AN ANALYSIS OF AMERICAN COMMODITY SHIPMENTS TO CANADA

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Introduction

The physical movement of goods plays a key role in many market transactions, making the transportation system an essential foundation for a national economy. As a trade-reliant nation with its population spread over a vast landscape, Canada is particularly dependent on an effective transportation system. And, in order to assess the national transport system and its ability to move freight, quality statistical information is required. In several OECD countries, a Freight Analysis Framework is used as a planning tool for assessing the transport network and its capacity to meet projected demand.

The principal data for such framework is a set of commodity origin-destination flows by mode, and there are two basic approaches to estimating these flows. First, data can be collected from the shipper, for example the manufacturer which sends the shipments. Alternatively, data can be obtained from the carrier, such as the railway, which delivers the shipments. In the United States (U.S.), the Bureau of Transportation Statistics (BTS) manages a framework program with baseline data from a shipper-based Commodity Flow Survey (CFS), conducted every five years by the U.S. Census Bureau (USCB).

A previous study assessed the options of measuring commodity flows in Canada and identified the strengths and limitations of each approach (Madar & McKeown, 2015). A noted limitation of the shipper-based approach is the exclusion of import shipments which originate from outside of Canada. There are several possibilities for obtaining data on these import shipments. One option is to ask survey respondents directly about the shipments they receive when asking about their outbound shipments. Another option is to use export shipments from other countries.

This study investigates the potential of capturing import shipments by examining American outbound shipments to Canada. It begins by reviewing a plausible Canadian framework and data considerations. To further our understanding of this shipper-based approach, it examines the number, value and weight of American export shipments to Canada from the 2012 CFS. Next, it focusses on other characteristics such as the region of origin, type of industry, commodity classification, and mode of transport. The study concludes by discussing the technical and organization considerations in moving forward.

A Canadian Freight Analysis Framework

A Freight Analysis Framework (FAF) can be used for assessing domestic and international trade flows, exploring patterns in freight movements, observing traffic volumes, and for analyzing impacts of transport policies. Another use is to forecast network capacity required in future years or under different conditions (i.e. a new link). In the U.S., the BTS manages a FAF program to estimate total volumes and values of freight moved among and within CFS-defined areas. Baseline data are provided by an establishment-based CFS, undertaken every five years by the USCB (U.S. Departments of Transportation and Commerce, 2015).

Madar and McKeown (2015) sketched out a plausible framework for Canada consisting of a series of matrices to capture commodity flows, both weight and value, by mode among a set of regions within the country (Figure 1). The framework starts with Canada's seventy-six Economic Regions (ER).[1] While import and export shipments are depicted as a single respective row or column in Figure 1, they would consist of a series of reciprocal gateways or ports of entry and exit (i.e. the Ambassador Bridge in Windsor, the Emerson Manitoba rail crossing into Pembina North Dakota) to be aligned with the American FAF.

O/D	ER_1	ER_2	...	ER_j	...	ER_{76}	EX	∑
ER_1								
ER_2								
⋮								
ER_i				F_{xy}^{ij}				
⋮								
ER_{76}								
IM								
∑								∑∑

where, F_{xy}^{ij} = Flow (weight, $) of Commodity x by Mode y from Origin i to Destination j.

Figure 1. A Canadian Freight Analysis Framework

Since 2014, Statistics Canada has been working with Transport Canada on the feasibility of a shippers' survey, the Canadian CFS (CCFS). With the overall design similar to the American CFS, part of the feasibility study entailed consultations with the BTS and USCB. While modifications can certainly be made to cover industries excluded by the American CFS but deemed important in Canada, such as forestry or oil and gas extraction, a concern from the outset with a shipper-based commodity flow survey was the exclusion of imports. As Madar and McKeown (2015) noted, these shipments are relatively more important to the Canadian economy compared to the United States.[2]

The matter of import shipments was considered by the 2015 Commodity Flow Survey Workshop organized by the Transportation Research Board (2016). Participants examined the best ways to modify the CFS to include questions in order to capture the American segments of import movements. The USCB subsequently investigated collecting the origin (domestic or import) and mode of inbound shipments from in-sample establishments. Initial testing of the ability to gather such data found that the information was either not readily available or would require the respondent to coordinate with other offices within the company, thereby increasing burden and impacting response. As a result, the USCB recommended that any such collection could not be implemented for the 2017 CFS.

Another possible option to measure imports discussed with the BTS is reciprocity. That is, the use of American CFS export shipments to Canada and Canadian CCF export shipments to the United States as respective import shipments. In order to begin investigating the potential of this option, our research examines American export shipments to Canada from the 2012 CFS. In June of 2015, the USCB made available online the 2012 CFS Public Use Microdata (PUMS) file, containing 4.7 million records collected from approximately 60,000 establishments.

Fields on the CFS PUMS consist of establishment-based estimates, including location and the North American Industry Classification System (NAICS) code. Additionally, there are shipment-based measures including the value, weight and Standard Classification of Transported Goods (SCTG) code along with

mode(s) of transport. The PUMS file classifies export shipments from the U.S. into those destined for Canada, Mexico and other countries. While the final city destination of export shipments within the receiving country is collected, it is not included on the PUMS file, limiting this first investigation.

The American Commodity Flow Survey

The CFS estimated that almost $13.9 trillion worth of goods weighing 11.3 billion tons[3] were shipped by American establishments an average distance (by all modes) of 630 miles in 2012 (U.S. Departments of Transportation and Commerce, 2015). About 86% by value of these products were shipped by a single mode – truck, rail, water, air or pipeline – with truck accounting for over 70%. By value, 92% of shipments had a domestic destination, while the other 8% by value was destined for export. The subsequent analysis will focus on the 8% of shipments destined for Canada, starting with a descriptive overview.

American Export Shipments to Canada – A Description

There were 221.7 million shipments to countries outside of the United States in 2012, of which 76.9 million, or 35%, were destined for Canada (Table 1). Those bound for Canada represented about 20% of the value and 16% of the weight of total export shipments. We now focus on a description of these 76.9 million Canadian bound shipments: Where they originated, both geographically and by industry; what they consisted of in terms of commodities; how they were transported; and the final U.S. port of export.

Table 1. Number, Value and Weight of American Export Shipments, 2012

	Shipments		**Value**		**Weight**	
	Number	*%*	*$ ('000s)*	*%*	*Tons ('000s)*	*%*
Canada	*76,898,095*	*35*	*227,602,000*	*20*	*88,729*	*16*
Mexico	*12,500,786*	*6*	*110,277,000*	*10*	*78,327*	*14*
Other country	*132,316,123*	*60*	*786,823,000*	*70*	*786,823*	*70*
Total	*221,715,005*		*1,124,652,000*		*564,488*	

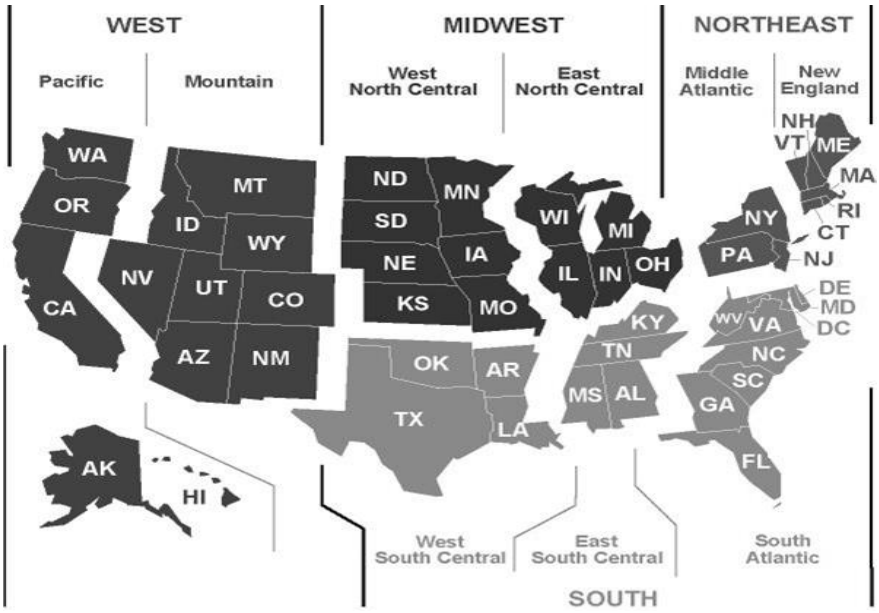
Source: 2012 Commodity Flow Survey, PUMS

The shipment origins were grouped into nine regions based on geography (Figure 2). Over one-quarter (26%) of total shipments originated in the Pacific region, mostly from California (Table 2). Over one-quarter by value (29%) and by weight (27%), originated in the East North Central region, particularly from Michigan and Ohio. Also an important origin region in terms of number of shipments was the Middle Atlantic, because of New York and Pennsylvania, but less so for value and weight.

Table 2. American Exports Shipments to Canada by Region of Origin, 2012

Regions	**Shipments**	**Value**	**Weight**
East North Central	*22 %*	*29 %*	*27 %*
East South Central	8 *%*	10 *%*	6 *%*
Middle Atlantic	13 *%*	10 *%*	7 *%*
Mountain	5 *%*	4 *%*	10 *%*
New England	4 *%*	4 *%*	6 *%*
Pacific	26 *%*	14 *%*	11 *%*
South Atlantic	10 *%*	10 *%*	14 *%*
West North Central	6 *%*	11 *%*	11 *%*
West South Central	5 *%*	8 *%*	8 *%*

Source: 2012 Commodity Flow Survey, PUMS



Source: United States Census Bureau

Figure 2. American Geographic Regions

The top American states as destinations or export ports (data not shown) for shipments to Canada, accounting for 87% of the total, included New York, Montana, Michigan, Washington, Maine and Tennessee. All states are contiguous to Canada except Tennessee, where a major courier company maintains its hub.

In terms of industry, establishments from the top seven NAICS industries produced about two-thirds (68%) of the shipments and just under one-half (45%) of the value of export shipments (Table 3). Reflecting the integrated North American motor vehicle manufacturing industry, the Transportation sub-sector accounted for a full one-quarter of the value of all export shipments to Canada. Besides electronic shopping and warehousing & storage, other top industries were wholesale establishments often dealing with relatively high-value and low-weight products. By weight, the top NAICS that produced export shipments to Canada were Mining (except Oil and Gas), accounting for 23% of the total shipments (data not shown).

Table 3. American Export Shipments to Canada by Top Industry of Origin, 2012

NAICS Industry	Shipments	Value	Weight
4541 – Electronic Shopping	*36 %*	*2 %*	*0* %*
4231 – Motor Vehicle & Parts	*9 %*	*5 %*	*5 %*
4931 – Warehousing & Storage	*5 %*	*5 %*	*1 %*
4238 – Machinery, Equipment	*5 %*	*3 %*	*1 %*
4236 – Electrical, electronic goods	*5 %*	*3 %*	*0* %*
4234 – Commercial Equipment	*4 %*	*2 %*	*0* %*
336 – Transportation Equipment	*4 %*	*25 %*	*6 %*

Source: 2012 Commodity Flow Survey, PUMS ** Value rounded to zero*

In the American CFS, the type of commodities shipped are categorized according to the Standard Classification of Transported Goods (SCTG). Those commodities coded as Electrical, transportation vehicles and equipment, instruments and miscellaneous furniture and lighting products accounted for 45%

of the total number of shipments destined for Canada and 43% of the total value (Table 4). In terms of individual commodity types, Motor vehicle and parts (SCTG 36) at 27%, Machinery (SCTG 34) at 11% and Electronic and other electrical equipment and components and office equipment (SCTG 35) at 8% were the most prominent commodities by value.

