business sales by the total number of employees for each industry sector. Businesses with higher productivity tend to be more efficient and profitable, which affects the number of firms operating within the sector.

Table 4-3 displays the results of the regression on the number of establishments. The initial sample consists of an unbalanced panel of 493 observations on NAICS 3-digit establishments (84 NAICS 3-digit sectors in the study area, 88 sectors in the control areas, and T=3 years). The table reports the naïve pooled ordinary least-squared (OLS) and the fixed-effects (FE) regression results, controlling for time-invariant, industry-specific effects. The study area is defined to be a one-mile radius around the Selmon Expressway and the control area is defined as the one-mile radius buffers around the Hillsborough County interstates and toll roads (See Figure 4-11). Both

models include year dummy variables to control for common exogenous shocks from business cycle effects and secular trends. Table 4-3 shows different specifications comparing establishment growth within the Selmon Expressway study area to control areas in proximity to toll roads (A), interstates (B), and toll roads and interstates combined (A + B).

Table 4-3. Changes in the Number of Establishments - Regression Results

	Toll Road Control (A)		*Interstate Control (B)*		*Combined (A + B)*	
Independent Variable	*OLS*	*FE*	*OLS*	*FE*	*OLS*	*FE*
Study area (treatment)	0.968***	0	0.0563	0	-0.169	.
	(0.272)	(.)	(0.283)	(.)	(0.285)	.
Year 2010	-0.0846	0.0444	0.108	-0.0782*	-0.0171	-0.0597
	(0.274)	(0.0525)	(0.282)	(0.0470)	(0.281)	(0.0471)
Year 2014	0.158	0.244***	0.253	0.200***	0.188	0.178***
	(0.274)	(0.0531)	(0.280)	(0.0469)	(0.281)	(0.0475)
Study area*Year 2010	**0.0909**	**-0.0760**	**-0.0587**	**0.0522**	**0.0523**	**0.0281**
	(0.383)	**(0.0731)**	**(0.402)**	**(0.0664)**	**(0.404)**	**(0.0674)**
Study area*Year 2014	**0.0826**	**0.0636**	**0.0183**	**0.114***	**0.0824**	**0.132***
	(0.381)	**(0.0733)**	**(0.398)**	**(0.0663)**	**(0.401)**	**(0.0675)**
Natural log of LQ	0.145	0.251***	0.684***	0.324***	0.494***	0.245***
	(0.112)	(0.0436)	(0.133)	(0.0399)	(0.151)	(0.0441)
Sales per employee	-0.000962***	-0.000359**	-0.00104***	-0.000407***	-0.00123***	-0.000416***
	(0.000354)	(0.000139)	(0.000373)	(0.000116)	(0.000382)	(0.000123)
Constant term	2.735***	3.059***	3.668***	3.551***	3.927***	3.665***
	(0.213)	(0.0387)	(0.213)	(0.0325)	(0.215)	(0.0342)
Observations	418	418	435	435	438	438
R-squared	0.119	0.316	0.096	0.422	0.065	0.339

*Standard error in parenthesis: * p<0.05; **p<0.01, ***p<0.001*

2006 is the baseline year of comparison

The parameters of interest are highlighted and represent the difference-in-differences estimators of Selmon Expressway effects on the growth in the number of business establishments. Both models show that the change in the number of establishments within the study area is greater in 2014 compared to the control areas (note that the OLS model parameter is not statistically significant). The FE model accounts for industry-specific, unobserved characteristics and provides statistical evidence of positive proximity effects on establishment growth. While there is no statistically significant difference in business growth in the study area compared to similar businesses located in proximity to other toll roads (A), the model finds a statistically significant difference in establishment growth with respect to businesses located in proximity to interstates (B) and with respect to businesses in the combined control areas (A + B).

Referring to the fixed-effect model as the preferred estimator and using the proportional change formula[6], the results show that, all else being equal, in 2014 establishments located in proximity to the Selmon Expressway were experiencing a 14.1 percent higher growth in number than comparable businesses located near other transport accessibility infrastructures (i.e., the combined control areas). Other factors explain business growth and are related to industry specialization, measured by the estimated LQ parameter associated with industry concentration. In particular, a 10.0 percent increase in localized industry specialization increases establishment growth by about 2.8 percent.

Changes in Employment Levels

While there is statistical evidence of positive growth in the number of establishments for firms located near the Selmon Expressway, these effects may encompass relocation decisions rather than creation of new businesses. As discussed earlier, expected and realized changes in accessibility have an impact on not only firm location, but also on growth within the firm. More specifically, at the firm level, increased accessibility from improvements to the Selmon Expressway, such as the REL system and the Brandon Parkway, may have an impact on business employment at the establishment level. This section tests the hypothesis that the infrastructure improvements have an impact on firm employment. The estimation strategy shares the statistical methods used in the previous section and is based on a difference-in-differences specification using the business employment level as a dependent variable.

Table 4-4 summarizes the regression results with the parameters of interest highlighted. The fixed-effect model performs better than the naïve estimator (OLS) in terms of explanatory power and in terms of accounting for unobserved firm effects. As in the previous analysis, the table shows different specifications comparing employment growth within the Selmon Expressway study area to control areas in proximity to toll roads (A), interstates (B), and toll roads and interstates combined (A + B).

[6] The proportional change is estimated by applying the following formula [(exp (β)-1)*100], where β is the estimated parameter expressing the interaction term between treatment project phase.

Table 4-4. Effects of the Selmon Expressway Infrastructure Investments on Business Employment

	Toll Road Control (A)		*Interstate Control (B)*		*Combined (A + B)*	
Independent Variable	*OLS*	*FE*	*OLS*	*FE*	*OLS*	*FE*
Study area (treatment)	-0.128***	-0.0608	-0.0399***	-0.0249	-0.0381***	-0.0305*
	(0.0141)	(0.0475)	(0.00861)	(0.0179)	(0.00802)	(0.0168)
Year 2010	0.00228	-0.00269	0.0108	-0.0128***	0.00649	-0.00851**
	(0.0173)	(0.00833)	(0.00931)	(0.00406)	(0.00820)	(0.00361)
Year 2014	-0.0259	-0.0101	0.00932	0.00220	-0.00322	0.00110
	(0.0164)	(0.0113)	(0.00869)	(0.00550)	(0.00769)	(0.00504)
Study area*Year 2010	**0.000345**	**-0.00931**	**-0.0101**	**0.00305**	**-0.00562**	**-0.00102**
	(0.0189)	**(0.00892)**	**(0.0121)**	**(0.00510)**	**(0.0112)**	**(0.00478)**
Study area*Year 2014	**0.0709*****	**0.0570*****	**0.0342*****	**0.0478*****	**0.0465*****	**0.0494*****
	(0.0178)	**(0.0122)**	**(0.0112)**	**(0.00717)**	**(0.0105)**	**(0.00684)**
Natural log of establishment sales	0.757***	0.643***	0.745***	0.658***	0.747***	0.658***
	(0.00272)	(0.0112)	(0.00225)	(0.00887)	(0.00208)	(0.00837)
Natural log of location quotient	-0.107***	-0.0150	-0.0650***	-0.0496***	-0.0930***	-0.0704***
	(0.00796)	(0.0146)	(0.00667)	(0.0143)	(0.00618)	(0.0143)
Natural log of Herfindahl Index	-0.0676***	0.0183***	-0.0462***	0.00667*	-0.0478***	0.00524
	(0.00270)	(0.00520)	(0.00197)	(0.00389)	(0.00187)	(0.00381)
Constant term	-3.596***	-2.580***	-3.519***	-2.750***	-3.537***	-2.754***
	(0.0240)	(0.0808)	(0.0183)	(0.0584)	(0.0170)	(0.0556)
Observations	38441	38441	56252	56252	63459	63459
R-squared	0.736	0.634	0.723	0.649	0.727	0.648

*Standard error in parenthesis: * p<0.05; **p<0.01, ***p<0.001*

2006 is the baseline year of comparison

The results, consistent across all models and control areas, show that when comparing 2014 to 2006, businesses operating in proximity to the Selmon Expressway experienced higher employment growth than businesses located near other toll roads and interstates. Specifically, study area businesses experienced a 5.9 percent higher growth in employment compared to employment growth in businesses along similar toll roads, 4.9 percent higher growth than comparable businesses located in proximity to interstates, and 5.1 percent higher growth than comparable establishments located in the combined control areas (toll roads and interstates).

