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Evaluation of Employment Benefits of Ultra-Heavy Trucks: Wisconsin Case Study

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EVALUATION OF EMPLOYMENT BENEFITS OF ULTRA-HEAVY TRUCKS:

WISCONSIN CASE STUDY

by

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ABSTRACT

EVALUATION OF EMPLOYMENT BENEFITS OF ULTRA-HEAVY TRUCKS:
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Allowing very heavy trucks, without permits, on United States' highways has been a subject of discussion in the past, and many politicians and industry advocates have argued that there are some benefits to much heavier trucks. Benefits include better air quality, reduced fuel usage, and increased industrial efficiency. The economic analysis of heavier trucks, however, remains incomplete. One way to measure economic benefits is by assessing employment growth. Wisconsin is used as a case study to evaluate employment benefits of ultra-heavy trucks. The current regulation of the maximum gross vehicle weight on all axles in Wisconsin is 80,000 pounds. Three scenarios of ultra-heavy trucks are proposed to have a much greater weight limitation – 100,000 pounds, 120,000, and 140,000 pounds.

The thesis focuses on four analyses that evaluate employment growth due to cost savings, accessibility, mode shift, and industry restructuring. The cost savings are calculated by using the CFIRE Truck Cost Model. The cost saving is also used to

estimate the job loss in trucking industry. The effects of accessibility improvements are estimated by using Montana HEAT business attraction model, previously adapted for Wisconsin. The mode shift analysis applies the cross elasticity between rail and truck to quantify the diversion from rail to truck. The numbers of employment associated with diversion from rail is estimated. IMPLAN model and REMI model, economic analysis tools, are implemented to understand the impacts of ultra-heavy trucks towards other industries. IMPLAN model is a basic input-output economic model uses the Social Accounting Matrix and multipliers model. REMI model is a dynamic model that integrates an econometric model, an input-output model, a general equilibrium model, and economic geography methodologies.

Overall, implementing ultra-heavy trucks will create more jobs in both trucking industries and other industries. It also improves the efficiency of trucking industry that makes it more competitive than other modes, which enhance the growth within trucking industry. In the long run, trucking industries will expand growth of the whole economy through exports and more economic activities. From this analysis, the critical weight of ultra-heavy trucks is inconclusive as this study only evaluates employment impacts. Other considerations in safety, pavement, bridges, environment, and others are needed before implementing ultra-heavy trucks.

.

To

My parents

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LIST OF ABBREVIATIONS

AAR	Association of American Railroads
AASHO	American Association of State Highway Officials (now AASHTO)
AASHTO	American Association of State Highway and Transportation Officials
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
CFIRE	National Center for Freight & Infrastructure Research & Education
CFS	Commodity Flow Survey
D	Double
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
GNE	General Network Editor
GSP	Gross State Product
GVW	Gross Vehicle Weight
HEAT	Highway Economic Analysis Tools
HERS	Highway Economic Requirement System
HPMS	Highway Performance Monitoring System
ICM	Intermodal Competition Model
IMPLAN	IMpact analysis for PLANning
ISTEA	The Intermodal Surface Transportation Efficiency Act of 1991
MAFC	Mid-America Freight Coalition
MAP-21	The Moving Ahead for Progress in the 21st Century Act of 2012
NAICS	North American Industry Classification System
NHN	Oak Ridge National Highway Network
NN	National Network
NTWAC	National Truck Weight Advisory Council
PCE	Passenger car equivalents
QRSII	Quick Response System II
REMI	Regional Economic Models, Inc.
SAM	Social Accounting Matrix
SCTG	Standard Classification Transportable Goods
STAA	The Surface Transportation Assistance Act of 1982
STT	Straight truck trailer
SU	Single unit truck
TRB	Transportation Research Board
TST	tractor-semitrailer
TTI	Texas Transportation Institute
USDOT	United State Department of Transportation
VMT	Vehicle-Mile Traveled
WisDOT	Wisconsin Department of Transportation

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1 Introduction

1.1 Background

Truck weight regulations exist for few reasons. First, they protect safety for roadway users, to automobile drivers, truck drivers, and others. They also protect roads from pavement and bridge deterioration. According to American Association of State Highway Officials (AASHO, now AASHTO) Road Test in 1950, as the truck weight goes up, pavement deterioration rapidly goes up (USDOT, 2000). Setting a truck weight limitation ensures that pavements have longer lifetimes. The weight regulations also attempt to minimize the negative impacts of heavy trucks towards traffic flow (congestion).

Truck weight regulations have been around since early 1900. Maine and Massachusetts were the first two states adopting truck weight regulations in 1913 (TRB, 1990). These regulations restricted the weight per inch of tire width to 800lb and the gross vehicles weight of 18,000 pounds in Maine and 28,000 pounds in Massachusetts (TRB, 1990). Many states followed this step, and by 1933, all states had some sort of truck weight regulations.

AASHO was concerned that the truck weight regulations were varied across the states, which made it challenging for carriers and industry to do interstate shipment. In 1932, AASHO recommended to have a uniform truck weight regulations across states for a single-axle limit (16,000 pounds) and a tandem-axle limit based on distance between

two axle (TRB, 1990). In 1946, AASHO revised the recommendation to be 18,000 pound for single-axle limits and 32,000 pounds for tandem-axle limits (TRB, 1990). The AASHO recommendation was not adopted until the federal government invested on national highway system across the country under the Federal-Aid Highway Act of 1956 (USDOT, 2000). This was the first time that the federal government has any truck weight regulations.

The current federal regulation for maximum gross vehicle weight (GVW) of trucks operating on Interstate Highway is 80,000 pounds. Most states, including Wisconsin, have adopted the same weight limit for most of its vehicles unless the states had adopted larger weight limit before 1956 when the federal weight regulation went into effect under a grandfather clause (USDOT, 2000). In addition, the trucks also have to comply with the Federal Bridge Formula when operating on the National Network (NN) bridges.

The freight industry has grown over the years. According to 2007 Commodity Flow Survey (CFS), in 2007, there were 12.5 billion tons of goods shipped across the country, which was an 8% increase since 2002. In addition, the ton-miles generated have increased 7% to 3.3 trillion ton-miles since 2002 (U.S. Census Bureau, 2007). The trucking industry shipped the majority of goods in the nation, 8.8 billion tons, or 70% of the total weight, and 1.3 trillion ton-miles or 39% of the total ton-miles (U.S. Census Bureau, 2007). It shows how the trucking industry contributes to the economy of the whole country. The growth of freight also occurs on the state level. Wisconsin estimates

that its freight demand would gain additional 70% growth through 2025 (Adams, 2009). Similar to the national level, Wisconsin's trucking industry also carried the largest portion of goods, 74% of total tonnage (Adams, 2009).

As trucks shipped more goods, many industries proposed to have greater weight limitations, which would allow the use of ultra-heavy trucks. An ultra-heavy truck, having much greater maximum weight, can carry more payloads per trip, which will reduce the number of shipments needed. The proponents of ultra-heavy trucks argue that this will improve the freight efficiency and productivity. Ultra-heavy trucks will also reduce the shipping cost, which benefit industry and carriers. Having fewer trucks on the road would also lead to environmental benefits like reducing air pollution emissions, greenhouse gas emissions, noise, and fuel consumption.

In spite of the benefits, ultra-heavy trucks generate concerns in terms of safety, pavement, bridges, and traffic flow. Many studies discussed how heavier trucks would affect road users safety and would cause more crashes (Adams, 2009). In addition, they also discussed whether heavier trucks would reduce the pavement lifetime, which would increases maintenance costs (TRB, 1990). Another concern is how costly it would be to post, replace, and update bridges to accommodate heavier trucks (TRB, 1990). Interruption in traffic flow due to longer braking and accelerating time for heavier trucks is also a concern (Adams, 2009).

To decide upon the weight regulations, the government entities need to balance between several factors such as safety concerns, infrastructure facility (maintenance and operation cost), and industry demand. These factors are sometimes conflicting each other,

thus, fulfilling every aspect is impossible. A good practice is to meet the industry demand while maintaining high standard in safety and quality of roads and bridges.

1.2 Definitions

1.2.1 Federal Bridge Formula

To protect bridges, any trucks operating on federal bridges must comply with the Bridge Formula (FHWA, 2014).

$$W = 500 \left[\frac{LN}{N-1} + 12N + 36 \right]$$

Where W = the overall gross weight on any group of two or more consecutive axles to the nearest 500 pounds,

L = the distance in feet between the outer axles of any group of two or more consecutive axles, and

N = the number of axles in the group under consideration.

In addition, the trucks also must meet these requirements:

- **Gross Weight** - 80,000 pounds
- **Single-Axle Weight -** 20,000 pounds
- **Tandem-Axle Weight** - 34,000 pounds

1.2.2 Ton-mile

One short ton of freight transported one mile (FHWA, 2014)

1.2.3 Economic Effects

In terms of transportation investments, there are three types of economic effects:

- Direct effects include a reduction in the direct cost of transportation for users, both business and consumer. The cost reductions may expand the current businesses or attract new business. (CSI, 2003)
- Indirect effects result from an increase in demand from raw materials, supplies, equipment, and services for the current business or the new business (CSI, 2003)
- Induced effects result from the increased consumer spending of workers of the directly or indirectly affected business (CSI, 2003)

1.2.4 Economic Multipliers

Economic multipliers is the ratio of total effect to direct effect (Weisbrod, 2000)

1.2.5 Employment

Employment indicates the number of employees needed to support the economy activity in the local economy (IMPLAN, 2014).

1.2.6 Labor Income

Labor Income indicates all forms of employment income, including employee compensation (wage and benefits) and proprietor income (IMPLAN, 2014).

1.2.7 Value Added

Value Added indicates the total income that the event generates in the local economy including employee compensation, proprietary income, other property type income, and indirect business taxes (IMPLAN, 2014).

1.2.8 Output

Output indicates the total economic value of the project in the local economy (IMPLAN, 2014).

1.2.9 Disposable Income

Disposable income indicates the amount of money that households have available for spending and saving after income taxes have been accounted for (Investodia, 2014)

1.2.10 Discretionary Income

Discretionary income indicates the amount of an individual's income that is left for spending, investing, or saving after taxes and personal necessities (such as food, shelter, and clothing) have been paid. Discretionary income includes money spent on luxury items, vacations and non-essential goods and services (Investodia, 2014).

1.3 Problem Statement

Most discussions of increasing weight limitation focused on its impacts to safety, pavement, bridges, and traffic flow. There is a lack of analysis on how greater weight limitation will affect the economy as a whole. Before federal or state government, invest more capital on roads and bridges to accommodate heavier trucks, there has to be a good justification whether it will generate economic benefits. In this study, economic benefits are measured in terms of employment growth. This study attempts to answer these questions:

1. What is the current stage of truck weight studies at the state and national levels?
2. What are the existing economic analysis tools to use for transportation analysis?
3. What is the direct impact of implementing ultra-heavy trucks for the economy?
4. What is the indirect impact of ultra-heavy truck implementation for the economy?
5. What is the critical weight of truck to give the best practice in balancing benefits and cost to implement it?
6. What other things need to be considered before implementing a policy allowing ultra-heavy trucks?
7. Does implementing ultra-heavy trucks will promote trucking industry productivity?

Wisconsin is used as the case study site. The current maximum GVW of trucks in Wisconsin is 80,000 pounds, with some exceptions for oversize and overweight trucks that require special permit from the Wisconsin DOT. This study evaluates three different scenarios of ultra-heavy trucks: 100,000-pound trucks, 120,000-pound trucks, and

140,000-pound trucks. The three weight limits provide an insight to the critical weight limit for most efficient practice. The study changes only the weights of trucks while other truck specifications remain the same. The ultra-heavy truck in this analysis is a tractor-semitrailer with a typical 53-foot trailer.

1.4 Thesis Overview

The thesis consists of four analyses that evaluate employment growth due to costs savings, accessibility, mode shift, and industry restructuring (Figure 1).

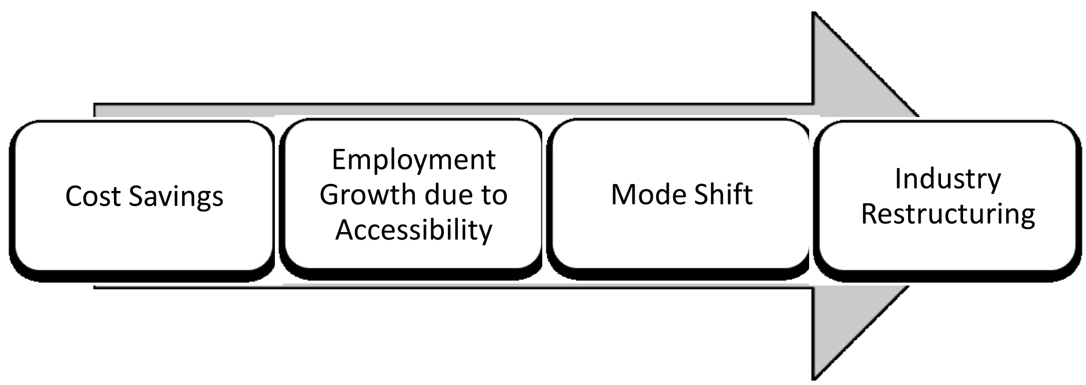


Figure 1 Economic Impacts Component

The thesis is organized into eight chapters as followed.

Chapter 1 provides background information, key term definitions, problem statement, and thesis organization.

Chapter 2 provides literature review regarding of truck weight and size study conducted by TRB, USDOT, and Wisconsin. It explains briefly about transportation economic development concept. This chapter also discusses various type of economic impacts model, such as HEAT (Wisconsin's application), input-output analysis, IMPLAN, and REMI.

Chapter 3 evaluates direct economic impacts of implementing ultra-heavy trucks. A brief explanation of the FIRE Truck Cost Model and its application to calculate cost savings is discussed here. This chapter also estimates the number of job loss due to more efficient trucking industry.

Chapter 4 presents employment growth due to accessibility by applying the HEAT model. The methodology and results are discussed.

Chapter 5 explains mode shift analysis of rail to truck diversion due to ultra-heavy trucks. Cross elasticity between rail and truck are used to estimate the mode shift. The employment growth due to mode shift is also estimated.

Chapter 6 examines the industry restructuring that could occur due to ultra-heavy trucks. Two distinct models are used, IMPLAN and REMI. The results of both models are discussed.

Chapter 7 provides total job gain analysis. The analysis combines the employment impacts of ultra-heavy trucks due to cost savings, accessibility, mode shift, and industry restructuring.

Chapter 8 summarizes the findings and concludes the thesis. In addition, future research topics are suggested here.

2 Literature Review

2.1 Truck Weight Study

Over the years, many organizations at different levels have conducted many studies in truck weight limits. These studies analyze different aspects affected by the changes of truck weight limits. Earlier, many of these studies focus heavily on the impact of heavier trucks on pavement and bridge infrastructure (Carson, 2011). The research in truck weight limits has evolved over time and more things are considered. It considers the impact of heavier trucks toward modal share, enforcement, highway safety, highway geometrics, industry costs, economic impacts, infrastructure financing, highway congestion, environment, and public opinion (Carson, 2011). The Directory of Significant Truck Size and Weight Research (Carson, 2011) provides detail comparison between different studies.

The thesis reviews several truck size and weight studies conducted at national and state level. Reviewing these studies provides better understanding on the truck weight limit. It also highlights different areas considered when proposing a change in the truck weight limit. Three studies are examined: two are from national organization and one from the state DOT. A summary of truck weight regulations changes is provided in chronological order.

2.1.1 Transportation Research Board Special Report 225: Truck Weight Limits: Issues and Options *(1990)*

The Surface Transportation and Uniform Relocation Assistance Act of 1987 asked Transportation Research Board (TRB) of the National Research Council to conduct

a study in assessing various proposals for future changes in the federal truck weight regulations. This study evaluates the impacts of ten different scenarios in terms of trucking productivity, pavements, bridges, and highway safety (TRB, 1990). The ten scenarios, focusing on the grandfather clause and federal bridge formula modification, are followed:

1. Grandfather Clause Elimination: elimination of existing grandfather clause exemptions in federal weight limits
2. Uncapped Formula B: elimination of the 80,000 pounds cap on GVW, so that it is controlled only by the current federal bridge formula
3. National Truck Weight Advisory Council (NTWAC) proposal: permit program for specialized hauling vehicles (SHVs)
4. Canadian Interprovincial Limits: proposal calling for higher gross weights and minimum axle spacing instead of a bridge formula
5. Texas Transportation Institute (TTI) Bridge Formula: formula proposed by TTI in a study for FHWA
6. TTI HS-20 Bridge Formula: modified version of the TTI formula that would allow higher weights on single-unit trucks and shorter combination vehicles
7. Uncapped TTI HS-20 Bridge Formula: same as Proposal 6 with the elimination of 80,000 pounds limit on GVW, so that GVW is controlled by the TTI HS-20 bridge formula
8. Combined TTI HS-20/Formula B: combination of proposals 2 and 6 under which single-unit trucks and shorter combination vehicles could take

advantage of the higher weights allowed by the TTI HS-20 formula, and longer combinations with seven or more axles could take advantage of the higher weights allowed by the current bridge formula

9. New Approach: variation on proposal 8 that would require lower axle weights for vehicles over 80,000 pounds
10. Freightliner proposal: exemption of steering axles from the bridge formula to encourage the use of trucks with set-back axles

The trucking productivity is evaluated under three methods, vehicle-mile traveled (VMT) of heavy vehicles, ton-mile of rail diversion to truck, and transport costs. The VMT of heavy vehicles are projected from the existing VMT data, based on vehicle type and weight, and then the projected VMT of scenario's and base case are compared (TRB, 1990). The mode shift from rail to truck is calculated by using the Intermodal Competition Model (ICM) developed by the Association of American Railroads (AAR) (TRB, 1990). The mode shift would show whether more efficient trucking industry could attract more business from other mode, rail. For transport cost, the cheaper the cost is, the more productive the trucking industry becomes.

The pavement costs consist of new pavement cost, reconstructed pavement cost, and pavement rehabilitation cost for each scenario. The pavement rehabilitation cost is estimated using the Pavement Rehabilitation Cost Model developed for this model by applying the truck miles projections, AASHTO load-equivalence factors, highway miles and paved area data from the FHWA Highway Performance Monitoring System (HPMS).

The bridge costs consist of replacement cost of existing bridges that have inadequate load-bearing capacity, new bridges costs, and cost of fatigue-related damage in bridges associated with repetitive loadings. The replacement cost of existing bridges accounts for the largest portion of bridge costs (TRB, 1990). The highway safety is measured in fatal accidents numbers, which were estimated using the accident rates and the projected VMT by vehicle type and operating weight (TRB, 1990).

TRUCK SIZE AND WEIGHT PROPOSALS			RAIL TON-MILES	TRANSPORT COSTS[1,2] ($ millions)
1	Grandfather Clause Elimination	No exemptions in federal limits	↑0.8%	↑230[3]
2	Uncapped Formula B	No 80,000-lb GVW cap; only federal bridge formula controls	↓2.2%	↓750[4]
3	NTWAC	Permit program for specialized hauling	↓0.9%	↓310[5]
4	Canadian Interprovincial Limits	Higher GVW and minimum axle spacing instead of bridge formula	↓6.6%	↓2,240[6]
5	TTI Bridge Formula	Alternate formula developed for FHWA	NA	NA
6	TTI HS-20 Bridge Formula	Higher single-unit/shorter combination vehicle weights	↓0.0%	0
7	Uncapped TTI HS-20 Bridge Formula	Higher single-unit/shorter combination vehicle weights (Proposal 6) and no 80,000-lb GVW cap; only TTI HS-20 bridge formula controls; less permissive when applied to 7+ axle vehicles	↓2.5%	↓850[7]
8	Combined TTI HS-20/ Formula B	Higher single-unit/shorter combination vehicle weights (Proposal 6) and no 80,000-lb GVW cap; only federal bridge formula controls (Proposal 2)	↓2.5%	↓860[8]
9	New Approach	Variation of Proposal 8 with lower axle weights for 80,000-lb+ vehicles	NA	NA
10	Freightliner	Exempts steering axles from bridge formula to encourage use of set-back axles	NA	NA

[1] *All costs are in 1988 dollars and were calculated assuming a discount rate of 7 percent.*

[2] *Competitive railroad rate decreases would reduce shipper costs however, this effect is not included because it represents a redistribution from railroads to shippers rather than a net decrease in costs.*

[3] *Competitive rate decreases by railroads would reduce shipper costs by an additional $50 million.*

[4] *Competitive rate decreases by railroads would reduce shipper costs by an additional $210 million.*

[5] *Competitive rate decreases by railroads would reduce shipper costs by an additional $90 million.*

[6] *Competitive rate decreases by railroads would reduce shipper costs by an additional $620 million.*

[7] *Competitive rate decreases by railroads would reduce shipper costs by an additional $240 million.*

[8] *Competitive rate decreases by railroads would reduce shipper costs by an additional $240 million.*

Figure 2 Estimated Freight Diversions from Rail to Truck for Various Proposed Truck Size and Weight Limit Modifications

Sources: (Carson, 2011) and (TRB, 1990)

The ton-miles of rail and the transport cost of rail for each scenario is shown in Figure 2. For most of the scenarios, the rail ton-miles decrease, except for grandfather clause elimination scenario. When the ton-miles decrease, the transport costs for rail also decrease. It shows how changing truck weight regulations would affect other modes, particularly rail.

2.1.2 U.S. Department of Transportation's Comprehensive Truck Size and Weight Study (2000)

The purpose of this study was to develop a framework to assess potential changes in truck weight limits and to estimate the benefits and cost of the changes. The study provided impact assessments on infrastructure cost, safety, traffic operation, energy and environment, rail impacts, and shipper costs (USDOT, 2000). The scenarios analyzed in the study are differentiated according to vehicle characteristics, gross weight limits and lengths of vehicles, and highway networks where trucks would operate (USDOT, 2000). The study analyzed different scenarios as followed:

- Uniformity Scenario
- North American Trade Scenario (1 and 2)
- Longer Combination Vehicles Nationwide Scenario
- H.R. 551 Scenario
- Triples Nationwide Scenario

The infrastructure costs were calculated based on the pavement cost, bridges cost, and geometrics improvements cost needed to support the proposed scenario. The pavement costs were estimated based on the VMT and axle loads changes for different

scenarios (USDOT, 2000). The bridge costs were calculated based on the gross weight of vehicles, the axle loads, the distance between axles, and the type and length of the bridge. In addition, the bridge costs included the delay costs and operating costs for users during construction periods (USDOT, 2000). The costs of major construction to upgrade the infrastructure due to changes in truck weight limits were included as part of infrastructure costs.

The safety impacts were evaluated based on the crash rates, public perception, and vehicle stability and control. The crash rates were predicted from the previous safety study and crash data. The public perception of trucks or larger vehicles was gathered from focus group meetings with stakeholders. Developing tools to evaluate stability and control properties of different vehicle configurations enhanced the safety impacts study. These tools helped identify which configurations have better performance in preventing rollover (USDOT, 2000).

The traffic operations were evaluated on changes in congestion levels and capacity impacts (USDOT, 2000). The energy and environment aspects covered the changes in emission generated from different truck classification, the fuel consumption, and the truck noise (USDOT, 2000). The sources of truck noise were the engine, the exhaust, and the tires (USDOT, 2000). To evaluate the impacts on rail, the Department’s Intermodal Transportation and Inventory Cost (ITIC) model and the Integrated Financial Model were implemented. The ITIC model estimates the diversion from rail to truck when the truck costs are lower, the remaining rail revenues after diversion, and the car miles remaining on the railroads (USDOT, 2000). The shipper costs include not only the

transportation cost itself but also account for inventory costs which estimated by the ITIC model (USDOT, 2000).

Table 1 Estimated Impact of Illustrative Truck Size and Weight Scenario

(Percent Change from Base Case)

	Uniformity	N.A. Trade (1)	N.A. Trade (2)	LCV Nationwide	H.R. 551	Triples
Pavement Costs	-0.3	-1.6	-1.2	-0.2	0	0
Bridge Costs	-13.0	+33.1	+42.2	+34.4	0	+10.4
Geometric Costs	0	+13.3	+13.3	+965.0	0	0
Congestion Costs	+0.6	-1.2	-1.2	-2.9	0	-7.6
Energy Costs	+2.1	-6.2	-6.3	-13.8	0	-12.8
Shipper Costs	+3.0	-5.1	-7.0	-11.4	0	-8.65
Rail Contribution[1]	na	-42.8	-49.7	-55.8	na	-38.2

N.A. Trade (1) – 44,000 pound tridem axles; N.A. Trade (2) – 51,000 pound tridem axles.
[1] The amount of rail revenue available to pay fixed costs after freight service (variable) costs have been covered.

Source: USDOT, 2000

The evaluation of different aspects for each scenario is shown in Table 1. Implementing a uniform truck weight regulation for all states has small impacts in comparison to other scenarios.

2.1.3 Wisconsin Truck Size and Weight Study (2009)

The purpose of this study was to assess potential changes in Wisconsin's truck weight regulations that would benefit Wisconsin economy while protecting roadway and bridge infrastructure and maintaining safety (Adams, 2009). There were a few considerations assessed in the study, which are business aspects, pavements, bridges, and highway safety. The impacts towards user and public agency were also considered. In addition, the overweight and oversize permit system was examined (Adams, 2009). There were six vehicle configurations with different weight limits evaluated in the study:

- Six-axle 90,000 pound tractor-semitrailer (6a TST 90)
- Seven-axle 97,000 pound tractor-semitrailer (7a TST 97)
- Seven-axle 80,000 pound single unit truck (7a SU 80)
- Eight-axle 108,000 pound double (8a D 108).
- Six-axle 98,000 pound tractor-semitrailer (6a TST 98) - *does not meet the Federal Bridge Formula*
- Six-axle 98,000 pound straight truck-trailer (6a STT 98) - *evaluated configuration does not meet the Federal Bridge Formula*

In Wisconsin's study, the business aspect evaluated the transportation cost and identified industries affected with the change of truck weight limits. Transportation costs account for the diesel price, international competition, changes in rail services, and shift to containerized shipments (Adams, 2009). Industries that mostly are affected by the truck weight limits are typically weight constrained, such as agricultural, paper, foundry, forestry, and manufacturing industries (Adams, 2009).

Highway safety was evaluated based on the truck-crash data at State and national levels, which gave the crash rates by vehicle classifications (Adams, 2009). The study accounted for the pavement life for each scenario, which depended on the magnitude and frequency of heavy vehicles (Adams, 2009). In addition, the pavement life also accounted for the deterioration due to weather. The cost of bridge inspection and posting signs when implementing new truck configuration were the component of bridge costs (Adams, 2009). Bridge costs also included maintenance and upgrades.

Congestion costs for each scenario are measured by using Passenger car equivalents (PCEs) of each vehicle configuration, Highway Economic Requirement System (HERS), and the Wisconsin Highway Performance Monitoring System (HPMS) (Adams, 2009). Energy and environmental impacts were measured from the fuel consumptions and the emission generated for each scenario (A, 2009). The emissions analysis calculated the amount of carbon dioxide (CO2), particular matter (PM), and nitrogen oxides generated.

Table ES.4 Annual Costs and Benefits for Candidate Configurations
Operating on Non-Interstate Highways Only

		System User Benefits			Public Agency Benefits and Impacts			Net Benefits	
Fed Bridge Formula	Configuration	Transport Savings	Safety	Congestion	Pavement	Bridge Costs for TSW Configs	Baseline Bridge Costs	With TSW Bridge Costs Only	With All Bridge Costs
Y	Base Case	0.00	0.00	0.00	0.00	0.00	(55.50)	0.00	(55.50)
Y	6a TST 90	5.50	0.46	0.92	2.57	(2.18)	(55.50)	7.26	(48.24)
Y	7a TST 97	6.27	0.70	0.85	3.87	(3.08)	(55.50)	8.62	(46.88)
Y	7a SU 80	2.46	0.11	0.08	0.40	(2.26)	(55.50)	0.78	(54.72)
Y	8a D 108	3.42	0.46	0.49	3.34	(6.02)	(55.50)	1.69	(53.81)
N	6a TST 98	19.19	1.52	1.89	1.10	(8.48)	(55.50)	15.23	(40.27)
N	6a STT 98	2.19	0.09	0.06	0.03	(4.22)	(55.50)	(1.85)	(57.35)

Note: All values in millions (assumes non-Interstate highway operation only).

Table ES.5 Annual Costs and Benefits for Candidate Configurations
Assuming Interstate Operation Is Allowable

		System User Benefits			Public Agency Benefits and Impacts			Net Benefits	
Fed Bridge Formula	Configuration	Transport Savings	Safety	Congestion	Pavement	Bridge Costs for TSW Configs	Baseline Bridge Costs	With TSW Bridge Costs Only	With All Bridge Costs
Y	Base Case	0	0	0	0	0.00	(55.50)	0.00	(55.50)
Y	6a TST 90	36.64	3.48	3.44	14.65	(2.18)	(55.50)	56.03	0.53
Y	7a TST 97	41.83	4.43	4.08	19.91	(3.08)	(55.50)	67.18	11.68
Y	7a SU 80	9.83	0.53	0.09	1.53	(2.26)	(55.50)	9.73	(45.77)
Y	8a D 108	22.77	2.90	1.65	16.76	(6.02)	(55.50)	38.06	(17.44)
N	6a TST 98	127.94	9.40	11.03	10.19	(8.48)	(55.50)	150.09	94.59
N	6a STT 98	14.61	0.68	0.26	0.32	(4.22)	(55.50)	11.65	(43.85)

Note: All values in millions (assumes Interstate highway and non-Interstate highway operation).

Figure 3 The Result of Wisconsin Truck Size and Weight Study

Based on the findings (see Figure 3), the study recommends that the Wisconsin's truck size and weight should not be changed (Adams, 2009). The decline of state revenue and the economic condition for Wisconsin and national when the study was conducted cannot support the high costs of changing truck weight regulation (Adams, 2009).

2.1.4 Comparison between Federal and State Truck Size and Weight Study

The summary of different topics considered in truck size and weight studies is shown in Table 2.

