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STATE HIGHWAY ADMINISTRATION

RESEARCH REPORT

MEASURING THE ECONOMIC CONTRIBUTION OF THE FREIGHT INDUSTRY TO THE MARYLAND ECONOMY

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16. Abstract

Economic impacts of freight movement to Maryland's economy were estimated by input-output analysis using the 2010 IMPLAN data. A freight economic output (FECO) index was also developed based on the historical payroll data and gross domestic product (GDP) between 2002 and 2010. This effort was motivated by the absence of defendable performance measures for the economic contribution of freight transportation services. It was found that the freight industry generates sizable ripple effects. While the trucking sector is the largest in terms of an absolute employment size, the spillovers of the freight water and port services are about seven times its employment size. The impact of government spending is also significant. The aggregate FECO index parallels the Maryland GDP and the national freight service index. Interestingly, the evidence of modal competition between truck and freight rail is observed. Their trends and the magnitude of the changes are generally moving in opposite directions. The findings and methodologies of the study will help decision makers understand the role that each freight mode plays in order to make more informed decisions. The economic indicators used in this study – jobs, income, and GDP – can be used for public outreach to mitigate the negative perception of freight movement. While travel time reduction and increased business productivity used in past impact studies are useful performance measures, jobs and income measures appeal to citizens.

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EXECUTIVE SUMMARY

This study measured the economic impacts of the freight industry on Maryland's economy. An input-output analysis was completed using the 2010 IMPLAN[1] data for the state. In addition, a freight economic output (FECO) index was developed using historical employment and Maryland's gross domestic product (GDP) data between 2002 and 2010. A FECO index will become more important as population, freight transport, and demands on Maryland's transportation system grow. Freight-related transportation investment decisions must be supported by sound performance measures. This effort was motivated by the absence of defendable performance measures for freight transportation services' economic contributions.

Economic Impacts

The study found that freight industry activities (i.e., direct impacts) generated sizable ripple effects to suppliers (indirect impacts) and local businesses that depend on household spending (induced impacts).

- In 2010, the freight industry supported 116,100 for-hire jobs in total. Nearly 70,000 people were directly hired by the freight industry, which helped sustain an additional 48,000 workers in various sectors. The job multiplier is 1.70, meaning that every 100 jobs in freight transportation supported an additional 70 jobs in other sectors.
- The industry generated the direct GDP of $4.9 billion, which is nearly 90% of the GDP generated by the entire Maryland transportation sector in 2010 (about $5.5 billion). Considering roughly 30% of jobs in the transportation sector are non-freight-related jobs, freight transportation has a greater ripple effect than non-freight modes.
- Sectors providing labor and facility/equipment services are top beneficiaries of the freight industry, especially the employment services sector that lists employment vacancies, referring, and/or supplying workers.
- The sectors closely related to basic necessities, e.g., food services, healthcare, housing, and consumer goods, benefited the most from the spending of household disposable income paid by the freight industry and supporting sectors.
- The trucking industry is the largest sector. It accounts for roughly 30% of the employment, 29% of the employee compensations (including wages and all benefits) and 28% of the GDP generated/supported by the freight industry.
- The ripple effects of the freight water and port sector are much higher than other sectors, considering its share of direct employment. While this sector accounts for only 3% of the total freight industry employment in 2010, nearly 17% of the total job impacts, over 15% of the total employee compensation (including wages and all benefits) and 16% of the total GDP are attributable to freight water and port services.
- The impact of government spending related to freight industry activities is crucial. The multipliers of all impacts generated by state and federal employees are higher than most of the modal sectors, except for freight water and port services. This indicates that a favorable business environment (i.e., government investment and policies) is a critical element of the economic performance of the freight industry.

[1] IMPLAN is a software package that assesses economic impacts.

The Freight Economic Output (FECO) Index

The FECO index was developed using employment data between 2002 and 2010 normalized by Maryland GDP.

- The aggregate FECO index parallels Maryland's GDP and the national freight transportation service index (TSI), indicating the usefulness of the index as a performance measure representing the freight industry's contribution as a whole. During the study period, the freight industry's economic activity in Maryland shared a similar cycle to the state economy as a whole and national freight transportation service cycles.
- The indices by freight mode help define the changes of each sector over time. Truck and freight supporting services indices show similar trends to the FECO index.
- The evidence of modal competition between truck and freight rail is observed. Their trends and the magnitude of the changes are generally moving in opposite directions.
- The freight water and port sector is the only sector whose contribution to Maryland's economy constantly increased during the study period. As the Panama Canal expansion nears completion, the economic contribution of the freight water and port services should increase sharply in the long run.

Suggestions for Implementation

- With a more stringent definition of the freight industry than used in past studies, the current study clearly shows a broad picture of the freight industry's economic contribution. The study will help decision makers understand the role that each freight mode plays, enabling them to make more informed investment decisions.
- The study methodology can be reproduced annually to review the annual performance of the freight industry as a whole and each modal sector separately. In addition, the FECO index can be used concurrently with other economic indicators such as business cycle, growth cycle, TSI, etc. in order to compare Maryland's freight industry performance with national trends. The Morgan team could provide assistance in updating the index and impact study. The methodology can be refined further with additional data collection such as a survey of industries that are highly dependent on freight movement.
- Jobs, income, and GDP can be essential performance measures for public outreach to mitigate the negative perceptions of freight movement and increase awareness of the relevance of commodity movement in every aspect of our lives. Performance measures used in past studies – such as travel time reduction, congestion mitigation, etc. – clearly benefit the freight industry's productivity and lessen negative externalities for Maryland residents. However, travel time reduction and increased business productivity, as a result of government investments, may not be the most tangible benefits to Marylanders. Instead, using jobs and income changes to disseminate the benefits of the freight industry appeals to Maryland residents.
- Alternative facilities such as consolidated freight distribution centers or freight villages can be considered at the state government level to promote efficient land use and minimize freight's footprint, while improving business productivity. As found in this study, the spillovers of government spending on freight-related tasks are significant, meaning more jobs and income for Marylanders.

INTRODUCTION

Freight transportation services enable various economic activities by connecting people, businesses, goods, and resources. Policy and investment decisions for the freight industry support and create jobs, increase household disposable income, and improve business productivity; that is, more economic development opportunities are created. Thus, the contributions of the freight industry to the economy and its historical trends must be understood and assessed before prioritizing freight transportation-related investment and policy decisions.

Maryland's economy, measured in real gross domestic product (GDP)[2], grew by approximately 55% between 2000 and 2012, to $317.7 billion in 2012 from $205.1 billion in 2000 (Bureau of Economic Analysis 2012). Assuming the past annual growth rate (roughly 3.7%) holds for the future, Maryland's real GDP would increase to $458 billion by 2022. At the same time, it is projected that Maryland's population would reach about 7 million by 2040, up from 5.8 million in 2010 (Maryland State Data Center 2014). The importance of the freight industry to Maryland's economy would increase, since goods movement demand is positively correlated with the growth of the economy and population (Federal Highway Administration 2014).

The contributions of the goods-dependent industry to Maryland's GDP increased from $55 billion in 2000 to nearly $80 billion in 2012 (Bureau of Economic Analysis 2013).[3] The industry's output will continue to grow with the forecasted increase in freight movement. The *2009 Maryland Statewide Freight Plan* estimated that the tonnage of goods moved using transportation infrastructure in Maryland is likely to double between 2006 and 2025 (Cambridge Systematics 2009, 2-3). The increase would be led by the trucking industry (a 108% increase) and rail (a 91% increase) (Maryland Department of Transportation 2006, 2-4). Accommodating the increasing demand necessitates careful planning by the state, and requires investment decisions in developing appropriate policy tools and infrastructure. Decision making needs to be supported by sound performance measures. In this vein, it is imperative for planners to develop sound and reliable performance measures of the freight industry's economic contribution to Maryland.

The importance, types, and measurement techniques of developing freight performance measures have been well studied. However, few studies, if any, answered the questions on the economic impacts of freight transportation services. Most studies focused on performance measures related to the reliability of the freight transportation system and negative impacts of the freight industry (Gordon Proctor & Associates 2011, Mallett, Jones and Sedor 2006). The former measured the impacts of public-sector investment in transportation infrastructure on the national and/or regional economy, or the impacts of infrastructure improvement on transportation network performance (RESI 1998, EDRG and Systematics 2012). Such performance measures include volume, speeds, reliability, pavement conditions, and others. Performance measures of the latter include emissions levels and crashes involving commercial

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[2] The Bureau of Economic Analysis (BEA) uses 2005 dollars for calculating real GDP to adjust inflation. The data was retrieved from the BEA website on November 6, 2012.

[3] The definition of the goods-dependent industry is from the 2009 Maryland Statewide Freight Plan. It includes agriculture, mining, utilities, construction, manufacturing, wholesale trade, retail trade, and transportation and warehousing.

motor vehicles. A relatively new study examined the impacts of the freight industry using input-output analysis (Cambridge Systematics and Marlin Engineering 2011); however, the freight industry was too broadly defined, resulting in a largely inflated economic impact of the sector. To the best of the study team's knowledge, no study has clearly measured the contributions of the freight transportation services, based on a clear and stringent definition of the freight industry, to the economy of a sub-national study area.

Transportation services have become increasingly important in the contemporary economy and business cycles. From the first quarter of 1953 to the second quarter of 2003, the share of the manufacturing-related goods in the GDP declined from 54% to 35%, while over the same time period, the share of the service sectors increased from 34% to 56% (Lahiri and Yao 2006, 872). Nevertheless, business cycle studies have focused mostly on the performance of the manufacturing industry, not freight transportation services (Lahiri and Yao 2006). As early as the first half of the 20^{th} century, many scholars had appreciated the pervasive influence of transportation services on all sectors of the economy and paid attention to the business cycles from the perspective of these services (Lahiri and Yao 2006). However, in the 1960s, the generation of many transportation service indicators was discontinued (Lahiri and Yao, Economic Indicators for the US Transportation Sector 2006). It was not until the early 2000s that the freight transportation services index was developed as part of the transportation services index (TSI) at the national level (Lahiri, Stekler, et al. 2003). So far, no state-level freight transportation service index has been developed.

Recognizing the absence of research on developing economic performance measures of the freight industry at the sub-national level, this study provides an objective assessment of the economic contribution of freight transportation services to Maryland's economy. This assessment provides a benchmark measure of freight's contribution to the state's economy. The developed measure can be used for understanding the importance of the freight industry in the state economy and by transportation agencies to make infrastructure investment decisions. Moreover, the benchmark measure would help lower the negative perception of freight movement that the general public may have. Despite its importance on daily life, freight transportation is widely perceived as a nuisance rather than an economic benefit. While the timely availability of a variety of goods is essential to maintain day-to-day living, many people take freight transportation for granted and consider it a cause of traffic congestion, and an environmental and safety hazard. The availability of performance measures of the sector's economic contribution in terms of jobs and income would raise Marylanders' awareness of the benefits of the freight industry. In general, people are more interested in tangible economic benefits affecting every aspect of their daily necessities.

This study measured the economic contribution in 2010. Economic impacts were presented as jobs, income, GDP, and output generated directly and indirectly and induced by the services provided by the freight industry. Using historical employment data, researchers estimated the GDP contribution of each freight transportation sector and turned the estimated GDPs into the freight economic output (FECO) index. The freight industry is defined as industry sectors whose primary purposes are to provide goods movement services and/or supporting services. These sectors do not produce goods as part of their business operations. Included are truck, rail, air, water, pipeline, warehousing and storage, couriers and messengers, the United States Postal

Service (USPS), other freight transportation services, and government services. In this study, in-house freight fleets (e.g., trucks owned and operated by manufacturers or retailers) were not considered. Although their contributions to the economy are not insignificant, no recent data are available. The latest in-house transaction data table is the 1997 Transportation Satellite Account (Bureau of Economic Analysis n.d.), which could not be used due to concerns about the reliability of extrapolating the 1997 estimates into the study year. Moreover, in-house freight transportation accounts only for 1.19% to 5% of the transportation jobs (Cambridge Systematics and Marlin Engineering 2011, 3-8) and using data that is almost two decade old is not appropriate.

Research Objectives

The primary objective of the study was to measure the economic contributions of the freight industry to the Maryland economy and develop a FECO index that tracks the economic performance of the freight industry over time.

Report Structure

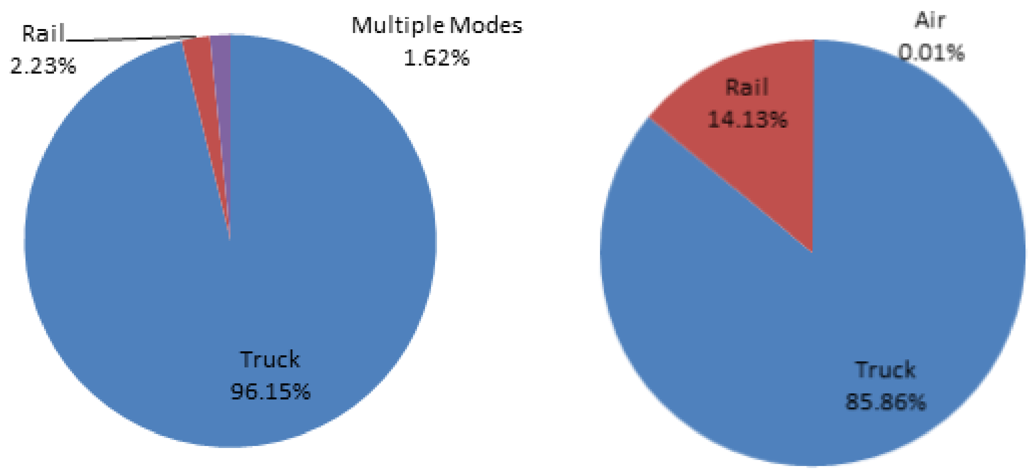
This report is organized in six chapters, including this Introduction. The second chapter provides a summary of relevant literature on the freight industry in Maryland, economic impact studies and index generation methods. In chapter 3, the methodologies employed for the current study are described. Chapter 4 discusses the data collection and compilation. Next, in chapter 5, the specific findings of the economic impact analysis and the FECO index are presented. Finally, the report concludes with a brief summary of findings, implications, and suggestions for implementation.

LITERATURE REVIEW

Freight Industry in Maryland

Trucking Industry in Maryland

Dependence on the trucking industry in goods movement is the most noticeable trait in Maryland. The 2007 Commodity Flow Survey (CFS), the latest goods movement information available as of August 2014, estimated that trucks accounted for approximately 96% of outbound and 86% of inbound shipments in terms of tonnage (Figure 1). The shares of the trucking sector are much higher than the national average of 71.3% in 2007 (U.S. Census Bureau 2010). Rail only accounted for 2.23% of the tonnage of outbound shipments, while 14.43% of the tonnage of goods coming into Maryland was shipped by rail (Figure 1). Other modes shipped insignificant amounts of goods, so their shipment information was not available due to the Census Bureau's privacy disclosure rule.

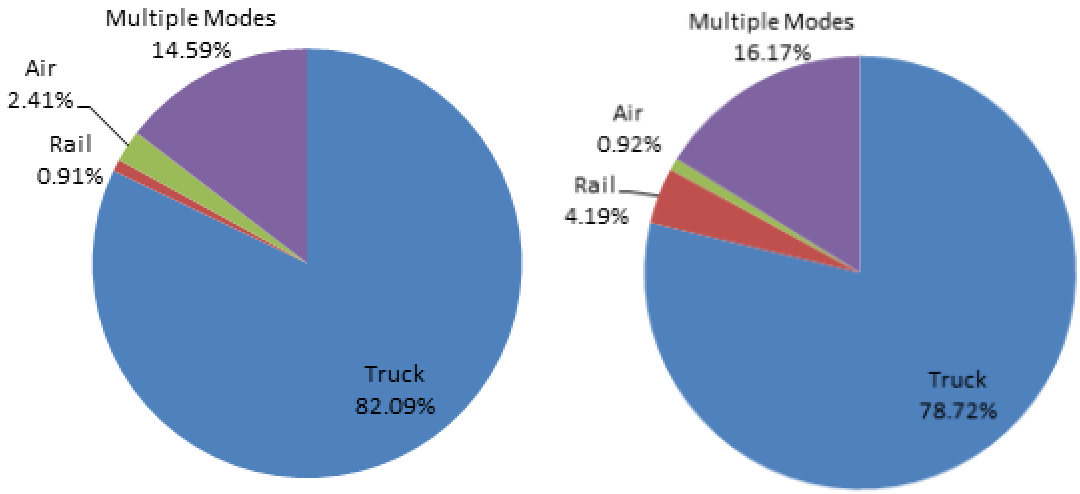


(a) Outbound (b) Inbound

Source: U.S. Census Bureau, 2007 Commodity Flow Survey State - Maryland

Figure 1: Percentage of Goods Movement in Tonnage by Mode in 2007

In terms of the value of shipment, roughly 82% of shipments originating in Maryland and 79% destined for Maryland were moved by trucks (Figure 2), which is higher than the national average of 75% in 2007 (U.S. Census Bureau 2010). While truck's shares of the value of shipment are smaller than those of tonnage movement, it is still a dominant means of goods movement. The *2009 Maryland Statewide Freight Plan* pointed out that truck dominance is likely to continue in the foreseeable future. It projected that the share of the trucking in goods movement would reach roughly 86% of tonnage and 87% of value by 2035 (Cambridge Systematics 2009).



(a) Outbound (b) Inbound

Source: U.S. Census Bureau, 2007 Commodity Flow Survey State - Maryland

Figure 2: Percentage of Goods Movement in Value by Mode in 2007

The American Transportation Research Institute (2012) estimated that in 2012 there were over 11,190 trucking companies in Maryland. They were mostly locally owned small businesses. Wages paid to employees in the Maryland trucking industry were more than $4.9 billion with an average annual salary in 2011 of $47,443 (American Transportation Research Institute 2012). Although trucks represent only about 10% of vehicle miles traveled (VMT) in Maryland, in 2009, the trucking industry accounted for 28% ($503 million) of federal and state roadway taxes and fees owed by Maryland drivers (American Transportation Research Institute 2012).

Positive economic contributions often result in unexpected by-products. First, trucks contribute to high accident rates, especially on I-495 in Prince George's County (average 198 crashes per year), I-695 in Baltimore County (average 168 crashes per year), and I-95 in Howard County between the two Beltways (average 72 crashes per year) (Cambridge Systematics 2009). The seriousness of truck-involved crashes lies in the fact that crashes with trucks result in more fatalities. For example, while large trucks accounted for only about 3% of the registered vehicles in the United States, they were involved in 10% of fatal crashes in 2012 (Insurance Institute for Highway Safety n.d.). Shin, Bapna, and Budharaju (2014) estimated, based on costings by Zaloshnja and Miller (2007), that the total costs of truck-involved crashes in Maryland in 2009 were about $625 million. Truck-involved fatal crashes incurred an average of over $4 million per fatality. This cost estimation includes lost opportunity costs such as wages, property damage, and psychological effects. In addition to costs to victims, truck crashes also cause infrastructure damage, cargo spills (including hazardous material), and significant delays in travel times, reducing the overall reliability of the transportation system (Cambridge Systematics 2009).

