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A Gravity Analysis of Inter-Provincial Trade

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Abstract

In this paper, we provide evidence of frictions associated with trade in goods and services among Canadian provinces. We examine empirical relationships between sector- and industry-level trade flows and trading frictions associated with intra-provincial trade, inter-provincial trade, and international trade. We also develop a novel method for estimating the magnitude of differences across provinces, industries, and time in relative inter-provincial trade frictions. We find that the ranking of these relative inter-provincial frictions across provinces and the degree of regional dispersion varies considerably across the sectors and industries we study. In addition, we find considerably more geographic dispersion in the frictions that provinces face as sellers of goods and services than those which they face in their roles as buyers. Finally, we evaluate quantitative associations between two Canadian inter-provincial regional trade agreements and inter-provincial trade flows for a variety of industries. We document considerable variation across sectors and manufacturing sub-industries in our estimates of the relationships between these provincial trade agreements and trade flows. For example, trade agreements signed among western provinces around 2010 are positively associated with trade flows in the mining sector, textiles, petroleum, and transportation equipment, but are negatively associated with trade flows in agricultural goods and manufactured food products.

Keywords: Intra-regional and inter-regional trade frictions; Trade agreements; Structural Gravity; Canada
JEL: F13; F14; F15

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1 Introduction

In this paper, we provide empirical analyses of frictions associated with trade in goods and services among Canadian provinces. We examine empirical relationships between disaggregated trade flows for four two-digit sectors and thirteen three-digit manufacturing industries and trading frictions associated with intra-provincial trade, inter-provincial trade, and international trade. We also develop a novel method for estimating the magnitude of differences across provinces, industries, and time in relative inter-provincial trade frictions associated with exporting and, separately, for importing. These new quantitative measures of relative inter-provincial trade frictions can be a useful tool for guiding policy makers concerned with implementing targeted policies to lower inter-provincial trade barriers. Finally, we evaluate quantitative associations between two Canadian inter-provincial trade agreements and inter-provincial trade flows for a variety of industries.

We explore these issues using modern structural gravity models and current best practices for estimation of those models. We apply the structural gravity estimation approach to data on sector- and industry-level intra-provincial, inter-provincial, and international trade flows from 1997 to 2018 in our analysis. Our results indicate significant quantitative differences across provinces and industries in relative inter-provincial trade frictions. We also find notable differences across industries in the relationships between inter-provincial trade flows and two inter-provincial trade agreements. In particular, for some industries we estimate a positive relationship while in others, we uncover a negative association between the implementation of a regional trade agreement and inter-provincial flows.

It is widely agreed upon by policy makers and economists that *intra-national* trade frictions are significant and can impact a country's economic performance.[1] For example, Ramondo et al. (2016) use a calibrated model to demonstrate the important role of within-country trade costs in explaining observed relationships between country size, productivity, import shares, and incomes. Other authors such as Arkolakis et al. (2012), Cosar and Demir (2016), and Cosar and Fajgelbaum (2016) provide theoretical and empirical evidence that the magnitude of within-country trade costs affect a country's ability to engage in international trade and the resulting gains from such trade. Focusing on Canada, Alvarez et al. (2019) estimate the tariff-equivalent magnitude of Canadian internal trade barriers, use a theoretical model to estimate the impact of those frictions on national economic performance measures, and make policy recommendations aimed at lowering those frictions.

To empirically examine the relative importance of various types of trade frictions, we include indicator variables for types of trade flows (intra-provincial, inter-provincial, and international) into state-of-the-

[1] We discuss these types of frictions in more detail in Section 2.

art structural gravity regressions applied to trade flows for four two-digit sectors and thirteen three-digit manufacturing industries. We document considerable variation across the broad sectors in the trends of inter-provincial and intra-provincial frictions for levels of trade flows relative to international trade frictions. For example, for manufacturing and services, our results suggest a fall in inter-provincial trade frictions relative to international trade frictions over the time period we study but for mining, we find evidence of a rise in those relative frictions. We also document considerable variation in the trends for relative trade frictions across three-digit manufacturing industries.

Furthermore, using a novel method we develop for measuring relative inter-provincial trade frictions, our analysis based on estimated multilateral resistance terms suggests that larger provinces generally tend to face lower trading frictions for exporting in the manufacturing and services sectors. Interestingly, we do not estimate a similar pattern for agriculture and mining. More generally, the ranking of these relative inter-provincial exporting frictions across provinces and the degree of regional dispersion varies considerably across industries. In addition, we find considerably more geographic dispersion in the frictions that provinces face as sellers of goods and services than those which they face in their roles as buyers.

