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## OPENING CANADA'S NORTH: A STUDY OF TRADE COSTS IN THE TERRITORIES

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### SUMMARY

Challenged by remote locations, small populations, rugged terrain and (at times) difficult climate conditions, Canada's territories rely heavily on imported goods to maintain their standards of living. At the same time, industries in the territories are highly reliant on access to export markets – especially the large and growing resource sectors of the region. But these trade flows face significant costs that improved infrastructure may help mitigate. A northern transportation corridor could help, and has recently gained prominence following recent reports and hearings by the Senate of Canada. The potential gains are large.

This paper estimates trade costs in Canada's North. We find policy-relevant trade costs (those trade costs that policy changes may help lower) are substantial. The regulatory differences, time delays and lower infrastructure quality that inhibit trade add between 20 to 30 per cent to the cost of a delivered good for Yukon and Northwest Territories and over 60 per cent for Nunavut. Infrastructure may be a large cause of higher trade costs. We find that distance-related costs are 45 per cent higher per kilometre for trade with a territory than for trade between two provinces.

The region's economy, productivity, income and investment are significantly lower as a result. Using a detailed model of the Canadian economy, we find that lowering these barriers – such as through improving northern transportation infrastructure – could add up to \$6.5 billion to Canada's GDP, with most of that gain occurring in the territories. For the Yukon, Nunavut and Northwest Territories the gains equal about \$40,000 per person, which is a 50 per cent increase in productivity.

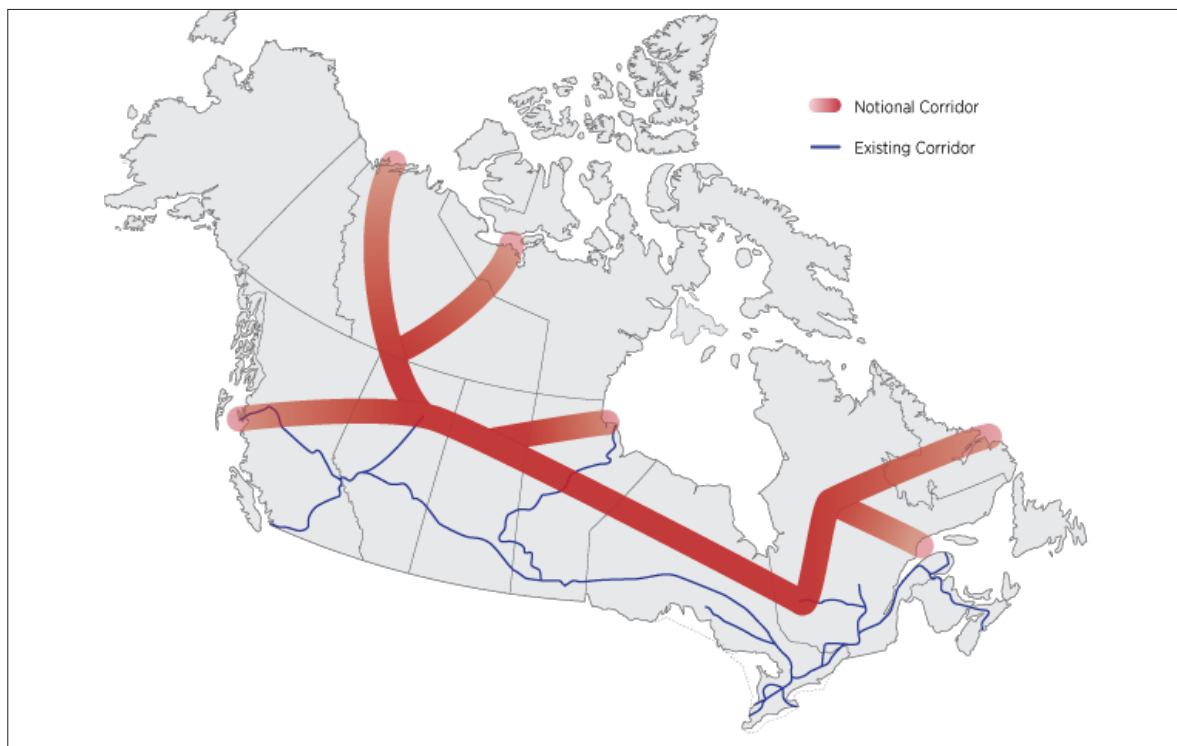
The Senate's advocacy for reducing trade barriers is encouraging and the federal government broadly supports knocking down these barriers. It is time for all three levels of government to work together to create policies on, and funding for, improved infrastructure in Canada's North and near-North.

## INTRODUCTION

Trade matters for Canada's economy. And while international trade receives disproportionate attention, Canada's internal trade among its various provinces and territories is no less critical. This is especially true for Canada's North.

The importance of internal trade for Canada's North has recently gained prominence in two sets of hearings and subsequent reports by the Senate of Canada. In 2016, the Senate released a report on the state of internal trade (Senate of Canada, 2016) that discussed the renewal of Canada's *Agreement on Internal Trade* as well as other measures to lower internal trade barriers, including harmonizing or mutually recognizing regulations across the provinces and territories. Shortly after, in 2017, the Senate released a report on the concept of a northern transportation corridor (Senate of Canada, 2017). This multi-modal corridor could house and facilitate new high-quality transportation infrastructure to serve Canada's North, near-North and other potentially under-served regions. The federal government broadly agrees with the Senate report, further substantiating national interest in the concept.<sup>1</sup>

MAP 1 A NOTIONAL ROUTING FOR THE CANADIAN NORTHERN CORRIDOR



<sup>1</sup> See "Federal Government Endorses Senate National Corridor Report." (Press Release) <https://sencanada.ca/en/newsroom/federal-government-endorses-senate-national-corridor-report/>

The northern corridor concept is a developing notion based on a research program (of which this paper is a part) put forward by The School of Public Policy. Conceptually, the northern corridor as envisioned here derives from the work of Sulzenko and Fellows (2016). Map 1 (above) gives a notional routing for the corridor.<sup>2</sup>

How valuable would such a corridor be? How much more difficult is trade for Canada's northern territories? To shed light on these questions, we present several measures of the internal and international trade costs faced by Canadian provinces and territories. Using these estimates, we conduct a series of counterfactual simulation experiments using a computable general equilibrium (CGE) model of the Canadian economy. In particular, we explore the economic effects of reducing or eliminating trade costs (through policy liberalization, infrastructure improvements or a combination of the two). We show that the northern territories have large trade costs and a high reliance on trade, implying a very large potential to gain from improved infrastructure and liberalization. In addition, though the 120,000 people in the territories account for only one-third of one per cent of Canada's population, we show there are material economic gains throughout Canada if trade with the territories improves.

Challenged by remote locations, small populations, rugged terrain and (at times) difficult climate conditions, Canada's territories rely heavily on imported goods to maintain their standards of living. The overwhelming majority of agricultural and manufactured goods purchased for use in the territories are imported – often at great cost in terms of time, fuel and lower quality. This matters for economic competitiveness, as imported inputs used by business become more costly, and it matters directly for household living standards. The government of Nunavut, for example, estimates the cost of groceries is roughly double the Canadian average across four dozen food items surveyed.<sup>3</sup> A typical box of corn flakes is nearly \$10 in Baffin Island but well below \$5 in the rest of Canada. The gap is even larger for fruits and vegetables. And for goods and services on the whole, a Library of Parliament report estimates northern prices are roughly 28 per cent higher than in southern Canada (Preville, 2008).

At the same time, industries in the territories are highly reliant on access to export markets – especially the large and growing resource sectors of the region. To illustrate, the resource sectors in the territories export over 80 per cent of their production while the same sectors in the provinces export closer to two-thirds. Infrastructure quality is critically important to access and export from the territories. The latest announcement of \$360 million in combined federal and territorial funding for the Yukon Resource Gateway Project is a concrete example of new spending that may help facilitate greater resource development in Yukon, boosting its economy, raising incomes, and lowering prices for businesses and households alike.<sup>4</sup>

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<sup>2</sup> This map is an updated version of map 2 from Sulzenko and Fellows (2016). As with Sulzenko and Fellows, we remain agnostic on the corridor's specific location; however, the map here has been updated to reflect plans already forwarded by the governments of Yukon and Northwest Territories for the Slave Geological Province Access Corridor. See <http://www.dot.gov.nt.ca/Projects/Future-transportation-corridors/Slave-Geological-Province-Access-Corridor>

<sup>3</sup> For detailed data, see <http://www.stats.gov.nu.ca/en/Economic%20prices.aspx>

<sup>4</sup> For details, see <http://pm.gc.ca/eng/news/2017/09/02/new-road-access-improvements-help-grow-yukons-natural-resources-sector>

Most shipments to and from the territories are by truck, and it is not hard to see how infrastructure quality can affect transportation and trade costs. First, the distances are vast and there is limited scope for air and sea shipments. Recently released data from Statistics Canada on internal trade show the average truck shipment destined for the territories travels over 2,100 kilometres compared to 1,400 for shipments to provinces. In addition, shipments to territories are heavier and of lower value than typical shipments to provinces. And the cost of shipping is higher. Carrier revenue is roughly 10 per cent of the value of shipments to the territories, compared to less than three per cent for the provinces. This is not just due to long distances and heavy loads, as the revenue per tonne-kilometre is also one-third higher for shipments to the territories. In short, trade is more costly for the territories, and this matters.<sup>5</sup>

Of course, trade also goes beyond physical goods and resource imports and exports. Consider tourism, which is a particularly important part of some territorial economies. For instance, visitors to Yukon spend over \$300 million annually – over 10 per cent of Yukon’s GDP. Overall, roughly one-fifth to one-third of output is exported either abroad or to the rest of Canada, depending on the territory. On the import side, nearly three-quarters of all spending on professional and scientific services is imported into the territories. Better facilitating trade in these services requires infrastructure, such as reliable telecommunications and broadband internet access.

Despite the importance of this issue, little research has been done on the nature, magnitude and consequences of high trade costs facing the territories. In part, the lack of prior research here is due to the difficulty of measuring the unobservable. Trade costs, broadly understood, include anything inhibiting trade between two regions that would have otherwise occurred. Taxes and fees on imports or exports, quota restrictions on the amount of imports, the distance and time required to ship goods, lack of knowledge of which products are available, poor quality transportation infrastructure and policies (such as regulations or product certifications that differ across regions), are just a few examples of what contribute to trade costs.<sup>6</sup> Not all of these factors are directly or easily observable – indeed, with the exception of explicit taxes and fees, most are not. And even if they were, aggregating the disparate factors together in a single measure of trade costs is a challenge. In addition, the degree to which policy-makers have control over trade costs in Canada’s North is an open question.

Using recent developments in international trade research and the latest data on internal trade from Statistics Canada, we overcome some of these challenges. We provide the first quantitative estimate of the size of trade costs facing Canada’s northern territories and the potential economic gains from policy liberalization and infrastructure development.

We begin our analysis with a broad review of the patterns of trade with and between the territories. With these data, and frontier methods from international trade research, we then quantify the size of Canada’s internal and external trade costs. We find they are

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<sup>5</sup> These data are based on the March 28, 2018 release of the Canadian Freight Analysis Framework (Statistics Canada 50-503-X).