Table 2 Comparison of Truck Size and Weight Study for Federal and State Level

<table>
<tr><th>TRB, 1990
Truck Weight Limits (1990)</th><th>USDOT Comprehensive Truck Size and Weight Study (2000)</th><th>Wisconsin Truck Size and Weight Study (2009)</th></tr>
<tr><td>Pavement Cost
New pavement cost
Reconstructed pavement cost
Pavement rehabilitation cost</td><td rowspan="2">Infrastructure Cost
Pavement Cost
Bridges Cost
Geometric Improvement Cost</td><td>Pavements and Bridge Decks</td></tr>
<tr><td>Bridges Cost
Existing bridges replacement costs
New bridges costs</td><td>Bridge Reconstruction, Rehabilitation, and Posting Costs</td></tr>
<tr><td>Highway Safety</td><td>Safety
Crash rate
Public perception
Vehicle stability and control</td><td>Safety</td></tr>
<tr><td rowspan="3">Truck Productivity
Heavy Truck VMT

Transport Cost

Ton-miles of Rail</td><td>Traffic Operation
Capacity
Congestion</td><td>Congestion</td></tr>
<tr><td>Shipper Cost
Transport Cost
Inventory Cost</td><td rowspan="2">Business Consideration
Transportation Cost
Affected Industries
Rail Diversion Sensitivity Analysis</td></tr>
<tr><td>Rail Impacts</td></tr>
<tr><td></td><td>Energy and Environment
Emission
Fuel Consumption
Noise</td><td>Energy and Environment</td></tr>
</table>

TRB's and Wisconsin's studies evaluated pavement and bridge costs separately, while USDOT's study combined both. In addition, the USDOT's study accounted for the geometric improvement cost. USDOT's study provided a comprehensive evaluation for

safety, which includes public perception and vehicle stability and control, in addition to crash rate. The early TRB study did not account for environment and energy. While the federal truck size and weight study was not specific in terms of what industries are affected by the changes of truck weight limits, Wisconsin's study described the industries and why they are affected.

2.1.5 Summary of the Federal Truck Weight Regulations

The summary of the federal truck weight regulations is provided in Table 3. Only few studies pertinent to the topic are included in the summary. The summary provides quick overview how the federal truck weight regulations have evolved over time. Typically, when a new transportation authorization bill is enacted, a new truck size and weight study is conducted. The latest transportation bill, MAP-21 requested USDOT to conduct the study, which is an on-going process and scheduled to be completed by the end of 2014 (MAP-21, 2014).

Table 3 Federal Truck Weight Regulations Timeline

1913	State Legislature of Maine, Massachusetts, Pennsylvania, and Washington adopted truck weight regulations for their states (Special Reports 225)
1932	AASHO recommended a uniform truck weight regulations Single-axle: 16,000 pounds (Special Reports 225)
1933	All states had adopted truck weight regulations (Special Reports 225)
1946	AASHO revised the uniform truck weight proposal Single-axle: 18,000 pounds Tandem-axle: 32,000 pounds Gross Vehicle Weight: 73,230 pounds (Special Reports 225)
1956	**The Federal-Aid Highway Legislation of 1956** The first federal truck weight regulation for vehicles operating on the new Interstate Highway System. Single-axle: 18,000 pounds Tandem-axle: 32,000 pounds Gross Vehicle Weight: 73,280 pounds (USDOT, 2000)
1975	As a respond to increasing fuel costs, Congress increased the limits: Single-axle: 20,000 pounds Tandem-axle: 34,000 pounds

	Gross Vehicle Weight: 80,000 pounds The limits were permissive and States could adopt lower limits if they chose. (USDOT, 2000)
1978	Congress asked the US DOT to conduct a study of truck size and weight issues to address the uniformity for maximum truck size and weight regulation, appropriate user charges for heavy vehicles, and changes in state permit and enforcement practices (TRB, 1990) Few states along Mississippi River retained the 73, 280 pounds weight limit while other states adopted 80,000 pounds, causing variances in truck weight regulations (DOT TSW 2000)
1982	**The Surface Transportation Assistance Act (STAA) of 1982** Designated National Network (NN) and Application of Federal Bridge Formula Single-axle: 20,000 pounds Tandem-axle: 34,000 pounds Max Gross Vehicle Weight: 80,000 pounds Width: 102 inches Length: 48 feet (longer if grandfathered) for semitrailers or 28 feet for trailers in a twin-trailer combination Allowed longer and wider trucks to operate on National Network Increased the federal fuel tax by 5 cents per gallon and increased other federal user charges on heavy trucks (USDOT, 2000)
1987	**The Surface Transportation and Uniform Relocation Assistance Act of 1987** Congress asked the TRB to conduct a study of truck size and weight issues: Elimination of existing grandfather provisions in federal weight limits for Interstate highways Alternative methods for determining vehicle weight limits The adequacy of the current federal bridge formula Treatment for vehicles that have difficulty complying with the current federal badge formula (TRB, 1990)
1990	Transportation Research Board Special Report 225: Truck Weight Limits
1991	**The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991** Imposed the "LCV freeze" operations (USDOT, 2000)
1997	Federal Highway Cost Allocation Study Developed a Freight Policy (8 principles to evaluate freight related issues) Ensure a safe transportation system Use advances in transportation technology to promote transportation efficiency and safety Promote economic growth by removing unwise or unnecessary regulation and through the efficient pricing of publicly financed transportation infrastructure Protect the environment and conserve energy Provide funding and a planning framework that establishes priorities for allocation of Federal resources to cost-effective infrastructure investments that support broad National goals Effectively meet our defense and emergency transportation requirements Facilitate international trade and commerce Promote effective and equitable joint utilization of transportation infrastructure for freight and passenger service (USDOT, 2000)
2000	The Comprehensive Truck Size and Weight Study Conducted by USDOT to develop an analytical framework to assess potential changes in truck weight size and weight regulation (USDOT, 2000)
2012	**The Moving Ahead for Progress in the 21st Century Act** USDOT conducted a comprehensive truck size and weight limits study to address this issues: Compliance comparative on enforcement program Infrastructure impacts on bridge structure and pavement Highway safety and truck crash Modal shift (MAP-21, 2014)

2.2 Transportation and Economic Development

Economic development impact is a type of economic analysis that specifically evaluates the economy growth of an area. One way to show economic development is through the flows of dollars in the economy of an area (Weisbrod, 2000). Another way to measure economic development of an area is from changes in jobs, wages, value added, and business output (Weisbrod, 2000). Other indicators of economic development are changes in productivity, investment, property values, and taxes (Weisbrod, 2000). For simplicity, in this paper, the economic development impact is referred as economic impacts.

Transportation is very important to support economic activities; it provides connection to people and goods between one place and another. To prevent any disconnection that could hinder economic activities, investing in transportation and infrastructure are required. To justify transportation investment, many government agencies try to show how transportation investment can generate economic impacts (Litman, 2010).

Figure 4 shows the connection between transportation investment and economic development (Litman, 2010). Transportation investment generates reduction in cost, which could enhance the economic efficiency through cost saving. The cost of doing business is reduced, thus with the same amount of capital, more goods can be produced, which increases productivity levels. Overall, the transportation investment increases economic development.

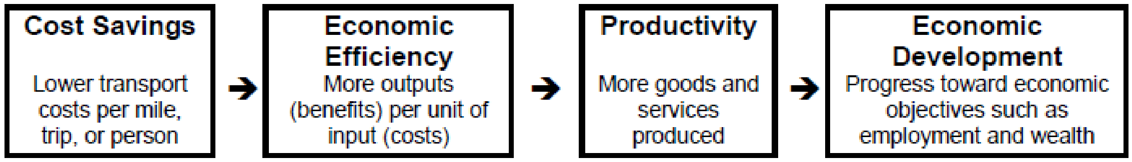


Figure 4 Transportation and Economic Impacts (Litman 2010)

2.3 Economic Impact Tools

Many economic impact tools have been developed to forecast the economic benefits of transportation projects. For example, HEAT, TREDIS, REMI, and IMPLAN are well respectable models and have been subject to much trial and discussion in the professional community. Few economic impact tools that are commonly used are discussed here.

2.3.1 HEAT Application in Wisconsin

Wisconsin adapted the business attraction module from Montana's Highway Economic Analysis Tool (HEAT) to forecast the economic benefits of highway projects in terms of employment growth in Wisconsin (Horowitz, 2007). HEAT is similar to Transportation Economic Development Impact System (TREDIS), a commercial economic analysis tool that evaluates transportation projects and their impacts to the economy (TREDIS, 2014). Originally, the business attraction module is in GIS form and the Wisconsin's version of HEAT is a form of spreadsheet. The parameters from Montana's HEAT were adjusted to Wisconsin parameters.

The model input is highway travel times before and after the improvement projects for county-to-county trip in Wisconsin. The output of the model is the amount of employment created for each county due to highway projects, broken down by industry.

The model includes 89 industries based on three-digit NAICS code. The employment growth in this model is the sum of influences of improvements in highways on each mode and on suppliers, customers and labor markets (Horowitz, 2007). The growth is influenced directly by highway travel and indirectly by the presence of air cargo and railroads (Horowitz, 2007). The sources of employment growth are (Horowitz, 2007)

- Highway access to airports
- Highway access to rail terminals
- General highway accessibility
- General highway accessibility to Canada (not used for Wisconsin model)
- Expanded customer markets
- Expanded labor markets
- Better accessibility to (and from) suppliers

To compute employment growth in seven sources explained earlier, this model use accessibility indexes (population accessibility and employment accessibility), which were the function of travel time (Horowitz, 2007). The employment growth for each industry in each county is constrained by location quotient or the regional growth limits (Horowitz, 2007). This provides better model, as it accounts for local economic condition. Since it is only account for travel time on highway, the model is not sensitive to the improvements upon other modes (Horowitz, 2007).

2.3.2 Input-Output Analysis

The Input-Output Model, invented by Wassily Leontief who received a Nobel Memorial Prize in Economic Sciences in 1973, describes how industries, households, and

government entities are interconnected in regional economy (Zamora). The model shows the transaction between industries both within the region and to outside the region (Stimson, Stough & Roberts, 2002). It is used to describe the regional economy, showing money flows from one industry to others. In addition, it can forecast the total impacts of certain events or policy changes in the region. An IO model consists of transaction table, direct requirements table and total requirements table.

An IO model generates multiplier indexes, which can measure total effect of an increase in demand, employment, or income (Zamora). There are three types of Multipliers (Harris & Doeksen):

- Type I Multipliers - includes direct and indirect effect
- Type II Multipliers - the induced effect
- Type III Multipliers - modified of Type II and based on spending pattern among different income groups.

2.3.3 IMPLAN

The Impact Analysis for Planning (IMPLAN) was developed to analyze the impacts of a project towards a regional or local economy. IMPLAN is a basic input-output economic model that uses the Social Accounting Matrix (SAM) and multipliers model (IMPLAN, 2014). IMPLAN models the way a dollar injected into one sector is spent and re-spent in other sectors of the economy, generating waves of economic activity, called "economic-multipliers' effects (IMPLAN, 2014). The economic impacts measured include direct impacts, indirect impacts, and induced impacts (IMPLAN, 2014).

- *Direct Impacts* refer to the dollar value of economic activity available to circulate through economy.
- *Indirect Impacts* refer to the "inter-industry" impacts of the input-output analysis. For example, the supply chain or the spending by the local and regional companies that the new households buy goods and services from are considered as indirect impacts.
- *Induced Impacts* refers to the impacts of household spending by the employees generated by the direct and indirect impacts. For example, the spending by the new households on the retail establishments and restaurants are considered as the induced impacts.

2.3.4 REMI

REMI, founded in 1980, was created to provide tools for government decision makers to test the economic effects of proposed policies before implementation. REMI model can help in answering various policy questions in different areas such as economic development, environment, energy, transportation, taxation, forecasting, and planning (REMI, 2014). Many government bodies, federal-level, state-level, regional-level, and even city-level have utilized REMI before making policy changes in their jurisdiction. Besides government agencies, other entities such as educational institutions and private consulting firms are also implementing REMI in their analysis process.

REMI model integrates several methodologies, such as an econometric model, an input-output model, a general equilibrium model, and economic geography methodologies, to form a comprehensive analysis tool (Tolliver and Dybing 2007). There

are two types of REMI models depending on simulation purposes. The first is PI+, which is the next generation of the Policy Insight® model. The next one is TranSight, which integrates economic model with travel demand modeling that will generate the impacts of transportation changes on jobs, income, population and other variables (REMI, 2014).

2.4 CFIRE Truck Cost Model

This study uses the CFIRE Truck Cost Model previously developed to calculate the shipping cost of various commodities per trip in a certain types of truck. The CFIRE Truck Cost Model is in the form of spreadsheet. The CFIRE Truck Cost Model uses two different sets of truck parameters: one set for a single-unit truck and another set for a tractor-trailer combination truck. This study only uses the tractor-trailer combination, since this type of truck can be more readily modified for heavier loads.

The cost model was first developed by Hussein in 2010, and it was originally designed to handle just five different commodities, corn, soybeans, plastic, motor vehicle parts, and dairy. This model accounts for a complete spectrum of shipping costs, such as fuel cost, labor cost, insurance cost, and overhead cost. The first version of the cost model is only based on distance, as a measure of spatial separation. In 2011, the CFIRE Truck Cost Model was modified by Mei to account for both distance and time as measures of spatial separation. Both distance and time are important parameters since trips between different origins and destinations have different speeds, depending on the traffic. In 2012, Kurniati expanded the CFIRE Truck Cost Model from having only five commodities to twenty-seven commodities. These twenty-seven commodities are top

commodities with the largest tonnage in Wisconsin. Besides commodities expansion, other adjustments are made to bring the model up to date. Those changes included updating the driving hour regulations recently changed by the Federal Motor Carrier Safety Administration (FMCSA) and the fuel cost update.

The twenty-seven commodities included in the latest version of the Truck Cost Model, along with their short names and their SCTG Codes are listed in Table 4 below.

Table 4 Commodity Short-Name

No	Short-Name	Commodity	SCTG Code
1	Corn	Corn, except sweet	022
2	Soybeans	Soybeans	034
3	CerealStraw	Cereal straw or husks, forage products, residues and waste from the food	041
4	AnimalFeed	Animal feed preparations	042
5	Meat	Meat including poultry, except preparations	051
6	NonalcBev	Nonalcoholic beverages, n.e.c. and ice	078
7	MaltBeer	Malt Beer	081
8	NatSand	Natural sands, except metal-bearing	110
9	Gravel	Gravel and crushed stone, except dolomite and slate	120
10	Dolomite	Dolomite	133
11	NonaggCoal	Nonagglomerated bituminous coal	151
12	Gasoline	Gasoline	171
13	FuelOils	Fuel oils	180
14	OthPetCoal	Other products of petroleum refining and coal products	199
15	InorgChem	Inorganic chemicals, n.e.c.	202
16	Fertilizer	Fertilizers and fertilizer materials	220
17	Plastics	Manmade fibers and plastics basic shapes and articles	242
18	UncoatedPaper	Uncoated paper and paperboard in large rolls or sheets	273
19	Paper	Paper or paperboard articles	280
20	Nonmetallic	Other nonmetallic mineral product	319
21	IronSteel	Flat-rolled products of iron or steel	322
22	Electronic	Other electronic and electrical equipment	359
23	MVParts	Parts and accessories for motor vehicles, except motorcycles and armored	364
24	Furniture	Furniture, mattress and mattress supports, lamps, lighting fittings	390
25	MiscPro	Miscellaneous manufactured products	409
26	MixedFreight	Mixed Freight	439
27	MetalWaste	Metallic waste and scrap	411

2.5 Elasticity of Truck-Rail

Truck and rail are competing modes and shipping cost changes in either mode will affect the other one. Many researchers attempt to create diversion models that estimate shipments shift between truck and rail due to change in shipping cost (Horowitz, 1999). For example, the Association of American Railroads (AAR) develops the Intermodal Competition Model (ICM) that predicts the cross elasticity between truck and rail (Cambridge Systematics, 1997). The cross elasticity is the percent change in rail demand given a one percent change in truck costs (Cambridge Systematics, 1997). A few elasticity values for various commodities are shown below. Commodities with heavy loads such as fabricated metals and machinery tend to have higher values of elasticity because these commodities are constrained by weight. A change in trucking cost will affect the shipment mode. Finished products tend to have higher elasticity than raw materials since raw materials. The elasticity of various commodities is listed on Table 5.

Table 5 Implicit Cross Elasticity's by Commodity Group Derived from ICM Results

Commodity	Low Elasticity	High Elasticity
Bulk Farm Products	0.02	0.03
Finished Farm Products	3.5	3.7
Bulk Food Products	0.62	0.83
Finished Food Products	2.0	2.2
Lumber and Wood	0.57	0.73
Furniture	4.0	4.7
Pulp and Paper	0.71	0.93
Bulk Chemicals	0.49	0.67
Finished Chemicals	3.2	3.5
Primary Metals	1.2	1.5
Fabricated Metals	5.2	7.3
Machinery	3.7	4.8
Electrical Machinery	4.1	4.8
Motor Vehicles	0.21	0.28
Motor Vehicle Parts	1.1	1.4
Waste and Scrap	0.17	0.22
Bulk All Else	0.14	0.19
Finished All Else	3.9	4.5

Source: NCHRP Report 388 (Cambridge Systematics, 1997)

2.5.1 The Concept of Arc Elasticity of Demand

Arc elasticity describes the relationship between demand and price of a commodity. The demand of a commodity will change when the price changes (Allen and Lerner 1933). An English economist, R.G.D. Allen, first advocates arc elasticity formula, where the percentage change of a variable is calculated based on the midpoint of two points instead of the points themselves, making it proportional and not absolute (Allen and Lerner 1933). The formula is shown below.

Arc Elasticity

$$E_p = \frac{\dfrac{x_2 - x_1}{(x_2 + x_1)/2}}{\dfrac{P_2 - P_1}{(P_2 + P_1)/2}}$$

Where E_P = Arc Elasticity of Demand,

x = demand

P = price

3 Cost Savings

The ultra-heavy trucks analyzed in this study consist of three weight limitations: 100,000 pounds, 120,000 pounds, and 140,000 pounds. The first part of the chapter provides the methodology of cost savings calculation. The second part of the chapter explains the findings. The cost savings of ultra-heavy trucks shows how more efficient the trucking industry can be. The third part of the chapter provides an estimation of job loss due to more efficient trucking industry.

3.1 Methodology of Cost Savings Calculation

The cost savings for each weight limitations are calculated by applying the CFIRE Truck Cost Model for all twenty-seven commodities previously listed (Table 4). The inputs of truck cost model comprise of the speed and distance of the trip, the type of commodities, and the payload of commodities. The payload of commodities is constrained by the gross maximum weight. The output is the shipping cost per trip for each commodity by distance category and by truck weight limitations. The process of evaluating cost savings of ultra-heavy trucks shown in Figure 5. There are mainly five steps. First is to identify the road network needed. Second is to implement truck cost model. Third is to calculate the total shipping cost for Wisconsin. Fourth is to examine the cost savings between three scenarios and the baseline. Lastly is to compare the result to understand the scale of savings.

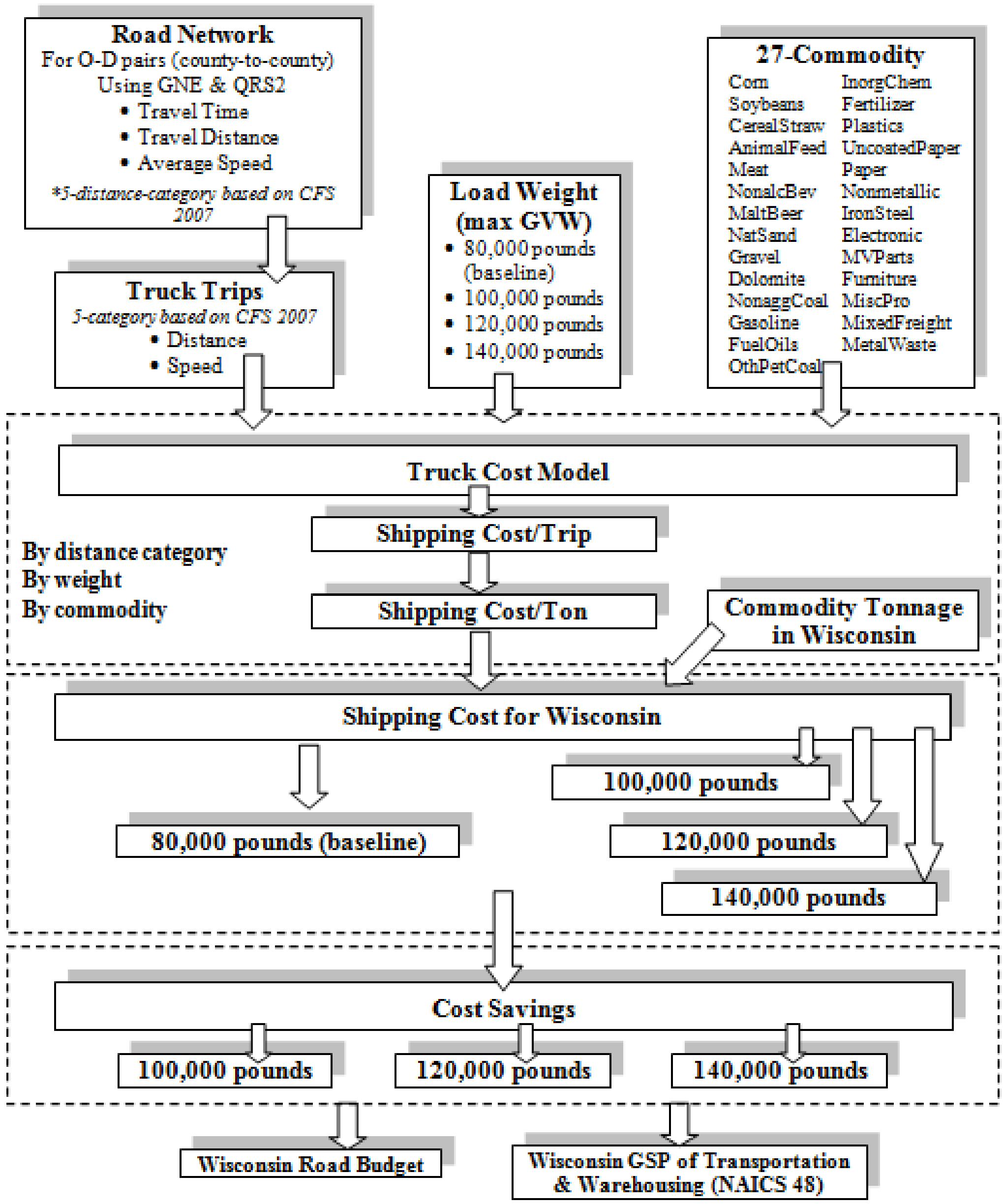


Figure 5 Cost Savings Methodology

3.1.1 Road Network

In this study, the first step is to determine the speed and distance combinations of all possible truck trips, which will be one of the inputs of truck cost model. The truck trips consist of O-D pairs between counties in Wisconsin (72-county) and several bordering counties (19-county) in Minnesota, Iowa, and Illinois. In addition, few

intermodal stations located near Wisconsin, such as Chicago Intermodal (IL), Minneapolis-St Paul Intermodal (MN), and Rochelle Intermodal (IL), are also included. The complete list of counties included as O-D pairs is shown in Table 6.

Table 6 Origin-Destination Counties

Counties in Wisconsin						Bordering Counties outside Wisconsin	
1	Adams	25	Iowa	49	Polk	1	Lake, IL
2	Ashland	26	Iron	50	Portage	2	McHenry, IL
3	Barron	27	Jackson	51	Price	3	Boone, IL
4	Bayfield	28	Jefferson	52	Racine	4	Winnebago, IL
5	Brown	29	Juneau	53	Richland	5	Stephenson, IL
6	Buffalo	30	Kenosha	54	Rock	6	Jo Davies, IL
7	Burnett	31	Kewaunee	55	Rusk	7	Dubuque, IA
8	Calumet	32	La Crosse	56	Sauk	8	Clayton, IA
9	Chippewa	33	Lafayette	57	Sawyer	9	Allamakee, IA
10	Clark	34	Langlade	58	Shawano	10	Houston, MN
11	Columbia	35	Lincoln	59	Sheboygan	11	Winona, MN
12	Crawford	36	Manitowoc	60	St Croix	12	Wabasha, MN
13	Dane	37	Marathon	61	Taylor	13	Goodhue, MN
14	Dodge	38	Marinette	62	Trempealeau	14	Dakota, MN
15	Door	39	Marquette	63	Vernon	15	Washington, MN
16	Douglas	40	Menominee	64	Vilas	16	Chisago, MN
17	Dunn	41	Milwaukee	65	Walworth	17	Pine, MN
18	Eau Claire	42	Monroe	66	Washburn	18	Carlton, MN
19	Florence	43	Oconto	67	Washington	19	St Louis, MN
20	Fond Du Lac	44	Oneida	68	Waukesha		
21	Forest	45	Outagamie	69	Waupaca		Intermodal Station
22	Grant	46	Ozaukee	70	Waushara	1	Chicago, IL
23	Green	47	Pepin	71	Winnebago	2	Minneapolis-St Paul, MN
24	Green Lake	48	Pierce	72	Wood	3	Rochelle, IL

To simplify the model, the speed and distance input will be placed into five different categories based on Commodity Flow Survey (CFS 2007) : <50 miles, 50-99 miles, 100-249 miles, 250-499 miles, and 500-749 miles. The farthest distance between any origin-destination counties is less than 750miles. The average distance between and across pairs of counties in Wisconsin within the previously distance categories are used as the distance input for the CFIRE Truck Cost Model. Similarly, the average travel speed between and across pairs of counties in Wisconsin within the CFS distance categories are used as the speed input in the CFIRE Truck Cost Model.

3.1.1.1 Travel Distance

Shipping costs are calculated based on county-to-county OD pairs of trips. The General Network Editor (GNE) and the Quick Response System II (QRSII) are used to find the distance between counties across the highway network that was developed for the MAFC Freight Model. The highway network in the MAFC Freight Model was derived from and has the same level of detail as the ORNL National Highway Planning Network.

The average travel distance is found for each CFS distance category from the travel distance matrix. The average distances for each CFS distance category relates to the average speed in the next step. In addition, these average distances will be used in the CFIRE Truck Cost Model as a distance input.

3.1.1.2 Travel Time

Similar to travel distance, the travel times between counties are calculated from the highway network for MAFC Freight Model. GNE and QRSII are used to estimate the travel time for each county-to-county pair. Similar to travel distance, the average travel time for each CFS distance category is calculated.

3.1.1.3 Average Speed

The average speed is calculated from average distance and average travel distance for each CFS distance categories. These average speeds are used in the CFIRE Truck Cost Model for such items as the fuel consumption rate. The summary of average distance and average speed for each CFS distance category is shown in Table 7.

Table 7 Distance Categories Characteristics

Distance Category	Average Distance (mi)	Average Travel Time (min)	Average Speed (mi/min)	Average Speed (mph)
<50 miles	33.80	50.19	0.67	40.40
50-99 miles	76.45	94.43	0.81	48.58
100-249 miles	173.16	193.98	0.89	53.56
250-499 miles	309.79	325.32	0.95	57.14
500-749 miles	529.52	529.59	1.00	59.99

3.1.2 Truck Cost Model Implementation

The second step is to implement the CFIRE Truck Cost Model. The average distance and average speed for each CFS distance category serves as the input the model. The commodities included in this analysis will follow the available commodities that the truck cost model has, which consists of twenty-seven commodities. Next is to determine the load carried for each commodity in the CFIRE Truck Cost Model. The commodity load depends on the maximum GVWs described earlier (80,000 pounds, 100,000 pounds, 120,000 pounds, and 140,000 pounds) and the commodity densities, which are already available in the latest revision of the CFIRE Truck Cost Model.

3.1.2.1 Cost/Trip and Cost/Ton

The model will generate the shipping cost per trip for twenty-seven commodities. Then for each commodity, the cost per ton is calculated by dividing the cost/trip by the commodity load carried on the trip for all four-weight limitations (80,000 pounds, 100,000 pounds, 120,000 pounds, and 140,000 pounds). The 80,000-pound trucks will be the baseline. The last two (120,000-pound trucks and 140,000-pound trucks), in particular should be considered “ultra-heavy trucks” because their maximum weights exceed those in current legislative proposal. These costs are broken out by commodity on Table 25 to Table 32 in the Appendix.

3.1.3 Total Shipping Cost for Wisconsin Case Study

The third step is to calculate the shipping cost for the whole state of Wisconsin separated by commodity. The statewide shipping costs are generated from multiplying the previously calculated cost/ton by the commodities tonnage being shipped by truck from Wisconsin. The commodities tonnage for all modes comes from the Commodity Flow Survey 2007. The commodities used are the same as those in the revised CFIRE Truck Cost Model. Consistent with the CFS, only those commodities shipped will be considered, since received shipments may cause double counting.

Exports are included, per the CFS, but imports are excluded from these data. Since the commodities tonnage is available for all modes and the cost savings are only for truck mode, the tonnage is multiplied by the percentage of tonnage shipped by truck. Table 8 lists the tonnage shipped by distance in Wisconsin by all modes. Highlighted cells are included in Table 8 for completeness, but are not used in the analysis. The percentage of tonnage shipped by truck is shown in Table 9.

The Wisconsin shipping costs for all weight limits (baseline, 100,000 pounds, 120,000 pounds, and 140,000 pounds) are shown in Table 33 to Table 36 in Appendix A. The total shipping costs is the summary of shipping cost of 27 top commodities in Wisconsin, which is an underestimate since Wisconsin shipped more commodities that are not included in this analysis.