Partially motivated by our findings regarding trends and regional and industrial dispersion in trade frictions, we then turn to analysis of relationships between disaggregated trade flows and two important inter-provincial trade agreements. In that investigation, we also employ a structural gravity approach for estimation aimed at quantifying relationships between regional trade agreements and trade flows.

Our results suggest that trade agreements signed around 2010 among western provinces (Alberta, British Columbia, Manitoba, and Saskatchewan) are positively associated with trade flows in the mining sector but negatively associated with trade flows in agricultural goods. An agreement signed in 2009 between Ontario and Quebec may have positively impacted mining trade while negatively impacting trade in services.[2] Furthermore, we document considerable variation across manufacturing sub-industries in our estimates of the relationships between these provincial trade agreements and trade flows. For example, for the aforementioned agreement among western provinces, we find a positive impact on petroleum trade but a negative impact on trade in manufactured food products.

Our research is related to at least two areas of research which examine frictions associated with within-country trade flows. The first area seeks to examine and quantify the relative importance of provincial borders on Canadian trade flows. The second related area primarily focuses on the effects of within-Canada provincial-level trade agreements on those flows.

In the first area, closely related papers include Agnosteva et al. (2019), Alvarez et al. (2019), Albrecht and Tombe (2016), Anderson and Yotov (2010), and Bemrose et al. (2020). In Agnosteva et al. (2019),

[2]Details regarding these regional trade agreements and others are discussed in Section 2.

the authors use intra-provincial, inter-provincial, and international-provincial data on trade flows for total manufacturing from 1997 to 2007 to examine the relative importance of different types of manufacturing trade frictions. They highlight at least three findings: (i.) those frictions are large and heterogeneous across provinces; (ii.) those frictions are systematically related to provinces' economic and geographic size; and (iii.) those frictions cannot be fully explained by standard gravity variables, i.e. there are unexplained trade barriers to inter-provincial trade.

Alvarez et al. (2019) and Albrecht and Tombe (2016) construct Head-Ries (2001) indexes (HRIs) using data on disaggregated industries' trade flows for Canadian provinces to quantify the magnitude and effects of internal trade costs. The first paper uses panel data while the second one primarily focuses on manufacturing trade in 2010 to estimate these HRIs as a proxy for non-tariff barriers (NTBs). Both studies document substantial variation in this measure of trade costs both across industries and across provinces. Furthermore, each article uses a theoretical trade model to provide estimates of potential welfare and GDP gains which could result from internal trade liberalization in Canada.

Anderson and Yotov (2010) use Canadian provincial and U.S. state level disaggregated trade flows from 1997 to 2003 to empirically examine trade frictions. They primarily focus on estimation of multilateral resistance terms that arise from a structural gravity approach to document variation in trade frictions across provinces and across time. They also find substantial variation in those frictions across provinces and in addition, provide evidence of a fall in within-province trade bias in Canadian trade trends.

Finally, Bemrose et al. (2020) use Canadian sub-provincial trade data on transaction-level truck and rail shipments to estimate the effects of provincial borders on trade. Using this highly disaggregated data and a structural gravity approach, they estimate that provincial borders represent a 6.9% tariff equivalent level of frictions to intra-national trade. Due to the nature of their method for measuring trade flows, their estimates are applicable to trade in goods.

The contributions of our paper in this area of the literature relative to these papers are as follows. We generally examine a longer time series and we focus on disaggregated trade data for both broad sectors (manufacturing, agriculture, services, and mining) and several three-digit manufacturing industries. Relative to Alvarez et al. (2019), who also use a relatively longer time series and disaggregated data, our approach to measuring relative trade frictions differs from theirs and is based on recent developments in structural gravity methods. Similar to Anderson and Yotov (2010), we also use what those authors refer to as a "neglected" property of the structural gravity model by developing an approach which involves exploiting the usefulness of estimated relative multilateral resistance terms. However, our methodology is distinct from theirs and we use these informative measures to document how the degree of dispersion across provinces in inter-provincial trade frictions varies across sectors, across industries, and over time. Due to these differences in data and approach, we uncover several novel findings, some of which we briefly describe here.

By incorporating data from later years (2008-2018) in our study, we uncover a downward trend in inter-provincial manufacturing trade frictions relative to those associated with international trade, which stands in contrast to the findings of Agnosteva et al. (2019) whose data spans 1997 to 2007. We speculate that our finding may be partially due to the rise in across-province trade agreements in the latter years, motivating our subsequent study of a subset of those agreements. Given our panel approach to examining disaggregated sectors and manufacturing industries, we are able to document that the trends in the relative importance of inter-provincial trade and intra-provincial trade frictions compared to international ones in agriculture, services, and mining contrast sharply with those in manufacturing trade. We also document significant variation in these trends across industries within manufacturing; for example, we find evidence of a fall in relative inter-provincial trade frictions for six of our manufacturing industries whereas three industries exhibit a rise in those relative frictions.