Second, diesel truck engines emit nitrous oxide and particulate matter. Excess levels of nitric oxide are a major cause of respiratory problems, chronic and acute bronchitis, and sometimes premature death (U.S. Environmental Protection Agency 2012). The Environmental Protection

Agency (EPA) has taken steps to ensure that heavy-duty trucks use cleaner fuel and reduce the hazardous emissions. The Highway Diesel rule (2007 highway rule) took effect in 2007 and aims to reduce pollution from heavy-duty highway vehicles by over 90 percent. Manufacturers of trucks, cars, and buses are, by virtue of the 2007 highway rule, required to meet emission standards (U.S. Environmental Protection Agency 2012).

Port of Baltimore and Water Freight

The Port of Baltimore has served as a channel connecting Baltimore to domestic and international markets. The Port activities are overseen by the Maryland Port Administration (MPA) which was established in 1956 to "stimulate the flow of waterborne commerce through the state of Maryland in a manner that provides economic benefit to the citizens of the state" (Maryland Port Administration 2007, 4).

The Port of Baltimore is one of the busiest domestic and international deep-water ports in the United States. It is the most active of all the 11 active water trade facilities in the state. In 2010, the Port handled over 83% (or 40 million tons) of all water-related trade activities undertaken in Maryland (The U.S. Army Corps of Engineers 2012). As one of the top 15 ports of international trade, in 2011, the Port of Baltimore handled 37.8 million tons of cargo internationally, an increase of 15% (or an increase of 5 million tons in absolute terms) over the 2010 figure (Port of Baltimore 2011, 1). In monetary terms, the Port of Baltimore handled $51.4 billion worth of cargo, an increase of 15.2% in tonnage from the 2010 figure (Port of Baltimore 2011, 1). In particular, the Port led other ports in the country in automobile cargo, handling 551,000 auto units in 2011 (Maryland Port Administration 2012). It also ranked first in the nation in terms of volume of roll-on/roll-off (ro-ro) farm and construction equipment and imported forest products, gypsum, and sugar (Maryland Department of Business and Economic Development n.d. (a)).

The port consists of publicly and privately owned terminals. The MPA owns the public terminals, including the Dundalk Marine Terminal, the Fairfield/Masonville Automobile terminals, the Seagrit Marine Terminal, the Intermodal Container Transfer Facility, the Hawkins Point Marine Terminal, the North Locust Point Marine Terminal and the South Locust Point Marine Terminal (Cambridge Systematics, 2009). The Dundalk Marine Terminal is the largest cargo facility with the capability to handle containers, break-bulk cargo, wood pulp, roll-on/roll-ro-ro equipment, automobiles, and project cargo. The terminal occupies approximately 570 acres with 13 berths (comprising six general cargo berths and seven container berths) and nine container cranes (Thuermer 2011).

According to an economic impact study conducted in 2011, the port supported 40,040 jobs (Martin Associates 2011). Of these, 14,630 jobs were directly related to cargo and vessel-related activities such as terminal operators, dock workers loading/unloading ships, freight forwarders, state government employees, steamship agents, towing, and pilots. Economic activities at the Port also contributed to supporting 10,940 indirect jobs resulting from purchasing goods and services from supporting sectors. Finally the above employees supported an additional 14,470 jobs through spending their wage income on economic activities such as grocery shopping, health, housing, and other daily necessities.

Freight Rail in Maryland

Freight rail services in Maryland consist of two long-haul Class I freight railroads (CSX and Norfolk Southern) and a number of Class III short-haul lines. CSX transportation operates about 557 miles of track while Norfolk Southern operates about 120 miles (Cambridge Systematics 2009). CSX moves approximately 800,000 carloads of various commodities and one million tons of metal products every year, including steel and aluminum (Maryland Department of Business and Economic Development n.d. (b)). It also handles nearly one million tons of chemicals in Maryland. In 2007, roughly 2.8 million tons of rail freight originated in Maryland, while 18.6 million tons of rail freight was transported to Maryland, accounting for 2.23% of outbound and 14.13% of inbound shipments, respectively (U.S. Census Bureau 2010). The tonnage of freight handled by rail is projected to increase by 200% to about 50 million by 2035 (Cambridge Systematics 2009). Despite rail freight service's potential benefits as compared to truck shipments, freight rail has faced some barriers. Rail companies, in meetings with government agencies, have promoted the benefits of double stacking containers. However, there are limitations to such double stacking on Amtrak-owned rail infrastructure. For example, the Howard Street Tunnel in downtown Baltimore is currently an impassible barrier for double-stacked containers. Long-term economic and social benefits of renovating or replacing the tunnel need to be assessed.

Air Cargo Industry in Maryland

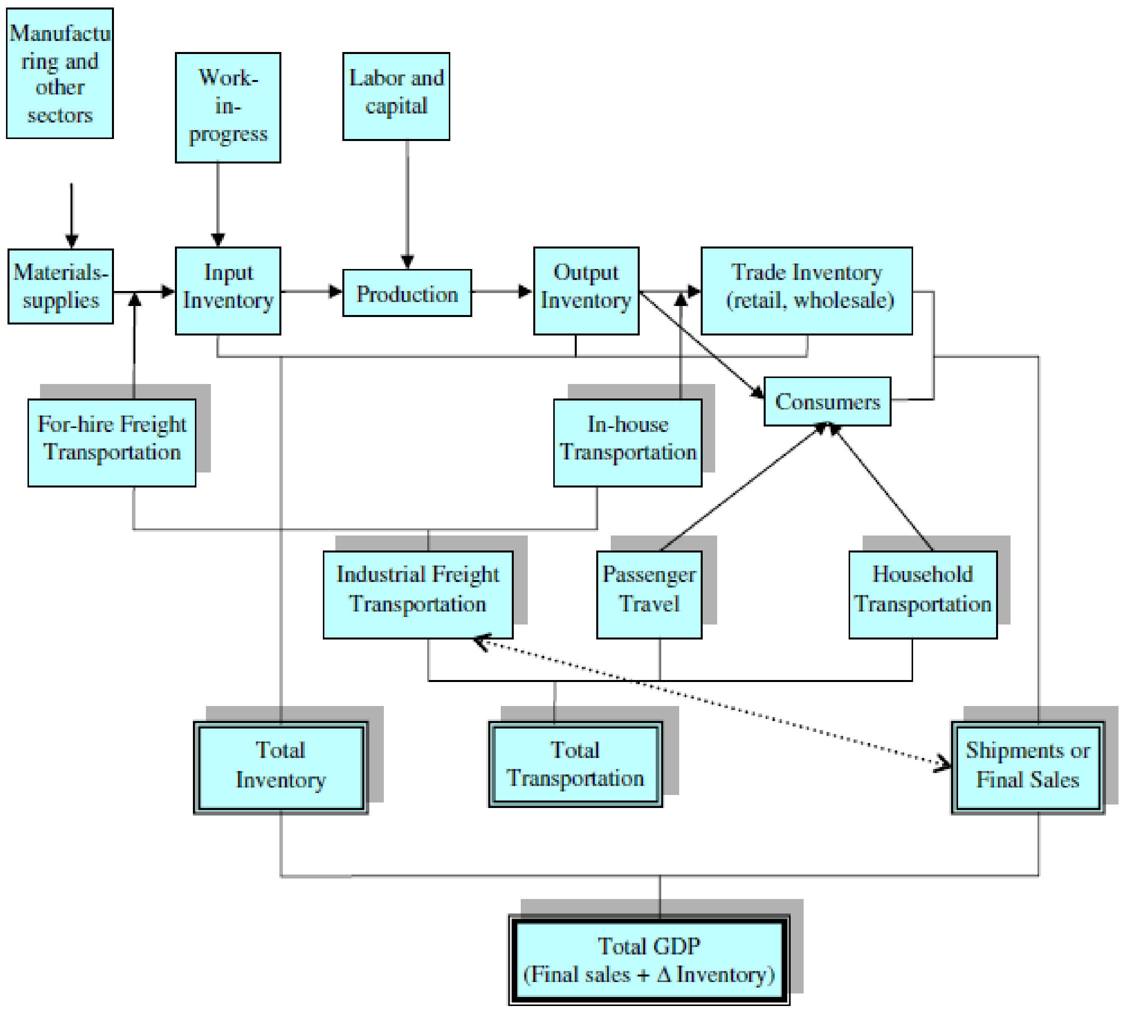
In 2007, air cargo accounted for about 2.41% of outbound shipment and 0.92% of inbound shipment in terms of value (U.S. Census Bureau 2010). Three airports in Maryland handle scheduled air cargo services: Baltimore/Washington International Thurgood Marshall (BWI Marshall), Salisbury-Ocean City Wicomico Regional Airport (SBY), and Greater Cumberland Regional (CBE) (Cambridge Systematics, 2009).

BWI Marshall Airport is home to the largest air cargo airport in Maryland. It is also the only all-cargo airport in Maryland, which means that it is served by aircrafts dedicated to the carrying of cargo, with a total annual landed weight of over 100 million pounds in addition to the other air transportation services that the airport provides (Cambridge Systematics, 2009). The airport is served by 30 air cargo carriers, including four all-cargo carriers: ABX Air Cargo/DHL, FedEx, Mountain Air/FedEx, and UPS. In 2011, BWI Marshall ranked 43rd among all-cargo airports in the country, handling approximately 485 million pounds of cargo, a 2.84% increase from the previous year (Federal Aviation Administration 2012).

No recent study measuring the economic impacts of just the freight air transportation sector in Maryland has been published. Thus, the 2010 economic impact study of the BWI Marshall airport was reviewed. In 2010, BWI Marshall accounted for nearly 94,000 jobs, resulting in personal income of $3.6 billion and tax revenues of $721 million (BWI Airport 2012). Nearly 62% of the jobs supported by airport activities were associated with residents of Baltimore City, Anne Arundel County, and Baltimore County.

Transportation and the Economy

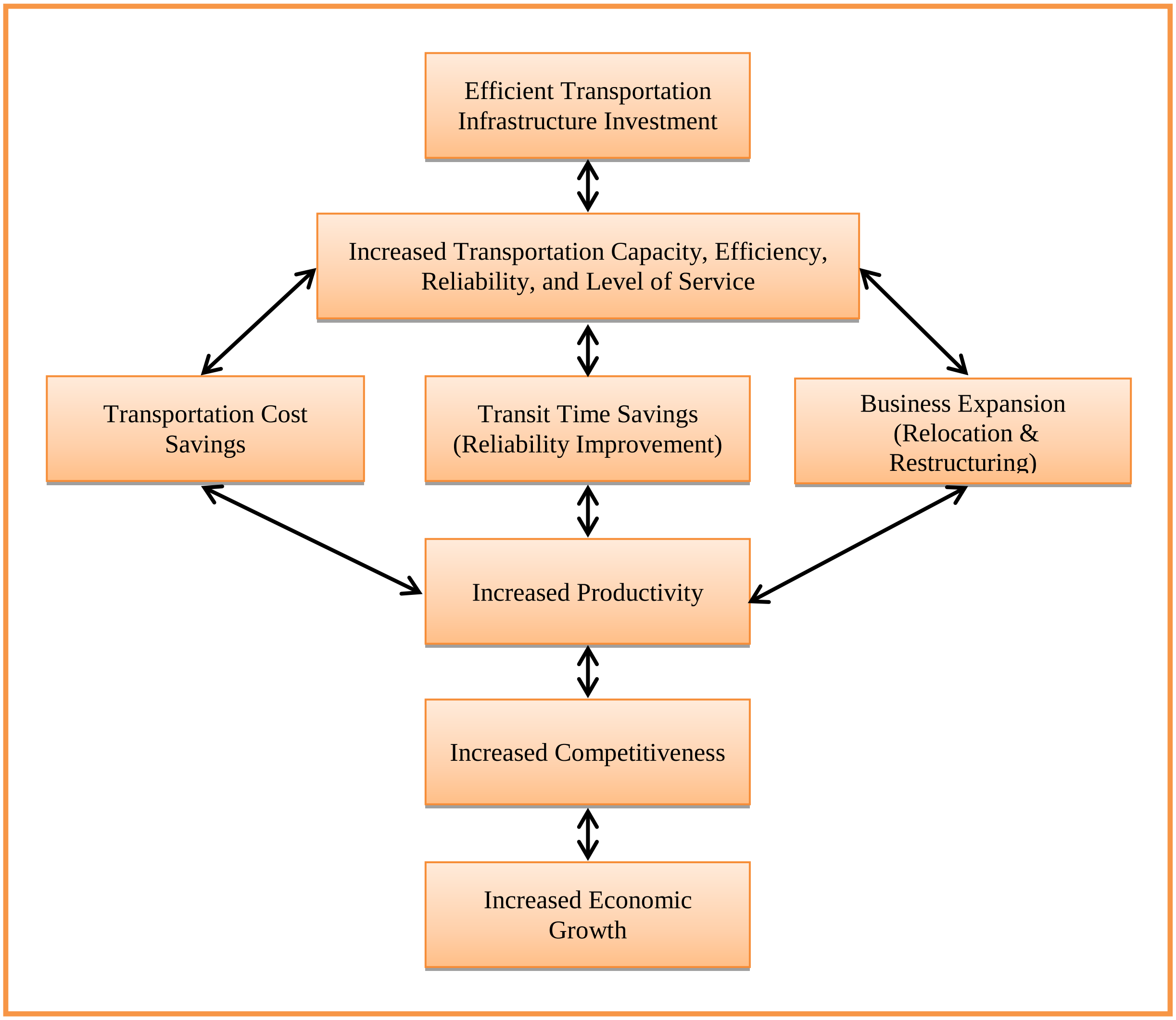
The linkage between transportation and economic growth has been well established. Transportation is a crucial facilitator of economic activities between sectors and across regions (Lahiri and Yao 2006). Figure 3 provides a schematic illustration of the stage-of-fabrication production process employed by a typical firm to transform input (e.g., purchased materials/supplies and work-in-progress) into output (i.e., finished goods) (Lahiri and Yao 2006). The middle and lower parts illustrate the role of freight transportation in this process. The sum of final sales and the change in inventories at the bottom of this supply chain is the overall size of the economy.



Source: Lahiri and Yao (2006, 873)

Figure 3: Stage-of-fabrication Model with Transportation

Since transportation and subsequent mobility is closely related to productivity, employment, and income in an economy, transportation improvements have been considered for boosting economic development (Schultz, et al. 2006). In particular, increases in freight tonnage and shipments are, more often than not, quoted as indicators of economic growth and recovery (Goodman 2010, The City Wire 2014, Young and Notis 2009). This is because the changes in freight shipment imply changes in demand for raw materials, intermediate input for production, and final products for consumers; eventually, an increase in shipment results in sustaining and creating jobs, contributing to an increase in GDP.



Source: Reproduced based on Exhibit 1 of ICF Consulting (2004)

Figure 4: Transportation and the Economy

From transportation planners' and/or policy analysts' perspectives, improving the productivity (e.g., travel time reliability) of the freight industry results in increasing the economic contribution of freight transportation. Thus, most studies estimating the economic impacts of the freight industry focused on productivity improvement as a result of government spending on infrastructure improvements (Mallett, Sedor and Sedor 2004). Broadly, there are three types of methods of analysis (Mallett, Sedor and Sedor 2004). First, the macroeconomic method focuses on the GDP contribution of infrastructure investments (e.g., highway expansion projects). Second, the microeconomic method estimates cost savings of individual firms from improved transportation networks. Lastly, the general equilibrium method measures the benefits of transportation improvements gained from regional specialization and technological changes. These approaches are based on a conceptual linkage between transportation and the economy (Figure 4). The figure indicates that improvements in infrastructure help save transportation costs from travel time, that is "productivity gains that filter through the economy in various ways (ICF Consulting 2004)." Eventually, cost savings and productivity increases lead to the growth of the economic competitiveness of a region. For example, a decrease in delivery time from roadway improvements may lower transportation costs which in turn may increase business profits, bring down consumer prices, and generate more tax revenue for governments. Litman (2010), summarizing the relationships between economic development and transportation, pointed out that transportation is "an input to economic activities, such as shipping, business travel, the delivery of services that affects production and distribution costs." He continued that "the improved transportation infrastructure boosts productivity of industry, people's accessibility to economic activities (e.g., employment, schools, and shops)."

The development of the TSI supports what is discussed above. Released in 2005, the TSI is a monthly index that measures the changes in transportation services, including freight and passenger transportation (Young and Notis 2009). It was found that the TSI moves in conjunction with economy and business cycles (Young and Notis 2009). This implies that the TSI reflects the changes in the economy as a whole. Since all for-hire services are included in the TSI, the influence of structural changes in the transportation sector can be accounted for. By incorporating all modes, the TSI is an aggregated measure; thus it "absorbs the competition among the modes, and reflects the overall economic change more accurately than a single measure (Young and Notis 2009)." For example, while the TSI remains almost the same at the aggregated level, the economic performance of freight rail could increase due to the shift of shipments from trucks.

Comparing the freight TSI to business and growth cycles revealed that the freight transportation service industry is directly tied to the supply chain and to the build-up and maintenance of inventories (Young and Notis 2009). When people anticipate the recovery of a business growth cycle, they order materials and finished goods in advance to realize maximum benefits when actual demand for goods increases. In contrast, when economic performance goes down, the demand for freight delivery also decreases. Therefore, understanding the freight industry trends helps predict changes in the economy.

Measuring Economic Impacts

"Economic impacts refer to any number of processes that trace how changes in spending resulting from an economic event, such as expansion, contraction, opening, closing, or existence, affect the economy (Day 2012)." An impact study is a quantitative method measuring the cumulative effects of spending by an economic sector of interest within a defined geographic region (Day 2012). Economic impacts are measured in terms of business output, valued added (GDP), property values, income, and jobs. However, user benefits of using a facility and social benefits of improving well-being (e.g., safety) are not considered as economic impacts (Day 2012). While they can be monetized in terms of willingness-to-pay for improved services, they are not accounted for unless the level of economic activity changes.

Selecting the most appropriate method for an economic impact study is of critical importance. Two types of economic analyses are introduced by Weisbrod and Weisbrod (1997): input-output models and economic simulation models. The input-output model is the most widely used model for economic impact studies. By tracing "the linkage of inter-industry purchases and sales within a given study area, the input-output model estimates the total direct, indirect, and induced impacts on jobs, income, value-added (GDP), and output. Direct impacts are the changes as a result of economic consequences of the industry, new investment, or policy change. Indirect impacts reflect changes in economic outcome of the suppliers to “the directly-affected businesses.” Induced impacts are generated by spending on consumer goods and services by workers of directly and indirectly affected businesses. The magnitude of economic impacts is expressed as multipliers, which is a ratio of the direct economic impact to the total economic impact (i.e., direct + indirect + induced impacts). A multiplier represents additional changes in jobs, income, GDP, or output that are generated per a unit of monetary spending or job. Multiplier impacts assume “continuation of current inter-industry trade patterns and local flows of money into and out of the area” (Weisbrod and Weisbrod 1997). Thus, forecasting into the future may not be reliable in input-output analysis.

Another class of analysis methods is the economic simulation models based on econometrics and general equilibrium theory. In addition to what can be done by input-output models, economic simulation models allow researchers to forecast economic impacts of future changes in input (e.g., costs, prices, wages, etc.). However, “economic simulation models involve more analytic sophistication and cost more to acquire than the input-output models” (Weisbrod and Weisbrod 1997). Both analyses methods have been widely used in measuring economic impacts of transportation sectors on the regional economy, or impacts of government spending/investment on transportation.

Economic Impacts of the Freight Industry

Economic impact studies associated with freight movement are discussed below. With the U.S. Department of Transportation’s Transportation Investment Generating Economic Recovery (TIGER) program, the importance of economic impact studies as a way to promote and justify investment decisions has become even more crucial to planners and policy makers (Alstadt and Weisbrod 2008).