Table 8 Commodities Weight in Wisconsin for all modes (CFS 2007)

Commodity (in-tons)	< 50 miles	50 - 99 miles	100 - 249 miles	250 - 499 miles	500 - 749 miles	750 - 999 miles	1,000 - 1,499 miles	1,500 - 2,000 miles	> 2,000 miles	Total
Corn	1,909,600	1,561,000	619,000	1,432,200	857,000	964,000	954,800	477,400	-	8,775,000
Soybeans	1,322,750	962,000	656,000	282,000	284,000	517,000	198,000	120,250	-	4,342,000
CerealStraw	2,075,000	509,000	1,038,000	560,000	372,000	151,000	503,000	166,000	-	5,374,000
AnimalFeed	2,075,000	509,000	1,038,000	560,000	372,000	151,000	503,000	166,000	-	5,374,000
Meat	347,000	232,000	666,000	371,000	207,000	206,000	80,000	65,000	1,000	2,175,000
NonalcBev	4,419,000	2,753,000	2,723,000	1,339,000	1,133,000	1,398,000	527,000	563,000	1,000	14,856,000
MaltBeer	1,347,000	585,000	565,000	504,000	23,000	46,000	23,000	-	-	3,093,000
NatSand	-	-	183,000	151,000	-	-	170,000	-	-	504,000
Gravel	20,182,000	10,545,000	4,083,000	1,622,250	1,261,750	721,000	479,000	1,124,000	-	40,018,000
Dolomite	-	-	-	41,000	-	-	-	7,000	-	48,000
NonaggCoal	-	-	-	-	-	-	-	-	-	-
Gasoline	5,536,000	2,204,000	863,000	186,000	-	-	-	-	-	8,789,000
FuelOils	2,598,000	1,213,000	845,000	34,000	14,000	15,000	12,000	3,000	-	4,734,000
OthPetCoal	490,000	186,000	104,800	104,800	104,800	78,600	12,000	78,600	52,400	1,212,000
InorgChem	1,570,000	751,000	801,000	614,000	469,500	391,250	313,000	234,750	156,500	5,301,000
Fertilizer	1,495,000	195,000	33,300	27,750	27,750	-	22,200	-	-	1,801,000
Plastics	416,000	260,000	431,000	444,000	330,000	233,000	121,000	104,000	-	2,339,000
UncoatedPaper	1,850,000	1,175,000	1,306,000	1,400,000	902,000	987,000	271,000	421,000	-	8,312,000
Paper	1,053,000	407,000	823,000	860,000	380,000	562,000	205,000	184,000	-	4,474,000
Nonmetallic	20,708,000	984,000	735,000	639,000	474,000	128,000	102,000	41,000	-	23,811,000
IronSteel	1,854,000	1,223,000	4,106,700	3,194,100	821,000	209,000	219,000	16,000	1,825,200	13,468,000
Electronic	299,000	105,000	190,000	173,000	222,000	165,000	93,000	104,000	3,000	1,354,000
MVParts	476,000	249,000	375,000	970,000	318,000	337,000	147,000	68,000	-	2,940,000
Furniture	136,000	75,000	121,000	217,000	117,000	112,000	57,000	43,000	-	878,000
MiscPro	340,000	229,000	289,000	243,000	184,000	118,000	101,000	36,000	2,000	1,542,000
MixedFreight	1,740,000	1,622,000	1,363,000	558,000	244,400	183,300	25,000	122,200	61,100	5,919,000
MetalWaste	1,082,000	514,000	565,000	178,000	50,000	90,000	-	26,000	-	2,505,000

Table 9 Percentage of commodities shipped by truck in Wisconsin

Commodity	Percentage of tonnage shipped by truck
Corn	52.8%
Soybeans	94.4%
CerealStraw	84.8%
AnimalFeed	84.8%
Meat	99.5%
NonalcBev	95.5%
MaltBeer	95.4%
NatSand	0.0%
Gravel	70.2%
Dolomite	0.0%
NonaggCoal	0.0%
Gasoline	100.0%
FuelOils	98.8%
OthPetCoal	97.6%
InorgChem	70.4%
Fertilizer	99.8%
Plastics	90.0%
UncoatedPaper	82.5%
Paper	90.4%
Nonmetallic	96.0%
IronSteel	98.4%
Electronic	93.8%
MVParts	91.5%
Furniture	97.4%
MiscPro	89.6%
MixedFreight	90.1%
MetalWaste	84.0%

3.1.4 Total Cost Savings

The fourth step is to calculate the cost savings of the ultra-heavy trucks. The cost savings for each weight limitations are calculated by evaluating the differences between the shipping costs of each weight limitations to the shipping cost of baseline 80,000-pound trucks. The shipping cost of an ultra-heavy truck is lower than the baseline, regardless of the weight limit. The actual cost savings might be larger, as this analysis only account for the largest twenty-seven commodities in Wisconsin.

3.1.5 Scale of Savings

The last step is to compare the cost savings of each weight limitations to the Wisconsin road budget and to the Gross State Product (GSP) for Transportation and Warehousing Industry (NAICS 48) to understand the significance of these savings.

3.2 Cost Savings of Ultra-Heavy Trucks

3.2.1 100,000-Pound Trucks

Across all 27-commodity, the total cost savings are $499 million, which is a considerable amount of money (see Table 37). The biggest cost savings occur within the 250-499 miles distance category, which is $139 million by itself. Longer distances are associated with larger cost savings per trip. Even though the cost savings occurring within the 500-749 miles distance category is slightly lower than the previous distance category, at $126 million, the trend of further distance generate larger cost savings is still applicable. The cost savings for shorter distances are much lower in comparison to larger distances (see Figure 6).

Besides distance, another factor affecting cost savings are the commodity types and their density. As commodities get heavier (larger densities), the cost savings become larger per trip, such as gravel and flat-rolled products of iron and steel. Light commodities (such as cereal straw and furniture) have less cost savings because they are unlikely to exceed the maximum weight limit for the baseline truck. For light commodities, the volume of the trailer is the constraining factor. The top three commodities with the larger cost savings are gravel, flat-rolled products of iron or steel, and nonalcoholic beverages, which are considered as heavy commodities.

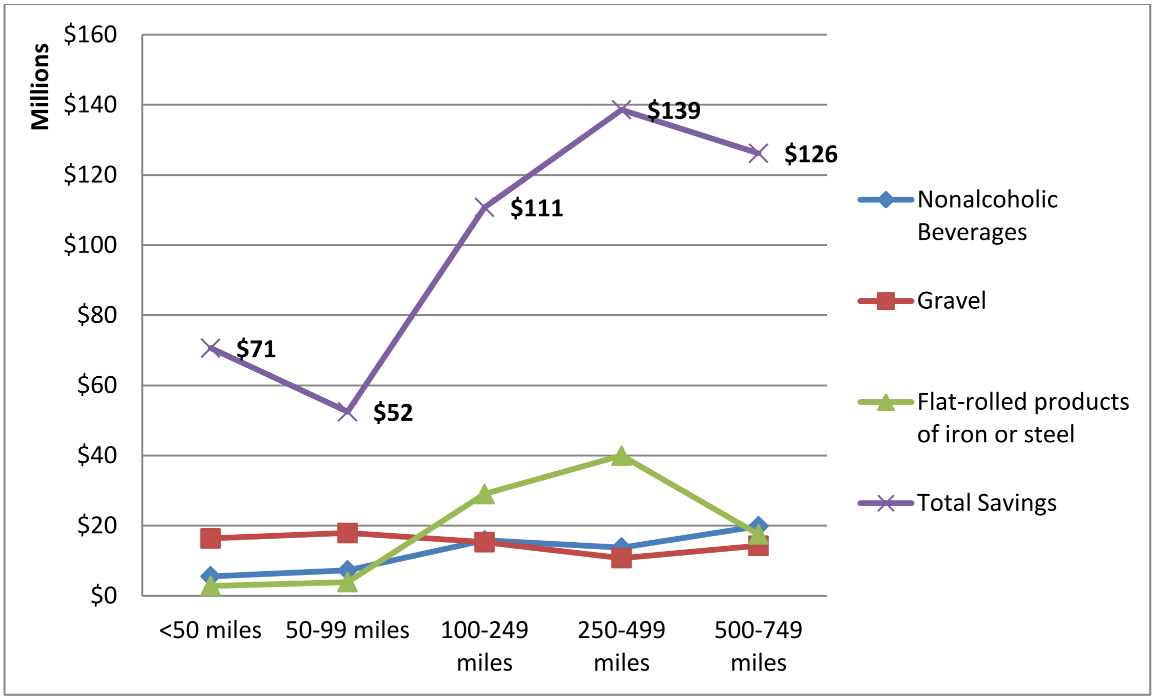


Figure 6 Top Three Commodities with the Largest Cost Savings for 100,000-pound trucks

3.2.2 120,000-Pound Trucks

For all 27-commodities, the total cost savings are $660 million, which is substantially larger than for a 100,000-pound truck (see Table 38). Similar to 100,000-pound trucks, the largest cost savings occur within the 250-499 miles distance category. The amount of savings, however, is much larger ($182 million instead of 139 million). For all combined commodities with 120,000-pound trucks, the longer distance also means larger cost savings (see Figure 7).

For light commodities (such as cereal straw and furniture), the cost savings of 100,000-pound trucks and of 120,000-pound trucks remain constant. The volume of trailer limits how much load of light commodities can be carried. Increasing weight limit will not change the load of commodity being shipped. The top three commodities with the larger cost savings are gravel, flat-rolled products of iron or steel, and nonalcoholic beverages, which are considered as heavy commodities.

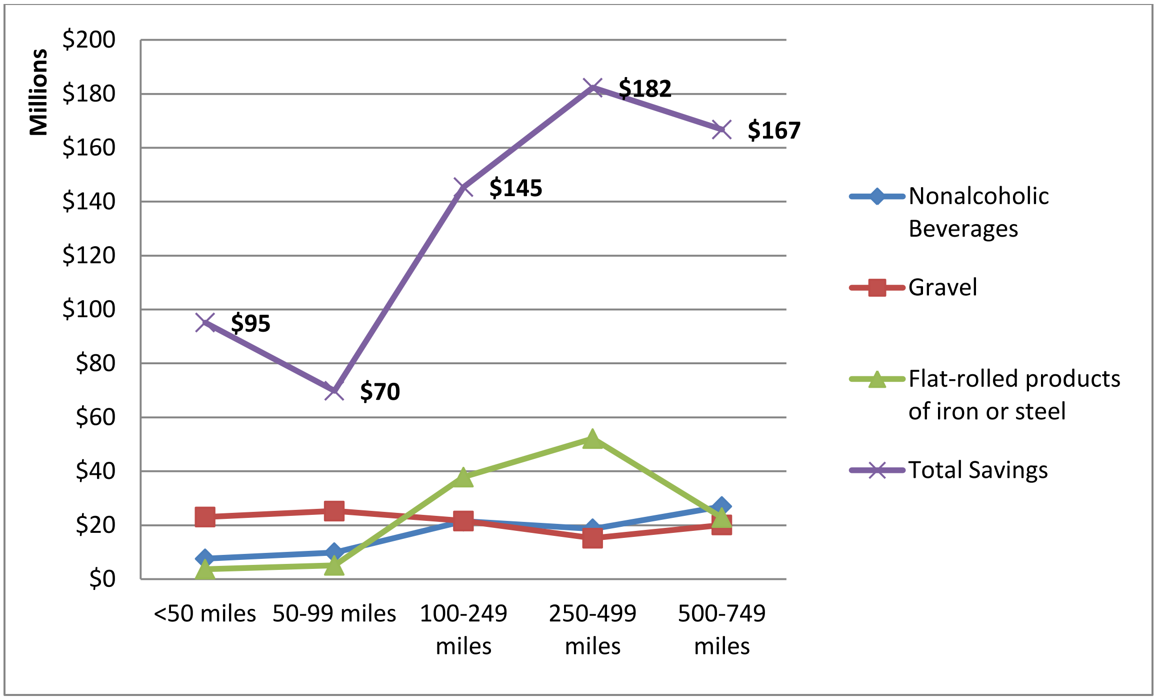


Figure 7 Top Three Commodities with the Largest Cost Savings for 120,000-pound trucks

3.2.3 140,000-Pound Trucks

For all 27-commodities, the total cost savings are $762 million, which is well beyond the savings from a 120,000-pound truck (see Table 10). The biggest cost savings, $210 million, occur within the 250-499 miles distance category when combining all 27-commodity. The commodities with the largest cost savings are flat-rolled products of iron or steel ($140 million) and gravel ($124 million). Heavier commodities with larger density like gravel and flat-rolled products of iron or steel, experience the greatest cost savings. On the other hand, the light commodities, which are constrained by trailer volume, do not experience the same rate of cost savings.

Table 10 Total Cost Savings for 140,000-Pound Trucks

Commodity	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles	Total
Corn	$1,673,340	$2,868,264	$2,508,767	$10,279,884	$10,482,989	$27,813,245
Soybeans	$2,773,520	$4,229,637	$6,361,878	$4,843,345	$8,312,552	$26,520,932
CerealStraw	$14,245	$7,327	$32,960	$31,492	$35,652	$121,676
AnimalFeed	$3,515,843	$1,808,438	$8,134,609	$7,772,167	$8,798,666	$30,029,722
Meat	$1,061,495	$1,438,859	$8,924,079	$8,671,355	$8,144,459	$28,240,247
NonalcBev	$8,804,987	$11,502,319	$25,094,601	$21,853,854	$31,513,536	$98,769,296
MaltBeer	$2,648,909	$2,412,291	$5,138,967	$8,118,442	$631,378	$18,949,987
NatSand	$0	$0	$0	$0	$0	$0
Gravel	$27,298,518	$29,908,591	$25,543,606	$17,973,614	$23,823,782	$124,548,111
Dolomite	$0	$0	$0	$0	$0	$0
NonaggCoal	$0	$0	$0	$0	$0	$0
Gasoline	$1,896,816	$1,622,201	$1,413,377	$541,313	$0	$5,473,707
FuelOils	$2,596,792	$2,604,490	$4,037,131	$288,658	$202,761	$9,729,832
OthPetCoal	$1,281,157	$1,044,679	$1,309,742	$2,327,416	$3,970,328	$9,933,323
InorgChem	$1,427,522	$1,466,855	$3,481,239	$4,741,963	$6,185,541	$17,303,120
Fertilizer	$4,221,768	$1,182,910	$449,485	$665,614	$1,135,468	$7,655,245
Plastics	$387,327	$507,713	$1,856,641	$3,387,549	$4,291,076	$10,430,306
UncoatedPaper	$3,346,571	$4,456,979	$10,926,961	$20,744,313	$22,777,042	$62,251,866
Paper	$48,749	$39,518	$176,282	$326,256	$245,693	$836,498
Nonmetallic	$39,456,515	$3,931,426	$6,477,328	$9,972,962	$12,607,281	$72,445,512
IronSteel	$4,243,823	$5,870,140	$43,477,888	$59,887,856	$26,233,316	$139,713,024
Electronic	$988,426	$745,635	$3,002,235	$4,857,644	$10,633,711	$20,227,651
MVParts	$1,200,072	$1,316,359	$4,372,800	$20,031,563	$11,191,544	$38,112,337
Furniture	$9,469	$10,952	$38,977	$123,801	$113,761	$296,959
MiscPro	$3,858	$5,450	$15,171	$22,592	$29,154	$76,226
MixedFreight	$26,204	$51,224	$94,947	$68,841	$51,385	$292,601
MetalWaste	$1,932,037	$1,924,535	$4,666,213	$2,603,460	$1,246,295	$12,372,540
Total for each distance category	$110,857,963	$80,956,792	$167,535,882	$210,135,954	$192,657,372	$762,143,964

3.2.4 Commodities Comparison

As the trucks having greater weight limitations, the cost savings are increasing (see Figure 8). The 140,000-pound trucks experiences the largest cost saving in comparison to the lighter ultra-heavy trucks. For heavier commodities, such as gravel and nonalcoholic beverages, heavier trucks generate larger cost savings. Even though the largest cost savings generated from 140,000-pound trucks, the critical maximum weight is inconclusive from this study. Additional analysis is needed to consider the operation and maintenance cost of ultra-heavy truck.

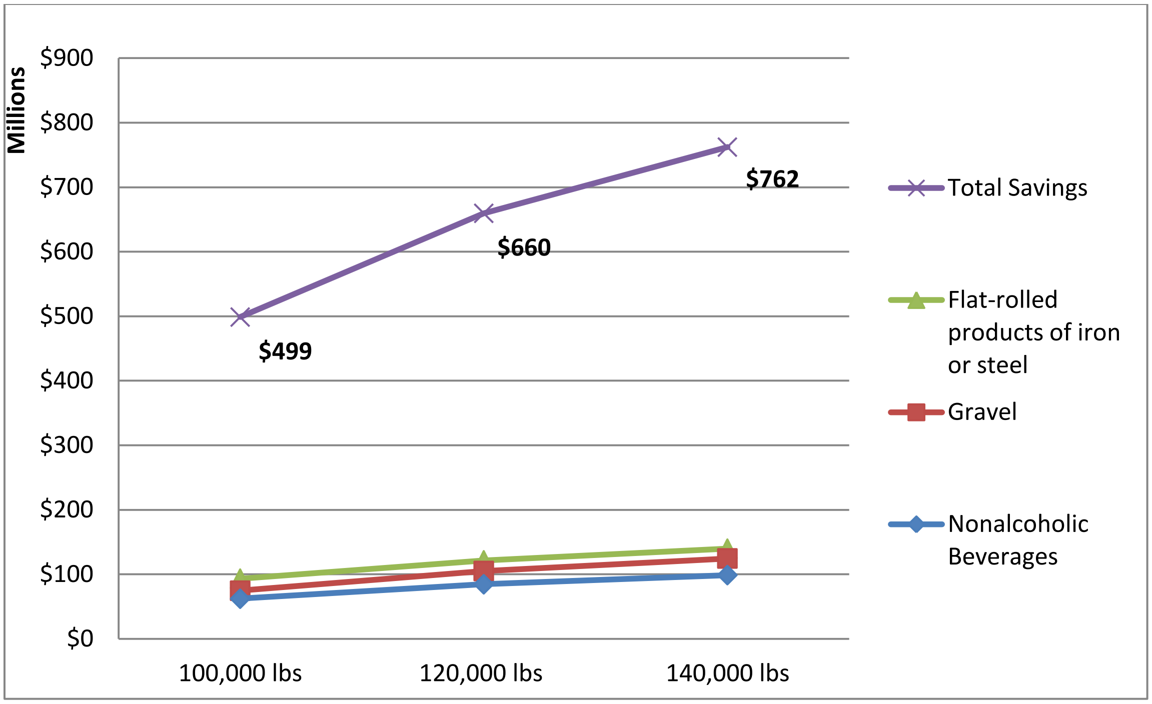


Figure 8 Cost Savings for Different Truck Weight by Commodity

3.2.5 Scale of Savings Relative to the Wisconsin Road Budget

In order to judge the significance of the savings, they can be compared to highway expenditures. A comparison to total highway spending is appropriate because ultra-heavy trucks will have an impact on the cost of road maintenance and could have an impact on road and bridge design. The total disbursement spent by Wisconsin in 2009 was $1.9 billion for highways (see Table 11). This includes capital expense for roads and bridges, maintenance and highway services, administration, research and planning, highway law enforcement and safety, interest and bond retirement.

Table 11 Disbursements for State-Administered Highways (2009)

	Wisconsin (in thousands)
Capital Outlay for Roads & Bridges	$1,193,332
Maintenance and Highway Services	$224,807
Administration, Research and Planning	$182,919
Highway Law Enforcement and Safety	$106,177
Interest	$111,546
Bond Retirement	$136,834
Total Disbursement	$1,955,615

SOURCE: FHWA HIGHWAY STATISTICS 2009

When implementing 100,000-pound trucks, the cost savings are $499 million, which is about a quarter (25%) of the total disbursement of highway construction and operations for Wisconsin in 2009. For 140,000-pound truck, the cost savings are $762 million, which is about 39% of the total road disbursement (see Table 12).

Table 12 Percentage of Cost Savings Relative to Total Wisconsin Road Disbursement (2009)

Truck Weight Limit	Cost Savings	Total Road Disbursement in 2009	
		For Wisconsin (in thousands)	Percentage
100,000 Pounds	$ 498,699,494	$1,955,615	25.5%
120,000 Pounds	$ 659,565,414	$1,955,615	33.7%
140,000 Pounds	$ 762,143,964	$1,955,615	39.0%

3.2.6 Scale of Savings Relative to Gross State Product for Transportation and Warehousing

In order to judge the significance of the savings, they can also be compared to the GSP for the transportation sector of the economy. The comparison to the GSP is appropriate because such cost savings could represent a direct reduction in GSP within this sector. For Transportation and Warehousing (NAICS Code 48), the Gross State Product (GSP) in 2012 for Wisconsin was $7,913 million. The cost savings for 100,000-pound trucks are $499 million, which is about 6% of the GSP within this sector (see Table 13). For 140,000-pound trucks, the cost savings are equivalent to nearly 10% of the GSP within this sector. These data show that the cost savings when implementing ultra-heavy truck is significant in comparison to bigger economic picture.

Table 13 Percentage of Cost Savings Relative to Gross State Product (2012)

Truck Weight Limit	Cost Savings	Gross State Product for Transportation & Warehousing (NAICS 48)	
		For Wisconsin (in millions)	Percentage
100,000 Pounds	$498,699,494	$7,913	6.3%
120,000 Pounds	$659,565,414	$7,913	8.3%
140,000 Pounds	$762,143,964	$7,913	9.6%

SOURCE: BUREAU OF ECONOMIC ANALYSIS 2012

3.2.7 Finding Summary

Based on the cost analysis of 27 commodities using the Truck Cost model, freight using ultra-heavy trucks (100,000 pounds, 120,000 pounds, 140,000 pounds) is significantly cheaper than using the baseline 80,000-pound trucks.

For 100,000-pound trucks, the cost savings are $499 million, which is equivalent to 25% of the total road expenditures for the State of Wisconsin in 2009. In addition, they are about 6% of the total GSP for Transportation and Warehousing industry in 2012.

For 120,000-pound trucks, the cost savings are $660 million, which is equivalent to 33% of the total road expenditures for the State of Wisconsin state in 2009. In addition, they are 8% of the total GSP for Transportation and Warehousing industry in 2012.

For 140,000-pound trucks, the cost savings are $762 million, which is equivalent to 39% of the total road expenditures for the State of Wisconsin in 2009. In addition, they are nearly to 10% of the total GSP for Transportation and Warehousing industry in 2012.

3.3 Job Loss Calculation

The cost savings of ultra-heavy trucks show that the trucking industry becomes more efficient, especially since the shipping cost is lower. When implementing ultra-heavy trucks, fewer trips are required since the truck can carry more payloads. This will make the trucking industry more efficient and fewer drivers are needed, causing job loss especially in trucking industry. This analysis estimates the number of job loss caused by ultra-heavy trucks.

To simplify the calculation, assume that the cost savings of ultra-heavy trucks is $800 million. According to Truck Cost Model, about 20% of total shipping cost includes labor cost (Hussein, 2010). From both assumptions, the cost savings from reduced labor cost is calculated.

$$20\% \times \$800{,}000{,}000 = \$160{,}000{,}000$$

The Occupational Employment Statistics (OES) estimates the annual mean wage for Heavy and Tractor Trailer Truck Drivers (Code 53-3032) for the State of Wisconsin in May 2007 is $38,350 (BLS, 2007). In Truck Cost Model, the shipping cost per trip accounts for fringe benefits for drivers, which includes health insurance, social security, and pension (Hussein, 2010). The amount of fringe benefits is about 51% of the labor wage calculated in the model (Hussein, 2010). Assuming that employers spend 51% more, in addition to the labor wage for fringe benefit, the total compensation that employers spend for one driver is $57,908.50. The estimated job loss can be calculated.

$$\frac{\$160{,}000{,}000}{\$57{,}908.50} = 2753\ job\ loss$$

Since this analysis is a linear model, when the cost savings change, the job loss also changes. The job loss for each scenario can be calculated. The largest job loss for trucking industry occurs when implementing 140,000-pound trucks, 2632-job loss (Table 14). Overall, the job loss due to ultra-heavy trucks is not too significant, in comparison to the total of trucking industry jobs, which is 54,423 in 2007 (U.S. Census, 2007). This is reasonable since only 20% of shipping cost covers labor cost related.

Table 14 Job Loss Estimation

Truck Weight Limit	Cost Savings	Cost Savings from reduced labor cost	Job Loss
100,000 Pounds	$498,699,494	$99,739,899	1722
120,000 Pounds	$659,565,414	$131,913,083	2278
140,000 Pounds	$762,143,964	$152,428,793	2632

4 Employment Growth Due to accessibility

4.1 Methodology

This project analyzes the employment growth for the Wisconsin case study when the maximum truck weights are 100,000 pounds, 120,000 pounds, and 140,000 pounds, with a baseline of 80,000 pounds. The employment growths from accessibility changes are calculated by implementing the Wisconsin's HEAT model. The methodology diagram is shown in Figure 9. The HEAT model was designed to estimate the employment growth, broken down by industry, due to the highway improvement projects. The model is based on the accessibility indexes calculated from differences of travel time before and after the improvements (Horowitz, 2007). Implementing ultra-heavy trucks does not change travel time because the trips are going from the same origin and destination. For this study, the travel time is not simply the duration of a trip from origin to destination; travel time means impedance where both the value of time (VOT) and cost per mile are considered.

4.1.1 CFIRE Truck Cost Model

The CFIRE Truck Cost Model is implemented to calculate the shipping cost per trip of 27 commodities for each weight limits. Based on distance and speed traveled for each truck trip, the regression line generates the value of time and cost/mile for each commodity. The sample calculation of regression line method is shown in Appendix B (Figure 23 and Figure 24).

4.1.2 Road Network

Travel time and travel distance of county-to-county in Wisconsin has been calculated by using GNE and QRS II in the previous analysis (Cost Savings analysis). For details, refer to Chapter 3.1.1.

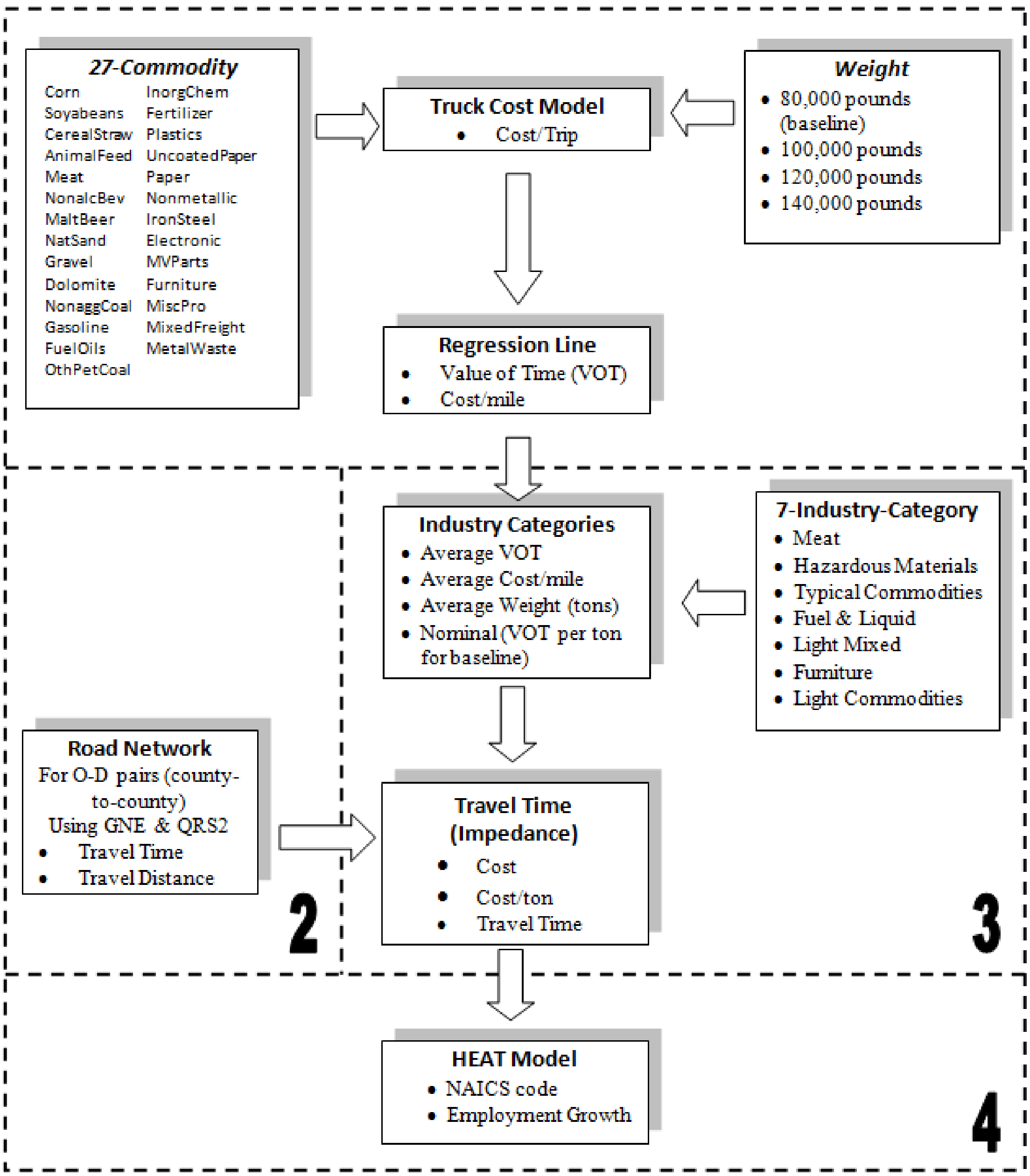


Figure 9 Employment Growth Methodologies

4.1.3 Travel Time (Impedance)

For commodities that have similar or closer values of time or cost/mile are categorized under similar categories (see Table 39 in Appendix B). The VOT and Cost/Mile for Industry Categories for all weight limits are shown in Table 15.

Heavier trucks have larger values of time in comparison to the baseline trucks, which means that shipper are willing to pay more for the shipping to save time (Table 15). On the other hand, heavier trucks have smaller cost/mile in comparison to the baseline trucks. It means that the shipping price goes down as the truck weight is increasing.

Table 15 VOT and Cost/Mile for Industry Categories

	Category	80,000-pound trucks		100,000-pound trucks		120,000-pound trucks		140,000-pound trucks	
		VOT	Cost/ Mile	VOT	Cost/ Mile	VOT	Cost/ Mile	VOT	Cost/ Mile
A	Meat	100.43	1.422	113.59	1.362	123.42	1.362	133.26	1.337
B	Hazardous Commodities	58.012	2.421	71.006	2.362	80.841	2.362	90.676	2.337
C	Typical Commodities	58.212	1.421	71.006	1.362	80.841	1.362	90.676	1.337
D	Fuel & Liquid	60.120	2.416	65.885	2.401	65.885	2.401	65.885	2.401
E	Light Mixed	49.785	1.442	49.817	1.442	49.814	1.442	49.814	1.442
F	Furniture	41.304	1.464	41.328	1.464	41.328	1.464	41.328	1.464
G	Light Commodities	37.113	1.475	37.114	1.475	37.114	1.475	37.114	1.475

Using the formula below, the cost for each county-to-county trip is calculated by each industry category for each weight limits.

$$\text{Cost} = \text{Travel Time} * \text{VOT} + \text{Travel Distance} * \text{Cost/Mile}$$

Then travel time with impedance in minutes is calculated. For more details about this calculation, refer Travel Time Calculation in Appendix B. These travel times will be the inputs to the HEAT model.

4.1.4 HEAT Model

There are 89 industries included in HEAT model based on three-digit NAICS Code. From the Truck Cost Model, the industries are categorized based on their similarity on VOT and Cost/Mile. The HEAT model will be implemented based on these seven industry categories. The NAICS code for each industry category is provided in Appendix B (Table 40).

This analysis only computes employment growth for producing industries only because ultra-heavy trucks implementation directly affecting these industries during shipment. The employment growths for other industries that are indirectly affected by ultra-heavy trucks are excluded in this analysis. The HEAT model is limited for accessibility impacts only, especially on highway, which generates the employment growth by industry category broken down by counties.

4.2 Findings

Implementing ultra-heavy truck does not generate significant numbers of employment growth, simply through accessibility considerations. Only four industries in the HEAT model experience employment growth, while other industries have zero growth (Table 18). The industries with employment growth are mostly industries that require heavier trucks due to the nature of the commodity in terms of weight and size, such as mining, beverage and tobacco product manufacturing, and waste management & remediation services, and wood product manufacturing. Besides wood product manufacturing, the three industries are part of typical commodity category. It shows how the industry categories are not perfect.