Summary of Findings

The analysis reports findings consistent with agglomerative effects associated with the Selmon Expressway accessibility improvements completed in 2006. More specifically, there is evidence to support that in 2014 these improvements resulted in a 14.1 percent higher growth in the number of business establishments relative to comparable areas within Hillsborough County (Table 4-5).

Table 4-5. Summary of Business Activity Impacts

Impact Type	*Toll Road Control (A)*	*Interstate Control (B)*	*Combined (A + B)*
Employment Growth	5.9%	4.9%	5.1%
Establishments Growth	NA[†]	12.1%	14.1%

[†]Effect not statistically significant

The analysis also provides evidence of increased employment, with growth increasing by 5.1 percent more than comparable locations. These effects may understate the true impact that THEA's investments have had on business establishments and employment growth given that businesses may have already begun opening locations in anticipation of the REL opening in 2006, the initial point of reference for the model.

Chapter 5
Impact on Urban Development

Since its inception, THEA has provided mobility benefits to a relevant share of commuters by improving accessibility for commuters living and working in both the western and eastern areas of Hillsborough County.

As discussed in Chapter 2, THEA has a long history of capital asset investments and improvements. In 1986, the Authority completed extension of the Crosstown Expressway to connect South Tampa to Interstate 75. In 1996, the Authority began planning the Brandon feeder roads, which resulted in a 3.5-mile system in the eastern part of Hillsborough County. Construction of the reversible express lane project was completed in 2006, resulting in added capacity and urban landscaping improvements. In addition, the improvements to Meridian Avenue along the Channelside district contributed to changing Tampa's downtown identity and spurred additional real estate development. During this time period, the areas around the Selmon Expressway experienced rapid growth in business and residential establishments.

The objective of this chapter is to ascertain the extent to which THEA capital improvements contributed to this growth. The analysis will identify changes in land use patterns that would not have occurred without THEA or a specific capital improvement project sponsored by THEA and will quantify the magnitude of these changes.

Changes in Property Values

The analysis is based on parcel data from the Hillsborough County Property Appraiser, which provides current tax roll and property sales data. The tax roll data provide detailed parcel information, including parcel size, building size and structural characteristics, the tax assessor estimated value, and the price and date of property sales transactions.

The tax roll datasets contain a land use code, which allows creating property-type categories for subsequent analysis:

- Residential (vacant, single-family, multi-family, condominium, other)
- Commercial
- Industrial
- Government (federal, state, and local)
- Other (public utilities, rights-of-way, rivers, lakes, parks, etc.)

The property appraiser Geographic Information Systems (GIS) office provides GIS shapefiles to plot the parcels, which allows merging information from other sources. In addition, the GIS office provides public access to a variety of land-use GIS shapefiles that are used to augment the parcel dataset for subsequent empirical analysis.

The study area map was imposed over the parcel layers to identify the parcels located within 0.5 miles of the Selmon Expressway. Figure 5-1 shows the location of 52,909 parcels (as of the 2015 tax roll), highlighting residential, commercial, and industrial land uses.

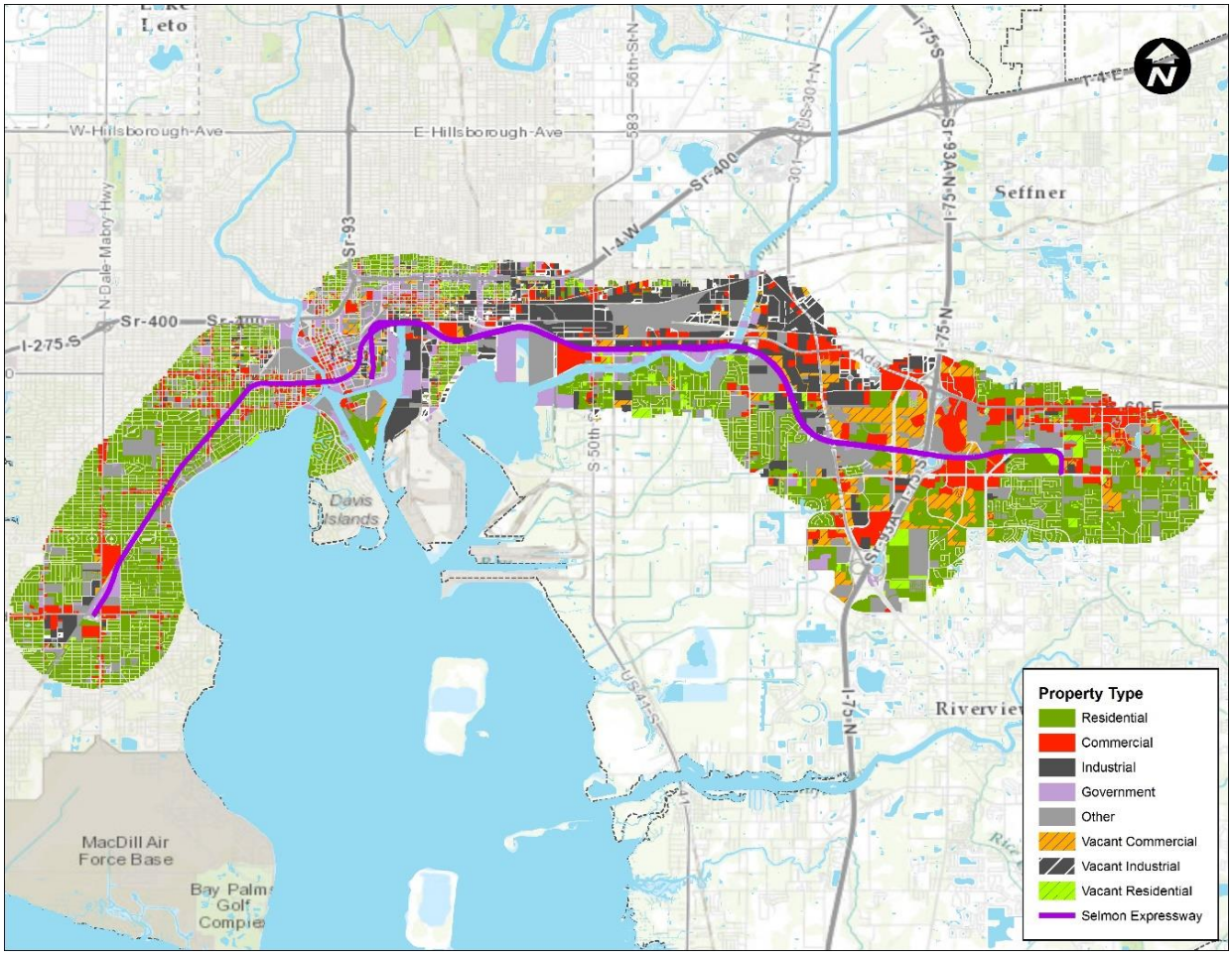

Figure 5-1. Parcels by Land Use

Figure 5-2 shows the property type breakdown in the study area and Figure 5-3 shows the property type breakdown in the county. The share of residential parcels in the study area (82.1%) is slightly lower than the rest of Hillsborough County (84.3%). This is because of the larger concentration of commercial (5.0%) and industrial (1.5%) properties, due to the location of the downtown Tampa central business district (CBD) and the industrial areas east of the CBD.