Table 4. American Export Shipments to Canada by Type, 2012

SCTG Group	Shipments	Value	Weight
01–05 –Animal, fish, grains	*1 %*	*3 %*	*7 %*
06–09 – Prepared foods & beverages	*1 %*	*3 %*	*6 %*
10–14 – Stones, gravel, minerals	*0* %*	*2 %*	*12 %*
15–19 – Coal, fuels oils, petroleum products	*0* %*	*2 %*	*18 %*
20–24 – Chemicals, fertilizers, rubber	*11 %*	*13 %*	*15 %*
25–30 – Wood, paper, textiles	*17 %*	*6 %*	*9 %*
31–34 – Metals and machinery	*11 %*	*20 %*	*17 %*
35-38 – Electrical, transport, manufacturing	*45 %*	*43 %*	*11 %*
39-99 – Misc, waste, mixed freight	*15 %*	*8 %*	*4 %*

Source: 2012 Commodity Flow Survey, PUMS ** Value rounded to zero*

To provide some insight into the patterns observed thus far, we examine export shipments to Canada by mode (Table 5).[4] Over 60% of all export shipments to Canada are transported to the final U.S. destination by parcel, postal or courier. This underscores the number of shipments (36%) from Electronic Shopping establishments, many located in the Pacific region, particularly California. Some specialized manufactured goods such as parts or instruments may also be delivered in this way. Trucking accounts for about one-third (32%) of shipments but almost three-quarters (74%) of the value. As expected, the rail and water modes, while almost indiscernible in terms of the number of shipments, account for about 30% of the weight of American export shipments to Canada.

Table 5. American Export Shipments to Canada by Mode, 2012

Mode of Transport	Shipments	Value	Weight
Air (including truck and air)	*6 %*	*3 %*	*0* %*
Non-parcel multiple mode	**0 %*	*4 %*	*9 %*
Parcel, postal or courier	*61 %*	*9 %*	*0* %*
Pipeline	*0* %*	*0* %*	*0* %*
Rail	*0* %*	*9 %*	*26 %*
Truck	*32 %*	*74 %*	*55%*
Water	*0* %*	*0* %*	*4 %*
All other modes	*0* %*	*2 %*	*6 %*

Source: 2012 Commodity Flow Survey, PUMS ** Value rounded to zero*

American Export Shipments to Canada – An Examination

From a Canadian infrastructure perspective, the salient information from an examination of American export shipments to Canada is the port of entry, the mode of transport and the final destination in Canada. In the previous section, we reported that 87% of the total of American export shipments to Canada are concentrated in destination or gateway states, five of which are contiguous to Canada. We now take a closer look at these export ports, or gateways, at a higher resolution using CFS-defined areas. There are a total of 134 such areas defined as either metropolitan or combined statistical areas along with rest of state areas and whole states.[5]