<sup>6</sup> Poor quality roads, such as the winter roads common in Canadian territories, have been estimated to increase per-mile fuel consumption by up to 50 per cent with associated cost implications. See Michaelis et al., (1996).

substantially higher for the territories than for provinces – average costs for Yukon and Northwest Territories are equivalent to a 100 per cent tariff on imports, and a 190 per cent tariff for Nunavut. That is, trade costs in the form of regulatory differences, time delays, infrastructure quality and all other inhibitors of trade, are equivalent to a tax of 100 per cent to 190 per cent (depending on the territory)<sup>7</sup> on goods traded to and from those regions. To be sure, not all of these costs are policy-relevant. We present two alternative measures that attempt to net out the factors beyond government control, though still find large territorial trade costs remain.

Finally, we develop a detailed model of the Canadian economy that allows us to gauge the economic consequences of these large trade costs. We find GDP, productivity, income and investment are all substantially lower as a result of high trade costs. To illustrate, if trade costs were as low per kilometre between the territories and the rest of Canada as they are between the provinces, we estimate territorial GDP would grow by over \$4.6 billion per year with additional net positive spillovers to GDP in the rest of Canada of \$2 billion per year (though the short-run effects are somewhat smaller). These gains are very large, increasing territorial GDP by nearly 50 per cent. We provide various alternative measures of policy-relevant trade costs, and find potential gains are also approximately \$4.5 billion to \$6 billion.

Would these gains justify large-scale infrastructure spending in the region? Potentially. These gains are annual, and discounted at a reasonable rate of, say, five per cent per year, represent present value gains on the order of \$100 billion. Our results suggest that, broadly speaking, the gains from such initiatives can potentially be very large.

Our analysis proceeds as follows. We begin with a summary of trade patterns with and between Canada's territories. With these data in hand, we describe and apply recent methods from the international trade research literature to infer the magnitude of trade costs within Canada. We then briefly and intuitively describe the CGE model of Canada's economy. Though we omit details of the model, we fully describe the results and the intuition behind them.<sup>8</sup> We conclude with policy recommendations.

## SUMMARY OF TRADE PATTERNS

How important is trade for the territories? What do they import and export, and to whom? We briefly answer these questions using the latest data from Statistics Canada. The national statistical agency produces among the highest quality and most detailed data on internal trade flows in the world. The latest data are found in CANSIM Table 386-0003 and reveal a few notable patterns.

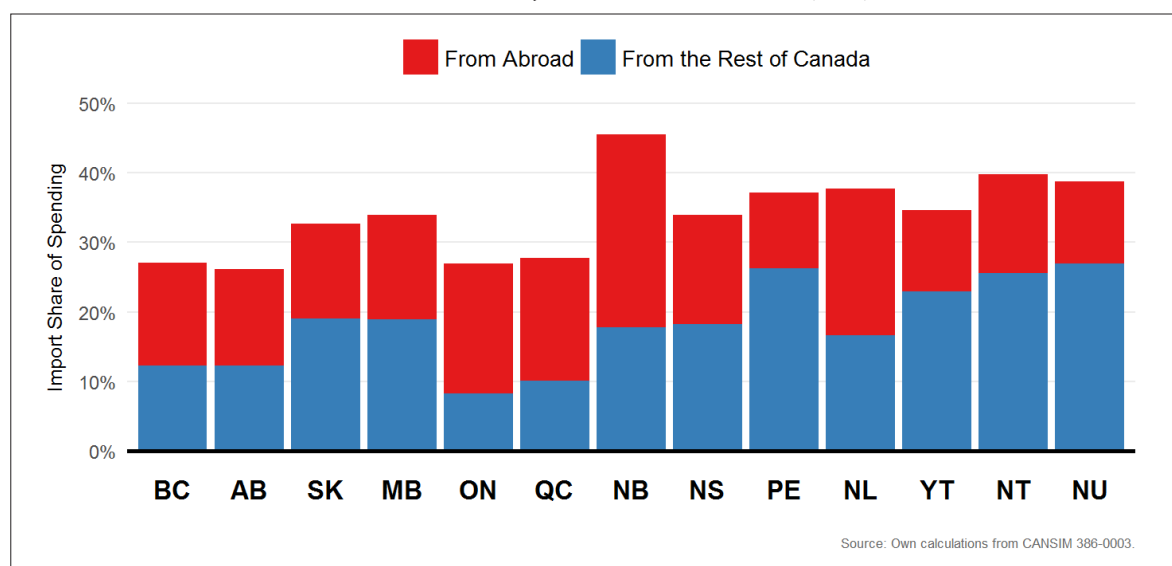
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<sup>7</sup> These trade cost measures also vary by sector.

<sup>8</sup> The guiding principle behind our CGE model approach is that we are simulating improvements in the per unit-mile cost of transportation to reflect improvements in infrastructure in the territories. This standard is agnostic in terms of specific transportation modes but broadly implies both reliability and cost improvements in northern transportation of goods and services. These include digital services served via telecommunications infrastructure as well as potential improvements in utilities transmission (power lines and pipelines) and traditional cargo infrastructure (ports, roads, railways and airports).

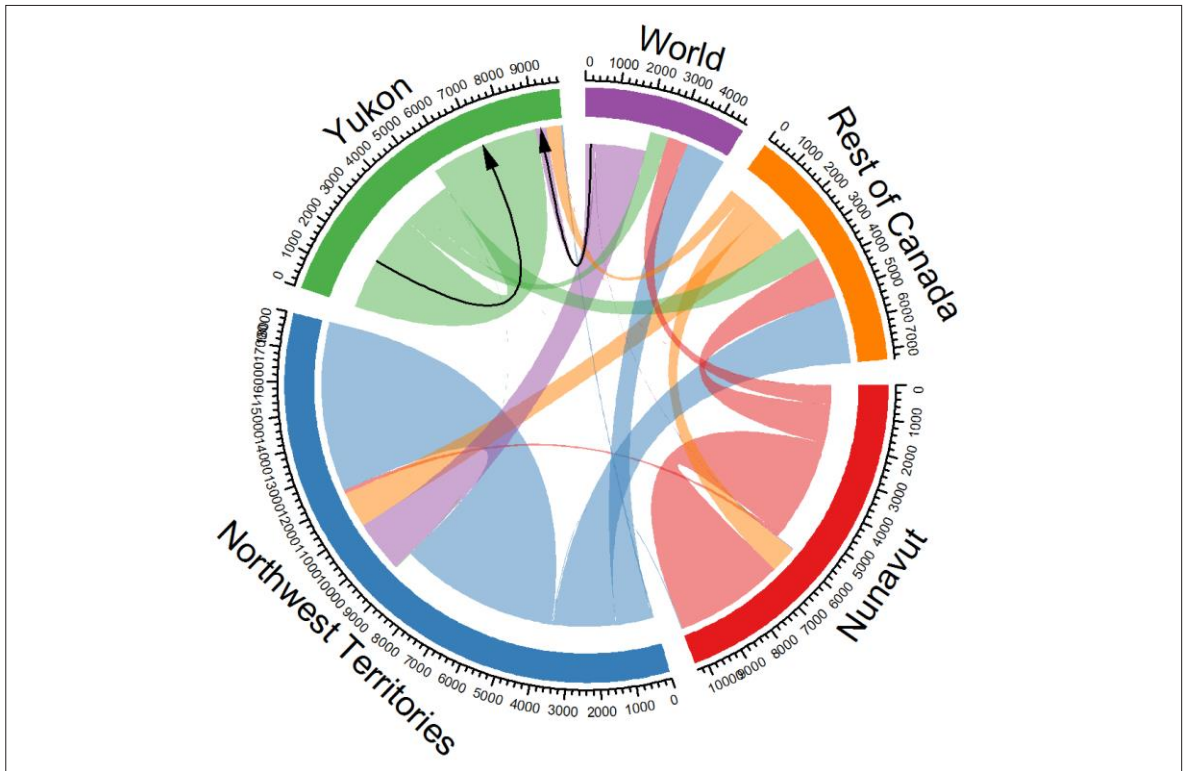
First, the territories rely heavily on imported goods. We plot in Figure 1 the share of total spending – on either final goods or inputs used by firms – that are allocated to imports from other regions of Canada or from abroad. We see that, like the Atlantic Provinces, the territories rely more on imports to meet their domestic demand than other regions. Overall, imports account for 35 per cent of Yukon spending, 40 per cent of Northwest Territories spending, and over 39 per cent of Nunavut spending. For the provinces as a whole, this average is 28 per cent. The higher spending on imports is also disproportionately allocated to suppliers in the rest of Canada, rather than on imports from international sources. Roughly one-quarter of their total spending is on goods and services that originate in southern Canadian provinces, which is twice the share allocated to imports from abroad.

**FIGURE 1 IMPORT SHARE OF TOTAL SPENDING, BY REGION AND SOURCE (2013)**



Second, there is very little trade between the territories. To see this, we present a visualization of the trade flows of each territory between each other, the world and the rest of Canada in Figure 2. Thicker connections indicate greater trade volumes. All territories import a great deal from both the rest of Canada and the world, but very little trade exists between the territories themselves. East-west connections in the North are essentially non-existent.

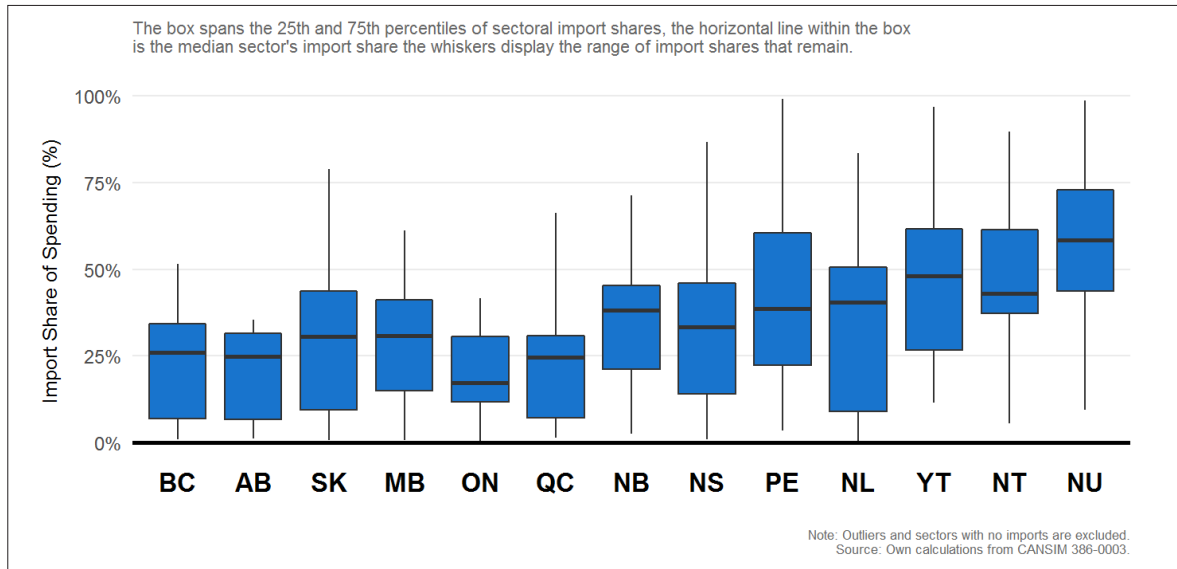
FIGURE 2 TRADE FLOWS OF THE CANADIAN TERRITORIES (2013)



To dig below the aggregate numbers, we construct industry-level trade flows from the product-level data provided by Statistics Canada. We define sectors according to standard sectoral classification codes (the North American Industry Classification System or NAICS) and aggregate the Statistics Canada commodity data to the two-digit sector level. For example, grains and crop products are assigned to the agricultural sector, as are live animals. We find some sectors are much more trade-intensive than others and this is especially true for the territories.