The most popular type of impact studies is the measurement of economic impacts of infrastructure improvement on freight movement. For example, the Mid-Ohio Regional Planning Commission measured the impacts of transportation improvements to serve an inland port in Columbus (Cambridge Systematics et al. 1994). The inland port was expected to make Columbus a hub of freight distribution in the Midwest and generate economic benefits. To achieve this objective, efficient long-haul services by all modes of freight transportation to attract more freight industry were critical. Travel time, annual truck trips, and value of time estimates were measured. Monetized values of these estimates were used to calculate the direct and indirect economic impacts of the improvements.

Economic impacts of the freight industry were estimated for Miami-Dade County, Florida (Cambridge Systematics and Marlin Engineering 2011). This is probably the only study whose stated objective is to measure the economic impacts of “the freight industry.” Thus, this study provided some insights for the current study. Input-output analysis was employed to measure direct, indirect, and induced impacts of the freight industry to the region. Data from a variety of sources were collected, including the Port of Miami (POM) and Miami International Airport (MIA) economic impact studies, the U.S. Census’ County Business Patterns (CBP), Florida’s Highway Safety and Motor Vehicles office (FHSMV), Florida Department of Revenue (DOR), Florida Department of Transportation (FDOT), the Bureau of Transportation Statistics’

Transportation Satellite Accounts (TSA), and several offices within Miami-Dade County. Proprietary Cambridge Systematics' industry information was also used.

The freight industry sector was directly responsible for 151,314 jobs in Miami-Dade County in 2008. These jobs, in turn, produced an additional 123,238 jobs in the county through indirect (48,841 jobs) and induced (74,397 jobs) impacts. In total, the freight industry supported 274,552 jobs in the region. The job multiplier was 1.81, meaning every job in the freight sector sustained a total of 1.81 jobs in Miami-Dade County. Economic sectors indirectly affected by the freight industry were business services sectors, such as banking, finance, and insurance. On the other hand, jobs in retail trade, healthcare, finance, and leisure/hospitality are created by household spending. Unlike most economic impact studies, the uniqueness of this study lies in the consideration of negative impacts of the freight industry. It documented the generation of negative impacts such as congestion, air pollution, highway deterioration, and crashes. However, they were not directly measured and not used as input to the input-output analysis, since it is extremely complicated, if not impossible, to account for negative impacts in input-output analysis.

Despite the uniqueness, this study seems to have some obscureness in the definition of the freight industry. The definition was so inclusive that the wholesale trade sector was included. The wholesale trade is not a freight transportation sector since its primary purpose is not to gain profits by providing transportation, but by selling goods to retailers. According to the most recent definition of the North American Industry Classification System (NAICS),

> *"The wholesale trade sector comprises establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. (…) The wholesalers sell or arrange the purchase or sale of goods for resale, capital or durable non-consumer goods, and raw and intermediate materials and supplies used in production* (U.S. Census Bureau 2012)*."*

The NAICS's definition suggests that the wholesale trade is not a pure transportation sector, but an intermediate process in the distribution of goods. In this process, transportation is a medium to move goods between suppliers and the wholesaler, or receivers and the wholesaler, and its costs (e.g., fuel, salary for drivers, vehicle maintenance, etc.) are part of the total output of wholesaling. Transportation costs generally account for on average about 50% of goods distribution (Sahling and Nuzum 2012, 15). However, the study, by including the wholesale sector, overestimated economic impacts. It should be noted that the wholesale trade sector accounted for nearly 50% of the total jobs and over 50% of total output and GDP of the study area (Cambridge Systematics and Marlin Engineering 2011, 3-7). To account for freight transportation activity in the wholesale sector, the ownership of transportation (i.e., for-hire or in-house fleet operated by wholesalers, suppliers, or retailers) first needs to be identified. Then, the economic contribution of wholesale transportation must be estimated separately. Moreover, some types of wholesalers, for example agents and brokers (NAICS 425), do not own their own trucks or other means of goods movement. Thus, they should not be counted as part of the freight industry.

Marr, Pomeroy, and Biles (Marr, Pomeroy and Biles 2008) examined the economic impacts of warehousing and trucking industries in rural Pennsylvania in 2007. Employment counts were used as proxies for economic activity; that is, the study assumed that the employment count in warehousing and trucking sectors is positively associated with their economic activity and influence. Data from the U.S. Bureau of Labor Statistics were used. The study found that warehousing has the lowest job multiplier compared to other sectors. A comparison of trucking's impact in urban and rural areas found that trucking in rural counties has a larger income multiplier than in urban counties. Interestingly, spillover effects of rural trucking are mostly captured by businesses in urban areas. Therefore, this study suggests that economic growth in rural Pennsylvania generates benefits for both rural and urban areas.

Ozbay et al. (2008) investigated "the relationship between truck movements and the economic performance of New Jersey" and examined whether truck movement on the I-95 corridor (New Jersey Turnpike) is a leading indicator of change in the performance of the New Jersey economy. Total non-agricultural employment in New Jersey from 1970 to 2005 was used as the indicator of economic activity. A regression model found that monthly truck volume was strongly associated with the number of monthly employment.

Economic Impact Studies in Maryland

The Maryland Department of Transportation (MDOT) conducted an economic impact study of the surface transportation program spending between 1997 and 2006. Spending data from the State Highway Administration (SHA), Maryland Transit Administration (MTA) and the subsidy it provided for the Washington Metropolitan Transit Authority (WMATA) were used for the impact study using IMPLAN. Specifically, this study traces how MDOT's spending on jobs, materials, and services impacts the economy of the state and how such spending affects businesses outside of Maryland. The study reported that during the 10-year study period, $20.1 billion were spent on surface transportation programs and generated a total of $44.9 billion of business output, which includes $16.1 billion in labor income paid on average to 32,703 workers each year. The multiplier of the total output was 2.2. Construction, services, and trade were the three sectors receiving the most benefits from MDOT's surface transportation spending. In addition, an average of 2.6 jobs within the Maryland economy is supported by each MDOT job. The importance of the government investment in transportation to generate economic benefits in Maryland is clearly articulated in the study.

CSX International conducted the economic impacts of the proposed Baltimore-Washington Rail Intermodal Facility that is part of CSX's National Gateway project (HDR Decision Economics 2011). An input-output analysis using IMPLAN estimated that the project development would generate over $200 million in economic activity, $25 million in federal, state, and local tax revenues, and over 1,300 jobs per year. The new facility would also generate cumulative long-term output impact in excess of $18.4 billion over the 2015-2044 period.

A team of Salisbury University researchers (BEACON 2010) conducted a freight impact study for the Delmarva Peninsula region that contains Caroline, Cecil, Dorchester, Kent, Queen Anne's, Somerset, Talbot, Wicomico, and Worcester counties in Maryland; Sussex, Kent, and New Castle counties in Delaware, and Accomack and Northampton counties in Virginia. The study estimated the economic impacts of the regional and national freight corridors on

Delmarva. Input-output analysis was used to measure the impact of losing a certain freight industry in the region. For example, after estimating impacts of freight rail and trucks separately, assuming they deliver the same type and amount of freight on an existing route, the total outputs of each sector were compared to examine the impact of mode shift from trucks to rails. The study estimated that the net effect of the mode shift to rail would be the generation of an additional half million dollars to Delmarva. It is not clear from the study, however, whether the region had additional rail capacity at the time of the study to replace a significant share of road goods movements and whether initial capital investments for expanding the existing rail networks were realistically considered. More importantly, the potential demand from the freight sector and the feasibility of the alternatives with the consideration of conflicting interests of various business sectors (e.g., freight rail, passenger rail, and trucking) should have been investigated by an extensive outreach activity.

Index Generation

An economic index is an aggregated measure of performance of a certain economic activity or related economic activities. Its critical role is to summarize the economic conditions. In business and government, indices have been important tools in decision making.

In transportation, the TSI has provided the performance of transportation services at the aggregated level for freight and passenger services (Lahiri, et al. 2003). The TSI is an economic measure of domestic transportation services in the U.S. that was developed using monthly data from January 1980 through April 2002 in order to trace the monthly changes in transportation service performances (Young and Notis 2009). It has provided an overall picture of the U.S. transportation services and has been used to predict the forthcoming turning points of the general business cycle (Wang and Peters 2009).

In order to generate the TSI, data representing air, rail, water, truck, transit, and pipeline activities were collected. Then, modal indices were first developed by aggregating data by mode. Finally, modal indices were combined by assigning a weight to each modal index. The weights were assigned because modal activity data represent various units of measure. For example, an index for the trucking sector was based on the tonnage of goods movement, using the trucking tonnage index (TTI) of the American Trucking Association's monthly reports. On the other hand, rail revenue ton miles of freight (RTMF) were utilized for developing a rail freight output index. Because truck tonnage and rail revenue cannot be directly compared to each other, each sector's contribution was converted to GDP. The GDP contribution by mode was used as a weight to measure the relative importance of each subsector to the entire sector. Trucking received the greatest weight (over 40%) of all sectors, while other sectors' weights were below 8%.

Then, the indices were compared with classical business and growth cycles of the overall economy in order to examine the relationships between the TSI and traditional business cycles. It was found that the TSI generally moved in conjunction with national economic cycles, "in particular the business cycle of recession and expansion, and the growth cycle (Young and Notis 2009)." When the accelerations and decelerations of the freight TSI (the turning points in the de-trended series) are compared to the growth cycles of the economy, the freight measure leads by an average of four to five months (Young and Notis 2009). On the other hand, "the passenger TSI was identified as a coincident indicator with the general economy (Young and Notis 2009)," reflecting the current state of economic activity.

Wang and Peters (2009) investigated the transferability of the TSI to New York State/Metro, recognizing the growing importance of freight transportation services for traditional sectors that sell and manufacture goods. While TSI methods provide guidance for developing an index for the region, they pointed out that the data availability would limit the application of TSI development methods. Nevertheless, they also suggested that additional variables be considered such as per capita lane miles, congestion metric, freight transportation costs, and employment in warehousing and distribution. In addition, the study contended that the production of transportation equipment, the construction of infrastructure, toll burden, hours of road interruption due to snow/ice conditions, and in-house freight fleet should have been explored in developing the TSI. While the suggestions by Wang and Peters (2009) might reinforce the accuracy and preciseness of the TSI, benefits from including the additional variables down to the last detail may not bring considerable gains in raising the quality of the index.

Despite some of the issues raised above, the TSI seems to provide relatively dependable indicators to paint past and current performance of transportation service sectors and predict their future performance in relation to the existing traditional business cycle indicators. Borrowing the conceptual framework of the conventional National Bureau of Economic Research (NBER) method, Lahiri and Yao (2006) probed the correspondence of four coincident indicators: transportation services (output), payroll (income), employment, and expenditure on transportation (sales). Graphical comparison and a series of t-tests showed strong evidence for the existence of common cycles among four transportation coincident indicators. Thus, they are qualified coincident indicators for this sector. Lahiri et al. (Lahiri, Stekler, et al. 2003) also pointed out that transportation cycles are more synchronized with the conventional economic performance indicators when employment, payroll, and expenditure on transportation services are considered. This finding provides grounds for the critical variables necessary for the current study.

Summary

The linkage between transportation and economic growth has been well established. In particular, increases in freight tonnage and shipments are, more often than not, quoted as indicators of economic growth and recovery. While at least one study estimated the economic contribution of the freight industry, the definition of the industry was too broad to produce a reliable reflection of freight industry activities and its findings may have doubled the impacts.

Given the difficulty of collecting detailed data with limited resources, findings from several studies hinted that the employment counts in the transportation sector can function as a proxy for the economic activity. Also, transportation coincidence indicators such as employment and payroll are found to move concurrently with the conventional economic cycle.

METHODOLOGY

This chapter discusses the methodologies used in the study. The definition of the freight industry for the study is provided, and then brief descriptions of input-output analysis and freight index generation are provided.

Defining the Freight Industry

There seems to be no agreed-upon definition of the freight industry, which is generally defined loosely. In the Maryland Statewide Freight Plan, "goods dependent industry" was used to define it. Goods dependent industries are defined as "business relying on transportation to receive raw supplies and manufactured goods and to send their refined/finished product to market (Cambridge Systematics 2009)." This definition includes eight industry sectors: agriculture, forestry, fishing and hunting; mining; utilities; construction; manufacturing; wholesale trade; retail trade; and transportation and warehousing. These sectors include not only freight transportation services, but also sectors that use transportation as a means to fulfill their inherent business goals. For this reason, if an input-output analysis is carried out based on this broad definition, the overall impact of the freight industry will be over-estimated. Transportation satellite account (TSA) of the Bureau of Economic Analysis could be used to extract the contribution of freight transportation (in-house fleets) out of these goods-dependent industries (Bureau of Economic Analysis n.d.). However, the data is too old (published in 1997); thus, it would be a daunting task to extrapolate TSA to the current year and the corresponding reliability of such an estimate may be questionable. A more refined definition was provided by a 2011 study that defined the freight industry as "the transportation (and related services) of goods from point of production or import through delivery at retail locations or ports for exports" (Cambridge Systematics and Marlin Engineering 2011, 3). However, the industry segments included in this definition are still inclusive. For example, the study included the wholesale sector in which transportation is part of its cost structure but not the primary goal for its existence. If a wholesaler does not own its own fleet, transportation costs will be borne by retailers. The use of broader or less-clearly defined industry segments may result in double counting or omitting some economic impacts.

Due to these reasons, a more stringent definition is used in the current study. The freight industry consists of (1) independent (not in-house) transportation service providers; that is, transportation is the primary business and (2) supporting services in private and public sectors. This definition includes trucks, freight rail, air freight carriers, pipeline, couriers and messengers, water freight, warehousing and storage, the United States Postal Services (USPS), transportation supporting services, and government employees assigned to freight transportation-related tasks. Each sector is defined using the North American Industry Classification System (NAICS) that is "the standard used by federal statistical agencies in classifying business establishments (U.S. Census Bureau n.d.)." NAICS 48 and 49 (Transportation and Warehousing) contain the freight transportation industry. A more thorough discussion on the freight sectors is provided later.

Analysis Tool

Input-Output Analysis

Input-output analysis, developed by Leontief in the late 1930s, is one of the most widely used economic impact analysis techniques (Miller and Blair 2009). It is a statistical model that analyzes and quantifies the interdependence of industries in an economy during a specified period, typically one year (Miller and Blair 2009). "It developed from a basic idea all transactions that involve the sale of products or services within an economy during a given period are arrayed in a square indicating simultaneously the sectors making and the sectors receiving delivery (Goldsmith 1955, 3)." Hence, one of the principal tasks of input-output analysis is to identify the indirect demands concerning the intermediate consumptions necessary to generate the outputs (Sargento 2009). The interdependence is represented as the flow of products between businesses and businesses and final consumers (IMPLAN Group LLC. n.d.). The flow of products becomes input or output, "because a portion of the output (i.e., sales) of one industry will appear as the input (i.e., purchases) of other industries" (Robinson 2009).

Input-output analysis is used mainly for two purposes. First, it is employed for the descriptive analysis of the current regional economy. Second, input-output analysis is conducted for the simulation of policy alternatives (Weisbrod and Weisbrod 1997). The Industry Economic Accounts tables produced by the Bureau of Economic Analysis (BEA) are the main sources of input-output analysis. These tables are then manipulated, combined, and customized for smaller regions such as states, counties, and zip codes so that the impact of initial changes in the economy at the sub-national level can be measured (Bess and Ambargis 2011).

The current study employed the single-region model that captures intra-regional effects alone; therefore interregional linkages are not considered. This model assumes that (Sargento 2009, 7):

- A constant return to scale throughout the entire economy exists.
- Output is consistent across industries. So, there is no substitution in the production process.
- The input-output model is based solely on backward linkage; thus, the equilibrium of supply and demand is maintained in input-output analysis.

Types of Economic Impacts

Economic impacts are estimated for output, income, employment, and value-added (GDP). They are expressed as a multiplier that is defined as "a number showing how changes in one industry will propagate to other industries in the study region" (Robinson 2009). It represents "the magnitude and distribution of economic impacts and measures three types of effects" (IMPLAN Group LLC. n.d.). Three impacts are defined below based on Weisbrod and Weisbrod (1997) but rephrased in terms of the economic impacts of the freight industry.

- ***Direct impacts*** are measured as changes created by providing freight transportation services. These include expenditures and revenues directly attributable to the operations of the freight industry.
- ***Indirect impacts*** are determined by the changes in the activities of suppliers who meet the supply needs of the freight industry. The changes include the supplies of

intermediate inputs necessary for the operation of the freight industry such as fuel, equipment, and machinery.

- ***Induced impacts*** are created by household spending of individuals employed by the freight transportation service providers, and suppliers indirectly affected by freight industry operations.

These impacts can be examined by two multipliers: Type I and Type II. A multiplier indicates the additional impacts to an economy as a result of economic activity (i.e., deliveries of goods). A Type I multiplier is a ratio of the direct impact to the sum of the direct and indirect impacts. That is, by excluding induced impacts (household spending), the impacts of the industry to suppliers can be observed. A Type II multiplier is a ratio of the direct impact to the total impact which includes the indirect and induced impact. The difference between the two multipliers provides the household spending impacts as a result of compensations (including wages and all benefits) from direct and indirect economic sectors. The comparison of the two multipliers becomes useful when investigating, for example, household spending impacts of sub-sectors of the economy.

To evaluate the economic impacts on the study area, only the "local" (i.e., the study area) expenditures are used in the input-output model. The rest are considered leakages. Leakages are expenditures incurred outside the study area. In other words, leakages are the imports of goods and services that the industry in the study area purchased from outside. More leakages implies smaller multipliers. The larger the local expenditures, the greater the multiplier effects become (Bess and Ambargis 2011). That is, an industry with a smaller multiplier may mean a large import of inputs from outside the study area or loss of consumption to outside the study area.

Economic impacts are expressed in various ways. Usually, they include employment, labor income, value-added (i.e., GDP), output, and taxes (Weisbrod and Weisbrod 1997). First, employment is the number of jobs supported as a result of freight industry operations. Second, labor income is cash earnings of employees. Third, value-added is the sum of the additional values created from each stage of economic activity. In other words, this is the sum of the net output of each business, more frequently called the gross domestic product (GDP). Next, output is the sum of all goods and services produced at each node of the supply chain. Output contains expenditures on the intermediary inputs (i.e., results in double counting); therefore output is larger than the GDP, a sum of the final sales. Finally, taxes include personal income taxes, indirect taxes less subsidies, and corporate income taxes paid to state and federal governments.

IMPLAN

The economic impacts of the freight industry were measured by IMPLAN using the 2010 input-output tables for the State of Maryland (IMPLAN Group LLC. n.d.). IMPLAN is a widely used commercial software package for input-output analysis.

Index Generation

An index is defined as "a number (as a ratio) derived from a series of observations and used as an indicator or measure (Merriam-Webster n.d.)." A number of different index development methods – e.g., the Laspeyres index, the Divisia index, and the Fisher ideal index – have been used in many disciplines (Bureau of Transportation Statistics n.d., Boyd and Roop 2004, Roos

1955). Broadly speaking, an index is developed by following several steps. First, a study subject and its sub-components are clearly defined. Next, an indicator(s) that reflects each sub-component's performance is identified or estimated. Lastly, all data are aggregated, if necessary with weights, to produce an aggregate index. These steps would be further refined depending on the availability of the data and the choice of index development methods.

