Parallel or Converging?

A COMPARATIVE ANALYSIS OF THE GRAIN AND RAIL TRANSPORTATION SYSTEMS IN CANADA AND THE UNITED STATES

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Disclaimer

The opinions and conclusions expressed are the authors' and do not necessarily represent the views of the University of Saskatchewan, Oak Ridge Labs, the USDA or AMS.

Preface

Agriculture in both Canada and the U.S. is going through a time of transition. The vast grain handling and transportation sector in each country is no different. The reasons for change are somewhat different across the two countries, but there are enough similarities to motivate a better understanding of the changes in this important agricultural and transportation sector.

On the surface, the two systems are not equal. By volume, Canada's grain handling and transportation system is about one-tenth the size of the U.S. system. But with the dismantling of the Canadian Wheat Board (CWB) in 2012, the border is less of a barrier to market access and integration for grain marketing than it used to be. Equally as important, both of Canada's Class I railways operate major networks inside the U.S., while three U.S. Class I carriers have access to limited trackage within Canada.

As an artifact of the CWB and its trade-driven agenda, the Canadian grain transportation market is still almost exclusively geared toward non-U.S. exports, while the U.S. grain transportation market is more or less equally split between domestic and export destinations. This means U.S. grain movement is much more diverse than in Canada. On an agronomic level, the Canadian grain transportation system still mostly moves varieties of wheat and canola. In the U.S., while wheat is also a major commodity, corn and soybeans comprise a significant portion of agricultural freight transported by rail. In addition, the topography of the Canadian rail network means that the two Canadian Class I railways operate in many areas as spatial monopolists for export grain transportation. By contrast, while spatial rail monopolies for grain movement exist in the U.S., the diversity of the grain transportation market means that there is also some regional and localized intermodal competition via barges or trucks.

Regarding the rail industry in the two nations, while operationally very similar, applicable regulations in both countries are quite different. While the U.S. has broad cost-based regulations in place governing all eligible freight moving by rail, Canada has distinct, broad regulations for railroads but also maintains specific regulatory oversight over grain movement. Over the past few years, it seems that when there is general concern about railroad performance in either country, concerned parties on both sides of the border look at their neighbor's regulatory system for ideas on how to improve their respective rail markets. This has been the case recently whereby rail regulators in both countries have been looking to regulations in the other country for due consideration in their home jurisdiction.

A good example of this is the concept known in Canada as final offer arbitration (FOA), or its approximate equivalent being proposed in the U.S., known as final offer rate review (FORR). FOA has been available to shippers for many years in Canada to resolve disputes. While a form of voluntary arbitration does exist before the Surface Transportation Board (STB), it has gone unused in the U.S. Only recently, in September 2019, did the STB propose to implement a formal rate review process resembling Canada's FOA, and this process in turn could benefit by remaining mindful how FOA is implemented and managed in Canada.

Another potential example of this is the concept known in Canada as "interswitching," or equivalently in the U.S., as reciprocal (or competitive) switching. Through 2014 to 2017, the eligible radius in Canada was extended (from 30 to 160 kilometers or about 18 to 100 miles). This resulted in at least one Class I U.S. railroad gradually finding it profitable to source increasing volumes of Canadian grain through its U.S. network through Canada's interswitching regulations. This natural experiment did not go unnoticed and was looked upon with some interest by industry participants. Despite a change back to the older interswitching rules in Canada in late 2017, this policy still has proponents among the U.S. rail shipper community as something that should be tried in the U.S. In 2018, a new provision—known as "long-haul interswitching"—was implemented in Canada, an approach that allows a shipper with access to only one railroad to switch to a competing railroad within 1,200 kilometers (745 miles).

Formulating accurate and fair regulation of freight transportation should not be a one-way exchange. Various shipping interests in Canada regard certain aspects of U.S. railroad regulation as visionary, particularly the latter's focus on costing techniques in attempting to set compensatory rates for disputed rail movements even though in the U.S. there is concern that the costing methods used are flawed and inaccurate. It is also worth noting that for the transportation of grain, a long-standing Canadian regulatory policy remains on railroad revenues, motivated by similar concerns to those formally contained in U.S. regulations on railroad revenue adequacy.

It is the goal of this research to explain as well as update the reader about the current and evolving situation in the grain handling systems in both countries. The two national rail systems are currently not very close to being integrated, but there remain signs that this could be a possible outcome from both a regulatory as well as an operations perspective. We let the reader judge for themselves where these changes will ultimately lead in this important and mature industry.

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Introduction

In this era of rapid economic transition, the entire North American agricultural transportation sector finds itself undergoing changes. While agriculture and grain production continue to evolve, national and international competition within the respective grain supply chains across both countries encourages continued efficiency gains in transportation and handling relative to the past. While Canada and the United States remain significant exporters of various grains and may appear to possess similar supply chains at first glance, their respective domestic grain supply chains remain very different, operating under distinct regulatory regimes and often under different market structures.

At least partially due to the massive grain transportation slowdown through 2013-2014 that occurred in both western Canada and the U.S. northern plains states, these national grain supply chains continue to find themselves under growing scrutiny. Both the United States and Canada have intervened to varying degrees at times in these transportation markets, actions stemming from increasing reporting requirements specifically on grain movements (U.S.) to implementing (and then rescinding) policies to facilitate more rail competition (Canada). Given these similarities, it is worth noting that several system-level analyses relevant to each country's grain transportation market have advocated looking to the other nation for insight for improving competition and economic efficiency in their own grain transportation system.

As an example, a 2015 Canadian freight system review conducted by the Federal government advocated a transition to a completely deregulated grain transportation system. Specifically, the primary recommendation of this report was for Canada to phase out extant regulations specific to grain movements, a suggestion very much motivated by a perception among the authors of the report that the U.S. freight rail market works efficiently and fairly for all participants. But across the border that same year, the National Academies of Science through the Transportation Research Board issued a detailed study (Special Report 318) of the U.S. freight rail system (TRB, 2015). After some discussion of rail industry problems, the authors of this study highlight the merits of several Canadian pro-competitive regulatory policies. Interestingly, the Surface Transportation Board (STB) Re-authorization Act (S.808) of 2015 added freight rate disputes to those issues eligible for STB-managed arbitration.[1] In the U.S., the STB is an independent agency that regulates railways on economic matters, such as rates, service, mergers, and acquisitions.[2] While the new law added rates to arbitration eligibility, it still did not compel parties to accept arbitration through the STB (STB, 2019a). To counter this, a modified rate arbitration process known in the U.S. as final offer rate review (FORR) was proposed in 2019 for smaller disputes, such as for grain movements, and as of this writing remains under review with the STB.[3]

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[1] See section 13 of Public Law 114-110, Surface Transportation Board Reauthorization Act of 2015.

[2] The Federal Railroad Administration, within the U.S. Department of Transportation, regulates rail safety.

[3] On September 11, 2019, the STB proposed a new procedure—Final Offer Rate Review—for challenging the reasonableness of railroad rates in smaller cases. Under this procedure, the STB would decide a case by selecting either the complainant's or the defendant's final "offer," subject to an expedited procedural schedule. On May 15, 2020, STB opened the docket for further stakeholder input through informal discussions held between June 1 and July 15, 2020.

Given current U.S. deliberations, the Canadian shipper relief policy deserving further clarification is known as final offer arbitration or FOA. Essentially, final offer arbitration means that all Canadian shippers (i.e. not just grain shippers) are free to bring a rate or service dispute to the Canadian Transportation Agency (the Canadian rail regulator), the arm of government tasked with identifying a third-party arbitrator to settle rail disputes (Padova, 2015). The only official reason a shipper can be prevented from asking for final offer arbitration is if they have previously signed a confidential contract with the railway they seek to file an FOA against (CPCS, 2015). While FOA would seem a useful policy for shippers facing uncompetitive transportation options, in fact FOA has only been used on a somewhat limited basis in Canada. There are good reasons for this and as discussed later, the STB appears to have taken at least some notice of its operational drawbacks. Data accessibility and transparency are important to this style of regulatory process.

To summarize, at a time when both countries appear to be looking to the other for guidance on future regulatory policies for freight railroads as well as issues specifically associated with (captive) grain transportation, this study develops a comparative qualitative and quantitative analysis of both U.S. and Canadian rail and grain transportation systems. Without question, grain transportation systems in both countries remain on the “front line,” so to speak, in the broader rail regulatory debate across North America. In particular, this study is conducted with an eye towards highlighting and identifying policies that will hopefully render the future grain supply chain in both countries more efficient as well as more economically fair to all participants.

The report starts with a broad overview of the grain handling and transportation systems in both countries, particularly with respect to rail. With each country considering the other for regulatory guidance in the rail sector, we illustrate recent data about the respective rail and grain transportation systems, as well as highlight various similarities and differences in the two grain supply chains. At this point, to help motivate some of the regulatory issues relevant to modern rail markets with large economies of scale, we introduce the theory of optimal rate setting in a situation where there exists market power.

Given on-going U.S. interest in the regulatory situation in Canada, we then discuss the Canadian regulatory system governing grain transportation. This includes details about the issue of interswitching as used in Canada as a solution to localized rail market power. The subsequent section is a high-level discussion of rail regulation in the United States, with a focus on arbitration as a rate relief mechanism. We also illustrate the potential effects of imposing reciprocal switching regulations across a major grain production region. Further, we provide more insight into how rail revenue is used for regulation. We start by describing the use of revenue adequacy in the United States, which leads to a detailed exposition of the maximum revenue entitlement policy for Class I railways currently active specifically on Canadian grain movements.

Next, a broad overview of the relative performance of the rail systems in the two countries is presented. Using operational and other metrics, we compare the two systems and examine their comparative performance, both in general and with respect to grain transportation. The final section concludes and offers some recommendations about future regulatory policies for the two countries that seem to offer the best way to mitigate against market power in many agricultural transportation markets.

1. Overview of the Grain Handling and Transportation Systems in the United States and Canada

Agriculture plays an important role in the economies of both Canada and the United States. Both nations are among the top ten largest exporters of agriculture and agri-food products in the world.[4] However, while Canada is the fifth-largest agricultural exporter in the world (by value in $US), the volume of its annual grain production is several times smaller than that of its southern neighbor.[5] In 2016, Canada's production of principal field crops totalled just under 84 million metric tonnes,[6] while in comparison, the volume of U.S. production totalled over 600 million metric tonnes.[7] An important factor to consider in comparing these sectors in the two countries is the amount of agricultural output consumed domestically. Canada exports roughly three quarters of the grain that it produces for foreign markets, while the U.S. exports closer to one quarter of its annual production.[8] While somewhat different in scale, millions of tonnes of grain are transported each year in both countries for either domestic consumption or export. Supporting an efficient and cost-effective grain transportation system helps both food security as well as helps keep grain farming in both nations competitive on the world grain market.

With respect to grains and grain production, in both Canada and the United States the majority of grain produced in both countries occurs in the continental interior. For grain bound for export markets, industry stakeholders in both countries face a similar challenge trying to transport grain from interior production areas to ocean ports in the most timely, efficient, and cost-effective way possible. In both countries, a mix of shipping modes, including truck, rail, and inland water transportation, are used to deliver grain to export locations.

At the same time, there are some important differences in the natural geography of the two nations that have shaped the development of the specific grain handling and transportation systems in place today. Specifically, there are several significant inland river systems in the United States that facilitate the transportation of grain by river barge. More discussion on these differences takes place later in the paper.

In both countries, the same basic supply chain for grain handling is used to process bulk grain destined for export (Figure 1). The first step in the process occurs when producers arrange for delivery of their grain to delivery points throughout regional production areas. At many of these delivery points, the elevator facility will conduct some processing before shipping it on, usually either by rail or, in certain locations in the United States, by barge (Park and Koo, 2001).

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[4] Agriculture and Agri-Food Canada (2016).
[5] Quorum Corporation (2014a).
[6] Statistics Canada (2017a). These include wheat, course grains (e.g. barley, corn), oilseed, pulses and other special crops (e.g. lentils, mustard).
[7] United States Department of Agriculture (2017a).
[8] Quorum Corporation (2013).

Figure 1: Common routes for grain moving from farm to export point

While natural geography is one factor that has shaped differences in the grain handling systems operating in both countries, another major influencing factor is the type of predominant crops that are grown in each country (Figure 2). In the United States, the three most prevalent grain crops as measured by annual production are corn, soybeans, and wheat.[9] Meanwhile, the three most prevalent Canadian grain crops as measured by annual production are wheat, canola, and corn.[10]

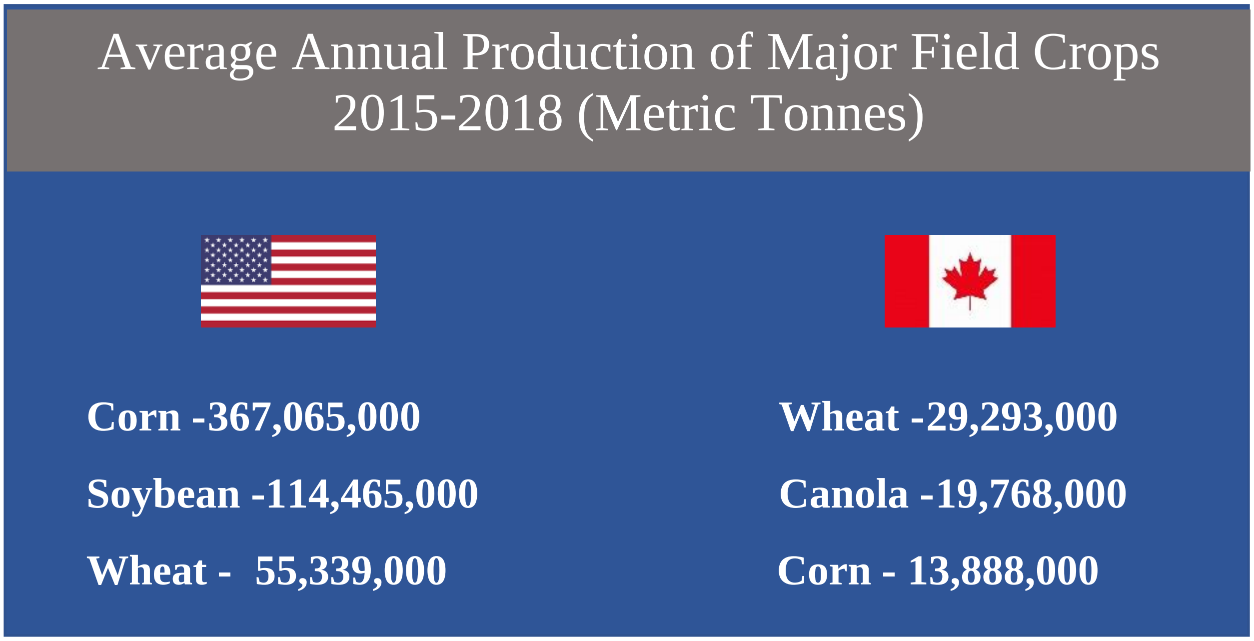

Figure 2: Average Annual Production of Major Field Crops, 2015-2018

While a certain amount of insight can be gained from production figures alone, it is also necessary to consider the portion of production destined for export and the routes that the various grains take to reach their export destinations. As previously mentioned, while overall Canadian production is significantly less than that of the United States, the portion of production that is exported each year is much higher. However, this is also dependent on the crop type. For instance, while corn is the third largest crop in Canada as measured by annual production, much of the production is for domestic consumption. As a result, the third largest export crop in Canada is soybeans.[11] In order to better familiarize readers with the routes that major export crops in each nation take to reach tidewater, Figures 3 and 4 show a combination of grain export data from the USDA and the Canadian Grain Commission.

As Figure 3 illustrates, the majority of Canadian wheat exports are shipped through the nation's West Coast ports of Vancouver and Prince Rupert in British Columbia.[12] All grain transshipped and then exported from these Pacific ports relies on rail service to deliver grain from inland shipping points to tidewater.

[9] United States Department of Agriculture (2018).
[10] Agriculture and Agri-Food Canada (2018).
[11] Canadian Grain Commission (2018).
[12] Additional graphics illustrating export routes for Canadian canola and soybeans are found in Appendix A.

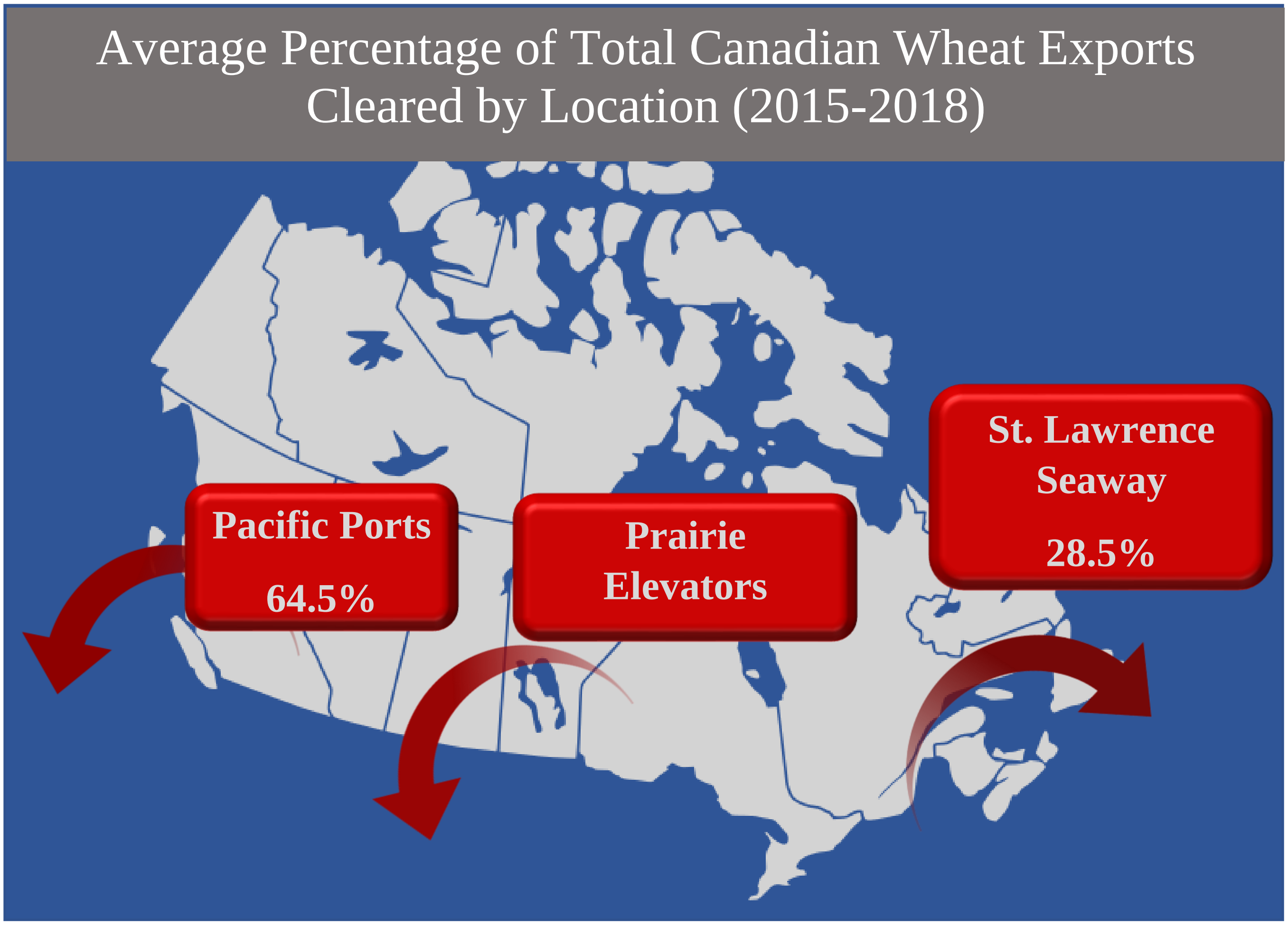

Figure 3: Average percentage of total Canadian wheat exports cleared by location (2015-2018)

The second most important export path for Canadian wheat is eastbound, through ports within the Great Lakes and St. Lawrence Seaway (GLSLS). Grain exported from these locations takes a wider variety of routes from the areas where it is produced to end up on ocean-bound vessels. For example, some grain from the Prairie regions is shipped via rail to the Port of Thunder Bay on Lake Superior. From there, the grain is transloaded onto "lakers" (bulk vessels that are small enough to traverse the locks of the GLSLS) or onto "salties," which are ocean-capable.[13] In addition, Western grain can be shipped by rail to various river ports along the St. Lawrence Seaway in Ontario and Quebec. These eastern ports can also draw grain from the local producing areas, as well as transload grain off of lakers traversing the GLSLS.

The remaining portion of Canadian wheat exports cross the border into the United States, either transported by rail or by truck. It should be noted that historically, the Port of Churchill in Northern

[13] Many modern ocean-going vessels are too large to traverse the relatively small locks on the Saint Lawrence Seaway, so large ocean-going vessels (salties) cannot travel further in than Montreal, Quebec. Another potential choke point is at the Welland Canal, which connects Lake Erie and Lake Ontario. Thus, some of the largest lakers just travel within the upper Great Lakes—Superior, Michigan, Huron, and Erie.

Manitoba was a location through which Canadian grains were also exported when available (typically mid-May to the end of November). While almost no grain had been exported through this port in recent years due to a deteriorating rail bed, it has recently re-opened. In 2018, the Arctic Gateway Group purchased the port and related infrastructure, restoring rail service by the fall of 2018. In September 2019, the first vessel carrying grain in four years left the Port of Churchill, with a total of four grain ships departing that season (Briere, 2019). According to the publication *The Western Producer*, "Four grain ships representing 150,000 tonnes left the port…..including three loaded with durum and one with lentils" (Briere, 2019).

Figure 4 shows comparative movements for U.S. export bound wheat. Of note is that grain exported through the Pacific Northwest is predominantly moved by rail, while the Gulf of Mexico ports are often served by both rail and barge. As is in Canada, the port of choice for export for any given grain shipper is mostly driven by proximity and its associated lower costs. However, grain shippers in growing regions located a significant distance from port are typically classified as being captive to their local railroad (Vachal and Bitzan, 2005).

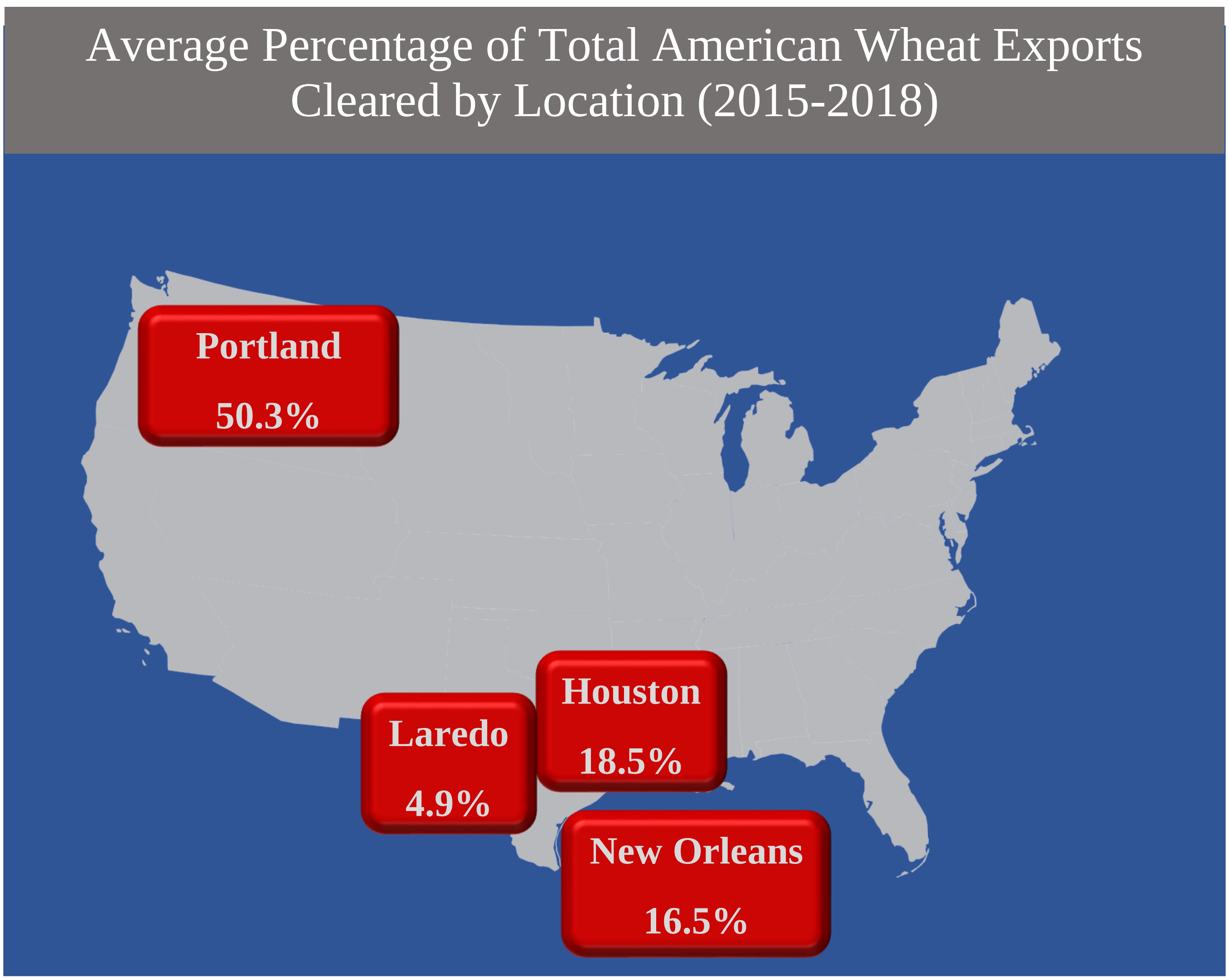

Figure 4: Average percentage of total U.S. wheat exports, by export location (2015-2018)

1.1. Key System Similarities and Differences

There are a number of explanations for the remaining differences in grain handling and transportation in the two countries. Table 1 contains a summary of respective system characteristics. Despite Canada having a greater landmass than its southern neighbor, the U.S. possesses considerably more arable acres. With almost 400 million acres of cropland in the continental United States (USDA, 2017), this is over four times the amount of arable cropland in Canada (about 90 million acres; Statistics Canada, 2016). In addition to having more arable land, another factor that contributes to larger U.S. grain production figures is corn. Due to a combination of corn's high yield potential relative to other crops plus its vast planted acreage, it comprises over 60 percent of total U.S. grain production (Quorum Corporation, 2013). Comparatively, corn makes up only 22 percent of total Canadian grain production. North of the border wheat is the most significant grain as measured by total production (Quorum Corporation, 2013).

Table 1: Selected characteristics of long-haul grain transportation, North America

Characteristic	Canada	United States
Network topography	linear, lengthy	planar, widespread
Grain destinations	3 primary ports (1 east, 2 west)	Multiple inland ports, several ocean ports serving east, west and south
Competition in transportation	Spatial monopoly/oligopoly – two Class I railways, several short lines	Regional differentiation from monopoly to competition – multiple Class I railroads but largely duopoly carriers each in the east and west, shortlines as well as barge operators
Regulation	Rail revenue monitoring, several limited competitive access provisions	Cost assessments, revenue adequacy, very limited access provisions
Number of primary firms in the supply chain	2 Class I railroads, several large grain companies	7 Class I railroads, dozens of barge operators and grain companies
Price/volume setting	Tariffs, private contracts, limited car auctions	Tariffs, private contracts, car auctions
Grain elevation, storage	424 elevators, 11.7 million-ton capacity, limited on farm capacity	approx. 8,500 elevators, >320 million-ton capacity, considerable on-farm capacity (>375 million ton capacity)

There are additional factors that contribute to the differences in the proportion of grain production that each country exports to foreign markets. In the U.S., one major contributor to its greater domestic grain consumption is the comparative size of its livestock industry. For example, the size of the U.S. cattle herd stood at about 103 million animals (NASS, 2017b) whereas in Canada, there were just 12.9 million cattle (Statistics Canada, 2017b). Another factor is the growth in biofuel production that has occurred in the U.S since the early 2000's. In a recent crop year, American ethanol producers used over 138 million tonnes of corn (USDA, 2017b). Contrast this to the 16 million tonnes the industry consumed in 2001, just prior to the introduction of a biofuel mandate and associated tax incentives that helped push biofuel production to its current levels (Quorum Corporation, 2013). As production and export levels for grain have grown over recent decades, the transportation and handling systems in both countries have had to evolve as well. While not the focus of this report, other factors such as shifts in cropping choices, the emergence of new global markets, and government agricultural/trade policies have all played a role in shaping the grain handling and transportation systems that operate in the two countries today.

Overall the capacity of total U.S. grain handling infrastructure is considerably larger than in Canada, both in terms of port terminal storage as well as inland storage and handling facilities (Quorum Corporation, 2013). While Canada is still catching up, Quorum Corporation (2013) notes that farmers in both countries now possess significant on-farm storage, albeit not near enough to store an average crop year's entire production. While farmers in both countries share the practice of transporting most of their grain from storage/fields to grain handling facilities on a truck, it is at this point that key differences begin to emerge.

Corresponding with larger annual U.S. grain production coupled with the greater area over which grain crops are grown, there are more country grain handling and storage facilities in the U.S. as compared to Canada (Quorum Corporation, 2013). Due to legislation, only grain handling facilities in Western Canada have to be officially licensed (with the Canadian Grain Commission), meaning that accessible statistics regarding handling facilities and capacities are readily available only for Western Canada. Since nearly 75 percent of Canada's grain production comes from the Western provinces as of 2016 (Statistics Canada, 2017a), much of the material presented in this report will necessarily focus on the operating environment in Western Canada.

According to the Canadian Grain Commission (2018), there were a total of 355 licensed primary handling facilities in Western Canada in 2018, a number dwarfed by the nearly 8,500 country grain handling and storage facilities that operate in the United States (Quorum Corporation, 2013). While there is some discrepancy between how the classifications of grain handling and storage facilities are classified in each country, there is no doubt that considerably more inland infrastructure exists in the United States.