In Figure 3, we show the import shares of spending by sector for each of Canada's regions. This box plot illustrates the individual import shares across sectors within a region and how they compare with each other. The top and bottom of the shaded box are the 25th and 75th percentiles – that is, within each box is half of all sectors. The horizontal black line within the box marks the median sector's import share. For the territories, nearly half the sectors have imports that account for a majority of total spending.

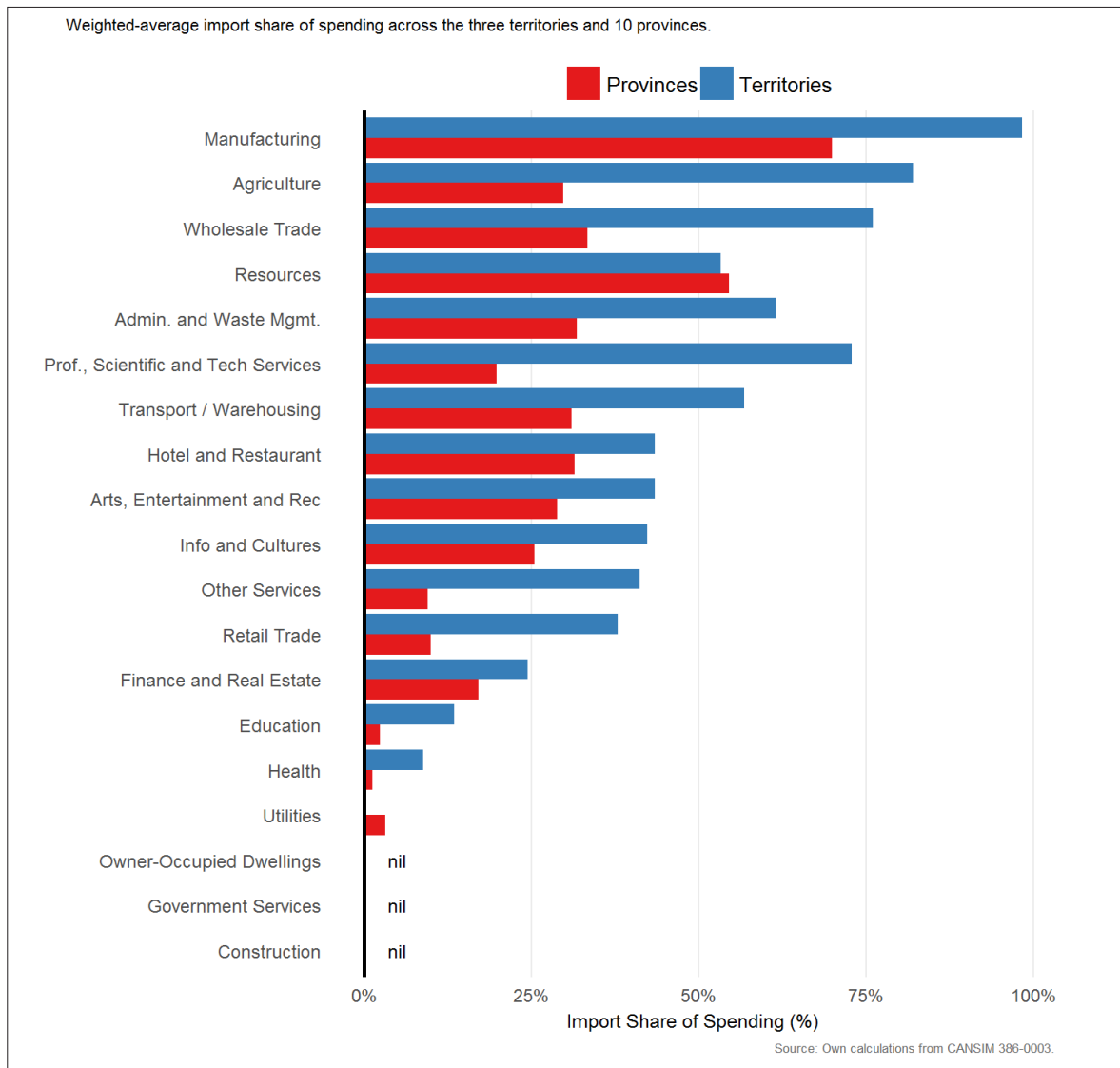
**FIGURE 3 IMPORT SHARE OF SECTORAL SPENDING, BY REGION (2013)**



Which sectors have higher import shares? And how do territories and provinces differ? To answer these questions, we aggregate the territories together and display the overall average import shares for each sector in Figure 4. Imports satisfy almost all final demand for manufactured goods, agricultural products, wholesale trade, and professional and scientific services. Imports satisfy less final demand for services such as utilities, which are more difficult to trade and local production is typically necessary, but also services such as health or real estate. For comparison, we also plot the provincial import shares. The starkest differences are for agricultural products, which are almost entirely imported into the territories while imports are only one-quarter of spending on agricultural goods in the provinces.

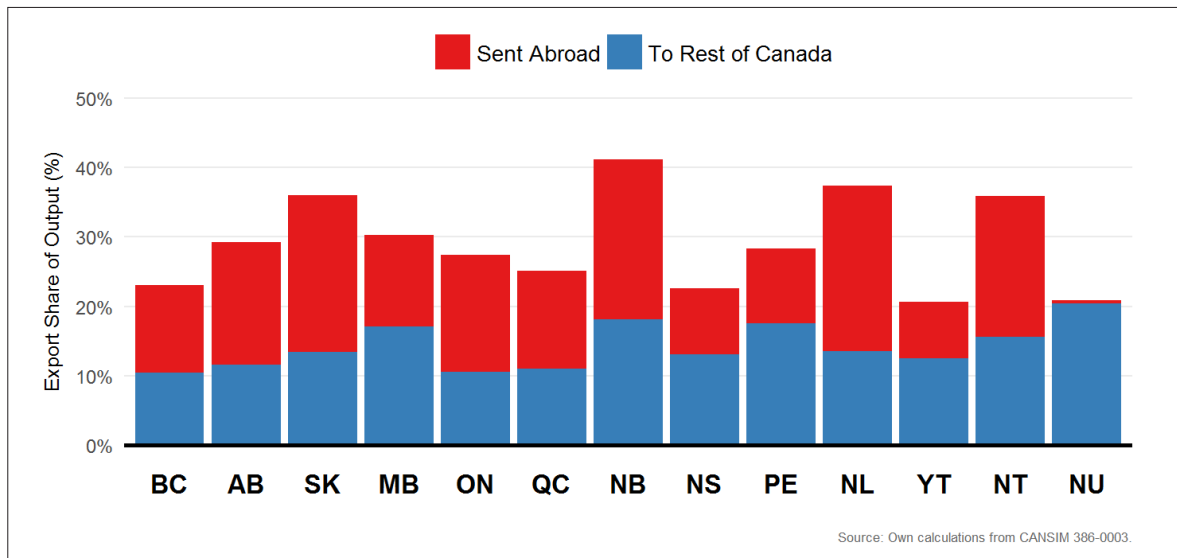


**FIGURE 4 IMPORT SHARES IN CANADA, BY SECTOR (2013)**



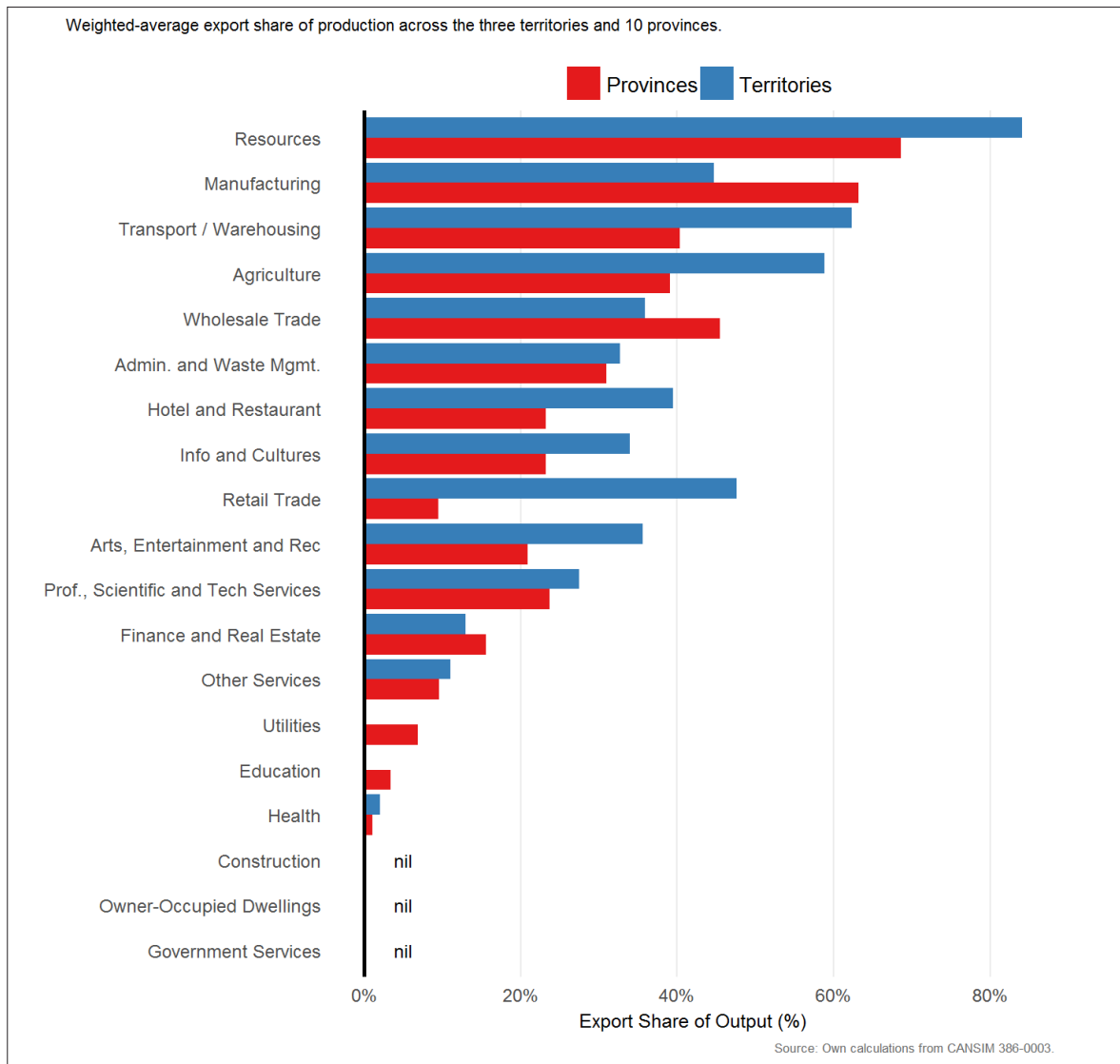
The above figures represent measures of how trade matters for imports of inputs by territorial business and final goods and services by households. Export patterns in the territories are equally interesting as indicated by Figure 5. Consider first the aggregate share of production exported across each of Canada's regions, separately for international exports and inter-regional trade within Canada.