Table 16 Employment Growth for Different Truck Weight Limits by NAICS Code

Industry Category	NAICS Code	NAICS US Title	100,000-pound trucks	120,000-pound trucks	140,000-pound trucks
A	311	Food Manufacturing	0.0	0.0	0.0
B	324	Petroleum and Coal Products Manufacturing	0.0	0.0	0.0
	325	Chemical Manufacturing	0.0	0.0	0.0
	334	Computer and Electronic Product Manufacturing	0.0	0.0	0.0
	335	Electrical Equipment, Appliance, and Component Manufacturing	0.0	0.0	0.0
C	111	Crop Production	0.0	0.0	0.0
	112	Animal Production and Aquaculture	0.0	0.0	0.0
	113	Forestry and Logging	0.0	0.0	0.0
	114	Fishing, Hunting and Trapping	0.0	0.0	0.0
	212	Mining (except Oil and Gas)	42.4	264.4	271.9
	213	Support Activities for Mining	0.0	0.0	0.0
	312	Beverage and Tobacco Product Manufacturing	7.0	27.8	27.8
	327	Nonmetallic Mineral Product Manufacturing	0.0	0.0	0.0
	331	Primary Metal Manufacturing	0.0	0.0	0.0
	332	Fabricated Metal Product Manufacturing	0.0	0.0	0.0
	333	Machinery Manufacturing	0.0	0.0	0.0
	336	Transportation Equipment Manufacturing	0.0	0.0	0.0
	562	Waste Management and Remediation Services	56.0	257.4	298.2
D	211	Oil and Gas Extraction	0.0	0.0	0.0
E	316	Leather and Allied Product Manufacturing	0.0	0.0	0.0
	321	Wood Product Manufacturing	7.5	1.5	1.5
	323	Printing and Related Support Activities	0.0	0.0	0.0
	339	Miscellaneous Manufacturing	0.0	0.0	0.0
F	337	Furniture and Related Product Manufacturing	0.0	0.0	0.0
G	313	Textile Mills	0.0	0.0	0.0
	314	Textile Product Mills	0.0	0.0	0.0
	315	Apparel Manufacturing	0.0	0.0	0.0
	322	Paper Manufacturing	0.0	0.0	0.0
	326	Plastics and Rubber Products Manufacturing	0.0	0.0	0.0
	Total		113	551	599

Heavier trucks generate more jobs. The 140,000-pound trucks are estimated to create 599 jobs total, while the 100,000-pound trucks only create 113 jobs (Figure 10). Industries with the largest growth are mining and waste management and remediation services. The commodity typically shipped in mining industry is very dense and heavy, thus, they experience the greater advantages of ultra-heavy trucks. Similarly, more jobs are created in waste industry, since waste commodity is typically heavier than regular commodities.

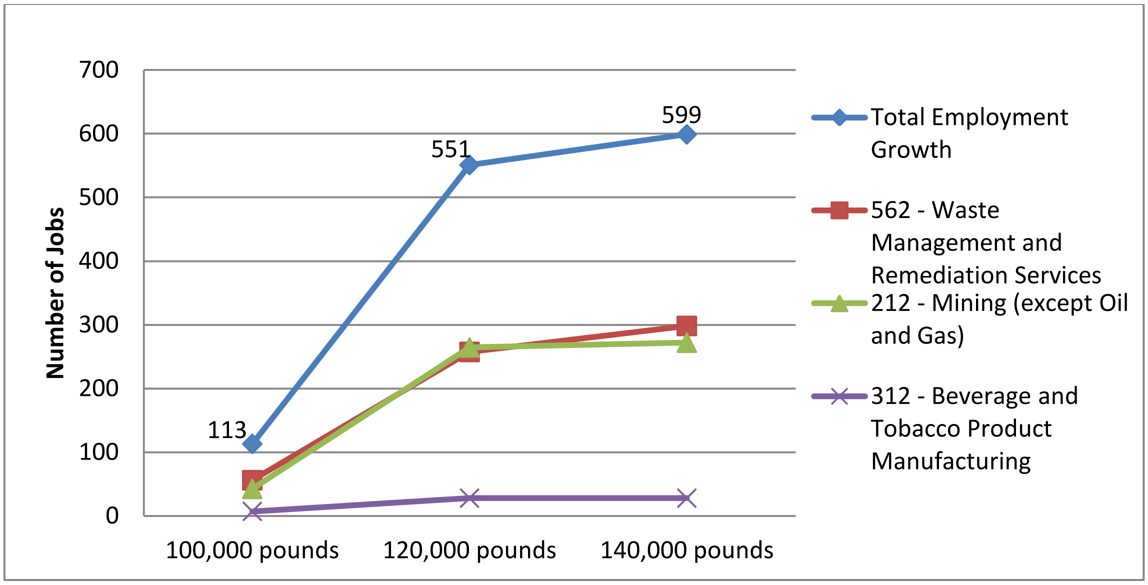


Figure 10 Top Three Industries with the Largest Employment Growth

5 Mode Shift

5.1 Methodology

The mode shift analysis is conducted by implementing the values of cross elasticity between rail and truck developed by the ICM. The changes in shipping costs for trucking have been calculated by truck cost model (Refer to the Cost Saving Methodology in chapter 3). The percentage change of truck cost between the ultra-heavy trucks and the baseline are calculated. Using the arc elasticity formula and the rail ton-miles information from Commodity Flow Survey (U.S. Census Bureau, 2007), the percentage change in rail ton-miles are calculated, which generates the ton-miles of rail being diverted from rail to truck. This number will be compared to the original truck ton-miles to see how significant it is in comparison to the whole picture. For details of this calculation, refer to Appendix C. Based on the ton-miles diverted from rail to truck, additional trucking jobs is estimated.

5.2 Findings

The ton-miles diverted from rail to truck increase as the trucks become heavier and the shipping cost become cheaper (see Figure 11). The largest diversion occurs when using the 140,000-pound trucks, which is 892 million ton-miles diverted from rail to truck. Although it is the largest diversion, the 892 million ton-miles only accounts for 5.81% of the entire existing truck ton-miles.

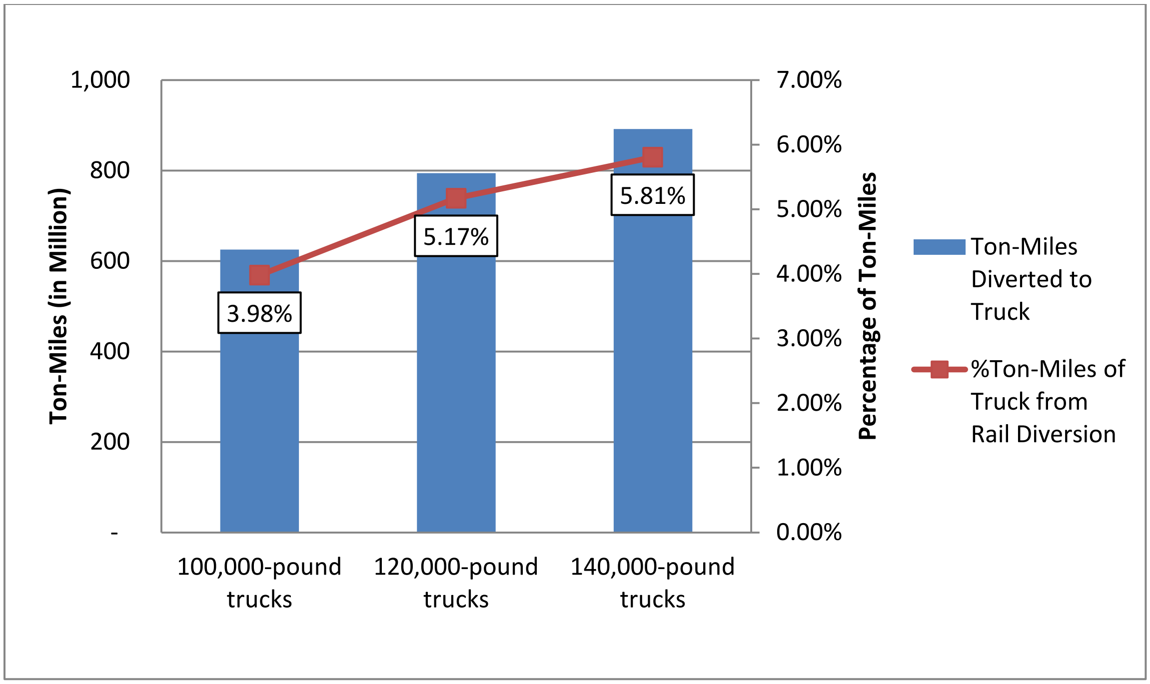


Figure 11 Diversion from Rail to Truck

In terms of commodities, the largest shift occurs for nonmetallic commodity. For nonmetallic commodity, the ton-miles diverted from rail to truck are the largest for all truck types (see Figure 12). The ton-miles increases are also significantly larger as the trucks become heavier. The second largest shift is for uncoated paper commodity. Compared to the ton-miles of nonmetallic commodity, the ton-miles of uncoated paper diverted to truck are much less. In addition, the increases of ton-miles for uncoated paper when trucks become heavier are slightly lower than the increase for nonmetallic commodity. For 100,000-pound trucks of uncoated paper, the ton-miles diverted are 161 million, while for 120,000-pound trucks, the ton-miles are 216 million.

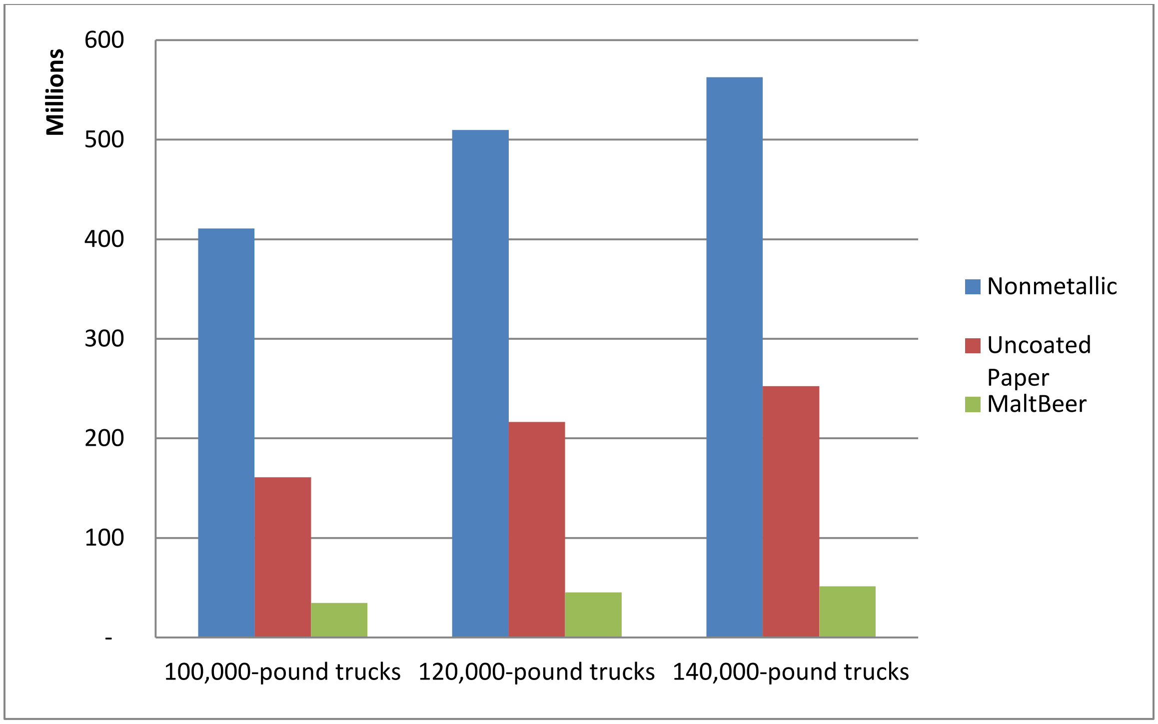


Figure 12 Top Three Commodities with the Largest Ton-Miles Diversion from Rail to Truck

The summary of rail-truck diversion by commodity and by truck type is shown in Table 5Table 17. Nonmetallic commodity experiences the largest percentage of change in truck ton-miles. For 140,000-pound trucks, there will be additional 51.02% truck ton-miles. This number is very significant, as the truck ton-miles will be increased by over half of what it currently has, due to the ultra-heavy trucks. It shows how the trucking industry becomes very competitive which encourages the industry to grow even more. It attracts more customers from other mode to shift to trucking. Other industries on the other hand, do not show significant diversion from rail to truck which might be because they are a small percentage of shipments by rail. The summary of ton-miles diversion for each truck type, broken down by industry, can be seen in Appendix C (Table 41 to Table 43).

Table 17 Ton-Miles of Commodities Diverted from Rail Mode to Truck Mode

Commodity	100,000-pound trucks		120,000-pound trucks		140,000-pound trucks	
	Ton-Miles Diverted from Rail To Truck	% of change in Truck Ton-Miles	Ton-Miles Diverted from Rail To Truck	% of change in Truck Ton-Miles	Ton-Miles Diverted from Rail To Truck	% of change in Truck Ton-Miles
CerealStraw	3,777	0.00%	3,777	0.00%	3,777	0.00%
AnimalFeed	881,824	0.05%	1,304,364	0.08%	1,604,772	0.10%
MaltBeer	34,723,810	8.29%	45,143,266	10.77%	51,269,999	12.24%
FuelOils	1,257,023	0.36%	1,257,023	0.36%	1,257,023	0.36%
Plastics	308,934	0.03%	308,934	0.03%	308,934	0.03%
Uncoated Paper	160,764,538	8.54%	216,428,097	11.49%	252,496,967	13.41%
Paper	252,316	0.02%	252,316	0.02%	252,316	0.02%
Nonmetallic	410,722,965	37.24%	509,889,265	46.23%	562,745,056	51.02%
MVParts	16,224,388	1.10%	19,865,421	1.35%	22,143,851	1.51%
Total Diversion	**625,139,575**	**3.98%**	**794,452,463**	**5.17%**	**892,082,694**	**5.81%**

5.3 Employment Calculation

Additional ton-mile in trucking will generate more jobs in trucking industry. The employment data for trucking industry in Wisconsin is used to estimate these additional jobs. Since ton-miles calculation uses 2007 as a base year, the 2007 employment data is used for this calculation to maintain consistency. According to County Business Patterns 2007, the number of employment for Trucking industry, NAICS 484, in Wisconsin is 54,423 (U.S. Census Bureau, 2007). Multiplying the percentage of change in truck ton-miles by the existing employment number generates additional jobs created. Detail calculation is shown in Appendix C.

The estimation shows that heavier trucks create more jobs in trucking industry (Figure 13). On the other hand, the rail industry will experience job loss since the ton-miles shipped by rail decreased. The job loss in rail industry is not included in this analysis. The 140,000-pound trucks generates the largest additional employment for trucking industry, 3160 jobs, since its ton-miles diverted from rail is the largest among

other scenarios. The 100,000-pound trucks generate 2167 jobs, while the 120,000-pound trucks generate 2815 jobs.

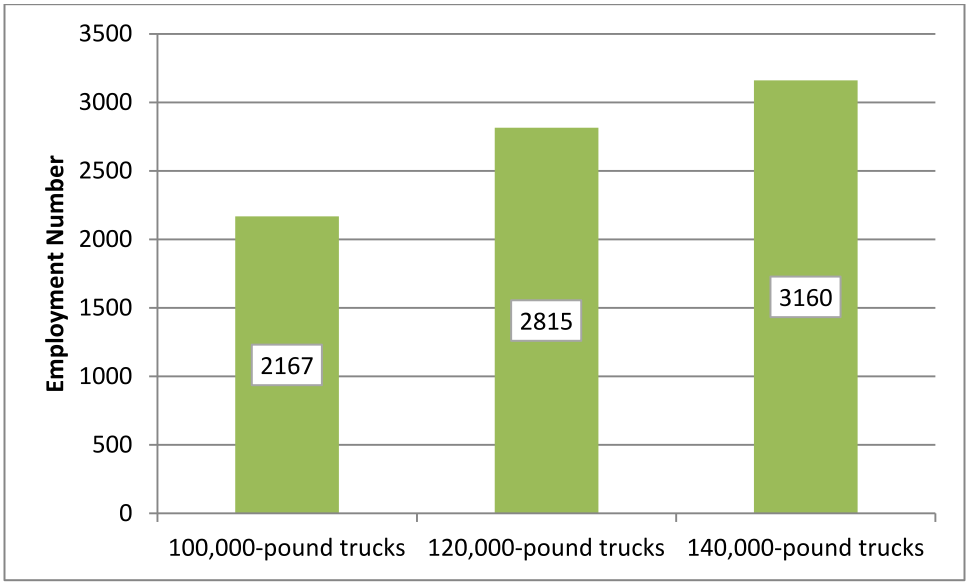


Figure 13 Additional Jobs in Trucking Industry

6 Industry Restructuring

For this study, IMPLAN and REMI model are used to understand the relationship between industries. WisDOT agreed to run both IMPLAN and REMI model. To simplify the process, $800 million cost savings is assumed as the input to both models.

IMPLAN model and REMI model have similar purpose, which is to forecast the regional economic impacts in terms of employment, labor income, value added, and output, classified by industry. IMPLAN and REMI are essentially duplicative and their results should not be double counted. Having both results, however, can provide insight of how industries interact with each other when applying different assumptions.

This chapter explains the result of IMPLAN model and REMI model individually. Then, a discussion of two models is presented. The last part of the chapter explains the process of scaling down the impacts of $800 million assumption to the cost savings of each scenario.

6.1 IMPLAN Model

The WisDOT agreed to run the IMPLAN model for the whole state of Wisconsin with these assumptions:

- The $800 million cost savings was added to the household income for the state of Wisconsin
- The model does not specify an industry in which employees are working
- 100% of earnings are spent in the state of Wisconsin only

The IMPLAN model evaluates the effect of injecting $800 million extra cash as household income. The model shows where the households are spending this essentially

tax-rebate-like. The result (see Table 18) shows that adding $800 million to the household income will not create additional jobs to trucking industry (direct effect). In addition, it will not create additional jobs to the supply chain industry related to trucking industry (indirect effect). However, as an induced effect, higher household income will create 7,321 jobs to other industries such as retailer establishments, restaurants, and other personal service provider. Besides employment, the model also estimated $295 million of labor income generated, which was mainly the induced effect. The model also estimated $560 million of value added and $901 million of output to the Wisconsin economy. The total output is slightly larger than the initial input, $800 million, which is logical as the model predicted it only had induced effects. The economic impacts for all 440-industry generated by IMPLAN model can be observed in Table 44 (Appendix D).

Table 18 IMPLAN Household Income Change Activity for 2014

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	$0	$0	$0
Indirect Effect	0	$0	$0	$0
Induced Effect	7,321.00	$295,603,685	$560,594,778	$901,860,112
Total Effect	**7,321.00**	**$295,603,685**	**$560,594,778**	**$901,860,112**

6.1.1 Employment

Higher employment for other industries not related to trucking industry is logical since higher household income will provide additional cash for them to spend on anything but the essential. This type of income is called discretionary income, which is disposable income (after-tax income) minus all payments that are necessary to meet current bills. The model predicted how households would spend their extra cash. The top ten industries with the highest new jobs (see Figure 14) include food service industry, real estate industry, medical related industries, retail stores, higher education, and family services, showing where the households are spending their extra cash. Food services and

drinking places have the highest number of new employment, 820 jobs, while real estate establishments have 580 jobs.

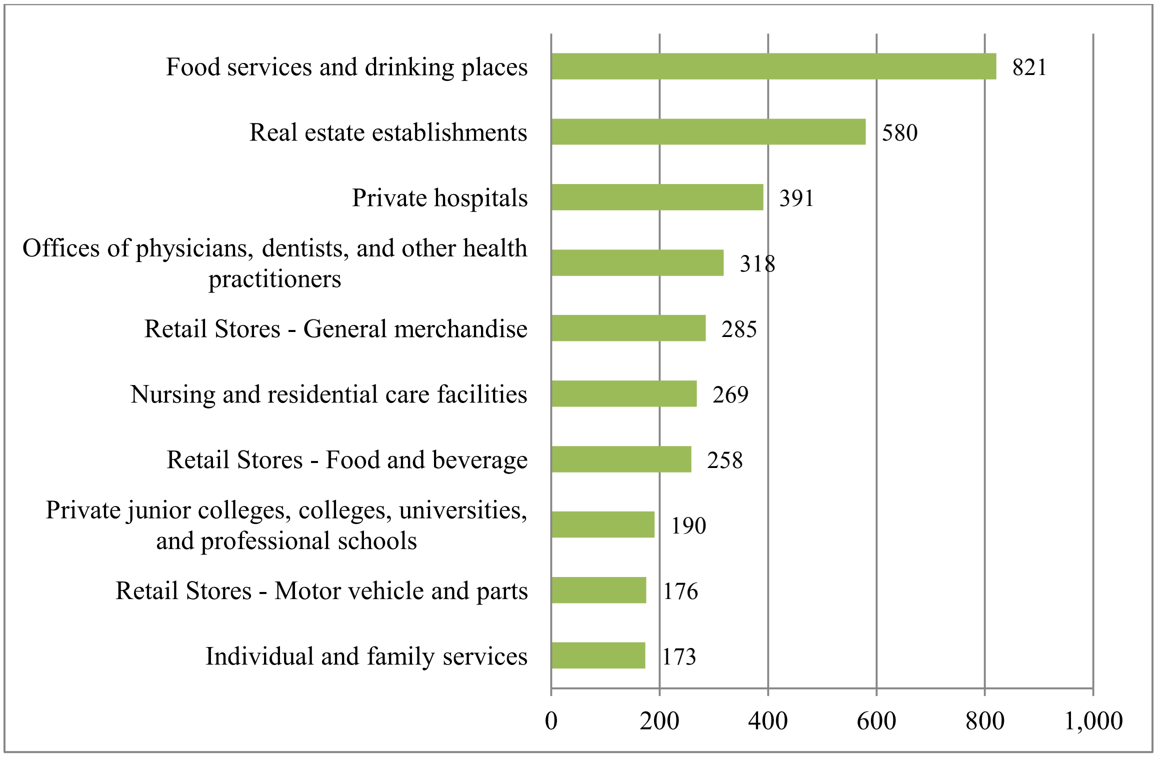


Figure 14 Top Ten Industries with the Largest New Employment

6.1.2 Labor Income

The medical services experience the largest labor income. From 440-industry, three of the medical services generate top ten industries with the largest labor income (see Figure 15). The offices of physicians, dentists, and other health practitioners experience the largest labor income from adding $800 million to the household income. These types of medical services are typically very expensive and unless it is not an immediate needs, the households will not expend their money on it. For these services, the labor income generated is over $30 million, showing that people have extra cash to pay for those services. In addition, the second largest labor income is private hospitals, $26 million. With the additional cash in their pockets, more households choose to go to private hospitals, which result in high labor income. Beside medical services, other industries

such as food services, wholesale trade and retail stores, monetary services and higher education also experience larger labor income.

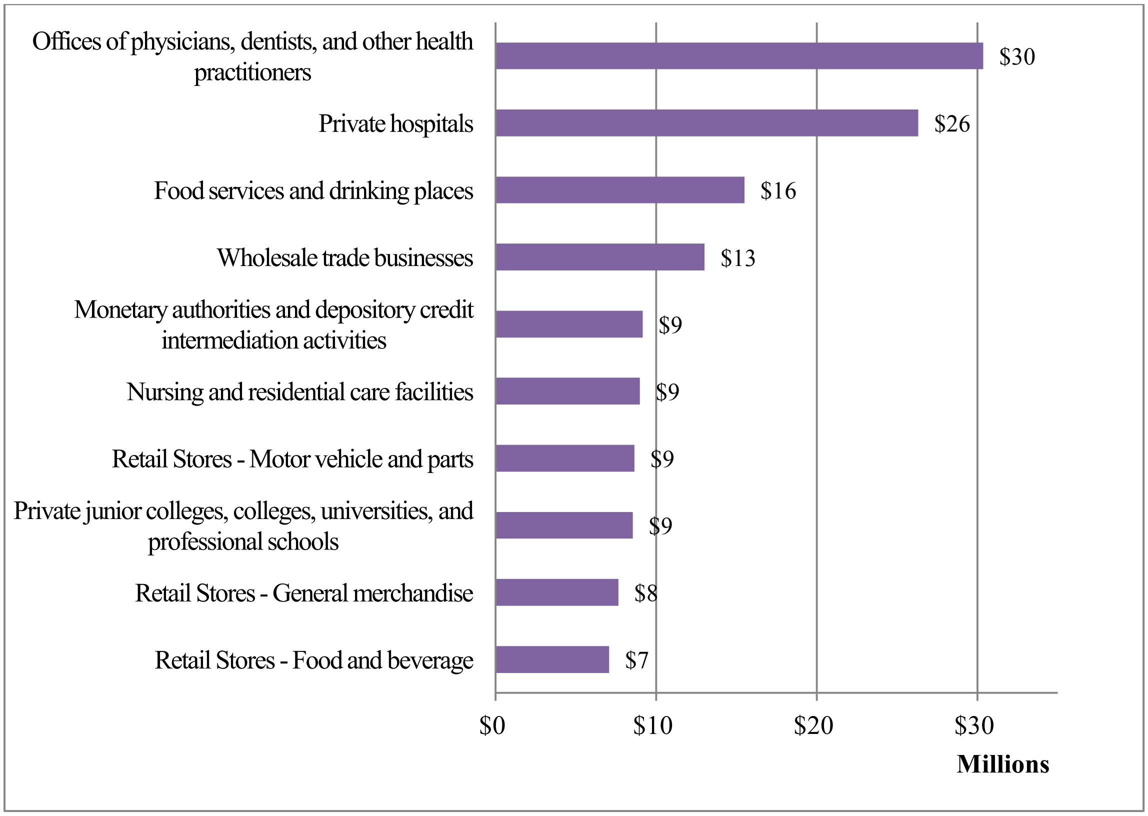


Figure 15 Top Ten Industries with the Largest Labor Income

Even though food services and drinking places experienced the largest new employment, they did not generate the largest labor income. In fact, the top two industries with the largest labor income are medical industry related. It shows that even though medical industries did not create more jobs than food industry, the skills required for medical jobs are at a higher-level, thus the wages for that industry are higher.

6.1.3 Value Added

The two top industries with the largest value added are the real estate establishments ($76 million) and the imputed rental activity for owner-occupied dwellings ($70 million), in which both industries are related to real estate (Figure 16).

The model shows how adding $800 million cash to the households would boost the property values. Having extra cash allowed households to invest in real estate by buying properties or do home improvements in their current properties, which essentially increased the property values.

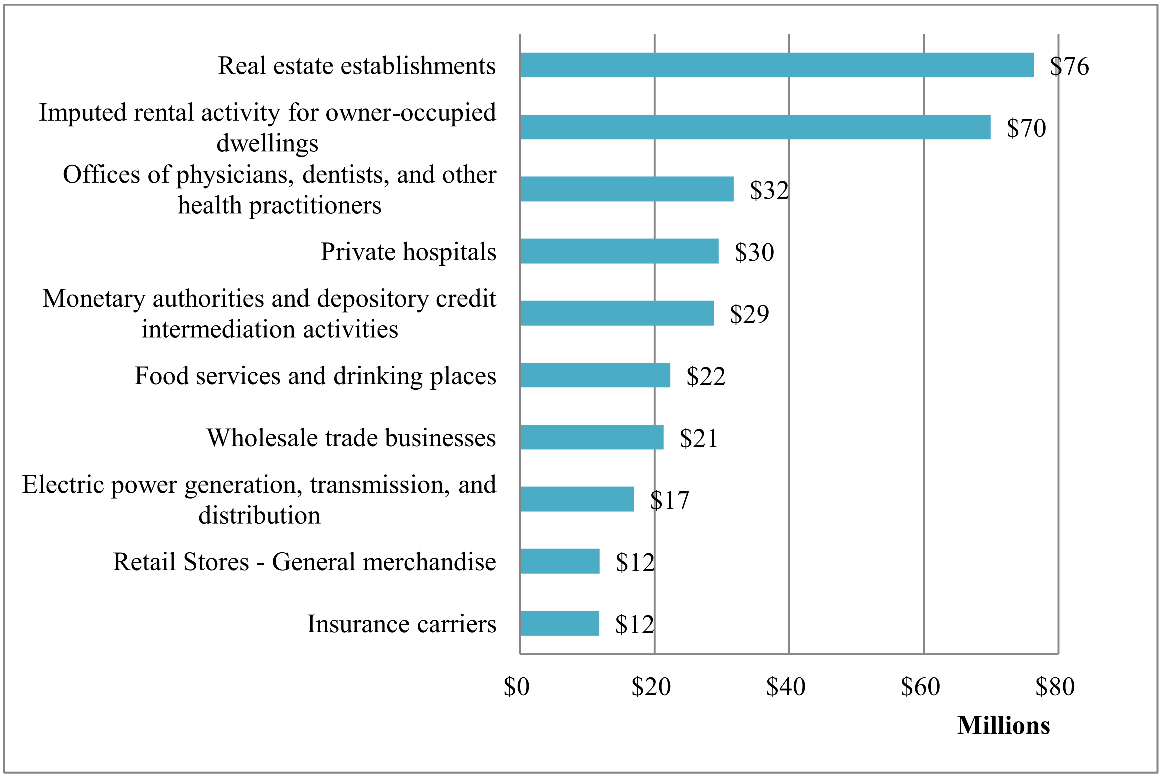


Figure 16 Top Ten Industries with the Largest Value Added

Besides real estate's industries, other top ten industries with the largest value added consist of medical industries, monetary services, food services, wholesale and retail stores. Even though this industry is neither part of the top ten industries with the largest employment nor with the largest labor income, the electric power generation, transmission and distribution has the eighth largest value added. Similarly, the insurance carriers industry is neither the top ten for largest employment nor largest labor income; it has the tenth largest value added.

6.1.4 Output

Top ten industries with the largest output are real estate industries, medical services, food services, monetary services, wholesale, securities, and commodity contracts related activities, and telecommunications (see Figure 17). The real estate industries have the first and second largest output: Imputed rental activity ($95 million) and real estate establishments ($94 million). Similar to medical expense, real estate costs high. Unless households have extra cash, they would not invest in real estate. Having additional $800million in the household income allowed them to work on house improvements projects, which explain why the output for these industries is significant.

These graphs shows where the households spend their additional income from the $800 million cost savings of ultra-heavy trucks. Most of the industries are secondary needs such as medical services, higher education, real estate services, wholesale trades, retail stores, and monetary services.