Another interesting difference in respective grain handling is the level of industrial concentration that exists within each of the two countries. Quorum Corporation (2013) asserts that amongst all licensed storage facilities in the United States, the top 10 companies accounted for 43 percent of the country's licensed storage capacity, while the market share of the top two companies comprised about 15 percent of the national licensed storage capacity. This contrasts sharply with the grain storage industry in Western Canada, where the two largest grain companies possess a market share of 47.5 percent as measured by licensed storage capacity (CGC, 2017).

There are additional differences between the two countries with respect to routing and infrastructure used to transship grain. In Canada, Western Canadian grain that is bound for export largely takes one of three routes: (1) shipped via rail to the West Coast ports of Vancouver and Prince Rupert, (2) shipped east by rail to be unloaded at Thunder Bay or further along the Great Lakes/St. Lawrence Seaway, and (3) exported directly to the U.S., via truck or rail is the final option available.

While grain exports in Canada rely heavily on a few select ways to deliver export bound grain to port position, farmers and grain shippers in the United States have a much more diverse set of options. There are five major grain export ranges in the United States, including the Mississippi River/Center Gulf region, the Atlantic Coast, the Texas Gulf, the Pacific Northwest, and the Great Lakes region (U.S. Grains Council, 2004). In addition to having easy access to more coastal port locations than in Canada, U.S. grain shippers also have the benefit of several major inland waterways that extend into the various major grain producing regions in the country.

The most extensive of these inland waterways is the Mississippi River System, which includes nearly 6,000 miles of navigable rivers and reaches into every state in the U.S. Corn Belt (U.S. Grains Council, 2004). There are dozens of grain terminals stretched along the Mississippi River system from which barges are loaded and move grain from inland river terminals to any of the 12 port terminals serving the Louisiana Gulf (Quorum Corporation, 2013). And in the West, while not as extensive as the Mississippi River system, the Columbia River in the Pacific Northwest possesses over 30 terminal and handling ports, which also reduce land-based overland transportation for grain movement (U.S. Wheat Associates, 2016). Seven of the 10 export terminals on the river are located inland from the coast along the Columbia River rather than directly on tidewater (Quorum Corporation, 2013). Therefore, due to inherent geographic characteristics, unique differences exist regarding the grain handling and transportation system in the United States as compared to Canada.

With respect to railroad infrastructure in each country, in the U.S. there are currently about 610 freight railroads operating over 137,000 miles of track (Association of American Railroads, 2017a). The vast majority of these are small regional or short line carriers with limited rail networks. However, more than 90 percent of railroad freight revenue in the United States is generated by the largest Class I railways (Quorum Corporation, 2013). These seven carriers comprise BNSF, Union Pacific, CSX Transportation, Kansas City Southern, Norfolk Southern, Grand Trunk Corporation (subsidiary of Canadian National Railway), and SOO Line Railroad Company (subsidiary of Canadian Pacific Railway) (STB, 2016).

In 2016, grain movement in the U.S. comprised nearly 10 percent of the total freight tons originated by the Class I railways, a total of 135.5 million metric tonnes of grain (Association of American Railroads, 2017b). While several modes move grain, as Chang et al. (2019) show, U.S. railways remain important to the grain transportation sector. For example, as of 2016, rail moved about 62 percent of U.S. grain that was destined for export. U.S. export bound grain is also moved by barge, with 29 percent of 2016 grain exports being transported via the latter mode. Chang et al. (2019) also point out that U.S. railways move a slightly smaller proportion of domestic grain since trucks are the preferred mode on short hauls. To this end, trucks move nearly 47 percent of all domestic U.S. grain movements (Chang et al., 2019).

The Canadian rail industry is much smaller than its American counterpart in terms of track, the number of railroads and the total number of freight tons moved per year. In total, roughly 60 different railroads move freight in Canada, and all but four of them are short line or regional railways (RAC, 2012). However, while there are technically four Class I railways operating in Canada, only two have significant cross-country operations. As the Railway Association of Canada (2012) notes, BNSF and CSX have a small amount of track that crosses the border to access Canadian destinations. But generally, Canadian Pacific Railway (CP) and Canadian National Railway (CN) are the two Class I rail options for freight shippers across much of the country (RAC, 2012).

Over the last 5 years, the grain tonnage moved in Canada has been growing, and on average stands at almost 41 million tonnes (Canadian Transportation Agency, 2016a). CGC (2016) highlights the fact that of these totals, still less than 5 percent of Western Canadian grain exports were delivered to their point of export via truck. In turn, all of the exported Canadian grain now moving by truck crossed the border bound for processing in the United States. Thus, while the handling and transportation system moving Canadian grain is considerably smaller in scope than the system in the United States, the importance of both systems in moving grain from farm gate to end user cannot be overstated.

1.2. Railroad Freight Composition in North America[14]

By their nature, bulk freight movements are critical to each of the North American Class I railways. Grains and agricultural products are still an important commodity to railroads. Focusing further on grain transportation in this section, the charts below help highlight the relative importance of agricultural movement as part of overall rail operations.

[14] Additional comparative metrics and data tables can be found in Section 6 and Appendices B and C.

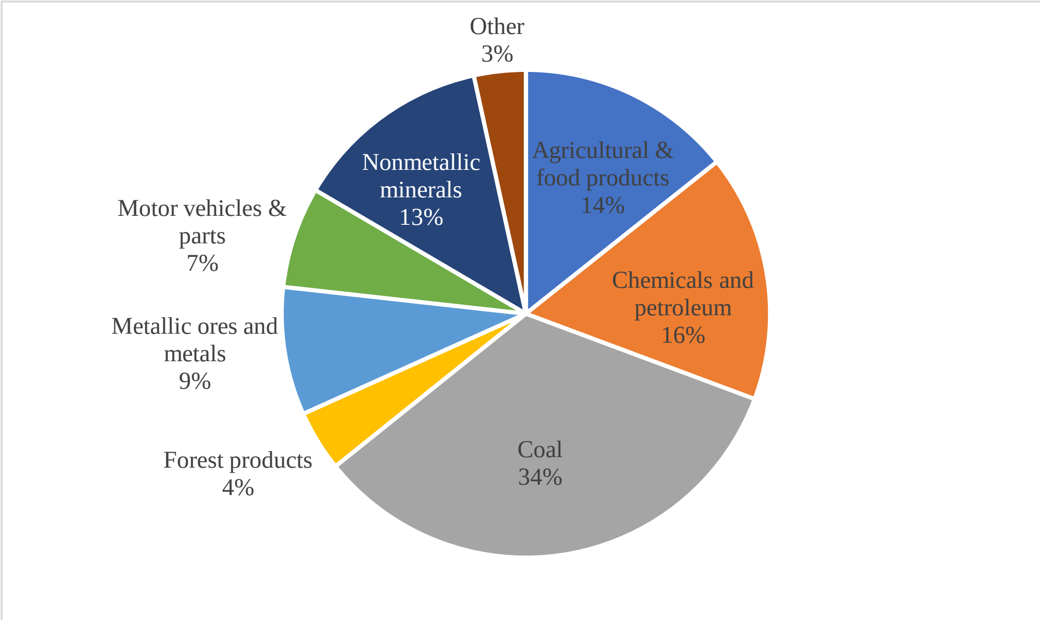

Figure 5: Carload composition, United States

Note: The data covers average carloads for the first nine months of the years 2015 and 2016. Source: The Association of American Railroads, https://www.aar.org/wp-content/uploads/2017/12/AAR-Rail-Time-Indicators-Sample.pdf.

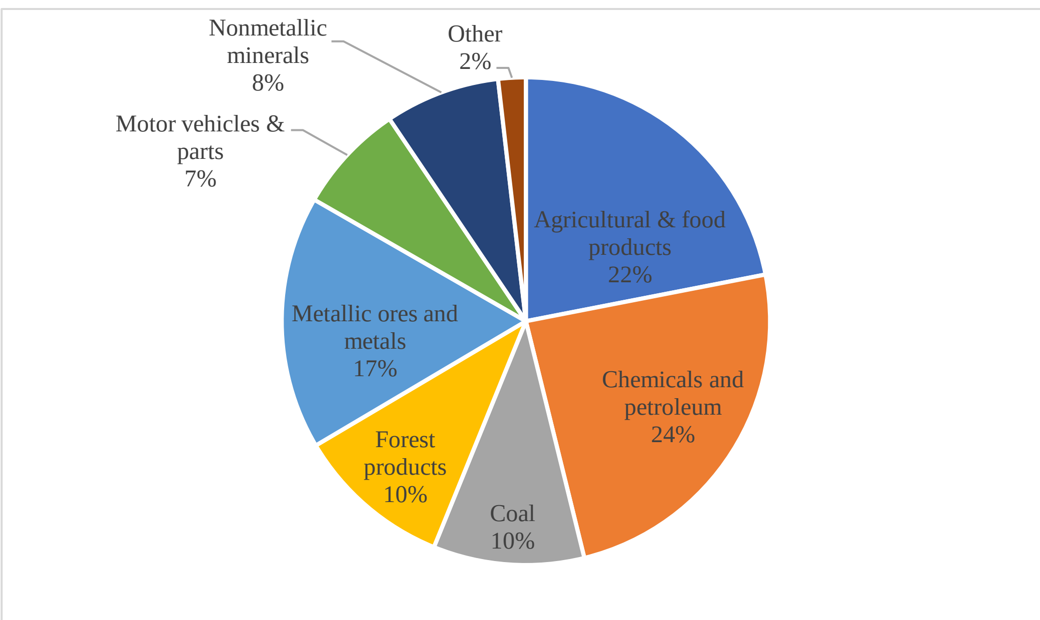

Figure 6: Carload composition, Canada

Note: The data covers average carloads for the first nine months of the years 2015 and 2016. Source: The Association of American Railroads, https://www.aar.org/wp-content/uploads/2017/12/AAR-Rail-Time-Indicators-Sample.pdf.

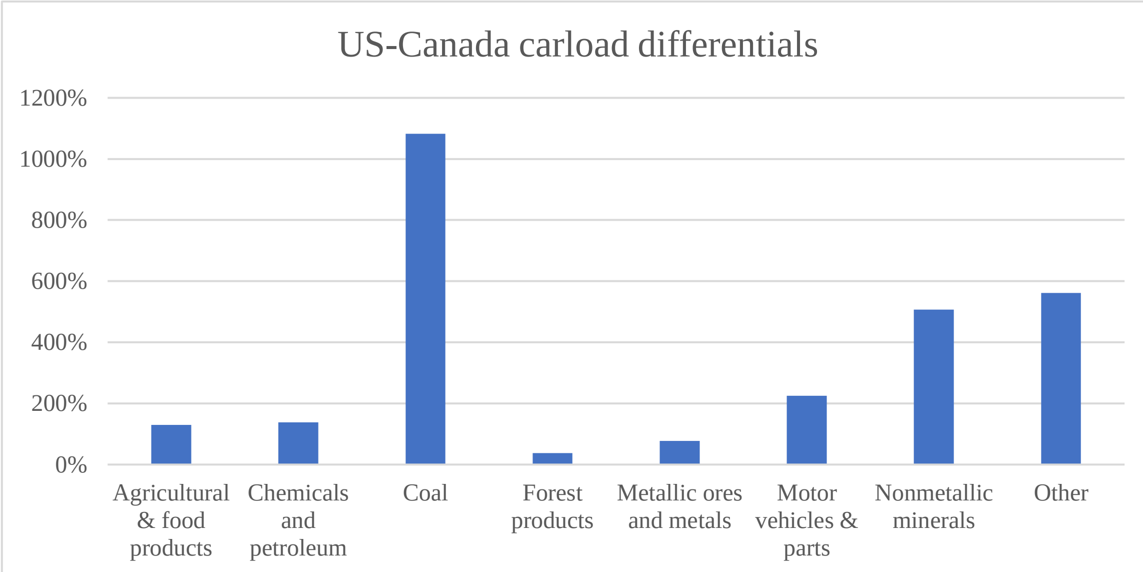

Figure 7: Carload differences, U.S. and Canada

Note: Average carloads for the first nine months, 2015 and 2016. Source: The Association of American Railroads, https://www.aar.org/wp-content/uploads/2017/12/AAR-Rail-Time-Indicators-Sample.pdf.

These figures indicate there is a somewhat unique structure to the grain supply chain between the two countries, a situation driven mostly topography and agronomic considerations. While the top three grains transported by rail in the U.S. are soybeans, corns, and wheat, the most frequently hauled grains by rail in Canada are wheat, barley, canola, and oats. With restricted arable farmland available for agricultural production in Canada, the vast majority of Canadian grain is transported from the Prairies in just two directions—to the West (Vancouver) and to the East (Thunder Bay on the Great Lakes). Conversely, U.S. grain transportation destinations are much more evenly dispersed. As a result, the total volume of grain transported in Canada is just a fraction (about one-fifth) of that moved within the U.S. As indicated in Figure 8, rail is especially important for wheat transportation in Canada and the U.S.

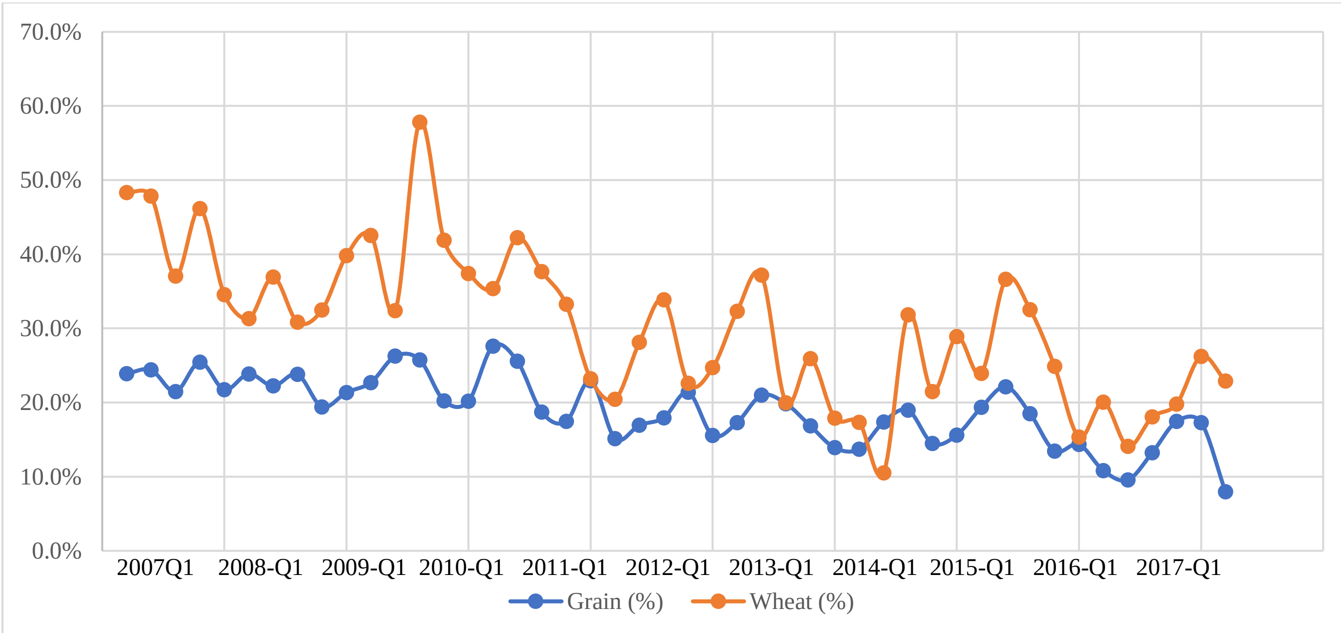

Figure 8: Percent volume of grains/wheat moved in Canada and U.S. by Class I rail (2007-Q1 to 2017-Q2)

Source: Authors' calculation based on Statistics Canada. Table 23-10-0062-01, Rail industry origin and destination of transported commodities and All Economic Data of Surface Transportation Board (https://www.stb.gov/econdata.nsf/AllData?OpenView).

2. Preamble on Rail Markets and Regulation

Despite the relative financial health of the rail industry in both countries, there remains considerable discontent over rates and especially service levels for more captive shippers, and many grain movements certainly fall under this category (Vachal and Bitzan, 2005). So, while the two North American rail regulatory regimes remain quite distinct, continued shipper frustration with railroad pricing and service is leading to a situation where certain aspects of each country's rail policies look to be gaining appeal with their neighbor. Broadly speaking, this includes arbitration concepts from Canada being seriously discussed in the U.S., while greater reliance on defensible costing procedures seems to have been motivated from the U.S. to Canada. While more about this on-going policy cross-pollination is discussed later, what seems to be common ground in both countries is a desire to identify better procedures for pricing contested rail movements in a fair and economically sustainable manner. This section provides a brief primer on rail pricing as a backdrop to better understand the regulatory concepts discussed in Sections 3 (Canada) and 4 (U.S.).

2.1. The On-going Challenge of Rail Rates and Regulation

A variety of factors—such as demand from buyers, availability of substitutes, and input costs—affect how firms set price. Price setting for railroads and other similar high-fixed-cost industries is not simple. Under the latter, marginal cost pricing does not enable firms to recover their fixed costs and sustain their operations. Since railroads operate with high fixed costs, they have to set market price above marginal cost in some markets in order to obtain enough revenues to cover the costs of fixed infrastructure, such as their rail network. In economic theory, marginal cost pricing is a "first-best" approach, but since this is not possible under these circumstances, economic theory highlights a "second-best" pricing approach known as Ramsey pricing.

The regulatory concept of Ramsey pricing, also referred to as "value of service" pricing, is conceptually related to third degree price discrimination (i.e. market prices set inversely related to demand elasticity), a policy practiced by firms in many industries today as a profit maximizing tool (Viscusi et al, 1996). More specifically in U.S. rail policy, these pricing schemes are often called "differential pricing," where customers with more elastic demand (i.e. those possessing more transportation alternatives) are charged lower rates. In turn, Ramsey prices are similar in construction, but are computed using an added constraint that the carrier earns "zero economic profits" using such pricing in relevant markets.[15] As highlighted by McCullough (2016), "Ramsey pricing is a theoretical ideal that economists have proposed for regulating a monopoly with high fixed costs when government subsidies are not available."

Consider a single utility possessing declining average costs over relevant output ranges (i.e., the firm has large economies of scale) in several markets. Ramsey pricing can be thought of as a situation where the utility company would be permitted to set different prices in each market according to demand elasticities, subject to an overall zero profit constraint. Done correctly, this

[15] Zero economic profit does not mean zero profit in the accounting sense. It means a situation where total revenues equal to total costs, whereby this differential includes a component of "normal profits" (i.e. a level of profit high enough to attract as well as employ the factors of production).

pricing scheme in effect allows a firm to avoid losses in those markets where competitive or marginal cost pricing would not compensate the firm for its average costs of providing that service.

Put another way, Ramsey pricing identifies socially optimal departures from marginal cost or competitive pricing in a multi-market context. The Ramsey pricing formula is equivalent to computing an optimal market markup over marginal costs as a function of the (inverse) market demand elasticity (willingness to pay). The pricing distortion generated under the formula is known as the Ramsey number, and it measures the deviation in the computed markup relative to the inverse demand elasticity (McCullough, 2016). The smaller the Ramsey number, the lower the deviation of the Ramsey markup from the inverse demand elasticity (Train, 1997). But the demand and cost information needed to precisely calculate Ramsey prices in a given situation makes them practically difficult to compute and maintain. So while Ramsey pricing is a defensible regulated pricing concept for firms possessing large economies of scale such as railroads, computational and data issues mean that it has rarely been fully implemented in practice (see Scott, 1986), though its conceptual idea is still referred to by railroads to rationalize what is in fact outright price discrimination. Currently (aside from grain movement in Canada), railroads set differential rates at their own discretion (e.g. they can charge different rates in different markets while moving nearly identical goods) but these rates are not necessarily Ramsey rates nor can they be set without limit due to regulation.[16]

In Canada, Class 1 railroads are subject to a formula-based revenue cap on grain traffic, constraining rates set in the substantial grain transportation market. Regulation over other commodity shipments is possible through several mechanisms, including arbitration, interswitching (both to be discussed subsequently) or (much less frequently) mandated access (Annand and Nolan, 2003). While alternate rate regulatory mechanisms also exist in the U.S. (Carlson and Nolan, 2005), most of the time when a railroad is found to possess market dominance over a particular shipment, specific processes are enacted in order to assess whether or not the railroad will be permitted to charge a contested rate (as defined).[17] Ultimately, trying to protect the financial health of the rail industry while also guarding shippers against pricing abuses attributable to a lack of effective competition makes the task of the rail regulator an extremely difficult one.

2.2. Barriers to Implementing Second Best (Ramsey) Pricing

While not currently under direct consideration in either country, this subsection discusses one way Ramsey pricing might be more formally incorporated within regulatory decision-making in both Canada and the U.S. It also highlights difficulties associated with Ramsey pricing, such as data reliability and firm incentives. Given the economic arguments for Ramsey pricing coupled with these challenges, we then discuss how the U.S. since the mid 1980's has residually regulated railways using what some argue is an approximation to Ramsey pricing (to be discussed in more detail in Section 4).

[16] Differential pricing is necessary because railroads are a capital-intensive industry. If railroads were forced to price all outputs at marginal cost, they would not be able to recover the costs of their infrastructure and eventually would go out of business.
[17] 49 U.S. Code § 10707, Determination of Market Dominance in Rail Rate Proceedings.

While others maintain that Ramsey prices are simply too bothersome to use in practicality (Hoffler, 2006), today's advances in computing and the collection of real time market demand data should allow an interested regulatory body to reliably compute timely and applicable Ramsey prices if desired. That this has not occurred to date is possibly a testament to a political lack of familiarity with Ramsey pricing and its suitability for this industry, outside of academic circles.

Facilitating Ramsey pricing is a research avenue that has been pursued by regulatory economists. Considering the computational issues associated with Ramsey pricing, Vogelsang and Finsinger (V-F) (1979) developed a related dynamic regulated utility pricing model. By design, over time they showed that their "ratcheted" pricing/revenue mechanism eventually converges to equivalent market Ramsey prices (see Train, 1997 (Ch. 5) for a detailed exposition). While potentially somewhat simpler to implement than performing Ramsey computations, once again the V-F mechanism appears to have been little used as a pricing model in any regulated utility sector. While the outcome of the V-F mechanism makes it attractive from a theoretical (second best pricing) perspective, it remains somewhat impractical. It also requires a diligent regulator to accurately track key regulatory variables (prices, outputs, costs). Given these data needs, clear incentives exist for the V-F regulated firm to misreport or inflate costs, for example. There is no such thing as a free lunch.

However, the development of Ramsey algorithms to help compute socially fair regulated pricing in both the U.S. and Canadian rail sectors would lead to more defensible regulatory outcomes. Relevant to the U.S., while under certain conditions stand-alone cost generated rates and Ramsey rates can converge, developing a consistent and reliable Ramsey price estimator applicable to a broad set of movements should arguably be less difficult to develop and maintain than the current individualized and idiosyncratic stand-alone cost rate cases. And in Canada, the new long-haul interswitching (LHI) regulation would very much benefit from a reliable Ramsey pricing algorithm to assist the CTA in setting a baseline for break-even access rates.

The foreseeable downfall with formal Ramsey pricing applied to the rail sector relates to the fact that, all other things equal, higher allowable Ramsey prices will be charged to more captive (i.e. more inelastic transport demand) shippers. Without other system adjustments, it is not entirely clear that agricultural and other captive shippers will be much better off under some form of regulated Ramsey pricing regime.

Finally, Ramsey prices are a function of the (estimated) marginal costs of service provision. In some cases, their calculation may be comparable to that of stand-alone costs, which are well known to be difficult and costly to calculate. However, under most market conditions, it is clear that the built in profit constraint (normal profits that just cover capital investment) inherent using Ramsey pricing for a given movement will further limit rates charged to shippers compared to what is computed using current U.S. stand alone cost (SAC) methods (McCullough, 2016). Additional research must be pursued if Ramsey pricing is to become truly more integrated into procedures and regulations governing the North American rail sector.

The following sections discuss the major rail regulatory issues in Canada (Section 3) and the U.S. (Section 4), both historically and presently under consideration.

3. Railroad Regulation in Canada

Rail regulation in both countries dates back to the 19th century. In Canada, the first form of federal rate regulation governing the transportation of grain by rail came in 1897 with the signing of the Crow's Nest Pass Agreement between the Canadian Pacific Railway and the Government of Canada. The agreement, which after being signed and passed into legislation as the *Crow's Nest Pass Agreement Act*, would go on to have a tremendous influence on rail regulation in Western Canada for many years to come. While the Crow's Nest Pass Agreement would be the mechanism that would first impose federal rate legislation on Canadian grain rail movements, several observers have noted that regulating rates was not necessarily the primary motivator behind this legislation (Bennett, 2017). Rather, the agreement's primary purpose was to arrange a contract of sorts between the federal government and Canadian Pacific Railway whereby the railway would complete a railway line from Lethbridge, Alberta to the coal fields in the Kootenay region of British Columbia and the government would reciprocate with a cash subsidy of C$11,000 per mile of constructed rail line.

Another condition required in the agreement was a reduction in the rates that the railway was charging at the time for eastbound grain and flour, as well as a reduction in the rates being charged on a specific list of westbound merchandise, ranging from agricultural implements to coal and oil (Library and Archives Canada, 2017). Importantly, the agreement made no provision for any adjustments to be made to the prescribed rates to correspond with changes in inflation or cost increases and essentially set a rate for movements going forward in perpetuity. However, this did not inflict any real hardship on the railway originally, as freight rates generally decreased until the beginning of World War I (Swanson and Venema, 2006).

The turn of the century introduced further regulation governing railways in Canada. In 1903, the Government of Canada passed *The Railway Act*, a substantial act containing many important elements that would shape Canadian rail regulation going forward. One such element was the formation of the country's first national independent regulatory agency—the Canadian Board of Railway Commissioners. The Board of Railway Commissioners was created, in part, to create a suitable avenue for shippers to bring complaints against carriers rather than the previous options of either bringing disputes before the courts or else the Railway Committee of the Privy Council. While the concept of an independent regulatory agency was novel in the Canadian setting, it was, in fact, simply following a precedent already forged in the United States in 1887 when the Interstate Commerce Commission was formed (Benidickson, 1991). While this section does not explore all the facets of the historic Board of Railway Commissioners, it had an important role in eventually paving the way for the Canadian Transportation Agency, Canada's current independent regulatory agency that still carries on many of the same duties of the Board of Railway Commissioners. Another important piece of *The Railway Act* was its requirement that railways provide adequate and suitable service and accommodation for all shippers due to their designation as common carriers (Padova, 2015).

While the Crow's Nest Pass Agreement did not pose a significant challenge to Canadian Pacific Railway's operations immediately after the signing, the arrival of World War I changed this. The arrival of war brought with it significant inflationary pressures as the price of labor and other inputs rose substantially (Swanson and Venema, 2006). In order to avoid railway insolvency and keep grain moving, the federal government introduced *The War Measures Act* in 1919 which removed the Crow Rate temporarily. However, by 1922, the Crow Rate was reintroduced and in 1925, its reach was expanded even further (Currie, 1968). The 1925 amendment meant that now, the Crow Rates on grain and flour movements would apply to all railways and all delivery points in the Prairies, something Bennett (2017) states was largely a political move driven to win support in the agrarian West, which was in the midst of a post-war economic downturn. A further amendment was also invoked in 1927 that saw the Crow Rate extended to also apply to grain shipments through the West Coast, as the grain export channel began to diversify away from only flowing to the East through Thunder Bay (Swanson and Venema, 2006).

After the amendments in the 1920's, the Crow Rate would remain virtually unchanged for 60 years, save for an expansion in crops covered. Specifically, the Crow Rate was extended to apply to crops such as rapeseed, flax, and pulses that were increasing in acreage on the Prairies. However, as shippers continued to benefit from the unchanging statutory rate, the railways began to suffer as wartime price controls were lifted in 1946 and their operating costs began to rise. This did not go unnoticed, however, as the Canadian government convened the Turgeon Commission in 1949 and later, the MacPherson Commission in 1959 to study the issue (Currie, 1968). Bennett (2017) notes that the MacPherson Commission estimated railway losses of $22.3 million in 1961, resulting in the recommendation that the railways should be compensated for their losses. However, due to the political environment of the day, namely a minority government facing pressure from their opposition, no government action was taken at that time (Bennett, 2017).

The financial reality facing the railways continued to deteriorate. By 1977, rising inflation paired with the fixed legislated grain transportation rate meant that only about 30 percent of the railroads' variable costs were being covered by these rates (Khakbazan and Gray, 1999). While shippers had enjoyed this extended period of discounted rates, a deterioration in the state of the grain handling and transportation system had occurred due to the railways' inability to reinvest adequate capital into the infrastructure of the system (Bennett, 2017). In addition, underinvestment in the transportation and handling system became apparent with the opening of new markets for Canadian wheat in China and the Soviet Union (Swanson and Venema, 2006). Due to increasing livestock herds and a series of droughts in the Soviet Union, an explosion in demand for Canadian grain ensued through the late 1960's and early 1970's (Morgan, 1979). By 1973, over $1.5 billion worth of Canadian grain was exported to the Soviet Union and the extant grain handling and transportation system was strained to its limits (Jenish, 2009). Some estimate that, due to the perpetual under-investment in Canada's grain handling system resulting from the Crow Rate policy, over $1 billion worth of export grain sales were either lost or deferred throughout the 1970's (Klein and Kerr, 1996). While it was increasingly clear that the Crow Rate was hindering the efficiencies and capacities of the Canadian grain handling system, there remained intense support amongst many stakeholders on the Canadian Prairies to retain the Crow Rate (Vercammen, 1998). As a result, the government turned to other alternatives in their attempt to rectify the situation.