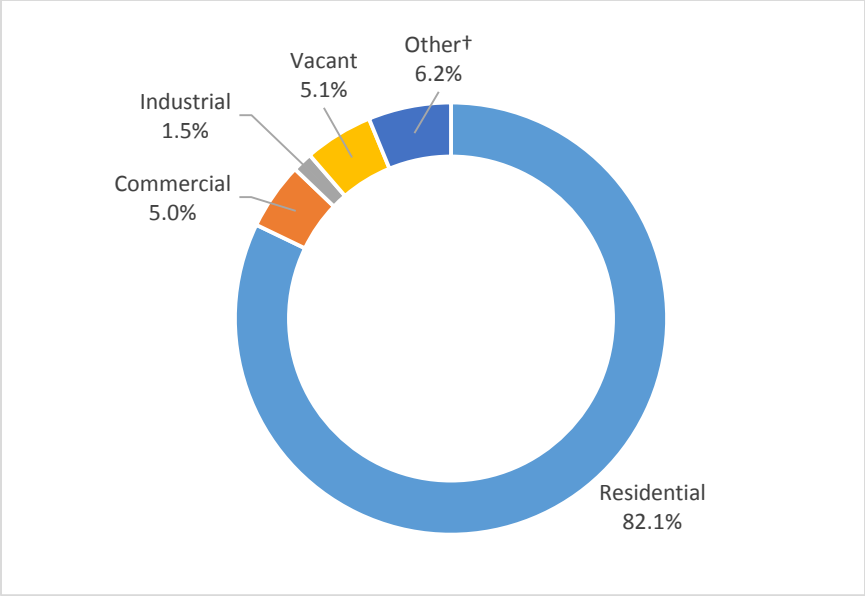

Figure 5-2. Parcel Counts by Property Type - Selmon Expressway Study Area

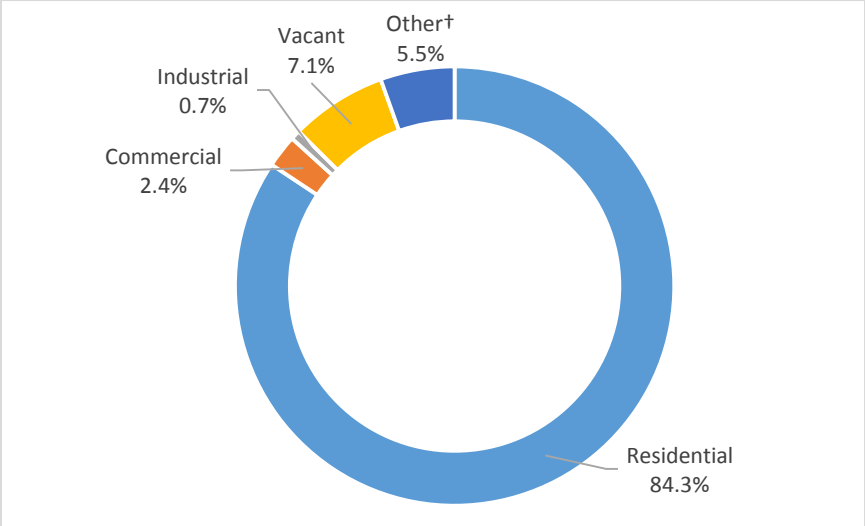

Figure 5-3. Parcel Counts by Property Type - Hillsborough County

†Includes government, public utilities, natural resources, public schools

Residential Properties

As of 2015, the study area contains about 45,000 residential parcels. Figure 5-4 shows the breakdown by single-family, condominium, vacant, and other residential properties. Single-family parcels comprise the vast majority of the total (53.9%), followed by condominium properties (26.4%). There are about 12,000 parcels in the study area categorized as condominium, which represent about 27.9 percent of all condominium parcels in Hillsborough County.

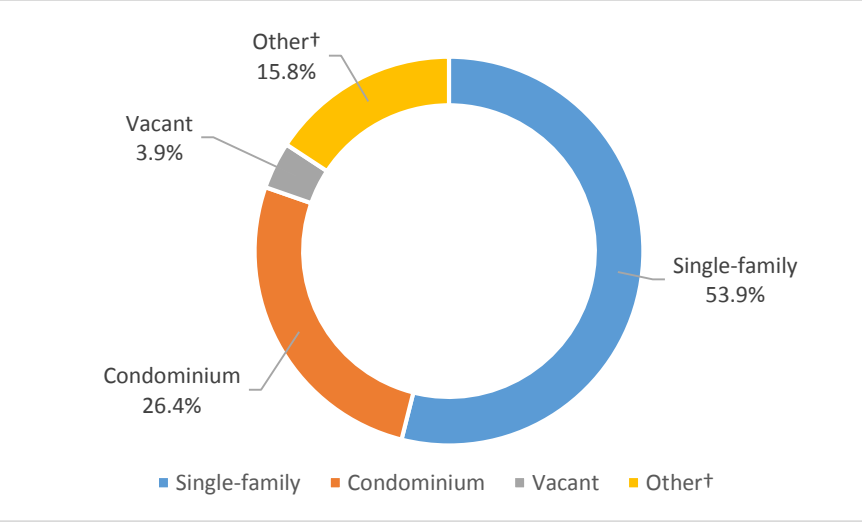

Figure 5-4. Residential Parcels – 2015

Figure 5-5 provides a historical perspective comparing average sale prices for residential property sales within the study area (one-mile buffer) to sales in comparable areas (as defined in Chapter 4) and the rest of Hillsborough County. On average, sale prices of single-family and condominium properties are higher in the study area compared to properties located in proximity to other interstates and toll roads and the rest of the county. The graphs show a generalized spike and downward trend in value corresponding to the 2006-2007 real estate bubble and the years following the Great Recession of 2008-2009. Sales of vacant parcels show a marked increase in value starting in 2010 and faster growth in the study area. When comparing average sale values in 2015 to 2006, single-family properties located in the study area appreciated on average 3.5 percent per year, while the rest of the county shows a yearly appreciation of 1.5 percent.

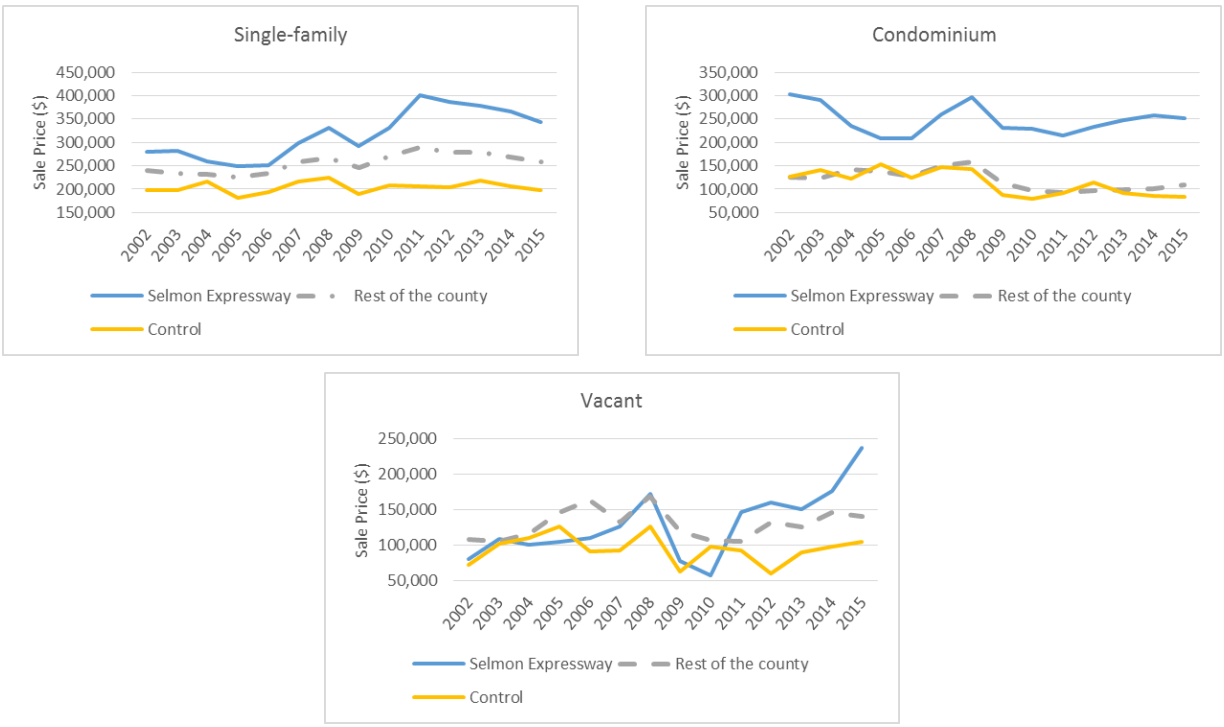

Figure 5-5. Single-Family Property Sales – 2002-2015

Commercial Properties

In 2015, the study area contains 3,368 commercial properties (occupied and vacant). Occupied commercial parcels represent about 23.0 percent of all commercial properties in Hillsborough County. Figure 5-6 provides a breakdown by type, showing that out of all commercial parcels, office parcels represent about 40.0 percent of the total.

