TITLE: Modal Diversion Estimates Using USDOT's ITIC-IM Model

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ABSTRACT

Spurred by transportation related findings from the Wisconsin Economic Development Corporation's *The Wisconsin Economic Future Study: Statewide and Regional Analysis*, a general interest in intermodal diversion from federal, state, and local transportation agencies (to alleviate roadway congestion, reduce road deterioration, and reduce transportation sourced emissions and pollutants), and seemingly constant commentary from the state's private sector freight stakeholders seeking increased intermodal services, this research outlines and demonstrates an approach and methodology for assessing domestic truck traffic suitable for diversion to intermodal truck to rail shipping. Estimates of diverted loads from trucking to truck-to-rail intermodal vary depending on the associated cost savings, the commodity being shipped, and the distance between origin and destination. Model results suggest that non-monetary incentives would be necessary for large volumes of freight to divert.

Keywords: freight, modal diversion, USDOT, Intermodal Transportation and Inventory Cost Model

INTRODUCTION

In June of 2013, the Wisconsin Economic Development Corporation (WEDC) released *The Wisconsin Economic Future Study: Statewide and Regional Analysis*. The economic report provided a snap-shot of the state's recent economic performance, as well as an analysis highlighting the industries that "drive" its economy. "From an economic perspective, driver industries are relatively concentrated in a region and produce more goods than can be consumed locally. These companies sell their products outside of the region, thereby bringing new monies back into the region. Thus, they drive regional economic growth." *(1)*

Manufacturing activity accounts for 15.4 percent of Wisconsin employment and 19 percent of the state's gross product. All but one of the 37 driver industries identified in the WEDC report are manufacturers classified at the subsector level. Combine the driver industries' importance with the state's reliance on agriculture and a mining sector reinvigorated due to frac sand, and it is obvious getting goods exported out of the state to domestic and global markets is crucial for individual companies as well as Wisconsin's economy as a whole.

In order for companies to achieve profitability, transportation infrastructure must be in place to provide companies with the ability to get raw materials, intermediate goods, and finished products from source to market. Do Wisconsin shippers have the access to the freight rail transportation network they need in order to do this economically? The WEDC report would lead us to believe the answer is no. As the report states, "Transportation and logistics costs for some products exceed the cost of goods sold for the product. Manufacturing executives encourage the development of regional rail hubs or multimodal distribution centers to better connect them and their goods to customer bases throughout the state and across the country."

Intermodalism allows shippers to utilize the rail network without being located directly on a rail line, and allows them to take advantage of the various modes used such as the economies of scale associated with moving freight long distances via rail as well as the flexibility to service the first and last mile using trucks. Both the public and private sectors seek ways to increase the volume of freight moved intermodally. While the details may vary, the benefits of using rail instead of truck are commonly accepted:

- Increased fuel efficiency: Railroads doubled their fuel efficiency between 1980 and 2014 making them four times more fuel efficient than trucks *(2)*, consuming roughly 320 British thermal units (Btu) per ton-mile compared to 1,390 Btu per ton-mile for trucking *(3)*.
- Reduced greenhouse gas emissions (GHGs) and pollutants: shipping by rail versus truck can reduce GHGs by two-thirds *(4)*, and reduce other pollutants significantly due to trucks emitting 6-12 times more pollutants than rail on a per ton-mile basis *(5)*. The Association of American Railroads (AAR) states if five percent of freight shifted from truck to rail, it would be the same as removing 1.8 million cars from the road (800 million gallons in fuel and nine million tons of GHGs) *(2)*.
- Reduced congestion: The AAR cites the *2015 Urban Mobility Scorecard*, which monetized the costs of roadway congestion in 2014 at $160 billion (6.9 billion hours of wasted time and 3.1 billion gallons of fuel). With one train's carrying capacity being equal to several hundred trucks, the 175 million tons of 2012 rail freight that originated from, terminated in, or moved through Wisconsin would have required 9.7 million additional trucks *(6)*.
- Reduced highway maintenance costs: Removing heavy trucks from roadways can extend the life of the pavement. The average impact of one tuck is equivalent to approximately 4,000 cars on flexible pavements and 6,200 cars on rigid pavements *(7)*.
- Increased economic competitiveness: According to WisDOT's rail plan, "A growing economy in Wisconsin requires a strong multimodal transportation system," and, "More efficient access to the freight rail system, such as new intermodal facilities and continuing state support of short lines, can lower transportation costs for shippers," that can then be leveraged to "help retain existing work forces and businesses and attract new ones."

The U.S. Department of Energy's 2013 report *Freight Transportation Modal Shares: Scenarios* *for a Low-Carbon Future* mentions sustainability is gaining popularity in the private sector. This interest includes the incorporation of sustainability metrics of GHG, pollutant emissions, and fuel efficiency into the supply chain decision-making process, a rise in programs and certifications recognizing and validating sustainability efforts such as the Environmental Protection Agency's SmartWay, and a growing recognition of the supply chain's role in helping a company achieve "greenness". However, despite this growing interest in sustainability, projections of continuing environmental regulations benefitting and inducing intermodal rail shipments *(8)*, and the fact intermodal is the rail industry's fastest growing market segment *(9)*, the report also highlights some remaining challenges limiting the amount of freight that can shift to the intermodal segment:

- Trucking's ability to outcompete other modes when considering the totality of cost, speed, and reliability from the shipper's perspective.
- Shipper's ability to obtain environmental efficiency gains via purchasing new or retrofitting old trucks, or through other pieces of the supply chain, such as changes in packaging or relocation of warehousing and distribution facilities.
- The limited market size from which to gain market share via mode shift (the tonnage of freight moving over 500 miles is smaller than the amount moving less than 500 miles).

Taking into consideration the transportation related findings from the WEDC report, the general interest in modal conversion to intermodal from federal, state, and local transportation agencies, and seemingly constant commentary from the state's private sector freight stakeholders seeking increased intermodal services, researchers set out to estimate potential truck-to-rail intermodal conversions should the number of intermodal terminals increase in the state.

STUDY AREA

Analysis covers the state of Wisconsin (the locations of WEDC shippers in selected industries, potential locations for intermodal terminals, and regions within the state down to the county level), regional intermodal terminals in Illinois and Minnesota, and various U.S. metro regions across the nation (the individual or aggregated FAF zones in Figure 1). In general, the study is interested in the volumes of select commodities moved between origins and destinations represented by the Wisconsin manufacturers from the WEDC report and the U.S. metro regions using either the trucking mode or a trailer on flat car (TOFC) truck-to-rail intermodal move. Industries analyzed were selected based on importance to the state's economy (size, forecasted growth rates, competitiveness, and volume of freight flows), and include: Wisconsin manufacturers exporting food and beverage products (NAICS 311 and 312); Wisconsin manufacturers exporting paper products (NAICS 322); Wisconsin manufacturers exporting machinery products (NAICS 333); and Wisconsin manufacturers importing plastics and rubber inputs (NAICS 326). The four industries represent roughly 43.5 percent of the businesses in the WEDC Driver Industry dataset, and are responsible for 8.2 percent of the entire state's domestic product.