**FIGURE 5 EXPORT SHARE OF TOTAL PRODUCTION, BY REGION (2013)**



The Northwest Territories exports a large share of its total production relative to most other regions of Canada and has an especially large international export share. Though other territories do not export much more than other provinces, this masks differences across sectors in the importance of trade for their production. Consider Figure 6, which displays the export shares by sector for the territories and the provinces. The resource sectors, which are central to the economic activity of the territories, export over 80 per cent of their production compared to a two-thirds share for the provinces in this sector. This sector also accounts for the majority of territorial exports.

**FIGURE 6 EXPORT SHARES IN CANADA, BY SECTOR (2013)**



Export patterns also provide an opportunity to examine in which sectors territories have a particular advantage. If a sector exports more of a good or service than most other regions, then one may conclude it has a so-called comparative advantage in that good or service. This common measure is the Revealed Comparative Advantage Index (also, the Balassa Index),<sup>9</sup> and it compares the composition of exports by region to the Canadian average. For example, two-thirds of Nunavut’s exports are accounted for in the resource sector, while for Canada as a whole it is only 16 per cent. In Table 1, we report this measure of revealed comparative advantage for the six most heavily traded products in Canada. All three territories share this strong measured comparative advantage in resources, and are of similar magnitude to Alberta’s. Both Yukon and Northwest Territories have a measured comparative advantage in tourism-related activities, and each also has a high measured advantage in wholesale and retail trade and transportation. These other activities, however, are minor as resources dominate by far.

<sup>9</sup> The Balassa Index indicates a comparative advantage or disadvantage relative to a value of one. Using the index, values above one indicate that the region has a comparative advantage in production in a given sector while a value below one indicates a comparative disadvantage in production in a given sector.

**TABLE 1 EXPORT SHARES AND REVEALED COMPARATIVE ADVANTAGE**

	Share of Interprovincial Exports				Revealed Comparative Adv.		
	CAN	YT	NWT	NU	YT	NWT	NU
Manufacturing	0.43	0.01	0.01	0.02	0.02	0.02	0.05
Resources	0.16	0.47	0.68	0.67	2.91	4.17	4.10
Wholesale	0.07	0.02	0.02	0.01	0.29	0.28	0.12
Transport / Warehousing	0.07	0.09	0.15	0.05	1.37	2.34	0.79
Finance and Real Estate	0.06	0.08	0.02	0.04	1.19	0.36	0.63
Prof., Scientific and Tech.	0.05	0.05	0.02	0.01	0.90	0.31	0.28

In this section, we've seen that trade has a large importance for the territories, particularly trade between them and Canada's provinces. How much does this trade matter for their economies? How costly is this trade? And by how much could they gain if trade were made easier? To answer these questions, we require more than just raw data. In the next section, we develop tools that allow us to estimate not only the value of trade, and the magnitude of costs that inhibit it, but also to gauge the importance of potential liberalizations and policy reforms to make trade to and from the territories easier.

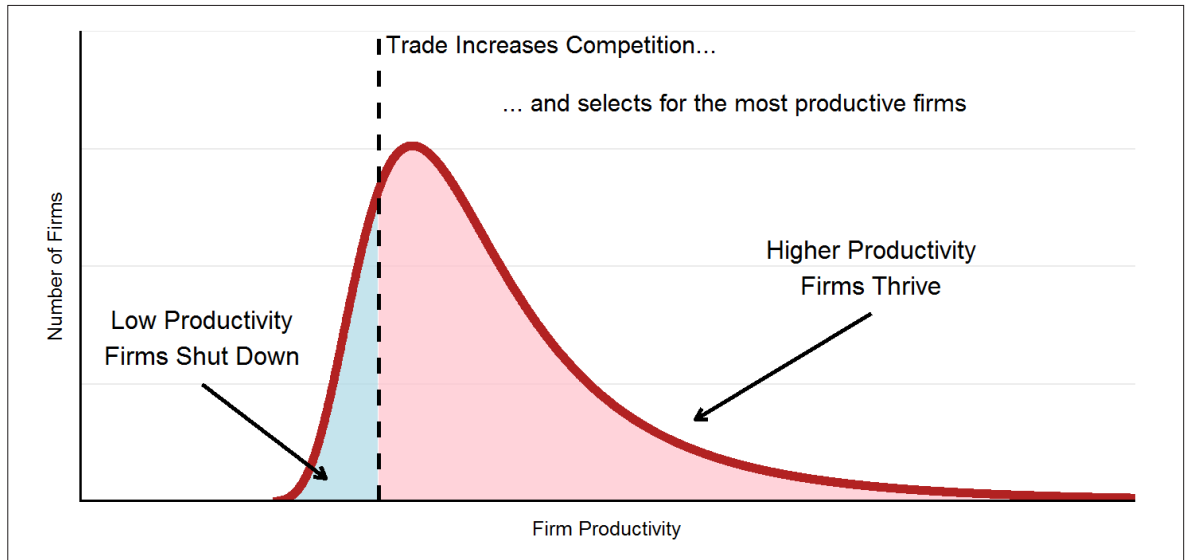
## THE BENEFITS AND COSTS OF TRADE

For centuries, economists have known trade boosts aggregate economic activity and productivity. By focusing on activities at which one is relatively good, and trading with others for the rest, aggregate productivity of all trading partners rises and households' income and consumption varieties increase. By how much our current level of trade contributes to overall productivity amounts to quantifying by how much productivity would fall if trade fell to zero (autarky). This is a difficult question to answer.

One option involves first presuming a certain distribution of productivity across producers of goods and services within an economy. Trade allows buyers to seek out the lowest-cost supplier of a particular good or service, and therefore the least productive domestic producers will tend to shut down in the face of import competition. We can't really know how many firms will shut down, or what the productivity of each firm in a sector is, but if we're willing to presume a certain distribution of firm productivity exists we can quantify the gains from trade. Consider Figure 7, which illustrates this intuition.

Trade increases competition, which puts disproportionate pressure on the lowest productivity firms. They will tend to shut down, shifting workers and investment capital towards the higher productivity firms that expand. The trick is to quantify the unobservable: the firms that would otherwise be operating but for the trade flows we currently observe.

FIGURE 7 ILLUSTRATING THE PRODUCTIVITY GAINS FROM TRADE



Recent advances in international trade research allow us to make progress. The specific structure of the mathematical models behind what follows is largely unimportant, but a simple result is fairly intuitive (Arkolakis et al., 2012). Aggregate gains from trade are given by

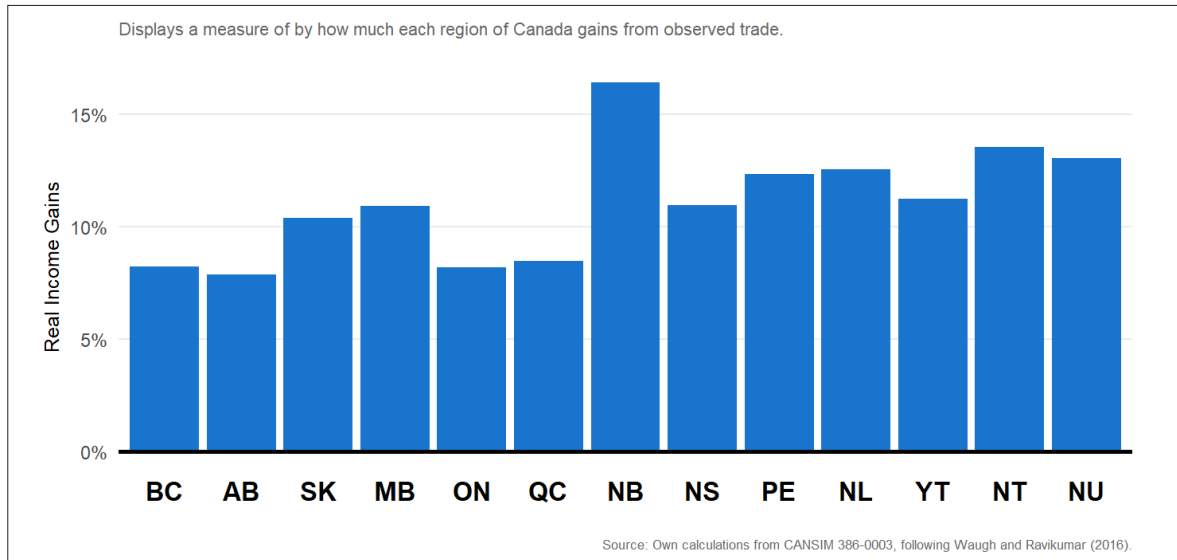
$$\text{Gains from Trade} = (1 - \text{Import Share of Spending})^{1/(\text{The "Elasticity" of Trade})} - 1$$

where the import share of spending is from the trade data presented earlier, and the elasticity of trade is an empirical measure of how sensitive trade flows are to trade costs. Many estimates strongly suggest such an elasticity is in the neighbourhood of -3 to -5 (Head and Mayer, 2014). We opt for a midpoint at -4 and therefore the above equation can be approximated simply as

$$\text{Gains from Trade} \approx 0.25 \times \text{Import Share}$$

Therefore, the larger a region's imports, the larger the estimated productivity gains from trade. Below, in Figure 8, we provide the estimated gains from trade for each of Canada's regions using the full equation rather than the approximation.

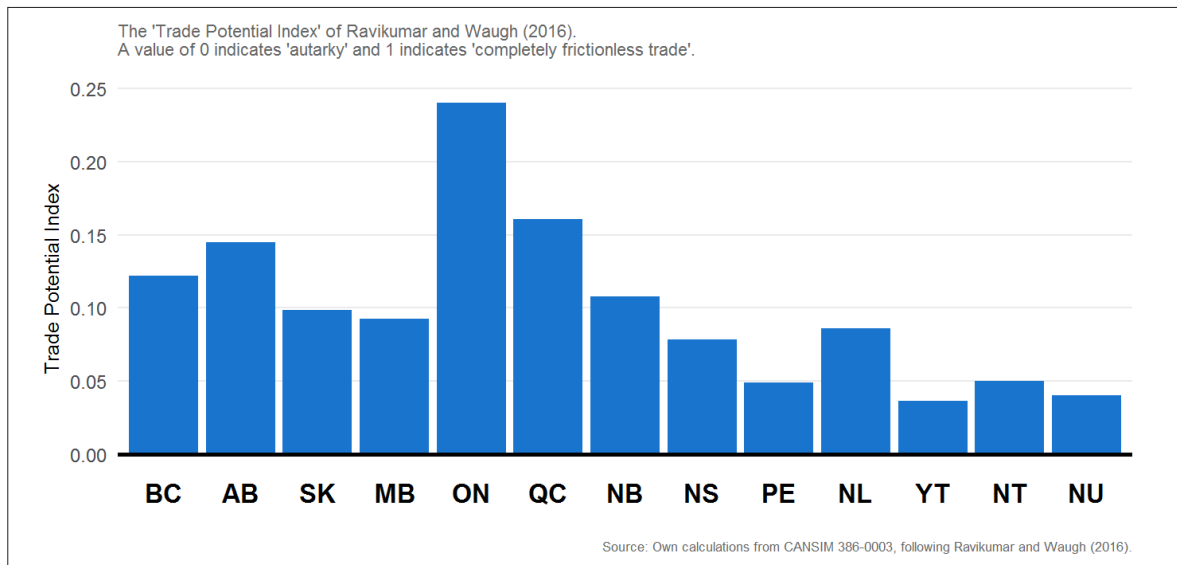
**FIGURE 8 THE GAINS FROM TRADE IN CANADA (2013)**



Consistent with their greater reliance on imports, Canada’s territories gain more from trade relative to most other provinces. Of course, this does not mean that trade is easy with the territories. We will show that the higher trade levels, and the consequently higher gains from trade, are in spite of larger trade costs that they face. To appreciate this point, consider the opposite hypothetical experiment: moving from currently observed trade to a world where trade is completely frictionless. That is, where moving a good or service from point A to point B is free and takes no time whatsoever. This is, of course, a fanciful but nonetheless useful benchmark.