Beginning in 1972, the federal government began purchasing rail cars as a method of investing in the rail transportation system. Over a 14-year span the Canadian government purchased 14,000 hopper cars, while the former Canadian Wheat Board and the provincial governments of Saskatchewan and Alberta combined to purchase an additional 6,000 cars (Bennett, 2017). In addition, the federal government further invested in the system by repairing railway branch lines to keep them operational (Swanson and Venema, 2006). However, despite the outside support, railways were continuing to struggle. The 1977 Snavely report found that the railway shortfalls were increasing at a rate of 15.5 percent per year and were projected to reach $1 billion by 1990 (Bennett, 2017). It would take until 1983, however, for the federal government to finally pass the first piece of legislation that would mark the beginning of the end of the Crow Rate.

The legislation that first began the government's move away from the Crow Rate came in the form of the *Western Grain Transportation Act* (WGTA) which was brought into law in 1983. While the new legislation did not necessarily end the premise of the Crow rate, it did begin a shift away from the era. Specifically, it replaced the ad-hoc government subsidies to the railways with a formal method of determining railway subsidies while increasing the share of transportation costs that grain shippers were paying (Bennett, 2017). When the WGTA was first passed, the subsidy to the railways, known as the Crow benefit, was originally set at $658 million in order to compensate the railways for their revenue shortfalls in the face of the legislated rates (Doan et al., 2006). However, soon after the WGTA was passed, there were already calls for it to be modified. Over time, other pressures led to the repeal of the WGTA in 1995, such as pressure to eliminate a large fiscal deficit in the mid-1990's and trade-distorting transportation subsidies (CTAR, 2015). In turn, the removal of the subsidy was expected to decrease land values due to the fact that the effective subsidy that grain farmers had been receiving through artificially low transportation rates had been capitalized into the price of their land (Doan et al., 2006). In order to counter-act this, as part of the repeal of the WGTA the government also issued a one-time cash payment to Prairie farmers of $1.6 billion. Further protection to farmers came the following year in the form of rate caps; the Canada Transportation Act of 1996 set maximum rates railroads could charge for shipping grain.

In 1997, Justice Willard Estey was commissioned to conduct a comprehensive review of Canada's grain handling and transportation system with the goal of setting recommendations on how the government might move forward with grain transportation policy (Nolan and Kerr, 2012). Justice Estey made a number of recommendations in his review, one of which was to remove the extant location-based rate cap policy. While Estey's calls for the removal of the rate cap were heeded, this was replaced with a form of incentive regulation known as the maximum revenue entitlement, or MRE, determined over railroad grain revenues. Still active, the MRE was designed to allow the railways increased freedom in their pricing strategies, while also protecting grain shippers from completely unrestrained rail rates. It is worth noting that among the various rate setting policies governing grain transportation that have been used in Canada since the removal of the historical Crow subsidy/rates, the MRE is by far the longest lived.

3.1. Recent Developments in Canada

Transportation legislation in the form of Bill C-49, the *Transportation Modernization Act*, was passed in mid-2018 in Canada. The Bill affected several modes including rail transportation. This section highlights a number of the changes that directly impact the transportation of grain by rail in Canada and has been drawn from drafts of the bill as well as video recordings of committee hearings on the bill by The Standing Committee on Transport, Infrastructure and Communities (CPAC, 2017).

Among the important changes the C-49 bill brings is a provision for reciprocal penalties to be built into service agreements between shippers and railways. Many witnesses at committee hearings noted the fact that while shippers can face penalties from the railways for not loading cars in an allotted timeslot, there is currently no retribution for those shippers when the railways fail to deliver cars on time to them. Shippers hope that by having the ability to penalize the railways for a failure to deliver on their service obligations, it will enable them to hold the railways to a higher degree of accountability and result in better service.[18]

Another important section of the legislation deals with the MRE. In the early days of the bill being considered, there had been discussion surrounding the possibility of the MRE being removed completely. However, this was not to be as the legislation continues to retain MRE provisions, albeit with a slight modification to the formula. In its updated condition, the MRE formula determining each railway's revenue for grain transportation now contains a component that rewards the railways for investments they make in the grain-handling system. That is, if an investment is made in grain handling infrastructure by a railway in a given year, such as purchasing new hopper cars, the maximum revenue entitlement of the railway will be adjusted up to correspond with the investment made. However, due to the way that the formula was originally structured, if one of the railways made an investment, the benefit derived from that investment was shared equally between both major railways, regardless of whether or not the other railway had invested anything into grain handling infrastructure. Therefore, Bill C-49 aimed to rectify this problem by only giving a benefit to the railway that actually makes the investment. It was hoped that by making this change, the railways would be more likely to invest in the grain handling infrastructure, and subsequent railroad behavior suggests that this has in fact happened.[19]

Another component of the legislation is a section that introduces a remedy for shippers known as long-haul interswitching or LHI. This remedy should not be confused with traditional inter-switching in Canada, which remains relatively unchanged and remains as an additional shipper relief option. LHI was a rate relief policy introduced to shippers served by a single Class I railway but also located more than 30 kilometers from the nearest designated interchange/interswitch point. The option to request an LHI order was available if this criterion applied to either the point of origin or the point of destination of the shipment. Moreover, an LHI order was only applicable if

[18] This has been a notable area of contention on the U.S. side. In May 2019, STB held a two-day oversight hearing on "demurrage and accessorial charges" and subsequently issued decisions to clarify the regulation of demurrage, billing requirements, among other topics.

[19] On May 24, 2018, Canadian National announced that it planned to acquire 1,000 new generation high-cube grain hopper cars over the next two years. On June 7, 2018, CP announced plans to invest more than $500 million on new high-capacity grain hopper cars. The press release added, "Over the next four years, CP plans to order approximately 5,900 hopper cars in total, enabling a complete removal of all low-capacity hoppers, including all Government of Canada cars, from the fleet. The investment is made possible by changes to the Maximum Revenue Entitlement formula through the passage of the Transportation Modernization Act, Act C-49, which provided CP the certainty needed to place the order."

it was for a distance less than 1,200 kilometers (about 745 miles). More on interswitching is discussed in Section 3.2.

Another recent development that has been little documented is the switch in Canada from tariff (public) rates for grain movement to contract (private) rate systems. This transition has been stark. Limited available information suggests that before 2012, about 80 percent of grain moved under tariff. Today, with the CWB gone and the few grain companies now dealing directly with railways for transportation service, it has been suggested that confidential contracts comprise over 90 percent of current grain movement. These shipments still fall under MRE regulation, but depending on the nature of the contract signed, shippers are either prevented or outright discouraged from seeking rate relief through available regulatory mechanisms. This is an on-going trend in Canada, so academic references are non-existent. The authors have based this assessment on anecdotal evidence accumulated from various sources, including grain companies and discussions with Agriculture and Agri-Food Canada.

3.2. Railroad Dispute Resolution Mechanisms in Canada – Interswitching

In Canada, the concept of interswitching or extended interswitching is a mandated railroad competitive access provision. Under interswitching, a shipper physically served by a single railroad is given mandated access to the network of a less proximate but competing railroad, via the serving railway's track. The basic concept is not new; it has been used in Canada in various formats since 1904 (Canadian Transportation Agency, 2016c). While many railroads frequently and voluntarily switch each other's traffic for efficiency reasons, this policy in Canada has been oriented towards those situations where a railroad may possess some market power over local shippers, while the latter seek additional competition for long haul shipments.

Known as reciprocal switching in the U.S., there are two critical regulatory elements in activating a policy of reciprocal switching. The first of these is to determine the radius of action for the policy, in effect deciding its scope for extending rail competition. The second is to determine fair compensation for the movement from the shipments' origin to the switching point between the two railroads. While there is some controversy as to how these rates are set, in Canada public interswitching rates are designed to be compensatory to the railroad using direct (not opportunity) cost considerations. In addition, in Canadian legislation, the act of interswitching is effectively automatic to a shipper. That is, if demanded and feasible, the shipper is granted the relief, and the regulation is enforced by the Canadian Transportation Agency.

For most of its history and at present in Canada, interswitching policy was constrained by a radial limit on the allowable interswitch of 30 km (18 miles) (Grimm and Harris, 1998). Associated with the policy is a set of pre-determined rates on movement associated with an interswitch. The regulated rates essentially vary by distance, as well as the number of cars moved by the originating railway. As well intentioned as this policy seems, given factors like branch line abandonment and network consolidation in the rail sector, the current topology of railroads in much of Canada means that as a way to encourage rail competition, the 30-km policy was almost never used in practice outside of urban areas. To our knowledge, the compensatory rates used were never contested by the railways under the 30-km radius policy.

The grain transportation slowdown of 2013-14 led to drastic government intervention in the form of Bill C-30. Among other changes implemented to get Western grain moving by rail, the bill included significant changes to the extant interswitching regulations, changes that were applicable only in Western Canada (Saskatchewan, Alberta, and Manitoba). Bill C-30 expanded the potential radius for an interswitch in those provinces to 160 km (about 100 miles), with the existing regulated switching rates adjusted by the CTA to accommodate this extra distance. While it took some time for Canadian grain shippers to adjust to this new reality, data indicates that the number of extended interswitches in fact increased gradually over time to the benefit of those shippers (AGCanada, 2016).

However, the extended distances did not last as legislation. The modified extended inter-switching zone was discontinued after the mandated expiration date as of August 2017. This meant any shipper who wanted to use extended interswitching once more had to be located within the original 30 kilometer (about 18 miles) radius from a designated track interchange point in order to make use of the provision.

More recently, with a change of government eventually came a new transportation bill (Bill C-49) in 2018. While not renewing the 160-km interswitching limits, what emerged from this bill is the aforementioned long-haul interswitching or LHI.[20] Essentially, an LHI is potentially applicable up to a large operating radius (up to 1,200 km or about 745 miles) but among other issues, the onus of its implementation has changed. No longer is a shipper automatically entitled to an LHI if they fit the basic criterion (as is the case under interswitching). Instead a shipper has to apply for approval through the CTA. Furthermore, posted compensation rates are no longer publicly available over greater distances than 30 km, meaning that under an LHI, the CTA would be tasked with computing the applicable compensatory rate on a case by case basis. Complicating things is that the updated legislation provides no guidance on how to compute LHI rates, so at the time of this writing, it is not clear how this will be done. Likely due to these complicating factors, to date no LHI's have been called for in Canada. This situation has not been a big surprise to many, as among shipping groups in Canada there remains considerable doubt that LHI will ever actually be attempted (Dawson, 2017).

[20] For more information on the long-haul interswitching provision, see https://www.otc-cta.gc.ca/eng/long-haul-interswitching-proposed-guidance-material.

4. Railroad Regulation in the United States

There is a considerable literature available on railroad regulation in the U.S. Good examples include Gallamore (1999) or McCullough (2016) with alternate perspectives. This section is intended to help the reader contextualize the state of regulatory policies across the North American rail sector.

Federal oversight of freight rates began in the United States when Congress enacted the Interstate Commerce Act in 1887 (Gallamore, 1999). This act facilitated the creation of the Interstate Commerce Commission (ICC). For more than a century, the ICC was tasked with providing federal regulatory oversight over the rail industry. As Dempsey (2012) notes, the ICC was initially created in order to provide the public with protection from monopolistic practices that railways in that era were exploiting. In response to railway behavior, Congress granted the ICC authority to oversee many aspects of rail operations, including rates and service. Similar to the Board of Railway Commissioners in Canada, the ICC would be the first independent regulatory agency created to regulate an industry in the United States (Dempsey, 2012).

While there were many changes within the ICC in the years ensuing its formation, including the addition of several other modes of transportation to its mandate, the most disruptive changes to U.S. rail legislation would begin in 1973. The state of the United States rail industry was in dire circumstances (Dempsey, 2012). Due to a number of factors including increased competition from motor carriers and a shift in the industrial manufacturing landscape of the United States, railways were quickly becoming unprofitable. Along with a dramatic decline in railway passenger business following World War II, the industry faced increasingly restrictive freight pricing policies under the ICC. These reasons seem to explain the dramatic erosion of financial viability in large parts of the U.S. rail industry through the 1950's and 1960's. Finally, the bankruptcy of the once-strong Penn Central Railway was a defining event that forced Congress into action in an attempt to improve the viability of the nation's freight railways. The response to these difficulties was the passage of the *Regional Rail Reorganization Act* (3R Act) (Gallamore, 1999).

The 3R Act aimed to reorganize the railroads in the Midwest and Northeast through two measures: the first was to provide federal assistance to those railroads that were failing and the other was to establish the United States Railway Association (USRA) and the Consolidated Rail Corporation (Conrail) (Macher et al., 2014). The purpose of the USRA was to take over some of the ICC's powers in order to allow bankrupt railroads to abandon unprofitable lines more easily while Conrail was a corporation set up to essentially nationalize bankrupt railroads in the Northeast. However, as the industry continued to struggle, further action was brought by Congress with the passage of the *Railroad Revitalization and Regulatory Reform Act* (4R Act) in 1976.

The 4R Act took major steps towards the reduction of federal rail regulations on carriers across the country in order to work towards returning greater financial viability to all railroads across the nation (InterVistas Consulting, 2016). Greater flexibility in rate-setting without need for ICC approval, as well as legislative changes to make mergers and consolidation easier, all aimed to attain a rail system that would be efficient and viable. However, Congress would soon take even more drastic measures in regard to de-regulation just four years later with the passing of the *Staggers Rail Act of 1980* (Grimm and Winston, 2000).

The Staggers Act built further on the steps towards de-regulation that were initiated in the 4R Act and aimed to allow competition and shipper demand to establish rates rather than the ICC (Grimm and Winston, 2000). Further, the new legislation also allowed the railroads to use differential pricing when setting their rates. While de-regulating the industry was done in order to allow railways to earn adequate revenues, measures were put in place to help protect shippers from the exercise of unfair market power. As Macher et al. (2014) state, the Staggers Act introduced the benchmark that rail rates less than 180 percent of the carrier's variable cost of moving the shipment would automatically be presumed to be reasonable rate. However, if the rate a shipper was being charged was greater than 180 percent of variable cost, as well as the shipper having an absence of other transportation alternatives, the legislation dictated that the ICC could find the railroad as having market dominance. Once market dominance was established, the ICC still had to decide whether the rates in question were unreasonably high. To this end, the mechanism by which to determine the reasonableness of rates being charged by a railway with market dominance was not detailed in the legislation but was left up to the ICC to decide (Tye, 1991).

In 1985, the ICC published its *Coal Rate Guidelines* which detailed three main principles known as "Constrained Market Pricing Principles" (CMP) with the purpose of creating a systematic approach with which to judge the reasonableness of rates (Tye, 1991). While Ramsey pricing represents a theoretical ideal on pricing under a natural monopoly with high fixed costs, there remain many challenges to its full implementation (see Section 2). Given this, some have argued that CMP was an attempt to put the Ramsey approach *into practice* (McCullough, 2016). One of these constraints is revenue adequacy, which states that railroads should be allowed to charge rates that allow them to earn normal profits (zero economic profits), but not more than that. The second constraint is a management efficiency constraint that tries to prevent shippers from having to pay excessive rates due to costs that would be avoidable if it were not for the inefficiencies present in the railway serving them. However, as Pittman (2010) notes, it is the third constraint that has been the predominant method by which shippers have contested the reasonableness of rates being charged to them.[21] This third constraint is known as the stand-alone cost (SAC) constraint and aims to simulate a contestable market as would hypothetically exist if a new entrant were to enter the market and serve the complainant traffic. In order to bring a rate complaint to the ICC using this third constraint, shippers were required to build a simulation of the shipping market that would exist with this new, stand alone railroad competitor.

The landscape of rail regulation in the United States has not changed substantially since the Staggers Act but one of the most significant events that did occur was the abolishment of the ICC. With most of the deregulation of the rail industry complete by 1995, Congress moved to terminate the ICC and transfer the remaining railroad regulatory oversight to the newly minted Surface Transportation Board (STB) (Wilson and Wolak, 2016).

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[21] CMP contains a more obscure fourth, "phasing constraint," which limits rate increases (even reasonable ones) when necessary for the greater public good. To our knowledge, it is rarely, if ever, used.

Recognizing the cost of litigation as being a barrier for shippers to bring complaints against railways, the STB introduced its first set of simplification measures in 1996 known as the Three-Benchmark procedure. Further simplifications were introduced in 2007, when a Simplified-SAC procedure was created in order to make the process of modelling the competitive railway less onerous on the complainant (STB, 2006). Finally, additional changes to the rate complaint process were brought in 2013 when the STB either removed or increased the relief available to complainants under the simplified procedures that had previously been introduced. However, despite the efforts of the STB to simplify the process, there has been a relatively small amount of cases brought forward under all of the complaint processes, and shippers have identified both the complexity and costs of the filing process as being barriers that have precluded them from making complaints (Wilson and Wolak, 2016).

4.1. The Foundation of U.S. Rail Regulation – Costing

Underlying regulatory responses to potential market power in the U.S. rail sector is the issue of costing. Fair and transparent rail costing is difficult, but from a theoretical perspective, it is germane to developing good regulation. Though the STB maintains a formal costing system known as the Uniform Rail Costing System (URCS) (where necessary, Canada uses a more informal set of costing methods, maintained by the CTA), costing for the purposes of determining appropriate rates for a given rail movement remains a major point of dispute between shippers and carriers in both countries.

Given the long-standing controversy surrounding URCS (see Rhodes and Westbrook, 1986; Bereskin, 1989; Wilson and Wolak, 2015), under the Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA) of 2005, the U.S. Congress called on the Secretary of Transportation to conduct a detailed study of the status of the nation's railroad industry as a follow up to various adjustments made subsequent to the Staggers Act of 1980. In 2012, Congress finally appropriated the funds to do the analysis. Overseen by the National Academy of Sciences and the National Research Council, the Transportation Research Board (TRB) was asked to manage the study due to its access to various experts on these topics. The committee formed through TRB was tasked with addressing and making recommendations on the following points (see TRB, 2015):

> "(1) the performance of the Nation's major railroads regarding service levels, service quality, and rates; (2) the projected demand for freight transportation over the next two decades and the constraints limiting the railroads' ability to meet that demand; (3) the effectiveness of public policy in balancing the need for railroads to earn adequate returns with those of shippers for reasonable rates and adequate service; and (4) the future role of the Surface Transportation Board [STB] in regulating railroad rates, service levels, and the railroads' common carrier obligations, particularly as railroads may become revenue adequate."

The chosen committee consisted of a number of academic transportation and rail market experts who developed and conducted the analysis. Overall, there was consensus in the report that freight rail is a viable and effective industry much of the time, but that long-standing problems with captive shippers of important bulk commodities, as well as the practice of discriminatory pricing for many of these shipments, remained an unresolved issue about fairness and the distribution of economic welfare. To this end, the essence of the technical contribution of the report was to argue that rail regulation based on costing specifications as practiced by the STB was misguided and even inappropriate. While insightful, in fact some elements of rail policy (like R/VC eligibility thresholds for rate review) are grounded in statute, so changing this process would be very difficult for the STB to initiate. Despite this, the report recommends the STB should rely instead on more modern empirical approaches to rate regulation. The latter suggests identifying comparable competitive rates for any given contested movement as a more appropriate metric against historical rate data consisting of similar commodities and moves.

More succinctly, the report also criticized the continued use of URCS that forms the basis of rail costing as performed by the STB for regulatory purposes. The report developed a data-intensive approach that allows comparison of actual rates on similar sets of movements, facilitating the development of comparative rate "distributions" for contested movements. The comparative rates to be used for CMP metrics thus are not cost-based but instead based on actual waybill charges or transactions over similar traffic.

By suggesting a deviation away from long established costing methods in regulation, there was considerable controversy generated by the report. For instance, while imperfect some argued that at least URCS was well-established as a benchmark and was founded on structural costing relationships in rail operations (Rhodes and Westbrook, 1986). On the other hand, shippers argued that using actual competitive rates over comparable traffic meant that STB rate reasonableness review would not necessarily have any basis in variable or marginal costs of the particular movement and could inherently include any markups already being charged by railways (Huneke, 2017). The STB itself seems reluctant to get rid of URCS for the more data driven methodology, and at the time of this writing the controversy remains.

4.2. U.S. Rate Dispute Resolution Mechanisms

The most recent STB re-authorization was completed at the end of 2015. While several changes were made to support shippers, as of this writing, additional new policies are being considered to respond to railway behavior (STB, 2019d). These on-going suggestions fall into the categories of regulated costing, assessments of revenue adequacy, and simplified rate dispute methods. While these issues are somewhat interlinked within U.S. rail regulation, they are worth examining as separate concepts.

We focus here on rate dispute issues. In order to dispute a rate, a U.S. shipper first has to show that the disputed rate exceeds a computed revenue to variable cost ratio of 180 percent (Tye, 1991). Costs must be computed using the STB-maintained Uniform Rail Costing System (URCS) data and software. The shipper also must show that the railroad has market dominance over the traffic at issue (that the market lacks effective competition). If a disputed rate meets these two conditions, the shipper then has to show that the rate is unreasonable. To determine reasonableness of a rate, the shipper must follow constrained market pricing (CMP) principles established by the STB for assessing rate challenges. Stemming from this need, the well-known stand-alone cost or SAC method was developed for use in rate cases. As a legal tool used by both defendant and litigant, the SAC test process has proven controversial.

Ultimately perceived by shippers as being too complex and costly to litigate (STB, 1996), there have been attempts by the Board to refine CMP methods away from SAC in order to make the process more accessible to shippers (STB, 2019d). Evolving from this need was the development of the so-called Three Benchmark test that can be applied to lesser valued (under US$4 million in value) CMP cases. In this case, three similar R/VC metrics are compared which help evaluate both the composition, distribution, and size of the rate markup (STB, 2019d). Essentially, the benchmarks assess why and how much the disputed rate surpasses the standard (180 percent R/VC) point of revenue adequacy—that arbitrary point at which the railroad is deemed to be earning enough revenue to cover its variable plus fixed and common costs.

Currently, and as response to continued complaints about the cost of CMP cases, the STB is evaluating ways to both modify and simplify rate disputes. These include suggestions to (1) use case or rate arbitration in a similar fashion to that currently used in Canada, (2) improve SAC so that components are standardized and simplified (keeping costs down), (3) develop other rate comparison methods in lieu of SAC, (4) adjust shipper remedies depending on the level of revenue adequacy, and (5) identify ways to improve the Three Benchmark test.

While each of these alternatives and modifications is interesting in its own right, since arbitration as an option for rate cases is new to the STB and could be motivated in part by Canadian rail policy, some additional discussion about the 2019 STB Notice of Proposed Rulemaking on final offer rate review (FORR), or rate arbitration, is necessary.[22] As part of what is now becoming a portfolio of CMP alternatives for shippers, FORR has been suggested by the STB as a possible reform process for rate resolution. The next section discusses how final offer arbitration is implemented in Canada.

4.3. Alternative Rate Dispute Resolution Methods – (Final Offer) Arbitration

Under the Canadian Transportation Act passed in 1996, if rate or service disputes between shippers and carriers could not be resolved privately, shippers were given the right to ask the Canadian Transportation Agency (CTA) for dispute resolution assistance via (final offer) arbitration. However, unlike the U.S. regulatory system, there are no preliminary screens to determine the validity of a case. While parties are encouraged by the CTA to negotiate privately and there are limits on the value associated with any given case, there is no formal "trigger" (like an R/VC threshold) necessary to move forward with an FOA case beyond the demands of a shipper to do so.

Basic or conventional arbitration is defined as "the hearing and determination of a case in controversy by a person chosen by the parties or appointed under statutory authority" (Brams 1990). Given the inherent flexibility on the part of the arbitrator to render any decision within the numerical boundaries of the offers, conventional arbitration is prone to attempts at influence and can produce biased outcomes. Decision flexibility also means it can sometimes be a time-consuming process for the disputing parties and the arbitrator. Cognizant of this drawback to

[22] On September 11, 2019, STB issued a Notice of Proposed Rulemaking in two dockets, EP 755 (Final Offer Rate Review) and EP 665 Sub-No. 2 (Expanding Access to Rate Relief). The STB noted these proceedings were not consolidated, and a single decision was issued for administrative convenience.

conventional arbitration, to resolve quantifiable transportation disputes, the CTA relies on a derivative of conventional arbitration known as "final offer arbitration," or FOA (Canadian Transportation Agency, 2018a).

FOA was initially conceived as an improvement on conventional arbitration. As a one-shot, winner-take-all process, all else equal, FOA incentivizes the conflicting parties to converge towards a "mid-point" solution to the dispute (Rehmus, 1979). As introduced in Canada in 1996, under FOA, each party in a transportation dispute must submit a "final offer" for consideration by a CTA-appointed arbitrator. The arbitrator must then choose one of the two final offers as the ultimate settlement. Unlike conventional arbitration, under FOA, the arbitrator does not compromise the offers in any way (Vercammen, 1996; Brams, 1990).

The mechanisms and rules for using FOA are described in detail on the CTA website (CTA, 2018a; CTA, 2018b). For instance, a CTA arbitration panel consists of either one or three arbitrators chosen from a list of certified individuals, and most FOA cases are decided within 60 days of filing. One point of distinction on the timing associated with an FOA decision relates to the value of freight charges in the case. If freight charges are valued at less than C$2 million, then the arbitrators are obliged to render a decision within 30 days of filing. If more, then the arbitrator can take more time. Typically, the costs of running an FOA case are shared equally by the shipper and carrier.[23]

Aside from case costs, there are other limitations for shippers with the FOA process as currently implemented in Canada. These limits are related to the sharing and dissemination of information. Simply put, carriers in Canada engage in FOA repeatedly (if infrequently) whereas any individual shipper might only bring a single case forward over a long time interval. Since FOA case details are not made public under Canadian law, other shippers never learn very much about how carriers and shippers have constructed their specific FOA arguments, along with any other key details about FOA cases. From a game theoretic perspective, as repeat players possessing more and better (asymmetric) information, under current conditions railways in Canada are always much better positioned to build an effective FOA case than any individual shipper.

Despite these obvious drawbacks, some interested parties have touted Canadian FOA as a useful tool for resolving rail rate or service disputes (CPCS, 2015; InterVistas, 2016). In reality, since its inception, FOA has not been used very frequently to resolve shipper/carrier disputes in Canada. Based on authors' calculations using CTA data, since 1996 the agency has handled on average between 1 to 2 rail disputes per year using FOA, out of potentially millions of individual shipper/carrier transactions conducted over that time. FOA's limited use in practice is supported by other findings. The TRB authors (2015) wrote:

> "Because the decisions of arbitrators are kept confidential, the number of decisions favoring shippers versus railroads is unknown. Cairns estimates that about 30 decisions in total have been rendered since the process was instituted in 1988. This estimate is consistent with that in a 2001 report by a panel appointed by the Canadian government to

[23] This wording is contained in the legislation under the heading "Arbitration Fees"; see https://laws-lois.justice.gc.ca/eng/acts/C-10.4/page-36.html.

> review the regulatory process. The panel reported 23 decisions during the process's first 13 years and estimated that half of the arbitration cases were settled before a decision."

More recently, Canadian Pacific Railway (CP)—one of the two major Class I railroads in Canada—stated it has been involved in only nine FOA cases over the past 10 years, with about half (five) involving rates (CP, 2019).

In addition, developing an FOA case from scratch, as most Canadian shippers have to do, does not come cheap. Few law firms in Canada possess the expertise to build a solid FOA case, and in spite of its apparent simplicity, FOA has proven over time to be both time-consuming and sometimes very expensive for litigants (McMillan, 2000). In its comments to the STB, CP explained that, despite the fact that the goal of FOA is to be abbreviated and efficiently solved, in fact the process involves substantial costs (CP, 2019).[24]

Returning to the arbitration process under consideration by the STB for rate review, while there is an extant arbitration procedure available through the STB, its use remains completely voluntary on the part of the railroads. Not surprisingly, to date no arbitration cases have occurred, and, for many years, only one Class I railroad has even signaled a desire to participate.[25] While the STB has expressed interest in the viability of legal arbitration to solve rail disputes (including smaller cases),[26] an important precursor is effective rate review. Without a way for a shipper to effectively challenge an unreasonable rate, there is no incentive for the railroads to arbitrate. To that end and after much consultation, the STB is currently considering a specific form of arbitration that could be used for challenging the reasonableness of railroad rates—which they call final offer rate review (FORR). As proposed, FORR will not be available to every shipper for every possible dispute. Specifically, FORR would be initially limited to smaller rate cases and only applicable against Class I railroads. While these are non-trivial limitations on a shipper's use of the proposed policy, one major difference between how the STB plans to conduct FORR cases versus how the CTA handles FOA cases in Canada is the level of information that will be made publicly available about previous resolved FORR cases. Under U.S. law, all finalized STB cases must be made available to the public. Even considering that U.S. FORR cases will be governed by revenue limits, if

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[24] CP (2019) wrote, "FOA proceedings are expensive. In CP's experience, the 'streamlined' procedural schedule does little to control costs and may even engender additional costs. FOAs involve briefing of complex issues and require a substantial amount of preparation. …The evidentiary record in such proceedings is typically many binders thick. …CP must dedicate a large team of lawyers, experts, consultants and in-house subject matter experts as well as numerous supporting personnel."

[25] Since June 2013, UP has opted into STB arbitration on certain issues. CSX and CN opted to arbitrate certain issues in June and July 2019, respectively. STB (2020) indicated, "To date, the Board's arbitration program—first established in 1997 and modified in 2013 and again in 2016—has gone unused. For more on STB arbitration, see: https://prod.stb.gov/resources/litigation-alternatives/arbitration/.

[26] In its 2020 decision to open docket EP 755 for further input and informal discussions, STB indicated, "The Board wishes to explore the issues raised in CN's comments and is interested in discussing whether, and if so, how, its arbitration program, see 49 C.F.R. part 1108, could be further modified so as to provide a practical and useful alternative dispute resolution mechanism, particularly for stakeholders with smaller rate disputes. …The Board intends to use the ex parte discussions to preliminarily explore these and other issues involving the potential use of voluntary arbitration to resolve smaller rate disputes." More recently, on July 31, 2020, five of the seven Class I railroads submitted a Joint Petition for Rulemaking to establish an alternative voluntary arbitration program for small rate disputes (see EP 765).

implemented, this simple reporting difference will render FORR in the U.S. more effective than FOA in Canada.

