ANALYZING THE TRANSPORTATION IMPACTS OF FREE TRADE AGREEMENTS

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Introduction

Canada has recently progressed several Free Trade Agreements (FTAs). The country has recently brought the Canada Korea Free Trade Agreement (CKFTA) into force, and has concluded the Comprehensive Economic and Trade Agreement (CETA) between Canada and the European Union and the Trans-Pacific Partnership (TPP) involving the Pacific Rim countries. Previous FTAs suggest sizeable impacts on Canada's trade may be imminent. For example, the cross-border trade between the United States (US) and Canada increased rapidly following the implementation of the North America Free Trade Agreement (NAFTA). In approximately just the last decade, US freight exports to Canada have increased by 61% and US freight imports from Canada have risen by 36% (Chi, 2014). Moreover, CETA is "broader in scope and deeper in ambition than the historic North American Free Trade Agreement" according to the Government of Canada (Government of Canada, 2015a). Finally, Canada has ongoing negotiations with other trade partners such as India, Japan, and the Caribbean Community (CARICOM).

While the federal government, namely Global Affairs Canada (GAC), formerly the Department of Foreign Affairs, Trade and Development (DFATD), carries out considerable analysis of the potential impact of trade agreements on the Canadian economy, little to no work is done to assess the potential impact on Canada's transportation system. Trade patterns ultimately manifest themselves in freight flows on transportation systems, but the translation of economic flows into transportation patterns is not straightforward (e.g., consider the role of transhipment points and vehicle routing patterns). Changes to Canada's economic environment also impact firm and household behaviour through mechanisms such as employment and income, leading to changes in passenger flows as well (e.g., work trips and discretionary travel). The objective of this research is to begin analyzing how CKFTA and CETA will impact Canada's transportation infrastructure and also what the resulting capacity effects will be on Canada's global competiveness.

Methods

Figure 1 shows the proposed modelling framework, which includes three main components: a model of the global economy that quantifies the impacts of the FTA on international trade flows; a multi-scale analysis that links changes in national production, consumption, and international imports and exports to subnational trade flows; and a freight model that translates subnational trade flows into freight flows. The framework can also be divided into six major steps. The framework begins with a Computable General Equilibrium (CGE) model to simulate the changes in worldwide output and trade associated with the implementation of a potential FTA (e.g., by introducing tariff cuts). Changes in national production, consumption, and trade are linked to provinces using a multi-scale Multi-Region Input-Output (MRIO) analysis (Bachmann, Roorda, & Kennedy, 2014). The resulting interprovincial and international trade flows are converted from monetary values to quantities using weight-value factors or a weight-value model. The trade flows measured in quantities are split among modes using the quantity shares of each mode or a mode share model. The total tonnage for each mode can be converted into shipments through fixed (exogenous) shipment dimensions (e.g., payloads); if this step is omitted, transportation flows are measured in tonnes instead of shipments. Finally, origin-destination matrices are assigned to a transport network model using standard traffic assignment techniques (e.g., shortest-path, user-equilibrium, etc.). Resulting transportation costs can be fed back to the CGE model (if possible) to consider the congestion impacts of the FTA, requiring all steps to be repeated until trade flows and trade costs stabilize. See Bachmann, Kennedy, and Roorda (2015) for further background information and details regarding the modelling framework.

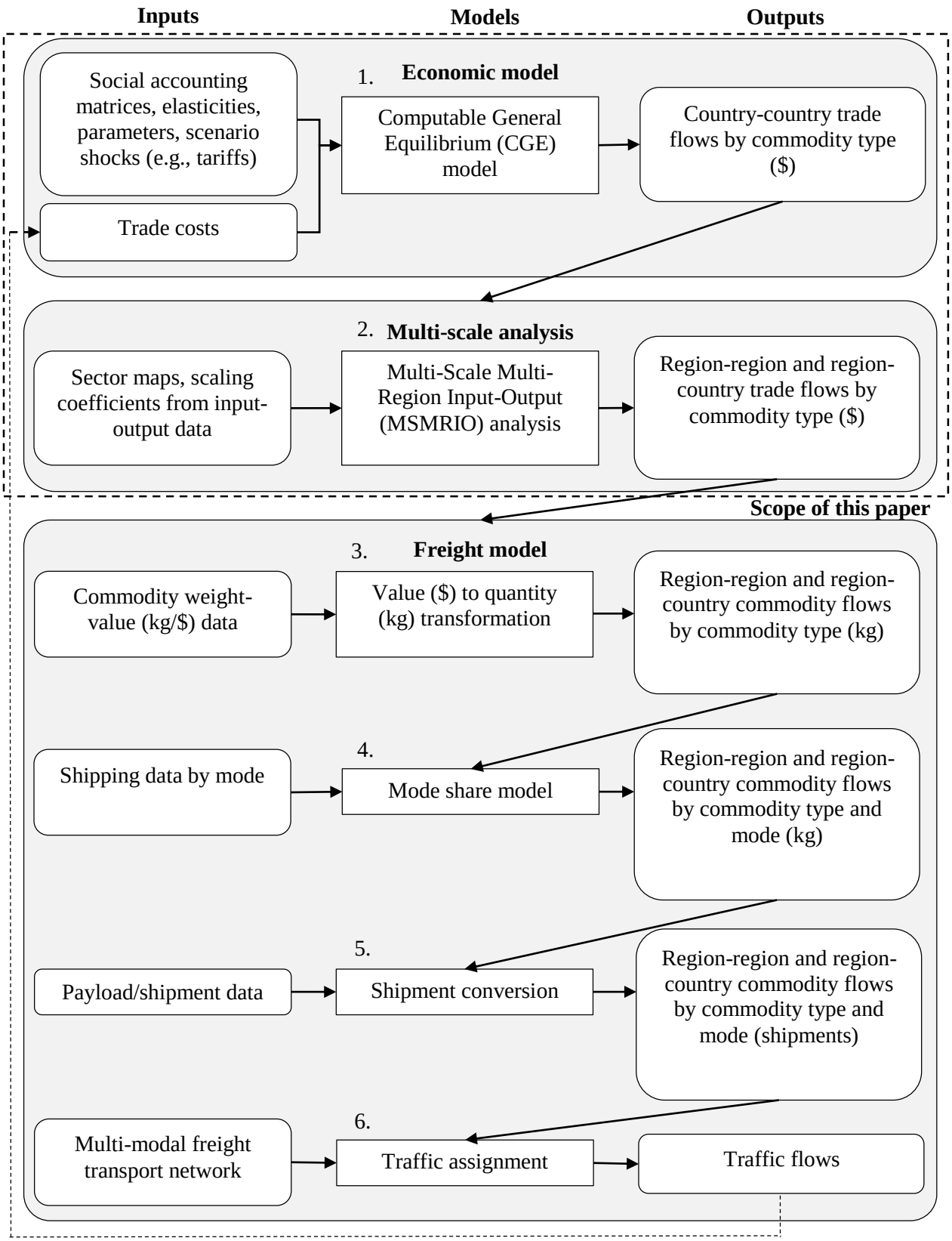

Figure 1. Modelling Framework

This paper describes the implementation of the first two components of the modelling framework for CKFTA and CETA as highlighted in Figure 1. The CGE analysis uses the standard Global Trade Analysis Project (GTAP) Model and the current release of the GTAP Data Base (version 9). The simulation of CETA follows the approach taken by the European Commission and Government of Canada (2008) and implements the same reductions in tariff barriers, non-tariff barriers (NTBs), and service trade barriers. For CKFTA, the ad-valorem tariff reductions at the 57 sector level estimated by Ciuriak and Xiao (2014) from the first formal analysis of the agreement as negotiated are adopted. Data for the MRIO analysis come from the Statistics Canada IO accounts. The linking of the CGE model and MRIO model is performed by apportioning the resulting international trade flows from the CGE simulations to individual provinces using Canada Border Services Agency (CBSA) trade flow data, allowing Canada's exports to be converted to provincial exports, and then applied as an exogenous demand shock to the MRIO model to determine interprovincial trade impacts.

Results

Table 1 and Table 2 summarize the macroeconomic impacts of CKFTA and CETA respectively. Table 1 shows that CKFTA has a greater impact with an unemployment model closure than with a neoclassical model closure. In the neoclassical model closure, quantities of primary factors (e.g., land, labour and capital) are exogenous and prices and rates of return are endogenous. On the other hand, there is a perfectly elastic supply of labour and capital at fixed real prices and rates of return respectively in the unemployment closure. The model closure should represent a valid economic environment, but what constitutes a "valid economic environment" is not entirely straightforward. In any case, the CKFTA generally has positive impacts on both countries, as measured by equivalent variation, regional household income, and change in GDP. According to these indicators, Canada as a whole benefits more from the CKFTA than Korea, but the agreement impacts parts of both economies differentially (sectoral impacts are discussed below). Similarly, Table 2 indicates that CETA is welfare improving for Canada, and to a lesser extent the EU. However, it is important to observe that tariff reductions alone lead to negative economic impacts by many indicators, and overall positive results from CETA depend on the assumed reductions in NTBs and service trade costs.

Table 1. CKFTA Macroeconomic Impacts for Alternative Model Closures
(% change over baseline unless indicated)

	Neoclassical		**Unemployment**	
Indicator	**Canada**	**Korea**	**Canada**	**Korea**
Equivalent Variation (millions $US)	387.8	26.3	4532.3	1385.9
Regional Household Income	0.103	0.001	0.285	0.103
Regional Household Income (millions $US)	161580.0	1026.2	447090.4	105700.2
Change in Value of GDP	0.098	0.003	0.282	0.109
GDP Quantity Index	0.006	-0.004	0.285	0.145
Private Consumption Expenditure	0.102	-0.005	0.283	0.095
Private Consumption Expenditure (millions $US)	1000.0	-31.7	2774.4	602.6
Government Consumption Expenditure	0.104	0.010	0.288	0.115
Government Consumption Expenditure (millions $US)	397.0	17.3	1099.4	198.9
Volume of Exports	0.038	0.062	0.309	0.209
Value of Exports (millions $US)	462.7	455.4	1524.0	1216.4
Volume of Imports	0.152	0.116	0.323	0.222
Value of Imports (millions $US)	711.8	687.6	1542.6	1330.6
Change in Trade Balance (millions $US)	-249.1	-232.2	-18.6	-114.2
Terms of Trade	0.061	0.012	0.007	-0.014

Table 2. CETA Macroeconomic Impacts on Canada by Policy Shock
(% change over baseline unless indicated)

Indicator	**Tariff Barriers**	**Non-Tariff Barriers (Goods)**	**Barriers to Trade (Services)**	**Total**
Equivalent Variation (millions $US)	2942	2086	2128	7155
Regional Household Income	-0.268	0.329	0.196	0.257
Regional Household Income (millions $US)	-4131	5072	3021	3962
Change in Value of GDP	-0.259	0.307	0.183	0.230
GDP Quantity Index	0.216	0.083	0.107	0.406
Private Consumption Expenditure	-0.287	0.325	0.195	0.233
Private Consumption Expenditure (millions $US)	-2763	3129	1877	2243
Government Consumption Expenditure	-0.237	0.334	0.199	0.296
Government Consumption Expenditure (millions $US)	-890	1255	746	1111
Volume of Exports	1.954	0.178	0.176	2.308
Value of Exports (millions $US)	8408	1466	1089	10963
Volume of Imports	1.930	0.549	0.363	2.843
Value of Imports (millions $US)	8825	2471	1636	12932
Change in Trade Balance (millions $US)	-417	-1005	-547	-1969
Terms of Trade	-0.174	0.140	0.060	0.026

Table 3 highlights the top five export and import impacts due to CKFTA and CETA. Canada's largest change in exports to Korea due to CKFTA occurs in the meat products sector (#20). This is followed by increases in exports to Korea of food products (#25). The agreement also leads to an increase of Canadian exports to Korea in the manufacturing sectors including machinery and equipment (#41), chemical, rubber, and plastic products (#33), and metals (#36). Overall, Canada realizes a total export gain to Korea of approximately $1.631 billion. The growth in Canadian exports to Korea represent large relative increases. For example, the growth in meat products (#20) exports to Korea represents an increase of 353% and the growth in food products (#25) exports to Korea is 156%. In terms of imports from Korea, the largest change occurs in the motor vehicles sector (#38). This is followed by increases in imports from Korea of auto related sectors including transport equipment (#39) and machinery and equipment (#41). The agreement also leads to an increase of Korean exports to Canada in the manufacturing sectors: chemical, rubber, and plastic products (#33) and textiles (#27). Overall, Korea realizes a total export gain to Canada of approximately $852 million.