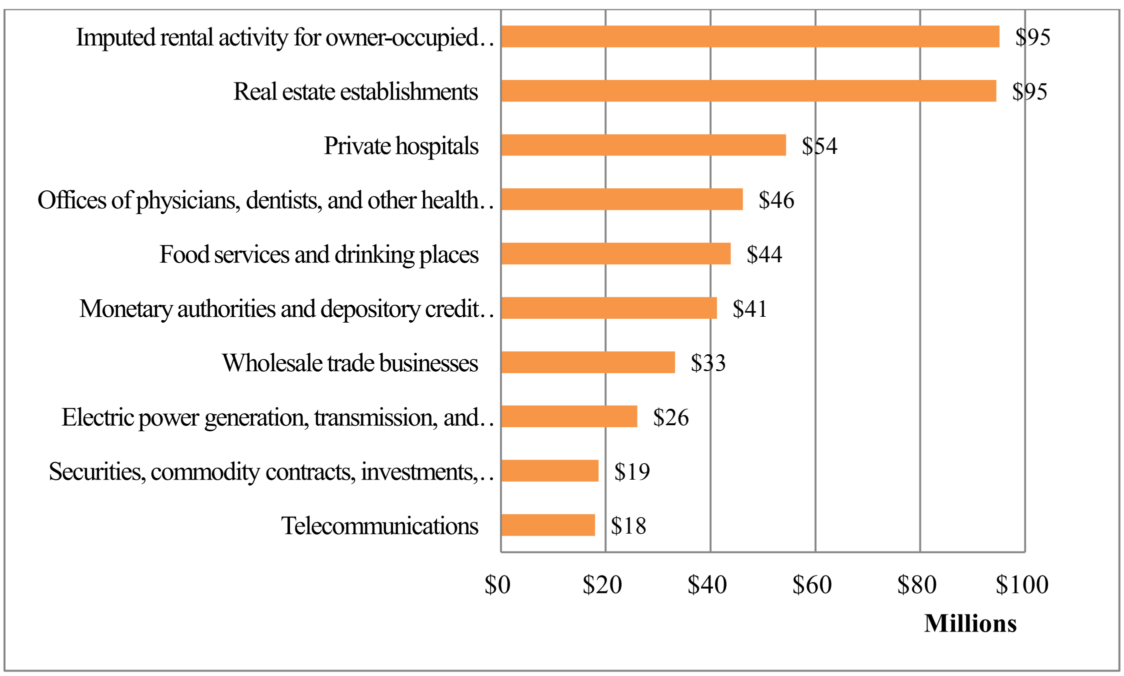


Figure 17 Top Ten Industries with the Largest Output

6.2 REMI model

As an alternative to IMPLAN, WisDOT agreed to run the REMI model for the whole state of Wisconsin with these assumptions:

- The $800 million cost savings was not redistributed to household spending.
- The $800 million was translated into less spending for the trucking industry (NAICS 48)
- The model projected the impact for 10-year period (2015-2025)

The economic impacts forecasted by REMI model comprise of personal income, value added, output, gross domestic products (GDP), and employment impacts. Since the assumption is taking $800 millions away from trucking industry, the model estimates significantly large negative impacts towards the economy of Wisconsin, which has to be analyzed carefully. The summary of economic impacts generated by REMI model can be observed in Table 45 (Appendix D).

6.2.1 Personal Income

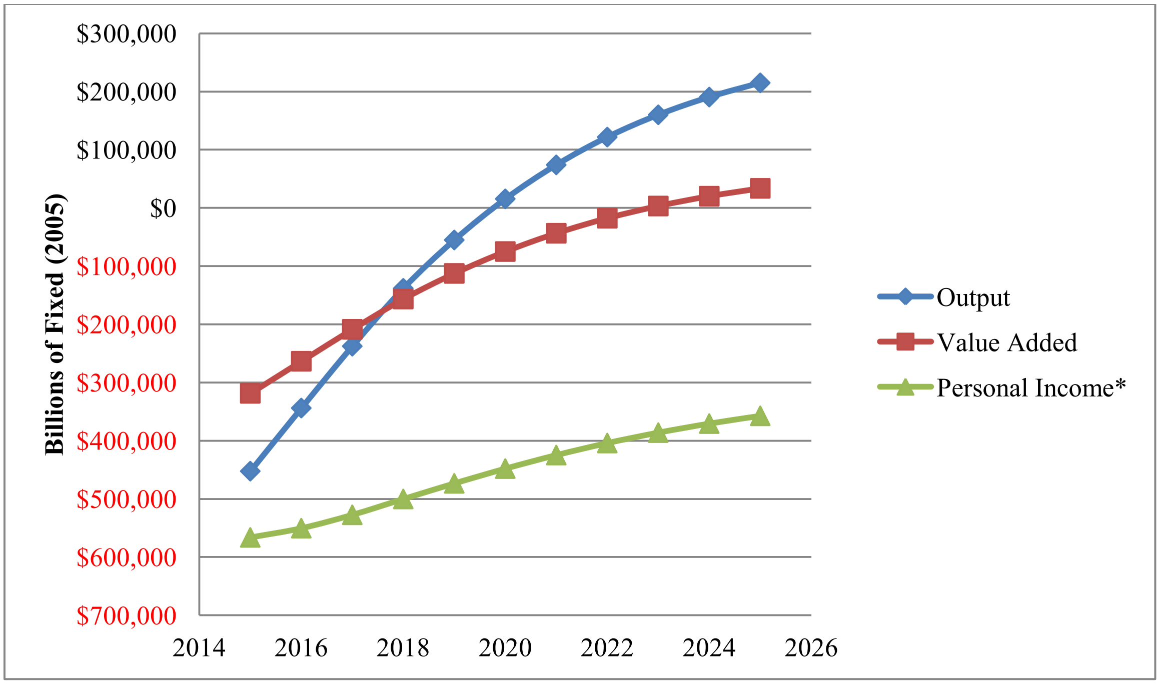
The REMI model estimated that $800 million less spending on trucking industry would reduce the personal income by 566,176 billion of 2014 dollars in the first year of implementation in year 2015 (see Figure 18). After 10 year, the personal income is still negative; 357,248 billions lower than the current personal income in year 201. The change is very slow, about 37%; change over 10-year period.

6.2.2 Value Added

The REMI model estimated that $800 million less spending on trucking industry would reduce the value added to the economy by 318,656 billion of Fixed (2005) dollar in the first year of implementation in year 2015 (see Figure 18). After 10 year, the value added is projected to be 33,600 billion of fixed (2005) dollars, which is about 111%, change over the period. The model shows that it will recover in year 2023 (8 years). The growth is very modest and slow, especially compared to output recovery.

6.2.3 Output

The REMI model estimated that $800 million less spending on trucking industry would reduce the economy output by 452,352 billion of fixed (2005) dollars in the first year of implementation in year 2015 (see Figure 18). After 10 year, the output is projected to be 214,912 billion of fixed (2005) dollars, which is about 148% change over the period. It takes 5 year to recover or when the output is positive, which is in year 2020. The trend shows if it is projected longer, it the output will be stable (and positive). Even though the output is negative, the slope is positive and steep, meaning that it is growing at quicker rate compared to value added. The output experience larger loss than value added, but not as much as personal income loss.



**Personal Income is in Billions of 2014 Dollars*

Figure 18 The Output, Value Added, and Personal Income Resulted from REMI Model

6.2.4 Gross Domestic Product

The REMI model estimated that $800 million less spending on trucking industry would reduce the Gross Domestic Products (GDP) of Wisconsin by 321,856 billion of fixed (2005) dollars in the first year of implementation in year 2015 (see Figure 19). After 10 year, the GDP is projected to be 21,472 billion of fixed (2005) dollars, which is about 107% change over the period. The model projects that the recovery will take 9 years until the GDP is positive, which is in year 2024. The change is modest.

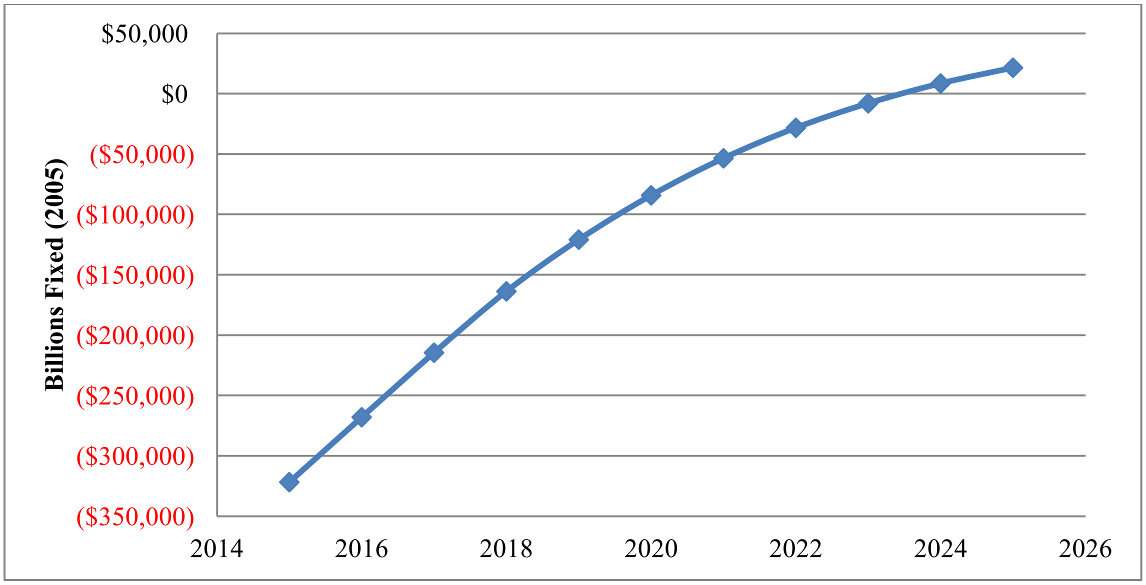


Figure 19 Projected Gross Domestic Products (GDP) for State of Wisconsin

6.2.5 Employment

The REMI model estimated that $800 million less spending on trucking industry would cause employment loss even after 10-year period. The private non-farm sector especially experienced the largest employment loss, while the government sector experienced much lower employment-loss (see Figure 20). The summary of employment impacts generated by REMI model can be observed in Table 46 (Appendix D). When first implementing the ultra-heavy truck policy that generates $800 million cost savings in 2015, the total employment loss was over 4.5 millions of jobs in the whole state. This number is quite large. The assumption of reducing $800 million from trucking industry significantly causes job loss. Over 10-year period, the employment loss was only 44,000. The economic condition is improved; however, the state is still experiencing employment loss. Even though private non-farm sector experienced larger employment loss, it is also experiencing faster recovery in comparison to government sector.

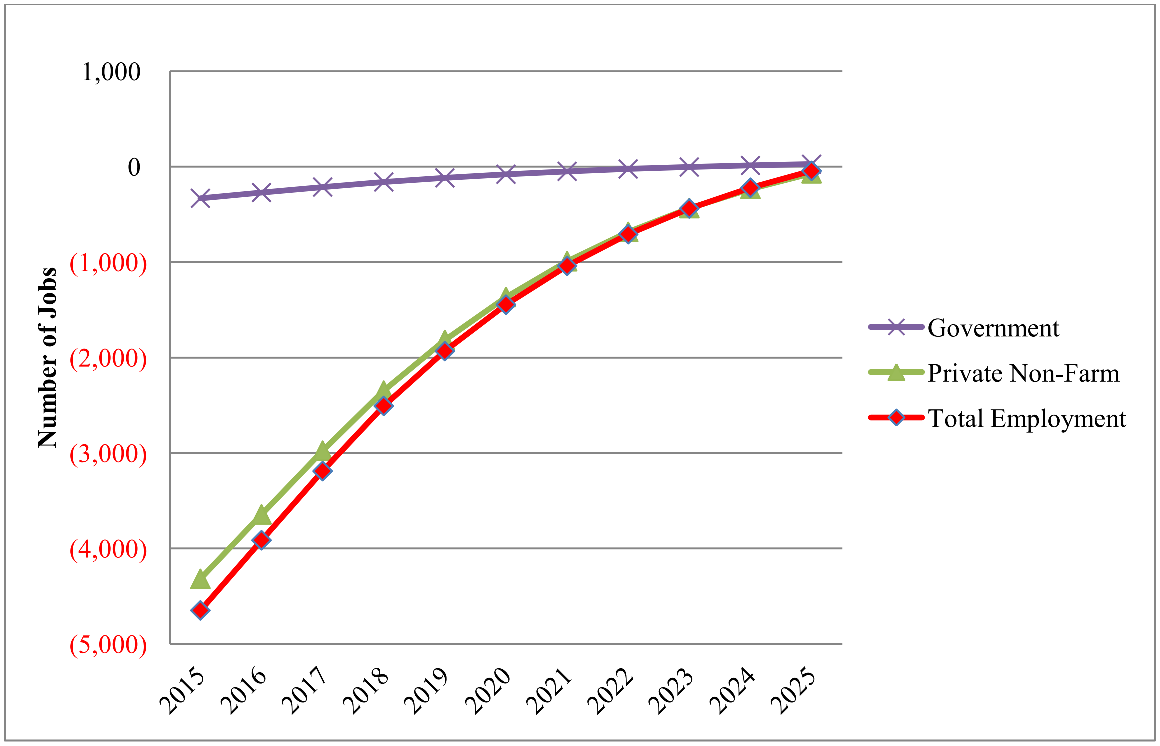


Figure 20 Employment Losses in the State of Wisconsin (in Thousands)

6.2.5.1 Private Non Farm Sector

Even though as a whole, Wisconsin experiencing job loss due to $800 million less spending on trucking industry, there are three industries that experienced employment gain. Those industries are transportation and warehousing, administrative and waste management services, and manufacturing (see Figure 21). The ultra-heavy truck will allow trucking industry to be more efficient by reducing the number of trips made to ship the same amount of tonnage. Fewer trips will reduce spending on maintenance, fuel, and wages, as fewer drivers are needed. This will essentially makes the industry more competitive as the shipping cost becomes cheaper. Because the trucking industry is very competitive with each other, the industry itself grows and requires more labor to support the growth. Similar to the trucking industry, ultra-heavy trucks will allow waste industry to pick up more waste with the same cost, which will make the industry more

competitive. The competitive waste industries will require more labor to support its growth. The employment growth for waste is more modest than for the trucking industry. The trucking industry that is more competitive will affect other industries like manufacturing. The low shipping cost will allow manufacturers to ship more products, which required them to produce more products to take advantage of the additional weight on trucks. As the manufacturers produce more products, more labor is needed to support the activity.

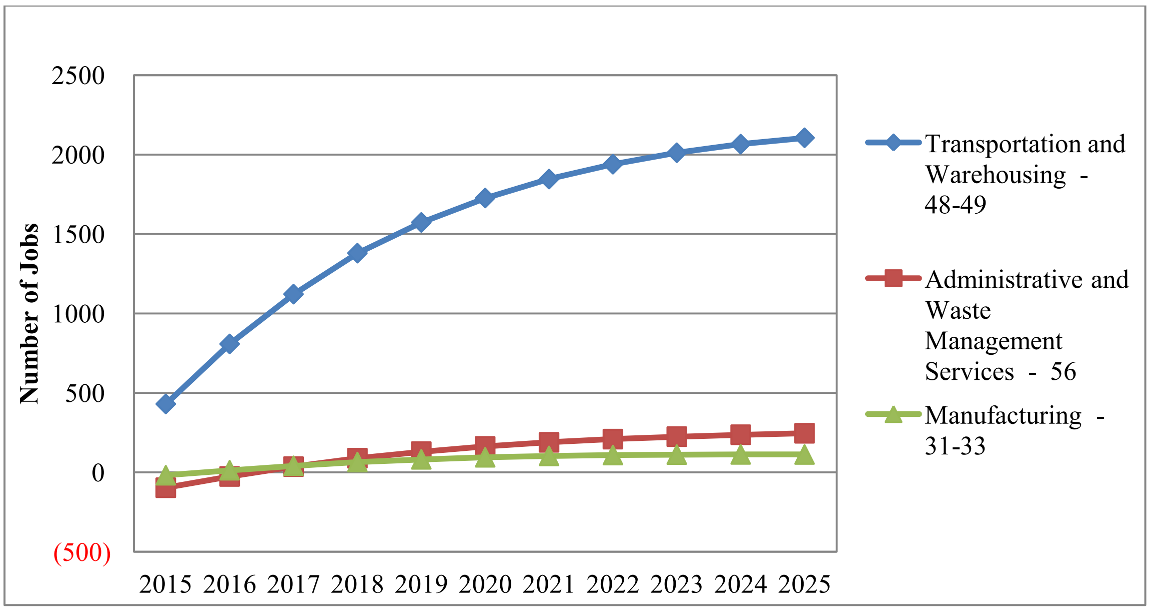


Figure 21 Top Three Industries with the Largest Employment Gain (in Thousands)

The REMI model shows three industries with the largest employment loss, which are retail trade, other services except public administration, and health care association (see Figure 22). Since the implementation of ultra-heavy truck causes a significant number of employment losses across industry, many people do not have income anymore. As people do not have income anymore, they barely make it to fulfill their basic need such as housing, food, and transportation. The households will not have extra cash to spend it on shopping, other services, or even health services. The retail trade,

which heavily depends on the shopping habits of consumers, will experience large losses, as their consumers do not buy anything. As for healthcare, many households will wait to get healthcare services until they have enough savings or if it is an emergency.

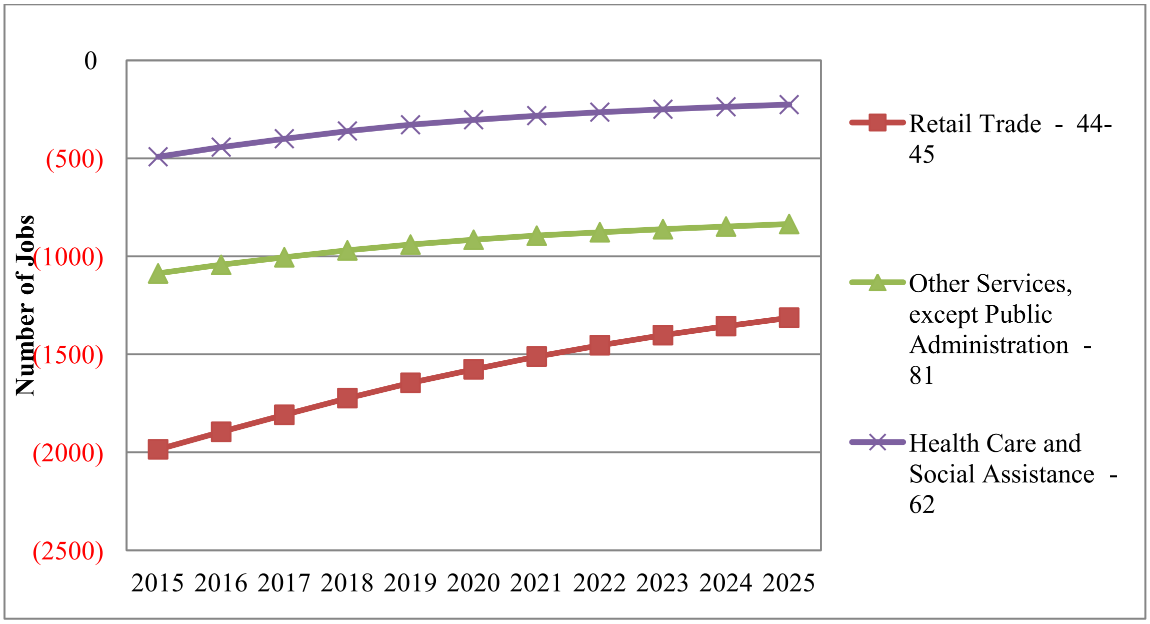


Figure 22 Top Three Industries with the Largest Employment Loss (in Thousands)

6.3 Comparison of IMPLAN and REMI model

The results IMPLAN model and REMI model are compared (see Table 19). IMPLAN model estimates growth for induced effects since the assumption is to add more income to household. On the other hand, REMI estimates extreme decline for most industries except trucking industry and few others since the assumption is reducing spending on trucking industry without redistribution to other industry. The actual impact is probably within these ranges. The models are only for prediction purposes only.

Table 19 IMPLAN and REMI Comparison

	IMPLAN (2014)	REMI (2015)	REMI (2025)
Employment	7,321	(4,648,750)	(44,000)
Labor Income	$295,603,685	($566,176)*	($357,248)*
Value Added	$560,594,778	($318,656)**	$33,600**
Output	$901,860,112	($452,352)**	$214,912**

**in Billions of 2014 Dollars*
***in Billions of Fixed (2005) Dollars*

It is interesting to see how IMPLAN and REMI estimated the impacts of ultra-heavy trucks on different industry. IMPLAN model predicted that the largest new employments would occur on other industry that are not directly related to trucking industry, such as food services, real estates, and private hospitals (Table 20). These industries experience growth as households have additional income to spend.

Table 20 Top Industries with the Largest New Employment Generated by IMPLAN

Industry	Year 2014
Food services and drinking places	820.8
Real estate establishments	580.3
Private hospitals	391.2

REMI model predicts that the largest new employments would occur on the trucking industry itself and other industry that are directly related to trucking industry, like manufacturing, and waste industry (Table 21). These industries experience growth as they become more efficient after using ultra-heavy trucks.

Table 21 Top Industries with the Largest Employment Gain Generated by REMI

Industry	Number of Employments (in thousands) Year 2015	Number of Employments (in thousands) Year 2025
Transportation and Warehousing - 48-49	430	2105
Administrative and Waste Management Services - 56	(97)	245
Manufacturing - 31-33	(19)	112

The drawback of IMPLAN model is it is static and only can be used to forecast one time only. The REMI model, on the other hand, can be used to forecast over a long period. In addition, the REMI model is more comprehensive as it uses many sources and has dynamic interaction between the data.

6.4 Assumptions Caveat

The quality of any models is mainly dictated by data and assumptions used in it. Both IMPLAN and REMI models have high quality data from reputable sources. The key to develop a high quality model is to have logical assumptions. For this study, IMPLAN model is assumed to have an additional $800 million to the household income. This assumption would generate positive output as adding more money to the flow will encourage economic growth. However, there is no guarantee that the cost savings of ultra-heavy trucks are redistributed directly to households in proportion to other income sources. A better approach may have been to distribute cost savings of ultra-heavy trucks to each industry in which the cost savings occur. In cost savings analysis (Chapter 3), the cost saving of 27-commodities are calculated. Distributing cost savings to each industry is more plausible than distributing cost savings directly to households.

REMI model is assumed to have $800 million less spending on Trucking and Warehouse Industry (NAICS 48) and no transfers of money elsewhere in the economy. The REMI model output would be negative as it reduced money flowing in the economics. A more efficient trucking industry should foster more growth in trucking industry, so reducing spending on trucking industry is not a reasonable assumption, by itself.

6.5 Scaling the Employment Impact

The result of $800 million cost savings in IMPLAN and REMI model will be adjusted to determine the economic impacts of three weight limitations. Both IMPLAN and REMI model are scalable. When the cost savings changes, the economic impacts in

employment, labor income, value added, and output, change based on the cost savings changes. IMPLAN model is linear, so the changes can be calculated by multiplying the ratio of changes. On the other hand, REMI model is more like black box, so changing the cost savings are not easily calculated.

Based on the previous analysis, the REMI model generates such large negative impacts towards the economy. This large negative impact is the results of the assumptions of reducing the spending on trucking industry by $800 million, without any money flows elsewhere in the economy. On the other hand, implementing ultra-heavy trucks not only generate cost savings for trucking industry, it could potentially add more money towards other industry. The assumption of using cost savings from trucking industry for other things is not included in the REMI model. REMI model also potentially predicts effects of accessibility improvements, which explains why the impacts are very large. However, the accessibility analysis is better handled by HEAT because HEAT accounts for the travel time with impedance based on VOT and cost/mile.

Since the result of REMI model is tremendously large and not comparable to other economic analyses performed in this paper, it is not used to calculate the employment gain through industry restructuring. In addition, to prevent double counting from similar analysis in REMI and IMPLAN, solely IMPLAN result is adequate to calculate the employment gain from industry restructuring.

6.5.1 Industry Restructuring from IMPLAN

The employment gain from industry restructuring is calculated by scaling down the $800 million to the ultra-heavy trucks cost savings for each scenario, previously calculated in Cost Saving analysis. The IMPLAN model treats the cost savings as

additional household income, which generates 7321 induced jobs in various industries. A sample calculation is shown below, for 140,000-pound trucks.

$$\frac{\$762{,}143{,}964}{\$800{,}000{,}000} \times 7321 jobs = 6975\ jobs$$

The job gain for different truck weight limits is shown in Table 22. A heavier truck generates more jobs, which correspond to larger cost savings. The job created here is induced jobs in industry that are not trucking industries, such as food and beverages services, real estate services, and medical services.

Table 22 Job Gain from Industry Restructuring

Truck Weight Limit	Cost Savings	Job Gain
100,000 Pounds	$498,699,494	4564
120,000 Pounds	$659,565,414	6036
140,000 Pounds	$762,143,964	6975

7 Total Employment Growth

The economic impacts of ultra-heavy trucks are evaluated based on the employment growth for the whole state of Wisconsin. The employment growth is influenced by trucking industry efficiency, improved accessibility, mode shift from rail to truck, and industry restructuring. The total job gain due to ultra-heavy trucks is the sum of all components as followed.

Total Job Gain = - (Jobs lost to trucking industry efficiency) + (Jobs gained by improvements in accessibility) + (Jobs gained by modal shifts from rail) + (Jobs gained by industry restructuring)

The degree of impacts of ultra-heavy trucks is explained. The jobs lost to trucking industry efficiency are direct impacts to trucking industry. The jobs gained by improvements in accessibility are indirect impacts towards other industries related to trucking industry, such as supply chain and users of trucking industry. The jobs gained by modal shifts from rail are direct impacts to trucking industry. The jobs gained by industry restructuring are induced impacts, which where the employees of trucking industry and related industries are spending their incomes.

The total job gain for each scenario of ultra-heavy trucks will be compared to the Wisconsin's employment number for trucking industry (NAICS 484) in 2007, which is 54,423 (U.S. Census Bureau, 2007). In addition, they will be compared to the total employment for all industry in Wisconsin, which is 2,484,051 jobs in 2007 (U.S. Census Bureau, 2007).

7.1 Total Job Gain Calculation

Using the formula explained earlier, the total job gain can be calculated. For employment growth from industry restructuring, only IMPLAN results is included in this analysis. The REMI model, even though is scalable, forecasts tremendously large employment loss, which is not reasonable. In addition, some analysis in REMI model also includes accessibility analysis, which already considered in the HEAT model. To prevent double counting, REMI model is excluded.

Even though the 140,000-pound trucks cause the largest job loss, 2632, they generate the largest job gain, 8102 (Table 23). The 120,000-pound trucks are estimated to generate 7123 jobs, which is not too different in comparison to 140,000-pound trucks.

Table 23 Total Job Gain

Truck Weight Limit	Job Loss (efficiency)	Job Gain (Accessibility)	Job Gain (Mode Shift)	Job Gain (Industry Restructuring)	Total Job Gain
100,000 Pounds	-1722	113	2167	4564	**5121**
120,000 Pounds	-2278	551	2815	6036	**7123**
140,000 Pounds	-2632	599	3160	6975	**8102**

Ultra heavy trucks generate additional jobs in the trucking industry. Even though the percentage of employment growth of all industry is relatively small, the employment growth in trucking industry is significant. The 140,000-pound trucks generate 0.33% employment growth for all industry, which signify to 15% additional jobs to the trucking industry in Wisconsin (Table 24). This is logical, as ultra-heavy trucks affects trucking industry the most. Ultra-heavy trucks allow trucking industry to be more efficient and to grow even more. The 140,000-pound trucks also create the most jobs in trucking industry.

Table 24 Employment Growth Percentage

Truck Weight Limit	%Trucking Job increase	%Employment Growth
100,000 Pounds	9%	0.21%
120,000 Pounds	13%	0.29%
140,000 Pounds	15%	0.33%

8 Conclusions

8.1 Result Summary

This study implements CFIRE Truck Cost Model, Cross elasticities, HEAT model, IMPLAN model, and REMI model to evaluate employment benefits of ultra-heavy trucks. Three scenarios of ultra-heavy trucks are examined, 100,000-pound trucks, 120,000-pound trucks, and 140,000-pound trucks. The 140,000-pound trucks generate the largest economic benefits in terms of cost savings and employment growth.

8.1.1 100,000-pound trucks

The total cost saving when implementing 100,000 pounds weight limits is $499 million. Total job created from implementing this type of truck is 5121 jobs which accounts for job loss and job gain from accessibility, mode shift, and industry restructuring. The more efficient trucking industry is estimated to cause 1722 job loss within trucking industry. This job loss is offset by the additional 2167 jobs created from mode diversion from rail to truck, from 113 jobs created from accessibility improvement, and from 4564 jobs created in other industry.

8.1.2 120,000-pound trucks

The total cost saving when implementing 120,000 pounds weight limits is $660 million. Total job created from implementing this type of truck is 7123 jobs trucking industry and other industries. The more efficient trucking industry is estimated to cause 2278 job loss within trucking industry. This job loss is offset by the additional 2815 jobs created from mode diversion from rail to truck, from 551 jobs created from accessibility improvement, and from 6036 jobs created in other industry.

8.1.3 140,000-pound trucks

The total cost saving when implementing 140,000 pounds weight limits is $762 million. Total job created from implementing this type of truck is 8102 jobs, which accounts for job loss (2632) and job gain from accessibility (599), mode shift (3160), and industry restructuring (6975). The more efficient trucking industry is estimated to cause 2632 job loss within trucking industry. This job loss is offset by the additional 2167 jobs created from mode diversion from rail to truck, from 113 jobs created from accessibility improvement, and from 4564 jobs created in other industry.

8.1.4 Ultra-heavy trucks

Across all three scenarios, the cost savings are larger when traveling longer distance. Commodities benefiting the most from heavier trucks typically are very heavy and have larger density. These commodities also experience the largest employment net growth from accessibility improvements and mode diversion from rail. Lighter commodities, on the other hand, are constrained by volume, so allowing heavier trucks will not have much impact on these types of commodities.

From all three scenarios, 140,000-pound trucks experience the largest cost savings and the largest employment net growth. As the trucks get heavier, the larger the benefits are from economy standpoints. However, this analysis only shows employment impacts of ultra-heavy trucks. Other consideration must be made before determining the critical weight.

8.2 Conclusion

Although many studies have been conducted to evaluate the impacts of truck weight changes, the truck weight regulations have not been changed since 1982.

Currently, under MAP-21 authorization bill, the USDOT is conducting a study to address issues of enforcement program, infrastructure impacts, highway safety and truck crash, and modal shift as impacts of truck size and weight limits. The common topics covered in the previous truck size and weight limits are infrastructure cost (pavement, bridge, geometric), safety (crash, perception), traffic operation and traffic flow (congestion, capacity), transportation cost, mode shift, and energy and environment (emission, fuel consumptions, noise). The only economic topic covered in the previous study is transportation cost. As a contract, this thesis is evaluating other economic impacts by measuring employment growth due to cost savings, improved accessibility, mode shift, and industry restructuring.

Overall, implementing ultra-heavy trucks will not cause job losses for two reasons. First, it will make the trucking industry more efficient, which further enhances its growth. As shown in the previous analysis, ultra-heavy trucks generate positive net job gain. As the trucking industry become more efficient, fewer workers are needed to support the industry. Trucking industry will become more competitive in the long run, which will potentially cause mode-shift from other modes. The 140,000-pound trucks will divert almost 6% of additional ton-mile to trucking industry.