4.4. Alternative Rate Dispute Resolution Methods – Reciprocal Switching

Another area of shipper protection in which the two countries differ is that of competitive access provisions. As Padova (2015) details, aside from the new long-haul interswitching provision, Canadian shippers still enjoy theoretical protection in the form of competitive line rates as well as the long standing (short distance) inter-switching. Competitive line rates were originally implemented as a means of providing competitive access to shippers that are only served by one railway but are situated too far from an interchange point to be able to make use of inter-switching. Competitive line rates allow shippers to apply for the Canadian Transportation Agency to determine a rate for which the originating railway must haul the shipment for delivery to an interchange point. However, a key element of competitive line rates is that a shipper must first have an agreement negotiated with the connecting railway before they can apply for a competitive line rate from the agency and as Tougas (2005) states, this means that the participation of the two major national railways is imperative in order for this measure to be effective.

The STB (2016b) notes that reciprocal switching measures have officially existed in the U.S. since 1985, but due to extremely restrictive access to the measure, not a single reciprocal switching measure has been granted in the history of the statute. It is worth noting that the current form of reciprocal switching being proposed includes applicability to certain regions or commodities. As in Canada, reciprocal switching is being considered primarily as a means to encourage more inter-rail competition for bulk shipping (Szakonyi, 2014). While the exact details of a potential U.S. version of reciprocal switching are some way from being worked out, it seems that distance will not be the primary determinant. Like the current LHI policy in Canada, it appears as if the STB would conduct reciprocal switching on a case-by-case basis.[27] So while the STB seems to have some interest in beefing up reciprocal switching as a shipper remedy, it remains a contentious issue.

To this end, the limited Canadian experience with extended interswitching limits is noteworthy. Under the implementation of the 100-mile limits, which existed from 2014 to 2018, not just Canadian railways sought traffic from one another. In fact, at least one Class I U.S. railway gained intermittent access to Canadian grain shippers under the legislation.

In order to help the reader better understand how reciprocal switching in the U.S. might work on a limited basis, Figures 9 – 12 illustrate a reciprocal switching policy applied to wheat shipments in the Northern Tier states of Washington, Idaho, Montana and North Dakota. Figure 9 shows the current status quo without mandatory switching zones, including the distribution of network locations identified as originating wheat shipments from the 2015 Carload Waybill Sample and

[27] The STB (2016c) wrote, "Imposing reciprocal switching on a case by case basis would also allow the Board a greater degree of precision when mandating reciprocal switching than is afforded under the [bright line] approach advanced by [the National Industrial Transportation League]."

associated rail junction locations where reciprocal switching activities might take place.[28] A total of 186 different locations were identified as origin areas for wheat shipments in the Northern Tier states during 2015.

Regional sub-clusters are observed in North Dakota, the Fertile Crescent of the Snake River in southeastern Idaho, and the Columbia Plateau/Palouse region of Washington State and Idaho. Within the Northern Tier, there are 89 junction locations where transfers between railroads occur. These would be potential center points for determining shipping locations subject to reciprocal switching.

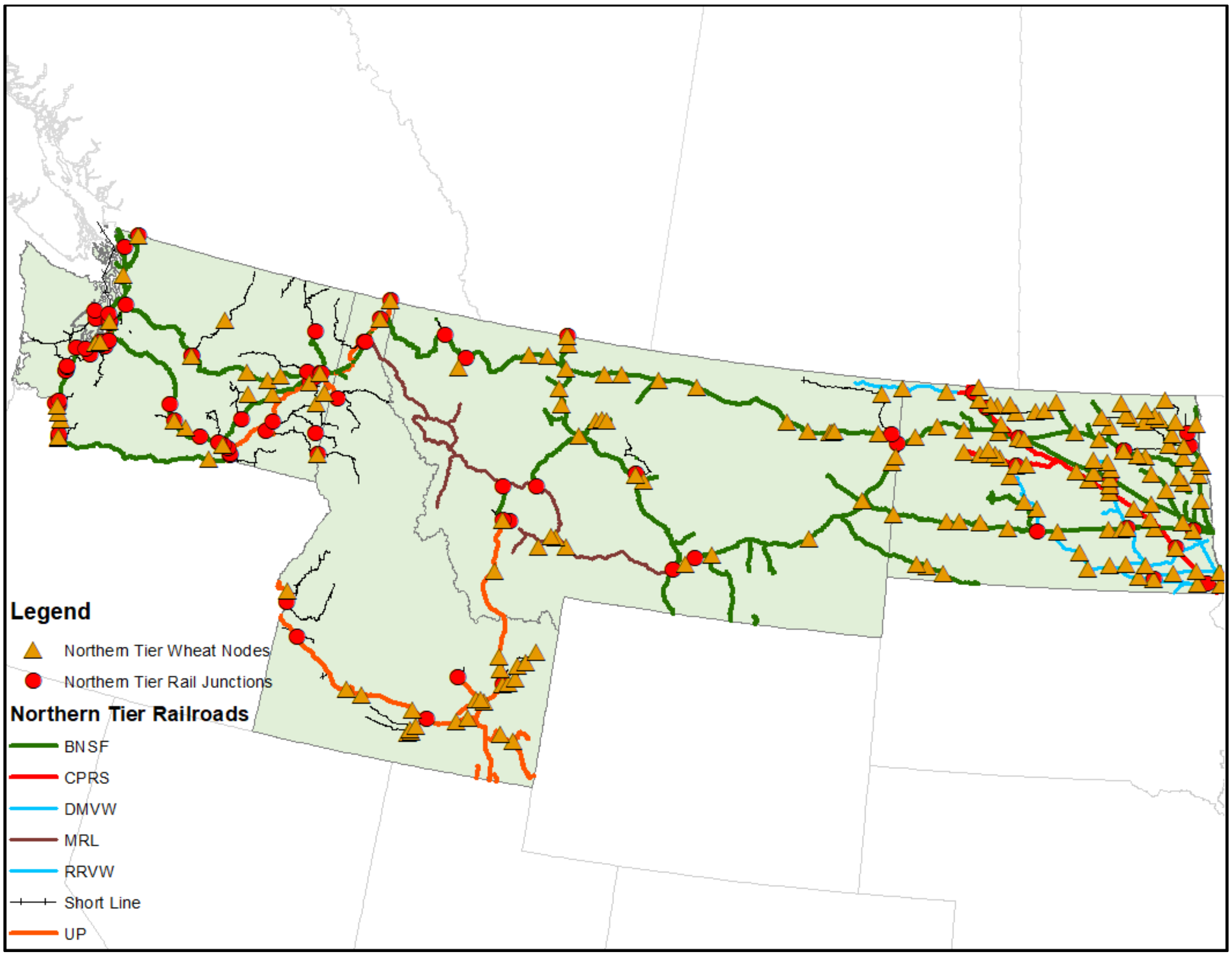

Figure 9: Northern Tier rail network status quo

[28] The rail locations were identified from information contained in the Carload Waybill Sample identifying shipments of wheat as denoted by STCC 01137 and by associating the originating location's SPLC value with nodes in the North American Rail Network maintained by the U.S. Department of Transportation. Junction locations were identified using the Rule 260 Junction code and a database of transfer locations maintained by Oak Ridge National Laboratory.

Figure 10 imposes a 50-mile (~80 km) radius buffer on the status quo network.[29] At this distance, most of the wheat shipping locations are covered, with Washington State being completely covered. Most of the uncovered territory is in more remote parts of northern and eastern Montana and southwestern North Dakota served by BNSF.

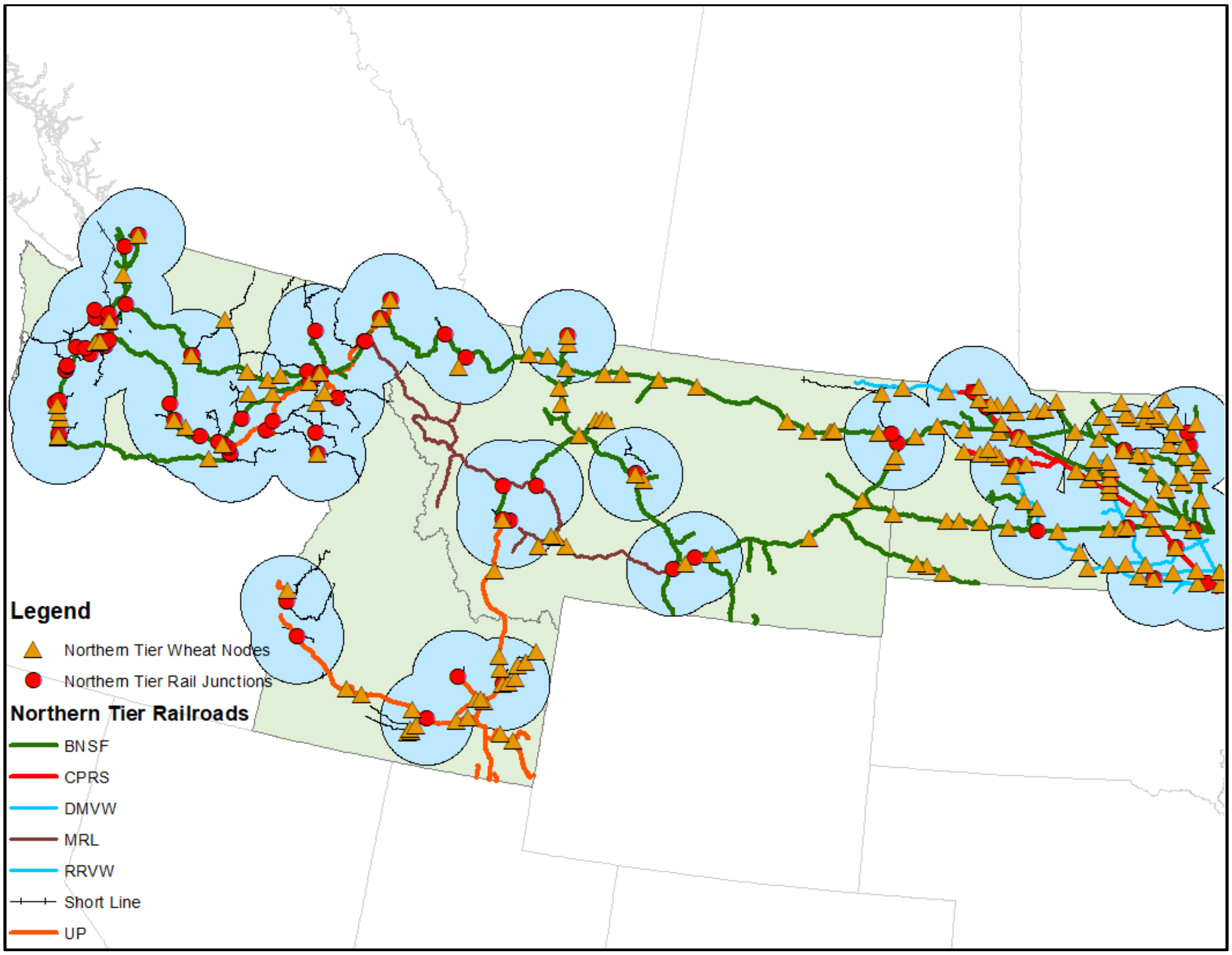

Figure 10: Northern Tier with 50 mile switching radius

At 100 miles (~160 km), as seen in Figure 11, the reciprocal switching environment mimics the recently rescinded Canadian regulatory regime. Under these circumstances, all of Idaho is now covered by potential reciprocal switching, with only 7 remote Montana and North Dakota shipping locations on BNSF remaining uncovered.

[29] It should be noted that these buffers assume a radial buffer from an identified rail junction location and do not represent actual rail-line distances which might be the basis used for any interswitch rulemaking. However, the buffer distances do closely approximate the possible rail-line distances that would be expected under such a regulatory regime.

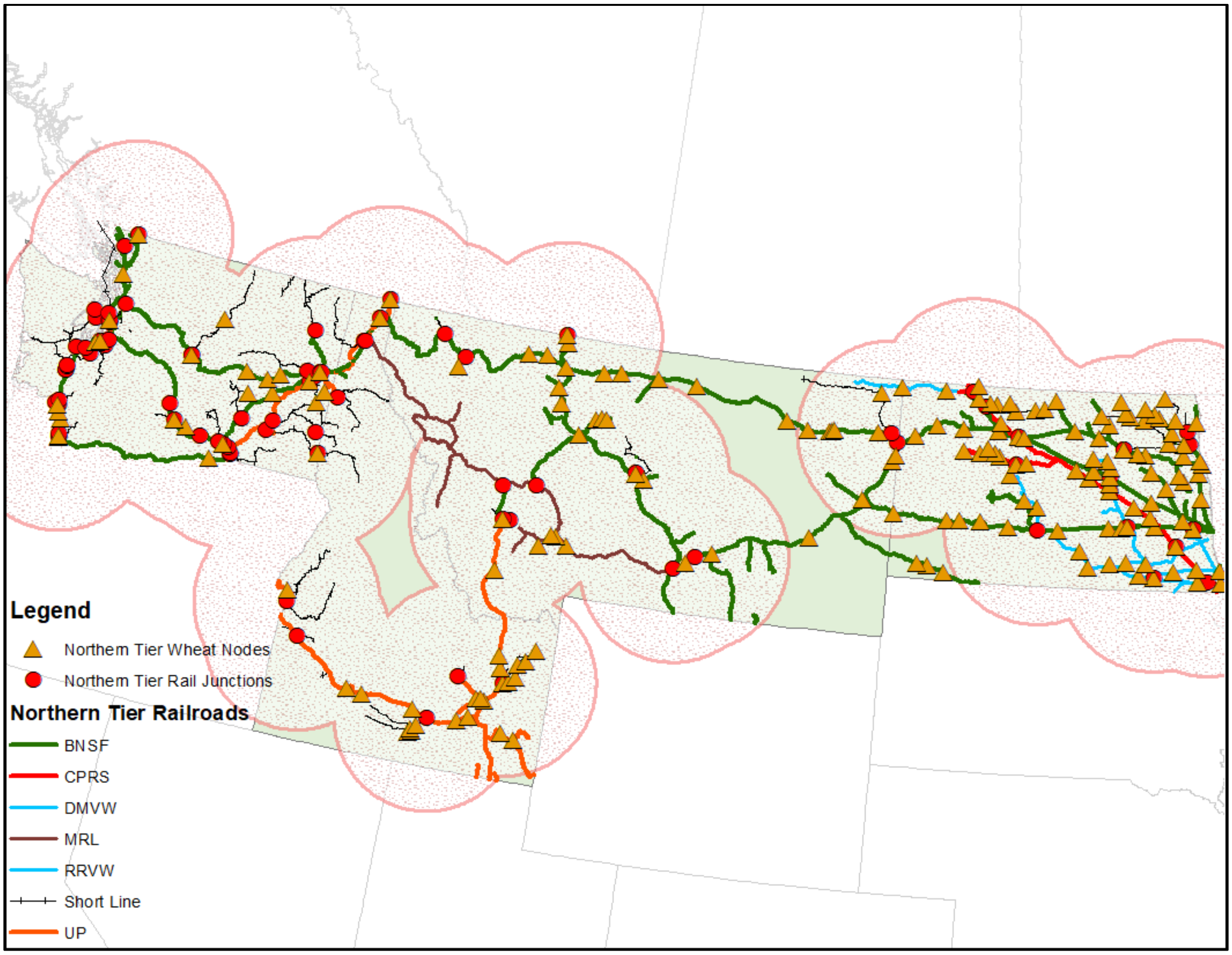

Figure 11: Northern Tier with 100 mile switching radius

For exposition, we can see in Figure 12 below that at 150 miles (~240 km), there are no uncovered wheat shipping locations in the Northern Tier states. One other item of note are the numerous locations close to the U.S. – Canadian border. If there were greater harmonization between U.S. and Canadian regulations on reciprocal switching, it is possible that switching distances would include those locations that were within the buffer limits on either side of the border. In turn, this would potentially affect BNSF and CP more heavily as BNSF operates in Vancouver, BC and up to Winnipeg, MB. CP has extensive rail operations in southeastern Saskatchewan, as well as southern Alberta and British Columbia, that could be susceptible to increased competition from U.S. railroads. However, even UP and CN are not immune depending on the distance used, as UP has operations in northern Idaho while CN has operations in southeastern Saskatchewan and in Manitoba that are encompassed by both the 100- and 150-mile radius.

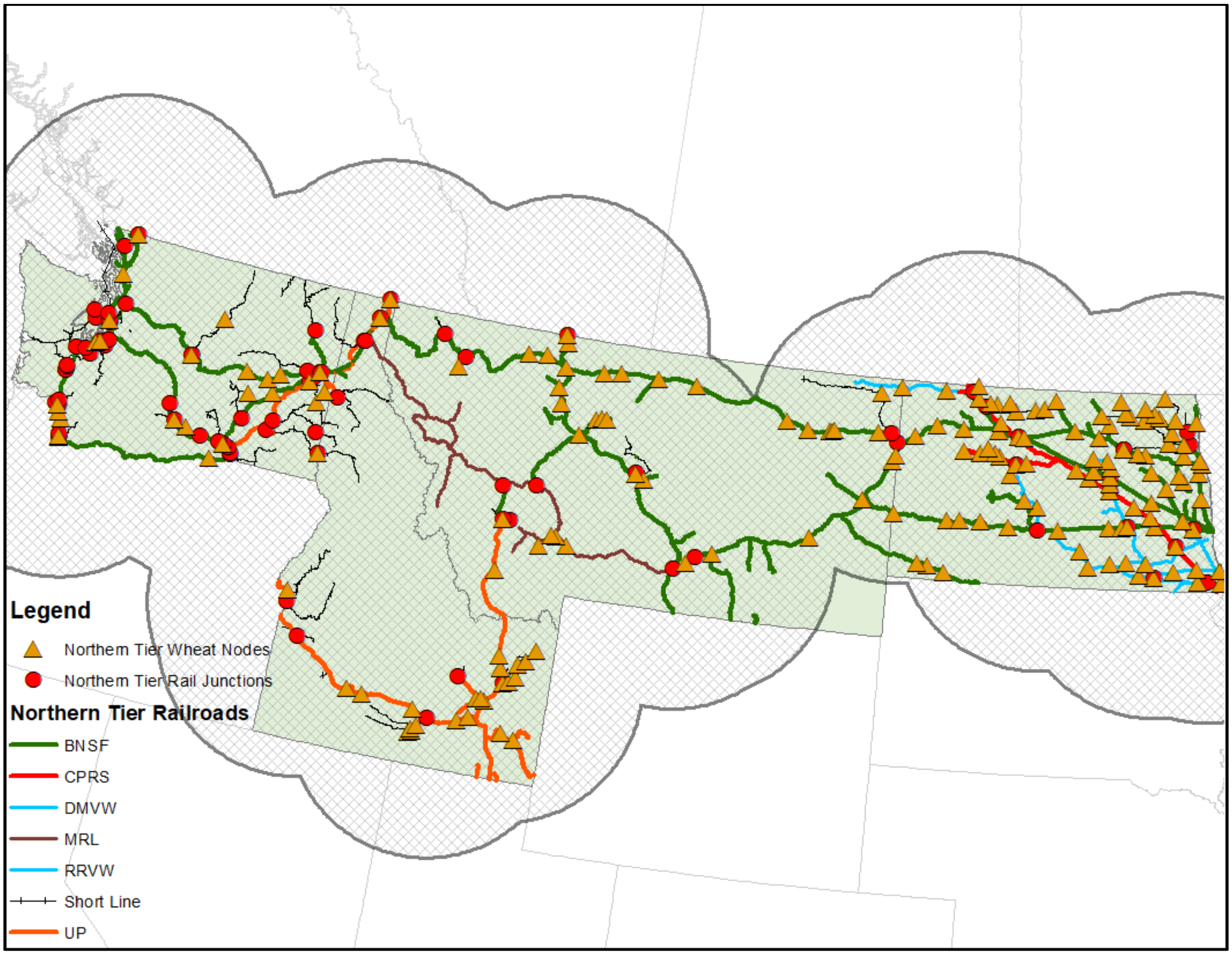

Figure 12: Northern Tier with 150 mile switching radius

Not surprisingly, the modified interswitching rules applied in Canada evidently took some time for shippers to absorb as they were slow to be used. But the data do show gradually increasing interswitching calls over the duration of the time the modified limits were in place. While grain shippers seemed to be positive about extended interswitching limits, what is not entirely clear is how much this cost the railways who had to perform regulated movements for the called interswitch. As they were originally set under the 30 km (18 mile) regime, regulated interswitching rates had to be modified to accommodate longer regulated hauls. However, anecdotally, the railways argued that even the modified set of interswitching rates were not compensatory to them for longer hauls. These behind the scenes arguments seem to have led to completely eliminating the modified (160 km) regulations. Railway suasion in turn generated the controversial new LHI policy, with the latter completely lacking the clarity and simplicity associated with the modified interswitching policy.

In evaluating the merits of a viable reciprocal switching/interswitching policy, the regulatory body needs to establish fair and acceptable compensation for the host railroad to move interswitched traffic to the appropriate switching point. The argument here is that even with economies of scale, moving a unit train several miles in one direction costs less on a per unit basis than moving the same unit train upwards of 100 miles. While accurate costing data is not readily available for comparison, it is possible that in Canada under the revised interswitching regulations, the rates imposed on longer hauls may not have been compensatory to the switching railway.

With respect to the potential for reciprocal switching in the U.S. rail system, identifying appropriate regulated rates is ultimately a question that will need to be addressed if reciprocal switching is to move forward. As a start, the reader may refer back to the prior discussion on both costing and Ramsey pricing to gain some context for setting economically sound regulated rates on individual rail movements. Interestingly, reciprocal switching may already have a more solid analytical foundation in the U.S. than existed in Canada. Under the current regulatory regime, there may be improved transparency in setting Ramsey prices for reciprocal switching. Aside from demand considerations, we offer that reciprocal switching rates could initially be developed either with the help of URCS or alternatively generated using comparable rates (Wilson and Wolak, 2016) contained in the U.S. waybill data.

5. The Role of Railroad Revenues in Regulation – United States and Canada

Modern railroads face an interesting investment dilemma. They are very capital intensive—a product of their ownership of expensive rights-of-way, locomotives, and freight cars—but even today hold a distinct efficiency advantage over other land-based modes of long-distance surface transportation. Yet in some of these markets, there may be other forms of viable intermodal competition available, such as barge or trucking. Such factors affect a railroads ability to earn revenue and stay in business. As discussed, the task of a regulator is a difficult one—ensure the sustainability of the industry by enabling carriers to earn sufficient revenue to recover their fixed costs, while also protecting shippers from abuses of market power.

5.1. A Brief Look at Rail Revenue Regulation in the United States

The STB is entrusted with protecting railroads' ability to earn adequate revenue to make capital investments, cover operating expenses, and provide a reasonable return on capital.[30] To this end, the STB, and ICC before it, has long applied a concept known as "revenue adequacy," a term as defined by the STB where a railroad earns operating income (revenues minus operating costs) resulting in a return on invested capital at least as great as its cost of capital. The STB determines the railroad industry's cost of capital (ranging from 9 to 12 percent from 2000 to 2017, see STB, 2019c) and then compares the rates of return earned on invested capital by each railroad to this figure. By the mid-2010's, most of the Class I railroads were judged by the STB to be "revenue adequate" by this standard.

Revenue adequacy is a measure founded upon financial statements, but it is less clear what this condition implies for railroad rate setting across various markets. There has been limited research on this topic but work by Friedlaender (1992) attempted to gain more insight into this link. She sought to determine how a single railroad would set differential rates in a situation where it moves a single good from a captive market, along with other goods shipped within more competitive markets. As part of this study, she found many railroads at that time operated at increasing returns to scale (using data from 1974-1986). That was important, because due to the latter, she found strong potential for railroads under these conditions to charge rates well in excess of marginal cost (even in the so-called competitive markets) in order to maintain operations (i.e. achieve revenue adequacy) in the short run. Rate setting ability or flexibility depended upon returns to scale and the captive share of total traffic in the overall traffic mix.

With respect to procedure, it is also unclear how the STB balances revenue adequacy with rate protections for shippers. As discussed in the next subsection, Canada implements an explicit cap on the revenue railroads can earn in the grain transportation market, known as the Maximum Revenue Entitlement or MRE. In the United States, no such special regulatory treatment exists for

[30] Formally, according to 49 U.S. Code § 10704, "The Board shall maintain and revise as necessary standards and procedures for establishing revenue levels for rail carriers providing transportation subject to its jurisdiction under this part that are adequate, under honest, economical, and efficient management, for the infrastructure and investment needed to meet the present and future demand for rail services and to cover total operating expenses, including depreciation and obsolescence, plus a reasonable and economic profit or return (or both) on capital employed in the business.

grain shippers. The specificity of the MRE policy stands in stark contrast to the regulatory oversight of grain transportation in the United States. As the National Farmers Union (2015) noted, at present the only protection for grain shippers against unreasonable rates is to bring a formal rate complaint to the STB. In theory—per the "constrained market pricing" principles set through ICC's *Coal Rate Guidelines* (discussed in Section 4)—a shipper could bring a rate case against any one of the listed constraints, meaning the "revenue adequacy constraint," the "management efficiency constraint," or the "stand-alone cost constraint." However, procedures for bringing such cases have only been clarified with respect to the stand-alone cost constraint.

In a 2014 decision announcing a hearing to look at issues pertaining to revenue adequacy, the STB wrote: "The Board has not yet had the opportunity to address how the revenue adequacy constraint would work in practice in large rail rate cases. Nearly all large rate reasonableness cases to date have relied upon the stand-alone cost constraint. The few revenue adequacy-based complaints have either settled or involved other transportation modes." In a subsequent paper examining linkages between revenue adequacy and constrained market pricing, McCullough (2016) identified four unresolved procedural questions on behalf of the STB. Namely:

- Does the STB's revenue adequacy measure define a lower bound (floor) or an upper bound (ceiling) for the revenues of Class I freight railroads?
- Are the revenue adequacy constraint and the stand-alone cost constraint described in the [Coal Rate] Guidelines mutually exclusive procedural alternatives, or can they be applied jointly in an STB rate reasonableness proceeding?
- Do the simplified procedures that the STB has adopted since the Guidelines provide reasonable alternatives to full SAC proceedings in cases where the defendant railroad is not revenue adequate?
- Should SAC-based rate regulation be abandoned in cases where a defendant railroad is revenue adequate and instead replaced by a revenue adequacy-based procedure?

In December 2019, the STB (2019e) held another hearing on revenue adequacy to address these issues as raised in its Rate Reform Task Force report (STB, 2019b). These concerns partially overlap with the questions raised by McCullough. For this hearing, STB sought input on elements, such the possibility of defining a "long-term" revenue adequacy measure as well as implementing a "rate increase constraint." The latter would effectively define a line beyond which long-term revenue adequate railroads would not be allowed to expand differential pricing practices.

5.2. Rail Revenue Regulation in Canada

Historically, the notion of revenue adequacy has not been a part of Canadian regulatory policy in rail. This is likely due to the long-standing involvement of government in railroad ownership of Canadian National Railway (which was eventually privatized in 1995), so there was no historical need to worry about profitability and survival. Due to this, long standing regulations on grain rates also included subsidies to both Class I railways to maintain their operations.

In effect, Canadian transportation policy has evolved multiple avenues through which protection is offered to shippers. One policy—Maximum Revenue Entitlement or MRE—is specific to the transportation of Western grain while others apply more broadly to all types of shippers. Formal shipper protection in the United States is similarly broad in nature but with most of the current protections focused on some form of costing. Both countries share similarities in the level of service of obligations on the railways due to both countries relying on the common principal of railroads being subject to common carrier obligations (CPCS, 2015).

While both countries have moved towards giving greater freedom for railways to set freight rates in almost all markets at their own discretion, Canada maintains unique protection for shippers of Western Canadian grains through the so-called Maximum Revenue Entitlement (MRE). As Padova (2015) describes, the MRE was implemented to provide grain shippers rate protection while also allowing the railways some freedom to set those rates. To this end, the MRE formula establishes an average rate cap on grain movement applicable for each year. The formula accounts for various input cost factors such as input price inflation, as well as total tons of grain moved and the average distance of those movements (see Appendix B for more on how MRE is calculated). Under the policy, railways are permitted to differentially price between grain shippers, so long as the total revenue they collect moving grain in a given year falls below the maximum allowable amount as determined through the formula. Should a railway earn revenues greater than the maximum allowable amount, a monetary penalty is administered.

When the MRE was first implemented, it was intended to only serve as a short-term measure (Pratte et al., 2015). Expectations among industry participants were that following a regularly scheduled review of transportation policy, the measure would be removed as the grain supply chain would move towards a more commercialized pricing structure. Also expected was that increased pricing freedoms for the railways would generate increased competition between them and encourage greater system efficiencies. The latter should have resulted in lower rates and negate the ultimate need for the MRE (Pratte et al., 2015; Monteiro and Robinson, 2011).

This was not to be. MRE data from the Canadian Transportation Agency (2016a) shows that while Canadian National in particular collected total grain revenues that were substantially less than their maximum allowable MRE level up to the fourth year following the introduction of the MRE, in fact both railways quickly adapted their pricing strategies to squeeze out grain revenues that were remarkable close to their allowable amount each year (see Table 2 below). Thus, despite what policymakers had hoped for, the MRE did not result in efficiency gains being passed on to shippers nor did rail competition drop average rates below MRE capped levels. Despite this, for the most part, grain shippers seem accepting of the average rate protection offered by cap computation. Due to the latter and even considering many modifications to other industry regulations, the MRE has been retained as a key component of grain transportation regulation in Canada.