To determine the data availability and index development method for the current study, four scenarios were developed and examined. They are described below.

Scenario 1: Collecting Historical Monthly Data

If multi-dimensional monthly freight industry data were available, an index similar to the national-level TSI could be developed. However, monthly records for Maryland were not publicly available, if any exist. As provided in Appendix A, annual data for each mode are available but there is no consistency in terms of regularity and unit of measure of each data.

Scenario 2: Historical IMPLAN Data

Since IMPLAN was used to measure economic impacts of the freight industry in 2010, an index can be developed using the historical IMPLAN data. Due to resource constraints, purchasing multiple years of the IMPLAN data was impractical. While at least one Maryland state agency uses IMPLAN for the state-level input-output analysis, the license agreement between the agency and IMPLAN limits the data sharing.

Scenario 3: Use of IMPLAN's Built-in Deflation Factors

The deflation factors in IMPLAN are simply derived by adjusting current year dollars (year 2010) to the years of interest (past years) so that they are in the same dollar value as the current dollars. However, IMPLAN deflation factors do not change over time. The only change is that the current dollars are deflated to the model year, while multipliers and shares of each industry's contribution remain the same as the base year. This is not a realistic assumption for the current study since potential changes in economic structure are not taken into account. An analysis using IMPLAN models requires IMPLAN data sets for the entire study period or equivalent data sets from a state agency using IMPLAN (i.e., Scenario 2).

Scenario 4: GDP-based Index

The last scenario was to develop an index by estimating GDP for each freight industry sector. Maryland GDP data from 2002 to 2010 was extracted from the query interface of the Bureau of Economic Analysis (Bureau of Economic Analysis 2014). The data provide GDPs (in 2005 dollars) aggregated at the three-digit NAICS level (i.e., by each mode such as rail, air, water, etc.); however, no separate information for the freight sectors at the six-digit NAICS (e.g., freight air, freight rail, etc.) is available. Thus, the GDP by each freight sector was calculated as the multiplication of the Maryland GDP for the sector at 3-digit NAICS and the annual payroll share of the Maryland sector at 6-digit NAICS used, as shown below:

$$GDP_{i,t} = MD\ GDP_{I,t} \times \frac{Freight\ Sector\ Annual\ Payroll_{i,t}}{Parent\ Sector\ Annual\ Payroll_{I,t}}$$

Where,

I= Parent Sector, i.e. 3-digit NAICS

i = Freight sector (i.e., 6-digit NAICS) included in the sector I
t = Year
$GDP_{i,\,t}$= Gross Domestic Product ($) of the freight sector i in year t
MD $GDP_{I,\,t}$= Maryland GDP ($) for the parent sector I in year t
Freight Sector Annual $Payroll_{i,t}$= Annual payroll of freight sector i in year t
Parent Sector Annual $Payroll_{I,t}$= Annual payroll of parent sector I in year t

For example, the 2010 GDP of the air freight transportation (NAICS 481112 and 4831212) is about $1.66 million (in 2005 dollars), which is calculated as:

$$GDP_{i,t} = MD\ GDP_{Air\ Transportation,2010} \times \frac{Payroll_{Air\ Freight\ Transportation,2010}}{Parent\ Sector\ Payroll_{Air\ Transportation,2010}}$$

$$= \$695\,million \quad \times \frac{\$711{,}000}{\$297{,}467{,}000}$$

$$= \$1.66\,million$$

The ratio of payroll was used to account for potential productivity and/or average payroll differences by six-digit sectors under the parent sector. The same calculation was done for all study years and the ratio between two subsequent years was used as the freight economic contribution index. The base year for the index is 2005, which is the same base year as the GDP provided by BEA. The ratio of payroll was used rather than the ratio of the number of employees to better reflect changes in productivity over time. It is assumed that the gross operational surplus and indirect taxes less subsidies at any given year is a constant fraction of the payroll. This assumption may not be valid year-over-year, and a breakdown of this assumption will result in the breakdown of that sector's index only if the ratio of the six-digit NAICS code payroll to the three-digit code payroll is small. In this study, in all instances, the ratio of freight to the transportation sector in Maryland's economy is nearly 95% or higher and 100% for truck, pipeline, and warehouse and storage sectors. In one instance (for air sector), the ratio was tiny and the research team did not compute the freight index for this sector.

DATA COLLECTION

While input-output analysis was initially developed for national-level applications, growing interest in applying the national-level analysis to sub-national levels led to some modifications in the national model, resulting in the development of a set of regional input-output models (Sargento 2009). In applying the national data to the regional level, one of the main challenges is obtaining the regional data necessary to implement input-output models and capturing interregional flows of goods and services.

Data for economic impact studies can be obtained by collecting publicly available data and the survey of study subjects. While surveying study subjects would be the best way to collect the most accurate and comprehensive information, resource constraints of conducting such a comprehensive study are an impediment to obtaining such primary data. Therefore, many studies reviewed earlier employed a mixed strategy, relying on publicly available data and collecting some additional information by conducting a survey. A similar strategy was used for the current study. Freight transportation services data were mostly collected from the secondary sources, and data from government employees working on freight-related tasks were collected by surveying freight transportation-related government agencies in Maryland.

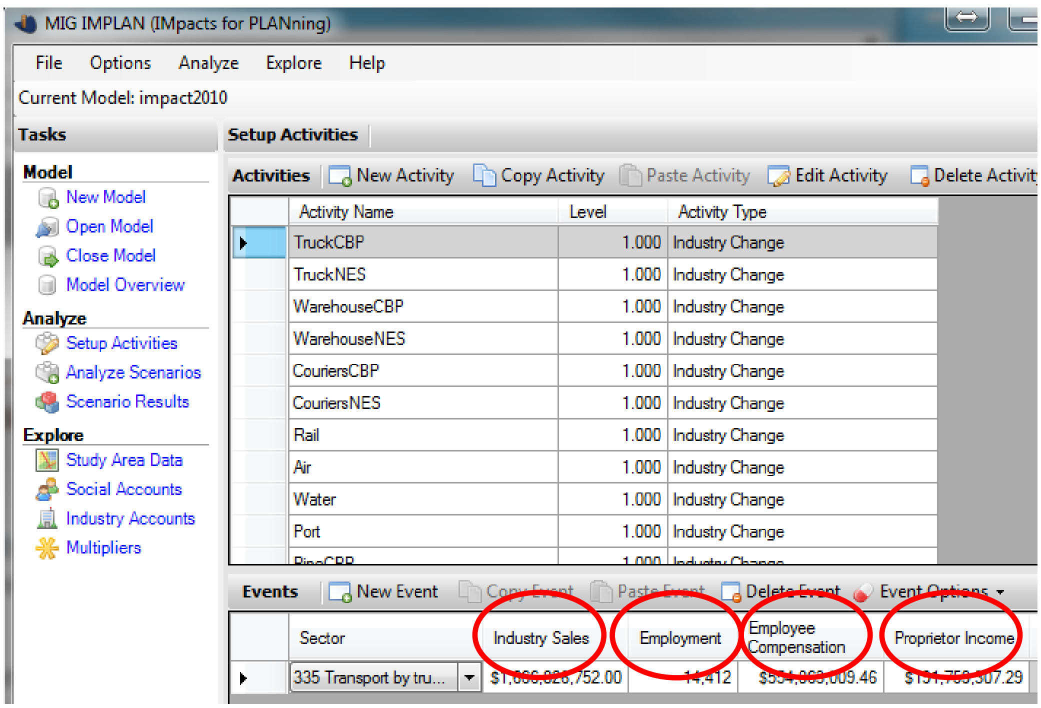


Figure 5: Activity Setup and Inputs

Input Variables

IMPLAN takes several variables as a base for economic analysis: jobs, expenditure, and wages. Depending on the data availability, IMPLAN can be modified for the study area. For example, the availability of a regional purchase percentage of intermediate commodity transactions could capture interregional flows more realistically, and detailed tax collection information would result in a more accurate measurement of economic impacts. Figure 5 shows an example of an activity set up window and several possible inputs in red circles. Industry sales are the total output (gross revenue) of an industry (IMPLAN 2014). Employment is the total full-time equivalent (FTE) count of workers of an industry. Employee compensation (i.e., labor income) is the total payroll cost of the employee paid by the employer. “This includes wage and salary, all benefits (e.g., health, retirement) and payroll taxes (both sides of Social Security, unemployment taxes, etc.)” (IMPLAN 2014). Proprietor income “consists of payments received by self-employed individuals and unincorporated business owners” (IMPLAN 2014). The data on industry sales, employee compensation, and proprietor income by freight sector in Maryland were not available to the study team. The study resources (time and monetary) were not sufficient to conduct a large-scale survey of the entire freight industry to obtain all the data in the state. Instead, the number of FTE employment figures by industry was used as the primary input data. Past studies have found that the employment can be used as a proxy of economic activity and transportation demands are coincident with employment levels (Guzavicius, Barkauskas and Tamulis 2013, Lahiri and Yao 2006, Ozbay, et al. 2008, Marr, Pomeroy and Biles 2008). IMPLAN’s default values on other variables (i.e., sales, compensation, and proprietor income) were used. The IMPLAN’s default values are estimated using the national input-output table by considering interstate flows of goods and services.

Freight Sectors in County Business Patterns

After an extensive data search, the study team decided to use county business patterns (CBP) as a primary data source. CBP is released yearly by the U.S. Census Bureau and reports subnational-level economic data by industry, including the number of establishments, employment, and annual payroll. CBP reports on the economic activity and an overall economic picture over time at the state and zip code levels (U.S. Census Bureau n.d.). CBP industry sectors are defined on the basis of the North American Industry Classification Systems (NAICS). Warehousing and transportation sectors (NAICS 48 and 49 respectively) contain information related to the freight transportation industry.

Table 1 shows freight-transportation-related sectors available from CBP. Warehousing and Storage (NAICS 493) is considered as the freight industry. According to the sector definition, NAICS 493’s primary objective is to support distribution of goods through freight movement, not making and/or selling products. According to the definition,

> *“The warehousing and storage subsectors are primarily engaged in operating warehousing and storage facilities. (…) They do not sell the goods they handle. (…) and also provide other logistics services* (U.S. Census Breau 2012)*.”*

The above definition clearly points to the difference of the warehousing and storage sector from other sectors such as manufacturing (NAICS 31), retail trade (NAICS 44 – 45) and wholesale trade (NAICS 42). The latter sectors do not sell transportation services; instead, transportation is some part of their business processes and costs in pursuing their primary goal, producing and selling goods. The very existence of the warehousing and storage sector is dependent upon freight movement; consequently, this sector is armed with enough domain-specific freight knowledge to provide logistics services.

While the CBP provides rich information, several freight-industry-related sectors are not included. They are rail transportation (NAICS 482), postal service (NAICS 491), government employees working on freight-related tasks, and one employee (non-employer or self-employed individuals) establishments (U.S. Census Bureau n.d.). For this reason, complementary data was collected, which is discussed later.

Table 1: Freight-Transportation-related NAICS

	NAICS	Description
Air Transportation	481112	Scheduled freight air transportation
	481212	Nonscheduled chartered freight air transportation
Water Transportation	483111	Deep sea freight transportation
	483113	Coastal and Great Lakes freight transportation
	483211	Inland water freight transportation
Truck Transportation	484110	General freight trucking, local
	484121	General freight trucking, long-distance, truckload
	484122	General freight trucking, long-distance, less than truckload
	484210	Used household and office goods moving
	484220	Specialized freight (except used goods) trucking, local
	484230	Specialized freight (except used goods) trucking, long-distance
Pipeline Transportation	486210	Pipeline transportation of natural gas
	486910	Pipeline transportation of refined petroleum products
Support Activities for Transportation	488119	Other airport operations
	488310	Port and harbor operations
	488320	Marine cargo handling
	488330	Navigational services to shipping
	488390	Other support activities for water transportation
	488490	Other support activities for road transportation
	488510	Freight transportation arrangement
	488991	Packing and crating
	488999	All other support activities for transportation
Couriers and Messengers	492110	Couriers and express delivery services
	492210	Local messengers and local delivery
Warehouse and Storage	493110	General warehousing and storage
	493120	Refrigerated warehousing and storage
	493130	Farm product warehousing and storage
	493190	Other warehousing and storage

Source: County Business Patterns (www.census.gov/econ/cbp)

Table 2: IMPLAN Sector vs. 6-digit NAICS

IMPLAN Sector		NAICS	
Bulk mail truck transportation, contract, local	335	484110	General Freight Trucking, Local
Container trucking services, local	335	484110	
General freight trucking, local	335	484110	
Motor freight carrier, general, local	335	484110	
Transfer (trucking) services, general freight, local	335	484110	
Trucking, general freight, local	335	484110	
Bulk mail truck transportation, contract, long-distance (TL)	335	484121	General Freight Trucking, Long-Distance, Truckload
Container trucking services, long-distance (TL)	335	484121	
General freight trucking, long-distance, truckload (TL)	335	484121	
Motor freight carrier, general, long-distance, truckload (TL)	335	484121	
Trucking, general freight, long-distance, truckload (TL)	335	484121	

Sources: IMPLAN version 3.0; and County Business Patterns (www.census.gov/econ/cbp)

Freight Sectors in IMPLAN

The next step is to match the CBP freight sectors with the corresponding sectors of IMPLAN. While there are 19,253 six-digit NAICS codes (U.S. Census Bureau 2013), IMPLAN contains 426 industry codes and the codes are further refined into 18,535 detailed job categories. Each of the IMPLAN job categories maps to a corresponding NAICS code. The IMPLAN industry sector 332, 334, 335, 337, 338, and 339 include the freight industry sectors. Table 2 provides an example of how the two classifications systems are mapped.

Description of Collected Data sets

County Business Patterns, 2002-2010

CBP from 1998 to 2010 were downloaded from the U.S. Census Bureau website (U.S. Census Bureau n.d.). The CBP data published before 1998 were not considered since they were based on the Standard Industrial Classification (SIC) system that does not correspond directly to industries as defined under NAICS. The 2010 CBP data for the State of Maryland is provided as an example in Appendix B.

Some cells in Appendix B do not have real numbers; instead they are filled with alphabetical codes. These codes indicate that the Census Bureau did not disclose the number of employees for some sub-sectors to protect data confidentiality, called “disclosure limitation procedure.” According to Evans, Zayatz, and Slanta (1998, 537-538),

> *“This disclosure limitation procedure is designed to prevent data users from being able to recover any respondent’s reported values using values appearing in the published tables. (…) [The Census Bureau] ensures that a cell value does not closely approximate data for any one respondent in the cell and, moreover, that one respondent or a coalition of respondents cannot subtract their contribution(s) from the cell value to achieve a ‘close’ estimate of the contribution of another respondent.”*

Instead, the number of employees is reported in various buckets of employment-size class (Appendix B). For example, error code '*a*' indicates that the total number of paid employees is between 0 and 19 for a certain employment sector. For this reason, the CBP employment information of some sectors is not complete.

Several techniques can address the issue of incomplete data. The easiest is the elimination of incomplete variables or records from the research data set. Alternatively, averages values using historical data may replace missing values. A modeling technique is often used to complement the research data set (Buchheit 2002). The last technique, which was employed for this study, is a curve fitting procedure, a standard procedure provided in statistics software like SPSS. It quickly estimates regression statistics and produces related plots. This procedure is "most appropriate when the relationship between the dependent variable and the independent variable is not necessarily linear" (IBM 2013), which is likely for the employment data due to different productivity and technology use by the freight transportation sector. Using national-level employment information from CBP as a benchmark figure, expected employment numbers were imputed for various buckets of employment-size. Appendix C provides a detailed discussion of this method. Table 3 shows the number of employees of the six sectors from 1998 to 2010, imputing only those values that were not disclosed.

Table 3: The Number of Employees by Sector in CBP: 1998 - 2010

Year	Air	Water	Trucking	Pipeline	Couriers & Messengers	Warehousing & Storage	Total
1998	1,115	4,955	17,503	162	11,218	10,405	61,718
1999	1,024	5,005	18,596	242	12,297	10,550	65,260
2000	1,239	4,840	19,015	263	13,706	10,696	67,558
2001	1,950	4,535	17,563	190	12,795	10,845	64,306
2002	1,173	4,485	17,883	206	13,214	10,996	64,614
2003	629	5,274	17,419	142	10,646	10,123	60,975
2004	1,061	5,401	17,840	112	11,559	11,910	64,275
2005	583	5,308	18,723	115	10,708	11,532	64,806
2006	660	6,170	20,792	115	11,062	11,824	70,329
2007	620	5,665	19,512	105	11,153	12,007	67,536
2008	771	6,204	17,977	272	11,378	12,900	66,225
2009	789	6,635	16,039	169	10,566	12,429	61,523
2010	639	7,094	14,683	133	10,296	12,060	58,696

Source: U.S. Census Bureau, County Business Patterns, 1998-2010.
Note: Numbers may not add up due to rounding.

Revising the Warehousing and Storage Sector Employment

The employment figures of the warehousing and storage sector needed to be revised due to the change in the inclusion criteria of establishments in 2003. The 1997 version of NAICS was used until 2002, which classified employment for auxiliary establishments for each sector into a single sector, NAICS 95: Unclassified Auxiliary Establishments (U.S. Census Bureau 2013, U.S. Census Bureau 2000). Starting from 2003, however, in the 2002 version of NAICS, such establishments were classified in the primary industry where they perform services. The warehousing and storage sector was greatly affected by this change, compared to the other freight transportation modes. Between 1998 and 2002, the number of employees in warehousing and storage was around 2,000. On the other hand, the change in the sector classification in 2003 boosted the employment numbers to over 10,000 employees. Based on that, it was necessary to impute the number of establishments prior to 2002. The available data for the number of establishments for 2003 to 2010 was used to generate the number of establishments for 1998 through 2002 using Excel's trend function that fits a straight line to return trend values (Microsoft n.d.). The employment figures of the warehousing and storage sector for 1998 to 2020 in Table 3 reflect the new numbers revised by the EXCEL trend analysis. Table 4 shows the results of the calculating new employment values for the trend fitted years 1998-2002.

Table 4: Imputing the Warehousing and Storage Employment by Trend Analysis

Year	Before	After Trend Analysis
1998	1,503	10,405
1999	1,799	10,550
2000	1,897	10,696
2001	2,078	10,845
2002	2,269	10,996
2003	10,123	10,123
2004	11,910	11,910
2005	11,532	11,532
2006	11,824	11,824
2007	12,007	12,007
2008	12,900	12,900
2009	12,429	12,429
2010	12,060	12,060

Non-Employer Statistics

County business patterns (CBP) does not include data on self-employed individuals. The information for self-employed individuals is collected by an annual survey, called Non-employer Statistics.