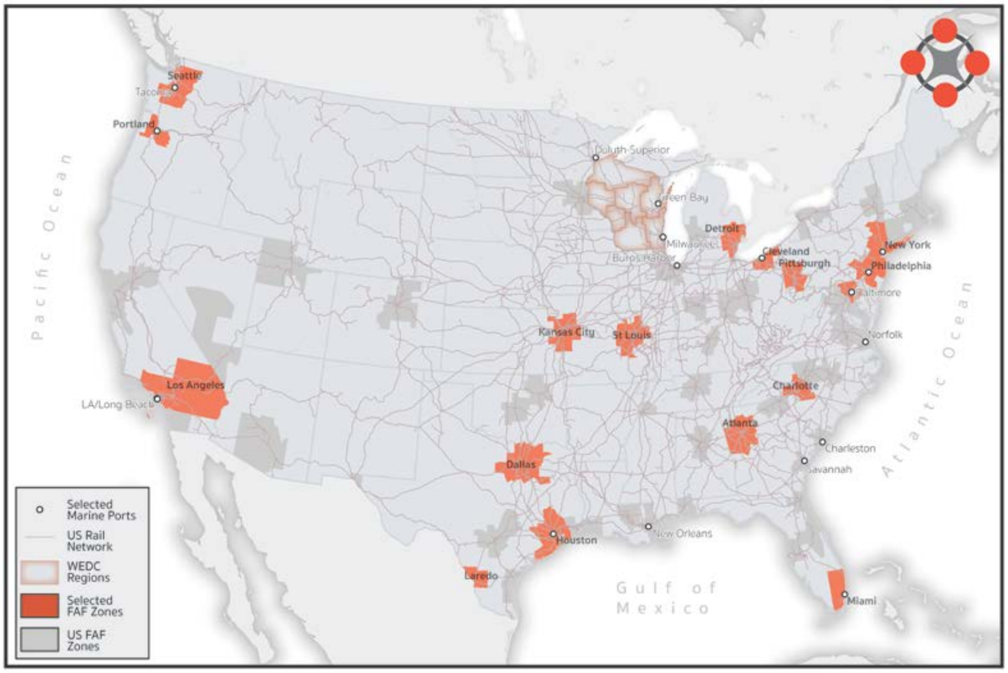

FIGURE 1 Study Area for Estimation of Potential Modal Diversion from Truck to Intermodal Rail.

METHODOLOGY AND DATA

The Intermodal Transportation and Inventory Cost Model (ITIC) was initially created in 1995 as a discrete choice model in conjunction with disaggregated freight movement data for performing policy analysis of issues concerning long-haul freight movement. It provides modal diversion estimates based on changes in transportation infrastructure, operations, or government policies, and the associated total logistics costs (including inventory costs) using a base-case versus policy-case analysis.

The particular model used in this effort, the Highway-to-Rail Intermodal version (ITIC-IM), is a slight variation of the model used by the U.S. Department of Transportation to report to Congress regarding its *Comprehensive Truck Size and Weight Study*. The National Transportation Research Center, Incorporated (NTRCI), used the ITIC-IM model to provide information describing the potential effects in various short-haul intermodal lanes due to a 50 percent increase in fuel costs and 25 percent reductions in both non-line-haul intermodal costs and transit times (*10*).

According to the model's user manual, a number of variables can affect the choice of supplier, the shipment size, and the mode to transport the freight. These are integrated into the model, and include:

- Type of Receiver: producer, wholesaler, retailer, government, or individual consumer
    - Affects buying decision and choice of supplier (length of haul, carriers available, and purchase price of product) and finally mode choice
- Type of Product: product annual usage, value per pound of product, time sensitivity (shelf life), storage requirements
    - Affects size of shipment and ability of receiver to hold product in inventory and choice of shipment size (cost of ordering, (un)loading, and pickup/delivery) and finally mode choice
- Transport Level of Service Attributes: transit time of mode, reliability of mode, waiting time for equipment
    - Affects cost of capital tied up in transit, safety stock holding cost and ability to serve as emergency, and finally choice of mode
- Commodity Attributes: density of product, weight and cube capacity of vehicle

- Affects loading of shipment by mode and possible need for consolidation of shipment with others, and finally choice of mode

ITIC-IM Inputs and Parameters

The model's user defined inputs (1-15) and parameters (16-24) are listed and explained below:

1. Commodity (2-Digit Standard Transportation Commodity Code) - four separate commodity groups were selected for modal conversion simulations: food or kindred products (20); pulp, paper, or allied products (26); chemicals or allied products (28); and machinery (35).
2. Pounds of commodity shipped per year - researchers queried FAF 3.5 2012 estimates to acquire the total tonnage shipped between Wisconsin and each of the U.S. metro regions as well as tonnage shipped by truck. This total was then divided by the number of non-rail served shippers from the corresponding industry within the study's dataset to come up with the number of annual shipments for each WEDC shipper (Table 1). This assumption implies each shipper within the analysis is identical in terms of volumes of freight shipped as well as maintains a shipping relationship with each of the metro regions within the analysis. While unrealistic, these assumptions allow for a generalized analysis to be conducted across the entire state absent point data containing establishment employment counts and detailed shipping information (a bill of lading, for example).

TABLE 1 Annual Freight Flows and Average Annual Shipments per Shipper by Commodity between Metro Region and Wisconsin

Food and Beverage

Metro Region	Annual Freight Flows	Annual Freight Flows by Truck	Truck %	Avg. Annual Shipments*
Atlanta	615,051,600	546,929,400	89%	64
Baltimore	99,936,200	86,858,000	87%	11
Charlotte	74,884,400	73,942,600	99%	9
Cleveland	165,467,800	164,283,200	99%	19
Dallas	871,541,000	669,657,800	77%	78
Detroit	951,605,600	797,781,800	84%	93
Houston	153,556,800	138,032,000	90%	16
Kansas City	336,089,200	327,339,600	97%	38
Laredo	253,143,400	149,073,600	59%	18
Los Angeles	815,329,200	518,385,800	64%	60
Miami	187,095,000	170,790,200	91%	20
New York	688,034,400	557,860,800	81%	65
Philadelphia	512,397,200	469,801,200	92%	55
Pittsburgh	143,401,400	141,862,000	99%	17
Portland	156,465,200	140,589,000	90%	17
Seattle	334,551,800	104,996,600	31%	13
St. Louis	259,115,600	256,839,200	99%	30

Plastics

Metro Region	Annual Freight Flows	Annual Freight Flows by Truck	Truck %	Avg. Annual Shipments*
Atlanta	126,236,800	94,589,200	75%	19
Baltimore	4,024,800	3,866,800	96%	1
Charlotte	80,268,600	80,211,800	100%	16
Cleveland	186,214,600	182,503,800	98%	37
Dallas	12,044,600	11,680,200	97%	3
Detroit	253,880,200	217,283,600	86%	44
Houston	1,174,666,800	78,915,800	7%	16
Kansas City	26,592,000	23,861,800	90%	5
Laredo	69,929,000	69,333,400	99%	14
Los Angeles	102,135,600	82,462,600	81%	17
Miami	5,650,800	5,048,200	89%	2
New York	125,840,600	102,754,800	82%	21
Philadelphia	73,555,400	29,626,800	40%	6
Pittsburgh	38,968,200	38,037,200	98%	8
Portland	3,058,000	1,880,600	61%	1
Seattle	48,718,800	37,805,600	78%	8
St. Louis	50,843,800	49,684,000	98%	10

Paper

Metro Region	Annual Freight Flows	Annual Freight Flows by Truck	Truck %	Avg. Annual Shipments*
Atlanta	435,645,400	429,273,200	99%	61
Baltimore	125,440,800	119,792,600	95%	17
Charlotte	143,874,600	104,329,800	73%	15
Cleveland	150,257,200	149,830,600	100%	22
Dallas	349,341,400	232,745,800	67%	34
Detroit	788,945,600	553,497,000	70%	79
Houston	15,723,800	14,750,600	94%	3
Kansas City	296,484,600	244,215,200	82%	35
Laredo	492,980,200	207,547,600	42%	30
Los Angeles	717,957,200	441,179,600	61%	63
Miami	72,784,400	68,375,000	94%	10
New York	389,271,200	262,661,400	67%	38
Philadelphia	236,777,200	202,666,800	86%	29
Pittsburgh	38,857,800	38,837,200	100%	6
Portland	58,401,800	53,063,600	91%	8
Seattle	153,171,200	87,883,200	57%	13
St. Louis	347,964,200	303,781,400	87%	35

Machinery

Metro Region	Annual Freight Flows	Annual Freight Flows by Truck	Truck %	Avg. Annual Shipments*
Atlanta	60,405,200	51,136,000	85%	6
Baltimore	103,122,200	99,572,000	97%	11
Charlotte	41,391,400	39,746,600	96%	5
Cleveland	34,555,600	31,805,400	92%	4
Dallas	27,936,400	21,861,000	78%	3
Detroit	658,036,800	568,157,000	86%	62
Houston	47,036,200	43,083,000	92%	5
Kansas City	21,646,800	21,270,000	98%	3
Laredo	126,922,600	123,076,400	97%	14
Los Angeles	88,936,000	53,452,400	60%	6
Miami	37,684,200	36,636,400	97%	4
New York	81,036,600	63,692,800	79%	7
Philadelphia	38,601,800	26,133,200	68%	3
Pittsburgh	23,711,600	23,566,200	99%	3
Portland	72,967,400	63,288,600	87%	7
Seattle	33,611,600	27,086,200	81%	3
St. Louis	12,731,000	12,030,200	94%	2

**Value Represents Average Annual Shipments per Non-Rail Served WEDC Shipper*

3. Pounds of commodity per shipment – a shipment payload factor was provided by WisDOT's statewide freight model. The payload factor estimates for 53-foot trailers:
    a. Food & Beverage: 44,212.22 lbs.
    b. Paper: 48,284.14 lbs.
    c. Plastics: 33,221.23 lbs.
    d. Machinery: 23,508.40 lbs.
4. Commodity value (dollars per pound) – the commodity values per pound were derived from the 2012 CFS for food or kindred products $0.5541 (SCTG codes 05, 06, and 07); pulp, paper, or allied products $0.6259 (SCTG codes 27 and 28); and machinery $10.1858 (SCTG code 34). A value per pound for plastic shippers was determined by the midpoint between the reported high and low price from the Plastics Exchange $0.62 (http://www.theplasticsexchange.com/).
5. Origin/Destination (O/D) Pairs: OState, DState, Ofips, and Dfips (Federal Information Processing Standard). The location of Wisconsin's non-rail served shippers served as one-half of the O/D pair with the other being a particular U.S. metro region. These fields in the model are mainly used to identify and track O/D pairs when analyzing the results. U.S. metro regions were chosen based on two criteria: (1) to achieve geographical representation of the United States; and (2) the metro regions represented large trading partners (by truck) with Wisconsin for one or more of the four commodities under analysis.
6. Observed Mode – since researchers used commodity totals moved by truck, the observed mode is "truck."
7. Trucking cost per mile – researchers received general trucking rates (current rates as well as the 12-month high and low) between Wisconsin and each of U.S. metro regions from a third-party logistics (3PL) company. The 12-month high for each region was selected as the trucking rate per mile in order to encourage the ITIC-IM model to divert freight from trucking to intermodal.
8. Trucking miles – the distance between the shipper and a generalized point within the particular U.S. metro region. The time and distance were derived using a "Network Analyst" tool, and the generalized point was created using the "Feature to Point" tool to obtain the geographic center of the metro region.
9. Trucking Load – same as the pounds per shipment.
10. Container type – This field is not applicable for our use of the model. If the observed mode was rail, this value in this field would correspond to the type of rail move: "1" for rail carload, "2" for TOFC (trailer on flat car), and "3" for COFC (container on flat car).
11. Junction Frequency – for the base case, this input was set as "0" since all Class 1 railroads interchange in Chicago. For the policy case, this input was set as "0" for moves to metro regions served by western railroads or served by both western and eastern railroads, and set as "1" for moves to metro regions served by only eastern railroads.
12. Observed rail revenue per hundredweight (cwt) – This field is not applicable since the observed mode is trucking.
13. Rail Variable cost per cwt – the model's parameter is preset with a function using $0.3106 for the variable cost per mile. This is multiplied by the number of linehaul miles and adds the total lift charges at the origination and destination to figure the total variable cost. This is then divided by the load's hundredweight value.
14. Rail Miles – researchers used the county-to-county distance matrix provided by the Oak Ridge National Laboratory (April of 2011 - http://cta.ornl.gov/transnet/SkimTree.htm).
15. Container Pick-up/Delivery charge - drayage rates used in the model vary depending on where the dray is taking place (Wisconsin or one of the metro regions). For the dray moves taking place in Wisconsin, the rate depends on whether or not it is a base case or policy case run of the model.
    a. U.S. Metro Regions - researchers utilized an online dray quoting tool to acquire current rates for various metro regions. Origin/destination pairs were created by using the city of the intermodal facilities within the metros, creating 15-, 30-, 50-, and 100-mile bins going

away from the facility's location (acquired from Class I websites), and then selecting cities within those bins. Researchers attempted to maintain geographic equity by selecting a city north, east, west, and south of the terminal, as well as to include other boundaries (a state border or river for example), in order to capture any rate differences within the mileage bins. The Kansas City metro region in Figure 2 provides a visualization of this process. The average dray cost from the 15-30 and 30-50 mile bins from all of the available metro regions ($382.16) was chosen as the dray cost for the non-Wisconsin portion of the freight move for both the base and policy case.

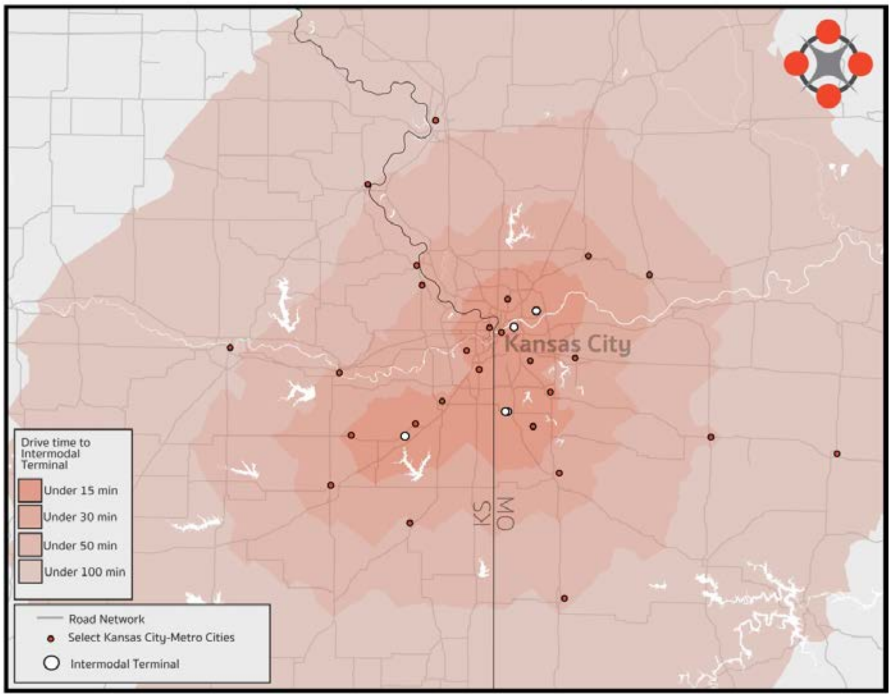

FIGURE 2 Kansas City Metro Region and Select Cities within Intermodal Dray Service Bins.

a. Wisconsin Base Case - the model's preset parameters are set to compute drayage costs with the following function: a flat rate of $125 and a variable rate of $1.38 per mile over 30 if the dray is greater than 30 miles. Researchers compared the computed values for each of the shippers to a current zoning rate structure obtained from a 3PL company, and found the model's dray cost estimates were considerably lower than the zoning rate structure. To accommodate, researchers doubled the dray cost to more accurately portray current rates.
b. Wisconsin Policy Case- the model's preset function (discussed above) was used in order to reflect rates associated with traditional drayage proximity and to encourage modal diversion estimates from the model.

16. Line-Haul Speeds - researchers used the model's preset parameters of 30 mph for rail intermodal and 50 mph for trucking. The 30 mph value is close to the historical average (11/21/14 through 11/20/2015) of 29.1 mph for the six Class I's which report their weekly performance: BNSF, CN, CSX, KCS, NS, and UP. The values range from 24.6 to 35.3 mph *(11)*.
17. Relative Transit Time Reliability Factor - researchers used the model's preset parameter values: 0.45 for rail and 0.40 for truck. The ITIC-IM user's manual defines this as *the variability in the ordering lead time* and incorporates it into a shipper's utility function to determine a total logistics costs associated with the ordering, transport, inventory, and use of the product being shipped. For more information, please see pages 12-15 of the user's manual.
18. Freight Loss and Damage as a fraction of freight revenue - researchers used the model's preset parameters: 0.002 for rail and 0.0007 for trucking.

19. Claim payment days - researchers used the model's preset parameters: 90 days for rail and 60 days for trucking
20. Terminal Processing Time (hours) - researchers used the model's preset parameter: 24 hours total with 12 hours figured at the origin and destination terminal.
21. Total Lift Cost - researchers used the model's preset parameter: $250 total represents a $125 lift at origin and destination.
22. Required Service Protection Level (percentage) - researchers used the model's preset parameter, which varies by commodity: food and beverage 97 percent; Pulp, paper, and allied products 90 percent; Chemical and allied products 95 percent; and Machinery 90 percent.
23. Inventory carrying cost percentage - researchers used the model's preset parameter, which varies by commodity: food and beverage 30 percent; Pulp, paper, and allied products 25 percent; Chemical and allied products 25 percent; and Machinery 30 percent.
24. Opportunity Cost of Mode Change - 3 percent was used in the base case, and three iterations were ran for the policy cases: 3, 1.5, and 0 percent.

Commodity Data Considerations

There are a number of ways to classify commodities including the Standard Transportation Commodity Codes (STCC), the Standard Classification of Transported Goods (SCTG), and classifications created by individual states. Aggregated commodity flow data sources such as the Commodity Flow Survey and the Freight Analysis Framework use the SCTG codes while the ITIC-IM Model and the Surface Transportation Board's Carload Waybill Sample uses the STCC codes. The crosswalk of SCTG commodity codes (used to determine freight volumes) to STCC commodity codes is outlined below:

- Food and Beverage: SCTG codes 04, 05, 06, and 07 to STCC code 20.
- Plastics and Rubber: SCTG code 24 to STCC code 28. The shipment of plastic related commodities causes an issue because the SCTG classification of "Plastics and Rubbers" does not allow an analyst to discern between the raw materials used in the manufacturing process and the outputs (intermediate goods and finished products). The two can have considerably different characteristics in terms of density and value. Within the STCC classification, the raw materials used in the manufacturing process are classified under the code of 28, while the intermediate goods and finished products are classified under the code of 30.
- Paper: SCTG codes 27 and 28 to STCC code 26.
- Machinery: SCTG code 34 to STCC code 35.

Base Case and Policy Case Assumptions

The model works by running a base-case iteration followed by a policy-case iteration to compute changes in logistics costs associated with the policy change. We define the base case as the time and distance from Wisconsin shippers to the nearest intermodal terminal in the Chicago region. The Minnesota terminals were excluded based on discussions at the 2015 Minnesota Freight Advisory Committee (MnFAC) meeting indicating a lack capacity forced shippers to dray containers to Chicago. Conversations with a 3PL reinforced the exclusion as they were precluded from gaining access to the terminals without contracts guaranteeing a consistently high-volume of containers. Regarding the Wisconsin terminals in Chippewa Falls and Arcadia, capacity issues, the predominate freight flows from and to the Port of Prince Rupert, and a lack of domestic and reefer services provided enough justification to remove them from the base-case analysis. The exclusion of these terminals likely overestimate the number of loads identified for modal diversion. The left map in Figure 3 shows the food and beverage shippers' drayage relationships in the base case.

We define the policy case as an expanded intermodal market that includes all currently operating terminals in the Chicago region, the Twin Cities, and Wisconsin, as well as the introduction of five proposed terminals in Wisconsin. Capacity improvements at terminals excluded from the base case were assumed in order to handle diverted freight volumes forecasted by the model, as was the addition of domestic and reefer service. In total, researchers ran three iterations of the model's policy case using cost differential threshold levels of 3, 1.5, and 0 percent. Essentially, this means the total logistics costs associated with intermodal rail to be at least a certain percentage less than trucking for the model to identify a load for modal diversion. The three-percent threshold represents a conservative estimate while the zero-percent is the most aggressive, with shippers choosing intermodal rail as long as the costs were on par with trucking. The right map in Figure 4 shows the drayage relationships once the five proposed Wisconsin intermodal terminals were added. A total of 13 shippers located closest to a Chicago region terminal were left out of the policy-case analysis since the introduction of new terminals would not change their proximity to an intermodal terminal.

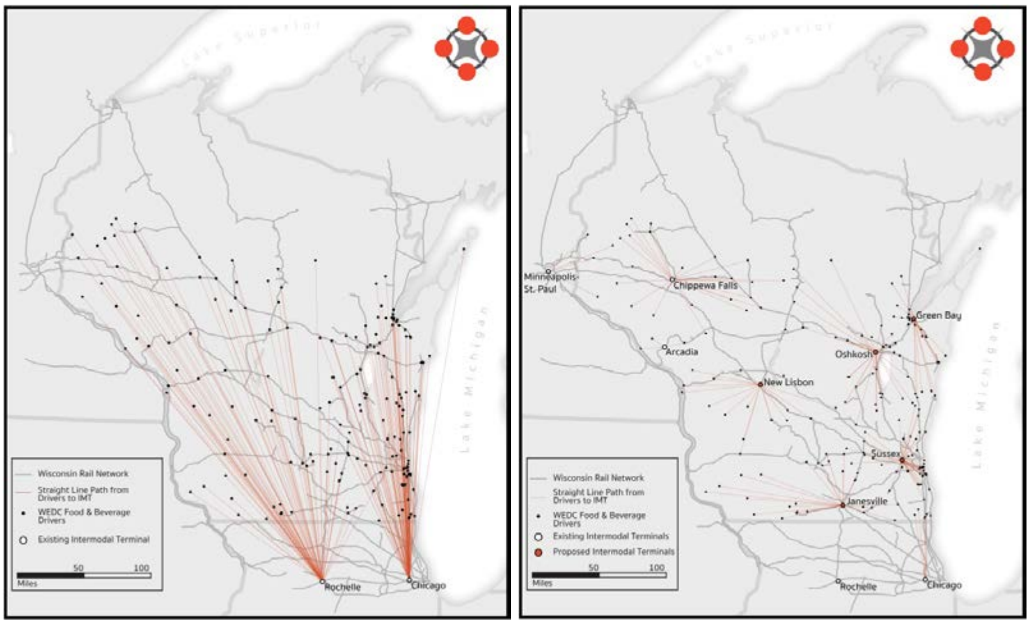

FIGURE 3 'As the Crow Flies' Comparison between WEDC Food & Beverage Shippers' Connections to Closest Chicago Region Intermodal Terminal Used for Base-Case Iteration (left map) and Connections to Nearest Intermodal Terminal Used for Policy Case Iterations (right map).

RESULTS: POTENTIAL MODAL DIVERSIONS

The base-case iteration of the model identified a number of origin-destination pairs (787) between WEDC shippers and metro regions where annual shipments (20,695) were diverted to rail because the total logistics costs associated with the rail move were three percent less than the total costs associated with a truck move (Table 2). Roughly 17.6 percent of the total Paper Product shipments were diverted to rail, while five percent of Food & Beverage and Plastics shipments were diverted. No shipments of Machinery were diverted to rail during the base case iteration. It should also be noted a total of 110 shipments were removed from the analysis because the model computed a rail rate below cost. These shipments were to Kansas City (27 Food & Beverage, 7 Paper Products, 37 Plastics, and 19 Machinery) and St. Louis (8 Food & Beverage, 2 Paper Products, 2 Plastics, and 8 Machinery).

TABLE 2 ITIC-IM Model's Base and Policy-Case Aggregate Output Summaries by Commodity

		BASE CASE		***POLICY CASE: Expanded Intermodal Market***					
				3% Threshold		**1.5% Threshold**		**0% Threshold**	
		Truck	**Rail**	**Truck**	**Rail**	**Truck**	**Rail**	**Truck**	**Rail**
Food & Beverage	**O/D Pairs**	3,022	275	2,818	112	1,813	1,117	540	2,390
	Shipments	114,643	6,199	109,183	1,904	71,159	39,928	16,849	94,238
	Tons Shipped	2,495,249	134,475	2,377,623	40,168	1,549,203	868,588	367,502	2,050,289
	Truck VMT	114,718,481	0	107,700,512	0	52,056,423	0	8,631,467	0
	Intermodal Dray VMT	0	959,325	0	147,596	0	3,318,768	0	7,464,016
	Rail Ton-Miles	0	206,052,491	0	83,274,882	0	1,403,289,187	0	2,404,754,717
	Logistics Costs	$326,902,944	$27,687,150	$308,998,639	$8,574,814	$176,279,925	$137,898,644	$31,793,181	$281,217,833
	*Six shippers to Northlake								
Paper Products	**O/D Pairs**	2,066	407	1,915	136	1,313	738	200	1,851
	Shipments	59,655	12,738	57,925	1,303	41,740	17,488	5,188	54,040
	Tons Shipped	1,416,428	303,477	1,376,447	29,842	995,493	410,796	122,458	1,283,832
	Truck VMT	51,630,199	0	48,666,342	0	28,500,987	0	2,310,450	0
	Intermodal Dray VMT	0	2,817,894	0	65,871	0	1,098,288	0	2,705,427
	Rail Ton-Miles	0	567,866,560	0	62,500,819	0	566,746,538	0	1,212,292,250
	Logistics Costs	$158,240,475	$50,317,392	$151,174,389	$5,865,717	$95,966,535	$59,740,015	$9,192,478	$145,632,498
	*One shipper to Northlake								
Plastics	**O/D Pairs**	2,423	105	2,354	18	1,488	884	163	2,209
	Shipments	32,465	1,758	31,595	186	19,053	12,728	4,307	27,474
	Tons Shipped	523,011	28,509	509,015	2,975	306,402	205,587	70,318	441,672
	Truck VMT	29,338,308	0	28,432,136	0	12,144,907	0	1,952,947	0
	Intermodal Dray VMT	0	485,604	0	15,680	0	889,377	0	1,636,628
	Rail Ton-Miles	0	43,707,001	0	5,112,035	0	288,891,507	0	456,299,101
	Logistics Costs	$89,330,661	$6,803,449	$86,881,521	$726,250	$43,875,298	$42,675,111	$7,651,518	$78,512,782
	*Zero shippers to Northlake								
Machinery	**O/D Pairs**	6,671	0	6,569	0	6,569	0	5,294	1,275
	Shipments	58,239	0	57,351	0	57,351	0	47,930	9,421
	Tons Shipped	652,162	0	642,221	0	642,221	0	536,257	105,964
	Truck VMT	52,142,706	0	51,410,279	0	51,410,279	0	35,346,334	0
	Intermodal Dray VMT	0	0	0	0	0	0	0	512,781
	Rail Ton-Miles	0	0	0	0	0	0	0	183,457,115
	Logistics Costs	$409,902,711	$0	$403,880,006	$0	$403,880,006	$0	$315,771,866	$87,710,493
	*Six shippers to Northlake								
Four Commodity	**O/D Pairs**	14,182	787	13,656	266	11,183	2,739	6,197	7,725
	Shipments	265,002	20,695	256,054	3,393	189,303	70,144	74,274	185,173
	Tons Shipped	5,086,850	466,461	4,905,305	72,985	3,493,319	1,484,971	1,096,534	3,881,756
	Truck VMT	247,829,695	0	236,209,269	0	144,112,597	0	48,241,198	0
	Intermodal Dray VMT	0	4,262,823	0	229,147	0	5,306,433	0	12,318,852
	Rail Ton-Miles	0	817,626,052	0	150,887,736	0	2,258,927,231	0	4,256,803,182
	Logistics Costs	984,376,790	84,807,990	950,934,555	15,166,781	720,001,764	240,313,770	364,409,043	593,073,606
	*13 shippers to Northlake								

A few metro regions dominate the diverted traffic (Table 3). The model diverted shipments for all but two Food & Beverage producers and all but three Paper product producers to Miami resulting in 3,880 and 1,430 rail shipments. 7,623 paper product shipments destined for Los Angeles were diverted representing products from 121 of the state's 146 shippers. The model also diverted 646 plastic input shipments from 38 shippers and 180 loads of Food & Beverage products between Los Angeles and Wisconsin. Some traffic between Laredo and Wisconsin was diverted to rail, 2,700 shipments from 90 Paper product shippers and 560 input shipments to 40 Plastic producers, as well as 1,020 Food & Beverage shipments from 60 shippers and 264 loads of paper product from 33 shippers to Portland. New York, Philadelphia, Atlanta, Baltimore, and Houston also had shipments diverted to rail.

Policy Case: Three Percent Cost Differential Threshold

The addition of five intermodal terminals in Wisconsin alone had little impact on intermodal rail's cost competitiveness for the WEDC shippers. In total, only an additional 3,393 shipments from 266 shippers were diverted to rail: 1.7 percent of food and beverage shipments, 2.2 percent of paper-product shipments, and 0.6 percent of plastic-input shipments. These shipments were concentrated in just two metro areas: Portland, receiving 1,904 of the diverted food and beverage loads and 744 of the paper product loads, and

Seattle, receiving 559 paper-product shipments and 96 plastic loads. The other shipments diverted to rail were found in the plastic-input shipments, with 48 coming from Houston, and 42 from Laredo. Each of the Wisconsin intermodal terminals would host a portion of the diverted shipments except Arcadia because it is not the closest terminal to any of shippers under analysis (Table 4). The distribution of diverted shipments is somewhat balanced, with two tiers becoming apparent: 902 for Green Bay, 880 for Oshkosh, and 724 for Sussex in one tier; and 371 for New Lisbon, 339 for Chippewa Falls, and 177 for Janesville in second tier.

Policy Case: 1.5 Percent Cost Differential Threshold

Reducing the minimum cost savings associated with an intermodal rail shipment from three percent to 1.5 percent has a considerable impact on the amount of shipments diverted from truck, totaling 70,144 annual loads. These diversions are somewhat consistent across the different commodities. Food and beverage shippers divert a total of 39,928 loads representing 38 percent of O/D pairs and 36 percent of shipments, paper product manufacturers divert a total of 17,488 loads representing 36 percent of O/D pairs and 29.5 percent of shipments, and plastic shippers divert a total of 12,728 loads representing 37 percent of O/D pairs and 40 percent of shipments. Interestingly, all machinery shipments remain on the highways.

A number of metro regions capture the majority of these diversions. Dallas in particular would see 20,053 loads diverted to rail intermodal with 190 of 196 shippers from the food and beverage industry, 145 of 146 paper-product producers, and 101 of 151 plastic shippers diverting their freight from truck to intermodal rail. O/D pairs between Wisconsin and Los Angeles would also be able to shift a large amount of freight to intermodal rail under this scenario: 187 of the 196 food and beverage shippers, 110 of the 151 plastics shippers, and 25 of the 146 shippers of paper products, resulting in a total of 14,665 diverted loads. While not on the same level when compared to Dallas or Los Angeles, the New York and Detroit metro regions would offer a large number of opportunities for WEDC shippers to divert to intermodal rail: 6,419 loads to and from New York, concentrated in the paper-products and plastics inputs with some food and beverage, and a total of 4,306 loads to and from Detroit pretty evenly distributed amongst shippers within the three industries. Laredo, Houston, Seattle, and Portland were also able to produce sizable amounts of diverted traffic (6,540, 5,561, 4,884, and 568 shipments respectively) building upon intermodal rail traffic from the three-percent threshold scenario.

The diverted shipments are distributed among the Wisconsin intermodal terminals with Sussex, Oshkosh, Chippewa Falls, and Green Bay all facilitating over 10,000 annual rail intermodal shipments, and New Lisbon and Janesville over 5,000 shipments. Sussex not only connects the largest number of O/D pairs with 700, but would also service the most intermodal rail moves with 16,641. The majority of Sussex's diversions would be food and beverage shipments of 8,848, compared to 4,186 shipments of plastic inputs and 3,607 loads of paper products. Oshkosh would be the second busiest intermodal terminal under this scenario, linking a total of 552 O/D pairs and facilitating the movement of 13,692 shipments (predominately in 6,916 shipments of food and beverage and 5,814 of paper products). While the number of O/D pairs serviced by the Chippewa Falls terminal is lower when compared to those of Sussex, Oshkosh, and Green Bay, the connections it does serve provide more diverted shipments on a per case basis.

Table 3 ITIC-IM Output Totals by Metro Region and Commodity.