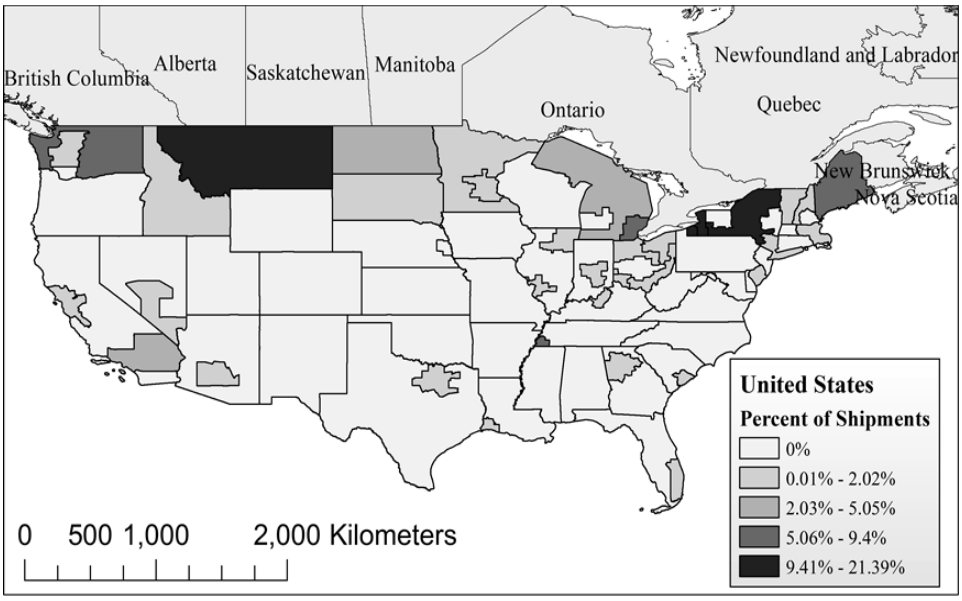


Figure 3. American Shipments to Canada by CFS Area Export Port, 2012

Using categories based on the number of shipments destined for Canada from American export ports, there are relatively large proportions of shipments from CFS areas in Montana and New York followed by CFS areas in Washington and Michigan as well as Maine (Figure 3). As noted previously, the Memphis CFS area also accounts for a discernible proportion of shipments given it is the hub location of a major courier. Falling into the third group of export shipments are the CFS areas of Los Angeles, North Dakota and the rest of Michigan. A fourth group includes the states of Idaho, South Dakota, Minnesota, Vermont and New Hampshire as well as other CFS areas that appear to contain major airports. Finally, this leaves a large group of over 100 CFS areas that play no function as export ports, each having no such shipments.

The top 10 CFS areas as export ports accounted for 90% of all shipments destined for Canada, 92% of the value and 80% of the weight (Table 6). The Buffalo-Cheektowaga, New York CFS area represents the largest gateway for American shipments to Canada accounting for over one-fifth (21%) of the shipments and more than one-quarter (28%) of the value (Table 6). This CFS area combined with the Detroit-Warren-Ann Arbor (DWAA), Michigan CFS area represented over one-quarter (27%) of all export shipments to Canada and almost one-half (48%) of the value with 40% of the weight. These two CFS areas are key gateways for American shipments into Canada and, conversely, for Canadian shipments into the U.S.

The Detroit-Warren-Ann Arbor Gateway

In 2012, 4.86 million of the export shipments from the U.S. to Canada crossed from the DWAA export port. Approximately one half (49%) of these shipments representing about one half of the value (51%) consisted of SCTG categories 35-38 – Electronic and other electrical equipment and components, Vehicles, Transportation equipment (other) and Precision instruments and apparatus. Of these approximately 2.4 million shipments that arrived at DWAA by weight, two-thirds (66%) came by truck, one-fifth by rail and about 13% by combined truck and rail. And in terms of dollar value, over one half (53%) were shipped from four NAICS industries: 1) Transportation equipment manufacturing; 2) Motor vehicle and parts; 3) Machinery, equipment, and supplies; and 4) Electrical and electronic goods merchant wholesalers.

Table 6. American Export Shipments to Canada by U.S. Export Port, 2012

CFS Area	Shipments	Value	Weight
Buffalo-Cheektowaga, NY	*21%*	*28%*	*16%*
Detroit-Warren-Ann Arbor, MI	*6%*	*20%*	*24%*
Remainder of Montana	*14%*	*13%*	*12%*
Remainder of New York	*13%*	*10%*	*8%*
Remainder of Washington	*9%*	*6%*	*7%*
Remainder of Michigan	*5%*	*5%*	*7%*
Remainder of Maine	*7%*	*3%*	*4%*
Remainder of North Dakota	*3%*	*2%*	*2%*
Memphis, TN	*7%*	*2%*	*0*%*
Los Angeles-Long Beach, CA	*3%*	*1%*	*0*%*
All other CFS Areas	*10%*	*8%*	*20%*

Source: 2012 Commodity Flow Survey, PUMS ** Value rounded to zero*

Approximately 45% of the 4.86 million shipments (53% of the value) arrived at the DWAA did so by truck. While about one half (49%) arrived via a Parcel or courier, they accounted for just 2% of the value. Courier shipments are more than likely ground deliveries and would continue on into Canada as such. Shipments arriving at this export port by rail accounted for 3% of the total number and nearly one-third (31%) of the value and just under one half of the weight (46%). Again, assuming that shipments arriving at the export port by a certain mode continue on to cross the border using the same mode, these results underscore the importance of the border crossing facilities – road and rail bridges – at this particular location.

Summary

In 2012, American establishments sent over one-third (35%) of their total export shipments to Canadian destinations. These 76.9 million shipments represented $227.6 billion worth of commodities. There was a certain concentration of products, industries and locations. For example, almost half the shipments by number (45%) and value (43%) consisted of Motor vehicles and parts, Machinery and Electronic and other electrical equipment and components (SCTG 35-38). And one-quarter (25%) of shipments by value originated with Transportation equipment and parts manufacturing establishments (NAICS 336). And establishments in the U.S. East North Central accounted for 22% of the shipments and 29% of their value.

The concentration of shipments geographically was even more acute when considering the export port, or the final U.S. location, from where the shipments crossed into Canada. For example, the Buffalo-Cheektowaga CFS area in New York along with the Detroit-Warren-Ann Arbor CFS area in Michigan were the export ports, or final U.S. destination, for more than one-fifth (21%) of the shipments and more than one-quarter of their value (28%) in 2012. In the case of the Detroit-Warren-Ann Arbor gateway, practically all (99%) of the shipments representing all of the value (99%) arrived by surface mode, either road or rail, underscoring the critical role of this key gateway in American – Canadian merchandise trade.

It appears that total CFS shipments to Canada have the potential to supply a large portion of the import flows for a Canadian freight analysis framework. The American CFS would capture all of the import flows by surface (i.e. road, rail), leaving only marine (overseas) and pipeline. A matter that remains unresolved however, is the classification system to be used in assigning the type of commodity being shipped.[6] As a next step, we propose working with U.S. Census Bureau in an effort to obtain the precise geographical location of the Canadian destination as well as the reported (as opposed to inferred) mode used for delivery from the final U.S. destination.[7]

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Endnotes

[1] ERs are comprised of complete Census Divisions. Some ERs would have to be grouped or collapsed for analysis and dissemination (Madar & McKeown, 2016). One option is to aggregate the regions into a set of 31 "Greater Economic Regions," which allows for more reliable estimates than would the 76 smaller ERs (Bemrose, et. al., 2016). Another alternative is to use CMAs based on some threshold or gateway function and then define rest of province areas.

[2] In 2013, the proportion of the value of imports to GDP at current prices was 25% in Canada, and 14% in the U.S (see *OECD StatExtracts*, http://stats.oecd.org/index.aspx?queryid=28966).

[3] The CFS converts all volume and weight units into imperial tons. One imperial ton contains 2,000 pounds and one metric tonne contains 1,000 kilograms (kg). With 1 kg equal to 2.204 pounds, one imperial ton weights less than one metric tonne by a few kgs.

[4] For export shipments, respondents identify the U.S. Exit Port and the mode(s) used to ship the commodities there. On the CFS PUMS file, the final Canadian destination and the mode of delivery were suppressed. It is reasonable to infer that, in almost all cases, there is no change in mode between origin state to U.S. "exit port" and when the shipment crosses the border.

[5] CFS-defined areas are comprised of 82 Combined Statistical or Metropolitan Statistical Areas, 36 rest of state areas (ROS) and 15 whole states.

[6] The 2017 American CFS is being collected using the Standard Classification of Transported Goods (SCTG) whereas the North American Steering Committee on Classification has adopted of the North American Product Classifications System (NAPCS).

[7] With the final city destination in Canada for export shipments, we could then estimate flow characteristics such as average weight, value and distance per shipment.