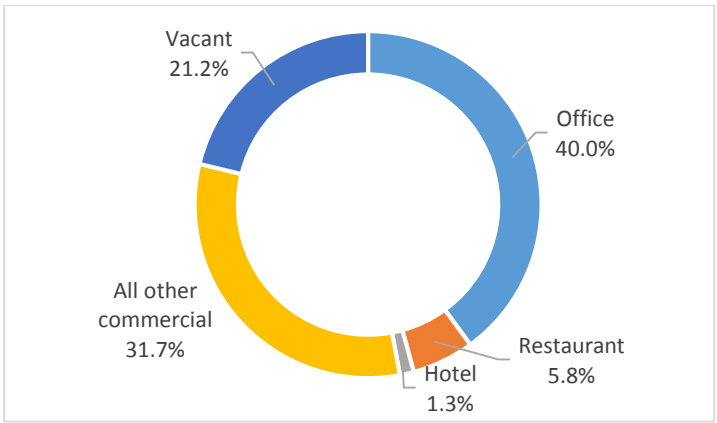

Figure 5-6. Commercial Parcels – 2015

Rapid commercial development occurred along commercially eligible sections of the Brandon Parkway during and after construction. Originally, the Brandon Parkway was designed in coordination with Hillsborough County transportation and economic development officials to

accommodate a future satellite office complex to consolidate government operations when more favorable economic conditions warranted. In addition, THEA coordination with local residents and community leaders during the development of the Brandon road projects resulted in the creation of a linear park with recreation trails along the Parkway, as well as hardscape features consistent with the identity of Brandon as a family-oriented suburban workforce residential community. THEA also coordinated closely with the Brandon Town Center management during the parkway and REL design phases and in development of the REL operating schedule in order to facilitate customer traffic and access. Subsequently, in January 2006, the shopping center commercial developer announced a $50 million, 150,000 square foot expansion to the Brandon Town Center Shopping Mall, which was completed in 2007.

Figure 5-7 shows historical trends in average property sale values for commercial parcels spanning the period 2002-2015. In particular, the market value graph shows that through 2006, commercial property values within the buffer were lower than the rest of the county, but the trend began reversing in 2007. This coincides with the opening of the REL and Brandon Parkway, where a relevant share of the commercial properties are located.

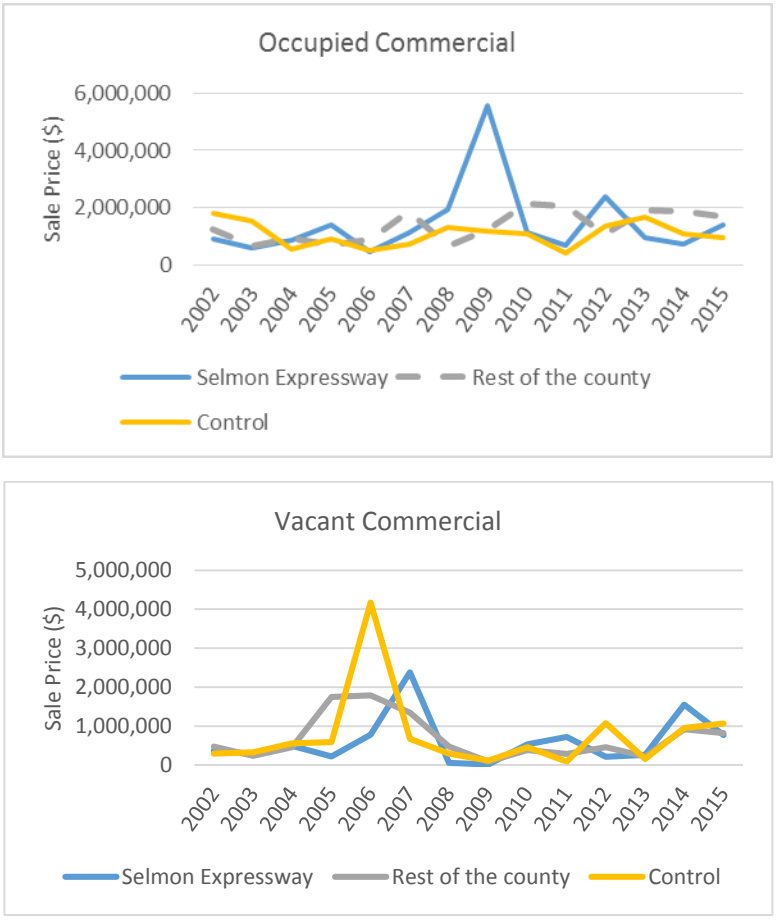

Figure 5-7. Commercial Property Sales – 2002-2015

Accessibility Improvements and Impacts on Property Prices

The accessibility improvements of the Selmon Expressway through the REL system, Meridian Avenue, and Brandon Parkway projects certainly contributed to the growth in the study area. However, the changes in property values and vacancy rates of the previous figures cannot be discerned between growth that would have occurred independent of the accessibility improvements and growth that can be causally attributed to the Selmon Expressway. Furthermore, the changes in property values in this area and across the whole county coincide with periods of positive economic and real estate market growth and the most recent economic downturn. To gauge this impact, the next section presents a statistical analysis directed at separating these two effects to uncover any underlying causality between THEA's accessibility improvement projects and changes in property values.

The objective is to test the hypothesis that accessibility improvements had an impact on property values and to quantify such impact. To test this hypothesis, the research team implemented a statistical analysis that allows distinguishing between changes in property values that would have occurred independent of the Selmon Expressway and changes attributable to the system's accessibility improvements. Appendix C presents details of the statistical approach.

Impact on Residential Property Sales

The empirical model is applied to a dataset of single-family residential property sales over the period 2002-2016. The study area is defined by a one-mile radius around the Selmon Expressway and the control area is defined by the one-mile radius buffers around the Hillsborough County interstates and toll roads (see Figure 4-11).

The Hillsborough County Property Appraiser (HCPA) provided information on parcel sizes and housing characteristics, such as dwelling size, number of bedrooms, age, sale year, and price. After cleaning the data for missing information, the final dataset consists of 34,885 sale records of single-family detached dwelling units.

Table 5-1 shows the regression results, employing a specification that compares property sale prices within the Selmon Expressway study area to control areas in proximity to toll roads (A), interstates (B), and toll roads and interstates combined (A + B). The model controls for several factors positively affecting property sales, such as parcel size, size of living space, number of bedrooms and bathrooms, waterfront, and golf course location. The model also controls for factors that might depress sale prices, such as proximity to industrial sites.