	Model Inputs		*Base Case Rail*		*3% Policy*		*1.5% Policy*		*0% Policy*	
	Shippers	Shipments	Shippers	Shipments	Shippers	Shipments	Shippers	Shipments	Shippers	Shipments
Los Angeles	**887**	**25,889**	**162**	**8,449**	**0**	**0**	**322**	**14,665**	**322**	**14,665**
Food & Beverage	196	11,760	3	180	0	0	187	11,220	187	11,220
Paper	146	9,198	121	7,623	0	0	25	1,575	25	1,575
Plastics	151	2,567	38	646	0	0	110	1,870	110	1,870
Machinery	394	2,364	0	0	0	0	0	0	0	0
Miami	**887**	**7,258**	**337**	**5,310**	**0**	**0**	**2**	**20**	**150**	**316**
Food & Beverage	196	3,920	194	3,880	0	0	0	0	0	0
Paper	146	1,460	143	1,430	0	0	2	20	2	20
Plastics	151	302	0	0	0	0	0	0	148	296
Machinery	394	1,576	0	0	0	0	0	0	0	0
Atlanta	**887**	**26,683**	**4**	**247**	**0**	**0**	**41**	**1,031**	**456**	**22,098**
Food & Beverage	196	12,544	1	64	0	0	0	0	166	10,624
Paper	146	8,906	3	183	0	0	6	366	142	8,662
Plastics	151	2,869	0	0	0	0	35	665	148	2,812
Machinery	394	2,364	0	0	0	0	0	0	0	0
Kansas City	**797**	**12,982**	**0**	**0**	**0**	**0**	**2**	**70**	**372**	**10,065**
Food & Beverage	169	6,422	0	0	0	0	0	0	125	4,750
Paper	139	4,865	0	0	0	0	2	70	136	4,760
Plastics	114	570	0	0	0	0	0	0	111	555
Machinery	375	1,125	0	0	0	0	0	0	0	0
Baltimore	**887**	**9,123**	**3**	**51**	**0**	**0**	**25**	**425**	**478**	**4,630**
Food & Beverage	196	2,156		0	0	0	0	0	188	2,068
Paper	146	2,482	3	51	0	0	25	425	142	2,414
Plastics	151	151	0	0	0	0	0	0	148	148
Machinery	394	4,334	0	0	0	0	0	0	0	0
Detroit	**887**	**60,834**	**0**	**0**	**0**	**0**	**67**	**4,306**	**393**	**28,205**
Food & Beverage	196	18,228	0	0	0	0	17	1,581	132	12,276
Paper	146	11,534	0	0	0	0	15	1,185	127	10,033
Plastics	151	6,644	0	0	0	0	35	1,540	134	5,896
Machinery	394	24,428	0	0	0	0	0	0	0	0
St. Louis	**867**	**12,942**	**0**	**0**	**0**	**0**	**5**	**75**	**287**	**7,125**
Food & Beverage	188	5,640	0	0	0	0	0	0	84	2,520
Paper	144	5,040	0	0	0	0	1	35	103	3,605
Plastics	149	1,490	0	0	0	0	4	40	100	1,000
Machinery	386	772	0	0	0	0	0	0	0	0
Charlotte	**887**	**8,340**	**0**	**0**	**0**	**0**	**42**	**665**	**458**	**6,028**
Food & Beverage	196	1,764	0	0	0	0	0	0	165	1,485
Paper	146	2,190	0	0	0	0	7	105	145	2,175
Plastics	151	2,416	0	0	0	0	35	560	148	2,368
Machinery	394	1,970	0	0	0	0	0	0	0	0
New York	**887**	**24,217**	**45**	**1,626**	**0**	**0**	**208**	**6,419**	**438**	**19,342**
Food & Beverage	196	12,740	12	780	0	0	13	845	178	11,570
Paper	146	5,548	9	342	0	0	87	3,306	136	5,168
Plastics	151	3,171	24	504	0	0	108	2,268	124	2,604
Machinery	394	2,758	0	0	0	0	0	0	0	0
Cleveland	**887**	**14,099**	**0**	**0**	**0**	**0**	**4**	**148**	**149**	**4,163**
Food & Beverage	196	3,724	0	0	0	0	0	0	30	570
Paper	146	3,212	0	0	0	0	0	0	54	1,188
Plastics	151	5,587	0	0	0	0	4	148	65	2,405
Machinery	394	1,576	0	0	0	0	0	0	0	0
Portland	**887**	**7,409**	**93**	**1,284**	**205**	**2,648**	**249**	**3,216**	**776**	**6,017**
Food & Beverage	196	3,332	60	1,020	112	1,904	136	2,312	136	2,312
Paper	146	1,168	33	264	93	744	113	904	113	904
Plastics	151	151	0	0	0	0	0	0	148	148
Machinery	394	2,758	0	0	0	0	0	0	379	2,653
Philadelphia	**887**	**17,102**	**10**	**420**	**0**	**0**	**76**	**1,273**	**473**	**15,123**
Food & Beverage	196	10,780	5	275	0	0	4	220	185	10,175
Paper	146	4,234	5	145	0	0	27	783	140	4,060
Plastics	151	906	0	0	0	0	45	270	148	888
Machinery	394	1,182	0	0	0	0	0	0	0	0
Pittsburgh	**887**	**6,598**	**0**	**0**	**0**	**0**	**6**	**48**	**278**	**2,518**
Food & Beverage	196	3,332	0	0	0	0	0	0	54	918
Paper	146	876	0	0	0	0	0	0	96	576
Plastics	151	1,208	0	0	0	0	6	48	128	1,024
Machinery	394	1,182	0	0	0	0	0	0	0	0
Dallas	**887**	**21,887**	**0**	**0**	**0**	**0**	**436**	**20,053**	**483**	**20,194**
Food & Beverage	196	15,288	0	0	0	0	190	14,820	190	14,820
Paper	146	4,964	0	0	0	0	145	4,930	145	4,930
Plastics	151	453	0	0	0	0	101	303	148	444
Machinery	394	1,182	0	0	0	0	0	0	0	0
Houston	**887**	**7,960**	**3**	**48**	**3**	**48**	**418**	**5,609**	**727**	**7,030**
Food & Beverage	196	3,136	0	0	0	0	190	3,040	190	3,040
Paper	146	438	0	0	0	0	83	249	145	435
Plastics	151	2,416	3	48	3	48	145	2,320	145	2,320
Machinery	394	1,970	0	0	0	0	0	0	247	1,235
Laredo	**887**	**15,538**	**130**	**3,260**	**3**	**42**	**353**	**6,582**	**679**	**11,146**
Food & Beverage	196	3,528	0	0	0	0	190	3,420	190	3,420
Paper	146	4,380	90	2,700	0	0	55	1,650	55	1,650
Plastics	151	2,114	40	560	3	42	108	1,512	108	1,512
Machinery	394	5,516	0	0	0	0	0	0	326	4,564
Seattle	**887**	**6,836**	**0**	**0**	**55**	**655**	**483**	**5,539**	**806**	**6,508**
Food & Beverage	196	2,548	0	0	0	0	190	2,470	190	2,470
Paper	146	1,898	0	0	43	559	145	1,885	145	1,885
Plastics	151	1,208	0	0	12	96	148	1,184	148	1,184
Machinery	394	1,182	0	0	0	0	0	0	323	969
Totals	**887**	**285,697**	**787**	**20,695**	**266**	**3,393**	**2,739**	**70,144**	**7,725**	**185,173**

Table 4 ITIC-IM Output Totals by Intermodal Terminal and Commodity.

	BASE CASE*		***POLICY CASE: Expanded Intermodal Market****					
			3% Threshold		**1.5% Threshold**		**0% Threshold**	
	O/D Pairs	Shipments	O/D Pairs	Shipments	O/D Pairs	Shipments	O/D Pairs	Shipments
Chippewa Falls	**65**	**1,972**	**21**	**339**	**372**	**11,348**	**748**	**20,551**
Food & Bev	35	1,095	17	289	183	7,303	385	14,381
Paper	25	772	1	8	57	1,863	94	2,714
Plastics	5	105	3	42	132	2,182	219	3,017
Machinery	0	0	0	0	0	0	50	439
Green Bay	**199**	**5,376**	**77**	**902**	**467**	**10,908**	**1,399**	**35,856**
Food & Bev	38	868	27	459	179	6,014	417	16,575
Paper	111	3,732	40	355	183	3,647	490	14,002
Plastics	50	776	10	88	105	1,247	346	4,252
Machinery	0	0	0	0	0	0	146	1,027
Janesville	**46**	**813**	**12**	**177**	**253**	**7,208**	**685**	**18,160**
Food & Bev	39	747	9	153	157	5,469	316	12,981
Paper	7	66	3	24	23	724	60	1,916
Plastics	0	0	0	0	73	1,015	222	2,496
Machinery	0	0	0	0	0	0	87	767
New Lisbon	**26**	**460**	**25**	**371**	**185**	**5,781**	**440**	**14,113**
Food & Bev	20	400	19	323	122	4,198	264	10,532
Paper	6	60	6	48	47	1,349	90	2,718
Plastics	0	0	0	0	16	234	47	654
Machinery	0	0	0	0	0	0	39	209
Oshkosh	**209**	**6,031**	**72**	**880**	**552**	**13,692**	**1,548**	**41,803**
Food & Bev	35	697	32	544	204	6,916	472	18,856
Paper	143	4,856	38	304	271	5,814	636	18,234
Plastics	31	478	2	32	77	962	256	3,356
Machinery	0	0	0	0	0	0	184	1,357
St. Paul	**42**	**1,333**	**0**	**0**	**210**	**4,566**	**360**	**6,184**
Food & Bev	13	624	0	0	28	1,180	51	1,716
Paper	10	310	0	0	14	484	22	616
Plastics	19	399	0	0	168	2,902	285	3,838
Machinery	0	0	0	0	0	0	2	14
Sussex	**188**	**4,457**	**59**	**724**	**700**	**16,641**	**2,545**	**48,506**
Food & Bev	85	1,586	8	136	244	8,848	485	19,197
Paper	103	2,871	48	564	143	3,607	459	13,840
Plastics	0	0	3	24	313	4,186	834	9,861
Machinery	0	0	0	0	0	0	767	5,608
Totals	**787**	**20,695**	**266**	**3,393**	**2,739**	**70,144**	**7,725**	**185,173**

*These O/D Pairs and Shipments from the base case are assigned to the closest proposed intermodal terminal despite being routed to the Chicago region for the base case analysis. Ten Food & Beverage O/D Pairs accounting for 182 shipments and two Paper Products O/D Pairs accounting for 71 shipments remained closest to the Chicago region and did not make it to the policy case analysis.

**1.5% Policy Case results include those already shown in 3%, as well for 0% include those from 3% and 1.5%- they are not additional- however, they do not include the results from the base case.

Policy Case: Zero Percent Cost Differential Threshold

A zero percent cost differential threshold resulted in 55 percent of O/D pairs and 71 percent of shipments being serviced by intermodal rail. Both of those market shares increase to 87 percent if machinery products are removed from the analysis. Roughly 82 percent of food and beverage O/D pairs and 85 percent of the shipments are diverted to rail in this scenario. For paper products, the percentages of O/D pairs and shipments are 90 and 91 percent respectively, and 93 and 86 percent respectively for plastic product inputs. Under this scenario, even manufacturers of machinery are able to divert some of their shipments to intermodal rail (16.4 percent).

A zero-percent cost threshold would offer increased opportunities to divert truck shipments to domestic intermodal rail service to the rest of the metro regions within the study's analysis, such as Atlanta, Baltimore, Charlotte, Kansas City, Philadelphia, and to a lesser extent St. Louis, Cleveland, and Pittsburgh. A large portion of Wisconsin manufacturers of machinery would also be able to divert some of their shipments to intermodal rail to the metro regions of Portland (379 of 394), Laredo (326 of 394), Seattle (323 of 394 shippers), and Houston (247 of 394). Wisconsin shippers of food and beverage products would also divert a large number of shipments destined for New York (10,725 of 12,740).

Decreasing the cost threshold to divert shipments to rail when the logistical costs are equal significantly increases the number of shipments into and out of each of the six Wisconsin intermodal terminals as well as the number of O/D pairs serviced. Sussex would be the busiest terminal providing connections to 2,545 O/D pairs and facilitating the movement of 48,506 shipments. Oshkosh and Green Bay would be the next busiest terminals with 41,803 and 35,856 shipments respectively with both having a large proportion of their lifts accommodating the food and beverage and paper product shippers, accounting for 89 and 85 percent of the moves under analysis, respectively. The concentration of diverted shipments in food and beverage products is also seen from the terminals in Chippewa Falls (14,381 of the total 20,551), Janesville (12,981 of the total 18,160), and New Lisbon (10,532 of the total 14,113).

SUMMARY AND CONCLUSIONS

Results from the above analysis suggest that in order for large volumes of freight to switch from trucking to truck-to-rail intermodal, shippers will have to be willing to modify their supply chains with little or no cost incentive to do so. Instead, social and environmental benefits such as improved fuel efficiency and economic competitiveness, and reductions in GHG emissions, other pollutants, roadway congestion, and highway maintenance costs must serve as motivation.

The proposed terminals of Sussex, Oshkosh, and Green Bay provide the most opportunities for diverting trucking to truck-to-rail intermodal. Related to the state's potential diverted shipments of the commodities under analysis, results suggest the three terminals combined would capture roughly 76 percent under the base case and approximately 78, 63, and 71 percent under policy case assumptions using the cost differtial minimum requirements of 3, 1.5, and 0 percent respectively. Assuming a zero percent cost differential threshold, food and beverage products stand out as the best opportunity for modal diversion producing 94,238 annual loads, followed by paper products (54,040), and rubber and plastic inputs (27,474). In general, the further the metro region is from Wisconsin, the better the opportunity is to divert from trucking to truck-to-rail intermodal- the ITIC-IM model suggests 337 shippers moving freight between Wisconsin and Miami, 162 between Wisconsin and Los Angeles, 130 between Wisconsin and Laredo, and 93 between Wisconsin and Portland could benefit from truck-to-rail intermodal moves even without an expanded intermodal market.

Transportation is incredibly local. The characteristics of one local business's supply chain can potentially be so different from another local business's operating in the same industry that one could economically ship via truck-to-rail intermodal while the other cannot. The ITIC-IM model is detailed enough to model these differences provided the user has complete knowledge of the supply chain. When attempting to analyze across an entire state however, it is not reasonable to acquire this proprietary information from all shippers. Instead, one has to disaggregate estimated aggregate data, as well as make a number of simplifying assumptions. So while the model can work on a statewide or regional basis to provide general estimates as to modal diversion from changes to policy, available infrastructure, and other market variables such as fuel and labor costs, it is better suited for modeling a single shipper's supply chain options.

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