Second, it will expand growth of the whole economy through exports and more economic activities. The cheaper transportation costs for commodities will affect not only the shipper, carrier and producer; it will affect the consumers and public. When the shipper and producer spend less on transportation costs, it will reduce the cost of the products for consumers, given the highly competitive nature of the freight industry.

Possibly, shippers can offer more commodities within the same total cost. Cost savings will have a variety of impacts within the economy.

Heavier trucks are associated with more cost savings, but it is not possible to find the optimal weight limit for ultra-heavy trucks without a cost analysis their impact on road construction and road maintenance budgets. Heavier trucks are also associated with lower air pollutant emissions, lower greenhouse gas emissions, and a reduced need for imported petroleum.

8.3 Future Studies

The following items are required for a full evaluation of the impact of ultra-heavy trucks:

- Cost estimation for infrastructure improvements (for pavements, bridges, and geometric);
- Safety analysis (crash rate estimation, vehicle design and technology);
- Public Opinion about ultra-heavy trucks (perception, comfort level, standpoint);
- Estimation of the traffic flow impacts and travel time impacts;
- Measurement of petroleum consumption reduction; and
- Measurement of the GHG emission reduction by implementing MOVES model (from US Environmental Protection Agency).

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Appendix A: Cost Saving

Table 25 Cost/Trip for 80,000-Pound Trucks (Baseline)

Commodity	Cost/Trip				
	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles
Corn	$104.78	$212.72	$454.25	$781.78	$1,300.44
Soybeans	$100.11	$204.03	$437.42	$755.53	$1,260.70
CerealStraw	$93.92	$192.49	$415.08	$720.68	$1,207.92
AnimalFeed	$101.78	$207.13	$443.43	$764.90	$1,274.89
Meat	$136.73	$272.89	$578.68	$992.01	$1,645.05
NonalcBev	$101.09	$205.85	$440.95	$761.04	$1,269.05
MaltBeer	$101.28	$206.21	$441.64	$762.12	$1,270.68
NatSand	$103.33	$210.02	$449.03	$773.63	$1,288.11
Gravel	$102.36	$208.21	$445.52	$768.17	$1,279.83
Dolomite	$103.60	$210.52	$449.99	$775.14	$1,290.39
NonaggCoal	$104.19	$211.63	$452.13	$778.48	$1,295.44
Gasoline	$138.96	$289.88	$628.79	$1,093.72	$1,833.21
FuelOils	$138.96	$289.88	$628.79	$1,093.72	$1,833.21
OthPetCoal	$136.84	$285.94	$621.15	$1,081.80	$1,815.17
InorgChem	$135.12	$282.72	$614.93	$1,072.11	$1,800.49
Fertilizer	$135.96	$284.30	$617.97	$1,076.86	$1,807.68
Plastics	$75.18	$157.60	$347.51	$615.24	$1,048.21
UncoatedPaper	$100.31	$204.40	$438.14	$756.66	$1,262.41
Paper	$76.63	$160.31	$352.74	$623.40	$1,060.57
Nonmetallic	$101.88	$207.33	$443.81	$765.50	$1,275.80
IronSteel	$99.39	$202.69	$434.84	$751.50	$1,254.60
Electronic	$132.53	$277.91	$605.60	$1,057.56	$1,778.47
MVParts	$96.85	$197.96	$425.67	$737.20	$1,232.96
Furniture	$81.00	$168.44	$368.50	$647.99	$1,097.82
MiscPro	$89.51	$184.28	$399.18	$695.86	$1,170.32
MixedFreight	$90.49	$186.11	$402.72	$701.39	$1,178.71
MetalWaste	$100.80	$205.31	$439.89	$759.39	$1,266.55

Table 26 Cost/Ton for 80,000-Pound Trucks (Baseline)

Commodity	Cost/ton				
	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles
Corn	$4.22	$8.56	$18.29	$31.47	$52.35
Soybeans	$4.78	$9.74	$20.88	$36.07	$60.19
CerealStraw	$5.94	$12.18	$26.27	$45.61	$76.45
AnimalFeed	$4.56	$9.27	$19.85	$34.24	$57.08
Meat	$6.28	$12.53	$26.57	$45.55	$75.54
NonalcBev	$4.64	$9.46	$20.26	$34.97	$58.31
MaltBeer	$4.62	$9.41	$20.14	$34.76	$57.96
NatSand	$4.37	$8.89	$19.00	$32.74	$54.51
Gravel	$4.49	$9.12	$19.52	$33.66	$56.08
Dolomite	$4.34	$8.82	$18.86	$32.49	$54.09
NonaggCoal	$4.28	$8.69	$18.57	$31.97	$53.20
Gasoline	$5.52	$11.52	$24.99	$43.47	$72.86
FuelOils	$5.52	$11.52	$24.99	$43.47	$72.86
OthPetCoal	$5.85	$12.22	$26.55	$46.25	$77.60
InorgChem	$6.15	$12.88	$28.01	$48.84	$82.02
Fertilizer	$6.00	$12.55	$27.27	$47.53	$79.78
Plastics	$280.00	$586.97	$1,294.25	$2,291.39	$3,903.96
UncoatedPaper	$4.75	$9.68	$20.75	$35.84	$59.79
Paper	$51.78	$108.31	$238.34	$421.22	$716.60
Nonmetallic	$4.54	$9.25	$19.79	$34.13	$56.89
IronSteel	$4.88	$9.96	$21.37	$36.93	$61.66
Electronic	$6.70	$14.04	$30.60	$53.43	$89.85
MVParts	$5.31	$10.86	$23.35	$40.45	$67.65
Furniture	$15.87	$33.00	$72.18	$126.93	$215.05
MiscPro	$7.37	$15.17	$32.85	$57.27	$96.32
MixedFreight	$6.99	$14.37	$31.10	$54.16	$91.02
MetalWaste	$4.68	$9.54	$20.44	$35.29	$58.86

Table 27 Cost/Trip for 100,000-Pound Trucks

Commodity	Cost/Trip				
	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles
Corn	$117.15	$235.75	$498.84	$851.32	$1,405.71
Soybeans	$117.15	$235.75	$498.84	$851.32	$1,405.71
CerealStraw	$93.95	$192.55	$415.20	$720.86	$1,208.20
AnimalFeed	$117.15	$235.75	$498.84	$851.32	$1,405.71
Meat	$152.77	$302.76	$636.51	$1,082.20	$1,781.58
NonalcBev	$117.15	$235.75	$498.84	$851.32	$1,405.71
MaltBeer	$117.15	$235.75	$498.84	$851.32	$1,405.71
NatSand	$117.15	$235.75	$498.84	$851.32	$1,405.71
Gravel	$117.15	$235.75	$498.84	$851.32	$1,405.71
Dolomite	$117.15	$235.75	$498.84	$851.32	$1,405.71
NonaggCoal	$117.15	$235.75	$498.84	$851.32	$1,405.71
Gasoline	$141.56	$294.71	$638.14	$1,108.31	$1,855.30
FuelOils	$148.17	$307.03	$661.99	$1,145.50	$1,911.60
OthPetCoal	$150.95	$312.20	$672.00	$1,161.11	$1,935.23
InorgChem	$144.39	$299.99	$648.36	$1,124.25	$1,879.43
Fertilizer	$150.95	$312.20	$672.00	$1,161.11	$1,935.23
Plastics	$75.18	$157.60	$347.51	$615.24	$1,048.22
UncoatedPaper	$117.15	$235.75	$498.84	$851.32	$1,405.71
Paper	$76.63	$160.31	$352.75	$623.41	$1,060.59
Nonmetallic	$117.15	$235.75	$498.84	$851.32	$1,405.71
IronSteel	$117.15	$235.75	$498.84	$851.32	$1,405.71
Electronic	$150.95	$312.20	$672.00	$1,161.11	$1,935.23
MVParts	$117.15	$235.75	$498.84	$851.32	$1,405.71
Furniture	$81.03	$168.50	$368.61	$648.16	$1,098.07
MiscPro	$89.54	$184.34	$399.28	$696.03	$1,170.58
MixedFreight	$90.54	$186.21	$402.91	$701.70	$1,179.18
MetalWaste	$117.15	$235.75	$498.84	$851.32	$1,405.71

Table 28 Cost/Ton for 100,000-Pound Trucks

Commodity	Cost/ton				
	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles
Corn	$3.33	$6.71	$14.19	$24.21	$39.98
Soybeans	$3.33	$6.71	$14.19	$24.21	$39.98
CerealStraw	$5.94	$12.17	$26.23	$45.55	$76.34
AnimalFeed	$3.33	$6.71	$14.19	$24.21	$39.98
Meat	$4.34	$8.61	$18.10	$30.78	$50.67
NonalcBev	$3.33	$6.71	$14.19	$24.21	$39.98
MaltBeer	$3.33	$6.71	$14.19	$24.21	$39.98
NatSand	$3.33	$6.71	$14.19	$24.21	$39.98
Gravel	$3.33	$6.71	$14.19	$24.21	$39.98
Dolomite	$3.33	$6.71	$14.19	$24.21	$39.98
NonaggCoal	$3.33	$6.71	$14.19	$24.21	$39.98
Gasoline	$5.18	$10.79	$23.35	$40.56	$67.90
FuelOils	$4.51	$9.35	$20.16	$34.88	$58.20
OthPetCoal	$4.29	$8.88	$19.11	$33.02	$55.04
InorgChem	$4.86	$10.10	$21.84	$37.87	$63.30
Fertilizer	$4.29	$8.88	$19.11	$33.02	$55.04
Plastics	$278.97	$584.80	$1,289.47	$2,282.91	$3,889.51
UncoatedPaper	$3.33	$6.71	$14.19	$24.21	$39.98
Paper	$51.73	$108.21	$238.10	$420.80	$715.89
Nonmetallic	$3.33	$6.71	$14.19	$24.21	$39.98
IronSteel	$3.33	$6.71	$14.19	$24.21	$39.98
Electronic	$4.29	$8.88	$19.11	$33.02	$55.04
MVParts	$3.33	$6.71	$14.19	$24.21	$39.98
Furniture	$15.80	$32.85	$71.85	$126.35	$214.05
MiscPro	$7.35	$15.14	$32.80	$57.17	$96.15
MixedFreight	$6.97	$14.33	$31.00	$54.00	$90.74
MetalWaste	$3.33	$6.71	$14.19	$24.21	$39.98

Table 29 Cost/Trip for 120,000-Pound Trucks

Commodity	Cost/Trip				
	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles
Corn	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74
Soybeans	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74
CerealStraw	$ 93.95	$ 192.55	$ 415.20	$ 720.86	$ 1,208.20
AnimalFeed	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74
Meat	$ 164.76	$ 325.08	$ 679.72	$ 1,149.60	$ 1,883.60
NonalcBev	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74
MaltBeer	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74
NatSand	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74
Gravel	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74
Dolomite	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74
NonaggCoal	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74
Gasoline	$ 141.56	$ 294.71	$ 638.14	$ 1,108.31	$ 1,855.30
FuelOils	$ 148.17	$ 307.03	$ 661.99	$ 1,145.50	$ 1,911.60
OthPetCoal	$ 162.93	$ 334.52	$ 715.21	$ 1,228.51	$ 2,037.26
InorgChem	$ 144.39	$ 299.99	$ 648.36	$ 1,124.25	$ 1,879.43
Fertilizer	$ 162.93	$ 334.52	$ 715.21	$ 1,228.51	$ 2,037.26
Plastics	$ 75.18	$ 157.60	$ 347.51	$ 615.24	$ 1,048.22
UncoatedPaper	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74
Paper	$ 76.63	$ 160.31	$ 352.75	$ 623.41	$ 1,060.59
Nonmetallic	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74
IronSteel	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74
Electronic	$ 162.93	$ 334.52	$ 715.21	$ 1,228.51	$ 2,037.26
MVParts	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74
Furniture	$ 81.03	$ 168.50	$ 368.61	$ 648.16	$ 1,098.07
MiscPro	$ 89.54	$ 184.34	$ 399.28	$ 696.03	$ 1,170.58
MixedFreight	$ 90.53	$ 186.19	$ 402.88	$ 701.64	$ 1,179.09
MetalWaste	$ 129.13	$ 258.07	$ 542.05	$ 918.71	$ 1,507.74

Table 30 Cost/Ton for 120,000-Pound Trucks

Commodity	Cost/ton				
	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles
Corn	$2.86	$5.71	$12.00	$20.34	$33.39
Soybeans	$2.86	$5.71	$12.00	$20.34	$33.39
CerealStraw	$5.94	$12.17	$26.23	$45.55	$76.34
AnimalFeed	$2.86	$5.71	$12.00	$20.34	$33.39
Meat	$3.65	$7.20	$15.05	$25.46	$41.71
NonalcBev	$2.86	$5.71	$12.00	$20.34	$33.39
MaltBeer	$2.86	$5.71	$12.00	$20.34	$33.39
NatSand	$2.86	$5.71	$12.00	$20.34	$33.39
Gravel	$2.86	$5.71	$12.00	$20.34	$33.39
Dolomite	$2.86	$5.71	$12.00	$20.34	$33.39
NonaggCoal	$2.86	$5.71	$12.00	$20.34	$33.39
Gasoline	$5.18	$10.79	$23.35	$40.56	$67.90
FuelOils	$4.51	$9.35	$20.16	$34.88	$58.20
OthPetCoal	$3.61	$7.41	$15.84	$27.20	$45.11
InorgChem	$4.86	$10.10	$21.84	$37.87	$63.30
Fertilizer	$3.61	$7.41	$15.84	$27.20	$45.11
Plastics	$278.97	$584.80	$1,289.47	$2,282.91	$3,889.51
UncoatedPaper	$2.86	$5.71	$12.00	$20.34	$33.39
Paper	$51.73	$108.21	$238.10	$420.80	$715.89
Nonmetallic	$2.86	$5.71	$12.00	$20.34	$33.39
IronSteel	$2.86	$5.71	$12.00	$20.34	$33.39
Electronic	$3.61	$7.41	$15.84	$27.20	$45.11
MVParts	$2.86	$5.71	$12.00	$20.34	$33.39
Furniture	$15.80	$32.85	$71.85	$126.35	$214.05
MiscPro	$7.35	$15.14	$32.80	$57.17	$96.15
MixedFreight	$6.97	$14.34	$31.02	$54.02	$90.79
MetalWaste	$2.86	$5.71	$12.00	$20.34	$33.39

Table 31 Cost/Trip for 140,000-Pound Trucks

Commodity	Cost/Trip				
	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles
Corn	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76
Soybeans	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76
CerealStraw	$ 93.95	$ 192.55	$ 415.20	$ 720.86	$ 1,208.20
AnimalFeed	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76
Meat	$ 176.74	$ 347.40	$ 722.93	$ 1,216.99	$ 1,985.63
NonalcBev	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76
MaltBeer	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76
NatSand	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76
Gravel	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76
Dolomite	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76
NonaggCoal	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76
Gasoline	$ 141.56	$ 294.71	$ 638.14	$ 1,108.31	$ 1,855.30
FuelOils	$ 148.17	$ 307.03	$ 661.99	$ 1,145.50	$ 1,911.60
OthPetCoal	$ 174.92	$ 356.84	$ 758.42	$ 1,295.90	$ 2,139.28
InorgChem	$ 144.39	$ 299.99	$ 648.36	$ 1,124.25	$ 1,879.43
Fertilizer	$ 174.92	$ 356.84	$ 758.42	$ 1,295.90	$ 2,139.28
Plastics	$ 75.18	$ 157.60	$ 347.51	$ 615.24	$ 1,048.22
UncoatedPaper	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76
Paper	$ 76.63	$ 160.31	$ 352.75	$ 623.41	$ 1,060.59
Nonmetallic	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76
IronSteel	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76
Electronic	$ 174.92	$ 356.84	$ 758.42	$ 1,295.90	$ 2,139.28
MVParts	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76
Furniture	$ 81.03	$ 168.50	$ 368.61	$ 648.16	$ 1,098.07
MiscPro	$ 89.54	$ 184.34	$ 399.28	$ 696.03	$ 1,170.58
MixedFreight	$ 90.53	$ 186.19	$ 402.88	$ 701.64	$ 1,179.09
MetalWaste	$ 141.12	$ 280.39	$ 585.26	$ 986.10	$ 1,609.76

Table 32 Cost/Ton for 140,000-Pound Trucks

Commodity	Cost/Ton				
	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles
Corn	$2.56	$5.08	$10.61	$17.88	$29.18
Soybeans	$2.56	$5.08	$10.61	$17.88	$29.18
CerealStraw	$5.94	$12.17	$26.23	$45.55	$76.34
AnimalFeed	$2.56	$5.08	$10.61	$17.88	$29.18
Meat	$3.20	$6.30	$13.11	$22.06	$36.00
NonalcBev	$2.56	$5.08	$10.61	$17.88	$29.18
MaltBeer	$2.56	$5.08	$10.61	$17.88	$29.18
NatSand	$2.56	$5.08	$10.61	$17.88	$29.18
Gravel	$2.56	$5.08	$10.61	$17.88	$29.18
Dolomite	$2.56	$5.08	$10.61	$17.88	$29.18
NonaggCoal	$2.56	$5.08	$10.61	$17.88	$29.18
Gasoline	$5.18	$10.79	$23.35	$40.56	$67.90
FuelOils	$4.51	$9.35	$20.16	$34.88	$58.20
OthPetCoal	$3.17	$6.47	$13.75	$23.49	$38.78
InorgChem	$4.86	$10.10	$21.84	$37.87	$63.30
Fertilizer	$3.17	$6.47	$13.75	$23.49	$38.78
Plastics	$278.97	$584.80	$1,289.47	$2,282.91	$3,889.51
UncoatedPaper	$2.56	$5.08	$10.61	$17.88	$29.18
Paper	$51.73	$108.21	$238.10	$420.80	$715.89
Nonmetallic	$2.56	$5.08	$10.61	$17.88	$29.18
IronSteel	$2.56	$5.08	$10.61	$17.88	$29.18
Electronic	$3.17	$6.47	$13.75	$23.49	$38.78
MVParts	$2.56	$5.08	$10.61	$17.88	$29.18
Furniture	$15.80	$32.85	$71.85	$126.35	$214.05
MiscPro	$7.35	$15.14	$32.80	$57.17	$96.15
MixedFreight	$6.97	$14.34	$31.02	$54.02	$90.79
MetalWaste	$2.56	$5.08	$10.61	$17.88	$29.18

Table 33 Shipping Cost of Commodities in Wisconsin for 80,000-Pound Trucks (Baseline)

Commodity	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles
Corn	$4,252,856	$7,057,931	$5,976,533	$23,798,625	$23,688,381
Soybeans	$5,968,084	$8,845,891	$12,932,417	$9,602,389	$16,136,517
CerealStraw	$10,459,155	$5,258,583	$23,124,284	$21,660,497	$24,116,881
AnimalFeed	$8,017,535	$4,002,537	$17,473,996	$16,261,675	$18,004,758
Meat	$2,167,784	$2,892,718	$17,609,071	$16,815,761	$15,558,696
NonalcBev	$19,601,642	$24,866,804	$52,686,158	$44,714,189	$63,090,459
MaltBeer	$5,936,500	$5,249,210	$10,857,992	$16,714,069	$1,271,722
NatSand	$0	$0	$0	$0	$0
Gravel	$63,544,777	$67,537,907	$55,955,376	$38,332,478	$49,672,973
Dolomite	$0	$0	$0	$0	$0
NonaggCoal	$0	$0	$0	$0	$0
Gasoline	$30,575,647	$25,393,537	$21,567,704	$8,085,544	$0
FuelOils	$14,176,717	$13,807,955	$20,864,442	$1,460,267	$1,007,830
OthPetCoal	$2,797,707	$2,219,078	$2,716,103	$4,730,439	$7,937,255
InorgChem	$6,802,772	$6,808,985	$15,795,617	$21,109,902	$27,108,538
Fertilizer	$8,953,089	$2,441,887	$906,427	$1,316,254	$2,209,548
Plastics	$104,833,298	$137,351,045	$502,040,795	$915,637,559	$1,159,475,014
UncoatedPaper	$7,251,270	$9,384,568	$22,358,964	$41,392,438	$44,493,901
Paper	$49,289,127	$39,851,971	$177,322,452	$327,471,134	$246,167,413
Nonmetallic	$90,315,919	$8,733,281	$13,963,913	$20,939,530	$25,886,915
IronSteel	$8,911,133	$11,987,502	$86,353,791	$116,075,686	$49,809,569
Electronic	$1,877,801	$1,382,789	$5,452,666	$8,670,020	$18,709,760
MVParts	$2,314,341	$2,474,504	$8,013,438	$35,898,441	$19,683,050
Furniture	$2,101,853	$2,410,341	$8,507,239	$26,828,283	$24,506,387
MiscPro	$2,244,229	$3,112,051	$8,507,343	$12,469,785	$15,880,192
MixedFreight	$10,954,468	$21,002,319	$38,189,966	$27,230,018	$20,043,052
MetalWaste	$4,257,280	$4,119,285	$9,701,833	$5,276,454	$2,471,999
Total	**$467,604,984**	**$418,192,678**	**$1,138,878,521**	**$1,762,491,440**	**$1,876,930,809**

Table 34 Shipping Cost of Commodities in Wisconsin for 100,000-Pound Trucks

Commodity	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles
Corn	$3,359,381	$5,526,430	$4,636,985	$18,309,712	$18,091,020
Soybeans	$4,160,377	$6,089,125	$8,785,913	$6,445,625	$10,718,614
CerealStraw	$10,444,910	$5,251,256	$23,091,324	$21,629,005	$24,081,229
AnimalFeed	$5,862,690	$2,894,153	$12,488,328	$11,498,145	$12,612,091
Meat	$1,500,176	$1,987,774	$11,996,434	$11,362,071	$10,436,387
NonalcBev	$14,060,809	$17,628,584	$36,894,539	$30,961,919	$43,259,510
MaltBeer	$4,281,529	$3,742,071	$7,647,296	$11,641,872	$877,252
NatSand	$0	$0	$0	$0	$0
Gravel	$47,204,593	$49,635,401	$40,665,636	$27,573,939	$35,412,675
Dolomite	$0	$0	$0	$0	$0
NonaggCoal	$0	$0	$0	$0	$0
Gasoline	$28,678,830	$23,771,336	$20,154,327	$7,544,231	$0
FuelOils	$11,579,924	$11,203,465	$16,827,312	$1,171,609	$805,069
OthPetCoal	$2,053,142	$1,611,946	$1,954,927	$3,377,825	$5,629,838
InorgChem	$5,375,249	$5,342,130	$12,314,379	$16,367,939	$20,922,997
Fertilizer	$6,405,380	$1,728,037	$635,176	$914,576	$1,524,328
Plastics	$104,445,971	$136,843,332	$500,184,154	$912,250,010	$1,155,183,938
UncoatedPaper	$5,085,207	$6,499,795	$15,286,505	$27,965,714	$29,751,495
Paper	$49,240,377	$39,812,453	$177,146,170	$327,144,879	$245,921,720
Nonmetallic	$66,235,730	$6,333,943	$10,010,820	$14,853,063	$18,192,731
IronSteel	$6,078,379	$8,069,180	$57,332,272	$76,100,503	$32,298,813
Electronic	$1,204,057	$874,541	$3,406,245	$5,358,892	$11,461,477
MVParts	$1,451,146	$1,527,666	$4,868,144	$21,490,016	$11,633,129
Furniture	$2,092,384	$2,399,389	$8,468,263	$26,704,482	$24,392,625
MiscPro	$2,240,370	$3,106,602	$8,492,172	$12,447,193	$15,851,038
MixedFreight	$10,922,694	$20,940,206	$38,074,835	$27,146,543	$19,980,742
MetalWaste	$3,028,234	$2,895,011	$6,733,468	$3,620,289	$1,679,181
Total	**$396,991,542**	**$365,713,824**	**$1,028,095,621**	**$1,623,880,051**	**$1,750,717,900**

Table 35 Shipping Cost of Commodities in Wisconsin for 120,000-Pound Trucks

Commodity	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles
Corn	$2,883,104	$4,710,045	$3,922,922	$15,383,782	$15,107,281
Soybeans	$3,570,538	$5,189,617	$7,432,946	$5,415,601	$8,950,801
CerealStraw	$10,444,910	$5,251,256	$23,091,324	$21,629,005	$24,081,229
AnimalFeed	$5,031,505	$2,466,618	$10,565,215	$9,660,718	$10,531,988
Meat	$1,259,622	$1,661,702	$9,974,078	$9,396,987	$8,590,707
NonalcBev	$12,067,334	$15,024,424	$31,213,046	$26,014,141	$36,124,750
MaltBeer	$3,674,514	$3,189,279	$6,469,667	$9,781,477	$732,568
NatSand	$0	$0	$0	$0	$0
Gravel	$40,512,147	$42,303,076	$34,403,421	$23,167,567	$29,572,089
Dolomite	$0	$0	$0	$0	$0
NonaggCoal	$0	$0	$0	$0	$0
Gasoline	$28,678,830	$23,771,336	$20,154,327	$7,544,231	$0
FuelOils	$11,579,924	$11,203,465	$16,827,312	$1,171,609	$805,069
OthPetCoal	$1,725,436	$1,344,728	$1,619,909	$2,782,497	$4,614,269
InorgChem	$5,375,249	$5,342,130	$12,314,379	$16,367,939	$20,922,997
Fertilizer	$5,383,003	$1,441,574	$526,325	$753,385	$1,249,354
Plastics	$104,445,971	$136,843,332	$500,184,154	$912,250,010	$1,155,183,938
UncoatedPaper	$4,364,250	$5,539,621	$12,932,493	$23,496,735	$24,844,603
Paper	$49,240,377	$39,812,453	$177,146,170	$327,144,879	$245,921,720
Nonmetallic	$56,845,140	$5,398,270	$8,469,226	$12,479,513	$15,192,217
IronSteel	$5,216,615	$6,877,171	$48,503,515	$63,939,486	$26,971,794
Electronic	$1,011,875	$729,565	$2,822,512	$4,414,408	$9,393,937
MVParts	$1,245,409	$1,301,993	$4,118,485	$18,055,868	$9,714,485
Furniture	$2,092,384	$2,399,389	$8,468,263	$26,704,482	$24,392,625
MiscPro	$2,240,370	$3,106,602	$8,492,172	$12,447,193	$15,851,038
MixedFreight	$10,928,264	$20,951,095	$38,095,019	$27,161,177	$19,991,666
MetalWaste	$2,598,906	$2,467,349	$5,696,563	$3,041,759	$1,402,235
Total	**$372,415,679**	**$348,326,090**	**$993,443,442**	**$1,580,204,448**	**$1,710,143,359**

Table 36 Shipping Cost of Commodities in Wisconsin for 140,000-Pound Trucks

Commodity	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles
Corn	$2,579,516	$4,189,667	$3,467,766	$13,518,741	$13,205,391
Soybeans	$3,194,564	$4,616,254	$6,570,540	$4,759,044	$7,823,964
CerealStraw	$10,444,910	$5,251,256	$23,091,324	$21,629,005	$24,081,229
AnimalFeed	$4,501,693	$2,194,099	$9,339,388	$8,489,508	$9,206,092
Meat	$1,106,289	$1,453,859	$8,684,991	$8,144,406	$7,414,237
NonalcBev	$10,796,656	$13,364,485	$27,591,557	$22,860,336	$31,576,923
MaltBeer	$3,287,591	$2,836,919	$5,719,025	$8,595,627	$640,343
NatSand	$0	$0	$0	$0	$0
Gravel	$36,246,259	$37,629,317	$30,411,769	$20,358,864	$25,849,191
Dolomite	$0	$0	$0	$0	$0
NonaggCoal	$0	$0	$0	$0	$0
Gasoline	$28,678,830	$23,771,336	$20,154,327	$7,544,231	$0
FuelOils	$11,579,924	$11,203,465	$16,827,312	$1,171,609	$805,069
OthPetCoal	$1,516,550	$1,174,398	$1,406,362	$2,403,023	$3,966,927
InorgChem	$5,375,249	$5,342,130	$12,314,379	$16,367,939	$20,922,997
Fertilizer	$4,731,321	$1,258,977	$456,942	$650,639	$1,074,080
Plastics	$104,445,971	$136,843,332	$500,184,154	$912,250,010	$1,155,183,938
UncoatedPaper	$3,904,699	$4,927,589	$11,432,003	$20,648,126	$21,716,859
Paper	$49,240,377	$39,812,453	$177,146,170	$327,144,879	$245,921,720
Nonmetallic	$50,859,404	$4,801,854	$7,486,585	$10,966,568	$13,279,634
IronSteel	$4,667,311	$6,117,362	$42,875,902	$56,187,830	$23,576,253
Electronic	$889,375	$637,155	$2,450,431	$3,812,376	$8,076,049
MVParts	$1,114,269	$1,158,145	$3,640,639	$15,866,878	$8,491,506
Furniture	$2,092,384	$2,399,389	$8,468,263	$26,704,482	$24,392,625
MiscPro	$2,240,370	$3,106,602	$8,492,172	$12,447,193	$15,851,038
MixedFreight	$10,928,264	$20,951,095	$38,095,019	$27,161,177	$19,991,666
MetalWaste	$2,325,243	$2,194,750	$5,035,620	$2,672,994	$1,225,705
Total	**$356,747,021**	**$337,235,886**	**$971,342,638**	**$1,552,355,486**	**$1,684,273,437**