Table 5-1. Single-Family Property Sales – Regression Results

Variable	*Toll Road Control (A)*	*Interstate Control (B)*	*Combined (A + B)*
Study Area (treatment)	0.111***	0.160***	0.157***
	(0.0193)	(0.0195)	(0.0181)
Study Area * Year 2004	0.0174	-0.0104	-0.00363
	(0.0258)	(0.0262)	(0.0244)
Study Area * Year 2004	0.0300	0.0137	0.0190
	(0.0249)	(0.0255)	(0.0238)
Study Area * Year 2005	0.0129	-0.0374	-0.0256
	(0.0249)	(0.0245)	(0.0231)
Study Area * Year 2006	-0.0254	-0.0557**	-0.0486**
	(0.0264)	(0.0253)	(0.0237)
Study Area * Year 2007	0.00456	-0.0542**	-0.0387
	(0.0275)	(0.0266)	(0.0249)
Study Area * Year 2008	-0.00339	-0.00378	0.00238
	(0.0310)	(0.0299)	(0.0283)
Study Area * Year 2009	-0.0523	0.209***	0.142***
	(0.0342)	(0.0359)	(0.0337)
Study Area * Year 2010	-0.0237	0.197***	0.137***
	(0.0332)	(0.0348)	(0.0328)
Study Area * Year 2011	0.0401	0.282***	0.212***
	(0.0333)	(0.0350)	(0.0332)
Study Area * Year 2012	0.00552	0.235***	0.176***
	(0.0321)	(0.0327)	(0.0311)
Study Area * Year 2013	0.0446	0.190***	0.154***
	(0.0288)	(0.0294)	(0.0278)
Study Area * Year 2014	0.0144	0.211***	0.164***
	(0.0284)	(0.0289)	(0.0273)
Study Area * Year 2015	0.0147	0.177***	0.139***
	(0.0262)	(0.0272)	(0.0256)
Study Area * Year 2016	-0.00343	0.174***	0.139***
	(0.0427)	(0.0414)	(0.0393)
Natural log of parcel size	-0.0168**	0.0203***	0.0417***
	(0.00813)	(0.00535)	(0.00473)
Natural log of living space	1.268***	1.211***	1.195***
	(0.0128)	(0.0104)	(0.00891)
Natural log of building age	0.0361***	-0.00324	-0.00912***
	(0.00420)	(0.00262)	(0.00238)
Bathrooms to bedrooms ratio	0.374***	0.330***	0.317***
	(0.0214)	(0.0171)	(0.0151)
Property located on edge of bay or inlet	0.283***	0.595***	0.465***
	(0.0263)	(0.0483)	(0.0253)
Property located on river or lakeside	-0.0672***	0.00657	0.0133***
	(0.00609)	(0.00567)	(0.00450)
Property located near magnet school (0.5 miles)	-0.457***	-0.128***	-0.150***
	(0.0171)	(0.0106)	(0.0104)
Property located near regional mall (0.5 miles)	0.0347	0.499***	0.343***
	(0.0248)	(0.0279)	(0.0205)
Property located near heavy industry site (0.25 mile)	-0.443	-0.500***	-0.525***
	(0.313)	(0.0624)	(0.0651)
Property adjacent to golf course	0.138***	0.218***	0.186***
	(0.0181)	(0.0485)	(0.0169)
Constant term	2.429***	2.981***	3.170***
	(0.106)	(0.0838)	(0.0727)
Observations	15,929	28,060	34,885
R-squared	0.60	0.59	0.60

*Standard error in parenthesis: * p<0.05; **p<0.01, ***p<0.001*

2002 is the baseline year of comparison

Year dummy variables to account for secular trends not reported

The parameters of interest are highlighted and represent the difference-in-differences estimators of Selmon Expressway accessibility improvements on property sales. The results do not show statistically significant property value increases when comparing the study area to comparable properties located in proximity to other toll roads. There is evidence of property value increases for properties located in proximity to interstates and toll roads combined, but in the years following the opening of the REL system (2007).

Using the year 2002 at the base year, Figure 5-8 reports the estimated property value changes using the proportional formula.[7] The results show that single-family properties within one mile of the Selmon Expressway on average sold at a 15.9 percent higher price during the first two years after the opening of the REL system and at 14.9 percent higher in 2016, two years after the opening of the I-4 Connector.

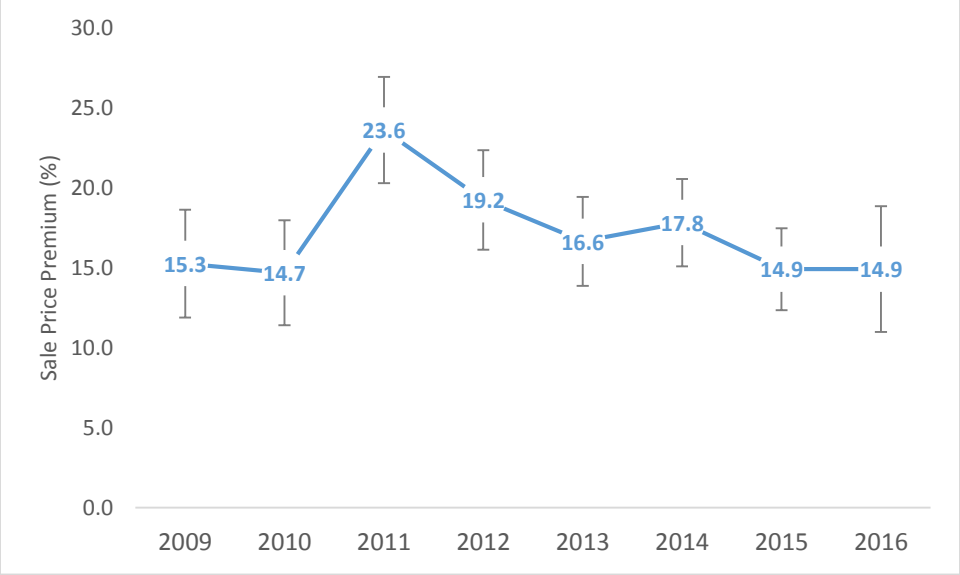

Figure 5-8. Single-Family Property Sales – Estimated Price Changes

Impact on Commercial Property Sales

The analysis of commercial parcels follows the same methodology applied to the assessment of residential properties. The HCPA sales database provides 797 sales transactions of commercial establishments for the period 2002-2016. Table 5-2 reports the regression results.

[7] The proportional change is estimated by applying the following formula [(exp (β)-1)*100], where β is the estimated parameter expressing the interaction term between treatment and year of sale.

Table 5-2. Commercial Property Sales – Regression Results

Variable	*Toll Road Control (A)*	*Interstate Control (B)*	*Combined (A + B)*
Study Area (treatment)	0.0427*	0.230***	0.185***
	(0.0254)	(0.0223)	(0.0202)
Study Area * Year 2003	0.0420	0.0126	0.0188
	(0.0343)	(0.0306)	(0.0276)
Study Area * Year 2004	0.0396	0.00131	0.0183
	(0.0336)	(0.0293)	(0.0266)
Study Area * Year 2005	0.0606*	0.00338	0.0279
	(0.0321)	(0.0277)	(0.0253)
Study Area * Year 2006	0.00724	-0.00121	0.0158
	(0.0350)	(0.0291)	(0.0266)
Study Area * Year 2007	0.00596	-0.0296	-0.00545
	(0.0393)	(0.0316)	(0.0289)
Study Area * Year 2008	0.00515	0.00964	0.0271
	(0.0395)	(0.0326)	(0.0299)
Study Area * Year 2009	-0.0730**	0.134***	0.0976***
	(0.0363)	(0.0309)	(0.0282)
Study Area * Year 2010	-0.0217	0.141***	0.101***
	(0.0362)	(0.0315)	(0.0286)
Study Area * Year 2011	-0.0165	0.173***	0.128***
	(0.0353)	(0.0306)	(0.0279)
Study Area * Year 2012	-0.0234	0.152***	0.120***
	(0.0340)	(0.0291)	(0.0266)
Study Area * Year 2013	0.0234	0.162***	0.139***
	(0.0326)	(0.0281)	(0.0256)
Study Area * Year 2014	0.0230	0.155***	0.139***
	(0.0322)	(0.0273)	(0.0249)
Study Area * Year 2015	0.0319	0.132***	0.122***
	(0.0308)	(0.0264)	(0.0240)
Study Area * Year 2016	0.0667	0.149***	0.150***
	(0.0436)	(0.0342)	(0.0313)
Natural log of parcel size	0.0100**	0.0415***	0.0565***
	(0.00405)	(0.00314)	(0.00276)
Natural log of living space	1.039***	0.983***	1.002***
	(0.00959)	(0.00728)	(0.00646)
Natural log of building age	-0.0184***	-0.0472***	-0.0552***
	(0.00350)	(0.00232)	(0.00212)
Constant term	4.549***	4.927***	4.883***
	(0.0812)	(0.0604)	(0.0537)
Observations	391	740	797
R-squared	0.446	0.476	0.494

*Standard error in parenthesis: * p<0.05; **p<0.01, ***p<0.001*

2002 is the baseline year of comparison

Year dummy variables to account for secular trends not reported

The results indicate that although the parameters exhibit a positive sign as hypothesized, they are not statistically significant for comparing the study area to other comparable properties located near other toll roads. When comparing the combined toll road and interstate control areas, the parameters are statistically significant and show a progressive increase in magnitude.

Figure 5-9 reports the estimated property value changes for commercial sales. Commercial property sales within the study area show sale price increases during the years following the REL opening. Commercial property sale prices increased by 10.3 percent during the first five years of operation, and increased to 16.2 percent higher in 2016.

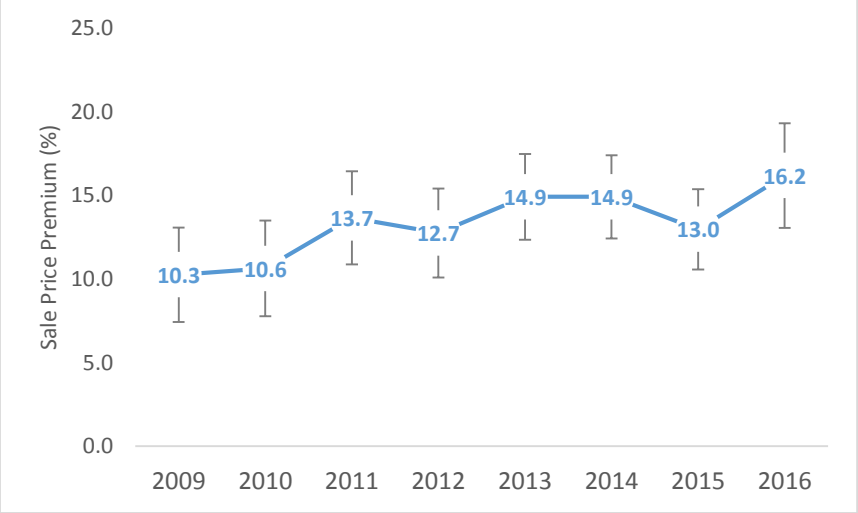

Figure 5-9. Commercial Property Sales – Estimated Price Changes

Summary of Impacts

The analysis finds empirical evidence that improved transport accessibility positively affected both residential and commercial property prices of parcels located in proximity to the Selmon Expressway. During the period 2002-2016, single-family residential units exhibit on average a 14.9 percent higher property sale price than comparable parcels not located in proximity to the Selmon Expressway. Commercial properties exhibit 16.2 percent higher sale prices than comparable parcels located in the control areas for the same time period.

The willingness to pay for more accessible properties also translates into increased property tax revenues. To estimate the change in assessed values within the study, the applicable single-family and commercial property value increases are applied to each parcel's 2015 taxable value. The taxable value corresponds to the property's just market value net of the applicable

homestead exemption. The appropriate millage rate is then applied to the taxable value to estimate the tax revenue.[8]

The analysis finds that the accessibility improvements on the Selmon Expressway resulted in an increase in tax revenue on commercial and residential properties by about $22.9 million, or 8.9 percent of the total estimated 2015 tax revenue of $290.8 million for the entire study area.

[8] http://www.hcpafl.org/Portals/HCPAFL/pdfs/2015FinalMillage.pdf

Chapter 6
Conclusions

Economic Impact of Capital Infrastructure Investments and Operations

Since its inception, the economic impact of THEA's capital infrastructure investments and operations has been substantial in terms of its contribution to economic growth measured by $2.4 billion in total output (gross business sales), $1.2 billion in local gross domestic product, and a combined 13,200 jobs for Hillsborough County and the rest of the state. THEA activities and strategic capital infrastructure investments provide a significant contribution toward supporting jobs in the most relevant industries of the region.

Impact on Urban Mobility

In addition to the impact generated by infrastructure investment spending, THEA's Selmon Expressway produces substantial benefits in terms of travel time reductions, increased safety, and reduction in harmful emissions. This study finds that the Selmon Expressway saves its users $274 million annually.

Selmon Expressway users save on average 3.8 hours in travel time per year. This represents a 7.4 percent reduction in the 52 hours of travel spent annually in congested conditions. Households residing in the study area using the expressway save $16.2 million per year in out-of-pocket costs due to reduced vehicle fuel and operating costs. Savings on fuel and vehicle operating costs represent money for use on other household expenditures. These savings provide an income benefit to households at lower income ranges, representing a consistent gain in purchasing power. Businesses also benefit from improved travel conditions, through savings of about $9.8 million in congested travel and fuel and operating costs.

A considerable amount of the state's motor vehicle accidents occur in the Tampa-St. Petersburg MSA, accounting for a significant amount of injuries and fatalities. In 2015, more than 54,000 motor vehicle crashes occurred in the Tampa-St. Petersburg metropolitan statistical area. This amounts to approximately 14.6 percent of the total crashes statewide. This study finds that THEA's Selmon Expressway contributes to increased safety by reducing the number of crashes and thus reducing property and injury damages by about $89.7 million annually.

Impact on Business Activity

Increased transportation accessibility leads to clustering of business and residential units in proximity to the expressway points of access. This leads to a larger pool of workers and customers, which in turn positively affects firm location decisions, sales, and employment levels. As of 2014, there are about 14,400 businesses operating within one mile of the Selmon

Expressway. These businesses employ approximately 137,000 workers and represent 23.3 percent of all establishments operating in Hillsborough County.

This study finds that by improving business and residential accessibility, THEA's strategic investments increased business clustering and specialization, which resulted in a 14.1 percent higher growth in the number of business establishments relative to comparable areas within Hillsborough County. Increased specialization determined a 5.4 percent higher employment growth than comparable locations.

Impact on Urban Development

Urban economic theory suggests that highway improvements influence urban growth patterns through land prices. The improved accessibility offered by highways generates higher property prices [20-24]. Since its inception, THEA has generated mobility benefits for a relevant share of commuters by improving accessibility for commuters living and working in both the western and eastern parts of Hillsborough County. The Authority engaged in several capital infrastructure projects that added capacity to the system and made home and work locations more accessible. During this period, the areas around the Selmon Expressway experienced rapid growth in business and residential establishments.

Through an extensive analysis of the changes in residential and commercial parcels, this study found empirical evidence that improved transport accessibility positively affected the property prices of both residential and commercial parcels located in proximity to the Selmon Expressway. Single-family residential units exhibit on average 14.9 percent higher property sale prices than comparable parcels not located in proximity to the Selmon Expressway. Commercial properties exhibit 16.2 percent higher sale prices over comparable parcels located in the control areas.

Accessibility improvements on the Selmon Expressway also resulted in an increase in tax revenue on commercial and residential properties of about $22.9 million, or 8.9 percent of the total estimated 2015 tax revenue of $290.8 million for the entire study area.

Conclusions

Investments in highways and other types of transportation system improvements are recognized as an important means to achieve economic growth and development at the local, state, and national levels. Infrastructure investments serve to support key industries, increase mobility, reduce business costs, and expand business opportunities, ultimately leading to economic growth and improved standards of living. This study estimated THEA's contribution to local economic growth through its strategic capital infrastructure investments and the mobility benefits associated with its Selmon Expressway.

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Appendix A
Choice of Input-Output Model

Input-output (I-O) modeling, originally introduced by Leontief [25], describes commodity flows from producers to intermediate and final consumers. It depicts an economic system as a set of tables where the total industry purchases of commodities, services, employment compensation, value added, and imports is equal to the value of the commodities produced. Purchases for final use (final demand) drive the model. Industries producing goods and services for final demand purchase goods and services from other producers. These other producers, in turn, purchase goods and services. This buying of goods and services (indirect purchases) continues until leakages from the region (imports and value added) stop the cycle. These indirect and induced effects (the effects of household spending) can be mathematically derived. The derivation is called the *Leontief Inverse*. The resulting sets of multipliers describe the change of output for each regional industry caused by a one-dollar change in final demand for any given industry.

To conduct economic impact analysis, I-O tables can be acquired by the Bureau of Economic Analysis [26] or by the IMPLAN Group, Inc. (MIG) [27]. IMPLAN is a web-based software that allows the user to develop local level input-output models to assess the economic impact of new firms moving into an area, construction expenditure impacts, firm relocation, professional sports teams, recreation and tourism, and many other activities. The IMPLAN model accounts closely follow the accounting conventions used in the "Input-Output Account of the U.S. Economy" by the Bureau of Economic Analysis and the rectangular format recommended by the United Nations.

This study makes use of the IMPLAN model because it offers a high degree of flexibility in both geographic coverage and model formulation. The data and software also generate a complete set of social accounting matrices for an advanced computable general equilibrium model and tax analysis.

IMPLAN databases are available at the county level and cover several industry sectors. This study uses the 2013 IMPLAN county data files that report economic data for 536 industry sectors. After the impact analysis is conducted at this level, the results are aggregated at major industry sectors. Table A-1 describes the IMPLAN industry sectors, which parallel the North American Industrial Classification System (NAICS) 2-digit level classification.

Table A-1. NAICS Industry Classification and IMPLAN

NAICS	*Industry*
11	Agriculture, forestry, fishing and hunting
21	Mining, quarrying, and oil and gas extraction
23	Construction
31-33	Manufacturing
22	Utilities
42	Wholesale trade
44-45	Retail trade
48-49	Transportation and warehousing
51	Information
52	Finance and insurance
53	Real estate and rental and leasing
54	Professional and technical services
55	Management of companies and enterprises
56	Administrative and waste services
61	Educational services
62	Health care and social assistance
71	Arts, entertainment, and recreation
72	Accommodation and food services
81	Other services, except public administration
92	Public administration
99	Unclassified

IMPLAN provides a means to assess economic impacts caused by changes made to the accounting expenditure matrix for the region analyzed. By entering a change, say, in expenditure in one industry sector, the analyst can see how this affects the overall economic structure of the region. The effects are measured by the same metric used to express the elements composing the original database matrix.

The changes are measured in terms of the following:

- Industry output
- Employment
- Value added
- Final demands

Industry output is a single number in dollars, or millions of dollars, for each industry located in the region. The dollars represent the value of an industry's production. Employment is listed as a single number of jobs for each industry. Data is usually derived from the ES202 employment

security data and supplemented by county business patterns and Regional Economic Information System (REIS) data. It includes both temporary and permanent jobs.

Value added is a subset of total output and is equal to total output minus the cost of materials and labor. It represents a measure of the contribution of production factors and is often used as a measure of economic activity (also defined as GDP). There are four subcomponents of value added:

1. Employee compensation
2. Proprietary income
3. Other property type income
4. Indirect business taxes

Employee compensation describes the total payroll costs (including benefits) of each industry in the region. It includes the wages and salaries of workers paid by employers, as well as benefits such as health insurance and life insurance. Proprietary income consists of payments received by self-employed individuals as income. Other types of income include payments for rents, royalties, and dividends. Indirect business taxes consist of excise taxes, property taxes, fees, licenses, and taxes paid by businesses.

Appendix B
Travel Improvement Impacts, Assumptions, and Data Sources

Travel Time Savings

The value of time measures 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 or other work. Table B-1 details the calculations applied to estimate travel time savings.

Table B-1. Estimation of Travel Time Savings

	Travel Time Savings (Vehicle Hours Traveled)		*Vehicle Occupancy*	*Travel Time Savings (Person Hours*		*Travel Time Savings ($, 2015)*		
Category	*Daily*	*Annual*		*Daily*	*Annual*	*Value of Time [†††] ($/hour)*	*Daily*	*Annual*
Private								
Personal[†]	4,677	1,707,158	1.7	7,904	2,885,098	10.7	84,577	30,870,544
Commuting[†]	13,883	5,067,280	1.1	15,688	5,726,026	21.4	335,718	122,536,954
Total Private[‡] (A)	18,560	6,774,438		23,592	8,611,123		420,295	153,407,498
Commercial[‡] (B)	1,086	396,352	1.0	1,086	396,352	17.5	18,992	6,932,198
Total (A+B)	**19,646**	**7,170,790**		**24,678**	**9,007,476**		**439,287**	**160,339,697**

[†] Split based on the 2011 Comprehensive Traffic and Revenue Study (66.7% commuting, 8.1% business, 25.2% leisure)

[‡] Split based on 2014 Florida Traffic Information database using annual VMT for Tampa-St.Petersburg MSA by vehicle type (94.4% private motorvehicle;6.6% commercial)

[†††] Value of time based on travel purpose (50% of prevailing wage rate for personal; 100% of prevailing wage for commuting and commercial). Wage rates for Tampa St.Pesterburg MSA were obtained from the Bureau of Labor Statistics http://www.bls.gov/oes/current/oes_45300.htm#00-0000)

Change in delay is measured as the change in vehicle hours of travel under congestion and is obtained from THEA traffic engineers.

Average vehicle occupancy is taken from the U.S. Department of Transportation's 2009 National Household Travel Survey person trip file, which reports the number of day trips by trip purpose. These data are available online using the Table Designer feature at http://nhts.ornl.gov/tables09/ae/TableDesigner.aspx.

The private versus commercial travel split data are from the 2014 Florida Traffic Information DVD, available from the Florida Department of Transportation at http://www.dot.state.fl.us/planning/statistics/trafficdata/fti.shtm.

The average prevailing wage rate for the Tampa-Saint Petersburg MSA is obtained from the Bureau of Labor Statistics at http://www.bls.gov/oes/current/oes_36740.htm.

Accident Cost Savings

Accident cost savings are estimated as the change in health and safety costs associated with vehicle crashes. To estimate these changes, the total social cost per accident by severity type is multiplied by the change in number of crashes in each severity class; its product is summed over all severity classes

$$Total\ Health\ and\ Safety\ Costs = \sum Total\ Crash\ Cost_i\ x\ Change\ in\ Number\ of\ Crashes_i$$

Table B-2 displays the calculations applied to estimate changes in accident cost savings. Changes in the accident rates were estimated using historical traffic accident data from Florida's Integrated Report Exchange System (FIRES).

Table B-2. Accident Cost Savings (2015 Dollars)

	Accidents[†]			*Cost per accident*[‡]	*Cost Savings*	*Share of Total*
Category	*Without Selmon*	*With Selmon*	Difference	*($)*	*($)*	
Vehicle Crashes	78,288	78,028	-260	45,975	11,953,480	13.3%
Total Injuries	82,094	81,821	-273	268,951	73,423,705	81.9%
Traffic Fatalities	597	596	-1	4,293,405	4,293,405	4.8%
Total	160,979	160,445	-534	4608331.09	89,670,590	100.0%

[†]*CUTR calculations based on historical crash data from the Florida Integrated Report Exchange System*

[‡]*CUTR calculations based on estimates from Blincoe et al. (2015), Table D-1, pp. 251*

Crash Costs

Crash cost estimates come from the National Highway Traffic Safety Administration (NHTSA) report on the economic impact of motor vehicle crashes [28]. The report provides estimates of average economic and comprehensive costs by crash-assigned injury scale (KABCO). Economic costs consist of loss of human capital, market productivity, household productivity, medical care, property damage, legal costs, and travel delay, and include the "willingness to pay" or intangible costs to avoid these events. The willingness to pay is included in the comprehensive cost estimates using a quality-adjusted life year (QALY) factor loss. The comprehensive cost estimates are presented in Appendix D of the same report (Table D-1, p. 251), and are reported below in Table B-3. These costs are updated from 2010 to 2015 dollars using the Consumer Price Index series for all urban consumers, South Region.

Table B-3. Monetary and Nonmonetary Crash Costs ($/Crash, 2010 Dollars)

Type	*No Injury (O)*	*Possible Injury (C)*	*Non-incapacitating Injury (B)*	*Incapacitating Injury (A)*
Medical Care	2,571	4,393	4,981	21,189
EMS	20	45	56	122
Market Productivity	2,184	5,096	6,465	24,403
Household Productivity	710	1,562	1,966	7,182
Insurance Administration	2,240	3,648	3,670	11,751
Workplace	7	208	1,459	3,941
Legal	56	1,125	1,684	8,557
Subtotal Injury	***7,788***	***16,077***	***20,281***	***77,145***
Congestion	1,026	1,009	995	1,385
Property Damage	1,624	2,407	2,465	3,518
QALYs	31,859	108,274	252,268	919,158
Subtotal Non-injury	***34,509***	***111,690***	***255,728***	***924,061***
Total	***42,297***	***127,767***	***276,009***	***1,001,206***

Source: [28] .[9]

The full report with the comprehensive cost of accidents is available from the National Highway Traffic Safety Administration at http://www-nrd.nhtsa.dot.gov/pubs/812013.pdf.