Table 3 indicates Canada's largest change in exports to the EU due to CETA occurs in metals (#36), which sees an increase of $2.450 billion. This is followed by increases in exports to the EU of other manufacturing sectors including: chemical, rubber, and plastic products (#33), transport equipment (#39), machinery and equipment (#41), and food products (#25). These top five commodity export increases are all within the modest range of 20% to 30% relative growth, except for food products (#25), which exhibits approximately 100% relative export growth. Overall, Canada realizes a total goods export gain to the EU of approximately $9.293 billion. Three of the EU's top five goods export increases to Canada are in the same sectors as the top five Canadian goods export increases to the EU: machinery and equipment (#41), chemical, rubber, and plastic products (#33), and food products (#25). The other two commodities in the top five are motor vehicles and parts (#38), and wearing apparel (#28). The three largest absolute increases (#38, 41, 33), are only small to modest relative gains (42%, 15%, and 15% respectively). On the other hand, the increases in food products (#25) and wearing apparel (#28) are relatively large gains (103% and 193% respectively). Overall, the EU realizes a total goods export gain to Canada of approximately $18.178 billion.

Table 3. Canadian Export and Import Impacts by Province
(millions of 2011 US $)

		NL, PE, NS, NB	QC	ON	MB, SK	AB	BC	Total
#	Description	Change in Exports from Canada to the EU due to CETA						
36	Metals nec	8	840	1040	33	521	8	2450
33	Chemical, rubber, plastic products	14	178	558	212	41	17	1020
39	Transport equipment nec	8	693	164	4	4	9	883
41	Machinery and equipment nec	17	289	403	31	48	50	837
25	Food products nec	88	313	88	35	131	20	675
		Change in Imports from the EU to Canada due to CETA						
38	Motor vehicles and parts	111	472	977	120	258	182	2125
41	Machinery and equipment nec	128	306	553	148	385	184	1713
33	Chemical, rubber, plastic products	76	308	645	102	143	138	1414
25	Food products nec	74	294	486	106	145	209	1318
28	Wearing apparel	49	185	305	49	106	97	793
		Change in Exports from Canada to Korea due to CKFTA						
20	Meat products nec	21	228	47	191	154	155	797
25	Food products nec	4	48	10	40	33	33	168
41	Machinery and equipment nec	1	18	72	2	29	6	127
33	Chemical, rubber, plastic products	1	14	42	20	5	8	89
36	Metals nec	0	4	14	4	5	28	56
		Change in Imports from Korea to Canada due to CKFTA						
38	Motor vehicles and parts	33	139	288	35	76	54	626
33	Chemical, rubber, plastic products	4	15	32	5	7	7	69
27	Textiles	2	7	12	2	4	4	32
39	Transport equipment nec	2	9	9	2	5	3	31
41	Machinery and equipment nec	2	5	9	2	6	3	28

Free trade agreements also have secondary impacts through trade creation and diversion – trade flows that are redirected from one country (diversion) to another country (creation), specifically due to the formation of the FTA. For example, Table 4 shows the total trade created and diverted due to CETA. Europe's increase in exports to Canada ($21.116 billion) partly displaces exports from all other regions including $5.159 billion from the United States and Mexico and $2.567 billion from Asia. On the other hand, Canada's increase in exports to Europe of $11.513 billion mostly displaces trade from countries within Europe ($10.421 billion). Aside from the changes to trade flows involving Canada and the EU, the United States imports slightly less from all regions except Mexico. The remaining regions are affected little by CETA. Overall, the net global trade created is $12.249 billion. Finally, to model the transportation impacts of CETA, the international export and import trade flows for Canada as shown in the Canada row and column of Table 4 respectively, can be disaggregated by commodity type and destination country (not shown for the sake of brevity) for subsequent conversion to quantities, mode-split, shipments, and so on.

Table 4. CETA's Trade Creation and Diversion, Total Goods and Services (millions of 2011 US $)

Origin/ Destination	Australia, New Zealand	Asia	Canada	US, Mexico	Europe	South America	Africa	Total
Australia, New Zealand	14	62	-83	-11	31	1	5	19
Asia	30	1232	-2567	-1017	2311	-5	102	86
Canada	-3	-41	0	-403	11513	-8	0	11058
US, Mexico	149	2176	-5159	372	1784	400	134	-144
Europe	-321	-5146	21166	-2999	-10421	-643	-449	1187
South America	3	58	-121	-57	162	23	17	85
Africa	0	18	-59	-19	3	-2	17	-42
Canada	-128	-1641	13177	-4134	5383	-234	-174	12249