Our results based on our novel method for measuring relative inter-provincial trade frictions suggest that the regional dispersion apparent in these frictions differs across the four broad sectors that we study, with the highest degrees of dispersion in services. We also find that the rankings in the severity of these frictions across provinces differs across broad sectors and across manufacturing sub-industries. Finally, because our approach allows us to measure relative frictions associated with selling separately from frictions associated with purchasing, we document that exporting frictions exhibit considerably more regional dispersion than importing frictions.

In the second area, quantifying the impact of within-Canada trade agreements on trade flows, perhaps the most closely related papers are Alvarez et al. (2019) and Beaulieu and Zaman (2019). In Alvarez et al. (2019), the authors estimate the relationship between five of the internal trade agreements listed in Table 1 and their measure of non-tariff barriers (NTBs) based on Head-Ries indexes, as described above. They use disaggregated Canadian and international trade data from 1997 to 2015 and ordinary least squares regression analysis. Their results suggest a negative relationship between NTBs and four of the five internal agreements.

Beaulieu and Zaman (2019) considers both a naive and a structural gravity approach to estimate the relationship between Canadian domestic trade flows and five of the internal trade agreements listed in Table 1. These authors do not include international flows but do evaluate lagged and lead, as well as contemporaneous, relationships between the agreements and domestic flows. In their preferred specification, their results indicate that after being in place for three years, the cumulative effect on trade flows is positive for three of the trade agreements they consider and negative for two others.

The contributions of our paper in this area of the literature relative to these papers are as follows. We consistently include trade between provinces and the rest of the world (international trade flows) in our analysis, which is crucial given that Canada is a relatively open country and, hence, international flows directly impact inter-provincial trade. We base our analysis on current best practices embedded in a structural gravity approach which provides a solid theoretical foundation for the analysis. Finally, we examine the associations between the regional trade agreements that we study and *sector- and industry-level* trade flows, providing more detailed analysis of which specific areas of the Canadian economy are more likely to be positively or negatively impacted by intra-national trade agreements.

The remainder of the paper is organized as follows. Section 2 provides background information regarding inter-provincial trade frictions and Canadian provincial trade agreements. Section 3 describes the data we use in our analysis. In Section 4, we present the results of our empirical analysis designed to quantify the relative magnitude of inter-provincial trade frictions and document how they vary across provinces, across industries, and across time. We turn to an analysis of relationships between two inter-provincial trade agreements and inter-provincial trade flows for various industries in Section 5. Section 6 concludes and discusses directions for future research.

2 Background on Inter-Provincial Trade Frictions and Inter-Provincial Trade Agreements

2.1 Inter-Provincial Trade Frictions

Internal trade barriers within Canada present significant frictions to trade across Canadian provinces.[3] These frictions increase costs for businesses and consumers, impede economic growth, and lead to inefficiencies by limiting firms' abilities to exploit economies of scale. According to Standing Senate Committee on Banking and Commerce (2016), it is estimated that eliminating internal frictions could increase Canadian GDP in the range between 0.5% and 7%.

There are at least three types of inter-provincial trade frictions. Natural frictions such as the costs of transporting goods and geographic barriers that affect ease of transport. Protectionist frictions such as regulations that directly limit or prevent the flow of inputs, goods, services across provinces or provincial subsidization of a local industry. Regulatory and administrative frictions such as those that lead to regulatory nonalignment across provinces and include local licensing and permit requirements and different safety standards.

Pittman et al. (2019) provide some noteworthy examples of protectionist policies and regulatory and administrative frictions. Regarding protectionism, Quebec, Nova Scotia, and Newfoundland and Labrador

[3] See Beaulieu et al. (2003), Kukucha (2015), Pittman et al. (2019), Standing Senate Committee on Banking and Commerce (2016), and Tombe and Winter (2013).

prohibit exporting live snow crabs to other provinces; the Alberta government provides subsidies for local craft breweries; and Saskatchewan does not allow vehicles registered in Alberta to enter construction sites. Regarding regulatory frictions, provinces have different regulations governing the sale, use, storage, and disposal of pesticides; the transportation sector faces province-specific regulations regarding licensing, permits, vehicle weights and dimensions; and there are provincial-specific qualifications in occupations such as nursing, social workers, and law. These are just a few examples of policies which inhibit inter-provincial trade.

Views differ on the most effective ways for identifying and lowering inter-provincial trade frictions. While our research does not address identification of barriers directly, our empirical analyses has the ability to point policy makers to regions, industries, and time periods where those frictions are relatively more significant.

2.2 Inter-Provincial Trade Agreements

Policy makers within Canada have long recognized the issue of internal trade barriers and have made several attempts at creating legislation to break down these barriers. The Agreement on Internal Trade (AIT) came into force in 1995 and was a national effort to address this issue with the stated aim of reducing and eliminating barriers to the free movement of persons, goods, services and investments within Canada. However, the AIT generally failed to achieve its potential and there were calls to modernize it to reflect the prevailing nature and scope of internal trade. Since the signing of the AIT, efforts to conclude international trade agreements have been more successful, leading to criticism that it is easier for international businesses to trade with Canada than it is for Canadian businesses in one province to trade with other provinces (Tkachuk and Day, 2016).

Areas that the AIT did not address include regulatory harmonization, an effective dispute resolution mechanism, adequate provisions to reduce barriers in the agricultural sector, the omission of a chapter on the energy sector, and trade in services. The latter is particularly important as the growth rate for trade in services has outpaced growth in trade for goods since 1994.

These failures of the AIT prompted negotiations to strengthen and modernize the agreement, leading to the Canadian Free Trade Agreement (CFTA) entering into force in 2017. This agreement incorporates a negative list approach, which means that all measures that restrict or impair the movement of goods, services, investment, and labor are subject to the agreement unless they are explicitly excluded. The agreement also covers most of the service economy, and contains a chapter extending to the energy sector. It features stronger dispute settlement provisions by doubling the maximum monetary penalty for governments that act in a manner inconsistent with the agreement. It also addresses issues related to regulatory harmonization by allowing for a dynamic process that first identifies barriers and then puts forward negotiations towards a reconciliation agreement between parties to address the problem.

In an effort to address some of the shortcomings of the AIT, Canadian provinces have also worked towards removing internal barriers through a series of bilateral and multilateral trade agreements among themselves. Table 1 provides a list of these agreements and the respective provinces involved in an agreement. Most notable among them is the Trade, Investment and Labour Mobility Agreement (TILMA) between British Columbia and Alberta, which was later expanded to include Saskatchewan and Manitoba under the New West Partnership Trade Agreement (NWPTA). Unlike the AIT, the TILMA/NWPTA contains a negative list approach and incorporates the idea of mutual recognition, whereby a person, good, service or investment that conforms with a standard or standards-related measure in one province is deemed to be conforming with that in another (Tkachuk and Day, 2016).

The Trade and Cooperation Agreement (TCA) between Ontario and Quebec and the Partnership Agreement on Regulation and the Economy (PARE) between New Brunswick and Nova Scotia in 2009 provided a limited expansion of the AIT. Along with the Atlantic Procurement Agreement (APA), these three agreements only partially include negative lists, relying more heavily on positive lists, whereby issues are covered only if specifically addressed in the agreement (see Kukucha (2015) and Public Policy Forum (2013)). The TCA made some progress on economic, energy, and regulatory cooperation through ensuring harmonization and mutual recognition on existing and future regulation. However, as Public Policy Forum (2013) points out, the scope of the TCA was limited because it included only a subset of sectors and industries.

In this paper, in our examination of inter-provincial trade agreements, we focus our research on empirical examinations of the effects of three of these agreements on Canadian trade flows. In particular, we investigate the combined effects of the TILMA and the NWPTA and we separately examine the impact of the TCA. We focus on a comparison of these two particular agreements as we anticipate that their effectiveness in lowering internal trade frictions has been quite different and with heterogeneous impacts across industries. As suggested above, the descriptive background literature surrounding these agreements clearly indicates that policy makers expected the TILMA/NWPTA to have a significantly stronger positive effect on inter-provincial trade flows than the TCA. To reiterate, this is primarily because the TILMA/NWPTA is characterized by fairly comprehensive coverage of the economy due to its negative list approach, whereas the TCA is limited to a subset of sectors and industries and primarily uses a positive list approach. Furthermore, given that we study disaggregated trade flows, we are well-positioned to compare and contrast the effectiveness of the agreements at the sectoral and industry level.

Table 1: Canadian Inter-provincial Trade Agreements

Agreement Title	Parties to the Agreement	Date of Entry Into Force	Date of Latest Amendment
Canadian Free Trade Agreement (CFTA)	National	July 1, 2017	December 10, 2019
Agreement on Internal Trade (AIT)	National	July 1, 1995	February 18, 2015
Trade, Investment and Labour Mobility Agreement (TILMA)	British Columbia Alberta	April 1, 2007	March 30, 2009
New West Partnership Trade Agreement (NWPTA)	British Columbia Alberta Saskatchewan Manitoba (2017)	July 1, 2010	May 26, 2022
Trade and Cooperation Agreement (TCA)	Ontario Quebec	September 11, 2009	September 1, 2016
Partnership Agreement on Regulation and the Economy (PARE)	New Brunswick Nova Scotia	February 24, 2009	—
Atlantic Procurement Agreement (APA) Atlantic Trade and Procurement Partnership (ATPP)*	New Brunswick Newfoundland and Labrador Nova Scotia Prince Edward Island	1992 (signed) January 13, 2020 (replaced)*	January 18, 2008
Agreement on the Opening of Public Procurement (OPP)	New Brunswick Quebec	1993	June 30, 2009
Interim Agreement on Internal Trade in Agriculture and Food Goods (AITA)	British Columbia Alberta Saskatchewan Manitoba Yukon	July 1, 2006	—

Some agreements have been omitted as they either pertain to Canadian Territories, pertain exclusively to the construction sector, or were pledges to increase intergovernmental cooperation.
Source: https://www.cfta-alec.ca/

3 Data

3.1 Trade Flows

3.1.1 Two-Digit Sectoral Trade Flows

We begin by examining trade flows for four important two-digit sectors: manufacturing, services, agriculture, and mining. We use annual data from 1997 to 2018 for bilateral exports and imports for ten Canadian provinces to measure flows.[4] For each province, this data includes intra-provincial flows, inter-provincial flows, and international flows to and from the rest of the world (ROW). We use reported data on these flows to construct consistent series expressed in producer prices over the time period we study. Details concerning the methods we use to measure these trade flow series are provided in Appendix A. Table 2 provides summary statistics for the various types of trade flows for each sector.

Table 2: Summary Statistics for Two-Digit Sectoral Trade Flows

Trade Flow	Mean	Median	SD	Min	Max	N
Manufacturing						
Intra-Provincial	228.27	39.60	332.13	2.03	1,360.41	220
Inter-Provincial	13.27	3.03	28.62	0.02	207.69	1,980
International	331.86	97.54	493.74	3.74	2,357.83	440
Internal ROW	343,466.90	312,555.53	116,223.52	209,924.50	544,480.38	22
Services						
Intra-Provincial	927.72	266.15	1,242.11	14.56	5,881.48	220
Inter-Provincial	14.84	3.09	34.37	0.02	287.50	1,980
International	83.28	21.46	119.93	0.68	649.93	440
Internal ROW	429,185.70	395,506.31	126,881.20	267,207.16	702,614.31	22
Agriculture						
Intra-Provincial	44.50	25.89	40.15	2.88	129.99	220
Inter-Provincial	1.12	0.24	2.32	0.00	20.50	1,948
International	11.13	5.22	14.41	0.03	81.77	440
Internal ROW	25,854.82	22,314.92	9,701.84	16,614.25	43,804.84	22
Mining						
Intra-Provincial	37.96	11.85	67.08	0.00	337.58	219
Inter-Provincial	3.45	0.21	8.93	0.00	82.11	1,410
International	55.56	15.11	107.86	0.00	815.07	437
Internal ROW	39,011.80	41,918.57	15,170.81	13,032.05	62,501.45	22

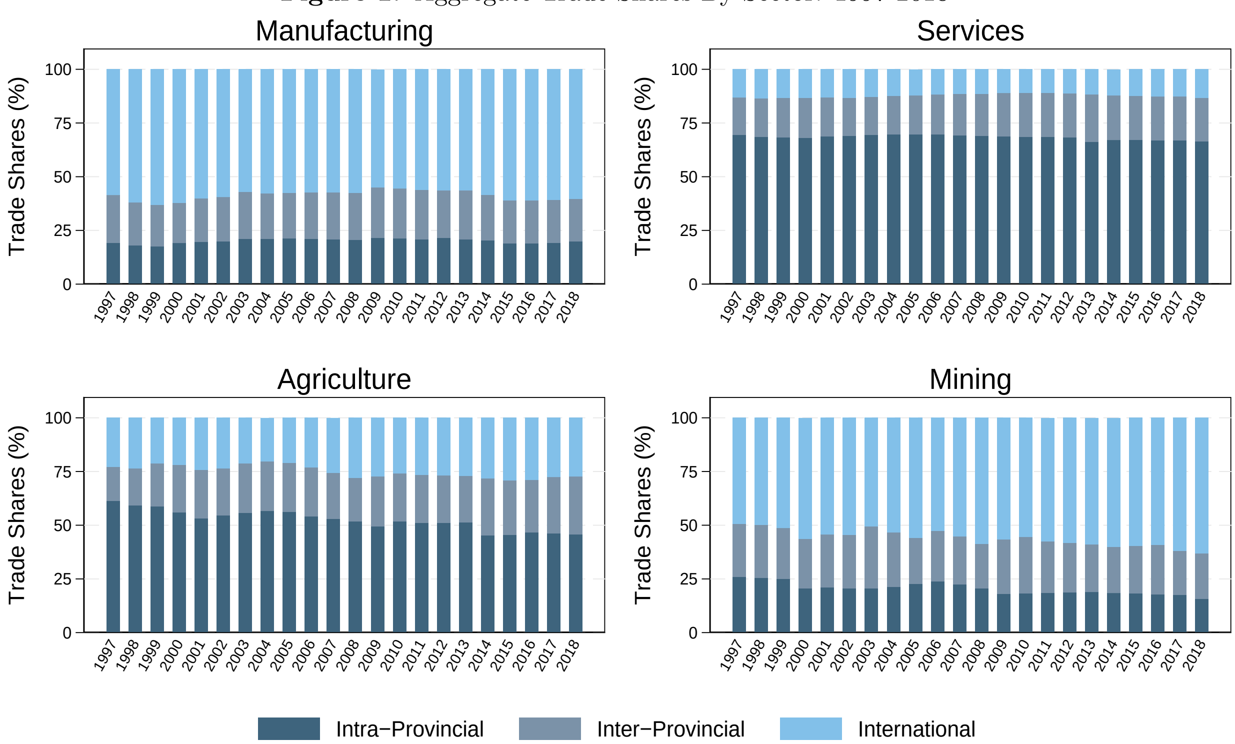
Notes: (1) Based on annual data for 1997 to 2018 for ten provinces and the rest of the world (ROW). (2) Trade flows are expressed in 100 million Canadian dollars.

[4]The data is taken from Statistics Canada Cansim Tables 121-000-85, 121-000-86, and 121-000-88. The provinces we include are Alberta(AB), British Columbia(BC), Manitoba(MB), New Brunswick(NB), Newfoundland and Labrador(NL), Nova Scotia(NS), Ontario(ON), Prince Edward Island(PE), Quebec(QC), and Saskatchewan(SK). We note that in the early years of the sample, data for trade flows are missing for agriculture and mining for some of the smaller provinces. We focus on these four broad sectors as data is available for these sectors which allows us to estimate sectoral internal trade flows for the rest of the world.

For each sector in our study, Figure 1 depicts the share of each of the three types of trade flows aggregated across the ten provinces. We note that for manufacturing and mining, the largest fractions are international flows while for services and agriculture, intra-provincial flows account for the highest share of trade. We also note that the relative importance of inter-provincial trade varies across sectors, suggesting that trade agreements aimed at lowering frictions for trade within Canada may have different effects on trade in different sectors. We examine these issues in Section 5.1 below.

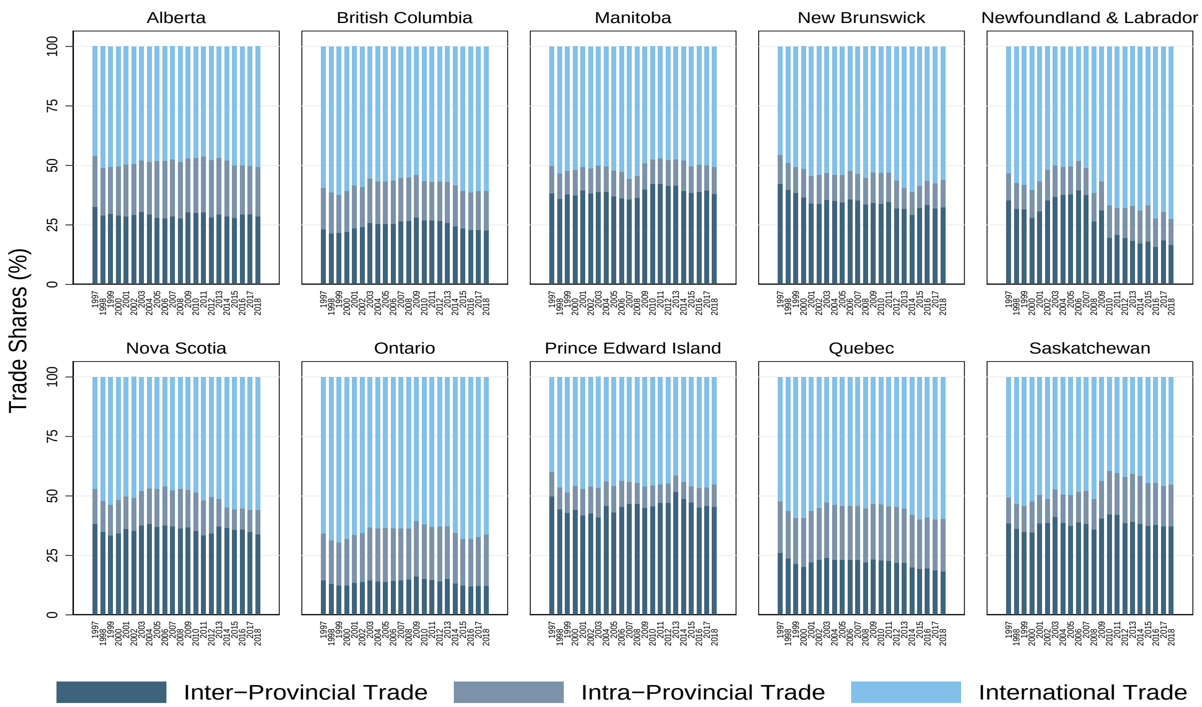
Figure 2 focuses on manufacturing flows and presents trade-type shares for that sector for each year and each province. The graphs demonstrate considerable variation across provinces in the relative importance of the different types of manufacturing trade flows. The figure suggests that Alberta, British Columbia, Ontario, and Quebec tend to exhibit the lowest share of inter-provincial flows. We also observe that trade fractions within a province are relatively stable over the time period we study. These observations are broadly consistent with the findings of Agnosteva et al. (2019) who examine similar data for manufacturing trade from 1997 to 2007. In the interest of space, analogous figures for the other three sectors are relegated in Appendix B but also suggest significant differences across provinces in the relative importance of the different types of flows.

Figure 1: Aggregate Trade Shares By Sector: 1997-2018



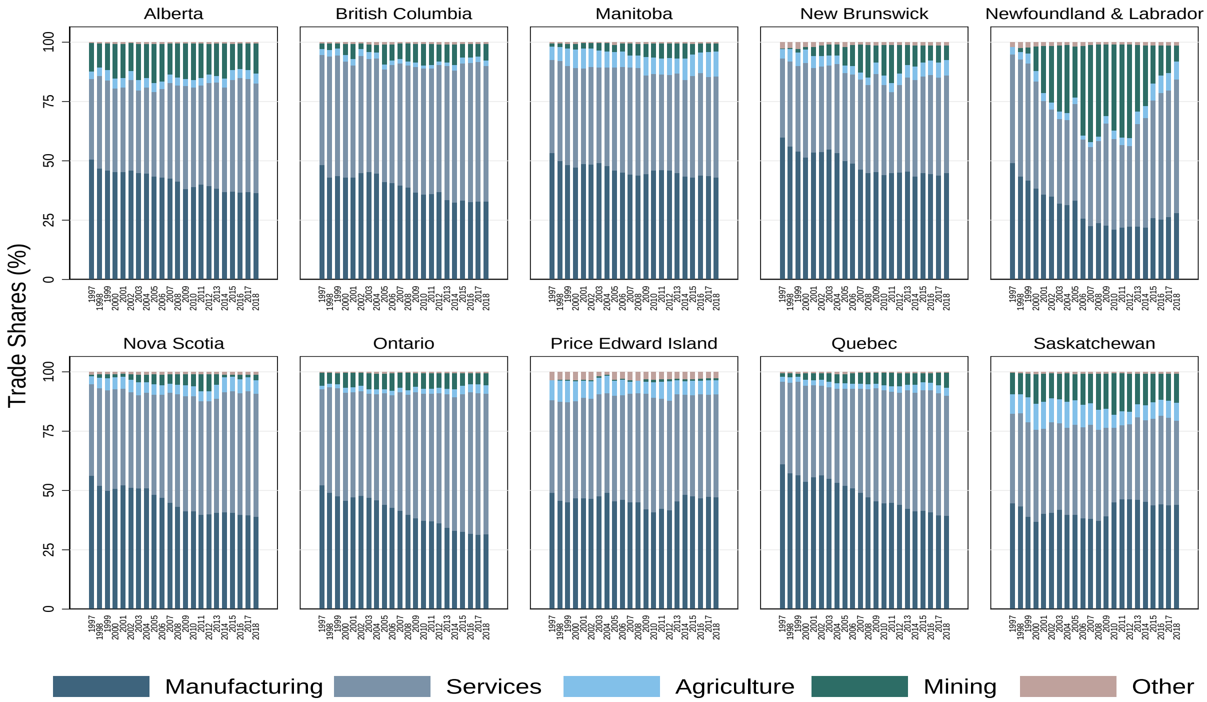
Given that our primary focus is on inter-provincial trade, Figure 3 presents the fraction of inter-provincial trade accounted for by each of these sectors for each province and each year in our analysis.[5] We observe that for most provinces, inter-provincial trade is dominated by manufacturing and services trade. In addition, we see a general decline in the share of manufacturing trade and an increase in the share of services trade across provinces over time. We also note a fair bit of variation in these shares across provinces and across time for some of the provinces. We speculate that some of this variation may be related to the impact of inter-provincicial trade agreements, particularly the New West Partnership Trade Agreeement, the Trade, Investment and Labour Mobility Agreement, and the Trade and Cooperation Agreement. We discuss these issues further in our analysis in Section 5.1 below.

Figure 2: Manufacturing Trade Fractions By Province: 1997-2018



[5]Other primarily includes Construction, Non-Market Goods and Services, and Utilities.

Figure 3: Sectoral Inter-Provincial Trade Shares by Year and Province: 1997-2018



3.1.2 Three-Digit Manufacturing Trade Flows

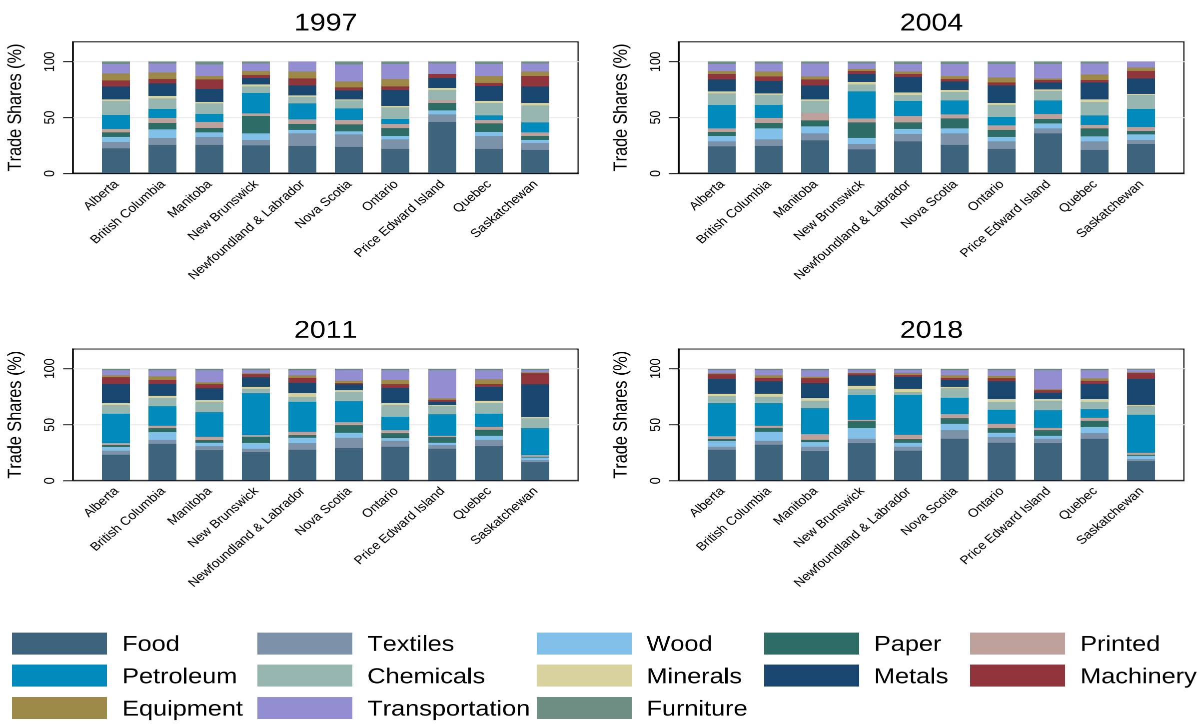
The highest level of product disaggregation that we examine is trade flows for three-digit manufacturing industries and we take up this analysis in Sections 4.2 and 5.2 below. Table 3 lists the thirteen three-digit manufacturing industries we study. Summary statistics for the various types of trade flows for each three-digit industry are presented in Table 9 in Appendix A.

Figure 4 depicts the relative importance of each industry in accounting for inter-provincial trade for select years for each province. As with the two-digit trade flows, we note considerable variation across provinces in the relative importance of different industries for inter-provincial trade flows. These differences may be related to province-industry-specific trade frictions and we seek to estimate these relative differences below.

Table 3: Three-Digit Manufacturing Industries

NAICS Code	Industry Name	Industry Abbreviation
311-312	Food, Beverages, Tobacco	Food
313-316,326	Textiles, Apparel, Leather, Rubber, Plastic	Textiles
321	Wood Products	Wood
322	Paper	Paper
323	Printed Matter, