Creating *Lean*, *Green* and *Agile* Supply Chains: the Benefits of Cabotage Liberalization

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Abstract

A significant proportion of offshore trade with North America is carried in 20 and 40 foot marine containers. It would appear logical to use empty international marine containers in domestic service if controlled by a Canadian carrier. Until recently this form of cabotage was restricted by Canadian customs regulations. This paper examines the environmental impact of the cabotage regime on the movement of international containers in Canadian domestic service and how these regulations influenced supply chain efficiencies. The discussion begins with a historical perspective and theoretical underpinning, followed by a comparison of North American container regulations. A review of global reforms and contemporary perspectives on cabotage regulations is provided, followed by a chronology of Canadian container regulatory reform. An economic framework and method of analysis is presented and three case studies are examined to illustrate the environmental and economic impact of a liberalized cabotage regime.

Acknowledgement

This article is based on a report prepared for Transport Canada: *A Review of Regulations Governing Use of International Marine Containers in Canadian Domestic Cargo Carriage* (2005). The opinions contained in this paper are the sole responsibility of the authors and do not necessarily reflect the views of Transport Canada.

Date of receipt of final manuscript: December 2009

1.0 Introduction

Taiichi Ohno (1912-1990) championed a unique way of improving efficiency at the Toyota Motor Company based on the identification of *muda*, or waste (Womack and Jones, 2003). Just as engineers quantify the strength of materials by their molecular properties, "lean thinking" reveals why some supply chains are weaker than others. As waste is identified and eliminated, supply chains become more efficient and cost effective.

The evolution of supply chain value analysis has shifted from a narrow perspective related solely to costs to include broader concepts such as sustainability. For example, the focus of the 1980's was on *lean* production. In the 1990's, the concept of *agility* was used to determine how responsive supply chains were to market shifts and disruption. Today, attention is focused on a product's "carbon footprint". This is leading to the development of *green* supply chains. As a result, another industry acronym can be added to the lexicon: *lean*, *green* and *agile* supply chains, or LEGRA.

Repositioning transportation equipment without a payload is one such waste. It consumes system capacity and the fuel burned generates unnecessary greenhouse gas (GHG) emissions. But market imbalances dictate that a certain percentage of empty equipment movements are unavoidable. In industry terms this is called "deadhead" backhaul and becomes more pronounced when regulations constrain the flexibility of supply chain networks.

A significant proportion of retail goods from offshore arrive in North America in 20 and 40 foot marine containers; the standard for international marine shipping. As of 2008, there are over 14 million containers worldwide, owned or leased by international marine container carriers. Once an import load is discharged in Canada, it seems logical to use empty marine containers in domestic service if control of the equipment is by a Canadian carrier. In regulatory terms, this is a form of *cabotage* and Canadian customs regulations restrict the use of empty foreign containers for domestic loads under strict conditions.

This paper examines the impact of the cabotage regime on the movement of international containers in Canadian domestic service and how these regulations influence supply chain efficiencies. The discussion begins with a historical perspective and theoretical underpinning, followed by a comparison of North American container regulations. A review of global reforms and contemporary perspectives on cabotage regulations is provided, followed by a chronology of Canadian container regulatory reform. An economic framework and method of analysis is presented for examining three case studies to illustrate the environmental and economic impact of a liberalized cabotage regime.

2.0 Historical and Theoretical Foundation

The word cabotage that comes from the French verb, *caboter*, and Spanish word, *cabo*, meaning "along the cape". It refers to ocean pick-up and delivery of goods along a coastline. Centuries ago, ships from northern Europe en route to the Mediterranean Sea would stop along the Atlantic coast to drop off and pick up cargo and passengers, making their trips more profitable. In an effort to protect their own shipping and ship building industries, the Portuguese restricted this practice to vessels that were locally owned and operated. As a result, they were the first to develop laws to prohibit cabotage. Nations that subsequently adopted similar laws were motivated by a desire to protect their nation's merchant fleet from competition and therefore, their economic sovereignty.

In an age of globalization, many are questioning both the relevancy of cabotage restrictions generally and government's role in maintaining container regulations, specifically. Bonsor (1984) and Stigler (1971) note that regardless of government's initial intentions, in establishing a regulatory agency, over time the agency can become "captive" to the industry it regulates. Bonsor cites cases where regulators were made up of individuals from the companies they intend to regulate. Kahn (1971) has observed that when regulators are responsible for the performance of an industry, the desire to protect the health of that industry and the companies they regulate soon follows, becoming a moral hazard. Regulatory protections, rather than competition become the instruments to assure performance. Ultimately, economic regulation can lead to inefficiency and waste.

The U.S. *Jones Act* is perhaps the most recognized transportation example of *capture theory*. The American marine and shipbuilding sectors are shielded from global competition by various *Jones Act* protections behind a wall of Washington lobbyists. The protection provided by the Jones Act has artificially nurtured the American marine shipping and shipbuilding sectors, under the guise of military necessity. Canadian container cabotage regulations, on the other hand, are a contradictory form of domestic market protection, given the Canadian container manufacturing industry is practically extinct.

Public inertia prevents timely regulatory reform, and can take decades to overcome. In the case of cabotage, such regulations have been a part of North American history since 1651; enshrined in the *Navigation Acts*, regulating the shipping of goods in Great Britain and its colonies by restricting trade to British and colonial ships**.** While cabotage became a regulated activity in ocean vessel shipping through the restrictions of foreign-flagged vessels on a particular coastline, the term came to be used to describe all forms of domestic transportation services that use foreign-owned equipment or conveyances. As alternative modes of transportation developed, similar protection was transferred to them. Interestingly, cabotage is not restricted by any specific law; it is prohibited by Customs rules and by Immigration and Employment regulations.

2.1 Container Cabotage in North America

Canadian Customs tariff 9801.10.00 governs the use of foreign-owned marine containers in Canada, and limits the time containers can remain in Canada to 30 days. If the container remains in Canada past the time allowed, it must be imported with the appropriate duties paid. Also, 9801 restricts the use of foreign containers for domestic shipments to only one trip in the direction of the port where it arrived. The container must exit through the port of arrival as well. No backtracking off the direct route is allowed between domestic points and speculative moves of empty containers are also prohibited. Essentially, foreign-owned containers are prevented from carrying domestic cargo – the practice known as cabotage.

An amendment to the rule, (Canada Customs Memo D3-7-1) allows containers to remain in the country for up to six months provided the carrier is a registered "pool" operator. But these companies must participate in the Customs Post Audit System and allow officials to audit their records (Vido and Kosior, 2001). The limitation to one domestic move remains the most restrictive operationally.

The United States has more liberal rules governing the use of international containers. The U.S. allows containers to remain in the country for one year (as opposed to 30 days) and containers are allowed to move around freely, without geographic restrictions provided the carrier is U.S.-based. Foreign containers are free to exit the U.S. through any American port.

Essentially, foreign containers are viewed by the Americans as "steel packaging" and are described as such under NAFTA regulations.

By comparison, the rigid Canadian regulations prohibit efficient repositioning of containers to pick up loads in inland locations within Canada, raising costs, consuming system capacity, and discouraging formation of intermediaries, like the Non-Vessel Operating Common Carriers (NVOCC) who provide services for the U.S. transportation industry. Furthermore, ocean carriers that serve both Canadian and American ports must follow two sets of rules for what they should view as one market. A segmented marketplace makes operating container equipment in Canada less desirable relative to the U.S (Vido, 2004).

Foreign containers with domestic U.S. loads from point to point in the United States are considered "in-transit" if traversing Canadian territory. The proviso was meant to accommodate Alaskan bound traffic, but now applies to general continental U.S. movements over Canadian territory. Similar movements are not allowed under Canadian cabotage law. No incidental domestic use is allowed when a foreign container transports goods from a point outside Canada in transit through Canada to another point outside Canada (i.e., U.S.-Canada-U.S.). Similarly, no incidental domestic use is allowed when a foreign container transports goods from a point in Canada in transit through a foreign territory to another point in Canada (i.e., Canada-U.S.–Canada).

Given the flexibility that container lines have when operating their equipment in the U.S., container lines may prefer to position their equipment in U.S. rather than Canada. This could put Canadian shippers at a competitive disadvantage relative to U.S. shippers.

2.2 Cabotage Reforms: Global Evidence

The European Union first began cabotage liberalization in 1999 to slow the drift of the EU fleet towards "flags of convenience"; countries that are far more attractive to ship-owners than Europe in terms of taxation, social legislation and safety or environmental standards. From 1985 to 1995, employment of seafarers on EU-flagged ships fell by 37 percent, while the number from non-EU countries rose by 14 percent over the same period. In 1970, 32 percent of world trade sailed under an EU flag whereas just 13 percent in 2000 sailed under EU flags (Tyrinopoulos, 2005).

A major obstacle to reform is a belief that cabotage prohibitions preserve domestic maritime know-how and employment. Critics of cabotage restrictions claim that such laws fail to achieve the goal of protecting a country's shipping capability, and simply increase costs of domestic shippers. Restricting cabotage is unlikely to assure domestic transport capability nor inhibit excessive foreign influence in domestic transport services (Hubner 2003).

Although limited data is available in the European case regarding cargo falling under cabotage restrictions, carriers and governments agree that its importance in terms of seaborne trade volumes is limited and constitutes more of an irritant than a major problem (Hubner, 2003).

3.0 Chronology of Canadian Container Regulatory Amendments

In 2001, a small scale university study questioned the relevancy of Canadian customs regulations as they pertain to container movements. This qualitative work examined the relevance in retaining such policies, evaluated their impact on supply chain efficiencies and was the earliest examination of container cabotage in Canada (Vido, Prentice and Kosior, 2001). Vido (2004) quantified the impact on agricultural supply chains using a gravity model. While the analysis calculated a $10 million export sales loss to lentil producers, the case study suggested that container cabotage was even more costly to Canada in terms of reduced transportation network efficiencies and capacity, which negatively affects all shippers.

A 2005 study sponsored by Transport Canada further quantified the impact of container cabotage restrictions in terms of transportation capacity, efficiencies and emissions reductions, using three case studies. In each case, carbon emissions were reduced due to a reduction of empty miles, increased supply chain speed and improved efficiencies (Prentice and Kosior, 2005).

In 2006, the Canadian Senate held hearings on intermodal transportation and container cabotage. Evidence given for limiting cabotage and the number of days that a container can remain in Canada is an issue of maintaining tax equity between foreign and domestic suppliers of containers, and if regulations are not in place, the incentive would be to acquire containers from outside the country. However, no data were provided to support this claim. The regulations have been in existence for at least 30 years and likely introduced in the early 1970’s when containerized international trade arrived in Canada. The suggestion is that truck trailer manufacturers sought protection from the new threat (Canadian Senate, Oct. 17, 2006).

Prentice and Kosior, (2005) report anecdotally that Canadian container cabotage restrictions may not effectively protect domestic manufacturers from foreign competition, in any case. For example, the world’s container fleets are largely manufactured in China, whose cost structures make domestically-manufactured container equipment uncompetitive. Even with potential tariff walls as high as 100%, containers manufactured in China can sell at 50% the price of a container manufactured domestically. Further evidence provided at the Canadian Senate hearings failed to quantify the effectiveness of regulation 9801, both in terms of amount of federal revenues collected under the tariff and the number of violations reported annually. Moreover, Canada (and the U.S. for that matter) does not have an efficient tracking system to monitor violators and that even if such a system were in place and capable, benefits of enforcing the regulation would not be worth the effort and greater benefits to the economy would be derived from repealing the legislation.

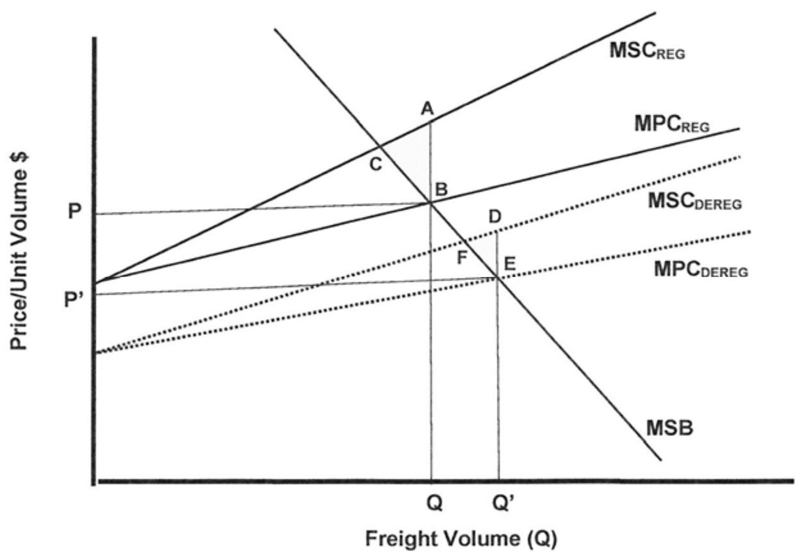
In 2008, the Canadian Senate Committee on Communications and Transportation presented its report to the Canadian Parliament that recommended tariff 9801 be repealed and harmonized with U.S. container regulations (Canadian Senate Committee, June 2008). On February 7, 2009, the federal government published proposed changes to the Customs Tariff governing foreign-owned containers in the Canada Gazette, Part 1. Interested parties were invited to make submissions on the proposed changes by April 2009. The Canadian federal review received several submissions in favour of reform and only one in opposition. Those most likely to express opposition to cabotage reform include labour groups, some domestic trucking interests and consolidators that have built businesses around the use/movements of domestic containers. These groups could face more competition because of an increased supply of international containers that would be used for domestic services.

On December 15, 2009, the Canadian parliament passed *Bill C51 Economic Recovery Act (Stimulus bill)* that included amendments to customs tariff 9801. Containers within Canada are now allowed multiple domestic loads within a 365 day window, consistent with American regulations. However, “in-transit” moves are still prohibited (i.e.: U.S.-Canada-U.S. and Canada-U.S.-Canada). Furthermore, containers cannot be moved into Canada “on-spec” and must have a booked import or export load. As such, the amendments only partially harmonize with U.S. regulations and do not create a single North American container network.

4.0 Economic Framework and Method of Analysis

Full capacity is always greater than effective capacity. A container train with 400 containers has an effective capacity of 75 percent if 100 of these containers are empty. Figure 1 shows the theoretical economic framework and rationale for cabotage reforms. If cabotage restrictions are an explanation for why these containers are empty and the regulations no longer fulfill their original intent, then opportunity exists to increase system efficiency and reduce emissions.

Figure 1
Improved welfare from cabotage deregulation



For freight movement, Q is usually represented by tonnes (or tonne-kilometres) and for this analysis will assume to consist of total system volume (headhaul plus backhaul) with P as the corresponding price per unit. The solid lines represent Marginal Social Costs (MSC_{reg}) and Marginal Private Costs (MPC_{reg}) under cabotage regulation with Marginal Social Benefits (demand plus any positive externalities) represented by the solid line in the opposite direction. The triangle ABC represents the deadweight loss of GHG emissions at the regulated market equilibrium of Q and P.

Under a deregulated regime (i.e. full cabotage), market efficiencies are gained in two ways, first the system is streamlined (less equipment to move same freight volume), and/or the price reduced from market competition. Assuming that the saving is passed on to shippers with a price change from P to P'; the total freight demand would increase from Q to Q'. MPC_{dereg} and MSC_{dereg} represent the reduced private resources and emissions reductions under a more efficient system and both shift downwards. The new equilibrium at P'Q' would have a deadweight loss of DEF. The net environmental benefit would be the difference between ABC and DEF for reduced GHG tonnage.

The theoretical analysis examines the container system in isolation from other modes (primarily bulk) and assumes market demand is price elastic and backhaul opportunities exist. But, the system will realize incremental volume from concomitant activity from bulk modal shift as prices fall. Presumably, this may have efficiency gains for bulk systems if smaller shipments move to container along with potential for reduced fuel consumption and emissions. The theory can be tested using case studies of actual container shipments. But micro-level analysis provides only an indication of the potential benefits of eliminating waste in the system. Case studies cannot be aggregated to determine the holistic energy savings on a network scale. Nevertheless, case studies can illustrate the inefficiency inherent in the current system and provide a quantification of the general range of direct environmental benefits. The case studies described in this paper are based on the environmental impacts of utilizing backhaul opportunities for 40-foot reefer containers.

Two formulas for fuel consumption will be utilized, one for truck and one for rail since fuel cost (based on consumption and per litre price) is a major cost component for carriers. Carbon dioxide, a major constituent of Green House Gas (GHG) emissions is proportional to fuel burned by the conversion factors of 2.4 kg/litre for gasoline and 2.7 kg/litre for diesel respectively (EPA, 2005). Three case studies are modeled in this analysis. The identities of the firms are hidden but the data are derived from actual shipping histories. The shipments are exports of meat products and seafood, the imports and domestic movements are those of a large merchandiser. Rail is the predominant mode for long haul transport in the first cases, but some short haul trucking is involved because the shipper is located in a city without an intermodal ramp. The third case involves long haul trucking from Toronto to St. John's Newfoundland. Rail could be used for part of this shipment, but for expediency the standard *modus operandi* is truck.

Railway fuel consumption is measured in average litres of diesel fuel consumed per metric tonne kilometre (L/T-KM)[1]. The estimate for average fuel consumption in Canada is 0.0057 L/T-KM. The volume of fuel consumed by incremental railcars, containers or cargo consignments is calculated by multiplying the added tonnes by the distance hauled times the fuel consumption estimate. In economic terms, this is the marginal fuel cost for each additional tonne carried. Some subtle fuel consumption differences are observed between eastern and western train movements, but this calculation is suitable for the micro-analysis case studies of average train operations[2].

For truck movements, the fuel consumption for each container carried by a tractor-trailer unit is fully allocated to the conveyance. In other words, each container has a dedicated power unit (the tractor-trailer) assigned to it for the trip[3]. Figure 2 shows the fuel efficiency of trucking with respect to gross vehicle weight (GVW). The equation is standardized for a highway speed of 105 KMH. The corridors are assumed to have less than 10 percent idling in the data mix. The general equation that is derived from Tardif (2000) and Ash (2001) shows a "fixed" cost from tire rolling resistance and a "variable" cost due to wind resistance that is an inverse curve as GVW increases[4].

An argument can be made that for both truck and rail operations, fuel consumption for two tonnes of freight hauled one kilometre is not the same as one tonne hauled two kilometres. While both are two tonne-kilometres of haulage, fuel consumed would be different. Subtle

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[1] Email correspondence with Marie Houde, Director of Network Strategies, CN Rail.

[2] A network approach would require the use of the Davis railway propulsion formula for train operations.

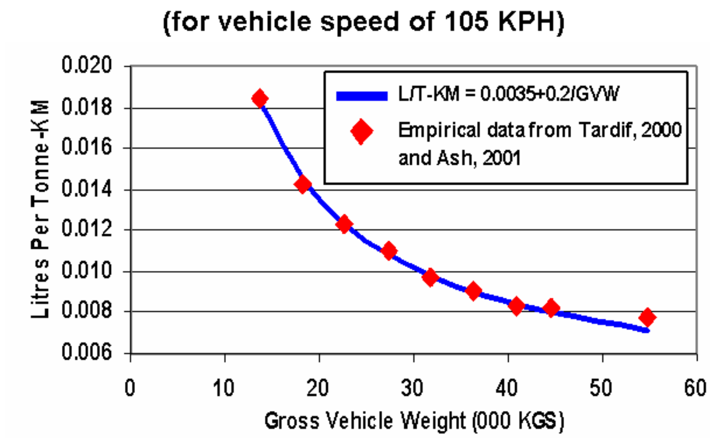
[3] In the case of rail operations, the train will still move between points in a corridor whether 300 or 400 containers are full.

[4] The Davis railway formula does follow an inverse relationship as well, but since modern trains are long and heavy, fuel consumption is "way down" the inverse curve and can be considered linear for all intents and purposes.

differences arise from operational considerations such as fuel burn during acceleration and wheel rolling resistance. But since we are using case studies with medium to long haul ranges, these differences are immeasurable. The Davis (Iwnicki, 2006), Tardif (2000) and Ash (2001) formulas for fuel consumption used in this paper are based on energy to move weight, and while engine technologies have improved since the formulas were first derived, they are adequate for the illustrative purposes of this study.

Figure 2

Truck fuel consumption



As of 2004, the Canadian federal government is engaged in a multi-year study called the Full Cost Investigation (FCI) initiative where both aggregate and unit costs of transportation modes are being determined. Over 33 reports are available for researchers and government officials for conducting economic analysis including monetizing elements such as emissions and noise (Transport Canada, 2009). However, these reports are for the base case year of 2000, and several are currently being updated for year 2006, so formulas used in this paper remain current until the updates are complete.

4.1 Case 1 - Meat Export and Generic Domestic Movement

The first case presents a 40-foot refrigerated container movement of frozen meat from Brandon, Manitoba to the Port of Vancouver. In order to ship a full container from Manitoba, an empty container must be positioned at the Brandon plant. The fronthaul shipment is represented as a solid heavy black line in Figure 3. The empty backhaul repositioning move is designated as the broken black line. Together, this fronthaul-backhaul combination completes the cycle which is designated as Loop 1 for the remainder of the analysis with trip summary in Table 1.

The round trip distance of Loop 1 includes transhipment at Winnipeg. The rail legs are 2,232 km between Vancouver and Winnipeg, and the truck haul is 200 km between Winnipeg and Brandon, for a total of 4,864 km. The rail legs take three days each way.

Figure 3
Meat export and domestic move

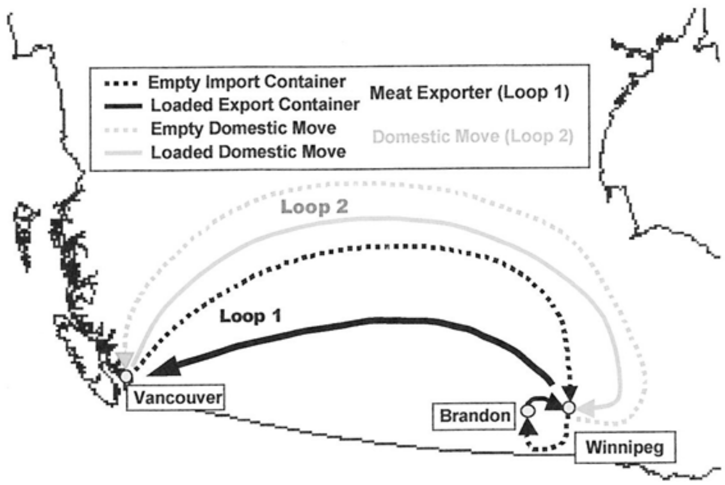


Table 1
Loop 1 – meat export

Origin	Destination	Distance (kms)	Mode	Cargo (MT)	Transit Time (Days)	Dwell Time (Days)	Total Trip Days	Fuel Used (L)	Carbon Emissions (kg)
Vancouver	Winnipeg	2,232	Rail	0	3.0	2.0	5.0	50.6	136.6
Winnipeg	Brandon	200	Truck	0	0.5	0.5	1.0	52.0	140.4
Brandon	Winnipeg	200	Truck	25	0.5	2.0	2.5	69.5	187.7
Winnipeg	Vancouver	2,232	Rail	25	3.0	3.0	6.0	368.7	995.5
Totals by Column ➡		4,864	N/A	N/A	7.0	7.5	14.5	540.8	1,460.2

Table 2
Loop 2 – domestic move

Origin	Destination	Distance (kms)	Mode	Cargo (MT)	Transit Time (Days)	Dwell Time (Days)	Leg Total Days	Fuel Used (L)	Carbon Emissions (kg)
Vancouver	Winnipeg	2,232	Rail	25	3.0	2.0	5.0	50.6	136.6
Winnipeg	Vancouver	2,232	Rail	0	3.0	3.0	6.0	368.7	995.5
Totals by Column ➡		4,464	N/A	N/A	6.0	5.0	11.0	419.3	1,132.1

The dwell period in the Winnipeg intermodal yard is two days. The 200 km road trip from the intermodal yard to the Brandon plant dock and the administration of documents takes six hours complete. Wait times are minimized because the product is perishable. Loading the container with meat is estimated at 12 hours. Dwell time at the Port of Vancouver is estimated at three days.

In summary, the transit time is 7 days and dwell periods equal 7.5 days for a total cycle time of 14.5 days. The transit and dwell estimations assume a 24/7 schedule with no weekend layover. The last actual loading time is Friday afternoon because the plant does not operate over the weekend. Only the marginal fuel required to move the empty container between Vancouver and Winnipeg is considered because the train is a scheduled run. The movement of an empty 40-bfoot reefer container between Vancouver and Winnipeg uses 50.6 litres of fuel. This is less than the fuel consumed on the short haul truck trip between Brandon and Winnipeg. The fuel required to move the tractor and container chassis is 49.2 litres with an additional 2.8 required to move the empty container for a total of 52.0 litres.

On the fronthaul trip, the fuel requires 69.5 litres to move the truck with 25 tonnes of cargo. The marginal fuel required to move the cargo is 17.5 litres. The rail fronthaul requires an additional 368.7 litres of fuel to move the cargo. In total Loop 1 consumes a total of 540.8 litres of diesel fuel and produces 1,460.2 kilograms of CO_2.

Loop 2 in Figure 3 is designated by light grey lines and represents an unrelated domestic shipment between Vancouver and Winnipeg with trip summary in Table 2. The interpretation is the same as for Loop 1 with a solid line for a full movement, and the broken line is an empty return. There is no short haul truck trip to Brandon. The five day dwell time in Winnipeg represents 2 days in the rail yard, 1 day to a consignee's dock unload and release of the container, then another two days waiting for a train. Loop 2 takes 11 days to complete, consumes 419.3 litres of fuel and produces 1,132.1 kilograms of CO_2.

Loop 3 in Figure 4 represents the merger of Loop 1 and Loop 2 in an ideal situation when the two shippers can co-ordinate movements with results shown in Table 3. The distance for the total circuit is 4,864 kms – the same as for Loop 1 with the difference that the inbound rail move from Vancouver to Winnipeg now includes the domestic cargo. The total time for the Loop 3 circuit is 15.5 days, or one day longer than Loop 1. The additional day is to unload the domestic cargo at the consignee's dock in Winnipeg. The only empty movement is from Winnipeg to Brandon. Fuel consumption is 858.9 litres for the complete circuit with 2,319.0 kilograms of CO_2 produced.

Figure 4

Combining meat export with domestic move

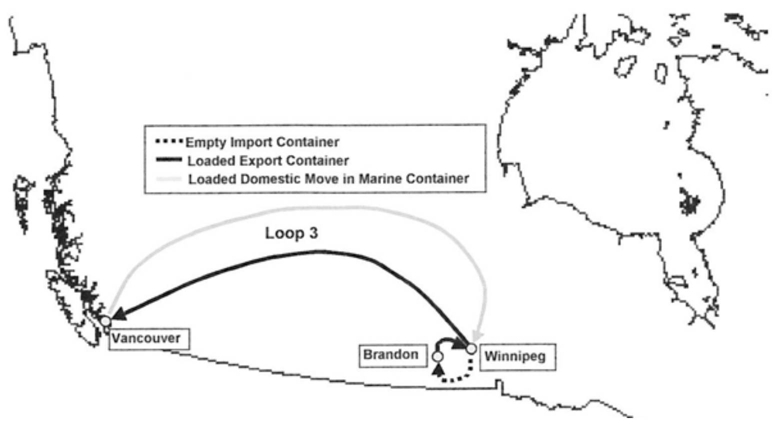


Table 3

Loop 3 – combined meat export and domestic move under cabotage

Origin	Destination	Distance (kms)	Mode	Cargo (MT)	Transit Time (Days)	Dwell Time (Days)	Leg Total Days	Fuel Used (L)	CO_2 Emissions (kg)
Vancouver	Winnipeg	2,232	Rail	25	3.0	3.0	6.0	368.7	995.5
Winnipeg	Brandon	200	Truck	0	0.5	0.5	1.0	52.0	140.4
Brandon	Winnipeg	200	Truck	25	0.5	2.0	2.5	69.5	187.7
Winnipeg	Vancouver	2,232	Rail	25	3.0	3.0	6.0	368.7	995.5
Totals by Column ➡		4,864	N/A	N/A	7.0	8.5	15.5	858.9	2,319.0

The cabotage movement eliminates 4,464 kilometres of empty container travel. Coordination of the circuit eliminates two long haul empty moves. The combined circuit frees up space to move another full cycle. The net time reduction in the merged Loop 3 is 10 days consisting of 6 days of transit time and 4 days of dwell time removed from the logistics pipeline. The combined circuit saves 101.2 litres of fuel and reduces 273.2 kilograms of CO_2 emissions.

4.2 Case 2 – Meat Export and Imported Merchandise Distribution

In this scenario, the meat export case designated Loop 1 is used in a merged circuit with the operations of an imported general merchandise distributor. In Figure 5 the merchandise retailer operation is designated as Loop 4 with data for each leg shown in Table 4.

The merchandise retailer normally transloads import freight from 40-foot international containers to 53-foot domestic containers at Vancouver to gain extra volume. It is assumed that the inbound freight is dense and "weighs out" before utilizing all available container volume, thereby negating the need for trans-loading. The analysis assumes that the distributor is able to separate heavy goods (pumps, rakes, shovels, etc.) from light goods (plastics, toys, household sundries) at the origin and use a 40-foot reefer container to bring their products to a Toronto warehouse.

Figure 5

Meat export with import merchandise retailer

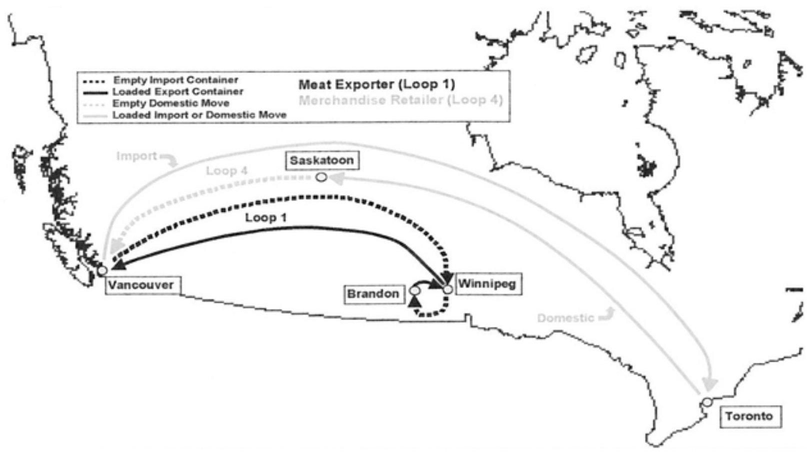


Table 4

Loop 4 – import merchandise retailer move

Origin	Destination	Distance (kms)	Mode	Cargo (MT)	Transit Time (Days)	Dwell Time (Days)	Leg Total Days	Fuel Used (L)	CO_2 Emissions (kg)
Vancouver	Toronto	4,464	Rail	25	7.0	5.0	12.0	737.4	1,991.0
Toronto	Saskatoon	2,957	Rail	25	5.0	5.0	10.0	488.5	1,319.0
Saskatoon	Vancouver	1,667	Rail	0	3.0	0.0	3.0	37.8	102.1
Totals by Column ➡		9,088	N/A	N/A	15.0	10.0	25.0	1,263.7	3,412.0

The inbound leg for the importer from Vancouver to Toronto by rail is 4,464 kilometres. It is estimated to take 7 days by rail and consume 737.4 litres of fuel. The Toronto dwell time of 5 days includes removing the container from the rail yard and transfer to a Toronto area warehouse where it is destuffed and reloaded with a domestic load for stores in Western Canada.

The second leg involves moving the domestic load to Saskatoon, which is a representative mid-Western Canadian point. Toronto to Saskatoon is 2,957 kilometres and the trip consumes 488.5 litres at an estimated 5 days by rail. The dwell time in Saskatoon is 5 days, similar to the dwell times for the previous loops. The empty leg to Vancouver from Saskatoon is 1,667 kilometres and takes an estimated 3 days by rail consuming about 37.8 litres of fuel. No well time is assigned to the container when it returns to Vancouver because it is placed back into the pool. The total circuit is 9,088 kilometres, taking 25 days to complete, using 1,263.7 litres of fuel and producing 3,412.0 kilograms of CO_2 emissions.

In Figure 6, Loop 5 is the combined operation of the merchandise importer and the meat exporter with trip data shown in Table 5. If the two shippers collaborated, the first half of merchandiser's logistics to Saskatoon is retained, and at that point the empty 40-foot reefer container is turned over to the meat exporter. An 829-kilometre leg from Saskatoon to Winnipeg, saving 838 empty kilometres, replaces the Saskatoon to Vancouver empty leg. This also eliminates the Vancouver to Winnipeg empty leg in Loop 1. The Saskatoon to Winnipeg leg takes about 2 days by rail with a dwell time of 2 days. Once the container is removed from the Winnipeg rail terminal, the latter portion of the meat exporter logistics pipeline prevails.

Figure 6

Combining meat exporter with import merchandise retailer

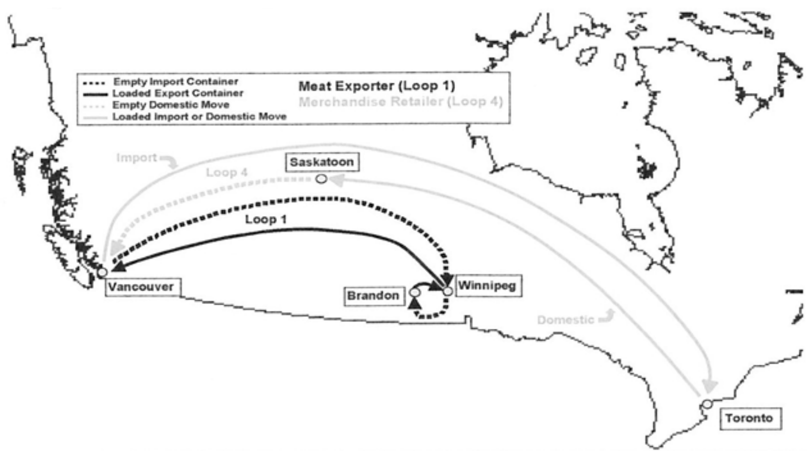


Table 5

Loop 5 – Combined meat export and merchandise retailer move under cabotage

Origin	Destination	Distance (kms)	Mode	Cargo (MT)	Transit Time (Days)	Dwell Time (Days)	Leg Total Days	Fuel Used (L)	CO_2 Emissions (kg)
Vancouver	Toronto	4,464	Rail	25	7.0	5.0	12.0	737.4	1,991.0
Toronto	Saskatoon	2,957	Rail	25	5.0	5.0	10.0	488.5	1,319.0
Saskatoon	Winnipeg	829	Rail	0	2.0	2.0	4.0	18.8	50.8
Winnipeg	Brandon	200	Truck	0	0.5	0.5	1.0	52.0	140.4
Brandon	Winnipeg	200	Truck	25	0.5	2.0	2.5	69.5	187.7
Winnipeg	Vancouver	2,232	Rail	25	3.0	3.0	6.0	368.7	995.5
Totals by Column ➡		10,882	N/A	N/A	18.0	17.5	35.5	1,734.9	4,684.2

Table 5 shows that 1,734.9 litres of fuel is consumed while producing 4,684.2 kilograms of CO_2 emissions. The combined circuit eliminates 3,070 empty kilometres of wasted rail capacity with 4 days of time removed from the combined circuits. Fuel savings amount to 69.6

litres while reducing 187.9 kilograms of CO_2 emissions. Only the dwell time savings are neutralized since they are the same for the separate and combined loops, and therefore no benefits are realized in terms of rail yard congestion savings.

Loop 5 takes about 35.5 days to complete, and thus, the longer time to finish the combined circuit exceeds the 30-day time limit currently stipulated in cabotage regulations. In addition, the "backtrack" from Saskatoon to Brandon under the literal interpretation of the regulations is prohibited.

4.3 Case 3 – Sea Food Export and Import Merchandise Distribution

Trucking is the standard conveyance between Newfoundland and central Canada because the island has no railway. Figure 7 maps out the route from Toronto by truck to North Sydney, Nova Scotia and ferry to Newfoundland. Tables 6 and 7 provide the supply chain data for a merchandise retailer (Loop 6) and a seafood exporter (Loop 7).

Figure 7

Merchandise retailer with seafood exporter

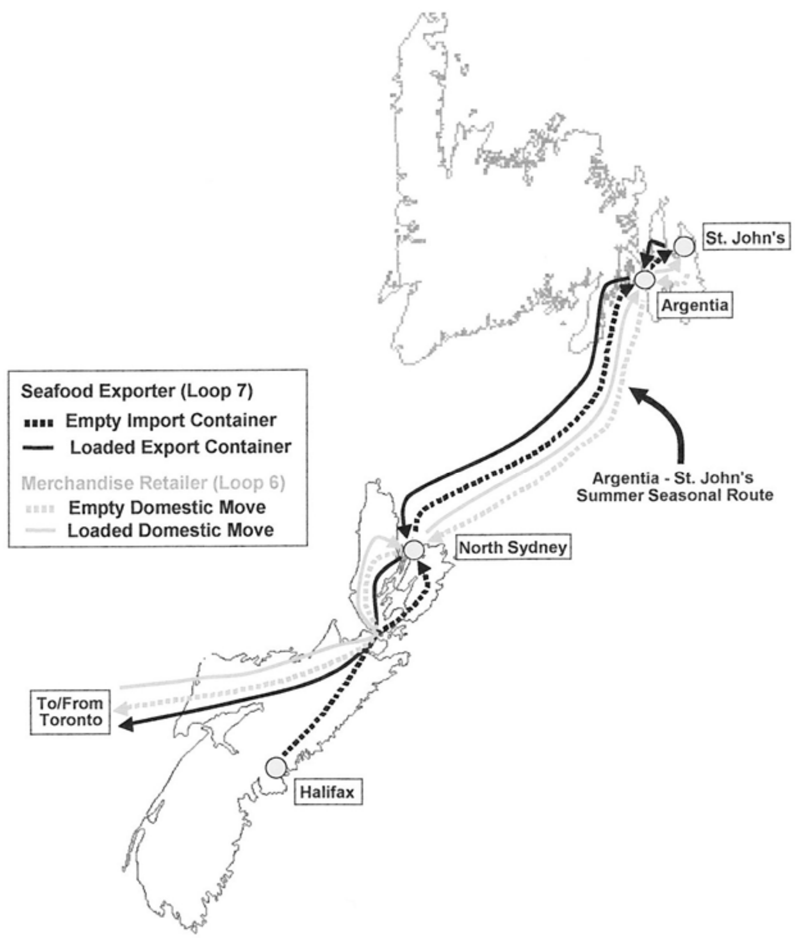


Table 6

Loop 6 – merchandise retailer in St. John's, NL

Origin	Destination	Distance (kms)	Mode	Cargo (MT)	Transit Time (Days)	Dwell Time (Days)	Total Trip Days	Fuel Used (L)	CO_2 Emissions (kg)
Toronto	North Sydney	2,013	Truck	25.0	2.00	0.50	2.50	699.5	1,888.7
North Sydney	Argentia	518	Vessel	25.0	1.00	0.00	1.00	107.0	288.9
Argentia	St. John's	131	Truck	25.0	0.25	3.00	3.25	45.5	122.9
St. John's	Argentia	131	Truck	0.0	0.25	0.50	0.75	34.1	92.1
Argentia	North Sydney	518	Vessel	0.0	1.00	0.00	1.00	43.5	117.5
North Sydney	Toronto	2,013	Truck	0.0	2.00	0.00	2.00	523.4	1,413.2
Totals by Column	➡	5,324	N/A	N/A	6.50	4.00	10.50	1,453.0	3,923.1

For Loop 6, the 2,013-kilometre truck journey takes 2 days and consumes 700 litres of fuel. If timed correctly, the truck has about a half day of wait time for the Marine Atlantic ferry to Argentia. The 518 kilometre ferry crossing takes 17 hours. This is the shortest time route to St. John's and uses 107 litres of fuel. The fuel calculation includes the tare weight of the truck and cargo carried by the ferry. At Argentia, the truck travels 131-kilometers to St. John's and uses 45.5 litres of fuel. The trip takes 12 hours and the container has a three day turnaround time in St. John's.

Table 7

Loop 7 – seafood exporter movement

Origin	Destination	Distance (kms)	Mode	Cargo (MT)	Transit Time (Days)	Dwell Time (Days)	Leg Total Days	Fuel Used (L)	CO_2 Emissions (kg)
Halifax	North Sydney	429	Truck	0.0	0.50	0.50	1.00	111.5	301.1
North Sydney	Argentia	518	Vessel	0.0	1.00	0.00	1.00	43.5	117.5
Argentia	St. John's	131	Truck	0.0	0.25	3.00	3.25	34.1	92.1
St. John's	Argentia	131	Truck	25.0	0.25	0.50	0.75	45.5	122.9
Argentia	North Sydney	518	Vessel	25.0	1.00	0.00	1.00	107.0	288.9
North Sydney	Toronto	2,013	Truck	25.0	2.00	2.00	4.00	699.5	1,888.7
Totals by Column	➡	3,740	N/A	N/A	5.00	6.00	11.00	1,041.1	2,811.0

For Loop 6, it is assumed that no arrangements have been made to co-ordinate a backhaul load and the container returns empty. The truck to Argentia consumes 34.1 litres of fuel, the ferry to North Sydney uses 43.5 litres of fuel and truck to Toronto takes 523 litres of fuel. Return transit times are the same, with no dwell times. At Toronto, the container re-enters the pool. No dwell time is assigned in the model. Loop 6 takes 10.5 days to complete (6.5 days in transit, 4 days dwell). The distance is 5,324 kilometres with 1,453 litres of fuel burned and produces 3,923.1 kilograms of CO_2 emissions.

Loop 7 is essentially the reverse of Loop 6. The export move requires an empty container to be trucked from Halifax to St. John's where it is loaded with seafood. Loop 7 takes 11 days to complete with 5 days in transit and 6 days dwell time. Transit is 1.5 days less but two days of extra dwell time when compared to Loop 6. The total distance is 3,740 kilometres and 1,041.2 litres of fuel are consumed.

Figure 8 shows Loop 8 that utilizes a fully loaded two-way move from Toronto to St. John's and return with trip data in Table 8. The total distance for this circuit is 5,324 kilometres requiring 13.5 days (6.5 in-transit, 7 dwell) to complete, burns 1,704 litres of fuel and produces 4,600.8 kilograms of CO_2 emissions

The waste eliminated in Case 3 is 3,740 empty container miles and GHG emissions from 790 litres of fuel. Trucking accounts of 80.5 percent of the GHG emissions. Additional utilization for the system is equal to 8 days (5 in-transit, 3 dwell)

Figure 8
Loop 8 – Combining merchandise retailer with seafood exporter

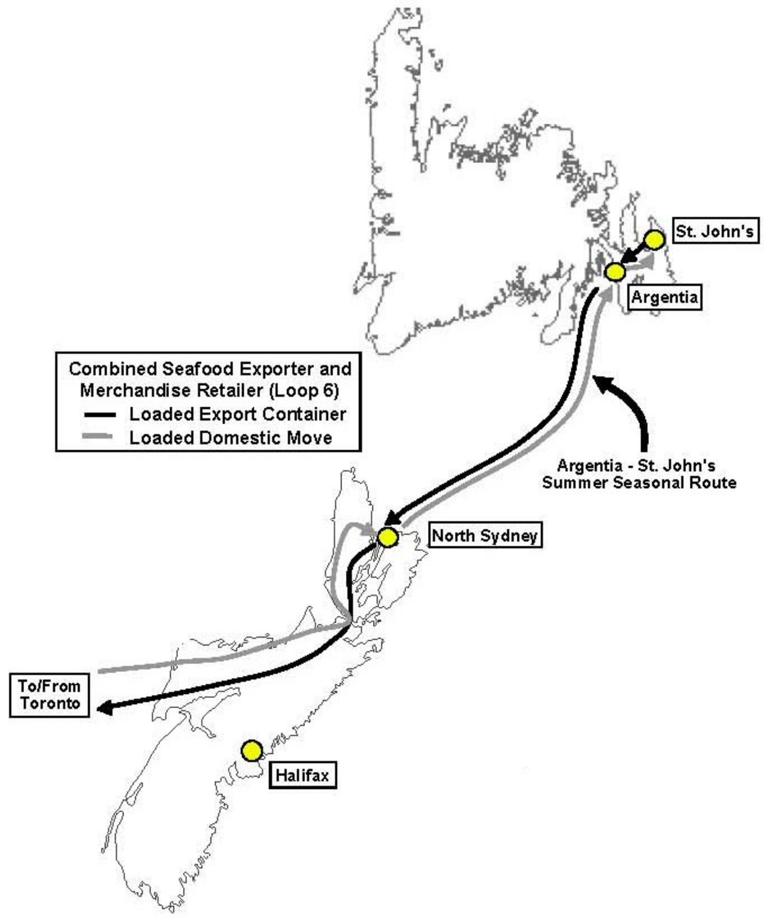


Table 8
Loop 8 – combining seafood exporter with merchandise retailer to St. John's, NL

Origin	Destination	Distance (kms)	Mode	Cargo (MT)	Transit Time (Days)	Dwell Time (Days)	Leg Total Days	Fuel Used (L)	CO_2 Emissions (kg)
Toronto	North Sydney	2,013	Truck	25.0	2.00	0.50	2.50	699.5	1,888.7
North Sydney	Argentia	518	Vessel	25.0	1.00	0.00	1.00	107.0	288.9
Argentia	St. John's	131	Truck	25.0	0.25	3.00	3.25	45.5	122.9
St. John's	Argentia	131	Truck	25.0	0.25	0.50	0.75	45.5	122.9
Argentia	North Sydney	518	Vessel	25.0	1.00	0.00	1.00	107.0	288.9
North Sydney	Toronto	2,013	Truck	25.0	2.00	3.00	5.00	699.5	1,888.7
Totals by Column	➡	5,324	N/A	N/A	6.50	7.00	13.50	1,704.0	4,600.8

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4.4 Summary

The data from the three case studies are summarized in Table 9. Amended container cabotage laws could increase transport system capacity and reduced fuel consumption. In all cases transport capacity is increased in terms of empty equipment days in transit and dwell times at terminals. The most dramatic fuel savings is Case 3 that combines merchandise imports from

Toronto with St. John's seafood exports. The fuel saving is 790 litres with 2,133 kilograms of carbon emissions eliminated.

The least dramatic change is Case 2 in which only 70 litres of fuel are saved. Under existing law, this case violates the 30-day time limit for containers to remain duty-free and would require special dispensation. In Case 1 the additional efficiency gain is precluded because a second domestic move is not allowed in the regulations. On an aggregate basis, the three case studies eliminate over 11,000 kilometres of extra travel, shave 22 days from the collective supply chains, burns 961 litres less fuel and produces 2.6 metric tons less carbon emissions.

Table 9

Summary of case study results

Loop	Round Trip Kilometers	Supply Chain Days	Fuel Consumed (Litres)	CO_2 Emissions (kg)
Case 1 - Meat Exporter with Domestic Shipper				
1	4,864	15	541	1,460
2	4,464	11	419	1,132
3	4,864	16	859	2,319
Savings	-4,464	-10	-101	-273
Case 2 - Meat Exporter and Import Merchandise				
1	4,864	15	541	1,460
4	9,088	25	1,264	3,412
5	10,882	36	1,735	4,684
Savings	-3,070	-4	-70	-188
Percent	22.0%	10.1%	3.9%	3.9%
Case 3 - Seafood Exporter with Import Merchandise				
6	5,324	11	1,453	3,923
7	3,740	11	1,041	2,811
8	5,324	14	1,704	4,601
Savings	-3,740	-8	-790	-2,133
Aggregate Weighted Average Results				
Before	32,344	87	5,259	14,198
After	21,070	65	4,298	11,604
Savings	-11,274	-22	-961	-2,594

5.0 Conclusion

In every scenario empty backhauls can be eliminated and fuel consumption can be reduced. The modeling analysis corroborated statements by industry spokespersons that equipment cycle time for combined operations would be greater than the 30 day limit, thus precluding synergies from logistical partnerships. However, added capacity from reduced empty movements is an immediate, tangible reality from amended regulations. While the micro-analysis suggests that cabotage regulations would improve capacity and reduce fuel consumption, a broader national network modeling effort would provide further evidence on the full impacts of amended regulations.

Leaner supply chains are known to have economic benefits, but environmental benefits of lean thinking are less known. The modeling presented here does not represent the worst cases.

The (preceding) 30-day limit was not viewed as negatively as the inability to backtrack or restrictions on the repositioning of empty containers without confirmed loads. Space does not allow for these examples, but the results are generally the same. Greater flexibility in the use of international containers for domestic traffic increase rail network capacity and reduces GHG emissions.

Despite the passing of *Bill C-51 Economic Recovery (Stimulus bill)* on December 15, 2009, in where the 30 day limit has been extended to 365 days and multiple moves are now allowed, amendments only partially address the needs. The third requirement, where containers with domestic loads from point to point in Canada can traverse American soil (and *vice versa*) was not liberalized. Although closer to mirroring the more permissive U.S. Customs regulations that treat containers as if they are "re-usable packaging" rather than a foreign vehicle, Canadian customs regulations still do not fully address the need of treating North America as an integrated market.

While the revised regulations require a network economic and environmental impact assessment, further work is needed to determine benefits of complete harmonization with American container cabotage *vis-à-vis* removal of the final restriction on "in-transit" movements.
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