The first major criteria that an MRE eligible shipment must meet is that it be the carriage of grain from any point west of Thunder Bay or Armstrong, Ontario destined either for one of Canada's major export ports in British Columbia, or alternatively to Thunder Bay or Armstrong, Ontario. However, a major exclusion is that any grain that is destined for consumption in the United States that is shipped through ports in British Columbia is not counted under the MRE (Canadian

Transportation Agency, 2011). Likewise, any exports that are shipped across the Western Canadian border to the United States directly by rail are not included. In addition, rail shipments originating in Western Canada that are destined for another Western Canadian location, besides the ports of export in British Columbia, are also excluded from the MRE.

Only grain moved by either CN or CP is counted under the MRE. And while the MRE only applies to shipments over Western Canada track, it is not necessary for a shipment to have originated in Western Canada. Specifically, should an American grain shipper route their movement through Canada for export from a port in British Columbia or through Thunder Bay or Armstrong, Ontario, only the segment of the shipment that occurred within Western Canada would fall under the MRE. The portion of the movement that occurred within the United States would not be subject to the MRE, even if it was carried by CN or CP. Figure 13 illustrates selected movements for which the MRE policy applies.

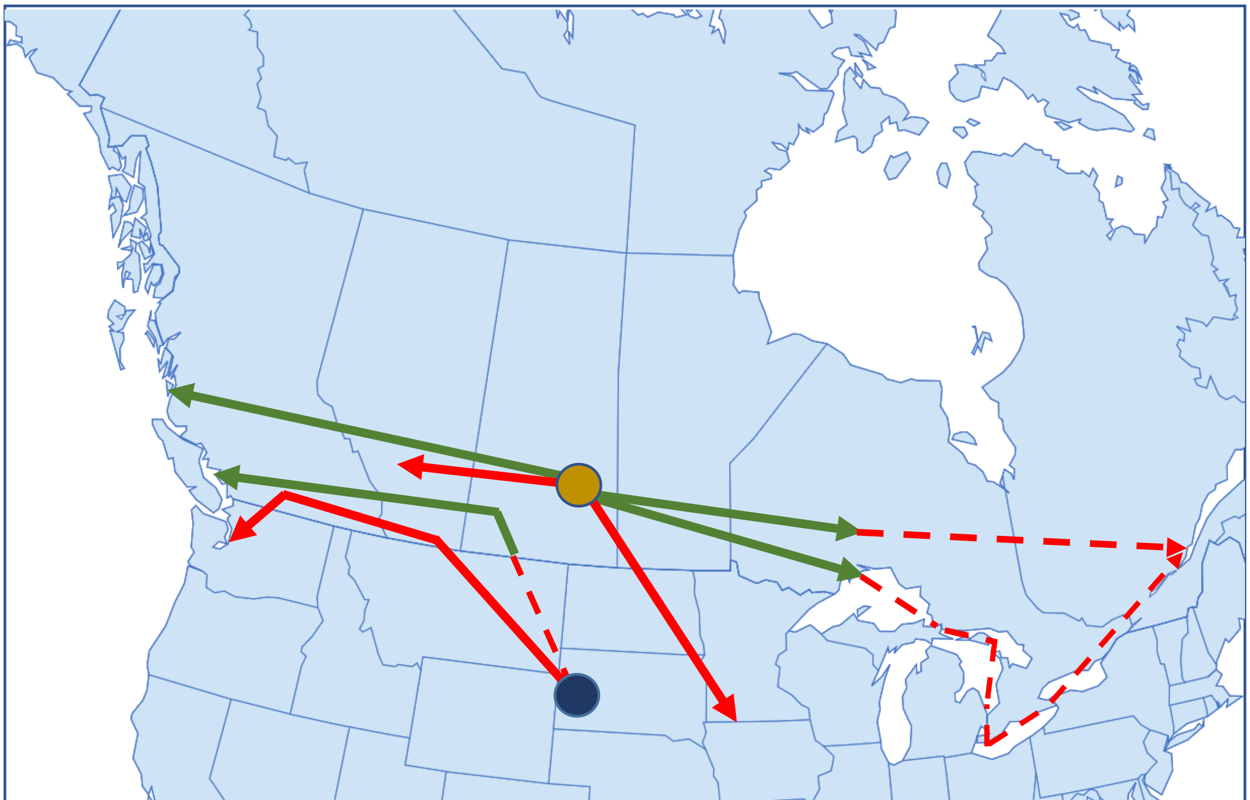

Figure 13: MRE applicability to grain movements

Adapted from: Canadian Transportation Agency (2011)

Under the current *Canada Transportation Act*, the MRE applies to the movement of all commodities under the Schedule II of the Act. Schedule II lists 58 different agricultural commodities that fall under the MRE, ranging from dehydrated alfalfa pellets, wheat, and canola oil (Government of Canada, 2018b). While most of the major Prairie export crops are included under the MRE, two notable exceptions to the schedule are soybeans and chickpeas. Additionally, while the MRE applies to field crops and field crop products, it does not include other types of agricultural commodities such as vegetables and fruits (AAFC, 2017). It should also be noted that in its current iteration, the MRE does not discern the type of railcar transporting the grain.

The Canadian Transportation Agency has also ruled on whether other idiosyncratic factors need to be included or excluded in the determination of the railways' MRE revenue calculations. Several other revenue sources are included in the calculation of a railway's MRE besides the revenue earned from transporting grains under contract or tariff rates. Included are grain related revenues earned for providing premium service, for ensuring car supply, for car hire, and for additional switching that is requested by the shipper. Conversely, performance penalties levied against shippers who fail to meet contractual obligations, rail car demurrage charges paid by shippers, and running rights compensation paid by other railways are all revenue sources that are not included in a railway's MRE determination (Canadian Transportation Agency, 2001).

Conversely, railroad expenses that reduce the balance of a railway's revenue counted under the MRE include railway contributions towards grain-related facilities, as well as amounts paid by the railway to another railway for interswitching. However, the Canadian Transportation Agency (2001) also lists several items that are not eligible to reduce a railway's revenues including penalties paid to shippers for poor railway performance as well as any amounts paid by the railways to shippers in return for the expedited unloading or loading of cars prior to the expiry of the agreed upon loading/unloading period.

The CTA must provide CN and CP with determinations of their maximum allowable revenues within 5 months of the end of a given crop year. In the event that the CTA determines that the revenue collected by a railway in a given crop year exceeds its maximum allowable amount under the MRE, the railway must pay back excess revenue it collected, in addition to a fine (Canadian Transportation Agency, 2001b). If the amount by which a railway exceeds its revenue limit is one percent or less of its total maximum allowable revenue, the penalty is five percent of the overage amount. But if overage is greater than one percent of the railway's maximum allowable revenue, the railway pays a penalty equal to 15 percent of the overage (Canadian Transportation Agency, 2001b).

Table 2: Historical MRE revenues – CN & CP

Year	% Over/Under MRE - CN	CN Penalty + Overage	% Over/Under MRE - CP	CP Penalty + Overage
Jan-00	-0.8	-	-0.7	-
Feb-01	-4.6	-	-3.0	-
Mar-02	-9.0	-	-2.8	-
Apr-03	-0.4	-	0.1	$338,008
May-04	0.04	$124,650	-0.2	-
Jun-05	0.7	$2,713,251	0.2	$699,529
Jul-06	-0.6	-	0.8	$3,532,821
Aug-07	6.3	$27,948,999	9	$38,671,234
Sep-08	0.1	$717,432	-0.2	-
Oct-09	-0.8	-	-0.4	-
Nov-10	-0.2	-	0.3	$1,314,636
Dec-11	0.04	$252,194	0.1	$420,139
2012/13	-1.1	-	0.03	$186,859
2013/14	0.7	$5,231,011	-0.3	-
2014/15	0.9	$7,209,925	0.3	$2,244,026
2015/16	0.2	$1,094,009	0.5	$3,555,807
2016/17	0.7	$6,062,428	0.1	$1,132,894
TOTAL		**$51,353,899**		**$52,095,953**

Adapted From: Canadian Transportation Agency (2016a)

As Table 2 shows, over most of the history of the MRE, the railways have managed to charge within one percent of their revenue entitlements. While the combined C$100 million in penalties and overage that the railways have paid over the course of the MRE policy might seem like a substantial figure, this must be considered in context. Over the course of the MRE, the two railways have moved over C$16 billion worth of MRE-eligible grain movements (Canadian Transportation Agency, 2016a). The C$103 million in overage and penalties that the railways have been required to pay back is just 0.6 percent of the total MRE capped revenue that has been earned during the policy. Furthermore, it is a testament to the logistical expertise of both railways that, excluding the 2007-2008 crop year when an adjustment was made by the CTA in the determination of the allowable revenues, they have been within 1.1 percent or less of their MRE amounts every year since 2003 (Canadian Transportation Agency, 2016a). This, despite the fact that demand for rail service from grain shippers has varied widely across this period, with a low of just 24.3 million tonnes moved by both railways in the 2004-2005 crop year to a high of nearly 43.2 million tonnes moved in the 2016-2017 crop year (Canadian Transportation Agency, 2016a).

The MRE policy has created a set of specific incentives for railways with respect to moving grain in Western Canada. In particular, they have learned how to forecast their MRE to within remarkable levels of accuracy given the dynamic nature of the industry. Given the importance of parameters in the formula, anecdotally the railways still lobby heavily over the setting of the VRCPI every year.

With respect to costing, there have been system savings driven by the cost focused structure of the MRE, but it is unclear to what degree shippers have benefitted. It has been approximately estimated that the average cost per tonne to move grain now sits at between $12 to $15 per tonne, down from about $18-$20 per tonne when the MRE formula was initially determined (Carlson and Nolan, 2005). However, MRE rates have risen gradually while transportation costs have fallen, meaning that the railways are internalizing most of the industry productivity gains. And as might be expected with the imposition of a revenue limitation on a commodity group within a multi-product firm, there have been several notable service level complaints with grain movement that have cropped up from time to time among the two Class I railroads. One of these slowdowns was significant enough that the Federal government intervened with special short-term legislation to force Canadian railways to move more grain for export (Brewin et al., 2017).

6. Two Countries, Proximate Markets: Comparative Metrics

We have seen how the two countries freight rail sectors are very similar yet very different. Aside from market power and shipper concerns, how do these regulatory differences affect operational performance between the two countries? This section illustrates several high-level metrics describing both Canadian and U.S. freight railway systems, including freight movements, rates, and overall operational performance. The first two subsections discuss cross-border movements and compare rail rates over similar traffic, respectively. These are followed by a comparison of rail service in each country and a look at grain car ownership and usage. Additional comparative metrics, such as fuel consumption, labor, and financial metrics, are included in Appendix C.

6.1. Grain Moving Across the Border[31]

With the demise of the Canadian Wheat Board in Canada in 2012, cross-border grain transportation from Canada into the U.S. became possible. In spite of this on-going opportunity, the cross-border grain market is still not significant as part of the overall grain transportation picture in North America. Since 2012, the grain products most frequently moved from Canada into the U.S. have been canola, wheat and oats. There have been slight fluctuations in quarterly volumes, but the amount of grain flowing from Canada into the U.S. has remained roughly the same.

Although trans-border grain transportation occupied about 20 percent of the domestic (non-export) capacity of Canadian Class I carriers, only 4 percent of Class I capacity was used for Canadian imported grains, while this ratio dropped to 2 percent for wheat. As a result, the cross-border movement of Canadian grains, especially wheat, had only a minor impact on the grain transportation market.

6.2. Comparative Grain Rates

While operational efficiencies are important, from a shipper perspective, freight rates are the foundation for all transactions. Historically, and due to its importance to the development and growth of Western Canada, grain movement in Canada has been regulated differently from all other commodities. For the U.S. rail sector, grain is just another commodity, but serving this sector has led to some novel marketing innovations, such as the long-standing (grain) car auction mechanism, started by the Burlington Northern (later BNSF) in the late 1980's (Wilson, 1989). While a boon to allocative efficiency for railroads, car auctions remain controversial and have been blamed for excessive grain rates, especially in the Great Plains region (Pautsch, 1995).

Due to these differences, there have been very few prior studies examining similar grain movements and rates on both sides of the border. One small-scale exception is that of Eley et al. (1996) who examined a very limited set of comparable grain movements, as well as the 2001 report by Park and Koo, which broadly compared the two grain handling systems (Park and Koo, 2001). The latter does some comparative cost discussions but avoids direct rate comparisons. With significant changes (i.e. the removal of the CWB) in the Canadian grain handling system now well established, we believe that comparative grain rates ought to be analyzed on a more frequent basis as the two grain transportation systems now can effectively encroach to some extent into each other's traditional operating areas. The following presents a basic comparative rate analysis using

[31] Tables containing more data for transborder grain movements can be found in Tables D13 to D15 in Appendix D.

available data, which highlights the ongoing rate differences in export grain shipments from the Western grain producing regions of both countries.

U.S. rates for grain movement were extracted from the Surface Transportation Board's confidential carload waybill sample. Since the Canadian railroads are regulated by the MRE, Canadian tariffs are public information and the rate sample was compiled by Quorum Corp. In order to render grain movements across the two countries comparable, the following criteria were used:

(1) Data only include Class I carriers.

(2) The grain transported is wheat.

(3) In Canada, the export destination is Vancouver, while in the U.S., the destination is either in Washington or Oregon, to capture the major U.S. wheat-export region of the Pacific Northwest.

(4) In Canada, the movement originates in either Saskatchewan, Manitoba, or Alberta. In the U.S., the comparable origin falls in one of North Dakota, Montana, South Dakota, Idaho, Washington, Oregon, or Wyoming.

(5) Rates are developed as "revenue per ton-mile" for shipments originating in (4) and terminating in (3). They are then averaged by quarter over time.

Following these criteria, we identified 827 O-D pairs for comparison, spanning 2005 to 2015. This time series of O-D grain rate comparisons is plotted in Figure 14.

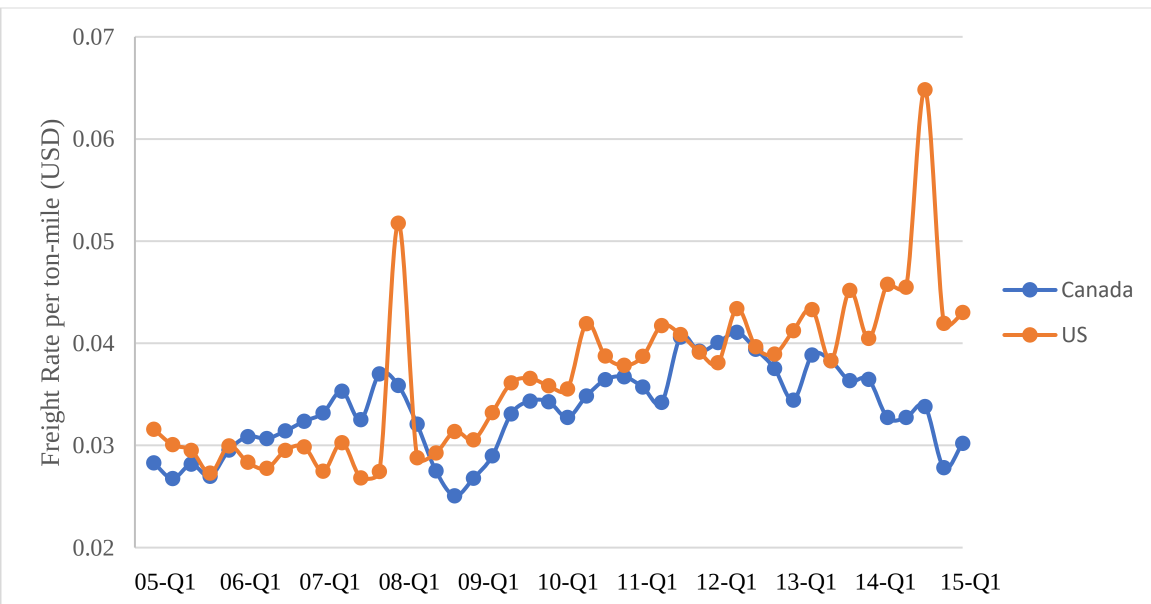

Figure 14: Rail rate (wheat) comparison, U.S. and Canada

Source: Author calculation based on the confidential Carload Waybill Sample of STB and Quorum (2005-2015).

From 2005 through 2008, Canadian regulated grain rates at times were greater than similar U.S. rates. However, since 2008, comparable Canadian rates for wheat remained consistently lower than U.S. rates, and further the U.S. market experienced more volatile rate changes over time. Given the extant regulatory structure on these rail movements in both markets, these differences are surely attributable to the revenue regulations active in Canada on grain movement. The widening rate differential that began in 2014 probably also reflects U.S. rail capacity constraints on grain movement during this time. It is worth noting that while there was a similar situation occurring in Canada, the regulated rates used at that time do not reflect limited capacity.

Overall, the Canadian wheat rate over this sample was 2.14 cents per ton-mile less than the comparable U.S. rate, translating to a 5 percent discount. While the U.S. wheat rate per ton-mile is slightly higher, the standard deviation (per quarter) of the U.S. rate is 0.77 percent, or 84 percent higher than in Canada (0.42 percent). So, as expected, the MRE-regulated Canadian rate regime produced lower and more predictable wheat rates over the duration of the sample.

6.3. Comparative Operational Performance

This section compares rail service between the two countries using available metrics, such as train speeds and dwell times.

On average Canadian trains travel three miles per hour slower than U.S. trains, but U.S. trains spend additional hours (fifteen on average) dwelling at terminals or transhipment points. This distinction is likely due to distances and topology differences between the respective rail and delivery points networks in each country. As mentioned, the Canadian rail system is much sparser than the U.S. and mostly linear, while the U.S. is more planar, dense, and multi-directional.

As shown in Figure 15, typically there are about 5 times more rail cars operating in the U.S. than in Canada. On its face, this result is not surprising; the U.S. moves significantly more traffic. The orange line attempts to take scale differences into account, by reflecting the percentage difference in freight ton-miles between U.S. and Canadian Class I carriers. From 2007 to 2012, the U.S. had, on average, 591 percent more ton-miles than Canada (the orange line). Effectively, this means, when macro level performance data is compared, measures falling below the orange baseline indicate an advantage for the U.S. rail sector, and vice versa.

Initially, the U.S. railroad sector seems to outperform its Canadian peers since it moves a greater volume of freight using comparatively fewer cars (the difference in total car numbers is 495 percent but the difference in freight is 591 percent). In turn, there is relatively more wheat being transported in Canada due to differences in the grain supply chain. Overall, Canadian railroads consume comparatively less fuel but use more employees. The latter is likely due to differences in average haul distance as well as labor market differences across the two countries.

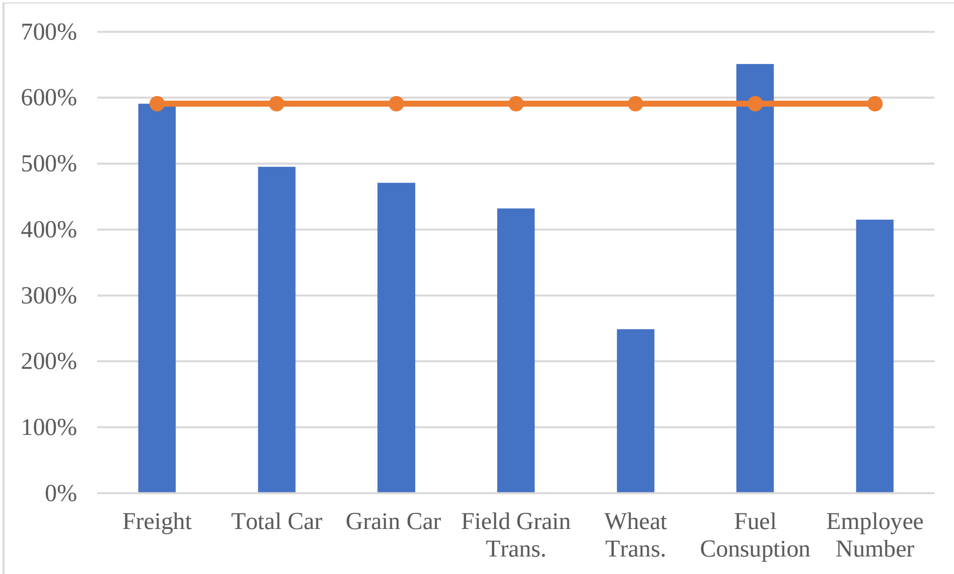

Figure 15: Operational and Performance Comparison between Canadian and US Class I Carriers: Aggregate Indicators

Note:

1. Data sources for tables and figures in the following sections are listed with each table and figure.
2. The difference of each indicator is calculated as:

$$\%\text{difference} = \frac{\text{Value of U.S. Railway} - \text{Value of Canadian Railway}}{\text{Value of Canadian Railway}}$$

Figure 16 shows comparative micro level indicators of performance and costs between various railways. Although the train speeds in the U.S. are about 16 percent faster than their Canadian counterparts, it seems U.S. trains spend about 200 percent more time sitting in yards or terminals. Fuel costs in the U.S. are cheaper per mile than in Canada, and U.S. railroad workers tend to work marginally more time (7 percent) than their Canadian peers but get compensated with a slightly higher hourly wage.

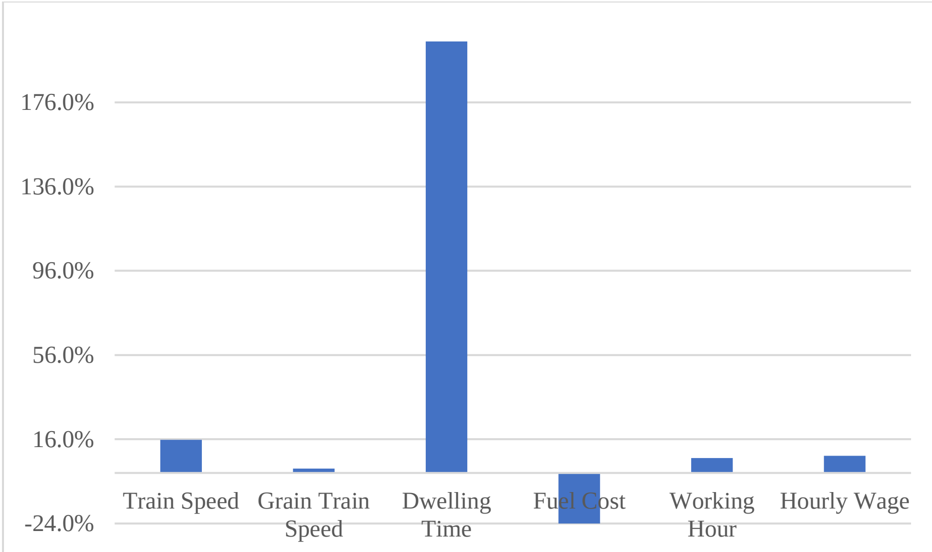

Figure 16: Operational and Performance Comparison between Canadian and U.S. Class I Carriers: Per Route and Per Person Indicators

Note:

1. Data sources for tables and figures in the following sections are listed with each table and figure.
2. The difference of each indicator is calculated as:

$$\%\text{difference} = \frac{\text{Value of U.S. Railway} - \text{Value of Canadian Railway}}{\text{Value of Canadian Railway}}$$

For a transportation business, one important proxy of efficiency is the speed or velocity at which it moves. Examining Figures 17 and 18 showing train velocities, we observe that since 2017 for both grain trains as well as all types of freight, U.S. railroads travel faster than Canadian railroads. U.S. trains average 15 to 20 percent higher speed, or about 3 mph greater velocity. Even more interesting is that the velocities of CN and CP, which operate in both countries, are greater on their respective U.S. based infrastructure. For comparison, the average overall velocity of Canadian railway subsidiaries is 24.1 mph, but in Canada, their average speed is only 19.2 mph. These differences are likely a product of slightly older track infrastructure in Canada, coupled with the typically and consistently harsher weather north of the border.

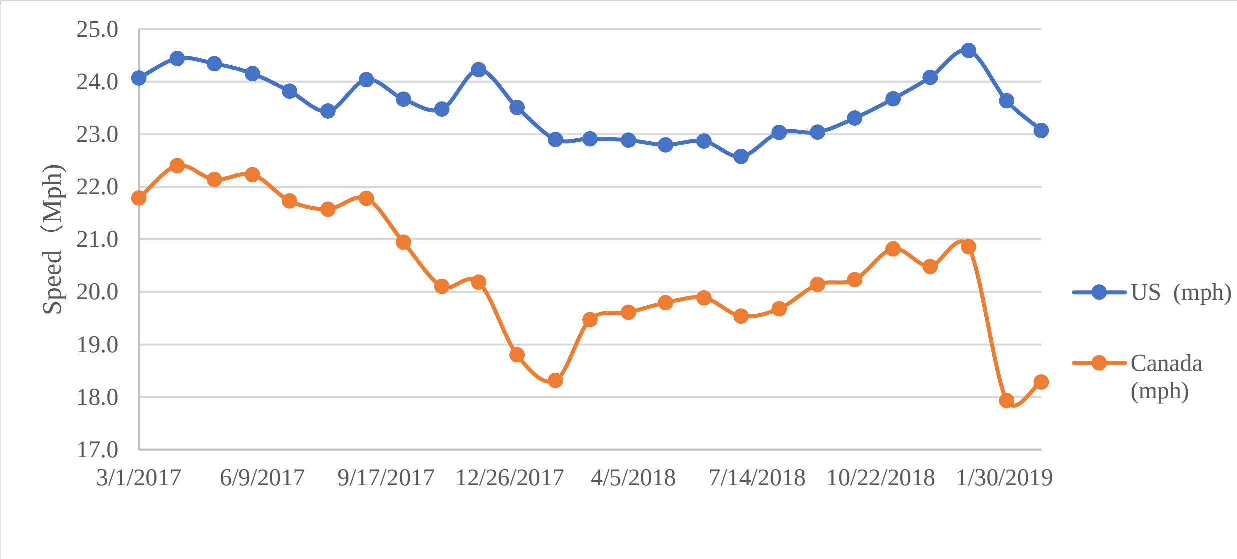

Figure 17: Overall train velocity, U.S. and Canada

Source: Authors' Calculation based on CN Weekly Metrics (https://www.cn.ca/en/investors/key-weekly-metrics/), CP Key Metrics (https://investor.cpr.ca/key-metrics/default.aspx), and Railway Performance Measures (http://www.railroadpm.org/).

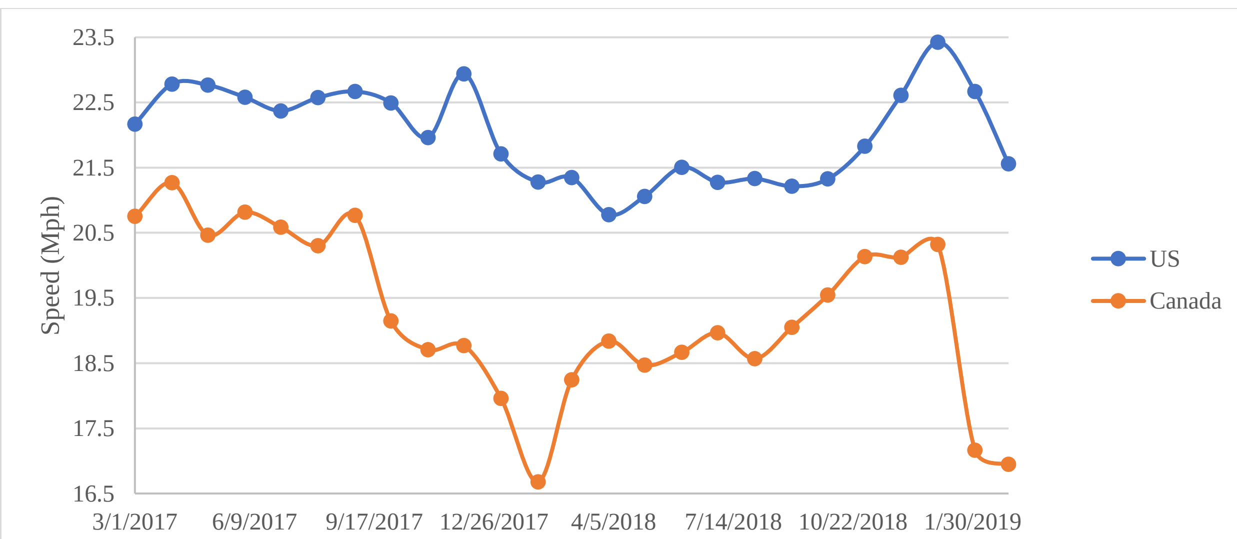

Figure 18: Overall grain train velocity, U.S. and Canada

Source: Authors' Calculation based on CN Weekly Metrics (https://www.cn.ca/en/investors/key-weekly-metrics/), CP Key Metrics (https://investor.cpr.ca/key-metrics/default.aspx), and Railway Performance Measures (http://www.railroadpm.org/).

Specifically, for grain trains operating in the U.S., their velocity is on average almost three mph (2.76) faster than in Canada. In addition, strong seasonal effects show up in Canadian railway velocities (Table 2). On average, the velocity of Canadian-based trains falls by about 1 mph in the first quarter. Conversely and perhaps not surprisingly, given the vast rail infrastructure across the U.S., we find no significant average velocity change in U.S. trains over winter months.

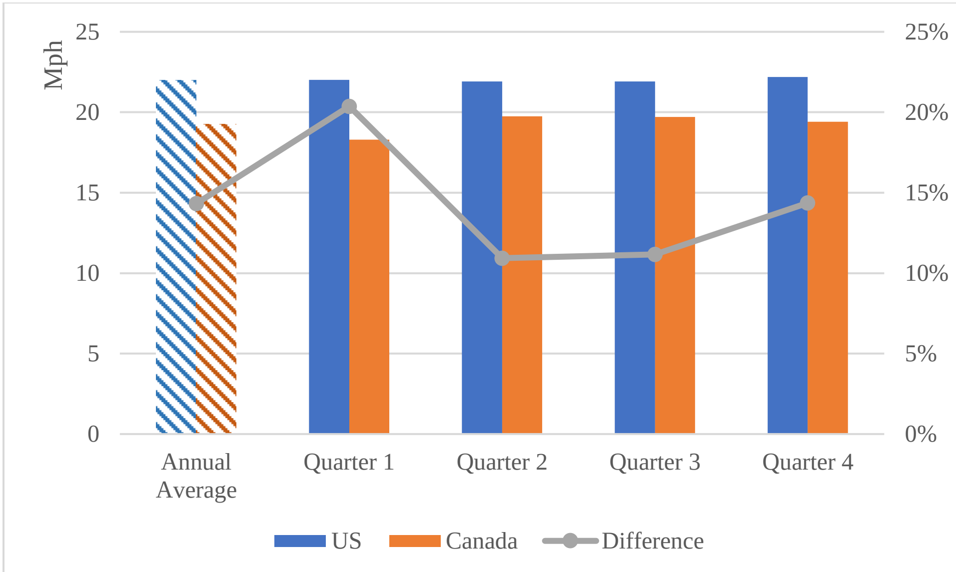

Figure 19: Seasonal Effects on Railway Velocity

Source: Authors' calculation based on CN Weekly Metrics (https://www.cn.ca/en/investors/key-weekly-metrics/), CP Key Metrics (https://investor.cpr.ca/key-metrics/default.aspx), and Railway Performance Measures (http://www.railroadpm.org/).

Although trains operating in the U.S. are faster on average (Figure 20), they spend 210 percent more time per trip relative to equivalent trips in Canada. This difference translates to approximately an average of about 15 hours per trip spent not moving or waiting, either on sidings or at terminal stations. Considering dwell time along with relative velocities, we observe that if a rail trip distance is less than 400 miles, the trip actually takes less time in Canada because of U.S. dwell times. We conclude that Canadian rail appears to be slightly more efficient on shorter trips, while U.S. rail is slightly more efficient on longer trips. Additional data on this metric can be found in Appendix D.

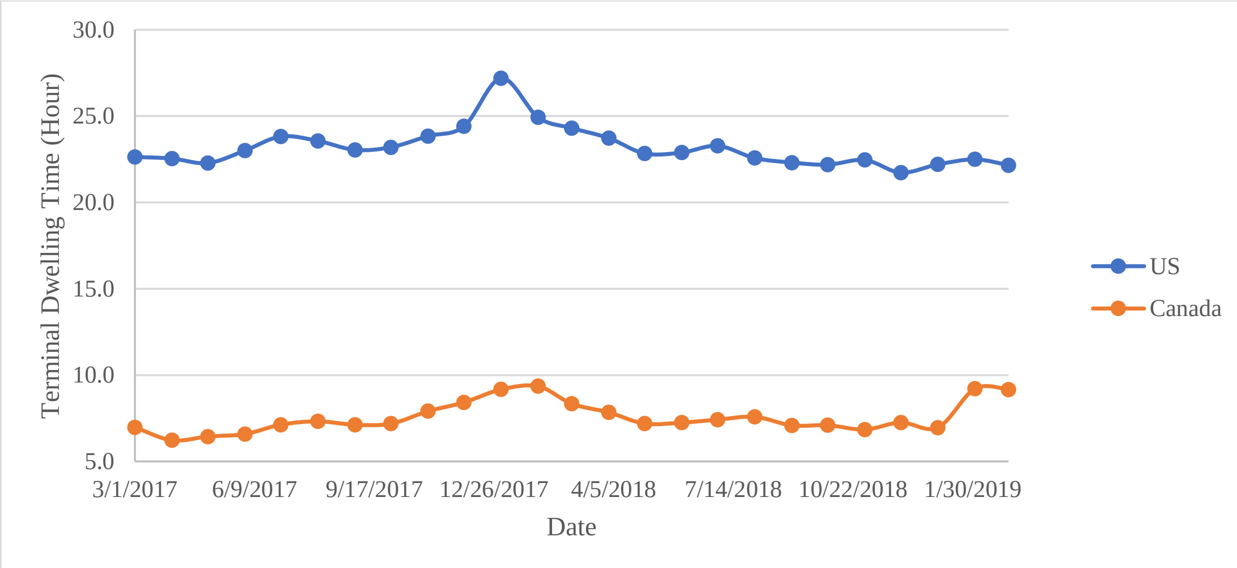

Figure 20: Average (Terminal) Dwell Time

Source: Authors' Calculation based on CN Weekly Metrics (https://www.cn.ca/en/investors/key-weekly-metrics/), CP Key Metrics (https://investor.cpr.ca/key-metrics/default.aspx), and Railway Performance Measures (http://www.railroadpm.org/).

6.4. Differences in Grain Car Ownership and Use

Due to property rights and the efficiency incentives that might manifest in moving infrastructure that is not owned, it is worth noting some of the car ownership differences that distinguish the two countries and, in particular, the grain sector. In Canada, as a legacy of the long-standing operations of the Canadian Wheat Board, a significant proportion of grain cars are still government-owned (about 25 percent), and it is projected that this part of the fleet will be unserviceable by 2035 (Cross, 2015). This means over the current planning horizon, grain cars in Canada will continuously need replacement. For years, the railways maintained that the Canadian regulations on grain transportation (in the form of the MRE) restricted their incentives to make capital investments in grain transportation, including hopper cars. The Canadian Class I's had made limited recent purchases of grain cars in anticipation of this problem, but many expected significant shortages in the next few years without regulatory changes (Cross, 2015). With the passage of Bill C-49 in 2018, this disincentive was changed. Since then, CN and CP have begun to make major investments in their grain car fleet. In the U.S. this situation does not exist as various railways and grain interests own cars in the current hopper fleet. According to the STB's public waybill data (USDA, 2020), about 64 percent of the grain and oilseed tonnage in the U.S. was moved in privately-owned rail cars in 2018, with the remainder moved in railway-owned cars. Incentives to invest in replacement grain hopper cars have not been curtailed by regulation like in Canada.

Considering these issues, we next show all rail cars in use, as well as grain cars in use (Figures 21 and 22) across both countries. Usage patterns remain relatively similar. To be expected, on average there are almost six (5.88) times more rail cars being used in the U.S. Through the months of January, March, May, August, and October, we observe an increase of approximately 1 million cars in the U.S., whereas a similar (smaller scale) increase takes place in Canada through the months of March, June, September, and December, with the latter change adding about one hundred thousand more cars into the system. For grain cars, the observed cyclical effects appear to be similar for both countries, with consistent seasonal demand increases in both the fourth and first quarters.

With respect to infrastructure use for grain movements, we note that Canadian Class I carriers currently use about 20 percent of their overall network capacity to move grain, while U.S. carriers use about 17 percent more of their network capacity to transport. Given the relative topography of grain movement in each country where the vast majority of Canadian moves are increasingly point-to-point within essentially a single linear corridor, while U.S. carriers move and load grain through all points of the compass, it is not surprising that the relative efficiency of Canadian carriers is slightly higher with respect to moving grain than their U.S. peers. Additional data on rail cars for each country can be found in Appendix D.

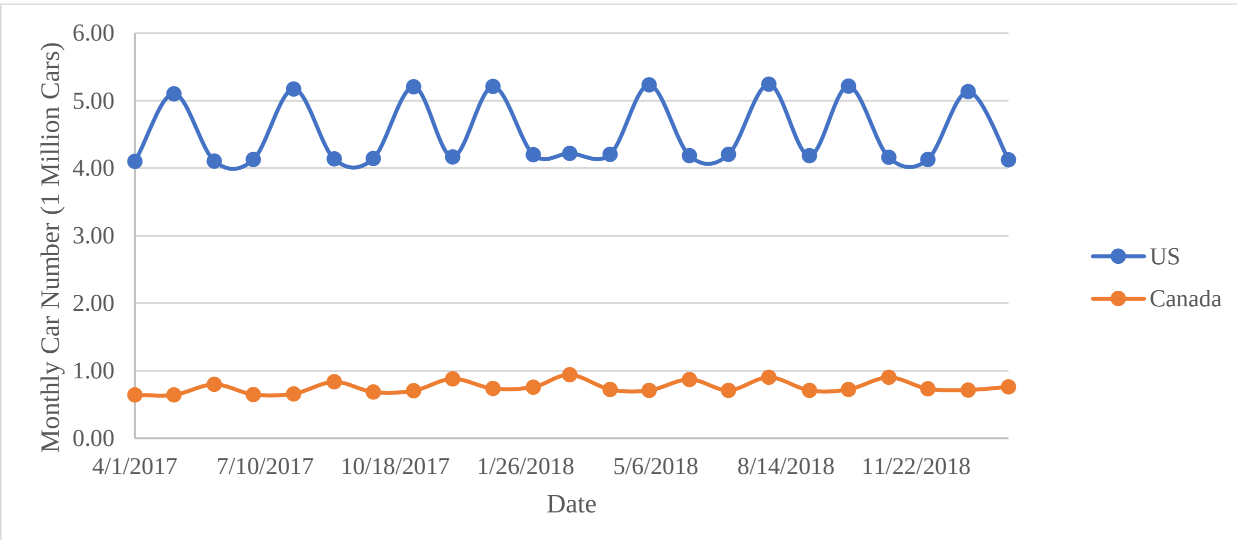

Figure 21: Rail cars in operation

Source: Authors' calculation based on CN Weekly Metrics (https://www.cn.ca/en/investors/key-weekly-metrics/), CP Key Metrics (https://investor.cpr.ca/key-metrics/default.aspx), and Railway Performance Measures (http://www.railroadpm.org/).

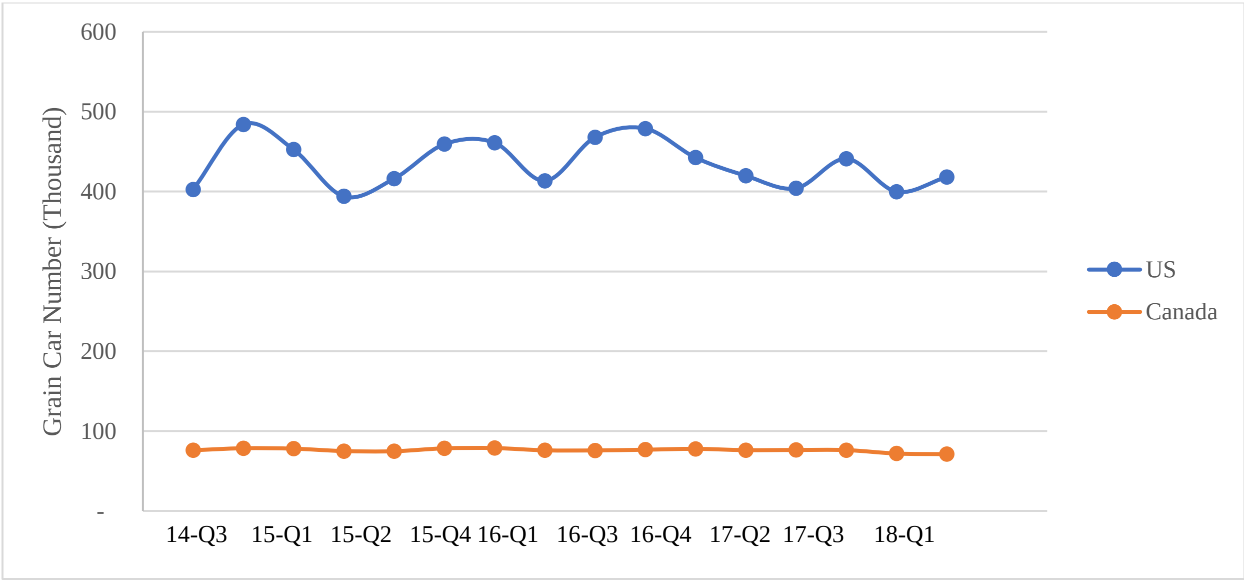

Figure 22: Grain cars in operation

Source: Authors' calculation based on StatsCan Table 23-10-0216-01 Railway carloading statistics, by commodity, by region, monthly; Economic data, Surface Transportation Board (https://www.stb.gov/econdata.nsf/AllData?OpenView)

7. Discussion and Conclusions

As with many aspects of the North American economy, the Canadian and U.S. rail industries are very similar, sharing key inputs like gauge, some service/switching areas, and logistics technology. Yet there are numerous aspects where the two rail industries are distinctly different. In effect, operationally they are similar, but from a regulatory perspective, there remain significant differences.

In the modern (post 1980) era of post-liberalization, what remains of U.S. rail regulation is very broad and not focused on a single commodity. The Surface Transportation Board oversees rail regulation on economic matters and has relied mostly on metrics of uncompetitive behavior on a case by case basis. While in theory there are a variety of market power remedies available under current STB authorization, only one aspect of constrained market pricing—the stand-alone cost constraint—has been used to (in)validate a contested rate.

In Canada, long standing industry regulation coupled with government ownership of a Class I railway (Canadian National) were eventually abandoned in favor of market liberalization (1967) and private rail ownership (1995). Despite this, the transportation of Western Canadian grain has never been fully deregulated. This distinction and associated regulatory tools contribute to some of the major identified differences across the two rail sectors.

What is interesting is that at the current time, both countries seem to be moving towards where they perceive the other country to be sitting with respect to regulation. For example, there remains a renewed push by railways in Canada to remove the MRE on grain movement and effectively deregulate rates in the Canadian grain transportation sector. Simultaneously, with continued complaints by certain commodity shipping groups, there is considerable interest in arbitration as a part of rate review as well as reciprocal switching rules (similar to those available in Canada) as potential alternative approaches to shipper relief beyond the established stand-alone cost methods.

Both Canadian railroads run sizeable operations within the continental U.S. In turn, three of the U.S. Class I railroads have actual track or trackage rights that cross the Canadian border, mostly accessing major Canadian freight markets. From an agricultural transportation perspective, with Canadian grain now able to move freely across the border, from a trade perspective it makes economic sense to move towards harmonizing rail regulations in an increasingly connected market.

What might harmonized North American rail regulations look like? With the conceptual distance that still exists between railroads and shippers, is there a middle ground? Railroads will certainly argue that the extant U.S. regulatory system and particularly the SAC framework and limited scope of interswitching works well for the industry in maintaining market freedoms. Alternatively, shippers in the U.S. seem to be paying more attention to the nuances, onus, and relative simplicity of certain Canadian regulations, especially on grain movement. While it will be very difficult to rationalize regulations specifically applicable to commodities as is currently done with the MRE in Canada, the STB has been gradually moving toward case classifications along with simpler metrics, in particular, to assist smaller shippers who cannot afford to build effective SAC cases.

In this regard, it appears as if some form of FORR/FOA could become the first broadly shared rail regulatory policy in North America since the implementation of the Staggers Act. The policy has long been a part of rail regulation in Canada and has generated much recent interest within the STB. In comparison, it seems doubtful there will be convergence on reciprocal switching in the near-term. Canada has recently undertaken a change to its own policy, replacing the short-lived 160-km rule (applicable only in the Western provinces) with the 1,200-km “long-haul interswitch” (LHI) provision available to all shippers. Ambiguity about this new policy means that as of this writing, no LHI’s have been demanded in Canada. On the other side of the border, reciprocal switching—while still an open topic on STB’s docket—has received little attention since late 2016.

Rail revenue regulation falls somewhere in the middle. On one hand, Canada has an explicit policy capping the revenue railroads can earn on grain traffic. While it seems unlikely the STB would go in such a targeted direction with regulation, as highlighted they continue to explore elements relating to overall railroad revenue with respect to revenue adequacy. In the U.S. it remains unclear whether revenue adequacy refers to a floor or a ceiling, or even how the concept should be considered in rate cases, particularly given it is a component of the STB’s “constrained market pricing” principles, as well as its likely role in potential FORR cases. The extent to which the STB can clarify and reduce uncertainty related to the role and treatment of the revenue adequacy concept in future rail regulation should benefit both shippers and carriers.

Further, this research notes that the Canadian experience with final offer arbitration (FOA) has led to several observations about its effective use, lessons that need to be considered in any future U.S. FORR policy. These are:

(1) As a repeated interaction performed more frequently by individual railways, significant information asymmetry advantages are conferred to the railways over current and future cases. Individual FOA case information has never been made public. Recall that FOA is still not used very frequently in Canada. It is our understanding that one key reason for the lack of use is that individual shippers simply do not possess the vast FOA case experience railways possess and thus they feel at a significant disadvantage in setting up an FOA case. Using the Canadian shipper experience with FOA as a guide, we conclude that detailed information about individual arbitration cases and methods needs to be made public so that railways and shippers alike can learn equally as much about the final offer arbitration/final offer rate review process.

(2) In Canada, FOA arbitrators are chosen in consultation with the litigants from a public list of arbitrators maintained by the CTA. In effect, once an arbitrator(s) is chosen and the information is passed to the arbitrator, FOA cases move out of the Agency’s direct control. While it is still unclear how this subtlety affects FOA decisions in Canada, on the surface it appears to be a situation that could be prone to litigant influence. At this time and if implemented, it looks as if FORR cases will be conducted under the oversight of the STB for the duration of the case. This fact alone is surely an improvement on Canadian methods and should protect against unwanted influence on the arbitrator.

Finally, in formulating viable economic regulation in this unique and mature industry, whether it remains revenue based or instead uses a pricing methodology, establishing reliable firm costing estimates is fundamental (Huneke, 2017). In Canada, there is no public rail costing system, but the

Canadian Transportation Agency maintains a proprietary costing model, in particular to help shippers with FOA cases (CTA, 2015b). In the U.S., with long-standing concerns about the validity and inherent bias of the aged Uniform Rail Costing System (URCS) costing estimates for rate cases, it should be worth the effort for the STB to consider alternative costing models to run both with and against URCS estimates. Sound and fair economic regulation relies heavily on defensible cost estimates. To help keep economic regulation flexible and move the regulatory process into the modern age of computation and big data, the STB needs to embrace modern empirical analytics to analyze railroad market level data, particularly for rates (TRB, 2015). This transition will allow the STB to continually evolve and improve their regulatory solutions in directions as suggested by this comparative analysis.

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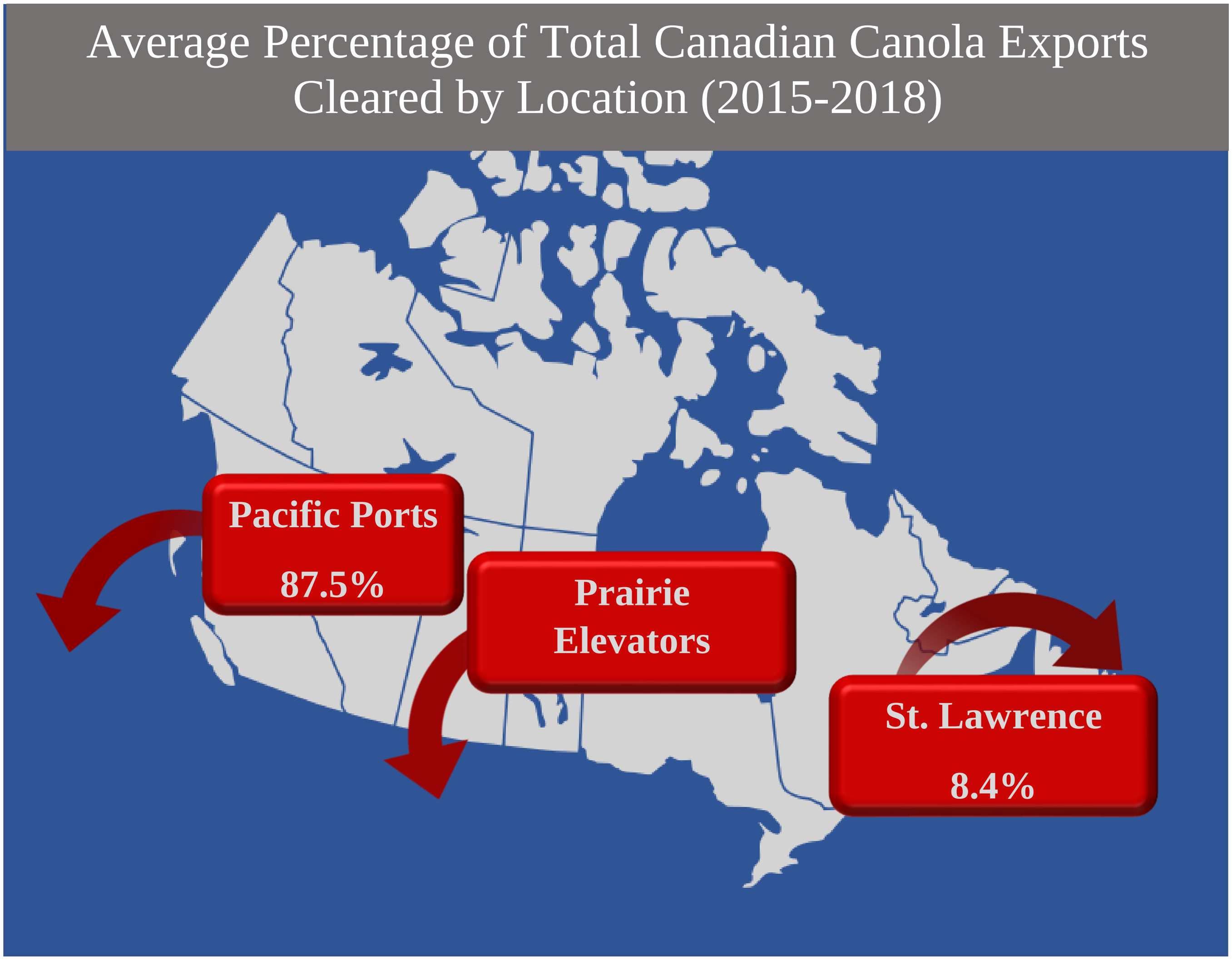
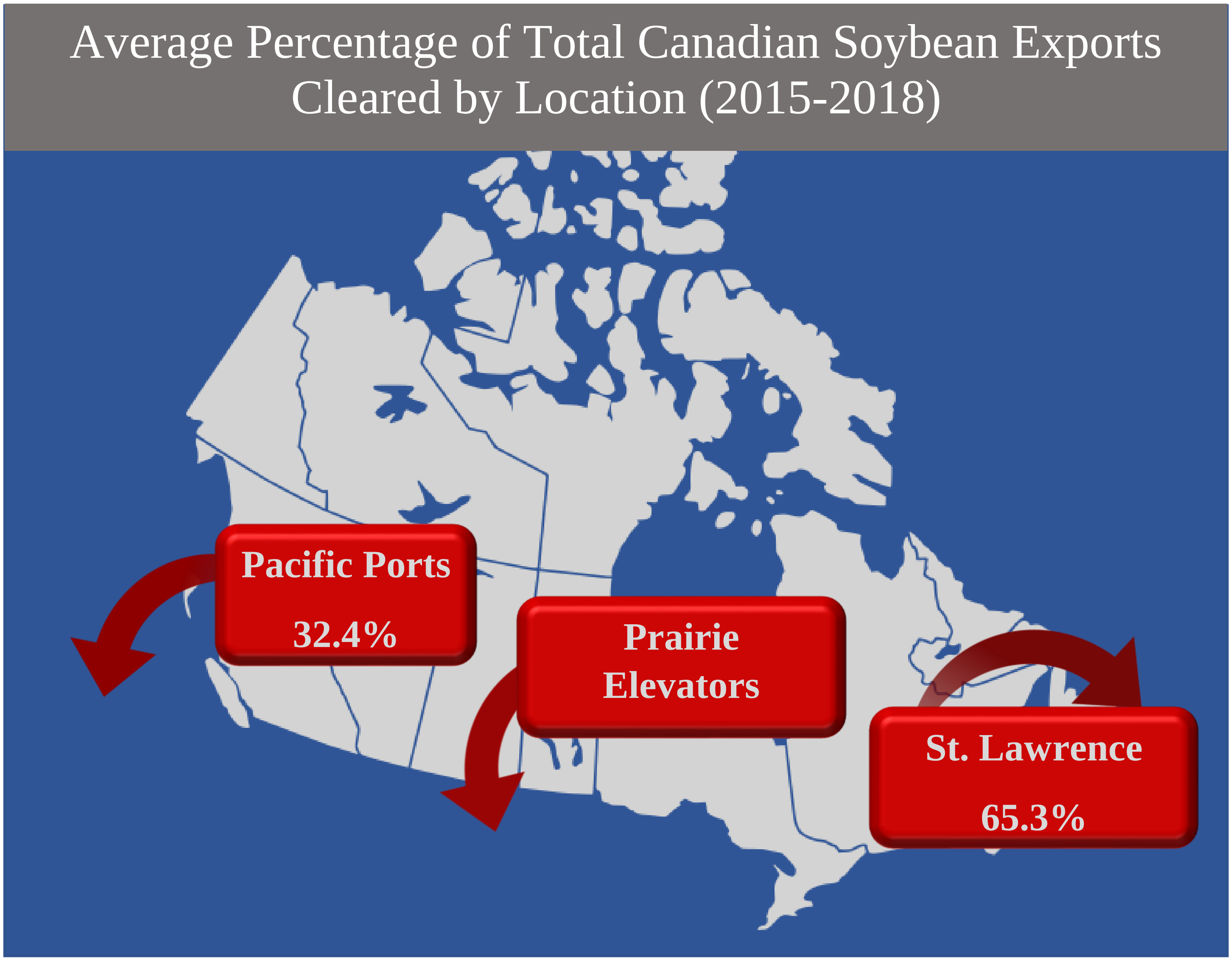
Appendix A: Export Routes for Canadian Grain




Average Percentage of Total Canadian Soybean Exports Cleared by Location (2015-2018)
Pacific Ports
32.4%
Prairie Elevators
St. Lawrence
65.3%

Appendix B: The Maximum Revenue Entitlement Calculation

The MRE formula is as follows:

Maximum Revenue Entitlement = [A/B + ((C - D) × $0.022)] × E × F

where: A = Railway Base Year Grain Movement Revenues
B = Railway Base Year Tonnes of Grain Moved
C = Railway Average Length of Haul in Current Crop Year
D = Railway Average Length of Haul in Base Year
E = Railway Current Crop Year Tonnes of Grain Moved
F = Volume-Related Composite Price Index

(Source: *Canadian Transportation Agency, 2016b*)

Variables within the MRE formula can be divided into two major categories: static base year variables and dynamic variables that are specific to the crop year for which the MRE is being calculated (Pratte et al., 2015). The MRE formula incorporates length of haul and tonnage figures from each railway from 1998 to compute base year figures from which the equation builds off (Pratte et al., 2015). However, the figure that is used as the base year revenue was arrived at through a process that was meant to reflect the productivity gains that the railways had achieved since the last major (1992) railway costing review done in Canada.

As part of previous transportation policy in Canada, railway costing reviews were mandated every four years to ensure that the government was setting the regulated grain transportation rates at appropriate compensatory levels (Canadian Transportation Agency, 1989). Among other major changes, with the privatization of Canadian National, formal rail costing as a regulatory tool was eventually repealed. Since the time gap between the repeal of costing and the determination of the MRE initial parameters was several years, the Federal government was faced with the challenge of determining what should be used as baseline grain revenues for the two railways.

In lieu of another full costing review, an analysis was done to estimate railway costs, revenues, and productivity changes (Pratte, et al, 2015). The Federal government eventually decided on a strategy of using cost levels from the final 1992 costing review, then applied an inflationary factor for each year up to the first full year of MRE implementation (2000). The computed average rates were reduced once more by 18 percent in order to effectively share industry productivity gains with shippers that had been achieved since 1992 (Schulman, 2015). As a result, the MRE legislation was passed with CN's base year revenue being set to C$27.98/ton and CP's set to C$26.12/ton (Schulman, 2015).

Looking at the equation, the average rate per ton in the base year forms its foundation, with the division of base year revenue by tons hauled in the base year. The next component of the formula adjusts for differences in the average length of haul in a given crop year as compared to the base year. This difference in distance is multiplied by $0.022, an adjustment factor that compensates the railway should its average length of haul in a given year be greater than that of the base year. This adjustment factor is a constant that has not changed since the inception of the MRE, but due to the structure of the formula it is effectively updated by the inflation multiplier in each new calculation (Canadian Transportation Agency, 2016b).

The variable outside the brackets is called the Volume-Related Composite Price Index (VRCPI). The VRCPI is an inflation multiplier that the CTA needs to calculate each year. It reflects input price changes in labour, fuel, and material and capital (Canadian Transportation Agency, 2016b). While revenue entitlements are calculated separately for CN and CP, the same VRCPI factor is used for both railways (Canadian Transportation Agency, 2012). The VRCPI was set to unity as of 2000 and has been adjusted each subsequent year to reflect changes in railway operating costs due to inflation (Government of Canada, 2018a). Additionally, the *Canada Transportation Act* specifies that the CTA must make adjustments to the VRCPI in order to reflect any grain hopper car investments that the railways might have made in a given year (Government of Canada, 2018a). Other components that influence the VRCPI in a given year include cost changes in labour, fuel, materials, and the railways' cost of capital (Canadian Transportation Agency, 2012). The VRCPI has averaged roughly 2 percent per year over the existence of the MRE (Schulman, 2015).

The final variable in the MRE formula is simply the tons of grain moved by the particular railway in that crop year. This variable simply multiplies the inflation-adjusted average rate per ton allowed under the MRE by the total grain tons moved. Note that not all grain movements by Canadian railroads are included as part of the MRE calculation.

Appendix C: Additional Comparative Metrics

C.1. Fuel Consumption

Railroad fuel (diesel) prices across both countries share the same trend (Figures C1 through C3 below). However, we find that on average, diesel costs 13 percent (or 0.35 USD) more in Canada. Although Canada has a slightly higher fuel efficiency since 2 percent more ton-miles of freight are carried per gallon of diesel fuel, diesel cost per ton-mile is comparatively the same as the cost per gallon. As a result, the higher price of diesel fuel leads to negative overall efficiency effects on Canadian Class I railroads. It is also important to note that fuel efficiency in the U.S. has experienced almost no change during this 10-year period, but diesel fuel efficiency in Canada has kept rising. A complete set of fuel data can be found in Appendix D.