> *"[It] is an annual series that provides subnational economic data for businesses that have no paid employees and are subject to federal income tax. Most non-employers are self-employed individuals operating unincorporated businesses (known as proprietorships), which may or may not be the owner's principal source of income (U.S. Census Bureau n.d.)."*

The non-employer statistics between 1998 and 2010 were downloaded from census.gov (U.S. Census Bureau n.d.). While they only account for roughly 4% of sales and receipts in the U.S. economy (U.S. Census Bureau n.d.), the inclusion of self-employed individuals allows for the most realistic estimation of the economic activity of the freight industry because the trucking sector consists of a large number of self-employed, i.e., owner-drivers (Burks, et al. 2010). Indeed, the number of self-employed for the trucking and courier and messenger sectors accounts for almost a third of each of those sectors, which is larger than the majority of economic sectors in Maryland (U.S. Census Bureau n.d.). For example, of 14,700 individuals employed in the total employment in couriers and messengers in 2010, self-employed persons accounted for 30%. In trucking, the number of the self-employed was roughly 27% of the trucking employment captured by CBP. Table 5 shows the summary of non-employer statistics of four freight transportation sectors. Other freight sectors were not included because the data were not reported at the levels disaggregated enough to obtain freight-only employment. This is because "data for non-employers generally are provided at broader levels of industry detail than data for employers" [CBP] (U.S. Census Bureau 2014). Some sectors have the employment data at the five-digit NAICS level. However, most information for the transportation sectors is available at the three-digit NAICS level. Trucking, warehousing and storage, couriers and messengers, and pipeline have their own three-digit NAICS codes: 484, 493, 492 and 486, respectively. On the other hand, other freight transportation sectors are part of higher NAICS levels and they were reported only at the three-digit NAICS level: air (481), water (483), and support activities for transportation (488).

Table 5: Summary of Non-employer Statistics: 1998-2010

	Trucking	Warehouse & Storage	Couriers & Messengers	Pipeline
1998	7479	80	947	8[a]
1999	8147	58	1051	8[a]
2000	7536	60	1130	6
2001	8311	63	1183	8
2002	5180	89	4495	8[a]
2003	5346	102	4769	7
2004	5571	128	4845	8[a]
2005	5800	141	4819	8
2006	6091	140	5067	11
2007	6594	114	5325	5
2008	5924	110	4853	8[a]
2009	5440	130	4530	6
2010	5473	113	4447	9
Source:	U.S. Census Bureau, Nonemployer Statistics: 1998-2010			
Note a -	The information was not available. The average of the other years was used.			

Contribution Analysis

While non-employer statistics complemented CBP, it was not clear how the economic activities of self-employed individuals are treated in IMPLAN. We assumed that multipliers of the self-employed would be different from employees captured in CBP. This is because IMPLAN's employment figures include wage and salary of workers as well as proprietors.[4] However, self-employed workers can be treated only as proprietors, not salaried workers, and their spillovers to the economy are probably smaller than that of establishments included in CBP. Without modifying the default conditions in IMPLAN, the economic contribution of the self-employed

[4] Discussion with an IMPLAN technical contact, March 21, 2013.
http://www.implan.com/index.php?option=com_kunena&view=topic&catid=84&id=15478&Itemid=1679#15478

individuals may be exaggerated. To avoid double-counting by adding them to the CBP sectors, the contribution analysis was recommended by an IMPLAN technical contact. The contribution analysis adjusts default IMPLAN assumptions to avoid double-counting by not allowing intermediate effects to the final output. The adjustment is done by taking the reciprocal of the Social Accounting Matrix (SAM) multiplier of the industry sector (IMPLAN n.d.). SAM represents a flow among industries and the amount of intermediate inputs as a result of the flow of the goods (Defourny and Thorbecke 1984, Robinson, Cattaneo and Del-Said 2001). For example, the number of self-employed workers in the trucking sector was 5,473 and the SAM multiplier of the same sector was 1.029624. The number of self-employed is multiplied by the reciprocal of SAM (i.e., 1/1.029624) and the product is 5,316 self-employed workers. This is the adjusted employment figure after removing potential double counting. Table 6 shows the revised employment figures by sectors.

Table 6: The Adjusted Number of Self-employed Individuals

	Trucking	Warehouse & Storage	Couriers & Messengers	Pipeline
1998	7264	75	938	8
1999	7913	55	1041	8
2000	7319	57	1119	6
2001	8072	59	1172	8
2002	5031	84	4452	8
2003	5192	96	4723	7
2004	5411	121	4798	8
2005	5633	133	4772	8
2006	5916	132	5018	11
2007	6404	107	5274	5
2008	5754	104	4806	8
2009	5283	122	4486	6
2010	5316	106	4404	9

Freight Rail Employment

The number of individuals working in the freight rail sector was obtained from the Association of American Railroads, an association of the major freight railroads in the United States, Canada, and Mexico (AAR 2013). There were no reliable public data sources for the freight rail employment. Table 7 presents the freight rail employment between 2000 and 2010 in Maryland.

Table 7: Freight Rail Employees in Maryland: 2000-2010

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Employees	1,817	1,778	1,675	1,625	1,547	1,555	1,615	1,642	1,600	1,501	1,472

Source: Association of American Railroads

The U.S. Postal Service Employment

The U.S. Postal Service (NAICS 491) is another large delivery sector that plays a similar role to couriers and messengers (NAICS 492). USPS accounts for about one-fifth of the package delivery market in the United States (Adler 2011). The occupational employment statistics survey released by the Bureau of Labor Statistics provides the number of USPS employees. The summary of the USPS employment from 1998 to 2010 is provided in table 8.

Table 8: The U.S. Postal Service Employment: 1998-2010

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Employees	12,460	15,120	14,500	14,130	17,930	16,840	13,550	13,520	13,750	13,330	13,240	12,070	11,280

Source: Bureau of Labor Statistics, Occupational Employment Statistics, 1998-2010

Government Employees (NAICS 92)

The number of government employees assigned to freight transportation-related tasks was collected directly from relevant state agencies, since CBP does not collect government employment information. Since only a few employees were working solely on freight tasks in most agencies, the contacted state agencies were asked to provide full-time equivalent (FTE) employees assigned to freight transportation-related tasks. Over 10 freight transportation-related offices were contacted, and seven offices provided the FTE information (Table 9).

Table 9: Full-Time Equivalent Government Employees in Freight-related Tasks

Agency	FTE
Maryland Port Administration (state)	284
Maryland Port Administration (federal)	222
Maryland Department of Environment, Hazmat Waste Program	10
Comptroller of Maryland's Motor Fuel Tax Office IFTA	62
Motor Carrier Office	11
Maryland Transit Administration	25
Commercial Vehicle Enforcement Division, Maryland State Police	117
Commercial Vehicle Safety Unit, Maryland Transportation Authority Police	77
Total	808

Compiled Data

Table 10 summarizes the compiled data by modes and data sources. Most variables between 1998 and 2002 are complete; some missing values in pipeline had to be filled using the average value of the available years. Government employment figures are not complete due to the difficulty in tracking FTE employment during the study period. It should be noted that the total number of employment of the trucking sector may bring some confusion since some reports (e.g., a previously mentioned ATRI document) provide much higher numbers for the sector. Appendix D discusses in detail the derivation of the trucking employment count based on federal data sources.

The 2010 data is complete and used for the economic impact analysis. Figure 6 presents the total employment by freight sector in 2010. Trucking is the largest employer among freight industries in Maryland. Almost 20,000 people are employed in the sector, which accounts for 29.3% of the total freight transportation sector employment. Couriers and messengers are the second-largest employers, hiring 14,700 workers (21.5%), followed by warehousing and storage (12,166 jobs, 17.8%), USPS (11,280 jobs, 16.5%), and water and port (7,094 jobs, 10.4%). The top five sectors account for 95.5% of the total freight sector employees. In other words, the remaining sectors – air, rail, pipeline and government employees – constitute a minor share of roughly 4.5%.

Table 10: Employment by Freight Sectors in Maryland (1998-2010)

Economic Sectors	Data source	Years												
		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Trucking	County business	17,417	18,516	18,900	17,403	17,714	17,310	17,393	18,394	20,356	19,079	17,405	15,495	14,412
	CBP[1] (supporting services)	86	80	115	160	169	109	447	329	436	433	572	544	271
	NES[2]	7,264	7,913	7,319	8,072	5,031	5,192	5,411	5,633	5,916	6,404	5,754	5,283	**5,316**
	Truck Total	**24,767**	**26,509**	**26,334**	**25,635**	**22,914**	**22,611**	**23,251**	**24,356**	**26,708**	**25,916**	**23,731**	**21,322**	**19,999**
Warehouse & Storage	CBP[3]	10,405	10,550	10,696	10,845	10,996	10,123	11,910	11,532	11,824	12,007	12,900	12,429	**12,060**
	NES[2]	75	55	57	59	84	96	121	133	132	107	104	122	**106**
	Storage total	**10,480**	**10,605**	**10,753**	**10,904**	**11,080**	**10,219**	**12,031**	**11,665**	**11,956**	**12,114**	**13,004**	**12,551**	**12,166**
Couriers & Messengers	CBP	11,218	12,297	13,706	12,795	13,214	10,646	11,559	10,708	11,062	11,153	11,378	10,566	**10,296**
	NES[2]	938	1,041	1,119	1,172	4,452	4,723	4,798	4,772	5,018	5,274	4,806	4,486	**4,404**
	Messengers total	**12,156**	**13,338**	**14,825**	**13,967**	**17,666**	**15,369**	**16,357**	**15,480**	**16,080**	**16,427**	**16,184**	**15,052**	**14,700**
Rail	**Rail Total[4]**			**1,817**	**1,778**	**1,675**	**1,625**	**1,547**	**1,555**	**1,615**	**1,642**	**1,600**	**1,501**	**1,472**
Air	CBP	58	54	138	975	116	61	60	26	10	15	89	190	**18**
	CBP[1] (Supporting services)	1,057	970	1,101	975	1,057	568	1,001	557	650	605	682	599	**621**
	Air Freight Total	**1,115**	**1,024**	**1,239**	**1,950**	**1,173**	**629**	**1,061**	**583**	**660**	**620**	**771**	**789**	**639**
Water	CBP	**379**	**429**	**444**	**451**	**477**	**675**	**706**	**783**	**722**	**850**	**946**	**1,019**	**1,150**
Port[5]	CBP* (Supporting services)	**4,576**	**4,576**	**4,396**	**4,084**	**4,008**	**4,599**	**4,695**	**4,525**	**5,448**	**4,815**	**5,258**	**5,616**	**5,944**
	Water & Port	**4,955**	**5,005**	**4,840**	**4,535**	**4,485**	**5,274**	**5,401**	**5,308**	**6,170**	**5,665**	**6,204**	**6,635**	**7,094**
Pipeline	CBP	162	242	263	190	206	142	112	115	115	105	272	169	**133**
	NES[6]	8	8	6	8	8	7	8	8	11	5	8	6	**9**
	Pipe total	**170**	**250**	**269**	**198**	**214**	**149**	**120**	**123**	**126**	**110**	**280**	**175**	**142**
USPS	**USPS Total[7]**	**12,460**	**15,120**	**14,500**	**14,130**	**17,930**	**16,840**	**13,550**	**13,520**	**13,750**	**13,330**	**13,240**	**12,070**	**11,280**
State[8]	MPA[9]	369	315	312	311	312	314	307	307	296	292	290	291	284
	MDE Hazmat													10
	IFRA													62
	MVA IRP													11
	MTA Freight													25
	CBED[10]			154	154	154	154	147	135	122	146	129	126	117
	CVSU[11, 12]			93	93	93	93	93	85	83	84	71	78	77
	State total													**586**
Federal	**Federal (MPA)[13]**													**222**
Total Employment														**68,300**

Note 1: NAICS 488490 (Other support activities for road transportation) was included to the mode.
Note 2: These are revised numbers after conducting a contribution analysis in IMPLAN. This is to account for smaller income impacts (proprietary income) of the self-employed.
Note 3: The data for years 1998 through 2002 were updated using trend analysis in EXCEL.
Note 4: American Association of Railroads provided the data.
Note 5: Port activities are included in NAICS 488 (Support activities).
Note 6: For 2002, 2004, and 2008, the average of other years was used.
Note 7: BLS, Occupational Employment Statistics, http://www.bls.gov/oes/tables.htm
Note 8: The data were collected directly from government agencies in Maryland.
Note 9: The figures are from MPA.
Note 10: For years 2000, 2001, and 2002, the 2003 number was used as per CVED's comment.
Note 11 For year 2003, the figure was 61.93% of the CVED's 2003 figure. The percentage is the ratio of the sum of CVSU employees to the sum of CVED employees from 2004 to 2010.
Note 12: For years 2000, 2001, and 2002, the 2003 number was used.
Note 13: Information from an MPA technical contact.

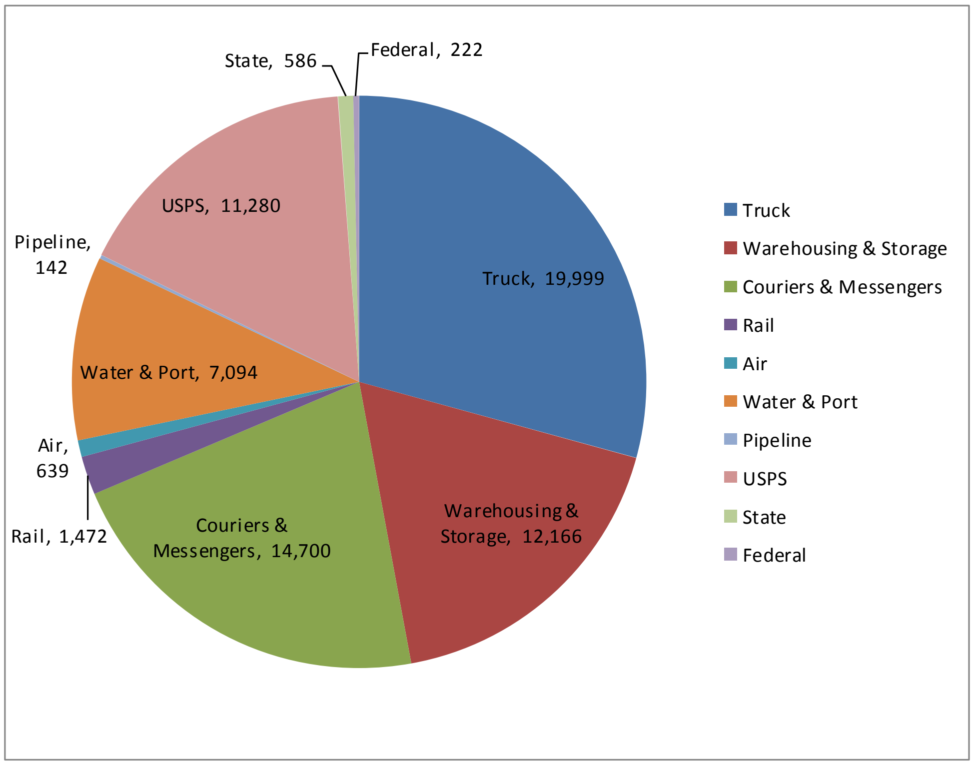


Figure 6: Total Employment by Freight Sector, 2010

RESEARCH FINDINGS AND DISCUSSION

This chapter discusses the estimated total economic impacts of the freight industry on the Maryland economy and FECO indices at the aggregate and modal levels. Input-output analysis results indicate that the freight industry has widespread economic impacts across Maryland's economy. The direct impacts, indirect impacts, and induced impacts were measured in terms of employment, labor income, value added, and total output. Total impacts will be discussed first; then each impact will be further discussed by freight transportation mode. It is important to recognize that the freight activity is not confined within the Maryland state boundaries. Rather, its activity is affected in part by the economic activities of other states and countries. However, such impacts are not considered in this study as they have not been considered in past studies. The FECO indices were compared with other economic indicators, such as Maryland GDP and the national level TSI. The FECO indices change concurrently with these economic indicators, confirming the reliability of the developed indices.

Economic Impacts of the Freight Industry on the Maryland Economy, 2010

The freight industry's contribution to the Maryland economy was measured using the 2010 employment data by the freight industry sector and state and federal governments. The results reveal how the freight industry affected economic activity in the state. More specifically, the results show that freight industry activities (i.e., direct impacts) generated sizable ripple effects to suppliers (indirect impacts) and local businesses that depend on the spending of the affected employees (induced impacts).

Table 11: Total Economic Impacts of the Freight Industry in Maryland (2010)

Impact Type	Jobs	Labor Income (million $)	GDP (Value Added, million $)	Total Output (million $)
Direct	68,300	3,890	4,926	7,810
Indirect	16,224	836	1,257	1,946
Induced	31,576	1,361	2,469	3,878
Total	116,100	6,088	8,652	13,635
Type II multiplier	1.70	1.56	1.76	1.75

Note: Numbers may not add up due to rounding.

Total Impacts

Total economic impacts of the freight industry were estimated (Table 11). In 2010, the freight industry supported 116,100 jobs in total. Nearly 70,000 people were directly hired by the freight industry, which helped sustain an additional 48,000 workers in various sectors. The job multiplier is 1.7. In other words, every 100 jobs in freight transportation supported an additional 70 jobs in other sectors. The GDP (total value added) is $8.7 billion, which represents the size of the monetary contributions of the freight sector. Every $100 spent in the freight industry generated an additional $76 (i.e., multiplier of 1.76). In particular, the direct GDP of $4.9 billion produced by the freight industry is nearly 90% of the GDP generated by the entire transportation sector in Maryland, which is about $5.5 billion (Bureau of Economic Analysis 2013).

Considering that roughly 70% of jobs in the transportation sector are freight-related jobs (U.S. Census Bureau n.d.), it is clear that the freight industry provided tremendous additional benefits to Maryland's economy. The total output of $13.6 billion generated by freight activities in Maryland is nearly 60% larger than the total GDP. Nevertheless, in general, the total GDP is considered a more meaningful measure of economic impacts than output because the total output counts all rounds of impacts at each node of the supply chain, resulting in double counting of intermediate inputs. As discussed earlier, in-house freight transportation was not included in the analysis since no recent data for input-output analysis are available. One study estimated that in-house freight transportation accounts for roughly 1.19% of total output of freight-dependent sectors such as construction and manufacturing (Cambridge Systematics and Marlin Engineering 2011, 3-8). Some sectors are more freight transportation dependent in terms of the transportation cost shares. Construction and farming spent about 5% of their spending, while miscellaneous manufacturing spent about 0.74% for in-house transportation (Cambridge Systematics and Marlin Engineering 2011, 3-8). Assuming that the in-house freight transportation's contribution holds constant as the previous study, the freight industry's GDP contribution to Maryland would be over $8.8 billion.

Tables 12 and 13 present the top 10 most affected sectors in terms of indirect and induced job impacts. Examining the two tables provides a clear idea about the difference between indirect and induced economic impacts of the freight industry. Sectors providing labor and facility/equipment are the top beneficiaries of the demand of the freight industry. The employment services sector that lists employment vacancies, referring, and/or supplying workers, is affected most by the freight industry, followed by such sectors as services to buildings and dwellings, real estate establishments, and maintenance and repair construction of nonresidential structures. They are all supporting services for the freight industry. On the other hand, the top 10 induced job impacts occurred in the sectors closely related to the quality of life, basic necessities – including food services, medical services, housing, and other consumer goods and services – and personal preference items (e.g., drinking places and beverages) (Table 13). This is because of the nature of the induced effects which is the spending of disposable income.

Table 12: Indirect Employment Impact: Top 10 Sectors

Sector Description	Induced Jobs
Employment services	1,966
Services to buildings and dwellings	868
Real estate establishments	812
Maintenance and repair construction of nonresidential structures	665
Food services and drinking places*	430
Accounting, tax preparation, bookkeeping, and payroll services	342
Insurance carriers	324
Nondepository credit intermediation and related activities	308
Office administrative services	274
Management, scientific, and technical consulting services	269

* This term is represented as *IMPLAN Sector 413* that corresponds to *NAICS 722: Food Services and Drinking Places.* This sector includes catering, mobile food services, drinking places selling alcoholic beverages, and restaurants and other eating places that may or may not serve alcoholic beverages.

Table 13: Induced Employment Impact: Top 10 Sectors

Description	Induced Jobs
Food services and drinking places*	3,415
Offices of physicians, dentists, and other health practitioners	1,970
Private hospitals	1,948
Real estate establishments	1,229
Retail Stores - Food and beverage**	1,181
Nursing and residential care facilities	1,168
Retail Stores - General merchandise	1,003
Wholesale trade businesses	812
Private household operations	804
Retail Stores - Motor vehicle and parts	678

* This term is represented as *IMPLAN Sector 413* that corresponds to *NAICS 722: Food Services and Drinking Places.* This sector includes catering, mobile food services, drinking places selling alcoholic beverages, and restaurants and other eating places that may or may not serve alcoholic beverages.

** This term is represented as *IMPLAN Sector 324* that corresponds to *NAICS 445: Food and Beverage Stores.* This sector includes grocery stores (NAICS 4451); specialty food stores (NACIS 4452), such as meat, fish and seafood, fruit, baked goods, etc.; and liquor stores.

Table 14: Job Impacts and Multipliers by Mode, 2010

	Impact Type				Type I	Type II
	Direct	Indirect	Induced	Total	Multiplier	Multiplier
Truck	19,999	6,101	9,095	35,195	1.31	1.76
Couriers & Messengers	14,700	1,271	3,903	19,874	1.09	1.35
Warehousing & Storage	12,166	2,659	4,839	19,663	1.22	1.62
USPS	11,280	982	6,945	19,207	1.09	1.70
Water & Port	7,094	2,837	4,193	14,124	1.40	1.99
Rail	1,472	1,185	1,378	4,035	1.81	2.74
Air	639	183	325	1,148	1.29	1.80
Pipeline	142	201	243	586	2.41	4.13
State	586	611	514	1,712	2.04	2.92
Federal	222	194	141	557	1.87	2.51
Total	68,300	16,224	31,576	116,100	1.24	1.70

Note: Numbers may not add up due to rounding

Economic Impacts and Multipliers by Mode

This section discusses the results of the economic impact analysis by types of impacts, magnitude of multipliers, and freight transportation sector.

<u>Job Impacts</u>

Table 14 presents job impacts by freight modal sectors and government. Trucking supported the most jobs with 35,195, followed by couriers and messengers, and warehousing and storage. Although the total employment size is small, pipeline has the largest Type II multiplier effect with 4.13 among all freight sectors. Over 201 indirect and 243 induced jobs were sustained by 142 pipeline workers. The Type II job multiplier of freight rail is the second largest among freight modal sectors, supporting 2.74 jobs per freight rail employee, followed by water and port (1.99). The comparisons among private freight sectors revealed that despite the sheer employment size of truck, couriers and messengers, warehousing and storage, and USPS, their Type II multiplier impacts are smaller than those of water and port, rail, and pipeline. Unlike one's expectation, freight air does not contribute much to the job market. This is because air courier services are captured by couriers and express delivery services (NAICS 492110) of couriers and messengers (NAICS 492) (U.S. Census Bureau 2012). The sectors with high Type II multipliers probably require more supporting services and suppliers for their operations. Every state employee working on freight-related tasks supported 2.92 jobs in the state. Every federal employee stationed in Maryland helps sustain 2.51 jobs. These findings are in line with the findings of MDOT's previous studies on the economic impacts of MDOT's surface transportation spending that considered impacts of state spending on "all" surface transportation modes (EDRG and Cambridge Systematics 2006, EDRG and Systematics 2012).

Government sectors, again, lead the Type I multiplier impacts. Every state government employee working on freight tasks sustained more than one worker in the sectors that provide support to state government. Similarly, almost one job was supported by every federal employee. By contrast, most surface freight transportation sectors have low Type I multipliers, meaning that not many supporting sector jobs are related to these sectors. This is probably because the sector is not producing any goods; thus, supporting services, as seen in Table 12, are not labor-intensive sectors but sectors that can be managed by a relatively small number of people. Of interest is the difference between Type I and Type II multipliers for these sectors. While the Type I multiplier of USPS is 1.09, its Type II multiplier is 1.70, 56% larger than the Type I multiplier. While only about 1,000 employees were hired by indirect activities of USPS, nearly 7,000 household spending-related induced jobs were sustained by USPS, generating significant local spending and supporting sector employees.

Comparing employees by sector to total job impacts of corresponding sectors shows the relative economic contribution of each sector. Figure 7 (a) depicts the shares of the employment size (direct jobs) and Figure 7 (b) presents the shares of total employment impacts. Comparing figures 7 (a) and 7 (b), it is apparent that the employment shares of most sectors have changed. In particular, the water and port sector, which hires roughly 3% of the total freight-related employees, accounts for 12.2% of the total job impact. Its relative importance in freight-related jobs and their spillovers to the job market is significant. While freight rail comprises only a small share of the freight transportation-related jobs, the proportion of total freight rail's job impact is nearly three times larger than that of the direct jobs in that sector. In contrast, the relative influences of warehousing and storage and couriers and messengers have decreased with wide margins.

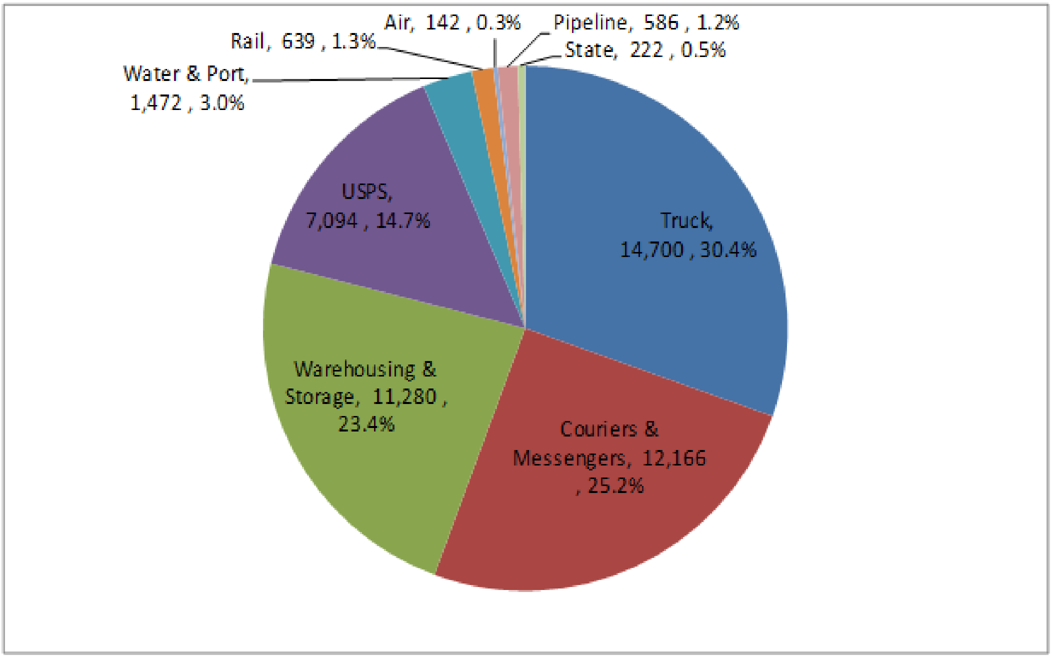


Figure 7 (a): Share of Direct Jobs by Sector

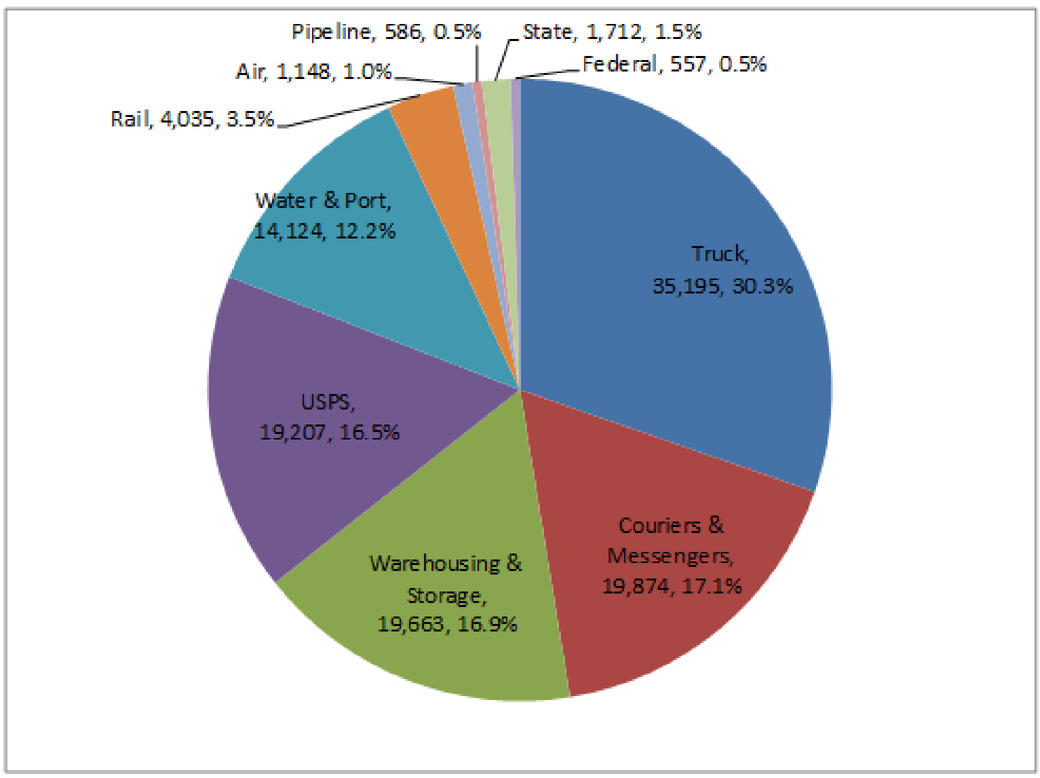


Figure 7 (b): Share of Total Job Impacts by Sector

Income Impacts

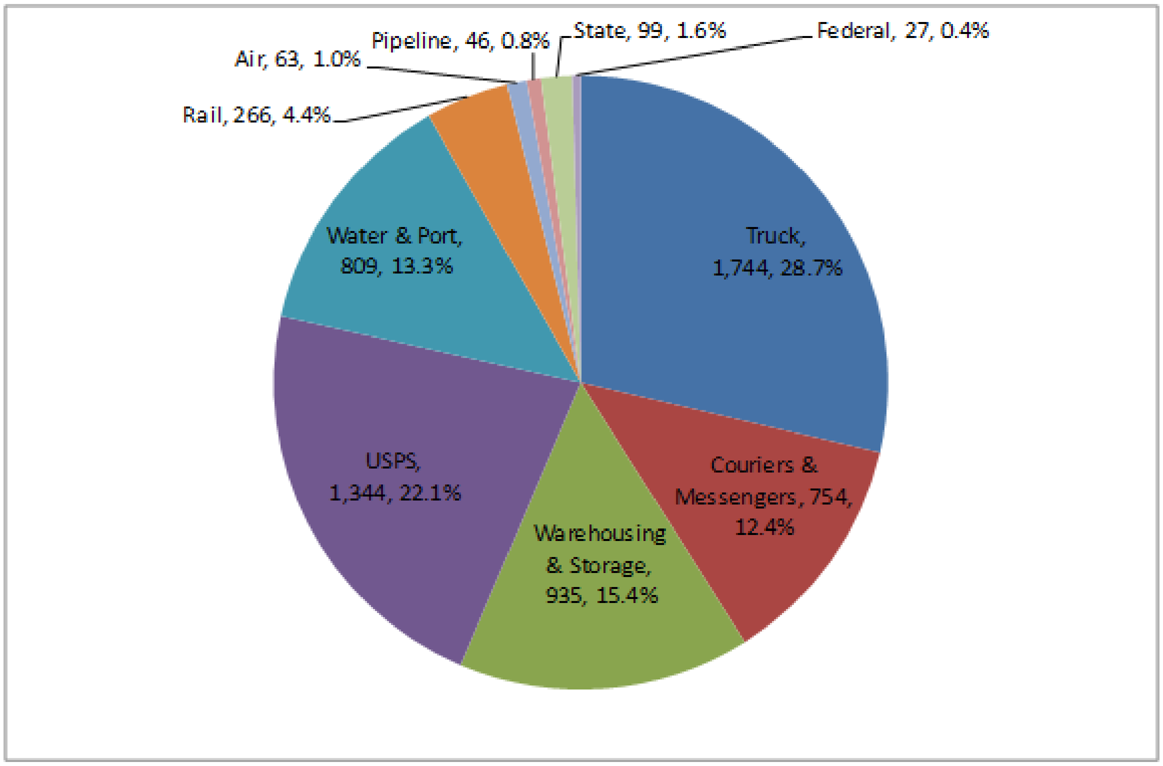
The average income multiplier (Type II) of the freight industry, including government employees, is 1.56 (Table 15). That is, an additional 56 jobs are sustained as a result of hiring 100 jobs in the freight industry. Like the job impact, federal and state jobs related to freight tasks have the highest Type II multipliers. Of the freight transportation sectors, Type II multipliers of pipeline, rail, and water and port are the highest, 1.87, 1.87, and 1.69 respectively. In terms of the Type I multiplier, a similar trend to Type I job multipliers is observed. That is, the surface freight transportation modes have smaller Type I multipliers, while they generally have comparatively larger induced impacts. This implies most of their employees live in the state and they also spend in the state.

Figure 8 presents shares of total income impacts by sector. The trucking sector, the largest employer among the freight industry, accounts for 28.7% of the total income impacts. The USPS ranks second with 22.1%, which is larger than USPS's direct jobs (14.7%) and total job impacts (16.5%). This is largely related to the sheer employment size of each sector. Like job impacts, the ripple effect of the water and port sector is significant. The sector hires roughly 3% of the total freight jobs, but their share of the total income is 13.3%. The total income impacts of warehousing and storage, and couriers and messengers are smaller than the respective sector's direct and total job impacts.

Table 15: Income Impacts and Multipliers by Mode, 2010

	Impact Type				Type I	Type II
	Direct	Indirect	Induced	Total	Multiplier	Multiplier
Truck	1,038	315	391	1,744	1.30	1.68
Couriers & Messengers	520	65	168	754	1.12	1.45
Warehousing & Storage	596	131	209	935	1.22	1.57
USPS	995	49	300	1,344	1.05	1.35
Water & Port	479	149	181	809	1.31	1.69
Rail	143	64	59	266	1.45	1.87
Air	39	9	14	63	1.24	1.59
Pipeline	25	11	10	46	1.45	1.87
State	43	34	22	99	1.80	2.32
Federal	11	10	6	27	1.88	2.43
Total	3,890	836	1,361	6,088	1.21	1.56

Note: Numbers may not add up due to rounding.



Note: Numbers may not add up due to rounding.

Figure 8: Shares of Total Income Impacts by Sector

GDP (Value added) Impacts

The GDP is a measure of total monetary value of all final goods and services produced by workers within a study area over a year. That is, in this study, the GDP is the total gross operating surplus of the freight transportation-related activities in Maryland in 2010. The GDP of the freight industry, compared to the total GDP in the Maryland transportation sector, shows the relative size and economic contribution of the freight industry. In addition, the shares of GDP by freight sector measure the relative contribution of each freight sector to the freight industry.

As discussed earlier, the total GDP impacts of the freight industry accounted for nearly 90% of the total GDP generated by the entire transportation sector in Maryland in 2010. Again, public sector and pipeline generated the highest Type II multipliers, while couriers and messengers, and USPS were among the lowest. Similar to the previous sections, surface freight modes have larger household spending impacts (Type I multipliers) than do other sectors. In terms of the relative contribution of each sector, surface transportation sectors are the largest contributors. Trucking accounted for nearly 28% of the total GDP generated by the freight industry, followed by USPS, warehousing and storage, and couriers and messengers (Figure 9). By contrast, the comparison between the total direct job contribution of each sector (Figure 7(a)) and the GDP contributions by sector (Figure 9) reveals that the ripple effect of water and port is very large considering the overall direct employment size of the sector, similar to the sector's large job and income impacts.

Summary of Impact Study

It was found that the contribution of the freight industry to the Maryland economy is not insignificant. The direct GDP of the industry constitutes nearly 90% of the GDP produced by the entire transportation sector in Maryland, while the freight industry's employment share is only about 30% of the transportation sector. Examining by mode, the trucking industry is the largest sector in terms of the absolute size and share. It supported just over 30% of the jobs, nearly 29% of the compensations (including wages and all benefits), and 28% of GDP in the freight industry. In terms of the ripple effects, on the other hand, the freight water and port sector has the most significant contribution to the Maryland economy. While the sector accounts for only 3% of the total employment in the freight industry, it constitutes nearly 17% of the total job impacts, over 15% of the total compensation (including wages and all benefits), and nearly 16% of the total GDP. Its ripple effects clearly contrast to those of other surface freight transportation sectors whose effects have shrunk, compared to their share of the direct jobs. When Type I and Type II multipliers are compared, it becomes apparent that the Type I multipliers of the freight modal sector are lower than those of federal and state government workers involved in freight-related tasks. This is probably due to the nature of the freight transportation services. That is, it is providing services, not producing commodities that need multiple intermediary inputs. On the other hand, government sectors' Type I multipliers are relatively higher than the modal sectors, implying its ripple effects to the related business such as construction, transportation consulting services, and office supplies. However, higher Type II multipliers in most freight modal sectors indicate that freight activity benefits the local economy the most and most of its spending is captured within the state. This re-emphasizes the importance of the freight industry to Maryland's economy in general and to the residents specifically.

Table 16: GDP Impacts and Multipliers by Mode

	Impact Type				Type I	Type II
	Direct	Indirect	Induced	Total	Multiplier	Multiplier
Truck	1,248	456	710	2,415	1.37	1.93
Couriers & Messengers	910	95	305	1,310	1.10	1.44
Warehousing & Storage	771	225	379	1,375	1.29	1.78
USPS	973	75	543	1,591	1.08	1.64
Water & Port	662	219	328	1,209	1.33	1.83
Rail	241	87	108	436	1.36	1.81
Air	45	13	25	84	1.29	1.86
Pipeline	24	16	19	59	1.68	2.48
State	37	52	40	129	2.39	3.47
Federal	15	18	11	44	2.16	2.88
Total	4,926	1,257	2,469	8,652	1.26	1.76

Note: Numbers may not add up due to rounding.

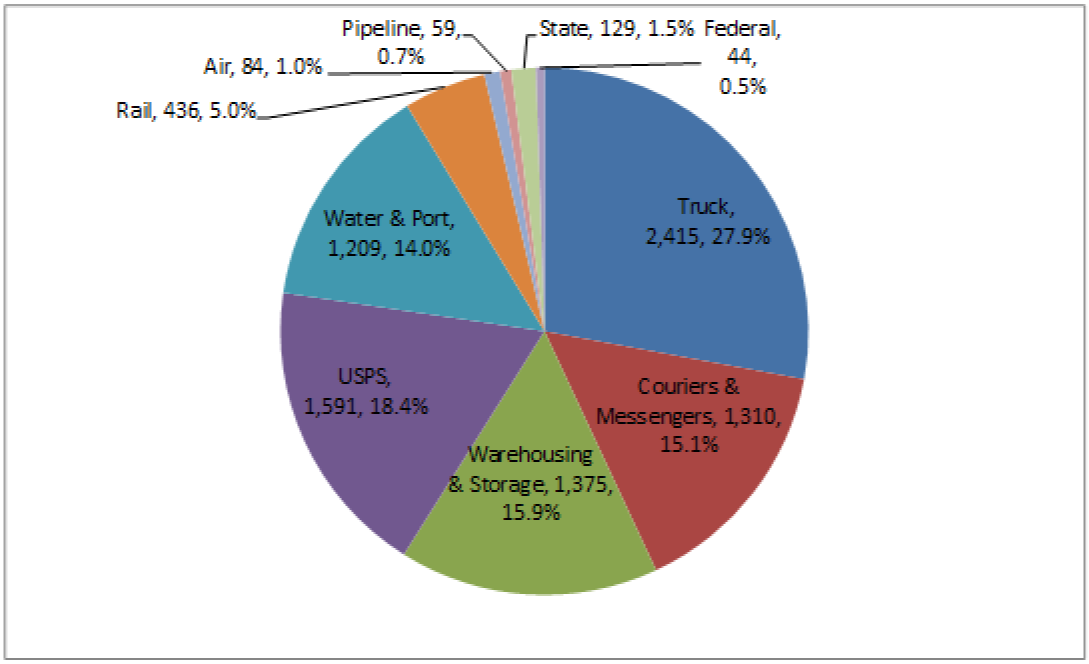


Figure 9: Shares of Total GDP Impacts by Sector

Freight Economic Output (FECO) Index

Using data from 2002 to 2010, a freight economic output (FECO) index was developed. As discussed in the methodology section, the index was calculated by using the GDP of the freight sector for each year (and imputing the GDP when the figure was not available). The FECO indices at the aggregate and modal levels are presented in Table 17. As noted under that table, two sectors –air and rail –were not included in computing the aggregate FECO index. Due to unreported values of the freight contributions in these two sectors, a reliable estimate of the index value for these sectors could not be derived. In the case of freight rail, while no GDP values for the sector were available, the number of employees in the freight rail sector was used as a proxy for the rail index since this sector is a stable sector, operating for several decades.

FECO indices provide the changes in the contributions of the freight industry to the Maryland economy. The year 2005 is used as the base year since the GDP from the BEA is presented in 2005 dollars. At the aggregate level, the contribution of the freight industry peaked in 2006, declined slightly for the subsequent two years, and then dropped by a wide margin in 2009 to climb back to the highest level in 2010. The aggregate FECO index for 2010 was 104, moving up to the peak at the 2006 level. Overall, FECO has risen from 2002. At the modal level, the increase of the warehouse and storage index and steady contribution of the freight water sector are noticeable.

The changes by mode in Figure 10(a) and Figure 10(b) reveal the historical performance of each by year in comparison with the aggregate FECO index. In general, the truck index and “freight support” index parallel the aggregate FECO index. The economic contribution of warehousing and storage fluctuated the most. Its index was 105 in 2002, but plunged by 20% to 84 in the following year. Since then, despite wide yearly variations, the warehousing and storage index has moved upward, reaching 120, the highest point, in 2010. On the other hand, the freight rail services' performance has moved downward. The freight rail index peaked in 2002 with 108. After three years of downward movement, the index rebounded to 106 by 2007. However, the index sharply decreased to 95, or by 10%, by 2010. Interestingly, the truck index is somewhat inversely associated with the freight rail index. While the truck index increased sharply (14 points) between 2002 and 2006, the freight rail index dropped by 8 points during the same time period. Then they moved upward together for a year and then downward until 2009. During this time period, the aggregate FECO index also decreased sharply. Thus, it could be inferred that the overall economic activity of the freight industry in Maryland was weakened. Nevertheless, the decrease of the truck index is noticeable. While the truck index has bounced back since 2009, the rail has continued sliding downward. Considering the competitive relationships between freight rail and truck, somewhat opposite movements of their activity look reasonable. Another interesting finding from the comparisons of modal indices is that the water index is the only sector that has consistently increased its contribution to Maryland's economy. While the overall direct contribution to the GDP of this sector is not high, during the study period the index has increased by almost a factor of seven. Increasing direct employment and gross operating surpluses generated by the inland water transportation sub-sector may be a contributing factor to this sector's increasing importance to Maryland's economy. Further study of this sub-sector's contribution to Maryland's economy is outside the scope of this study, but is warranted.

The contribution of the pipeline freight index to Maryland's economy has fallen by almost a factor of three from 2002 to 2010, and the overall contribution to Maryland's freight is less than 2%. This sector comprises the transport of natural gas and refined petroleum products. A decrease in the gross operating surplus may be a contributing factor for a decline of this sector's index; however, the cause of this decline is beyond the scope of this study.

The Freight Support sector includes couriers and messengers (NAICS 492), freight transportation arrangements (NAICS, 488510) port and harbor activities (NAICS 488310, 488320, 488330, 488390), other support activities for road transportation (NAICS 488490), and packing and crating (NAICS 488991). With the completion of the Panama Canal expansion in the near future, the water and port services will become more important, reflecting increases in both of these indices. The performance of the FECO index was evaluated by comparing it with the normalized Maryland GDP and the national-level freight TSI produced by the Bureau of Transportation Statistics (2014). It was assumed that the FECO index should show similar trends to these figures in order to be a credible performance measure of the freight industry's economic contribution. The Maryland GDP values between 2002 and 2010 were normalized using the year 2005 as the base. The correlation analysis of the FECO index and the Maryland GDP was statistically significant at a 98% confidence level (Table 18). The FECO index was highly correlated with the changes in the Maryland GDP. Among modal indices, the freight support index showed a strong correlation with Maryland's GDP. Other sectors also showed at least moderate associations. Moreover, Maryland's FECO index changes in line with the freight TSI (Figure 11). Since the freight TSI is a monthly index, the yearly averages were computed and plotted. The correlation analysis revealed that their association is statistically significant with the rho of 0.617 at a 95% confidence level. These comparisons indicate that during the study period the freight industry's economic activity in Maryland and the Maryland economy shared similar cycles, confirming that "demand for transportation services is also affected by the current state of economy, especially in terms of employment and consumption expenditure (Lahiri and Yao 2006, 886).” Also, these findings are evidence of the soundness and usefulness of the FECO index.

Table 17: Freight Economic Output (FECO) Index[1, 2]

	2002	2003	2004	2005	2006	2007	2008	2009	2010
MD Rail GDP ($ millions)	157	165	161	151	166	169	187	173	166
Freight Rail Employment (number)[3]	1675	1625	1547	1555	1615	1642	1600	1501	1472
Freight Rail Index	**108**	**105**	**99**	**100**	**104**	**106**	**103**	**97**	**95**
MD Water ($ millions)	58	58	61	75	104	149	208	238	379
Freight Water ($ millions)	57	57	60	74	103	148	205	235	375
Freight Water Index	**76**	**77**	**81**	**100**	**139**	**198**	**276**	**316**	**505**
Truck GDP ($ millions)	1,238	1,279	1,364	1,436	1,494	1,476	1,408	1,225	1,270
Truck Index	**86**	**89**	**95**	**100**	**104**	**103**	**98**	**85**	**88**
Pipeline GDP ($ millions)	37	47	41	20	9	10	11	10	10
Pipeline Index	**185**	**235**	**205**	**100**	**45**	**50**	**55**	**50**	**50**
Other Support GDP ($ millions)	1,467	1,510	1,651	1,760	1,745	1,636	1,737	1,576	1,706
Courier/Messengers, Port, Intermodal, and other Support Activities for Freight GDP ($ millions)[4]	1,365	1,372	1,493	1,603	1,656	1,528	1,561	1,375	1,486
Freight Support Index	**85**	**86**	**93**	**100**	**103**	**95**	**97**	**86**	**93**
Warehouse and Storage GDP ($ millions)	715	569	597	679	671	741	690	697	813
Warehouse & Storage Index	**105**	**84**	**88**	**100**	**99**	**109**	**102**	**103**	**120**
Total GDP of Freight Transportation (Less air, rail)[5]	3,411	3,325	3,555	3,812	3,934	3,902	3,875	3,542	3,955
FECO Index (less air, rail)	**89**	**87**	**93**	**100**	**103**	**102**	**102**	**93**	**104**

Note 1: The GDP is millions of chained 2005 dollars. The source of the data is www.bea.gov/regional

Note 2: The GDP share was computed as the multiplication of the sector GDP by the wage share of the corresponding sector.

Note 3: Railroad employment was used because no rail data is available from CBP. Thus, the wage share could not be calculated.

Note 4: The chosen industries within this sector have freight-related activities.

Note 5: Air and Rail were not included due to the inability to separate passenger from freight GDP figures for all of the years.

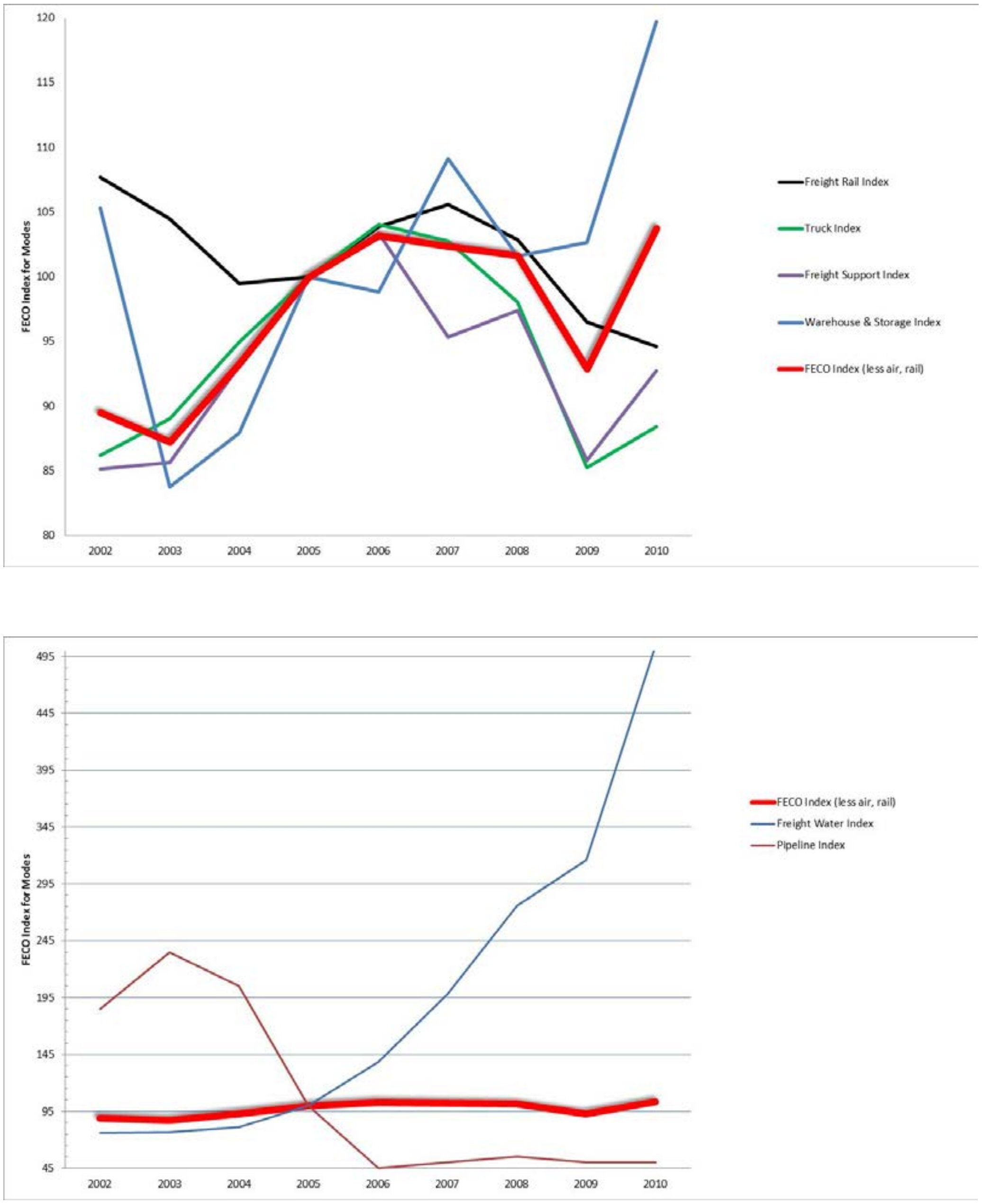
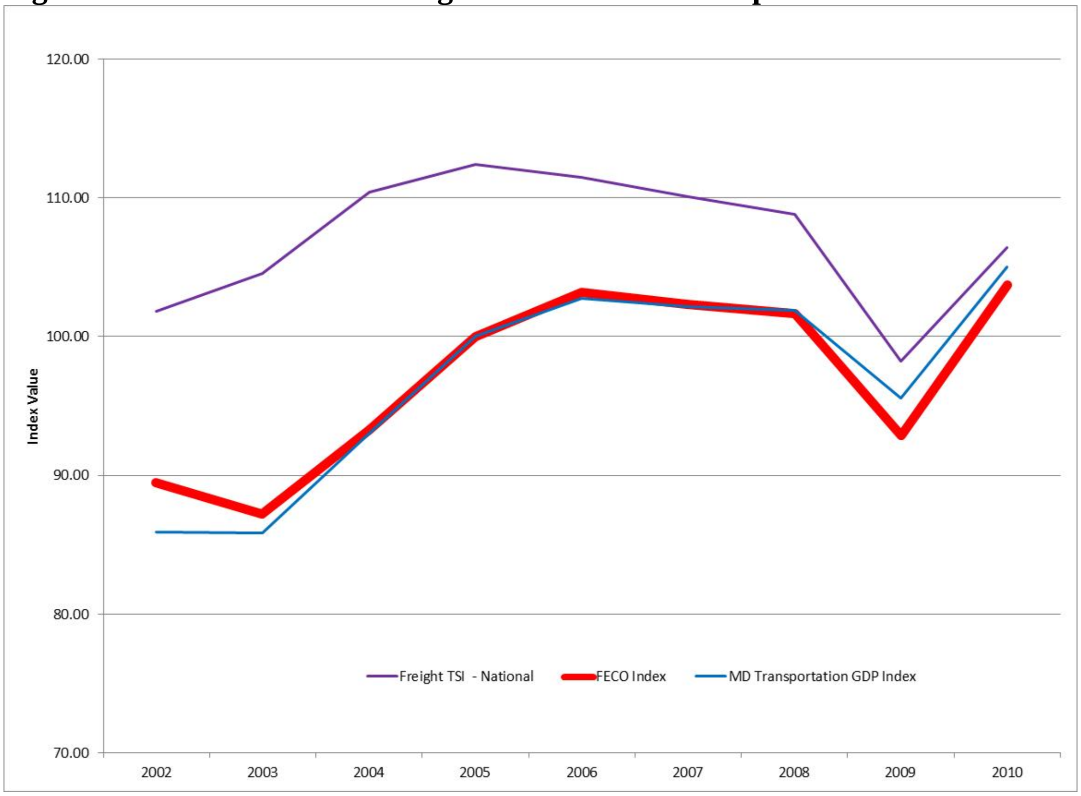


Figure 10(a) and 10(b): Freight Mode Indices and FECO Index: 2002-2010

Table 18: Correlations of FECO with MD GDP

	MD Transportation Index
FECO Index	0.977
Freight Water Index	0.614
Truck Index	0.584
Freight Support Index	0.758
Warehouse and Storage Index	0.602

Figure 11: FECO Index vs. Freight TSI and MD Transportation GDP



CONCLUSIONS AND RECOMMENDATIONS FOR IMPLEMENTATION

This study measured the economic impacts of the freight industry on Maryland's economy through an input-output analysis using 2010 IMPLAN data for the state. In addition, the freight economic output (FECO) index was developed based on the historical employment and GDP data between 2002 and 2010. This effort was motivated by the absence of any defendable performance measures for the economic contribution of freight transportation services, which have not been clearly studied and defined in this field. The need for these measures has become more important due to forecasted increases in goods movement and population in Maryland. Investment decisions in the freight transport sector must be supported by sound performance measures.

The input-output analysis estimated the direct, indirect, and induced impacts of the freight industry in terms of jobs, labor income, value added (GDP), and total output. The results show that freight industry activities (i.e., direct impacts) generated sizable ripple effects to suppliers (indirect impacts) and local businesses that depend on household spending (induced impacts). In 2010, the freight industry supported 116,100 jobs in total. Nearly 70,000 people were directly hired by the freight transportation industry, which helped sustain an additional 48,000 workers in various sectors. Every 100 jobs in freight transportation supported an additional 70 jobs in other sectors. The analysis estimated that the freight industry generated total GDP of $8.7 billion in 2010. In particular, the direct GDP of $4.9 billion is nearly 90% of the GDP generated by the entire Maryland transportation sector in 2010, which is about $5.5 billion (Bureau of Economic Analysis 2013). Considering roughly 30% of jobs in the transportation sector are non-freight-related jobs (U.S. Census Bureau n.d.), it is clear that the freight industry provides tremendous additional benefits to Maryland's economy.

Examining by mode, the trucking industry is the largest sector in terms of the absolute size and share of impacts. Its contribution constituted roughly 30% of the jobs, 29% of the compensations (including wages and all benefits) and 28% of the GDP generated/supported by the freight industry. The ripple effects of the water and port sector, by contrast, were the highest considering its share of direct employment size. While this sector accounted for only 3% of the total freight industry employment in 2010, nearly 17% of the total job impacts, over 15% of the total compensation (including wages and all benefits) and 16% of the total GDP were attributable to the water and port services. These findings contrast sharply with surface freight transportation sectors whose effects were relatively small compared to their shares of the direct jobs. This study also validates the importance of government spending for the freight industry. The multiplier impacts of state and federal employees were higher than for most of the modal sectors. This indicates that economic performance of the freight industry is a direct beneficiary of government support. It should be noted that the multiplier impacts of the public sector in this study does not include the government funding for infrastructure.

The comparisons between Type I and Type II multipliers indicate that the Type I multipliers of the freight sector are lower than those of federal and state government workers involved in freight-related tasks. However, higher Type II multipliers in most freight sectors indicate that freight activity mostly benefits the local economy and most of its spending is captured within the state. It re-emphasizes the importance of the freight industry to Maryland's economy, in general, and to the residents specifically.

The aggregate FECO index parallels Maryland's GDP and the national freight TSI. This indicates the usefulness of the FECO index as a performance measure of the overall freight economy. In addition, the modal indices help interpret the changes of each sector over time. Truck and freight supporting services indices showed similar trends to the FECO index, which was computed using these two largest contributors to freight movement in Maryland. Interestingly, a modal competition between truck and freight rail was also observed in this study. Their trends and the magnitude of the changes were generally opposite. Another interesting finding from the comparisons of modal indices is that the water sector is the only sector that has constantly increased its contribution to the Maryland economy, growing by more than a factor of seven over eight years. As the Panama Canal expansion nears completion, the economic contribution of the water and port services will increase sharply in the long run.

The performance of the FECO index was evaluated by comparing it with the normalized Maryland GDP and the national-level freight TSI. The correlation analysis revealed the statistically significant relationships between the FECO index and Maryland GDP and the FECO index and freight TSI. These comparisons indicate that during the study period the freight industry's economic activity in Maryland and the Maryland economy shared similar cycles.

Suggestions for Implementation

This study was intended to develop economic performance measures of the freight industry. By defining the freight industry stringently, unlike past studies, this study clearly and specifically showed the importance of the freight industry and each of the freight transportation modes. Accurate measures will help decision makers understand the role that each freight mode plays in the state to make more informed investment decisions.

This study's results and methodology can be used to review the annual performance of the freight industry as a whole and each modal sector separately. In addition, the FECO index can be concurrently used with other economic indicators like business cycle, growth cycle, TSI, etc. in order to compare the state freight performance with national trends. A close examination of trends will help forecast the future direction of the freight industry in the state. The Morgan team could provide assistance in updating the index and impact study. The methodology can be even more refined with additional data collection like a survey of industry.

Moreover, the economic indicators used in this study – jobs, income, and GDP – can be important information for public outreach efforts to mitigate the negative perceptions of freight and thereby increase the awareness of the presence of commodities in every aspect of our lives. Performance measures used in past studies - such as travel time reduction, congestion reduction, etc. - clearly benefit the freight industry's productivity and mitigate negative externalities for residents and businesses in Maryland. However, travel time reduction and increased business productivity as a result of government investment may not be the best story-lines to convey tangible benefits to Marylanders. Jobs and incomes appeal to citizens as visible benefits. A wise use of statistics would help promote public policy initiatives. Sound policies have often failed due to the lack of understanding of public needs and issues in communicating such policies (Pressman and Wildavsky 1984).

A more proactive strategy in communicating the importance of the freight delivery network is suggested. Although transportation contributes to economic productivity, it also imposes significant economic costs. Therefore, increasing demand for goods movement does not necessarily provide benefits. At one point, social costs from negative externalities may surpass economic benefits generated by the freight industry. Alternative facilities such as consolidated freight distribution centers or freight villages can be considered at the state government level to promote efficient land use and minimize freight's footprint, while improving business productivity. As this study found, the spillovers of the government spending are significant, meaning more jobs and income for Marylanders. For example, a vision report by the Sparrows Point Partnership (2013) offers a freight village as one of the alternatives that can provide jobs to the distressed Sparrows Point and Middle River communities, while providing a shared-use freight facility where shipments are consolidated and deconsolidated before they are transferred to the final destinations. Ripple effects of such a sizable investment will be significant and ready the state for the post-Panama Canal expansion era.

Limitations and Future Research

This study can be further improved by addressing a few limitations. First, the lack of the detailed historical data by freight mode was a barrier to developing a monthly index similar to the TSI. Although the FECO index's reliability was evaluated, the monthly index would be even more useful to practitioners. To overcome this barrier, several routes can be taken, assuming that adequate resources are available. First, a large-scale survey of the freight industry in Maryland could collect detailed information on each establishment's monthly performance. Since it was shown that the employment data is sufficient to measure economic performance via the input-output model, the collection of employment information by establishment would be much easier than the traditional method of collecting income, sales, expenditure, taxes, etc., which are sensitive business information. Second, an easier, but probably more costly, method than the survey is the purchase of freight industry data from private data consulting firms such as InfoUSA, Dun & Bradstreet, and Transearch. Third, the state-level impact study does not consider leakage to surrounding states. Using the newly developed multiregional impact analysis module of IMPLAN, the performance of Maryland's freight industry interacting with the markets in surrounding states can be analyzed. Fourth, from the equity perspective, negative externalities should be factored into the future impact studies. Then, the net benefits or costs of the freight industry in Maryland can be estimated. A comprehensive study could be carried out by an interdisciplinary team of transportation planners, travel demand modelers, environmental emission modelers, and economists.

APPENDIX A. Examples of Historical Data of Freight Activities

Gross Domestic Product for Maryland

- Data available from
    - 1963-1997 (SIC)
    - 1997-2011 (NAICS)
- Note: SIC and NAICS do not exactly match.

County Business Patterns (CBP)

- Data available from 1998-2010
- Employment data by sectors
    - All freight sectors are covered
- Note: Like GDP, the data produced before 1998 used SIC that does not correspond well to NAICS.

Water

- U.S. Waterway Data: Foreign Cargo Inbound and Outbound (1997-2009):
    - Raw data
    - Information by state may be available
    - Cargo flows between U.S. ports/waterways and foreign ports
- U.S. Waterway Data: Principal Ports of the United States (1996-2009)
    - Commodity tonnage summary (total, domestic, imports & exports)
- U.S. Waterway Data: State Summary Tonnage Data (2001-2010)
    - Annual State Summary from the Waterborne Commerce Statistics Center (WCSC) Cargo Detail file listing tonnages between states, within state, and to foreign locations
- Note: Compared to other modes, lots of information is publicly available.

Commodity Flow Survey

- Released 1997, 2002, 2007, and 2012
- Note: While pretty detailed information by mode can be obtained, CBP is published once every five years. Since there are only four annual data sets (1997, 2002, 2007, and 2012), using extrapolation methods to estimate data for missing years is not feasible.

APPENDIX B. 2010 County Business Pattern: Transportation and Warehousing in Maryland

NAICS code	NAICS code description	Paid employees for pay period including March 12 (number)	Total establishments
48 and 49	Transportation and warehousing	61553	3307
481	Air transportation	4178	49
4811	Scheduled air transportation	h	27
48111	Scheduled air transportation	h	27
481111	Scheduled passenger air transportation	h	21
481112	Scheduled freight air transportation	a	6
4812	Nonscheduled air transportation	314	22
48121	Nonscheduled air transportation	314	22
481211	Nonscheduled chartered passenger air transportation	274	14
481212	Nonscheduled chartered freight air transportation	a	2
481219	Other nonscheduled air transportation	b	6
483	Water transportation	1180	41
4831	Deep sea, coastal, and Great Lakes water transportation	1143	26
48311	Deep sea, coastal, and Great Lakes water transportation	1143	26
483111	Deep sea freight transportation	390	15
483112	Deep sea passenger transportation	a	1
483113	Coastal and Great Lakes freight transportation	f	8
483114	Coastal and Great Lakes passenger transportation	a	2
4832	Inland water transportation	b	15
48321	Inland water transportation	b	15
483211	Inland water freight transportation	a	4
483212	Inland water passenger transportation	b	11
484	Truck transportation	14412	1379
4841	General freight trucking	8379	674
48411	General freight trucking, local	2710	374
484110	General freight trucking, local	2710	374
48412	General freight trucking, long-distance	5669	300
484121	General freight trucking, long-distance, truckload	2672	223
484122	General freight trucking, long-distance, less than truckload	2997	77
4842	Specialized freight trucking	6033	705
48421	Used household and office goods moving	2083	173
484210	Used household and office goods moving	2083	173
48422	Specialized freight (except used goods) trucking, local	2837	433
484220	Specialized freight (except used goods) trucking, local	2837	433
48423	Specialized freight (except used goods) trucking, long-distance	1113	99
484230	Specialized freight (except used goods) trucking, long-	1113	99

NAICS code	NAICS code description	Paid employees for pay period including March 12 (number)	Total establishments
	distance		
485	Transit and ground passenger transportation	10056	674
4851	Urban transit systems	1191	30
48511	Urban transit systems	1191	30
485112	Commuter rail systems	a	1
485113	Bus and other motor vehicle transit systems	1190	29
4852	Interurban and rural bus transportation	c	5
48521	Interurban and rural bus transportation	c	5
485210	Interurban and rural bus transportation	c	5
4853	Taxi and limousine service	1058	140
48531	Taxi service	480	62
485310	Taxi service	480	62
48532	Limousine service	578	78
485320	Limousine service	578	78
4854	School and employee bus transportation	4678	379
48541	School and employee bus transportation	4678	379
485410	School and employee bus transportation	4678	379
4855	Charter bus industry	563	45
48551	Charter bus industry	563	45
485510	Charter bus industry	563	45
4859	Other transit and ground passenger transportation	2407	75
48599	Other transit and ground passenger transportation	2407	75
485991	Special needs transportation	2086	39
485999	All other transit and ground passenger transportation	321	36
486	Pipeline transportation	c	13
4862	Pipeline transportation of natural gas	b	8
48621	Pipeline transportation of natural gas	b	8
486210	Pipeline transportation of natural gas	b	8
4869	Other pipeline transportation	b	5
48691	Pipeline transportation of refined petroleum products	b	5
486910	Pipeline transportation of refined petroleum products	b	5
487	Scenic and sightseeing transportation	251	41
4871	Scenic and sightseeing transportation, land	153	14
48711	Scenic and sightseeing transportation, land	153	14
487110	Scenic and sightseeing transportation, land	153	14
4872	Scenic and sightseeing transportation, water	97	26
48721	Scenic and sightseeing transportation, water	97	26
487210	Scenic and sightseeing transportation, water	97	26

NAICS code	NAICS code description	Paid employees for pay period including March 12 (number)	Total establishments
4879	Scenic and sightseeing transportation, other	a	1
48799	Scenic and sightseeing transportation, other	a	1
487990	Scenic and sightseeing transportation, other	a	1
488	Support activities for transportation	9006	629
4881	Support activities for air transportation	1435	56
48811	Airport operations	621	17
488119	Other airport operations	621	17
48819	Other support activities for air transportation	814	39
488190	Other support activities for air transportation	814	39
4882	Support activities for rail transportation	190	13
48821	Support activities for rail transportation	190	13
488210	Support activities for rail transportation	190	13
4883	Support activities for water transportation	3160	54
48831	Port and harbor operations	c	5
488310	Port and harbor operations	c	5
48832	Marine cargo handling	2742	17
488320	Marine cargo handling	2742	17
48833	Navigational services to shipping	84	10
488330	Navigational services to shipping	84	10
48839	Other support activities for water transportation	c	22
488390	Other support activities for water transportation	c	22
4884	Support activities for road transportation	1437	230
48841	Motor vehicle towing	1166	196
488410	Motor vehicle towing	1166	196
48849	Other support activities for road transportation	271	34
488490	Other support activities for road transportation	271	34
4885	Freight transportation arrangement	2583	245
48851	Freight transportation arrangement	2583	245
488510	Freight transportation arrangement	2583	245
4889	Other support activities for transportation	201	31
48899	Other support activities for transportation	201	31
488991	Packing and crating	198	27
488999	All other support activities for transportation	3	4
492	Couriers and messengers	10296	229
4921	Couriers and express delivery services	9794	132
49211	Couriers and express delivery services	9794	132
492110	Couriers and express delivery services	9794	132
4922	Local messengers and local delivery	502	97

NAICS code	NAICS code description	Paid employees for pay period including March 12 (number)	Total establishments
49221	Local messengers and local delivery	502	97
492210	Local messengers and local delivery	502	97
493	Warehousing and storage	12060	252
4931	Warehousing and storage	12060	252
49311	General warehousing and storage	9324	168
493110	General warehousing and storage	9324	168
49312	Refrigerated warehousing and storage	529	13
493120	Refrigerated warehousing and storage	529	13
49313	Farm product warehousing and storage	c	11
493130	Farm product warehousing and storage	c	11
49319	Other warehousing and storage	2024	60
493190	Other warehousing and storage	2024	60

Note:

a 0 to 19 employees
b 20 to 99 employees
c 100 to 249 employees
e 250 to 499 employees
f 500 to 999 employees
g 1,000 to 2,499 employees
h 2,500 to 4,999 employees
i 5,000 to 9,999 employees
j 10,000 to 24,999 employees
k 25,000 to 49,999 employees
l 50,000 to 99,999 employees
m 100,000 employees or more

APPENDIX C. Employment Imputation

It quickly estimates regression statistics and produces related plots. This procedure is "most appropriate when the relationship between the dependent variable and the independent variable is not necessarily linear (IBM 2013)."

Imputing the number of employees where data is not available

Due to privacy requirements, the Census Bureau does not disclose the number of employees for some sub-sectors in the transportation and warehousing sector, e.g., for NAICS code 483113 (Coastal and Great Lakes freight transportation), the data is hidden in County Business Patterns (CBP). However, CBP does provide the number of establishments in various buckets of employment-size class (Table 19).

Table 19: County Business Patterns Number of establishments by employment-size class

NAICS code	NAICS code description	Total establishments	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500-999	1000 or more

A typical relationship between number of employees and number of establishments by employment-size class, at a more granular level (http://www.census.gov/econ/susb/) is shown in Figure 13.

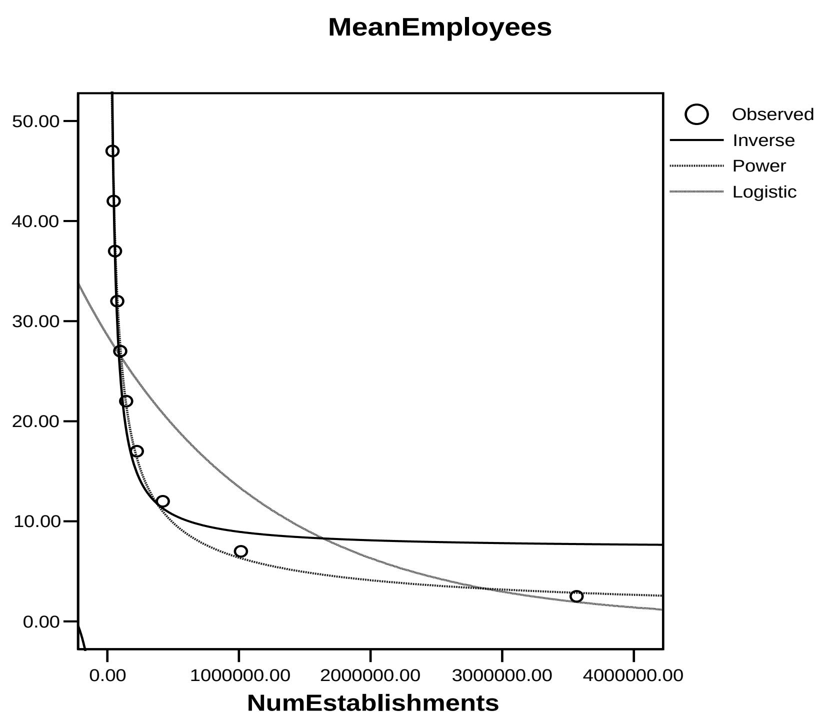


Figure 12: Relationship between Number of Establishments and Mean Number of Employees

Since the number of establishments with fewer employees is far more than the number of establishments with more employees, it is necessary to find the mean number of employees in each of the employee-size class. The mean number of employees will necessarily be less than the mid value of the bucket of the employee-size class.

A curve-fitting methodology was used to obtain the relationship between the mean number of employees for each of the employee-size class and the number of establishments for all U.S. establishments. Based on the results of the curve-fit, two power curves, each with 99.5% R-squared, were used to determine the mean number of employees in each of the CBP buckets.

The mean number of employees, based on the curve-fit model, for each of the employment-size buckets is shown in Table 20. That value is multiplied by the number of establishments in that bucket for Maryland and summed over all the buckets to arrive at the number of employees in the specific sub-sector where the data on number of employees is hidden.

Table 20: Mean Number of Employees in each of Employment-Size Class

Employment-Size Class	'1-4'	'5-9'	'10-19'	'20-49'	'50-99'	'100-249'	'250-499'	'500-999'	'1000 or more'
Mean Number of Employees	1.671	6.563	13.594	30.881	69.937	160.000	350.000	680.000	2000.000

As a validation exercise, we found the R-square of a linear model between the numbers of employees where that information was available with our calculated values. The linear regression model gave an R-square of 99.89%, thus validating the curve-fit model.

APPENDIX D. Derivation of the Number of Employment in the Trucking Industry

This appendix describes the methodology in deriving the number of the trucking sector employment for this study. While a variety of assumptions can be made by researchers, the study team focused on keeping the consistency among collected data and industry classification systems.

Mismatch between MMTA and CBP

The Maryland Motor Truck Association (MMTA) provided *Maryland Fast Facts* that describes Maryland trucking industry information such as jobs, average annual salary, economic impacts, and safety. The data for *Maryland Safety Facts* were compiled and published by the American Transportation Research Institute (ATRI).

According to the ATRI document, "the U.S. Bureau of Labor Statistics reported in May 2011 that truck drivers, heavy, tractor trailer and light, delivery drivers, held 37,120 jobs (American Transportation Research Institute)." Although the clear reference was not provided, the study team found that the number is from the Occupational Employment Statistics (OES). Table 21 shows the number of employment two standard occupation classification (SOC) codes.

Table 21. Number of Trucking Employment by SOC, May 2011

Standard Occupation Classification (SOC)	Description	Number of Employment
53-3032	Heavy and Tractor-Trailer Truck Drivers	19,900
53-3033	Light Truck or Delivery Services Drivers	17,220
Total		37,120

Source: BLS, Occupational Employment Statistics, http://www.bls.gov/oes/tables.htm

While the total in Table 21 is the same as the ATRI data, this data cannot be used because of the differences in the definition of SOC and the standard industry codes, i.e. the North American Industry Classification System (NAICS). SOC consists of 7-digit codes by occupation. Therefore, Occupations are assigned based on types of work, skills, education, training, and credentials (Bureau of Labor Statistics, n.d.), i.e., grouping by the nature of the work. As a result, some occupations can be found in multiple industries (The United States Census Bureau, n.d.). In other words, truck drivers in the trucking industry as well as truck drivers hired by manufacturers, wholesalers or retailers, i.e., in-house truck fleet, are included in OES. Since the in-house trucking (or private trucking) is not considered for this study, a logical answer for the total number of the trucking industry must be less than 37,120.

To verify the study team's logic, the NACIS code-based employment data were used: County Business Patterns (CBP) and Nonemployer Statistics (NES). The CBP is an annual data of the number of establishments, employment, and salary by industry (The United States Census Bureau, n.d.). The NES is a compilation of self-employed workers by industry that are not captured by CBP (The United States Census Bureau, n.d.). Both data are collected and organized by NAICS. Thus, the sum of all trucking industry employment in CBP and NES data should be the most accurate employment information.

NAICS 484 represents the trucking industry. In addition, NAICS 492 mostly consists of delivery truck-related jobs. It should be noted that NAICS 492 is treated separately in the current study. The sector also includes related operations in airports and/or ports. Lastly, NAICS 48849 was added to the trucking industry. NAICS 488 represents various support activities for transportation that are heavily affected by the existence of the transportation sector. Of this sub-sector, only NAICS 48849 is associated with trucking. This sub-sector includes supporting activities such as repair and maintenance, towing and networking for truck transportation. Table 22 shows the number of employment by the trucking sector and total employment in 2011 classified by NAICS. The trucking industry hired about 35,714, which is 1,406 fewer (or less than 4%). This seems logical since in-house freight transportation accounts for 1.19% to 5% (Cambridge Systematics and Marlin Engineering 2011, 3-8).

Table 22. The Total Employment of the Trucking Industry based on CBP and NES, 2011

Sub-trucking industry	NAICS	Employment
Truck Transportation	484	15,232
Truck Transportation NES	484	5330
Couriers and Messengers	492	10,580
Couriers and Messengers NES	492	4,289
Other Support Activities for Road Transportation	48849	283
Total		35,714

In summary, the trucking employment for this study is based on NAICS that CBP and NES use. The benefit of CBP and NES is the consistency of employment sector classification. While BLS data provide higher employment figures, it is not clear how much of that employment was hired by the non-trucking sector. The objective of this study is to measure the economic impact of the freight industry. Therefore, the use of consistent and clear industry classification system is of critical significance.

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