Changes in Pollution Emission Costs

Table B-4 details the calculations of savings in pollution emissions. For each mode *i* and each pollutant *k*, the total pollution cost *PC* is equal to

$$PC_{ik} = \sum \left(\frac{gram_{ik}}{mile}\right)(VMT_i)\left(\frac{\$}{gram_k}\right)$$

Table B-4. Changes in Pollution Emission Costs

Category	*Reduction in Emissions†*		*Reduction in Costs‡*	
	(kg/day)	*(kg/year)*	*($/kg)*	*($/year)*
Global Warming (CO_2 Equivalent)	18904.79	6,900,249	0.07	472,973.6
Carbon Monoxide (CO)	118.13	43,118	0.14	5,911.0
Nitrogen Oxides (NOx)	0.94	343	4.97	1,704.5
Nitrogen Dioxide (NO_2)	1.30	476	4.97	2,363.2
Particulate Matter (PM2.5)	0.02	6	6.61	41.1
Particulate Matter (PM10)	0.46	167	6.61	1,106.1
Sulphur Oxides (SOx)	0.05	18	11.52	205.4
Volatile Organic Compounds (VOC)	0.31	112	3.77	423.1
Total	*19,026*	*6,944,489*		*484,728*

†CUTR calculations based on EPA MOVES emission rates and THEA traffic engineer estimates

‡CUTR calculations based on unit cost estimates from Delucchi (2002)

[9] KABCO scale classifies crash victims as K–killed, A–incapacitating injury, B–non-incapacitating injury, C–possible injury, or O–no apparent injury.

Emission Costs

Emission costs are measured in $/Kg damages related to health and visibility impacts and physical impacts on the environment. For purposes of this report, cost estimates by Delucchi were adopted [29]. Delucchi's calculations account for exposure damage, which are scaled according to population density levels. This exposure scalar is equal to the ratio of population density in each individual area to the average urban-area population density in Delucchi's original analysis of 1991 (2,150 persons per square mile). The original 1991 cost estimates were updated to 2015 dollar values using the consumer price index (CPI).

Fuel and Vehicle Operating Costs

This study estimates changes in fuel and vehicle operating costs associated with private travel. The change in fuel consumption is measured in total gallons saved. THEA engineers provided the estimates of annual gallons saved. These estimates account for changes in fuel efficiency due to traveling in congested periods. Changes in vehicle operating costs are based on changes in overall travel, measured by VMT. Table B-5 details these calculations.

Table B-5. Changes in Fuel and Vehicle Operating Costs

Category	*Gallons Saved*[†] *(gallons/year)*	*Fuel Cost*[†] *($/gallon)*	*Fuel Cost Savings ($/year)*	*Operating Cost*[†††] *($/mile)*	*Reduced Travel*[†] *(VMT/year)*	*Operating Cost Savings ($/year)*
Fuel Cost Savings (VHT)	7,057,286	2.26	15,914,180	0.06	-3,076,220	187,342
Fuel Cost Savings (VMT)	133,170	2.26	300,298			
Operating Cost Savings						
Total			*16,214,478*			

[†]*CUTR calculations (Appendix B)*

[††]*Energy Information Administration*

[†††]*AAA, Your Driving Costs, 2009 Edition*

The annual average cost per gallon of fuel net of taxes is available from the Energy Information Administration: http://tonto.eia.doe.gov/dnav/pet/pet_pri_refoth_dcu_nus_a.htm.

Per-mile vehicle operating costs (net of fuel costs) are provided by the American Automobile Association (AAA): http://exchange.aaa.com/wp-content/uploads/2015/04/Your-Driving-Costs-2015.pdf.

Appendix C
Difference-in-Difference Analysis of Changes in Property Values

Urban economic theory suggests that transportation improvements influence urban growth patterns through land prices. The improved accessibility offered by transportation investments generates higher property prices. Empirical studies demonstrate that there is generally a positive relationship between accessibility improvements and property values, although results vary by area, investment type, and evaluation method. Early research summarized by Huang [30] and Ryan [31] shows that new highways make land that is farther from the urban center more suitable for residential development by reducing the commute-travel costs. This translates into increasing prices that users pay for residential and other properties. Being too close to a highway can also negatively affect housing prices and reduce accessibility improvements, due to increased noise and pollution exposure.

The basic framework to empirical investigation relies on the use of a hedonic price function relating sale price changes to transportation accessibility improvements, after controlling for housing and location attributes. The hedonic equation usually employs a control either in the form of a dichotomous variable to classify parcels based on buffer distances from the accessibility improvements, or in the form of a continuous variable measuring Euclidean distance from the improvement (a highway, public transit stop, etc.).

To study the impact on residential and commercial property values, this study adopted a model developed by the principal investigator to study changes in commercial and residential property values resulting from transport infrastructure improvements[32]. The model relies on a quasi-experimental design to test for the empirical evidence of price differentials before, during, and after construction and operation of network improvements. To analyze the impact on property prices, the proposed general functional specification is based on an extension of the hedonic function as

$$y_i = \alpha_0 + \alpha_1 T + \alpha_2 YR + \alpha_3 TYR + \beta_k x_{ik} + u_i$$

where y_i is the price of property (*i*); *T* is a categorical variable indicating that the parcel belongs to the treatment group (*T=1*) receiving the roadway improvement or to the control group (*T=0*); *YR* is a time period categorical variable indicating treatment phase (*YR=1* treatment phase, *0*= base or reference); and, x_{ik} is a vector of controls for housing and neighborhood characteristics.

The parameter of interest (α_3), the difference-in-differences estimator (DID), measures the difference in housing price over treatment phases and is equal to

$$\hat{\alpha}_3 = \left(\bar{y}_{YR=1,T=1} - \bar{y}_{YR=1,T=0}\right) - \left(\bar{y}_{YR=0,T=1} - \bar{y}_{YR=0,T=0}\right)$$

The parameter $\hat{\alpha}_3$ measures the difference in average price between treatment and control parcels resulting from changes in accessibility, after controlling for exogenous shocks in sale prices over time, assuming that treatment and control properties do not appreciate at different rates for other reasons not accounted for by the model.

Essentially, by estimating $\hat{\alpha}_3$, the question is: What would have happened to the treatment parcels' sales prices in the absence of accessibility improvements?

When applied to the study of residential and commercial property values, the empirical models also account for spatial autocorrelation among parcel units.

Controlling for Spatial Correlation in Property Price Regression

The multivariate regression models used to estimate the parameter $\hat{\alpha}_3$ do not account for spatial autocorrelation that might exist between parcel units. For example, the final sale price of a house could have spillover effects on similar adjacent properties. Failing to account for the presence of spatial factors affecting sales leads to omitted bias adversely influencing the reliability of parameter estimates. Following Anselin [33], this analysis implements a spatial-autoregressive model with spatial disturbances (SARAR) of the form

$$y_i = \lambda \sum_j^n w_{ij} y_j \, \alpha_0 + \alpha_1 T + \alpha_2 YR + \alpha_3 TYR + \beta_k x_{ik} + u_i$$

$$u_i = \rho \sum_j^n m_{ij} u_j + \varepsilon_i$$

where λ is an autoregressive parameter (spatial-lag); ρ is the autoregressive error term parameter (error lag); and the parameters w_{ij} and m_{ij} represent spatial weights.

Spatial econometric methods require *a priori* specification of a weighting matrix of spatial relations between observations. The choice of a specific relationship is arbitrary, although some guidance exists in the literature [34, 35]. For example, in analyzing the effect of highway proximity on real estate values, Heider and Miller [36] assume that spatial spillover effects on property prices are confined to a 2-km radius, assuming that house values are not correlated beyond this distance. By adopting inverse-distance weights, this analysis restricts spatial dependence to a radius of 3 km. This restriction is justified based on the quasi-experimental approach, which allows spatial dependence between parcels located within the treatment areas, and assumes spatial independence between treatment and control areas. The STATA [37] command *spmat* [38] generates the inverse distance matrices W and M, and the command

spreg [39] allows estimating generalized least-square models that account for heteroscedasticity. By default, *spreg* assumes homoscedastic errors and utilizes maximum likelihood methods. Given the heteroscedasticity issues discussed earlier, this analysis employs the generalized least-square estimator (command *gs2sls*) with the heteroscedastic option.