Table 37 Total Cost Savings for 100,000-Pound Trucks

Commodity	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles	Total
Corn	$893,475	$1,531,501	$1,339,549	$5,488,913	$5,597,360	$14,850,798
Soybeans	$1,807,707	$2,756,766	$4,146,504	$3,156,764	$5,417,902	$17,285,644
CerealStraw	$14,245	$7,327	$32,960	$31,492	$35,652	$121,676
AnimalFeed	$2,154,846	$1,108,384	$4,985,669	$4,763,530	$5,392,667	$18,405,096
Meat	$667,608	$904,944	$5,612,637	$5,453,690	$5,122,309	$17,761,188
NonalcBev	$5,540,833	$7,238,220	$15,791,619	$13,752,270	$19,830,949	$62,153,892
MaltBeer	$1,654,971	$1,507,138	$3,210,696	$5,072,197	$394,469	$11,839,472
NatSand	$0	$0	$0	$0	$0	$0
Gravel	$16,340,184	$17,902,506	$15,289,740	$10,758,539	$14,260,298	$74,551,267
Dolomite	$0	$0	$0	$0	$0	$0
NonaggCoal	$0	$0	$0	$0	$0	$0
Gasoline	$1,896,816	$1,622,201	$1,413,377	$541,313	$0	$5,473,707
FuelOils	$2,596,792	$2,604,490	$4,037,131	$288,658	$202,761	$9,729,832
OthPetCoal	$744,564	$607,132	$761,177	$1,352,614	$2,307,418	$5,772,904
InorgChem	$1,427,522	$1,466,855	$3,481,239	$4,741,963	$6,185,541	$17,303,120
Fertilizer	$2,547,709	$713,850	$271,251	$401,678	$685,221	$4,619,709
Plastics	$387,327	$507,713	$1,856,641	$3,387,549	$4,291,076	$10,430,306
UncoatedPaper	$2,166,063	$2,884,773	$7,072,459	$13,426,725	$14,742,406	$40,292,426
Paper	$48,749	$39,518	$176,282	$326,256	$245,693	$836,498
Nonmetallic	$24,080,188	$2,399,337	$3,953,093	$6,086,468	$7,694,184	$44,213,271
IronSteel	$2,832,754	$3,918,322	$29,021,519	$39,975,183	$17,510,756	$93,258,535
Electronic	$673,743	$508,249	$2,046,421	$3,311,128	$7,248,283	$13,787,824
MVParts	$863,195	$946,838	$3,145,294	$14,408,425	$8,049,922	$27,413,674
Furniture	$9,469	$10,952	$38,977	$123,801	$113,761	$296,959
MiscPro	$3,858	$5,450	$15,171	$22,592	$29,154	$76,226
MixedFreight	$31,775	$62,113	$115,132	$83,475	$62,309	$354,804
MetalWaste	$1,229,046	$1,224,274	$2,968,365	$1,656,165	$792,818	$7,870,667
Total for each distance category	**$70,613,442**	**$52,478,854**	**$110,782,900**	**$138,611,389**	**$126,212,909**	**$498,699,494**

Table 38 Total Cost Savings for 120,000-Pound Trucks

Commodity	<50 miles	50-99 miles	100-249 miles	250-499 miles	500-749 miles	Total
Corn	$1,369,752	$2,347,886	$2,053,611	$8,414,843	$8,581,099	$22,767,191
Soybeans	$2,397,546	$3,656,274	$5,499,472	$4,186,789	$7,185,716	$22,925,796
CerealStraw	$14,245	$7,327	$32,960	$31,492	$35,652	$121,676
AnimalFeed	$2,986,030	$1,535,919	$6,908,781	$6,600,957	$7,472,770	$25,504,458
Meat	$908,162	$1,231,015	$7,634,992	$7,418,774	$6,967,989	$24,160,932
NonalcBev	$7,534,309	$9,842,380	$21,473,113	$18,700,049	$26,965,709	$84,515,558
MaltBeer	$2,261,986	$2,059,931	$4,388,325	$6,932,592	$539,154	$16,181,988
NatSand	$0	$0	$0	$0	$0	$0
Gravel	$23,032,630	$25,234,831	$21,551,955	$15,164,911	$20,100,885	$105,085,212
Dolomite	$0	$0	$0	$0	$0	$0
NonaggCoal	$0	$0	$0	$0	$0	$0
Gasoline	$1,896,816	$1,622,201	$1,413,377	$541,313	$0	$5,473,707
FuelOils	$2,596,792	$2,604,490	$4,037,131	$288,658	$202,761	$9,729,832
OthPetCoal	$1,072,271	$874,350	$1,096,195	$1,947,943	$3,322,986	$8,313,744
InorgChem	$1,427,522	$1,466,855	$3,481,239	$4,741,963	$6,185,541	$17,303,120
Fertilizer	$3,570,086	$1,000,313	$380,102	$562,869	$960,195	$6,473,564
Plastics	$387,327	$507,713	$1,856,641	$3,387,549	$4,291,076	$10,430,306
UncoatedPaper	$2,887,019	$3,844,947	$9,426,471	$17,895,703	$19,649,298	$53,703,439
Paper	$48,749	$39,518	$176,282	$326,256	$245,693	$836,498
Nonmetallic	$33,470,779	$3,335,011	$5,494,687	$8,460,018	$10,694,698	$61,455,193
IronSteel	$3,694,518	$5,110,331	$37,850,276	$52,136,200	$22,837,775	$121,629,102
Electronic	$865,926	$653,225	$2,630,153	$4,255,612	$9,315,823	$17,720,739
MVParts	$1,068,932	$1,172,511	$3,894,953	$17,842,573	$9,968,565	$33,947,534
Furniture	$9,469	$10,952	$38,977	$123,801	$113,761	$296,959
MiscPro	$3,858	$5,450	$15,171	$22,592	$29,154	$76,226
MixedFreight	$26,204	$51,224	$94,947	$68,841	$51,385	$292,601
MetalWaste	$1,658,375	$1,651,935	$4,005,270	$2,234,695	$1,069,764	$10,620,039
Total for each distance category	**$95,189,304**	**$69,866,589**	**$145,435,079**	**$182,286,992**	**$166,787,450**	**$659,565,414**

Appendix B: Employment Growth

Regression Line for 100,000-pound trucks for Gravel Commodity

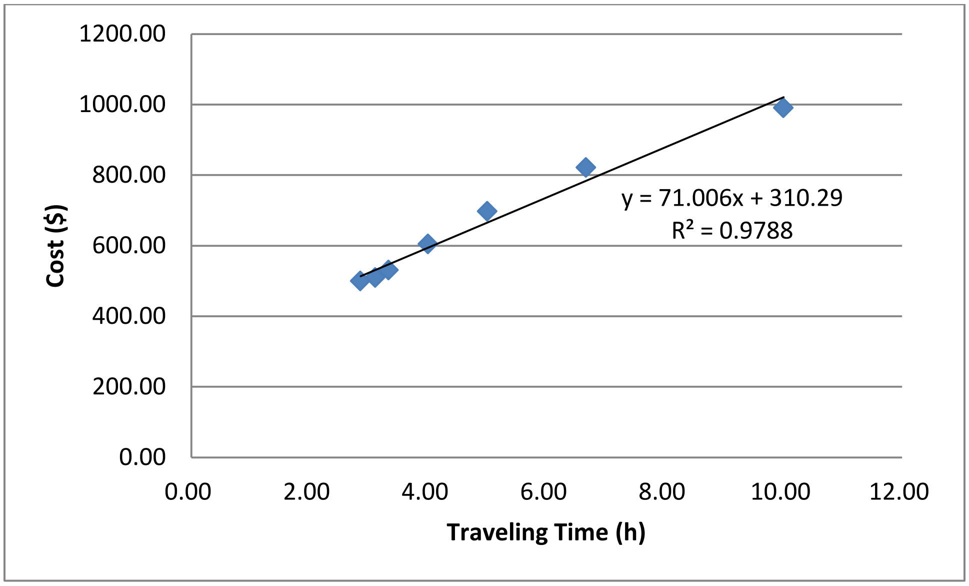

Figure 23 Regression Line for VOT (Time-Based)

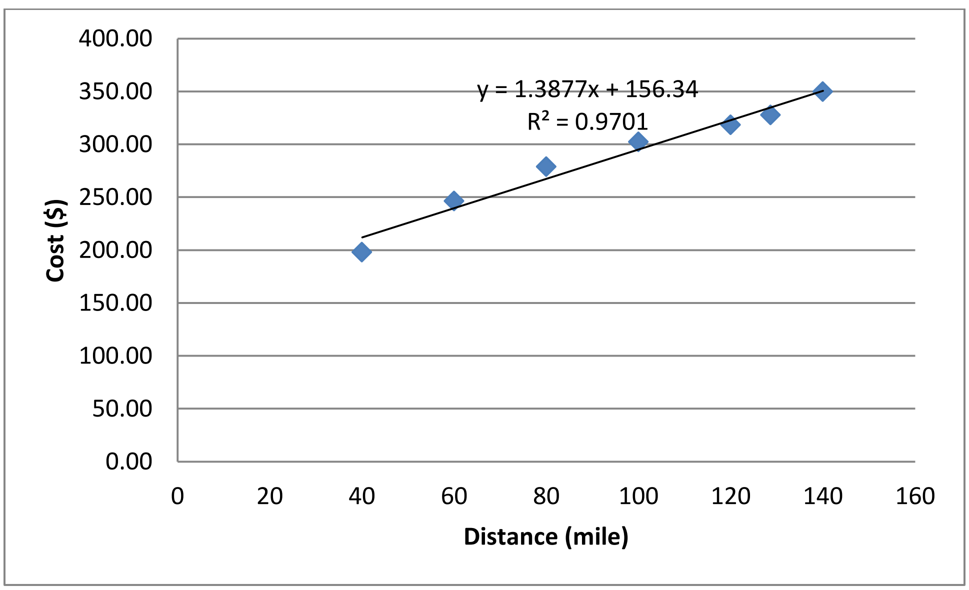

Figure 24 Regression Line for Cost/Mile (Distance-Based)

Industry Categorization for 140,000-pound trucks

Table 39 Industry Categories Based on VOT & Cost/Mile

Name in Excel	VOT	Cost/Mile	VOT	Cost/Mile	Industry Category	
Meat	133.26	1.337	133.26	1.337	A	Meat
OthPetCoal	90.676	2.337	90.676	2.337	B	Hazardous Material
Fertilizer	90.676	2.337				
Electronic	90.676	2.337				
CornExSweet	90.676	1.337	90.676	1.337	C	Typical Commodity
Soybeans	90.676	1.337				
AnimalFeedPrep	90.676	1.337				
NonalcBev	90.676	1.337				
MaltBeer	90.676	1.337				
NatSand	90.676	1.337				
Gravel	90.676	1.337				
Dolomite	90.676	1.337				
NonaggCoal	90.676	1.337				
UncoatedPaper	90.676	1.337				
Nonmetallic	90.676	1.337				
IronSteel	90.676	1.337				
PartsMV	90.676	1.337				
MetalWaste	90.676	1.337				
FuelOils	68.728	2.394	65.885	2.401	D	Fuel and Liquid
InorgChem	65.627	2.402				
Gasoline	63.301	2.408				
CerealStraw	51.961	1.437	49.814	1.442	E	Light Mixed
MixedFreight	49.153	1.444				
MiscPro	48.329	1.446				
Furniture	41.328	1.464	41.328	1.464	F	Furniture
Paper	37.71	1.473	37.114	1.4745	G	Light Commodity
Fibers	36.518	1.476				

Travel Time Calculation

Calculation example for Meat commodity shipment on 140,000-pound trucks for:

- Door County to Dane County
- LaCrosse County to Buffalo County

For Meat Commodity

Truck Weights	VOT	Cost/Mi	Weight(ton)
80,000 pounds	100.43	1.422	21.78
140,000 pounds	133.26	1.337	55.16

Nominal Value of baseline (80,000 pounds) for Meat commodity

$$\frac{VOT}{payload\ weight\ (ton) * 60} = \frac{100.43}{21.78 \times 60} = 0.077$$

Door County to Dane County	LaCrosse County to Buffalo County
Travel Distance = 210.2407 mi Travel Time = 228.4262 mi	Distance = 54.90855 mi Travel Time = 81.52223 mi
COST **80,000 pounds = $681.31** $\frac{228.4262}{60} \times 100.43 + 210.2407 \times 1.422$ **140,000 pounds = $788.43** $\frac{228.4262}{60} \times 133.26 + 210.2407 \times 1.337$	COST **80,000 pounds = $214.53** $\frac{81.52223}{60} \times 100.43 + 54.90855 \times 1.422$ **140,000 pounds = $254.47** $\frac{81,52223}{60} \times 133.26 + 54.90855 \times 1.337$
Cost/Ton **80,000 pounds** $\frac{\$681.31}{21.78} = 31.28$ **140,000 pounds** $\frac{\$788.43}{55.16} = 14.29$	Cost/Ton **80,000 pounds** $\frac{\$214.53}{21.78} = 9.85$ **140,000 pounds** $\frac{\$254.47}{55.16} = 4.61$
Travel Time **80,000 pounds** $\frac{31.28}{0.077} = 406.23min$ **140,000 pounds** $\frac{14.29}{0.077} = 185.58min$	Travel Time **80,000 pounds** $\frac{9.85}{0.077} = 127.92min$ **140,000 pounds** $\frac{4.61}{0.077} = 59.87min$

NAICS Code for Industry Category

Table 40 Industry Category based on NAICS Code

Industry Category		NAICS	NAICS US Title
A	Meat	311	Food Manufacturing
		324	Petroleum and Coal Products Manufacturing
		325	Chemical Manufacturing
		334	Computer and Electronic Product Manufacturing
B	Hazardous Commodities	335	Electrical Equipment, Appliance, and Component Manufacturing
		111	Crop Production
		112	Animal Production and Aquaculture
		113	Forestry and Logging
		114	Fishing, Hunting and Trapping
		212	Mining (except Oil and Gas)
		213	Support Activities for Mining
		312	Beverage and Tobacco Product Manufacturing
		327	Nonmetallic Mineral Product Manufacturing
		331	Primary Metal Manufacturing
		332	Fabricated Metal Product Manufacturing
		333	Machinery Manufacturing
		336	Transportation Equipment Manufacturing
C	Typical Commodities	562	Waste Management and Remediation Services
D	Fuel and Liquid	211	Oil and Gas Extraction
		316	Leather and Allied Product Manufacturing
		321	Wood Product Manufacturing
		323	Printing and Related Support Activities
E	Light Mixed	339	Miscellaneous Manufacturing
F	Furniture	337	Furniture and Related Product Manufacturing
		313	Textile Mills
		314	Textile Product Mills
		315	Apparel Manufacturing
		322	Paper Manufacturing
G	Light Commodities	326	Plastics and Rubber Products Manufacturing

Appendix C: Mode Shift

Rail to Truck Diversion Calculation (ton-miles)

The calculation below will show how the diversion from Rail to Truck is estimated using the arc elasticity formula shown below. This example uses 140,000-pound trucks for MVParts commodity.

Arc Elasticity Formula

$$E_p = \frac{\dfrac{x_2 - x_1}{(x_2 + x_1)/2}}{\dfrac{P_2 - P_1}{(P_2 + P_1)/2}}$$

Where E_P = Arc Elasticity of Demand,

X = demand

P = price

1. Cross elasticity between rail and truck resulted from ICM (NCHRP#388)

Commodity	Low Elasticity	High Elasticity
Motor Vehicle Parts	1.1	1.4

$$E_P = Average\ Elasticity = \frac{1.1 + 1.4}{2} = 1.25$$

2. Shipping Cost for Truck resulted from Truck Cost Model

	Original Cost (80,000-pound trucks)	New Cost (140,000-pound trucks)
Truck Shipping Cost	$ 68,383,774	$ 30,271,437

$$\%Price\ Change_{truck} = \frac{(new\ cost - original\ cost)}{\frac{(new\ cost + original\ cost)}{2}}$$

$$\%Price\ Change_{truck} = \frac{(\$30{,}271{,}437 - \$68{,}383{,}774)}{\frac{(\$30{,}271{,}437 + \$68{,}383{,}774)}{2}} = -77.26\%$$

3. Rail Ton-Miles

Ton-Miles for Rail (CFS 2007)	34,000,000

$$\%Change_{rail\ \text{ton-miles}} = E_P \times \%\text{price}\ change_{truck}$$

$$\%Change_{rail\ \text{ton-miles}} = 1.25 \times (-77.26\%) = -96.58\%$$

$$\%Change_{rail\ \text{ton-miles}} = \frac{(new_{rail\ ton-miles} - original_{rail\ ton-miles})}{\frac{(new_{rail\ ton-miles} + original_{rail\ ton-miles})}{2}}$$

$$new_{rail\ ton-miles} = \frac{original_{rail\ ton-miles} \times (1 + \frac{\%change_{rail\ \text{ton-miles}}}{2})}{\left(1 - \frac{\%change_{rail\ \text{ton-miles}}}{2}\right)}$$

$$new_{rail\ ton-miles} = \frac{34{,}000{,}000 \times \left(1 + \frac{(-96.58\%)}{2}\right)}{\left(1 - \frac{(-96.58\%)}{2}\right)} = 11{,}856{,}149\ ton - miles$$

4. Ton-miles Diversion

Assume that all ton-miles diverted from rail go to truck.

Ton-Miles for Rail (CFS 2007)	34,000,000
New Ton-Miles	11,856,149
Ton-Miles Diverted from Rail	**22,143,851**

$$\text{Ton} - \text{Miles Diverted from Rail} = 34{,}000{,}000 - 11{,}856{,}149 = 22{,}143{,}851\ \text{ton} - \text{miles}$$

5. Percentage of Additional Truck Ton-miles

Ton-Miles for Truck (CFS 2007)	1,469,000,000
Additional Ton-Miles from Rail Diversion	22,143,851
Percentage of Change in Truck Ton-Miles	**1.51%**

$$\%Changes_{truck\ ton-miles} = \frac{22{,}143{,}851}{1{,}469{,}000{,}000} \times 100\% = 1.51\%$$

Table 41 Rail-Truck Diversion for 100,000-pound trucks

Commodity	Ton-miles for Rail (CFS 2007)	Ton-Miles Diverted from Rail To Truck	% of change in Truck Ton-Miles
Corn	-	-	-
Soybeans	-	-	-
CerealStraw	105,000,000	3,777	0.00%
AnimalFeed	105,000,000	881,824	0.05%
Meat	-	-	-
NonalcBev	-	-	-
MaltBeer	65,000,000	34,723,810	8.29%
NatSand	-	-	-
Gravel	-	-	-
Dolomite	-	-	-
NonaggCoal	-	-	-
Gasoline	-	-	-
FuelOils	37,000,000	1,257,023	0.36%
OthPetCoal	-	-	-
InorgChem	-	-	-
Fertilizer	-	-	-
Plastics	20,000,000	308,934	0.03%
Uncoated Paper	590,000,000	160,764,538	8.54%
Paper	309,000,000	252,316	0.02%
Nonmetallic	510,000,000	410,722,965	37.24%
IronSteel	-	-	-
Electronic	-	-	-
MVParts	34,000,000	16,224,388	1.10%
Furniture	-	-	-
MiscPro	-	-	-
MixedFreight	-	-	-
MetalWaste	-	-	-
Total Diversion		625,139,575	3.98%

Table 42 Rail-Truck Diversion for 120,000-pound trucks

Commodity	Ton-miles for Rail (CFS 2007)	Ton-Miles Diverted from Rail To Truck	% of change in Truck Ton-Miles
Corn	-	-	-
Soybeans	-	-	-
CerealStraw	105,000,000	3,777	0.00%
AnimalFeed	105,000,000	1,304,364	0.08%
Meat	-	-	-
NonalcBev	-	-	-
MaltBeer	65,000,000	45,143,266	10.77%
NatSand	-	-	-
Gravel	-	-	-
Dolomite	-	-	-
NonaggCoal	-	-	-
Gasoline	-	-	-
FuelOils	37,000,000	1,257,023	0.36%
OthPetCoal	-	-	-
InorgChem	-	-	-
Fertilizer	-	-	-
Plastics	20,000,000	308,934	0.03%
Uncoated Paper	590,000,000	216,428,097	11.49%
Paper	309,000,000	252,316	0.02%
Nonmetallic	510,000,000	509,889,265	46.23%
IronSteel	-	-	-
Electronic	-	-	-
MVParts	34,000,000	19,865,421	1.35%
Furniture	-	-	-
MiscPro	-	-	-
MixedFreight	-	-	-
MetalWaste	-	-	-
Total Diversion		794,452,463	5.17%

Table 43 Rail-Truck Diversion for 140,000-pound trucks

Commodity	Ton-miles for Rail (CFS 2007)	Ton-Miles Diverted from Rail To Truck	% of change in Truck Ton-Miles
Corn	-	-	-
Soybeans	-	-	-
CerealStraw	105,000,000	3,777	0.00%
AnimalFeed	105,000,000	1,604,772	0.10%
Meat	-	-	-
NonalcBev	-	-	-
MaltBeer	65,000,000	51,269,999	12.24%
NatSand	-	-	-
Gravel	-	-	-
Dolomite	-	-	-
NonaggCoal	-	-	-
Gasoline	-	-	-
FuelOils	37,000,000	1,257,023	0.36%
OthPetCoal	-	-	-
InorgChem	-	-	-
Fertilizer	-	-	-
Plastics	20,000,000	308,934	0.03%
Uncoated Paper	590,000,000	252,496,967	13.41%
Paper	309,000,000	252,316	0.02%
Nonmetallic	510,000,000	562,745,056	51.02%
IronSteel	-	-	-
Electronic	-	-	-
MVParts	34,000,000	22,143,851	1.51%
Furniture	-	-	-
MiscPro	-	-	-
MixedFreight	-	-	-
MetalWaste	-	-	-
Total Diversion		892,082,694	5.81%

Additional Jobs in Trucking Industry

According to County Business Patterns (CBP), the employment number for trucking industry (NAICS 484) for Wisconsin in 2007 was 54,423.

	Ton-Miles Diverted to Truck	%Ton-Miles of Truck from Rail Diversion	Additional Jobs in Trucking Industry
100,000-pound trucks	625,139,575	3.98%	2167
120,000-pound trucks	794,452,463	5.17%	2815
140,000-pound trucks	892,082,694	5.81%	3160

For 140,000-pound trucks

$$Additional\ Jobs\ in\ Trucking\ Industry = 5.81\% \times 54{,}423 = 3160\ jobs$$

Appendix D: Industry Restructuring

Table 44 IMPLAN Result by Industry

		Induced Effects			
Sector	Description	Employment	Labor Income	Value Added	Output
1	Oilseed farming	0.5	$22,809	$21,982	$50,854
2	Grain farming	1.8	$33,795	$28,322	$121,652
3	Vegetable and melon farming	4.8	$1,172,596	$699,459	$1,332,092
4	Fruit farming	1.8	$454,122	$242,015	$458,845
5	Tree nut farming	0	$49	$44	$74
6	Greenhouse, nursery, and floriculture production	1	$224,662	$130,917	$192,886
7	Tobacco farming	0	$0	$0	$0
8	Cotton farming	0	$0	$0	$0
9	Sugarcane and sugar beet farming	0	$0	$0	$0
10	All other crop farming	0.1	$9,857	$7,281	$22,094
11	Cattle ranching and farming	4.5	$93,344	$138,722	$792,868
12	Dairy cattle and milk production	13.9	$476,879	$1,319,053	$2,725,196
13	Poultry and egg production	0.5	$96,381	$69,362	$336,698
14	Animal production, except cattle and poultry and eggs	9	$136,555	$284,196	$464,051
15	Forestry, forest products, and timber tract production	0	$4,071	$5,822	$12,285
16	Commercial logging	0.5	$19,609	$14,214	$39,081
17	Commercial Fishing	0.2	$2,118	$2,590	$7,998
18	Commercial hunting and trapping	1.3	$63,220	$85,080	$173,631
19	Support activities for agriculture and forestry	5.8	$178,018	$87,605	$126,259
20	Extraction of oil and natural gas	0.9	$12,111	$5,508	$148,575
21	Mining coal	0	$0	$0	$0
22	Mining iron ore	0	$0	$0	$0
23	Mining copper, nickel, lead, and zinc	0	$0	$0	$0
24	Mining gold, silver, and other metal ore	0	$531	$1,827	$2,422
25	Mining and quarrying stone	0.4	$25,840	$120,677	$157,467
26	Mining and quarrying sand, gravel, clay, and ceramic and refractory minerals	0.2	$19,270	$35,982	$55,486
27	Mining and quarrying other nonmetallic minerals	0	$345	$780	$2,068
28	Drilling oil and gas wells	0	$0	$0	$0
29	Support activities for oil and gas operations	0	$499	$567	$4,759
30	Support activities for other mining	0	$246	$166	$4,546
31	Electric power generation, transmission, and distribution	30.7	$4,633,631	$16,973,431	$26,030,773
32	Natural gas distribution	1.4	$165,187	$402,153	$1,461,010
33	Water, sewage and other treatment and delivery systems	1.5	$158,288	$300,863	$429,864
34	Construction of new nonresidential commercial and health care structures	0	$0	$0	$0
35	Construction of new nonresidential manufacturing structures	0	$0	$0	$0
36	Construction of other new nonresidential structures	0	$0	$0	$0
37	Construction of new residential permanent site single- and multi-family structures	0	$0	$0	$0
38	Construction of other new residential structures	0	$0	$0	$0
39	Maintenance and repair construction of nonresidential structures	42.9	$2,646,546	$2,568,532	$5,901,658
40	Maintenance and repair construction of residential structures	8.7	$542,715	$2,420,339	$3,154,272
41	Dog and cat food manufacturing	0.7	$51,674	$146,535	$860,748
42	Other animal food manufacturing	0.9	$62,143	$120,290	$1,212,270
43	Flour milling and malt manufacturing	0.2	$15,572	$27,911	$244,630
44	Wet corn milling	0	$0	$0	$0
45	Soybean and other oilseed processing	0	$432	$529	$20,759
46	Fats and oils refining and blending	0	$0	$0	$0
47	Breakfast cereal manufacturing	0.1	$11,353	$31,199	$96,607
48	Sugar cane mills and refining	0	$0	$0	$0
49	Beet sugar manufacturing	0	$0	$0	$0
50	Chocolate and confectionery manufacturing from cacao beans	0.6	$52,561	$78,582	$550,782

		Induced Effects			
Sector	Description	Employment	Labor Income	Value Added	Output
51	Confectionery manufacturing from purchased chocolate	1.1	$52,855	$93,240	$405,587
52	Nonchocolate confectionery manufacturing	0.4	$24,144	$37,861	$189,245
53	Frozen food manufacturing	6.5	$356,700	$470,214	$2,297,529
54	Fruit and vegetable canning, pickling, and drying	3.7	$232,544	$384,598	$1,970,155
55	Fluid milk and butter manufacturing	3	$202,042	$446,353	$3,814,444
56	Cheese manufacturing	4.5	$304,238	$435,520	$4,574,485
57	Dry, condensed, and evaporated dairy product manufacturing	1.2	$83,458	$116,623	$1,124,099
58	Ice cream and frozen dessert manufacturing	0.7	$40,374	$54,051	$266,125
59	Animal (except poultry) slaughtering, rendering, and processing	9.6	$571,191	$469,648	$3,333,510
60	Poultry processing	10.1	$532,264	$762,728	$4,581,118
61	Seafood product preparation and packaging	0.3	$12,644	$13,856	$112,417
62	Bread and bakery product manufacturing	8.7	$342,447	$413,258	$1,536,202
63	Cookie, cracker, and pasta manufacturing	1.5	$75,837	$116,939	$653,899
64	Tortilla manufacturing	0.1	$4,872	$6,985	$27,796
65	Snack food manufacturing	1.3	$82,915	$195,416	$944,922
66	Coffee and tea manufacturing	0.4	$5,702	$9,705	$274,192
67	Flavoring syrup and concentrate manufacturing	0.4	$41,250	$224,624	$875,875
68	Seasoning and dressing manufacturing	1.4	$116,589	$148,555	$852,192
69	All other food manufacturing	1.9	$115,646	$160,221	$642,394
70	Soft drink and ice manufacturing	3.9	$379,334	$439,934	$3,105,854
71	Breweries	1.8	$163,852	$347,127	$1,573,109
72	Wineries	0.7	$33,172	$37,517	$244,680
73	Distilleries	0.1	$4,992	$10,347	$67,845
74	Tobacco product manufacturing	0	$685	$2,827	$10,987
75	Fiber, yarn, and thread mills	0	$1,068	$1,507	$8,381
76	Broadwoven fabric mills	0.3	$24,789	$37,755	$105,071
77	Narrow fabric mills and schiffli machine embroidery	0	$0	$0	$0
78	Nonwoven fabric mills	0.1	$6,369	$14,994	$44,266
79	Knit fabric mills	0	$1,447	$1,670	$8,547
80	Textile and fabric finishing mills	0	$645	$1,023	$3,987
81	Fabric coating mills	0	$1,699	$3,105	$11,687
82	Carpet and rug mills	0	$355	$461	$2,346
83	Curtain and linen mills	0.2	$9,156	$16,032	$43,527
84	Textile bag and canvas mills	0.2	$10,753	$14,694	$34,498
85	All other textile product mills	0.4	$19,363	$29,509	$82,905
86	Apparel knitting mills	0.8	$21,503	$29,508	$93,800
87	Cut and sew apparel contractors	0.1	$1,751	$2,071	$5,518
88	Mens and boys cut and sew apparel manufacturing	0.3	$7,265	$11,192	$36,644
89	Womens and girls cut and sew apparel manufacturing	0.1	$1,674	$4,112	$20,484
90	Other cut and sew apparel manufacturing	0.6	$17,622	$23,053	$65,852
91	Apparel accessories and other apparel manufacturing	0.3	$8,878	$11,807	$43,602
92	Leather and hide tanning and finishing	0	$1,695	$3,116	$16,410
93	Footwear manufacturing	0.4	$17,182	$23,992	$62,783
94	Other leather and allied product manufacturing	0.1	$3,419	$5,349	$14,323
95	Sawmills and wood preservation	0.7	$28,987	$34,309	$176,065
96	Veneer and plywood manufacturing	0.2	$9,967	$15,829	$54,594
97	Engineered wood member and truss manufacturing	0.2	$11,505	$19,747	$55,050
98	Reconstituted wood product manufacturing	0	$3,194	$3,785	$10,937
99	Wood windows and doors and millwork manufacturing	1.3	$56,201	$68,045	$226,718
100	Wood container and pallet manufacturing	1.5	$60,627	$76,153	$203,956
101	Manufactured home (mobile home) manufacturing	0	$330	$332	$1,055
102	Prefabricated wood building manufacturing	0.1	$4,577	$5,581	$15,657
103	All other miscellaneous wood product manufacturing	0.5	$25,227	$35,349	$105,313
104	Pulp mills	0	$232	$369	$1,891
105	Paper mills	2.3	$221,453	$448,035	$1,825,193
106	Paperboard Mills	0.1	$10,216	$17,995	$90,369
107	Paperboard container manufacturing	2.6	$211,665	$268,399	$1,122,004
108	Coated and laminated paper, packaging paper and plastics	1.2	$103,568	$158,764	$515,286