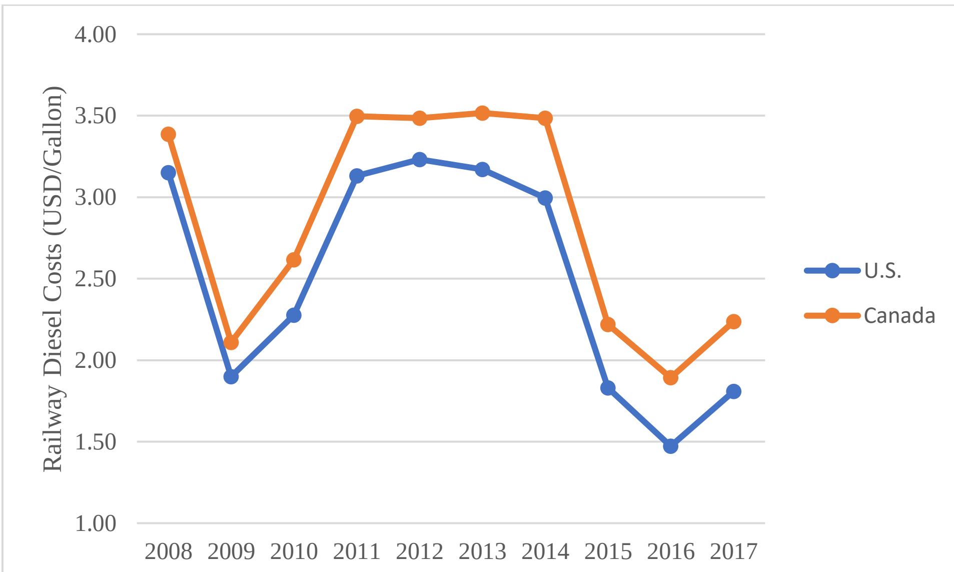


Figure C1: Annual U.S. and Canadian Railway Diesel Prices (2008-2017)

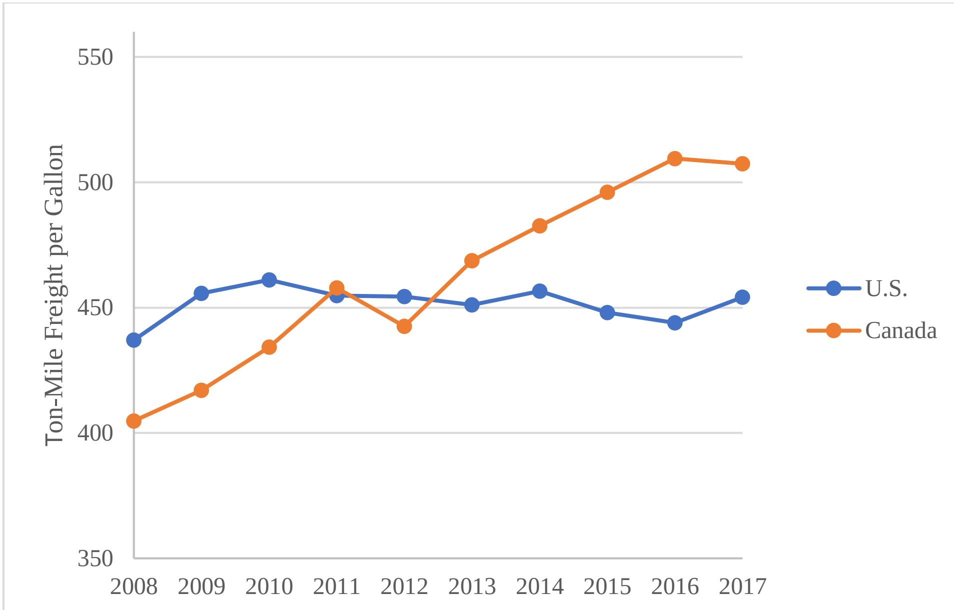


Figure C2: Annual Ton-Mile Freight per Gallon of U.S. and Canadian Railways (2008-2017)

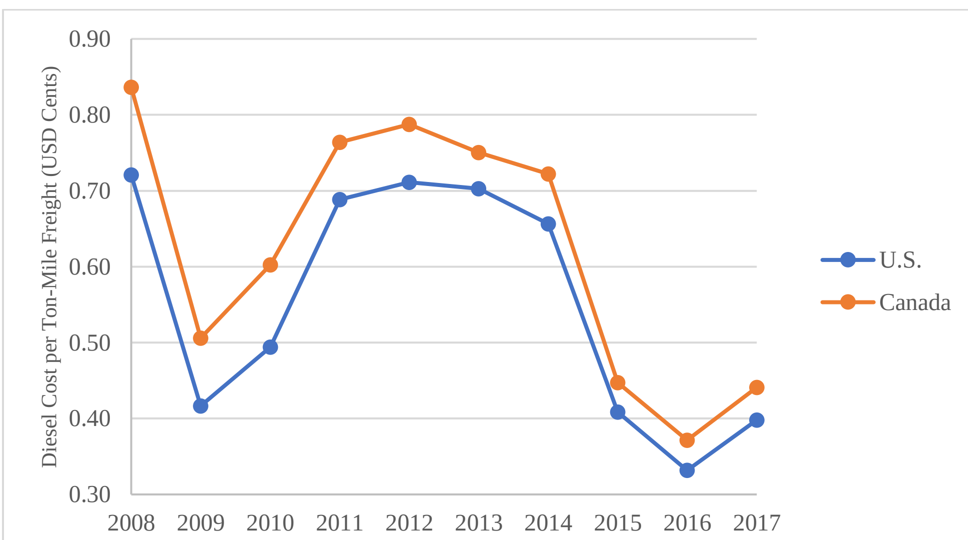


Figure C3: Diesel Cost per Ton-Mile Freight of U.S. and Canadian Railways (2008-2017)

C.2. Labor

Since trains are still crewed, employee data can be indicative of operational efficiencies. Figures C4 to C6 show the number of annual employees, working time, and wages for U.S. and Canadian Class I railways. In terms of wages, we observe dramatic increases and decreases in the real hourly wage for Canadian railway workers, while much less variation is found in U.S. wages. On average, Canadian railway workers earn about 8 percent less than U.S. workers. If we assume that railway workers work 5 days per week, average working hours for U.S. workers are 10.86 per day, while their Canadian colleagues work 10.13 hours per day. This likely explains why workers in the U.S. are paid slightly more. However, this differential may also be partially due to exchange rate fluctations.

An adjusted wage analysis is shown in Figure C5, comparing the hourly wage of a railway worker against the respective national average hourly wage. Although wages for Canadian railway workers are lower in absolute value, they are actually 52 percent higher than the national average. Compared to a similar value of 34 percent for U.S. railway workers, Canadian railway workers enjoy relatively higher wages than their U.S. counterparts compared to the national average.

However, relatively higher wages do not necessarily translate to higher efficiencies. From Figure C6, we observe that on average, Canadian railway workers transport 3.04 thousand ton-miles of freight per person per hour, whereas U.S. railway workers transport 4.16 thousand ton-miles of freight in the U.S. As a result, we conclude that over this time period, the working efficiency of Canadian railway workers was 36.6 percent lower than their U.S. colleagues.

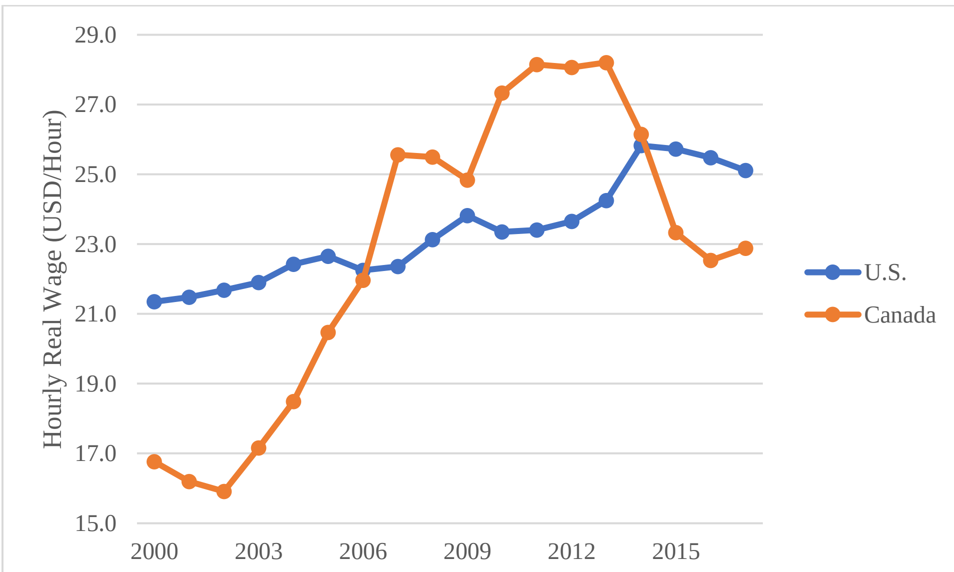


Figure C4: Real hourly wages, U.S. and Canadian Class I Railroad employees (2000-2017)

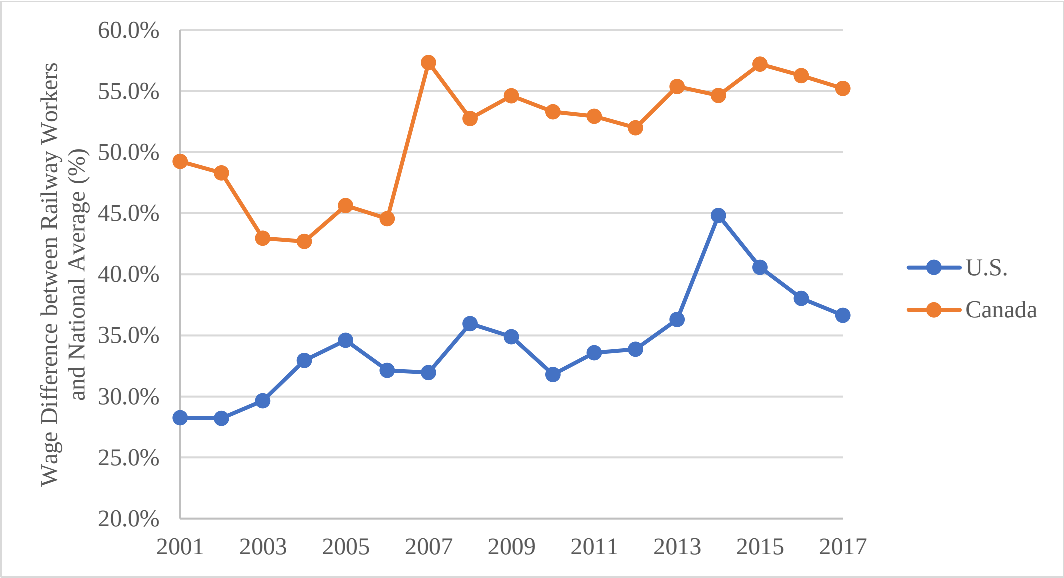


Figure C5: Hourly wages, U.S. and Canadian Class I Railway Employees (2000-2017)

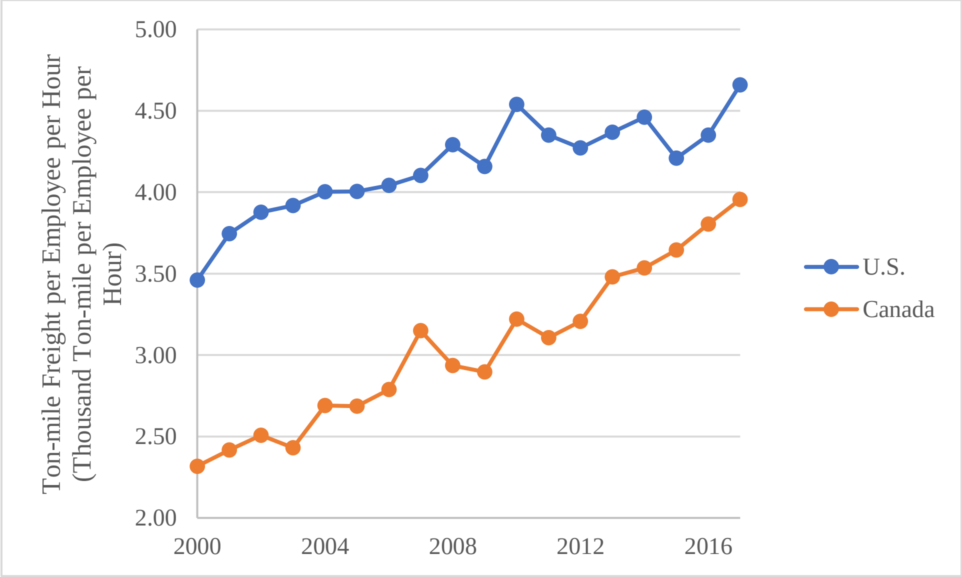


Figure C6: Ton-Miles of freight (thousands) per employee-hour, U.S. and Canadian Class I Railroads (2000-2017)

C.3. Financial Metrics

Overall, Table C1 illustrates that the cost of way and structures (including depreciation) is greater in Canada (very likely due to the average harsher weather). However, the costs of train operations and administration in the U.S. are greater. Another noticeable difference is the "Train, Yard and Yard Common Cost" measure, which could be associated with higher dwell times for U.S. railroads. And as mentioned in the previous section, the absolute wage and working efficiency for Canadian workers are lower than their U.S. colleagues. As a result, the two effects mostly cancel each other, meaning that the percentage of wage costs borne by U.S. and Canadian carriers are very close. The cost of fuel is a slightly more important operational factor for Canadian railways, due to the higher diesel cost per gallon (and not fuel efficiency).

Table C1: Operational costs, Canada and U.S. Class I railroads (2012-2017, annual)

Costs Composition	US (%)	Canada (%)
Way and Structures Cost	19.6%	22.3%
Equipment Cost	19.3%	19.3%
Train, Yard and Yard Common Cost	42.9%	35.4%
Administrative Cost	11.3%	9.51%
Other Costs	7.04%	13.4%
In which:		
Wage Costs	27.4%	27.0%
Diesel Costs	18.5%	20.7%

Note: Cost percentage is the total operational costs divided by the specific cost items.

Source: Authors' calculations based on economic data are from the Surface Transportation Board (https://www.stb.gov/econdata.nsf/AllData?OpenView) and Statistics Canada (Table 23-10-0045-01 Railway industry operating and income accounts, by mainline companies, x1,000).

Using appropriate ratios as well as comparisons of financial values from income statements and balance sheets over the past several years, we find that Canadian railroads have been slightly more profitable than U.S. railroads. This is likely due to revised operational practices including so-called "precision railroading" that both Canadian railroads have now fully implemented, whereas these practices are still in transition (or have not been implemented) for U.S. Class I's.

U.S. railways have over nine times more assets than those in Canada, but U.S. assets devoted to transportation operations are only five and a half times greater (Table C2). U.S. carriers have more current assets, especially higher receivables. Moreover, the other major difference comes from management and general costs since U.S. Class I's are typically larger than their Canadian counterparts. Canadian railroads have more efficient operations because of higher receivables and their total asset turnover ratio, but we note that the ratios for both carriers fall within the range of what can be considered "healthy" companies (see Table C3). Both Canadian railways are more profitable than their U.S. counterparts with about a 40 to 50 percent higher return on assets (ROA) and return on equity (ROE), but both also possess a similar likelihood of insolvency. In addition, observing a similar net profit and EBIT ratio, the non-operational costs for both Canadian companies are relatively close.

Table C2: Difference between Canadian and U.S. Class I carriers, balance sheet and income statements (2012-2017 Annual)

Account Receivables	1192%	Operational Revenue	514%
Total Current Asset	931%	Total Way and Structures	538%
Transporation Property	565%	Total Equipment Cost	630%
Total Assets	927%	Train, Yard and Yard Common	776%
Long term Debt	1149%	General and Administrative	872%
deferred income tax credits	1666%	Wage	645%
Total Libilities	832%	Diesel	529%
Additional Capital	1998%	Net Revenue from Operations	553%
Retained Earning	696%	Income Taxes	611%
Total Equity	1069%	EBIT	512%
Freight	593%	Net Income	678%

Source: Authors' calculations based on All Economic Data of Surface Transportation Board (https://www.stb.gov/econdata.nsf/AllData?OpenView), Statistics Canada. Table 23-10-0047-01, Railway industry balance sheet, by mainline companies (x 1,000) and Statistics Canada. Table 23-10-0045-01, Railway industry operating and income accounts, by mainline companies (x 1,000).

Table C3: *Average over annual financial indicators, Canada/U.S. Class I carriers (2012-2017)*

Indicators	U.S.	Canada
Freight/ Revenue Ratio	96.7%	91.6%
Receviable Turnover	4.31	7.75
Total Asset Turnover	0.33	0.47
ROA	9.24%	13.46%
ROE	15.3%	24.6%
DA Ratio	41.3%	45.1%
Current Ratio	32.1%	27.1%
Net Profit Ratio	29.8%	28.3%
EBIT Margin	30.7%	33.4%

Source: Authors' calculations based on economic data from the Surface Transportation Board (https://www.stb.gov/econdata.nsf/AllData?OpenView). Also, Statistics Canada Table 23-10-0047-01 Table 23-10-0045-01 and Railway - industry balance sheet, by mainline companies (x 1,000) and railway industry operating and income accounts, by mainline companies (x 1,000).

Appendix D: Detailed Data on U.S. and Canadian Class I Carriers

Table D1: Grain and wheat transportation in the U.S. and Canada

Year	Quarter	Field Grain Trans.			Wheat Trans.		
		US (Million Tons)	Canada (Million Tons)	Canada/US (%)	US (Million Tons)	Canada (Million Tons)	Canada/US (%)
2018	2	38.5	9.19	23.9%	8.6	4.15	48.3%
2018	1	36.0	8.78	24.4%	7.8	3.71	47.8%
2017	4	42.7	9.16	21.5%	9.7	3.60	37.0%
2017	3	39.2	9.97	25.5%	8.6	3.96	46.2%
2017	2	40.9	8.89	21.7%	11.9	4.12	34.5%
2017	1	41.8	9.97	23.9%	11.3	3.53	31.3%
2016	4	44.2	9.82	22.2%	8.7	3.20	36.9%
2016	3	43.5	10.36	23.8%	12.5	3.86	30.8%
2016	2	39.7	7.72	19.4%	11.4	3.71	32.5%
2016	1	43.3	9.25	21.4%	9.7	3.85	39.8%
2015	4	42.7	9.7	22.7%	8.9	3.79	42.6%
2015	3	39.3	10.32	26.2%	12.3	3.99	32.4%
2015	2	37.0	9.53	25.8%	9.3	5.35	57.8%
2015	1	42.5	8.59	20.2%	9.4	3.94	41.9%
2014	4	42.7	8.62	20.2%	9.3	3.48	37.4%
2014	3	37.9	10.5	27.6%	12.4	4.37	35.4%
2014	2	39.9	10.2	25.6%	11.2	4.74	42.2%
2014	1	40.7	7.62	18.7%	9.2	3.46	37.6%
2013	4	39.6	6.90	17.5%	8.5	2.84	33.2%
2013	3	34.6	7.92	22.9%	14.3	3.31	23.2%
2013	2	34.3	5.20	15.1%	12.0	2.45	20.4%
2013	1	39.7	6.74	17.0%	10.0	2.81	28.1%
2012	4	40.3	7.24	18.0%	9.2	3.13	33.9%
2012	3	38.1	8.16	21.4%	13.4	3.02	22.6%
2012	2	36.7	5.72	15.6%	10.7	2.63	24.7%
2012	1	39.5	6.84	17.3%	9.7	3.15	32.3%
2011	4	32.6	6.85	21.0%	7.2	2.68	37.2%
2011	3	38.6	7.66	19.9%	13.9	2.78	20.0%
2011	2	41.1	6.94	16.9%	13.3	3.45	25.9%
2011	1	43.2	6.01	13.9%	13.5	2.42	17.9%
2010	4	45.0	6.17	13.7%	11.8	2.05	17.3%
2010	3	40.5	7.03	17.4%	23.6	2.48	10.5%
2010	2	38.9	7.38	19.0%	11.1	3.53	31.8%
2010	1	43.8	6.34	14.5%	11.7	2.51	21.5%
2009	4	39.5	6.17	15.6%	9.5	2.74	28.9%
2009	3	36.4	7.05	19.3%	12.7	3.04	23.9%
2009	2	33.8	7.48	22.1%	10.3	3.77	36.6%
2009	1	38.0	7.03	18.5%	9.7	3.15	32.5%
2008	4	41.0	5.52	13.5%	10.5	2.62	24.9%
2008	3	41.8	6.00	14.3%	14.9	2.29	15.4%
2008	2	40.4	4.37	10.8%	11.8	2.37	20.0%
2008	1	48.2	4.61	9.6%	13.3	1.88	14.1%
2007	4	42.5	5.63	13.2%	11.6	2.09	18.1%
2007	3	39.7	6.93	17.5%	14.5	2.87	19.8%
2007	2	33.9	5.87	17.3%	12.2	3.20	26.2%
2007	1	64.1	5.10	7.9%	11.3	2.58	22.9%

Source: Authors' calculation based on Quorum Cooperation (http://grainmonitor.ca/) and U.S. Surface Transportation Board (https://www.stb.gov/econdata.nsf/AllData?OpenView).

Table D2: Velocity, all cars, Class I carriers, U.S. and Canada

Year	Month	US								Canadian			Difference
		BNSF	CN	CP	CSX	NS	UP	KCS	US Average	CN	CP	Canadian Average	
		(mph)	(mph)	(mph)	(mph)	(mph)	(mph)	(mph)	(mph)	(mph)	(mph)	(mph)	(%)
2017	3	20.5	25.0	26.3	18.7	18.0	22.0	24.7	22.2	19.2	22.3	20.8	6.82%
2017	4	22.2	24.6	27.6	19.1	17.4	22.9	25.8	22.8	20.0	22.6	21.3	7.13%
2017	5	22.2	25.3	28.1	18.8	17.0	23.6	24.5	22.8	18.7	22.3	20.5	11.3%
2017	6	22.3	25.6	27.2	18.4	16.2	23.3	25.1	22.6	19.2	22.4	20.8	8.48%
2017	7	22.3	24.9	26.4	17.9	17.3	23.4	24.5	22.4	18.7	22.4	20.6	8.67%
2017	8	22.5	25.6	26.2	16.2	18.0	23.7	25.8	22.6	18.3	22.3	20.3	11.2%
2017	9	22.9	25.9	25.4	17.6	17.3	24.1	25.6	22.7	19.0	22.6	20.8	9.17%
2017	10	22.3	23.9	25.3	19.1	17.4	23.7	25.9	22.5	17.1	21.2	19.1	17.5%
2017	11	22.7	22.8	24.3	19.3	16.0	23.1	25.5	22.0	17.0	20.4	18.7	17.4%
2017	12	24.0	24.0	25.9	20.7	16.5	24.3	25.2	22.9	15.7	21.8	18.8	22.2%
2018	1	23.7	21.4	22.5	20.8	14.6	23.8	25.2	21.7	15.5	20.4	18.0	20.9%
2018	2	23.0	22.0	21.6	18.8	14.4	23.2	26.0	21.3	15.1	18.2	16.7	27.6%
2018	3	22.3	21.4	22.4	20.1	14.8	22.9	25.6	21.3	16.7	19.7	18.2	17.0%
2018	4	21.8	21.4	19.2	19.5	14.0	24.3	25.3	20.8	17.4	20.3	18.8	10.3%
2018	5	21.4	22.9	21.7	19.3	13.0	24.0	25.1	21.1	16.8	20.1	18.5	14.0%
2018	6	21.4	23.0	23.6	18.9	15.1	22.9	25.7	21.5	16.1	21.2	18.7	15.2%
2018	7	21.6	21.9	22.7	18.7	15.4	23.3	25.3	21.3	16.5	21.5	19.0	12.2%
2018	8	21.2	23.4	22.5	19.5	16.3	23.0	23.4	21.3	16.1	21.1	18.6	14.9%
2018	9	21.5	24.5	21.3	19.2	15.5	23.2	23.4	21.2	17.3	20.8	19.0	11.4%
2018	10	21.9	23.7	22.8	19.8	14.1	23.3	23.7	21.3	16.9	22.2	19.5	9.12%
2018	11	22.4	24.4	25.9	20.1	13.4	23.1	23.6	21.8	17.0	23.2	20.1	8.40%
2018	12	23.0	24.2	27.4	20.4	15.0	24.1	24.2	22.6	17.2	23.0	20.1	12.3%
2019	1	23.8	25.3	25.9	22.6	18.0	24.8	23.6	23.4	18.4	22.2	20.3	15.3%
2019	2	22.3	24.7	24.1	22.6	17.6	23.0	24.3	22.7	15.5	18.8	17.2	32.1%
2019	3	20.4	23.9	20.7	22.1	17.4	22.4	24.0	21.6	15.4	18.5	16.9	27.2%

Table D3: Velocity, grain trains, Class I carriers in the U.S. and Canada

Year	Month	US								Canadian			Difference
		BNSF	CN	CP	CSX	NS	UP	KCS	US Average	CN	CP	Canadian Average	
		(mph)	(mph)	(mph)	(mph)	(mph)	(mph)	(mph)	(mph)	(mph)	(mph)	(mph)	(%)
2017	3	24.8	24.1	24.6	20.4	26.5	22.6	25.5	24.1	20.8	22.8	21.8	10.5%
2017	4	25.3	24.0	25.5	21.1	27.3	22.1	25.8	24.4	21.5	23.3	22.4	9.10%
2017	5	25.0	24.1	25.3	22.1	26.7	21.7	25.6	24.3	21.2	23.1	22.1	10.0%
2017	6	25.0	24.3	25.1	21.6	27.0	21.0	25.2	24.2	21.2	23.3	22.2	8.63%
2017	7	24.8	23.7	24.6	20.4	26.3	21.8	25.2	23.8	20.6	22.9	21.7	9.60%
2017	8	25.2	23.1	23.9	18.6	26.5	21.7	25.2	23.4	20.2	23.0	21.6	8.64%
2017	9	25.4	23.6	23.9	20.2	27.8	21.8	25.7	24.0	20.5	23.1	21.8	10.4%
2017	10	25.1	22.9	23.8	20.9	27.1	20.8	25.2	23.7	19.4	22.5	20.9	13.0%
2017	11	25.5	22.0	23.2	20.8	27.1	20.5	25.2	23.5	18.9	21.4	20.1	16.8%
2017	12	26.9	23.4	23.5	22.2	27.3	20.9	25.4	24.2	18.4	21.9	20.2	20.0%
2018	1	26.7	20.3	22.8	22.7	27.5	19.2	25.3	23.5	16.7	20.9	18.8	25.1%
2018	2	25.5	20.4	21.6	21.9	27.6	18.7	24.7	22.9	16.9	19.8	18.3	25.0%
2018	3	25.0	21.4	22.1	21.4	27.1	19.1	24.4	22.9	18.0	20.9	19.5	17.7%
2018	4	24.7	22.1	21.0	21.8	26.9	18.9	24.9	22.9	18.8	20.5	19.6	16.7%
2018	5	24.5	21.6	22.1	21.7	26.6	18.1	25.0	22.8	18.3	21.3	19.8	15.2%
2018	6	24.1	20.8	23.3	22.1	26.6	18.6	24.5	22.9	17.7	22.1	19.9	15.0%
2018	7	24.2	19.5	23.1	22.1	26.1	19.1	24.1	22.6	17.1	22.0	19.5	15.5%
2018	8	23.5	23.4	22.8	22.1	25.9	19.4	24.0	23.0	17.9	21.5	19.7	17.0%
2018	9	23.5	23.5	21.9	22.9	25.7	19.7	24.0	23.0	18.8	21.5	20.1	14.4%
2018	10	23.9	23.5	23.4	23.4	25.7	19.4	23.9	23.3	18.4	22.1	20.2	15.2%
2018	11	24.0	23.5	24.6	24.0	26.8	18.6	24.4	23.7	18.7	23.0	20.8	13.7%
2018	12	24.8	23.0	26.0	24.0	26.0	19.9	24.9	24.1	18.5	22.5	20.5	17.5%
2019	1	25.0	23.4	25.3	25.7	26.0	21.5	25.2	24.6	19.4	22.3	20.9	17.9%
2019	2	23.8	21.7	23.7	25.1	26.6	21.3	23.4	23.6	15.6	20.2	17.9	31.8%
2019	3	22.6	21.8	22.1	24.9	26.2	21.5	22.3	23.1	16.3	20.3	18.3	26.2%