Roughly speaking, if preferences and technologies were the same everywhere, a region would only buy from itself an amount proportional to its contribution to global economic activity. For example, if a region is one per cent of global GDP, then it should import from elsewhere 99 per cent of its spending. This would represent massive specialization, and productivity would consequently be much higher. To be sure, this abstracts from many considerations, such as local preferences or technology differences across locations, and the very fact that trade could never be completely frictionless. But it is a useful benchmark. In Figure 9, we plot an estimate – based on recent research by Waugh and Ravikumar (2016) – that effectively quantifies where Canadian provinces and territories are on the continuum between autarky and fully frictionless trade.

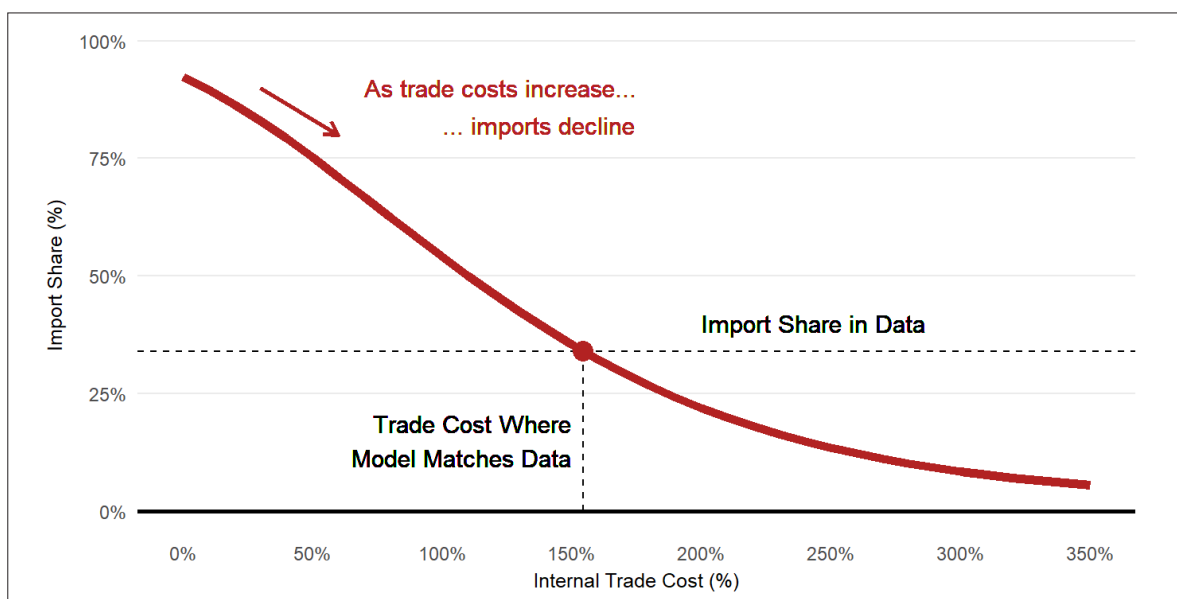
**FIGURE 9 HOW CLOSE TO FRICTIONLESS TRADE IS EACH REGION OF CANADA?**



The territories, though they trade a lot, therefore face significant trade costs and are further from frictionless trade than any other region in Canada. We can quantify this more precisely.

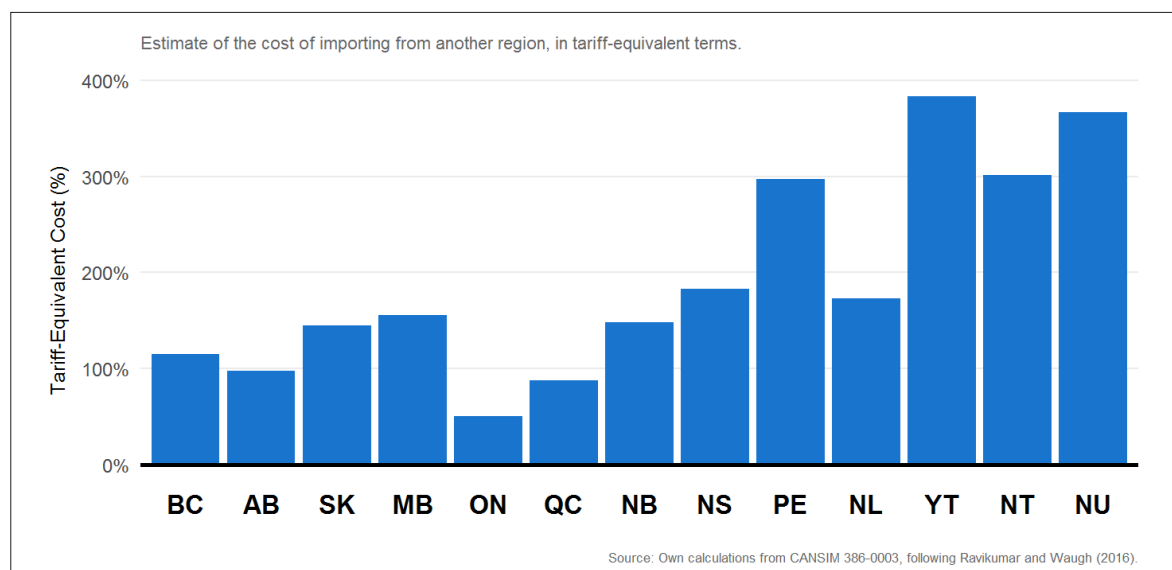
First, some intuition. If there are no trade costs whatsoever – no time delays, no information problems and instantaneous/free transportation – then the amount we would import from other regions would be substantially higher than what we observe in data. This is the frictionless trade scenario we described above. If trade costs are massive and prohibitive, then the amount we would import would be near zero. This is the autarky scenario. Between these two extremes is the actual observed level of trade flows, which can be used to infer the level of trade costs. We represent this straightforward procedure graphically in Figure 10.

**FIGURE 10 HOW TO COMBINE A MODEL WITH DATA TO INFER TRADE COSTS**



Applying this procedure to all regions of Canada, we find far higher trade costs in the territories than the provinces. The Atlantic Provinces also have high trade costs, and the lowest costs are found in Ontario, Quebec and Alberta. Consider this measure a simple way to capture all frictions inhibiting the purchase of imported goods and services into those regions. We plot these results below in Figure 11. The territories face trade costs that are more than double most other provinces.

**FIGURE 11 INTERNAL TRADE COSTS BY REGION OF CANADA (2013)**



To understand what is behind these costs, we estimate the bilateral costs between all trading pairs. This is slightly more complicated than inferring a single all-in measure of trade costs for each region. In short, we compare the volume of trade between two provinces relative to what they purchase from themselves. If one province buys less from, say, Alberta, than Albertans buy from themselves, then assuming consumer preferences and production technologies are the same for everyone, there must be a trade cost between them. Specifically,

$$\tau_{ni} = \left( \frac{\pi_{ni}\pi_{in}}{\pi_{nn}\pi_{ii}} \right)^{-\frac{1}{2\theta}},$$

where  $\pi_{ni}$  is the share of spending in region  $n$  allocated to purchases from region  $i$  and  $\theta$  is the sensitivity of trade flows to trade costs (the elasticity of trade discussed earlier). This is known as the Head-Ries Index after the two Canadian economists who formalized this intuition (Head and Ries, 2001). Broadly speaking, it is a flexible method of inferring trade costs from data.<sup>10</sup> The index is widely used in international trade research. The World Bank, for example, uses it as the foundation of its International Trade Cost Database.<sup>11</sup> We display the results of this method in Table 1. The territories face larger trade costs with almost all potential trade partners within Canada, though there is variation across sources.

<sup>10</sup> This index is also favourable since it applies equally well across a broad set of models of economic trade.

<sup>11</sup> <http://databank.worldbank.org/data/reports.aspx?source=escap-world-bank-international-trade-costs>



Yukon, for example, has an easier time trading with British Columbia and the Northwest Territories than with others in Canada. And the territories overall face the largest costs when trading with the Atlantic Provinces.

To be sure, the territories are further from markets, on average, than southern Canada. To some extent, the higher trade costs are thus not surprising and more difficult for policy-makers to overcome. Disentangling the policy-relevant trade costs from others is a key challenge that we attempt to overcome shortly.

**TABLE 2 BILATERAL TRADE COSTS IN CANADA**

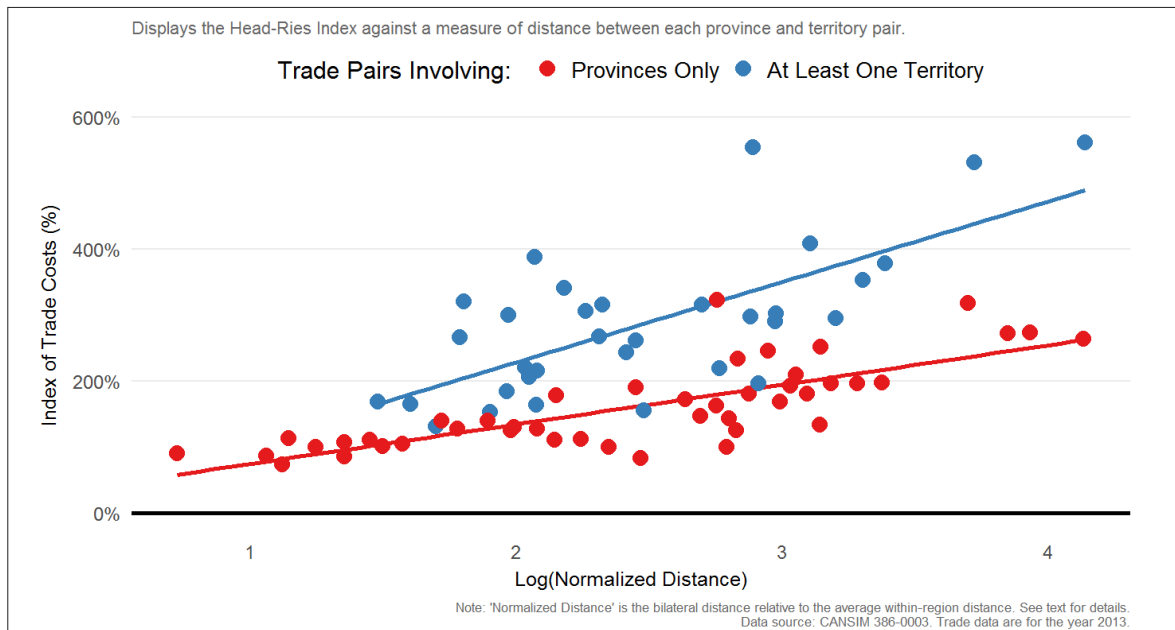
Importer	Exporter												
	BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	YT	NT	NU
BC	-	85%	140%	147%	100%	134%	197%	198%	264%	252%	164%	185%	243%
AB	85%	-	86%	111%	83%	125%	168%	181%	272%	181%	206%	165%	216%
SK	140%	86%	-	101%	111%	172%	234%	246%	318%	323%	315%	267%	300%
MB	147%	111%	101%	-	100%	143%	210%	197%	273%	193%	291%	261%	267%
ON	100%	83%	111%	100%	-	73%	127%	125%	162%	128%	197%	155%	153%
QC	134%	125%	172%	143%	73%	-	107%	139%	190%	131%	295%	219%	220%
NB	197%	168%	234%	210%	127%	107%	-	91%	100%	104%	353%	298%	388%
NS	198%	181%	246%	197%	125%	139%	91%	-	113%	111%	379%	303%	341%
PE	264%	272%	318%	273%	162%	190%	100%	113%	-	178%	562%	531%	554%
NL	252%	181%	323%	193%	128%	131%	104%	111%	178%	-	408%	316%	320%
YT	164%	206%	315%	291%	197%	295%	353%	379%	562%	408%	-	168%	306%
NT	185%	165%	267%	261%	155%	219%	298%	303%	531%	316%	168%	-	131%
NU	243%	216%	300%	267%	153%	220%	388%	341%	554%	320%	306%	131%	-

To begin, we consider how the relationships between trade costs and distance differ between Canada's provinces and territories. If shipping a given distance is more costly when the destination is a territory than when it is a province, then there are potentially policy-relevant costs involved, such as more limited infrastructure.

In Figure 12, we plot our index of trade costs for overall trade against a measure of normalized distance between trading partners within Canada.<sup>12</sup> Trading pairs that are far apart, such as B.C. and Nova Scotia, will tend to have higher trade costs than pairs that are close together, such as New Brunswick and Nova Scotia. This is not surprising. We separate pairs that involve the three territories from those that do not, and see that trade costs to and from the territories are higher for similar distances than between provinces, especially when distances are large. That is, for a given increase in distance, trade costs increase more for the territories than for the provinces. Visually, this is reflected in the trade cost to distance relationship being steeper for the territories than the provinces (the blue vs. the red lines).

<sup>12</sup> The normalized distance measure is a ratio of the average between-region population distance over the average within-region population distance.

**FIGURE 12 TRADE COSTS AND DISTANCE BETWEEN TRADING PAIRS IN CANADA**



Overall, trade pairs that involve at least one territory (such as B.C. to Yukon, or Yukon to Nunavut) have trade costs that are over 45 per cent larger than similarly distant trade pairs involving only provinces. These estimates are suggestive of the potential value of improved infrastructure in Canada’s territories. If infrastructure is of equivalent quality to what we find in southern Canada, then distance should not be more costly simply because a trading partner involved is a territory.<sup>13</sup> So, this provides a basis to consider a hypothetical increase in infrastructure quality between the territories and between the territories and the rest of Canada. Their remote locations present unavoidable challenges, but let’s consider an experiment where trade costs to and from the territories are similar to between provinces of similar distances.

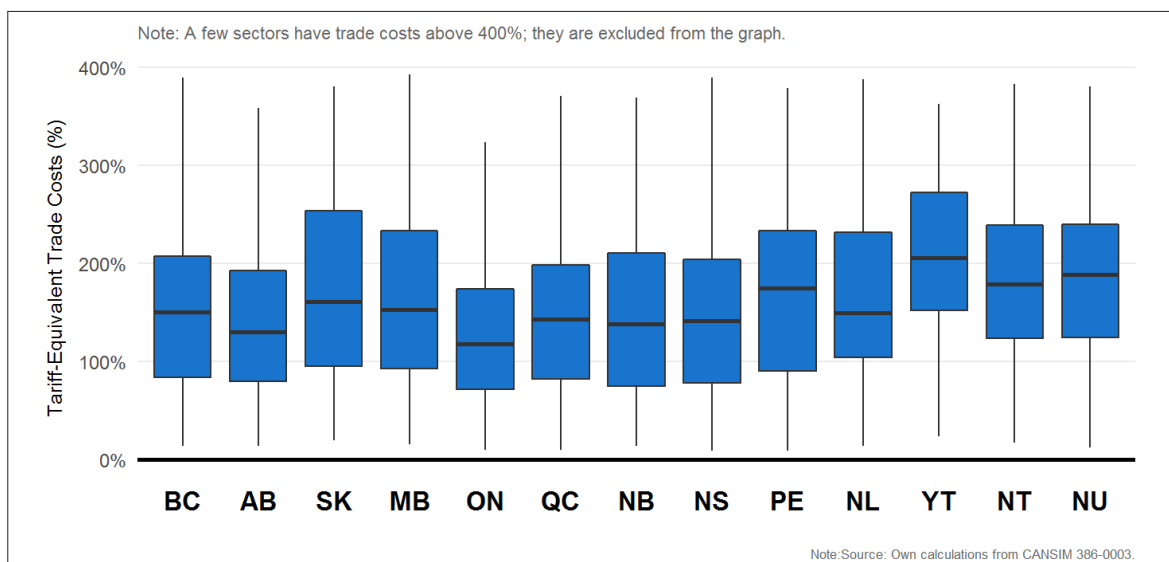
Next, we apply the Head-Ries Index to each sector and all trading relationships in the data and average those costs up by sector and exporting region. The results are in Figure 13. This box plot displays the range of trade costs across sectors by region, with the boxes spanning half the sectors’ trade costs and the whiskers displaying the range among the rest. The higher costs facing territorial trade are evident, as are the higher costs most sectors face, with the vast majority of those costs over 100 per cent.

<sup>13</sup> There is a potential caveat here in that certain idiosyncratic northern factors, specifically temperature and weather, may inflate transportation costs independently from infrastructure quality and distance. Absent more detailed analysis of these factors, we speculate that any such increases would be small relative to the overall internal trade costs. This seems especially likely in the case of territory-province pairs since only a portion of the overall transportation occurs in the North.

It is also natural to consider the role of coastal shipping in the North. The Yukon, Nunavut and Northwest Territories are not geographically land-locked, but these territories do face a shorter shipping season and presumably higher coastal shipping costs which may not be affected by improved infrastructure quality. That being said, while coastal shipping is relevant for international trade costs (Anderson and van Wincoop, 2004) it is likely far less relevant for interprovincial shipping costs wherein the revealed preference is for overland transportation (with the exception of Newfoundland and Labrador, which geographically does not have overland access to the rest of the country).

Given this, we continue with the interpretation that the inflated costs observed for trade pairs with at least one territory are predominantly the result of poorer quality infrastructure.

**FIGURE 13 ESTIMATES OF INTERNAL TRADE COSTS, BY SECTOR AND REGION (2013)**



We end this section by exploring some alternative specifications that closely follow the existing literature. First, we examine how trade costs vary across trading pairs in a way that distance doesn't explain. Earlier, we demonstrated that the territories face higher trade costs than provinces across similar distances. To systematically explore this across all trading relationships, we decompose trade costs between the portion explained by bilateral distance (that is, the distance between two trading partners) and the portion unexplained by distance. We refer to these costs as non-distance trade costs and they may provide an estimate that is relevant for policy-makers.

Specifically, based on all trading pairs in our data, we correlate trade costs to distances and extract the remaining variation in trade costs left unexplained. We do this at the sector level. We find that greater distances are systematically associated with higher trade costs. On average, 10 per cent greater geographic distance is associated with a 2.5 per cent higher trade cost. This is in line with evidence on the trade-cost and distance relationship between countries. Different sectors have different elasticities, but all range between a one per cent and four per cent increase in trade costs for a 10 per cent increase in distance. With these estimates in hand, we infer non-distance trade costs from

$$\tau_{ni}^{nd} = \tau_{ni} d_{ni}^{-\hat{\delta}},$$

where  $\hat{\delta}$  is our estimated distance elasticity and  $\tau_{ni}$  is the Head-Ries Index described earlier.

Second, we estimate differences in the cost of trading between two partners in one direction relative to the other. If it is more costly to ship from Yukon to B.C. than from B.C. to Yukon, then this is informative about policy-relevant costs. Perhaps B.C. has additional regulatory barriers that Yukon does not, making it difficult to ship into B.C. from elsewhere. The reverse could also be true. We refer to these costs as asymmetric trade costs and these are also informative for policy-makers. Essentially, this estimate looks at the trade data and asks – conditional on things like distance between trading partners or region-specific factors like productivity or wages – does one party tend to export less

than we would predict? Of course, this is a very loose way of thinking about asymmetric trade costs, but rather than provide a lengthy description of the methodology to perform these estimates, we refer interested readers to Albrecht and Tombe (2016). We follow them closely and use their data but expand it to include the territories. We also shift our focus to year 2010 for compatibility with their paper’s internal trade research for Canada and also because the CGE model with which we conduct our counterfactual experiments is calibrated to this year. Table 3 below displays the results.

**TABLE 3 AVERAGE TRADE COSTS BY REGION, AND TYPE OF TRADE COST**

Region	Policy-Relevant Trade Cost Measures	
	Asymmetric Costs	Non-Distance Costs
Yukon	26%	29%
Northwest Territories	38%	20%
Nunavut	58%	62%
Provinces	6%	13%

The territories have higher policy-relevant trade costs than the provinces do when measured in this way. Average non-distance costs are over 60 per cent for Nunavut, and between 20 per cent and 30 per cent for Yukon and Northwest Territories. Average asymmetric trade costs are also roughly 60 per cent for Nunavut, and between 26 per cent and 38 per cent for Yukon and Northwest Territories. To be sure, these are lower costs than many of the estimates presented above because they control for various characteristics of bilateral trading relationships over which policy-makers have little control. In what follows, we will quantify the effect of lower territorial trade costs by these amounts, along with several informative experiments.

## QUANTITATIVE ANALYSIS

To estimate the effect of trade costs on incomes, investment, productivity and overall economic activity in Canada, we require more than just data. We require a model. With a formal model of the Canadian economy we can explore counterfactual simulations that provide estimates of the magnitude and composition of economic growth if trade costs were lowered by various amounts.

To that end, we develop a computable general equilibrium (CGE) model and map it to detailed provincial data from Statistics Canada’s symmetric input-output tables. What follows is a summary description of the model structure. Readers uninterested in the model assumptions are free to skip to the Main Results section without losing too much in terms of understanding our approach or our results.

### Brief Description of the CGE Model

Our CGE model is essentially a collection of related supply-and-demand functions, representing the Canadian economy in its entirety. Consider that a simple supply-and-

demand relationship describes an outcome wherein an equilibrium price is reached, such that quantity demanded is equal to quantity supplied in one sector or market. Since sectors/markets interact with each other, a change affecting one market will have effects in other markets as well. That is, if some change (in our case, a change in trade costs) leads to a change in the equilibrium price and quantity of one good, it will also lead to a change in the equilibrium prices and quantities of all inputs into the production of that good as well as any goods which in turn use that good as an input.

In a general equilibrium model, we link all of the supply-and-demand equations together, and simultaneously solve for equilibrium of all markets in the system. If there is partial equilibrium in all markets, then we have a general equilibrium.

Our model features 12 separate regions: each of the 10 provinces plus Nunavut, a region representing the combined economies of Yukon and Northwest Territories and a region representing Canadian territorial enclaves abroad. These regional definitions are driven by the structure of the data we use to calibrate the model, specifically the 2011 Statistics Canada input-output tables.<sup>14</sup> These data group Yukon and Northwest Territories into a single region. This is unfortunate as the trade data reported above show that Yukon and Northwest Territories have different exposures to trade. Lumping the two territories together could potentially miss some of the important effects of reductions in trade costs. Despite this, we still feel the results are valid in terms of projecting the general magnitude of effects for the northern territories.

Production in each of the modelled regions is modelled for 33 productive sectors. In each sector, firms produce output using inputs of labour, capital and intermediate inputs.

On the consumption side, we model both a representative consumer and a representative government agent for each region (we do not distinguish between provincial and federal taxation and governments). Government revenue is raised through both direct and indirect taxes that we capture with fixed output tax rates on production. This tax revenue accrues to the representative government in the region in which it is collected. While the level of this tax revenue is endogenous, the level of government service provision is fixed (although the cost of government services is variable and will change due to endogenous price-level fluctuations). To ensure a balanced budget in every counterfactual scenario, we use endogenous lump-sum taxes (or subsidies) on the representative consumer.

Representative consumers generate income from three types of endowments: extractive-resource rents, labour and capital. The resource endowment is a measure of the value of resources, net of extraction costs, for four sectors: coal extraction, natural gas extraction, crude oil extraction and other mining.<sup>15</sup> The endowments' volume is fixed at the region

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<sup>14</sup> Statistics Canada, Provincial Symmetric Input-Output Tables, 2011 Catalogue 15-211-XCE.

<sup>15</sup> The available input-output tables do not distinguish between capital and resource income. We therefore construct a measure of the Ricardian rent by using bottom-up measures of net revenue for the oil and gas sector using ratios from Wood Mackenzie (2016). For the coal and mining sector, we assume that the Ricardian rent is responsible for one-fourth of the sector's net revenue after input and labour costs in the benchmark. Capital costs then comprise the other three-fourths of net benchmark revenue in these sectors.

and sector level; however, the endowments' value is endogenous. Labour endowments are region-specific, such that labour is not mobile across regional boundaries, but is mobile across sectors within a region.<sup>16</sup>

In all scenarios a fixed level of capital is allocated to representative consumers for each province and territory. However, by modifying the parameter values used, the model accommodates several assumptions regarding the supply of capital. For illustrative purposes, we have adopted three scenarios for capital supply which correspond to conventional interpretation of short-run, medium-run and long-run timelines. In the short run, capital is fixed at the region and sector level – it can neither increase nor decrease. In the medium run, a portion (50 per cent) of capital in each sector can move between regions and sectors. In the long run, capital is fully mobile between sectors and regions and the overall supply of capital can also change. Specifically, we presume the long-run capital supply adjusts to hold the rate of return on new capital fixed. This reflects the assumption of an internationally open capital market, wherein the return on capital is determined exogenously (equal to the level specified in the benchmark calibration). To further reflect this assumption, any income generated by an increase in the quantity of capital supplied exits the model (implicitly accruing to a foreign representative agent) rather than accruing to a representative consumer within the model.<sup>17</sup>

The utilities sector is an exception to the capital mobility conditions listed above. A portion of capital, representative of the input values of renewable resources such as hydro or wind, is held fixed across all short-, medium- and long-run scenarios. This fixed capital component is representative of the resource rents on renewable generation (like hydro) and is set as a proportion of the benchmark total capital input into the utilities sector. This ratio is set equal to half of the share of renewable generation present in each region's utilities sector.

All of the production in the model is specified through the use of nested constant elasticity of substitution (CES) production functions. In the short run, the presence of fixed sector-specific capital endowments induces diminishing returns to scale for all sectors. Moving to the medium- and long-run specifications, most production functions become constant returns to scale (CRS) with the exception of resource extraction sectors (coal, natural

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<sup>16</sup> This assumption is standard in the application of multi-region CGE models (see specifically Bataille and Melton, 2017; Carbone and Mackenzie, 2016; and Peters et al., 2010). While there are likely to be interesting labour dynamics related to the issue of interprovincial trade costs, a full analysis of these dynamics falls beyond the scope of this paper. In reviewing the results in the next section, if the labour mobility assumption were modified to permit inter-regional labour flows, the aggregate GDP gain to Canada would likely inflate, whereas the per-capita results for each province and territory would each lie closer to the mean per-capita gain for Canada.

<sup>17</sup> All of our modelled shocks imply an increase in the domestic demand for capital, so we are only dealing with long-run outcomes wherein the quantity of capital supplied increases. While it is not relevant to our set of counterfactual shocks, any decrease in the quantity of capital supplied would continue to implicitly accrue to a foreign representative agent rather than reflecting a change in domestic income. This reflects the assumption that domestic agents can and would choose to shift their capital from Canada to the rest of the world and thus would continue to earn the specified return on that capital.

gas, crude oil and mining) and the utilities sector which, due to the presence of fixed extractive-resource or natural resource capacity endowments, retains a diminishing returns characteristic.<sup>18</sup>

The nesting structures of these CES functions are generally consistent with other CGE models of the Canadian economy. Specifically, the nesting structure employed is based on the general equilibrium emissions model (GEEM) and Canadian integrated modelling system (CIMS) (Peters et al., 2010 and Paltsev et al., 2005). Similarly, elasticities for the CES production functions are generally consistent with GEEM and CIMS.

Bilateral trade between provinces and territories within Canada and with international trading partners is modelled using the Armington (1969) composite approach, which allows for the differentiation of goods produced in the same sector in different regions. This approach also aligns with the conventional iceberg class of trade models and is therefore consistent with our average trade cost measures based on the Head and Ries (2001) methodology.

To maintain consistency with the methodology for our trade cost estimates, the Armington functions are calibrated using elasticities from Caliendo and Parro (2015) where possible, and using an elasticity of substitution equal to five for all other sectors (as in Costinot and Rodriguez-Clare (2014)).<sup>19</sup> Each region and sector pair faces a unique iso-elastic demand function for international exports wherein the elasticity is again set consistent with Caliendo and Parro (2015) where possible, and equal to five elsewhere. Each region is modelled as a price taker for imports. We also specify an exogenous balance-of-payments constraint between each region and the rest of the world. This is done by fixing the current account surplus for each region at benchmark levels.

## Main Results

With this model in hand, we can conduct a variety of experiments to explore the effect of changing trade costs on economic activity in Canada. We separately report the results of a variety of experiments, from lower internal trade costs to lower international trade costs and from uniform trade cost reductions to our preferred estimate of the effect of improved infrastructure quality in the territories. Our model simulations generate values for a large set of variables. In the results presented below, we focus on summary measures of economic indicators – in particular, real GDP.

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<sup>18</sup> While individual sector functions are CRS, the presence of a fixed endowment of capital (in the short- and medium-run scenarios) and a fixed endowment of labour (in all scenarios) implies that aggregate output will exhibit diminishing returns to scale. To the extent that some sectors may actually experience increasing returns to scale, our model will underestimate economic gains for those sectors.

It should also be noted, with reference to Figure 7 above, that while our CGE model does not explicitly model the number of firms operating within a sector, the abstraction to sector-level production functions is nonetheless consistent with the interpretation that efficiencies arise from variations in the distribution of active firms with differing levels of productivity.

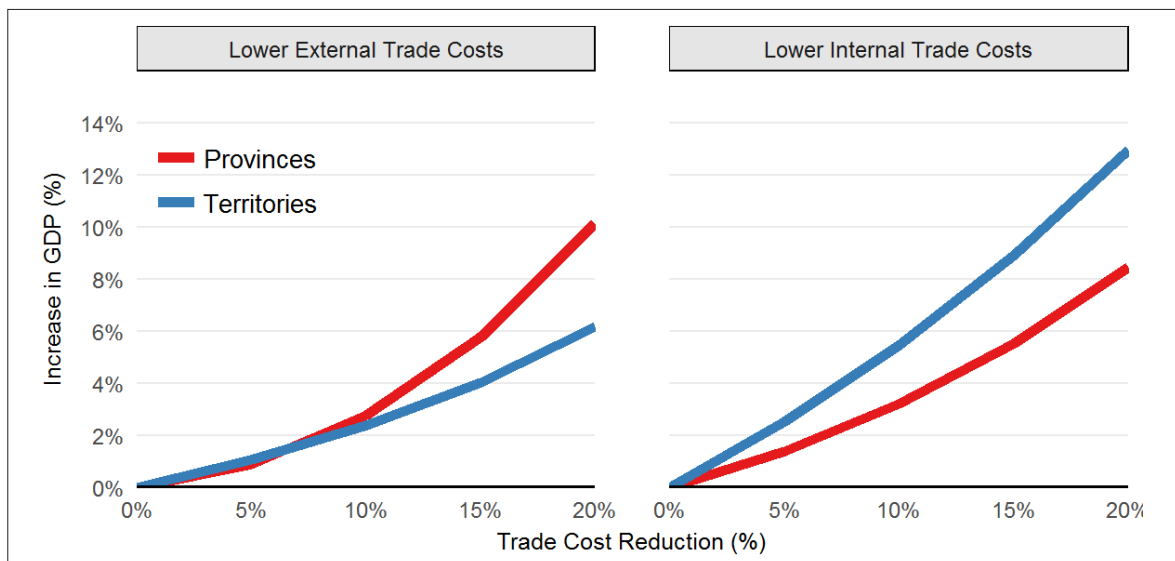
<sup>19</sup> These are the same elasticities used in Albrecht and Tombe (2016) and subsequently, in the estimation of the trade costs presented above.

## How Sensitive is GDP to Trade Costs?

Before turning to the effect of our measured trade costs on provincial and territorial GDP, it is useful to establish the overall sensitivity of GDP to trade costs. That is, by how much will GDP rise if trade costs fall by 10 per cent across the board? Figure 14 plots the provincial-level responses to a range of reductions in the cost of internally traded goods, externally traded goods and economy-wide (internally and externally) traded goods using our medium-run approach.

In Figure 14 we observe large gains from lower trade costs in all regions. But the gains for territories are largest for internal trade cost reductions, while the gains for provinces are largest for external trade cost reductions. This is important since Canadian policy-makers have better control over trade costs internally. This policy agenda potentially matters more for the territories than for provinces – though it matters significantly for all. For perspective, the 5.5 per cent increase in territorial GDP for a 10 per cent reduction in internal trade costs facing those regions is equivalent to nearly \$4,500 per person in additional economic activity in 2010.

**FIGURE 14 GDP GAINS FROM LOWER TRADE COSTS**



## How do Measured Trade Costs Affect GDP?

In this section, we separately present the results of CGE simulations based on the removal of internal trade costs, asymmetric trade costs and non-distance costs. The results therefore correspond to a simulated counterfactual outcome in which the costs associated with each of the specific estimates are no longer present in the Canadian economy.

We also add a fourth scenario to this set of estimates based on a summary measure of the contribution to trade costs resulting from poor quality infrastructure and other territory-specific factors. Figure 12 demonstrated that trade involving at least one territory had significantly higher trade costs compared to trade between two equally distant provinces. In particular, we find that the trading pairs involving at least one territory tend to face trade costs that are 45 per cent higher than trade between two similarly distant provinces.



To roughly estimate the gains from improved infrastructure, we remove these additional costs. Intuitively, this presumes sufficient infrastructure investments to allow similarly distant trading pairs to have the same trade costs, regardless of whether one involves a territory or not.

In comparing these results it is useful to bear in mind that the simulations based on the first two measures include the removal of internal as well as external trade costs, while the latter two measures include only the removal of internal trade costs.

Table 4 presents the results from simulations removing all identified trade costs (internal and external). While it is not reasonable to expect any set of trade liberalization policies and infrastructure improvements to actually eliminate all trade costs, these results are informative in producing an upper-limit estimate for the theoretical gains from trade which are forgone due to trade costs between regions within Canada and between Canada and its external trading partners.

**TABLE 4 GDP GAINS FROM REMOVING ALL INTERNAL AND INTERNATIONAL TRADE COSTS**

	Short Run	Medium Run	Long Run
Provinces	\$423,313 M	\$431,950 M	\$666,645 M
Territories	\$7,943 M	\$8,440 M	\$12,701 M
Total	\$431,283 M	\$440,448 M	\$679,370 M

In comparing the columns in Table 4, note that there is little difference between the short-run and medium-run gains. This is likely because of the fairly broad nature of identified trade costs. That is, the total trade costs tend to be widely distributed across regions and sectors in Canada. This implies a fairly limited scope for increased efficiencies related to capital reallocation since there is widespread upward pressure on the demand for capital across sectors and regions.<sup>20</sup>

In moving from the medium run to the long run, there are more substantial gains related to the introduction of new capital. The medium- to long-run gains are proportionally widespread across modelled regions, which is again consistent with the total trade cost estimates being widely distributed across Canadian sectors and regions. This also underscores the importance of factor-supply assumptions in determining the effects of trade liberalization and supporting infrastructure developments since policy directives that pair reductions in trade costs with either supports for new capital formation or liberalization of Canadian capital markets (either facilitating or encouraging greater foreign investment in Canada) are more likely to generate larger gains. While they are not modelled here, it is likely that policies facilitating greater labour mobility (both between regions and across international boundaries) may have similarly dramatic effects on Canadian real GDP.

Let's turn now to policy-relevant costs.

Table 5 presents the results of simulations based on the removal of contributions from asymmetric costs. Specifically, for each trade pair we set trade costs in both directions to

<sup>20</sup> Note that capital reallocation in the medium run is driven by relative changes in the demand for capital, not absolute changes.

equal the minimum trade costs across both directions between the pair. As indicated above, these are cost estimates based on differences in the cost of trading between two partners in one direction relative to the other. For all considered time frames the results in Table 5 are more modest than those presented in Table 4. This is expected since the estimated asymmetric costs can be statistically considered as a subset of the total cost measure presented above. The asymmetric measure of trade costs tends to have a higher variance across sectors and regions when compared with the total trade cost measure. This translates into a larger difference between the short- and medium-run real GDP gains since there is more scope to reallocate capital away from sectors experiencing a small shock to trade costs and toward sectors experiencing larger shocks.

**TABLE 5 GDP GAINS FROM REMOVING ASYMMETRIC TRADE COSTS**

	Short Run	Medium Run	Long Run
Provinces	\$130,267 M	\$146,679 M	\$442,708 M
Territories	\$2,001 M	\$2,353 M	\$5,671 M
<b>Total</b>	<b>\$132,325 M</b>	<b>\$149,122 M</b>	<b>\$448,453 M</b>

Table 6 presents the results of removing trade costs not associated with physical distances. As with the asymmetric costs results, removal of all or a portion of these non-distance costs is a more realistic objective than the removal of our total trade cost measures.

**TABLE 6 GDP GAINS FROM REMOVING NON-DISTANCE TRADE COSTS**

	Short Run	Medium Run	Long Run
Provinces	\$75,494 M	\$76,087 M	\$102,690 M
Territories	\$3,512 M	\$3,743 M	\$4,881 M
<b>Total</b>	<b>\$79,011 M</b>	<b>\$79,839 M</b>	<b>\$107,574 M</b>

As indicated above, a critical distinction is that the results in Table 5 include reductions in both internal and external trade costs, while the results in Table 6 are based solely on internal trade cost reductions. This difference is driven by the estimation methodology used to identify the different measures of trade costs. While the asymmetric measure is able to accommodate external and internal trade costs, the non-distance measure requires the identification of population centroids for every trading pair. To simplify our analysis, and given that the data do not distinguish which country abroad any given territory or province is trading with, we choose to focus on liberalizing internal non-distance trade costs.

Finally, trade involving at least one territory had significantly higher trade costs compared to trade between two equally distant provinces. We demonstrated earlier that trade involving the territories faces trade costs that are 45 per cent higher than trade between two similarly distant provinces. Table 7 presents the results of a simulation removing these costs. While the real GDP gains presented in Table 7 are small by comparison to those in tables 4 through 6, it is important to recognize that this simulation only deals with adjustments to trade costs wherein either Nunavut or Yukon and Northwest Territories is a trading partner. Given the territories' relatively small role in the Canadian economy, this set of estimates reflects a fairly minor shock overall.

**TABLE 7 GDP GAINS FROM IMPROVED NORTHERN INFRASTRUCTURE QUALITY**

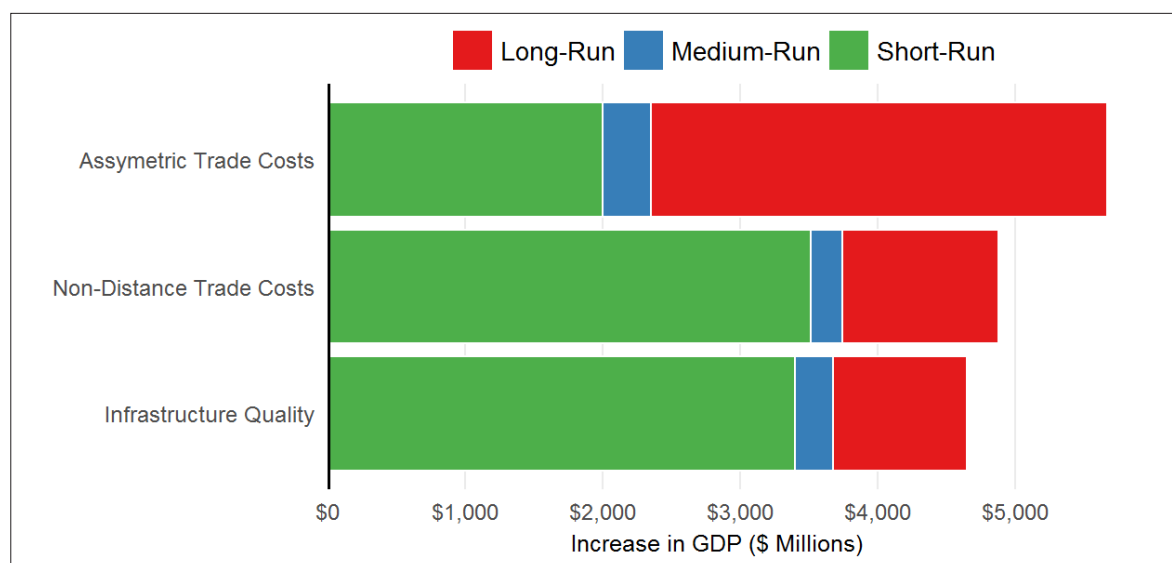
	Short Run	Medium Run	Long Run
Provinces	\$972 M	\$629 M	\$1,822 M
Territories	\$3,398 M	\$3,677 M	\$4,652 M
Total	\$4,371 M	\$4,307 M	\$6,474 M

The overall gains to the territories are substantial across these simulations. Even the short-run gain in Nunavut GDP amounts to almost \$25,000 per capita while Yukon’s and Northwest Territories’ gain works out to just over \$32,000 per capita.<sup>21</sup> A limitation of the model is that it does not address labour migration; however, labour migration and the implied population growth would seem likely in these scenarios given such increases in the territories’ real GDP. This may mitigate the per-capita gains but would also increase the GDP impact since the available labour in the territories would increase.

Departing from the real GDP results above, Table 8 presents the simulation results for the territories’ three sources of income (wages, capital and resource income).

As Table 8 indicates, there is substantial growth in resource income in Yukon and Northwest Territories; however, this growth starts from a relatively small base. Overall, the majority of aggregate growth comes from capital income in the short run (where immobile capital implies relative scarcity) and wage income in the long run.

**FIGURE 15 TERRITORIES’ GDP RESPONSES TO TRADE COST COUNTERFACTUALS (\$M)**



<sup>21</sup> Using 2010 population figures from CANSIM 051-0001.

**TABLE 8 TERRITORIES' INCOME RESPONSES TO IMPROVED INFRASTRUCTURE QUALITY**

Real Income Change	Short Run	Medium Run	Long Run
Wage Income	30%	38%	51%
Capital Income	47%	17%	12%
Resource Income	40%	97%	148%
Total Change in Dollars	\$3,347 M	\$2,786 M	\$3,422 M

It is interesting to note that in the medium term, the territories' total income falls relative to the short term. This suggests that the reduction in territorial import costs (and by extension the gains from production and associated capital demand in regions exporting to the territories) plays a larger role than the reduction in territorial export costs (the gains and associated capital demand to export industries located in the territories).

We should also note that we have assumed that the direct impact of improved infrastructure quality would accrue only to the territories (with provincial benefits arising due to general equilibrium effects). Fellows and Sulzenko (2016) speculate that improvements in northern infrastructure would lead to reduced volumes on the southern networks and thus reduce congestion and travel-related trade costs in the South as well as in the North. In such a case, our national-level simulations could be dramatically under-representing the total national economic gains from improved infrastructure.

## CONCLUSION

Canada's territories are uniquely reliant on trade for their businesses' economic health and their households' living standards. We show that while trade volumes are higher, relative to the size of their economies, than elsewhere, they face much larger trade costs. Infrastructure quality and the consequentially higher costs associated with shipping are particularly important factors in explaining these high costs. Through detailed analysis of the latest trade data, coupled with frontier methods from international trade research, we find that the potential gains from trade liberalization and improved infrastructure quality may be on the order of \$4.5 billion-\$6 billion added to territorial GDP annually. Though these are our long-run estimates, they represent gains of over \$40,000 per person, or productivity gains of roughly 50 per cent. Equivalently, and perhaps more intuitively, they represent a reduction in the overall cost-of-living of roughly one-third. In all simulated scenarios, benefits to the territories have net positive spillover effects.

Climate change is a relevant factor here as well. In recent years, the season for ice roads (currently used in much of the North to transport goods to and from remotely located industrial/mining production and communities) has become generally shorter and less predictable.<sup>22</sup> This has meant greater reliance on air transport with an associated higher per tonne-km cost compared to trucking. Policy responses to this can already be seen in the two-lane, all-weather gravel road between Inuvik and Tuktoyaktuk that opened last November and the current proposal for the Slave Geological Province Access Corridor.

<sup>22</sup> In particular, the shorter 2006 season implied significantly higher transportation costs and a reduction in economic activity (Pearce et al., 2011).

The latter will provide a link between existing southern infrastructure and a deep-water port in Nunavut running through the Slave Geological Province. These developments suggest that the disadvantage imposed on the territories by high trade costs may increase in the baseline (inaction) scenario, further emphasizing the potential importance of improved northern infrastructure.

There may also be significant potential for new technologies to bring down the cost of higher quality northern infrastructure. While we don't comment on the desirability of any specific project here, it is worth considering that new modes of transportation for the North need not be mirror images of those currently employed in the South. For example the development of autonomous vehicles, if they are well suited for long-distance transportation, could result in significantly more intensive use of these technologies in the North when compared with the South, due to the fixed and sunk nature of infrastructure investment and the implied path dependency of such investment.

Though more detailed work is necessary to fully understand the specific projects and policy liberalizations government should prioritize, our analysis points to large potential gains. The results presented here therefore stand as evidence of the continued importance of the priorities identified in the Senate of Canada's studies on both internal trade (Senate of Canada, 2016) and the northern corridor concept (Senate of Canada, 2017). Further study in this area is certainly warranted and needed to ensure potential gains from trade are realized in Canada's provinces and territories.

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