Sector	Description	Induced Effects Employment	Labor Income	Value Added	Output
	film manufacturing				
109	All other paper bag and coated and treated paper manufacturing	0.3	$24,348	$28,861	$117,597
110	Stationery product manufacturing	0.2	$15,211	$20,742	$86,349
111	Sanitary paper product manufacturing	1.4	$128,502	$371,479	$1,141,124
112	All other converted paper product manufacturing	0.4	$29,550	$39,210	$138,108
113	Printing	17.6	$1,067,503	$1,279,509	$3,189,783
114	Support activities for printing	0.2	$13,464	$15,787	$27,794
115	Petroleum refineries	0.1	$15,241	$80,271	$681,436
116	Asphalt paving mixture and block manufacturing	0	$396	$2,531	$5,028
117	Asphalt shingle and coating materials manufacturing	0	$233	$1,316	$3,630
118	Petroleum lubricating oil and grease manufacturing	0	$1,270	$7,979	$15,577
119	All other petroleum and coal products manufacturing	0	$2,676	$16,395	$43,238
120	Petrochemical manufacturing	0	$0	$0	$0
121	Industrial gas manufacturing	0	$723	$1,293	$5,191
122	Synthetic dye and pigment manufacturing	0	$523	$695	$4,668
123	Alkalies and chlorine manufacturing	0	$1,132	$1,488	$9,405
124	Carbon black manufacturing	0	$0	$0	$0
125	All other basic inorganic chemical manufacturing	0	$522	$735	$3,497
126	Other basic organic chemical manufacturing	0.1	$11,985	$16,863	$197,773
127	Plastics material and resin manufacturing	0	$3,908	$5,541	$54,121
128	Synthetic rubber manufacturing	0	$1,082	$1,468	$11,250
129	Artificial and synthetic fibers and filaments manufacturing	0	$0	$0	$0
130	Fertilizer manufacturing	0	$995	$1,472	$16,329
131	Pesticide and other agricultural chemical manufacturing	0.2	$20,301	$40,442	$272,728
132	Medicinal and botanical manufacturing	0	$2,064	$3,148	$9,749
133	Pharmaceutical preparation manufacturing	0.9	$106,697	$238,687	$1,204,054
134	In-vitro diagnostic substance manufacturing	0.3	$35,514	$42,475	$182,165
135	Biological product (except diagnostic) manufacturing	0.1	$14,016	$18,674	$72,133
136	Paint and coating manufacturing	0.2	$18,456	$25,703	$130,922
137	Adhesive manufacturing	0	$5,735	$7,651	$37,524
138	Soap and cleaning compound manufacturing	1	$188,803	$662,736	$1,742,733
139	Toilet preparation manufacturing	0	$1,790	$4,647	$17,732
140	Printing ink manufacturing	0.1	$11,177	$11,628	$51,953
141	All other chemical product and preparation manufacturing	0.1	$10,671	$13,792	$63,749
142	Plastics packaging materials and unlaminated film and sheet manufacturing	1	$83,683	$145,014	$454,268
143	Unlaminated plastics profile shape manufacturing	0.1	$7,892	$12,469	$36,958
144	Plastics pipe and pipe fitting manufacturing	0.1	$3,923	$7,287	$34,466
145	Laminated plastics plate, sheet (except packaging), and shape manufacturing	0	$1,370	$2,067	$7,387
146	Polystyrene foam product manufacturing	0.2	$13,350	$27,473	$91,720
147	Urethane and other foam product (except polystyrene) manufacturing	0.2	$12,535	$19,939	$70,028
148	Plastics bottle manufacturing	0.3	$15,911	$31,240	$110,776
149	Other plastics product manufacturing	3	$189,347	$285,627	$829,695
150	Tire manufacturing	0	$838	$1,439	$9,473
151	Rubber and plastics hoses and belting manufacturing	0	$1,907	$3,057	$7,353
152	Other rubber product manufacturing	0.2	$9,756	$15,925	$51,965
153	Pottery, ceramics, and plumbing fixture manufacturing	0.1	$2,282	$4,194	$10,388
154	Brick, tile, and other structural clay product manufacturing	0	$255	$659	$1,536
155	Clay and nonclay refractory manufacturing	0	$36	$10	$92
156	Flat glass manufacturing	0	$1,453	$4,515	$10,551
157	Other pressed and blown glass and glassware manufacturing	0	$280	$649	$1,798
158	Glass container manufacturing	0.3	$25,465	$68,075	$144,878
159	Glass product manufacturing made of purchased glass	0.4	$25,600	$46,467	$113,976
160	Cement manufacturing	0	$162	$461	$1,470
161	Ready-mix concrete manufacturing	0.6	$39,110	$62,197	$192,244
162	Concrete pipe, brick, and block manufacturing	0.1	$5,138	$11,628	$30,223

Sector	Description	Induced Effects Employment	Labor Income	Value Added	Output
163	Other concrete product manufacturing	0.7	$42,701	$70,901	$151,341
164	Lime and gypsum product manufacturing	0.1	$8,830	$25,818	$59,970
165	Abrasive product manufacturing	0	$2,057	$7,766	$16,549
166	Cut stone and stone product manufacturing	0.9	$46,082	$63,650	$134,854
167	Ground or treated mineral and earth manufacturing	0	$1,237	$7,519	$12,766
168	Mineral wool manufacturing	0	$2,932	$8,592	$20,299
169	Miscellaneous nonmetallic mineral product manufacturing	0	$1,079	$2,845	$6,895
170	Iron and steel mills and ferroalloy manufacturing	0	$1,445	$959	$18,695
171	Steel product manufacturing from purchased steel	0.1	$6,485	$5,405	$56,570
172	Alumina refining and primary aluminum production	0	$0	$0	$0
173	Secondary smelting and alloying of aluminum	0	$365	$280	$6,874
174	Aluminum product manufacturing from purchased aluminum	0.1	$3,289	$2,430	$32,324
175	Primary smelting and refining of copper	0	$0	$0	$0
176	Primary smelting and refining of nonferrous metal (except copper and aluminum)	0	$0	$0	$0
177	Copper rolling, drawing, extruding and alloying	0	$362	$247	$3,819
178	Nonferrous metal (except copper and aluminum) rolling, drawing, extruding and alloying	0	$317	$126	$5,535
179	Ferrous metal foundries	0.1	$8,236	$7,080	$29,346
180	Nonferrous metal foundries	0.1	$4,959	$4,651	$17,166
181	All other forging, stamping, and sintering	0.1	$8,206	$10,648	$46,153
182	Custom roll forming	0	$475	$725	$2,348
183	Crown and closure manufacturing and metal stamping	0.2	$12,596	$20,277	$73,924
184	Cutlery, utensil, pot, and pan manufacturing	0.5	$43,684	$65,740	$161,819
185	Handtool manufacturing	0.1	$6,861	$9,441	$24,270
186	Plate work and fabricated structural product manufacturing	0.3	$22,484	$30,396	$90,128
187	Ornamental and architectural metal products manufacturing	0.8	$51,274	$63,664	$178,275
188	Power boiler and heat exchanger manufacturing	0.1	$10,305	$13,624	$38,972
189	Metal tank (heavy gauge) manufacturing	0	$2,391	$3,251	$10,195
190	Metal can, box, and other metal container (light gauge) manufacturing	0.6	$48,571	$90,821	$395,421
191	Ammunition manufacturing	0.1	$3,399	$6,289	$17,933
192	Arms, ordnance, and accessories manufacturing	0.1	$2,969	$6,275	$17,448
193	Hardware manufacturing	0.1	$8,395	$13,151	$35,868
194	Spring and wire product manufacturing	0.1	$8,081	$12,042	$31,421
195	Machine shops	0.5	$32,645	$38,535	$86,859
196	Turned product and screw, nut, and bolt manufacturing	0.1	$5,850	$8,283	$21,589
197	Coating, engraving, heat treating and allied activities	0.3	$18,274	$26,284	$77,697
198	Valve and fittings other than plumbing manufacturing	0.1	$3,607	$8,785	$28,500
199	Plumbing fixture fitting and trim manufacturing	0	$2,311	$3,328	$9,220
200	Ball and roller bearing manufacturing	0	$1,564	$2,601	$7,438
201	Fabricated pipe and pipe fitting manufacturing	0.1	$4,984	$6,658	$18,179
202	Other fabricated metal manufacturing	1.1	$73,733	$119,719	$316,294
203	Farm machinery and equipment manufacturing	0	$2,260	$4,295	$16,005
204	Lawn and garden equipment manufacturing	0.1	$5,042	$9,790	$38,242
205	Construction machinery manufacturing	0	$992	$1,982	$9,741
206	Mining and oil and gas field machinery manufacturing	0	$242	$357	$1,312
207	Other industrial machinery manufacturing	0.1	$9,582	$16,096	$46,897
208	Plastics and rubber industry machinery manufacturing	0	$279	$354	$1,015
209	Semiconductor machinery manufacturing	0	$0	$0	$0
210	Vending, commercial, industrial, and office machinery manufacturing	0	$2,122	$2,740	$9,618
211	Optical instrument and lens manufacturing	0	$117	$155	$490
212	Photographic and photocopying equipment manufacturing	0	$100	$195	$500
213	Other commercial and service industry machinery manufacturing	0.1	$6,232	$12,337	$34,576
214	Air purification and ventilation equipment manufacturing	0.1	$3,969	$7,355	$20,115
215	Heating equipment (except warm air furnaces) manufacturing	0.1	$5,774	$7,935	$21,855
216	Air conditioning, refrigeration, and warm air heating	0.2	$16,123	$21,101	$54,153

Sector	Description	Induced Effects Employment	Labor Income	Value Added	Output
	equipment manufacturing				
217	Industrial mold manufacturing	0	$1,830	$2,221	$3,908
218	Metal cutting and forming machine tool manufacturing	0	$632	$944	$2,258
219	Special tool, die, jig, and fixture manufacturing	0	$2,187	$2,639	$5,289
220	Cutting tool and machine tool accessory manufacturing	0	$1,552	$2,128	$4,219
221	Rolling mill and other metalworking machinery manufacturing	0	$221	$299	$727
222	Turbine and turbine generator set units manufacturing	0	$1,037	$2,492	$5,201
223	Speed changer, industrial high-speed drive, and gear manufacturing	0	$2,684	$4,115	$9,281
224	Mechanical power transmission equipment manufacturing	0	$1,977	$3,068	$7,794
225	Other engine equipment manufacturing	0.1	$10,439	$19,963	$103,118
226	Pump and pumping equipment manufacturing	0	$2,177	$3,466	$10,525
227	Air and gas compressor manufacturing	0	$271	$378	$1,446
228	Material handling equipment manufacturing	0	$2,591	$4,125	$13,773
229	Power-driven handtool manufacturing	0	$468	$803	$2,268
230	Other general purpose machinery manufacturing	0	$798	$1,128	$3,096
231	Packaging machinery manufacturing	0	$1,499	$1,813	$4,586
232	Industrial process furnace and oven manufacturing	0	$839	$1,442	$3,120
233	Fluid power process machinery manufacturing	0	$1,032	$1,517	$4,225
234	Electronic computer manufacturing	0.1	$8,033	$22,847	$99,556
235	Computer storage device manufacturing	0	$1,420	$4,029	$15,762
236	Computer terminals and other computer peripheral equipment manufacturing	0.1	$3,389	$4,679	$19,897
237	Telephone apparatus manufacturing	0	$1,776	$3,873	$11,575
238	Broadcast and wireless communications equipment manufacturing	0	$1,222	$1,159	$7,795
239	Other communications equipment manufacturing	0	$1,757	$2,648	$8,146
240	Audio and video equipment manufacturing	0.1	$3,123	$4,295	$26,662
241	Electron tube manufacturing	0	$193	$185	$831
242	Bare printed circuit board manufacturing	0	$1,826	$2,142	$7,311
243	Semiconductor and related device manufacturing	0	$444	$1,266	$4,033
244	Electronic capacitor, resistor, coil, transformer, and other inductor manufacturing	0	$799	$1,221	$2,629
245	Electronic connector manufacturing	0	$104	$148	$491
246	Printed circuit assembly (electronic assembly) manufacturing	0.1	$9,007	$10,973	$37,606
247	Other electronic component manufacturing	0	$2,480	$2,935	$8,914
248	Electromedical and electrotherapeutic apparatus manufacturing	0.7	$75,723	$140,415	$339,371
249	Search, detection, and navigation instruments manufacturing	0	$190	$296	$860
250	Automatic environmental control manufacturing	0	$662	$1,083	$3,176
251	Industrial process variable instruments manufacturing	0	$1,253	$1,736	$5,030
252	Totalizing fluid meters and counting devices manufacturing	0	$906	$1,341	$5,823
253	Electricity and signal testing instruments manufacturing	0	$183	$288	$646
254	Analytical laboratory instrument manufacturing	0	$2,761	$3,659	$11,046
255	Irradiation apparatus manufacturing	0.1	$7,373	$14,858	$32,816
256	Watch, clock, and other measuring and controlling device manufacturing	0	$3,925	$5,621	$15,945
257	Software, audio, and video media for reproduction	0	$2,307	$3,107	$10,675
258	Magnetic and optical recording media manufacturing	0	$0	$0	$0
259	Electric lamp bulb and part manufacturing	0	$0	$0	$0
260	Lighting fixture manufacturing	0.2	$13,337	$19,198	$70,265
261	Small electrical appliance manufacturing	0.2	$17,850	$31,463	$105,296
262	Household cooking appliance manufacturing	0.2	$11,961	$16,898	$75,992
263	Household refrigerator and home freezer manufacturing	0.1	$6,870	$10,859	$42,655
264	Household laundry equipment manufacturing	0	$0	$0	$0
265	Other major household appliance manufacturing	0.2	$12,754	$21,515	$97,698
266	Power, distribution, and specialty transformer manufacturing	0	$2,689	$3,647	$10,331
267	Motor and generator manufacturing	0.1	$6,003	$9,403	$29,678

		Induced Effects			
Sector	Description	Employment	Labor Income	Value Added	Output
268	Switchgear and switchboard apparatus manufacturing	0.1	$7,669	$12,523	$32,524
269	Relay and industrial control manufacturing	0.1	$18,900	$26,328	$62,843
270	Storage battery manufacturing	0.1	$13,436	$16,953	$59,052
271	Primary battery manufacturing	0.4	$38,619	$101,062	$241,283
272	Communication and energy wire and cable manufacturing	0	$3,095	$4,973	$18,783
273	Wiring device manufacturing	0.1	$4,858	$8,067	$26,490
274	Carbon and graphite product manufacturing	0	$1,842	$2,836	$9,544
275	All other miscellaneous electrical equipment and component manufacturing	0	$2,115	$2,920	$8,633
276	Automobile manufacturing	0	$372	$397	$5,471
277	Light truck and utility vehicle manufacturing	0	$0	$0	$0
278	Heavy duty truck manufacturing	0.1	$7,246	$8,923	$90,677
279	Motor vehicle body manufacturing	0.1	$4,097	$3,992	$16,805
280	Truck trailer manufacturing	0	$67	$67	$416
281	Motor home manufacturing	0	$1,027	$990	$7,200
282	Travel trailer and camper manufacturing	0.1	$5,810	$5,851	$30,997
283	Motor vehicle parts manufacturing	0.6	$40,678	$40,241	$287,688
284	Aircraft manufacturing	0	$144	$124	$918
285	Aircraft engine and engine parts manufacturing	0	$288	$251	$1,849
286	Other aircraft parts and auxiliary equipment manufacturing	0	$266	$255	$1,176
287	Guided missile and space vehicle manufacturing	0	$0	$0	$0
288	Propulsion units and parts for space vehicles and guided missiles manufacturing	0	$11	$11	$29
289	Railroad rolling stock manufacturing	0	$343	$303	$2,048
290	Ship building and repairing	0	$86	$89	$303
291	Boat building	0.3	$16,717	$16,189	$90,943
292	Motorcycle, bicycle, and parts manufacturing	0.5	$62,949	$83,907	$418,003
293	Military armored vehicle, tank, and tank component manufacturing	0	$10	$9	$41
294	All other transportation equipment manufacturing	0	$3,786	$2,515	$26,534
295	Wood kitchen cabinet and countertop manufacturing	0.7	$30,758	$31,812	$97,951
296	Upholstered household furniture manufacturing	0.6	$23,907	$36,024	$97,022
297	Nonupholstered wood household furniture manufacturing	1.7	$90,049	$135,705	$253,970
298	Metal and other household furniture manufacturing	0.1	$4,474	$5,147	$14,007
299	Institutional furniture manufacturing	0.1	$4,716	$11,454	$28,067
300	Office Furniture	0.2	$10,568	$17,511	$36,108
301	Custom architectural woodwork and millwork manufacturing	0	$120	$146	$323
302	Showcase, partition, shelving, and locker manufacturing	0.1	$5,088	$8,624	$22,391
303	Mattress manufacturing	0.3	$17,735	$40,449	$112,434
304	Blind and shade manufacturing	0.5	$35,951	$38,203	$78,264
305	Surgical and medical instrument, laboratory and medical instrument manufacturing	0.2	$13,692	$18,366	$43,997
306	Surgical appliance and supplies manufacturing	0.6	$41,067	$62,709	$127,592
307	Dental equipment and supplies manufacturing	0.1	$8,647	$13,975	$30,442
308	Ophthalmic goods manufacturing	0.1	$4,865	$7,535	$16,725
309	Dental laboratories manufacturing	1.1	$58,179	$59,249	$92,027
310	Jewelry and silverware manufacturing	0.1	$4,435	$6,958	$26,659
311	Sporting and athletic goods manufacturing	0.5	$29,010	$45,965	$121,625
312	Doll, toy, and game manufacturing	0.2	$15,702	$25,830	$62,140
313	Office supplies (except paper) manufacturing	0.1	$6,642	$11,876	$20,497
314	Sign manufacturing	1.5	$119,597	$119,882	$240,838
315	Gasket, packing, and sealing device manufacturing	0	$2,851	$3,549	$7,748
316	Musical instrument manufacturing	0.1	$5,223	$5,959	$12,500
317	All other miscellaneous manufacturing	2.7	$185,874	$244,428	$532,234
318	Broom, brush, and mop manufacturing	0.5	$26,492	$48,321	$99,008
319	Wholesale trade businesses	169.6	$13,018,083	$21,362,946	$33,216,354
320	Retail Stores - Motor vehicle and parts	175.5	$8,655,462	$10,261,910	$14,776,647
321	Retail Stores - Furniture and home furnishings	33.6	$1,278,181	$1,639,378	$2,951,841
322	Retail Stores - Electronics and appliances	41.1	$1,841,334	$2,783,628	$3,577,336

Sector	Description	Induced Effects Employment	Labor Income	Value Added	Output
323	Retail Stores - Building material and garden supply	84.4	$3,061,416	$4,336,953	$6,282,350
324	Retail Stores - Food and beverage	258.4	$7,078,677	$9,095,375	$13,414,321
325	Retail Stores - Health and personal care	83.6	$3,310,584	$3,978,457	$5,928,681
326	Retail Stores - Gasoline stations	86	$2,881,361	$4,177,866	$5,745,119
327	Retail Stores - Clothing and clothing accessories	96	$2,117,406	$3,696,927	$6,002,793
328	Retail Stores - Sporting goods, hobby, book and music	69.2	$1,401,726	$2,168,554	$2,973,856
329	Retail Stores - General merchandise	284.9	$7,643,074	$11,854,828	$15,082,883
330	Retail Stores - Miscellaneous	150	$2,523,463	$4,240,226	$5,621,358
331	Retail Nonstores - Direct and electronic sales	140.9	$3,275,943	$10,059,152	$12,772,264
332	Transport by air	5.6	$340,914	$638,288	$1,675,201
333	Transport by rail	1.6	$223,422	$433,755	$845,916
334	Transport by water	0.2	$11,398	$19,371	$72,207
335	Transport by truck	56.1	$3,340,173	$4,018,117	$8,278,777
336	Transit and ground passenger transportation	42.5	$1,432,793	$1,917,831	$2,522,584
337	Transport by pipeline	0.5	$72,844	$133,248	$262,883
338	Scenic and sightseeing transportation and support activities for transportation	8.2	$285,082	$295,275	$672,327
339	Couriers and messengers	19.6	$890,389	$1,154,900	$1,813,384
340	Warehousing and storage	20.5	$1,079,878	$1,399,657	$1,841,749
341	Newspaper publishers	12.7	$486,128	$628,617	$1,393,048
342	Periodical publishers	5.5	$293,860	$388,915	$1,443,994
343	Book publishers	2	$132,831	$260,970	$662,383
344	Directory, mailing list, and other publishers	0.7	$48,629	$86,639	$220,925
345	Software publishers	4.3	$422,166	$880,517	$1,858,521
346	Motion picture and video industries	9.2	$198,035	$350,281	$1,111,965
347	Sound recording industries	1.2	$81,245	$224,118	$825,654
348	Radio and television broadcasting	8	$521,582	$458,014	$1,527,992
349	Cable and other subscription programming	0.5	$54,909	$62,043	$223,328
350	Internet publishing and broadcasting	1.4	$94,319	$81,457	$236,225
351	Telecommunications	33.4	$2,396,532	$9,165,566	$17,970,860
352	Data processing, hosting, ISP, web search portals and related services	13.5	$1,091,478	$2,346,176	$3,690,029
353	Other information services	0.2	$7,186	$11,950	$22,659
354	Monetary authorities and depository credit intermediation activities	132.2	$9,157,630	$28,802,452	$41,211,028
355	Nondepository credit intermediation and related activities	33.1	$2,845,231	$2,725,651	$4,521,325
356	Securities, commodity contracts, investments, and related activities	123.8	$6,071,722	$5,110,499	$18,620,668
357	Insurance carriers	50.3	$3,949,989	$11,772,441	$17,382,908
358	Insurance agencies, brokerages, and related activities	26.4	$1,690,061	$3,206,027	$4,410,894
359	Funds, trusts, and other financial vehicles	26.9	$816,528	$2,051,830	$8,037,599
360	Real estate establishments	580.3	$6,214,488	$76,337,782	$94,504,191
361	Imputed rental activity for owner-occupied dwellings	0	$0	$69,919,374	$95,113,167
362	Automotive equipment rental and leasing	6.7	$329,827	$760,488	$1,298,133
363	General and consumer goods rental except video tapes and discs	13.3	$628,889	$630,666	$1,065,812
364	Video tape and disc rental	3.8	$88,759	$172,540	$263,789
365	Commercial and industrial machinery and equipment rental and leasing	1.7	$137,779	$218,585	$419,601
366	Lessors of nonfinancial intangible assets	0.5	$23,205	$995,665	$1,087,896
367	Legal services	62.8	$4,881,426	$7,428,491	$9,361,887
368	Accounting, tax preparation, bookkeeping, and payroll services	34.3	$1,845,031	$2,901,537	$3,618,289
369	Architectural, engineering, and related services	17.2	$1,044,472	$1,061,997	$1,860,367
370	Specialized design services	2.5	$139,806	$240,761	$327,440
371	Custom computer programming services	2.7	$201,741	$229,872	$361,561
372	Computer systems design services	8.7	$597,246	$477,862	$749,886
373	Other computer related services, including facilities management	3	$318,421	$542,245	$733,427

Sector	Description	Induced Effects Employment	Labor Income	Value Added	Output
374	Management, scientific, and technical consulting services	21.8	$1,625,497	$1,697,064	$2,556,225
375	Environmental and other technical consulting services	6	$353,429	$375,605	$531,327
376	Scientific research and development services	11.9	$949,594	$1,074,145	$2,041,553
377	Advertising and related services	21.9	$1,118,251	$2,304,908	$3,177,283
378	Photographic services	2.7	$73,561	$229,781	$288,180
379	Veterinary services	24	$742,397	$853,736	$1,441,777
380	All other miscellaneous professional, scientific, and technical services	6	$429,471	$795,087	$1,066,579
381	Management of companies and enterprises	35.5	$3,905,091	$4,529,620	$7,483,607
382	Employment services	132.9	$3,760,899	$4,225,843	$5,131,142
383	Travel arrangement and reservation services	6.9	$426,840	$812,006	$1,191,487
384	Office administrative services	9.7	$666,165	$608,273	$963,298
385	Facilities support services	0.5	$56,449	$132,486	$163,302
386	Business support services	34.8	$1,189,019	$1,256,790	$2,082,263
387	Investigation and security services	18.9	$533,229	$547,323	$805,922
388	Services to buildings and dwellings	88.6	$2,200,493	$2,816,383	$5,094,895
389	Other support services	14.5	$484,920	$971,206	$1,460,928
390	Waste management and remediation services	13.3	$804,625	$1,356,039	$2,692,979
391	Private elementary and secondary schools	49.4	$1,330,489	$1,733,858	$2,408,254
392	Private junior colleges, colleges, universities, and professional schools	190.3	$8,547,206	$9,039,625	$16,051,103
393	Other private educational services	108.3	$2,631,268	$3,336,330	$5,359,084
394	Offices of physicians, dentists, and other health practitioners	318.4	$30,367,320	$31,773,803	$46,149,042
395	Home health care services	62.6	$2,082,737	$2,262,945	$3,171,513
396	Medical and diagnostic labs and outpatient and other ambulatory care services	94.4	$6,812,181	$11,552,309	$14,443,044
397	Private hospitals	391.2	$26,320,948	$29,516,703	$54,387,053
398	Nursing and residential care facilities	268.5	$8,984,424	$10,367,663	$15,802,119
399	Child day care services	139.4	$3,211,288	$4,278,955	$6,097,458
400	Individual and family services	173.2	$4,167,866	$4,093,197	$6,379,984
401	Community food, housing, and other relief services, including rehabilitation services	56.7	$1,776,503	$1,764,540	$2,950,209
402	Performing arts companies	24.8	$248,179	$274,204	$668,685
403	Spectator sports companies	22.9	$1,252,847	$1,095,255	$1,663,463
404	Promoters of performing arts and sports and agents for public figures	23.7	$199,726	$260,861	$1,072,392
405	Independent artists, writers, and performers	5.2	$65,559	$116,913	$306,396
406	Museums, historical sites, zoos, and parks	6.5	$200,800	$366,711	$707,437
407	Fitness and recreational sports centers	34	$508,683	$620,461	$1,149,863
408	Bowling centers	2.9	$39,158	$56,431	$90,541
409	Amusement parks, arcades, and gambling industries	38	$904,817	$1,041,341	$2,231,182
410	Other amusement and recreation industries	37.2	$740,441	$1,041,503	$1,695,733
411	Hotels and motels, including casino hotels	9.2	$210,416	$416,631	$899,867
412	Other accommodations	1.2	$38,656	$53,584	$107,400
413	Food services and drinking places	820.8	$15,502,093	$22,358,776	$43,876,576
414	Automotive repair and maintenance, except car washes	70.1	$3,070,977	$3,409,394	$5,481,856
415	Car washes	11.4	$260,583	$285,601	$461,373
416	Electronic and precision equipment repair and maintenance	6.8	$633,136	$767,581	$1,139,737
417	Commercial and industrial machinery and equipment repair and maintenance	9	$637,889	$774,940	$1,102,878
418	Personal and household goods repair and maintenance	4.9	$286,935	$429,558	$619,005
419	Personal care services	86.5	$3,107,188	$3,356,951	$5,131,576
420	Death care services	17	$1,069,810	$1,128,862	$1,707,328
421	Dry-cleaning and laundry services	26.7	$1,329,655	$1,283,544	$1,509,889
422	Other personal services	20.9	$777,875	$939,078	$2,083,819
423	Religious organizations	6.2	$267,261	$1,307,663	$1,793,493
424	Grantmaking, giving, and social advocacy organizations	84	$4,288,286	$3,656,456	$6,736,374
425	Civic, social, professional, and similar organizations	161	$4,952,154	$4,120,966	$7,113,048
426	Private household operations	79.5	$505,592	$505,592	$508,502

Sector	Description	Induced Effects			
		Employment	Labor Income	Value Added	Output
427	US Postal Service	27.2	$2,126,682	$2,008,214	$2,445,781
428	Federal electric utilities	0	$0	$0	$0
429	Other Federal Government enterprises	3.7	$221,346	$480,831	$621,143
430	State and local government passenger transit	7	$351,691	($368,327)	$183,523
431	State and local government electric utilities	1.4	$128,098	$240,193	$377,903
432	Other state and local government enterprises	49.8	$3,533,811	$4,594,896	$9,576,594
433	* Not an industry (Used and secondhand goods)	0	$0	$0	$0
434	* Not an industry (Scrap)	0	$0	$0	$0
435	* Not an industry (Rest of the world adjustment)	0	$0	$0	$0
436	* Not an industry (Noncomparable foreign imports)	0	$0	$0	$0
437	* Employment and payroll only (state & local govt, non-education)	0	$0	$0	$0
438	* Employment and payroll only (state & local govt, education)	0	$0	$0	$0
439	* Employment and payroll only (federal govt, non-military)	0	$0	$0	$0
440	* Employment and payroll only (federal govt, military)	0	$0	$0	$0

Table 45 Economic Summary of Ultra-Heavy Trucks using REMI Model

Category	Units	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Total Employment	Thousands (Jobs)	(4,649)	(3,914)	(3,189)	(2,507)	(1,932)	(1,446)	(1,040)	(707)	(438)	(221)	(44)
Total Employment as % of Nation	Percent	(0)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Private Non-Farm Employment	Thousands (Jobs)	(4,319)	(3,643)	(2,976)	(2,346)	(1,816)	(1,366)	(991)	(684)	(434)	(233)	(70)
Private Non-Farm Employment as % of Nation	Percent	(0)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Gross Domestic Product	Billions of Fixed (2005) Dollars	(321,856)	(268,064)	(214,592)	(163,776)	(120,928)	(84,256)	(53,536)	(28,320)	(8,000)	8,448	21,472
Gross Domestic Product (GDP) as % of Nation	Percent	(0)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	0.00	0.00
Output	Billions of Fixed (2005) Dollars	(452,352)	(343,872)	(237,568)	(138,176)	(55,104)	15,552	73,984	121,728	160,000	190,464	214,912
Value Added	Billions of Fixed (2005) Dollars	(318,656)	(263,488)	(208,608)	(156,544)	(112,576)	(74,976)	(43,552)	(17,664)	3,264	20,096	33,600
Personal Income*	Billions of Current Dollars	(566,176)	(550,336)	(527,328)	(500,096)	(473,312)	(447,904)	(424,672)	(404,000)	(386,080)	(370,560)	(357,248)
Personal Income as % of Nation	Percent	(0)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Disposable Personal Income	Billions of Current Dollars	(478,240)	(465,664)	(446,848)	(424,288)	(401,952)	(380,576)	(360,960)	(343,456)	(328,128)	(314,880)	(303,424)
Disposable Personal Income as % of Nation	Percent	(0)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
PCE-Price Index	2005=100 (Nation)	(0)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
Real Disposable Personal Income	Billions of Fixed (2005) Dollars	(426,272)	(405,504)	(384,784)	(362,016)	(341,056)	(321,088)	(303,424)	(287,552)	(274,176)	(262,464)	(252,032)
Real Disposable Personal Income as % of Nation	Percent	(0)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Population	Thousands	(687)	(996)	(1,098)	(1,043)	(883)	(649)	(368)	(62)	256	572	884
Population as % of Nation	Percent	(0)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	0.00	0.00	0.00

Table 46 Employment Impacts of Ultra-Heavy Trucks using REMI Model

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Total Employment	(4,648,750)	(3,913,750)	(3,189,250)	(2,506,500)	(1,932,000)	(1,446,000)	(1,039,500)	(707,250)	(437,500)	(220,500)	(44,000)
Private Non-Farm	(4,318,500)	(3,642,750)	(2,975,500)	(2,346,250)	(1,815,750)	(1,365,750)	(990,500)	(683,500)	(433,750)	(232,750)	(69,750)
Government	(330,594)	(270,813)	(213,313)	(160,281)	(116,813)	(79,906)	(49,250)	(24,094)	(3,688)	12,750	25,906