Another secondary impact of FTAs is a change in subnational trade flows as a result of multiplier effects. For example, increased food exports to Korea represents an increase in final demand for Canadian food (recall that exports are a form of final demand). Increases in the final demand for food triggers increases in the inputs required to produce food, including other commodities, as well as value added (i.e., factors of production such as land, labour and capital). Of course, these increased demands for inputs also trigger new inputs for their production, and so on. Inputs are often sourced locally, but also from neighbouring regions and even more distant trade partners. Hence, FTAs impact international trade flows (through trade creation and diversion) as well as subnational trade flows (through interregional multiplier effects). Table 5 shows the total impact of CETA on Canada's interprovincial trade flows. The diagonal elements of Table 5 have the largest values in their columns, meaning that provinces generally supply themselves with their greatest share of total domestic inputs. Quebec, Ontario, and Alberta have the largest intra-provincial trade increases, while the largest interprovincial trade growth occurs between Ontario and Quebec.

Table 5. CETA's Interprovincial Trade Impacts, Total Goods (millions of 2011 US $)

Origin/Destination	Newfoundland and	Prince Edward	Nova Scotia	New Brunswic	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia
Newfoundland and Labrador	-4	0	2.8	-0.5	16.7	5.2	0	0.1	0.1	0
Prince Edward Island	0	-0.1	0.8	-0.3	0.4	0.3	0	0.1	0	0
Nova Scotia	5.6	0.1	30.5	-2.4	4.9	0	-0.5	0.2	-1.1	-1.2
New Brunswick	9.2	0.6	6.4	-9.5	18.6	1.5	0	0.2	1	-0.1
Quebec	-0.9	-0.4	5.9	-4.9	472.4	30.9	-3	0.7	-2.1	-10.3
Ontario	0	-0.1	8	-5	81.9	314.8	-6.3	11.2	11.5	-13.7
Manitoba	-0.1	0	0.5	-0.2	3.2	7.2	-2.4	5.3	1.8	-2
Saskatchewan	0	0	0.4	-0.2	5.2	10.7	-0.4	83.5	9.5	-1.6
Alberta	1.5	0	1	-0.4	24.1	42.1	6.4	44.6	287.8	-3.2
British Columbia	-0.4	0	1.1	-0.6	5.1	1.8	-0.5	4.2	27.5	-57.8

Discussion

The simulation of FTAs is complex. First, the choice of model closure (i.e., choice of endogenous versus exogenous variables) is debatable. As the results in this paper show, the macroeconomic impacts of CKFTA vary with the model's closure. Overall, the agreement has a greater impact in the long-run (unemployment) closure than in the medium-run (neoclassical) closure. In the medium-run, fixed endowments often lead to higher factor prices when industries expand, resulting in increased prices and damped demand effects. In the long-run, fixed factor prices create a limitless pool of factors, promoting industry expansion. The downside of the long-run closure is that factors may be drawn from a pool that does not actually exist. In this light, researchers may choose to experiment with different model closures and prioritize consistent results among alternative closures. Second, the choice of "shocks" to represent the FTA influences the model results. As the results in this paper show, the elimination of tariffs alone to represent CETA can lead to detrimental consequences in Canada (e.g., value of GDP, regional household income, and total goods output), and hence concurrent reductions in NTBs and service trade costs are required for Canada to have benefits from CETA. Shocks to NTBs and service trade costs are more difficult to model however, since they are not represented analytically in the model. The European Commission and Government of Canada (2008) suggest a notional cost reduction of 2% of the value of trade in non-commodity goods sectors between Canada and the EU is supported by anecdotal evidence, including a sample of regulations identified as having trade-inhibiting effects and economic assessments of the trade-deepening effect of regional economic integration agreements. However, the Canadian Center for Policy Alternatives noted this assumption was not supported by actual empirical evidence (Stanford, 2010). Reductions in service trade costs are similarly difficult to model. In this study, a cost reduction amount equivalent to that estimated to have been achieved in service trade among EU members was adopted for CETA. These estimates come from the results of a gravity model that quantified the "EU effect" (i.e., the extent to which the costs of providing services within the EU have been reduced through the implementation of the single market). For the sake of transparency, results indicating the contribution of the assumed reductions in tariff barriers, NTBs, and service trade barriers, to the total economic and trade impacts should be presented. Given the complexity of CGE modelling and the opportunity for variability in the results due to the large number of assumptions, a sensitivity analysis is recommended at the conclusion of the analysis (i.e., for transportation impacts). For example, a distribution of traffic flow volumes at a particular border crossing could be determined based on varying assumptions about model closures and parameter values.

FTAs have primary and secondary (or direct and indirect effects) on transportation demands. FTAs primarily impact trade flows between member countries (e.g., Canada and Korea with CKFTA, Canada and the EU with CETA). However, FTAs also create secondary effects through trade creation and diversion – trade flows that are redirected from one country (diversion) to another country (creation), specifically due to the formation of the FTA. In the case of CKFTA, Canada's increase in exports to Korea partly displaces exports from other countries such as the United States, the EU, and South America. Similarly, Canada's import mix changes in response to an FTA: in the case of CETA, Canada's increase in imports from the EU partly displaces imports from all other regions including large volumes from the United States and Asia. Transportation impacts are likely since these trade flows may use different infrastructure (e.g., highways, ports, rail, etc.) for the Canadian leg of the journey. Another secondary effect results from increased intermediate inputs to satisfy increased export demand. In other words, since Canadian industries use commodities to make commodities, their increased outputs trigger increased inputs, and hence increased production and interprovincial trade. In Canada, the interprovincial trade changes are relatively small compared to international trade changes for 3 reasons: 1) international export demand growth is a direct demand change in commodity *output*, whereas these smaller trade changes are derived demands for commodity *inputs* used to make those exports; 2) provinces generally supply themselves with their greatest share of total domestic inputs; and 3) the net change in provincial trade flows is a result of the relatively small total changes in domestic consumption, in export demand (net of trade created and diverted due to the FTA), and in intermediate demands from other domestic industries.

Conclusion

Free trade agreements impact trade flows and therefore transportation flows. Preliminary results from simulations of CKFTA and CETA indicate differing trade flow impacts. CKFTAs impacts are concentrated in fewer sectors and tend to have larger relative increases. On the other hand, CETAs impacts are larger and spread across several sectors, although these impacts are smaller in relative terms. From an economic view, simulations suggest CETA will have a larger impact. From a transportation view, the simulation results do not provide sufficient evidence to draw detailed conclusions for two reasons. First, while CETA's economic impacts are large in absolute terms, they tend to be smaller in relative terms. This might suggest CETA has existing supply chains which will be strengthened by the FTA. On the other hand, CKFTA's trade flow impacts are smaller in absolute terms, but higher in relative terms. This indicates CKFTA may result in the development of new supply chains that did not previously exist. Second, without simultaneously modelling all of the changes in transportation flows (i.e., changes in imports and exports to all countries), it is not possible to determine transportation impacts because each trade flow uses a particular path or set of competitive paths in the network. In fact, macroeconomic impacts alone can be misleading. For example, consider a hypothetical scenario where Korea imports more of a certain commodity from Canada, and the United States begins importing exactly the same amount less of that commodity from Canada. In this case, there is no net change in output to the Canadian industry producing the commodity. In other words, there is little or no macroeconomic impact because there is no shift in commodity production before and after the change in trade patterns. However, the transportation implications should be obvious: the commodity is no longer being exported to the United States, but rather to Korea. In this case, there is a change in trade flows despite the constant level of commodity production and hence transportation impacts are likely. Therefore, it is not possible to immediately deduce transportation impacts without further analysis, such as the remaining steps in the modelling framework (Figure 1).

In an increasingly globalized world, there is a need to understand: 1) what new demands from economic activities tied to global networks will be placed on Canada's transportation infrastructure; and 2) what investments will maximize the capacity, reliability, and resiliency of the Canadian transportation network to enhance the vitality of Canada's economy and support its global competitiveness. To the best of the author's knowledge, no studies have specifically identified the impacts of a potential FTA on a country's domestic infrastructure, such as highways, bridges, border crossings, railways, marine ports, and airports. Hence, this paper has focused on the first question in the context of FTAs. However, future global trade patterns will be shaped by many different events. Population growth and developing economies will create increased consumption and emerging markets throughout the world. For example, Asia is expected to contain two thirds of the world's middle class by 2030 and half of global GDP by 2050 (Government of Canada, 2015b). International transportation costs, transport technology, and trade-oriented infrastructure, will impact trade flows through trade costs. For example, technological changes in air shipping and the declining cost of rapid transportation has been a critical input into globalization thus far (Hummels, 2007). In this light, future global trade patterns will be the result of a complex and dynamic interaction of economies, technologies, infrastructure, and policies, all of which must be considered in planning Canada's domestic trade infrastructure. Finally, research is needed on the latter and perhaps more complex question: how can Canada's transportation system be optimized for Canada's economy and global competitiveness?

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