Table D4: Terminal dwell time, Class I Carriers, U.S. and Canada

Year	Month	US								Canadian			Difference
		BNSF	CN	CP	CSX	NS	UP	KCS	US Average	CN	CP	Canadian Average	
		(Hour)	(Hour)	(Hour)	(Hour)	(Hour)	(Hour)	(Hour)	(Hour)	(Hour)	(Hour)	(Hour)	(%)
2017	3	27.9	14.6	16.7	25.4	22.0	23.4	28.5	22.6	7.26	6.68	6.97	225%
2017	4	27.4	14.4	17.0	24.0	22.6	24.3	28.2	22.5	6.77	5.68	6.22	262%
2017	5	26.5	15.1	16.1	23.7	22.2	24.5	27.8	22.3	7.13	5.75	6.44	246%
2017	6	27.1	15.1	16.6	25.0	22.4	25.9	28.9	23.0	7.19	5.98	6.58	249%
2017	7	26.8	15.6	17.7	27.1	23.8	26.1	29.7	23.8	7.61	6.65	7.13	234%
2017	8	24.9	16.2	18.0	28.9	23.5	24.5	29.0	23.6	7.89	6.75	7.32	222%
2017	9	25.3	15.6	17.5	26.3	20.7	24.8	31.2	23.0	7.86	6.38	7.12	224%
2017	10	26.0	16.4	17.1	24.5	22.5	25.5	30.3	23.2	8.07	6.30	7.19	223%
2017	11	26.0	18.1	18.9	24.7	22.6	26.3	30.4	23.8	8.84	6.98	7.91	202%
2017	12	24.3	17.0	19.5	24.4	25.9	26.2	33.5	24.4	9.35	7.48	8.42	190%
2018	1	27.0	21.2	20.2	26.3	25.1	31.6	39.0	27.2	10.4	7.98	9.17	197%
2018	2	27.7	21.8	18.7	22.9	21.1	29.8	32.6	24.9	10.7	7.98	9.35	166%
2018	3	27.3	18.7	18.8	23.1	22.2	27.9	32.3	24.3	9.04	7.64	8.34	191%
2018	4	26.8	17.9	18.9	23.1	21.9	27.2	30.3	23.7	8.40	7.28	7.84	203%
2018	5	26.1	17.0	16.2	21.2	21.5	28.6	29.3	22.8	7.88	6.50	7.19	218%
2018	6	26.5	17.0	15.5	20.3	21.9	29.6	29.4	22.9	8.11	6.38	7.25	216%
2018	7	27.2	18.3	17.0	20.1	22.1	28.6	29.7	23.3	8.24	6.60	7.42	214%
2018	8	27.9	15.7	16.6	18.6	22.8	27.1	29.3	22.6	7.99	7.17	7.58	198%
2018	9	27.9	14.9	18.0	18.4	22.2	25.8	29.0	22.3	7.29	6.88	7.09	215%
2018	10	27.7	14.9	17.1	18.4	23.9	25.5	27.8	22.2	7.40	6.79	7.09	213%
2018	11	28.4	14.8	16.0	19.2	26.1	26.3	26.3	22.5	7.40	6.29	6.84	228%
2018	12	27.6	15.0	15.2	19.3	24.4	24.9	25.8	21.7	7.80	6.72	7.26	199%
2019	1	28.4	15.5	15.8	19.7	25.6	25.0	25.4	22.2	7.24	6.69	6.96	219%
2019	2	31.5	17.4	17.9	19.3	21.7	23.2	26.5	22.5	9.77	8.66	9.21	144%
2019	3	31.8	16.6	19.1	18.3	20.3	20.9	28.2	22.2	9.47	8.84	9.16	142%

Table D5: Monthly total car amounts, Class I carriers, US and Canada

Year	Month	US								Canadian			Canada/US
		BNSF	CN	CP	CSX	NS	UP	KCS	US Average	CN	CP	Canadian Average	
		(1 Million Cars)	(1 Million Cars)	(1 Million Cars)	(1 Million Cars)	(1 Million Cars)	(1 Million Cars)	(1 Million Cars)	(1 Million Cars)	(1 Million Cars)	(1 Million Cars)	(1 Million Cars)	(%)
2017	4	0.96	0.17	0.10	0.83	0.12	0.74	1.18	4.10	0.34	0.31	0.64	15.7%
2017	5	1.20	0.22	0.12	1.02	0.16	0.92	1.47	5.10	0.34	0.30	0.64	12.6%
2017	6	0.96	0.17	0.10	0.82	0.13	0.74	1.18	4.11	0.42	0.38	0.80	19.4%
2017	7	0.96	0.18	0.10	0.85	0.12	0.73	1.19	4.13	0.34	0.30	0.65	15.7%
2017	8	1.18	0.22	0.13	1.09	0.16	0.91	1.48	5.17	0.35	0.31	0.66	12.8%
2017	9	0.95	0.18	0.11	0.84	0.12	0.73	1.20	4.14	0.45	0.38	0.84	20.2%
2017	10	0.95	0.19	0.10	0.83	0.13	0.74	1.20	4.14	0.38	0.31	0.69	16.6%
2017	11	1.19	0.24	0.13	1.03	0.16	0.94	1.51	5.21	0.39	0.31	0.70	13.5%
2017	12	0.95	0.19	0.11	0.81	0.13	0.75	1.23	4.17	0.49	0.39	0.88	21.1%
2018	1	1.16	0.25	0.13	0.99	0.16	0.97	1.54	5.21	0.42	0.32	0.74	14.1%
2018	2	0.94	0.21	0.11	0.78	0.12	0.78	1.24	4.20	0.4	0.32	0.76	18.1%
2018	3	0.96	0.21	0.12	0.78	0.13	0.78	1.24	4.22	0.5	0.41	0.94	22.3%
2018	4	0.97	0.20	0.12	0.78	0.13	0.78	1.22	4.20	0.40	0.33	0.72	17.2%
2018	5	1.22	0.25	0.14	0.96	0.16	0.99	1.51	5.23	0.38	0.33	0.71	13.6%
2018	6	0.99	0.19	0.11	0.75	0.13	0.80	1.21	4.19	0.48	0.39	0.87	20.9%
2018	7	0.99	0.20	0.11	0.75	0.13	0.79	1.22	4.21	0.39	0.32	0.71	16.9%
2018	8	1.26	0.24	0.14	0.93	0.17	0.98	1.53	5.24	0.49	0.42	0.90	17.2%
2018	9	1.01	0.19	0.11	0.73	0.14	0.78	1.23	4.19	0.37	0.34	0.71	16.9%
2018	10	1.25	0.24	0.13	0.91	0.18	0.97	1.53	5.21	0.39	0.34	0.72	13.9%
2018	11	1.02	0.19	0.10	0.73	0.14	0.78	1.20	4.16	0.49	0.41	0.90	21.7%
2018	12	1.02	0.18	0.10	0.74	0.14	0.77	1.19	4.13	0.40	0.33	0.73	17.8%
2019	1	1.27	0.22	0.12	0.92	0.17	0.95	1.48	5.14	0.38	0.34	0.72	13.9%
2019	2	1.04	0.18	0.10	0.73	0.13	0.74	1.21	4.13	0.42	0.34	0.76	18.5%
2019	3	0.80	0.14	0.08	0.54	0.10	0.54	0.91	3.10	0.34	0.26	0.60	19.3%

Table D6: Quarterly number of grain cars, Class I carriers, U.S. and Canada

Year	Quarter	US								Canada			Canada/US
		KCS	BNSF	UP	CSXT	CP	CN	NS	Total	CN	CP	Total	
		(1000 Cars)	(1000 Cars)	(1000 Cars)	(1000 Cars)	(1000 Cars)	(1000 Cars)	(1000 Cars)	(1000 Cars)	(1000 Cars)	(1000 Cars)	(1000 Cars)	(%)
2014	4	17.6	201	97.7	48.0	43.9	37.6	56.0	484	37.4	41.1	78.5	16.2%
2014	3	16.5	158	94.5	38.9	23.7	39.1	48.2	403	35.8	40.2	76.0	18.9%
2015	4	16.4	210	96.6	46.0	23.8	30.8	52.3	459	39.6	38.8	78.4	17.1%
2015	3	16.8	185	78.3	45.2	19.6	34.6	52.9	416	37.0	37.7	74.8	18.0%
2015	2	16.6	164	84.7	47.9	19.5	25.0	52.5	394	36.8	38.2	75.0	19.0%
2015	1	16.1	194	94.2	50.2	26.4	33.6	54.5	452	36.6	41.4	78.0	17.2%
2016	4	16.8	218	89.0	46.4	31.1	34.7	59.7	479	34.9	41.8	76.7	16.0%
2016	3	15.4	225	84.2	38.6	27.7	39.6	52.6	468	35.6	40.2	75.8	16.2%
2016	2	18.3	175	107	41.1	13.8	25.7	50.9	413	36.6	39.3	75.9	18.4%
2016	1	15.5	200	117	45.1	17.6	27.3	53.5	461	37.6	41.1	78.7	17.1%
2017	4	17.8	189	108	38.3	23.1	31.2	50.9	441	36.5	39.7	76.2	17.3%
2017	3	17.6	171	95.1	32.7	19.8	33.0	52.0	404	35.9	40.5	76.4	18.9%
2017	2	17.3	197	90.2	35.3	16.4	29.1	51.9	420	36.5	39.6	76.1	18.1%
2017	1	17.0	190	98.4	41.9	24.4	33.9	54.3	442	36.1	41.7	77.8	17.6%
2018	2	16.2	211	96.4	39.8	19.7	33.9	17.0	418	37.4	33.7	71.1	17.0%
2018	1	17.0	198	92.4	37.4	18.7	30.4	23.2	400	36.5	35.4	71.9	18.0%

Table D7: Annual financial data, Class I carriers, U.S. and Canada

Indicators	2017 (%)	2016 (%)	2015 (%)	2014 (%)	2013 (%)	2012 (%)
Account Receivables	1477%	1295%	1619%	1046%	918%	799%
Total Current Asset	1102%	1004%	1225%	899%	747%	606%
Transporation Property	666%	692%	639%	524%	450%	422%
Total Assets	1145%	1145%	1045%	865%	711%	651%
Long term Debt	1369%	1325%	1319%	1055%	934%	889%
deferred income tax	1142%	2127%	2105%	1701%	1455%	1466%
Total Libilities	757%	1052%	1039%	832%	677%	634%
Additional Capital	2883%	2835%	2222%	1850%	1128%	1069%
Retained Earning	1155%	821%	706%	548%	506%	437%
Total Equity	1493%	1221%	1024%	840%	1252%	585%
Freight	597%	611%	630%	589%	570%	561%
Operating Revenue	514%	537%	546%	513%	492%	481%
Total Way and Structures	626%	637%	550%	485%	465%	465%
Total Equipment Cost	606%	686%	682%	640%	571%	594%
Train, Yard and Yard Common	786%	834%	848%	769%	730%	689%
General and	1844%	1265%	564%	533%	539%	490%
Wage	675%	704%	805%	677%	551%	458%
Diesel	474%	475%	520%	552%	580%	571%
Net Revenue from Operations	447%	446%	583%	619%	544%	679%
Income Taxes	389%	426%	671%	779%	767%	631%
EBIT	407%	418%	865%	476%	531%	373%
Net Income	1099%	630%	1412%	339%	335%	254%

Table D8: Annual balance sheets and income statements, Class I carriers, U.S. and Canada

Indicators	Unit	US						Canada					
		2017	2016	2015	2014	2013	2012	2017	2016	2015	2014	2013	2012
Account Receivables	(Billion USD)	20.4	16.5	20.6	17.5	14.0	12.0	1.29	1.19	1.20	1.53	1.38	1.33
Total Current Asset	(Billion USD)	25.2	21.6	26.8	24.1	21.1	17.2	2.10	1.96	2.03	2.41	2.50	2.43
Transporation Property	(Billion USD)	192	188	179	169	154	148	25.1	23.7	24.2	27.0	28.0	28.3
Total Assets	(Billion USD)	253.5	241.5	230.7	216.9	192.0	178.6	20.4	19.4	20.2	22.5	23.7	23.8
Long term Debt	(Billion USD)	20.6	20.7	20.2	17.9	17.0	16.5	1.41	1.46	1.42	1.55	1.65	1.66
deferred income tax credits	(Billion USD)	40.5	59.6	56.1	53.7	50.1	46.6	3.26	2.68	2.55	2.98	3.22	2.98
Total Libilities	(Billion USD)	83.1	102	101	92.8	80.9	78.9	9.69	8.84	8.91	10.0	10.4	10.7
Additional Capital	(Billion USD)	62.2	62.2	52.9	52.9	34.3	34.7	2.08	2.12	2.28	2.72	2.79	2.97
Retained Earning	(Billion USD)	107	76.7	71.5	62.8	62.7	53.3	8.49	8.33	8.87	9.69	10.4	9.9
Total Equity	(Billion USD)	170	139	126	118	179	89.3	10.7	10.5	11.2	12.5	13.3	13.0
Freight	(Billion USD)	70.0	64.7	71.7	77.7	72.9	70.1	10.0	9.09	9.82	11.3	10.9	10.6
Operating Revenue	(Billion USD)	67.3	63.2	69.0	75.1	70.5	67.6	11.0	9.94	10.7	12.3	11.9	11.6
Total Way and Structures	(Billion USD)	10.3	9.71	9.73	9.83	9.06	8.94	1.42	1.32	1.50	1.68	1.60	1.58
Total Equipment Cost	(Billion USD)	9.19	9.55	10.0	9.94	9.23	8.94	1.30	1.22	1.28	1.34	1.38	1.29
Train, Yard and Yard Common	(Billion USD)	18.6	16.3	19.6	25.6	24.0	23.5	2.10	1.74	2.07	2.95	2.90	2.98
General and Administrative	(Billion USD)	6.10	6.64	3.36	5.51	5.89	5.55	0.31	0.49	0.51	0.87	0.92	0.94
Wage	(Billion USD)	12.8	12.9	14.6	14.7	13.1	12.6	1.66	1.61	1.62	1.90	2.01	2.26
Diesel	(Billion USD)	6.67	5.26	7.10	12.1	12.2	12.2	1.16	0.91	1.15	1.86	1.80	1.82
Net Revenue from Operations	(Billion USD)	23.1	20.5	23.0	23.6	21.3	19.6	4.22	3.76	3.36	3.28	3.31	2.51
Income Taxes	(Billion USD)	23.3	21.0	23.1	23.1	21.1	19.2	4.59	4.06	2.39	4.00	3.35	4.05
EBIT	(Billion USD)	6.16	5.14	5.60	6.28	5.74	4.75	1.26	0.98	0.73	0.71	0.66	0.65
Net Income	(Billion USD)	40.0	22.5	25.1	14.4	11.7	12.0	3.33	3.08	1.66	3.29	2.68	3.40

Table D9: Other financial indicators, Canadian and U.S. Class I carriers

Year	U.S.						Canada					
	2017	2016	2015	2014	2013	2012	2017	2016	2015	2014	2013	2012
Freight/ Revenue	96.2%	97.8%	96.2%	96.6%	96.8%	96.4%	91.7%	91.5%	92.0%	92.0%	91.4%	91.1%
Receivable Turnover	3.79	3.48	3.77	4.93	5.60	NA	8.10	7.63	7.21	7.76	8.03	NA
Total Asset Turnover	0.28	0.27	0.32	0.38	0.39	NA	0.51	0.46	0.46	0.49	0.46	NA
ROA	15.8%	9.32%	10.9%	6.7%	6.1%	6.7%	16.4%	15.9%	8.3%	14.6%	11.3%	14.3%
ROE	23.5%	16.2%	19.9%	12.3%	6.5%	13.5%	31.2%	29.2%	14.8%	26.3%	20.2%	26.1%
D/A Ratio	32.8%	42.2%	44.0%	42.8%	42.1%	44.2%	47.6%	45.6%	44.2%	44.3%	44.0%	45.2%
Current Ratio	40.4%	26.6%	33.0%	32.2%	33.1%	27.5%	25.3%	26.5%	27.1%	28.7%	28.5%	26.8%
Net Profit Ratio	57.1%	34.8%	35.1%	18.6%	16.0%	17.2%	33.2%	33.9%	16.9%	29.2%	24.7%	32.1%
EBIT Margin	33.2%	32.5%	32.2%	29.7%	29.0%	27.3%	41.9%	40.8%	22.4%	32.7%	28.1%	34.8%

Table D10: Annual Ton-miles of freight, Canadian and U.S. Class I railways

Year	U.S. (Trillion Ton-mile)	Canada (Trillion Ton-mile)	Difference (%)
2000	1.55	0.20	672%
2001	1.60	0.20	696%
2002	1.61	0.20	713%
2003	1.60	0.20	711%
2004	1.68	0.21	700%
2005	1.70	0.22	675%
2006	1.77	0.22	709%
2007	1.77	0.22	694%
2008	1.78	0.21	741%
2009	1.53	0.19	722%
2010	1.69	0.21	697%
2011	1.73	0.22	690%
2012	1.71	0.23	643%
2013	1.74	0.24	625%
2014	1.85	0.26	617%
2015	1.74	0.26	579%
2016	1.59	0.25	545%
2017	1.67	0.26	536%
Average	1.68	0.22	665%

Table D11: Fuel consumption and costs, Canadian and U.S. Class I railways

Year	U.S.							Canada							Difference		
	Total Cost	Fuel Consumed	Rail Cost per Gallon	Fuel per Ton-Mile Freight	Fuel Cost per Ton-Mile Freight	Diesel Retail Price	Discount	Total Cost	Fuel Consumed	Rail Cost per Gallon	Fuel per Ton-Mile Freight	Fuel Cost per Ton-Mile Freight	Diesel Retail Price	Discount	Difference in Diesel Cost	Difference in Diesel Consumption per Ton-Mile Freight	Difference in Diesel Costs per Ton-Mile Freight
	(Billion USD)	(Billion Gallon)	(USD)	(Ton-Mile per Gallon)	(USD Cent)	(USD/ Gallon)	(%)	(Billion USD)	(Billion Gallon)	(USD)	(Ton-Mile per Gallon)	(USD Cent)	(USD/ Gallon)	(%)	(%)	(%)	(%)
2017	6.67	3.69	1.81	454	0.3981	2.65	31.8%	1.16	0.52	2.24	507	0.4410	0.44	-407.4%	-19%	-11%	-10%
2016	5.26	3.57	1.47	444	0.3317	2.30	36.1%	0.91	0.48	1.89	509	0.3715	0.37	-409.5%	-22%	-13%	-11%
2015	7.10	3.88	1.83	448	0.4084	2.71	32.4%	1.15	0.52	2.22	496	0.4475	0.45	-396.0%	-18%	-10%	-9%
2014	12.1	4.05	3.00	457	0.6563	3.83	21.7%	1.86	0.53	3.49	483	0.7221	0.72	-382.7%	-14%	-5%	-9%
2013	12.2	3.86	3.17	451	0.7028	3.92	19.2%	1.80	0.51	3.52	469	0.7503	0.75	-368.7%	-10%	-4%	-6%
2012	12.2	3.77	3.23	454	0.7113	3.97	18.6%	1.82	0.52	3.48	442	0.7876	0.79	-342.5%	-7%	3%	-10%
2011	11.9	3.80	3.13	455	0.6886	3.84	18.5%	1.67	0.48	3.50	458	0.7639	0.76	-357.8%	-10%	-1%	-10%
2010	8.35	3.67	2.28	461	0.4939	2.99	23.9%	1.28	0.49	2.62	434	0.6023	0.60	-334.3%	-13%	6%	-18%
2009	6.38	3.36	1.90	456	0.4165	2.47	23.1%	0.94	0.45	2.11	417	0.5060	0.51	-317.0%	-10%	9%	-18%
2008	12.8	4.07	3.15	437	0.7209	3.80	17.2%	1.77	0.52	3.39	405	0.8365	0.84	-304.8%	-7%	8%	-14%
Average	9.50	3.77	2.50	451.67	0.55	3.25	24.2%	1.44	0.50	2.84	462.07	0.62	0.62	-362.1%	-13%	-2%	-11%

Source: Authors' calculation based on Statistics Canada. Table 23-10-0053-01 Railway industry diesel fuel consumption, All Economic Data of Surface Transportation Board (https://www.stb.gov/econdata.nsf/AllData?OpenView), U.S. No.2 diesel price by U.S. Energy Information Administration (https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx) and Statistics Canada, Table 18-10-0001-01 monthly average retail prices for gasoline and fuel oil, by location.

Note: Canadian diesel retail price is the average of the average of the average of the monthly retailed prices in ten provinces.

Table D12: Annual employees, working hours and hourly wages, Canadian and U.S. Class I railways

Year	U.S.					Canada					Difference			
	Number of Employees	Working Hours per Employee	Hourly Norminal Wage	National Average Wage	Hourly Real Wage	Number of Employees	Working Hours	Hourly Norminal Wage	National Average Wage	Hourly Real Wage	Difference in Number of Workers	Difference in Working Hours	Differences in Norminal Wage	Difference in Real Wage
	(1,000 Employees)	(1 Million Hours)	(USD)	(USD)	(USD)	(1,000 Employees)	(1 Million Hours)	(USD)	(USD)	(USD)	(%)	(%)	(%)	(%)
2017	148	359.43	35.7	26.2	25.1	27.5	66.5	31.3	20.2	22.9	436%	440%	14.3%	9.7%
2016	145	364.45	35.5	25.7	25.5	27.1	64.7	30.3	19.4	22.5	436%	464%	17.1%	13.1%
2015	150	412.93	35.4	25.2	25.7	29.2	70.2	31.0	19.7	23.3	414%	488%	14.4%	10.3%
2014	161	415.08	35.5	24.5	25.8	29.9	73.0	34.3	22.2	26.2	438%	468%	3.4%	-1.2%
2013	163	398.48	32.8	24.1	24.2	29.8	68.9	36.3	23.4	28.2	447%	478%	-9.6%	-14.0%
2012	163	400.96	31.5	23.6	23.6	30.8	71.9	35.8	23.6	28.1	428%	458%	-11.9%	-15.7%
2011	161	397.43	30.6	22.9	23.4	30.3	70.4	35.4	23.1	28.1	432%	464%	-13.59%	-16.84%
2010	154	372.47	29.6	22.4	23.3	29.2	65.8	33.4	21.8	27.3	429%	466%	-11.41%	-14.6%
2009	147	368.47	29.7	22.0	23.8	28.9	64.3	29.8	19.3	24.8	407%	473%	-0.41%	-4.13%
2008	161	414.10	28.9	21.3	23.1	31.3	72.0	30.5	20.0	25.5	414%	475%	-5.15%	-9.27%
2007	164	431.53	26.9	20.4	22.4	31.1	70.8	29.9	19.0	25.6	429%	509%	-9.9%	-12.5%
2006	168	438.42	26.1	19.7	22.3	30.8	78.6	25.1	17.4	22.0	445%	458%	3.7%	1.3%
2005	165	423.64	25.7	19.1	22.7	31.5	81.5	23.0	15.8	20.5	423%	420%	11.9%	10.7%
2004	159	420.68	24.6	18.5	22.4	31.0	78.3	20.3	14.2	18.5	414%	438%	21.2%	21.2%
2003	153	409.25	23.4	18.0	21.9	31.6	81.3	18.5	12.9	17.2	385%	403%	26.6%	27.64%
2002	154	414.16	22.6	17.7	21.7	32.0	78.8	16.7	11.2	15.9	382%	426%	35.8%	36.3%
2001	158	426.94	22.1	17.2	21.5	34.0	83.1	16.6	11.1	16.2	365%	414%	33.0%	32.6%
2000	166	446.84	21.3	NA	21.3	35.4	86.5	16.8	NA	16.8	368%	417%	27.3%	27.34%
Average	158	406.40	28.8	21.7	23.3	30.6	73.70	27.5	18.5	22.8	416%	453%	8.15%	5.65%

Source: Authors' calculation based on Statistics Canada. Table 23-10-0061-01 Railway industry summary statistics on employment, by occupational categories and mainline companies, All Economic Data from the Surface Transportation Board (https://www.stb.gov/econdata.nsf/AllData?OpenView), Federal Reserve Bank of Minneapolis (https://www.minneapolisfed.org/community/financial-and-economic-education/cpi-calculator-information/consumer-price-index-and-inflation-rates-1913), Statistics Canada. Table 18-10-0005-01 Consumer Price Index, annual average, not seasonally adjusted, Statistics Canada, U.S. Department of Labor (https://www.dol.gov/general/topic/statistics/wagesearnings) and Statistics Canada. Table 14-10-0320-02 Average usual hours and wages by selected characteristics, monthly, unadjusted for seasonality (x 1,000) Note: Inflation is based on annual CPI from above-mentioned sources, and the base year is 2000.

Table D13: Grains transported from Canada to the U.S.

Year	Quarter	Wheat	Durum	Barley	Canola	Canola Meal	Canola Oil	Oats	Peas	Soybeans	Rye	Flaxseed	Other	Total
		(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)
2014	3	173	40.1	43.8	16.7	448	240	206	14.9	0.00	5.91	9.9	47.4	1,245
2014	4	195	91.3	70.9	25.9	713	336	310	6.53	0.00	6.17	18.9	75.1	1,849
2015	1	292	102	79.7	58.0	745	314	351	31.3	0.00	5.36	19.0	89.7	2,088
2015	2	151	97.2	50.3	2.74	715	344	227	1.11	0.00	2.33	16.7	91.0	1,699
2015	3	146	32.4	45.8	11.1	747	416	214	2.71	0.00	3.92	10.1	81.9	1,711
2015	4	183	30.2	66.7	16.4	872	354	287	6.08	0.00	4.06	7.98	83.3	1,910
2016	1	210	68.5	63.1	10.3	738	375	209	4.64	0.00	8.34	16.1	93.9	1,797
2016	2	53.8	37.4	18.1	34.3	671	399	141	3.33	0.00	4.48	3.94	94.6	1,461
2016	3	12.5	8.38	4.86	67.0	688	402	348	1.92	0.83	18.3	2.88	87.0	1,641
2016	4	65.9	28.6	17.2	41.7	776	394	316	3.73	0.00	14.8	0.75	73.7	1,732
2017	1	188	40.6	25.3	45.8	667	407	275	6.80	23.5	4.72	8.47	85.4	1,778
2017	2	223	63.4	20.5	23.1	624	420	143	4.50	11.7	6.81	8.12	87.8	1,636
2017	3	269	87.3	11.7	12.5	666	407	336	8.59	4.54	9.53	10.9	90.1	1,913
2017	4	273	125	22.4	51.3	721	420	299	8.30	18.5	11.4	11.2	80.6	2,042
2018	1	350	184	24.7	84.9	683	395	269	6.70	10.5	19.1	21.7	80.4	2,129
2018	2	335	188	19.5	60.2	697	377	198	5.12	9.57	33.0	14.1	92.5	2,030

Source: Quorum Co. (http://grainmonitor.ca/)

Table D14: Grains transported from the US to Canada

Year	Quarter	Wheat	Durum	Barley	Canola	Canola Meal	Canola Oil	Oats	Peas	Soybeans	Rye	Flaxseed	Other	Total
		(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)	(1000 Tons)
2014	3	-	-	-	-	-	0.93	-	-	-	-	-	4.58	8.51
2014	4	5.16	-	-	-	0.34	4.61	-	-	-	-	0.05	13.9	28.0
2015	1	3.00	-	0.09	-	-	5.72	-	-	-	-	-	13.5	23.3
2015	2	7.70	-	-	-	-	4.06	0.18	-	-	-	-	20.2	34.1
2015	3	0.05	-	0.57	-	-	9.74	0.07	-	-	-	0.03	20.2	33.6
2015	4	1.16	-	2.70	-	-	11.1	0.08	-	-	-	0.05	16.9	36.0
2016	1	3.75	0.04	2.49	-	-	0.47	-	-	-	-	0.17	24.9	32.8
2016	2	1.53	-	0.58	-	-	7.28	-	-	-	-	-	27.3	38.7
2016	3	4.55	-	14.4	-	-	19.7	-	2.43	0.58	0.06	0.24	69.4	114
2016	4	1.77	-	0.30	-	-	21.3	-	-	1.95	-	0.02	23.0	52.4
2017	1	0.06	-	11.6	-	-	0.44	-	-	2.19	0.06	-	25.9	41.2
2017	2	0.09	-	4.07	-	-	0.26	0.11	1.19	1.24	0.30	0.45	11.8	21.5
2017	3	0.03	-	2.26	-	-	0.09	0.10	0.09	0.99	0.06	-	8.46	15.1
2017	4	-	-	-	-	2.05	-	-	-	3.11	0.02	-	11.7	20.9
2018	1	5.31	-	-	-	1.12	-	0.10	-	11.63	0.02	-	12.3	31.5
2018	2	0.82	-	-	-	-	-	-	0.09	13.47	0.02	-	34.4	50.8

Source: Quorum Co. (http://grainmonitor.ca/)

Table D15: Relative percentage, cross-border grain transportation to domestic (non-export) grain transportation

Year	Quarter	From Canada to US				From US to Canada			
		All Grains		Wheat		All Grains		Wheat	
		% of US Domestic	% of Canadian Domestic	% US Domestic Wheat	% Canadian Domestic Wheat	% of US Domestic	% of Canadian Domestic	% US Domestic Wheat	% Canadian Domestic Wheat
		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
2014	3	3.24%	13.6%	2.02%	4.17%	0.02%	0.09%	0.00%	0.00%
2014	4	5.14%	21.1%	2.51%	5.25%	0.08%	0.32%	0.07%	0.14%
2015	1	4.89%	22.8%	3.01%	8.12%	0.05%	0.25%	0.03%	0.08%
2015	2	4.34%	17.0%	1.76%	3.82%	0.09%	0.34%	0.09%	0.19%
2015	3	4.19%	19.2%	1.22%	3.54%	0.08%	0.38%	0.00%	0.00%
2015	4	4.57%	19.2%	1.62%	5.18%	0.09%	0.36%	0.01%	0.03%
2016	1	4.07%	18.3%	2.42%	6.55%	0.07%	0.33%	0.04%	0.12%
2016	2	3.36%	14.1%	0.43%	1.39%	0.09%	0.37%	0.01%	0.04%
2016	3	4.13%	21.3%	0.11%	0.34%	0.29%	1.48%	0.04%	0.12%
2016	4	4.00%	18.7%	0.68%	1.71%	0.12%	0.57%	0.02%	0.05%
2017	1	4.16%	18.3%	2.12%	4.97%	0.10%	0.42%	0.00%	0.00%
2017	2	4.16%	15.9%	1.81%	5.58%	0.05%	0.21%	0.00%	0.00%
2017	3	5.18%	20.1%	2.91%	5.03%	0.04%	0.16%	0.00%	0.00%
2017	4	4.81%	23.8%	2.90%	6.92%	0.05%	0.24%	0.00%	0.00%
2018	1	4.99%	24.7%	3.76%	10.0%	0.07%	0.37%	0.06%	0.15%
2018	2	5.36%	19.4%	2.71%	7.67%	0.13%	0.49%	0.01%	0.02%

Source: Authors' calculation based on data from Quorum Co. (http://grainmonitor.ca/)

Note: Calculations for domestic (non-export) movement apply to Class I carriers only.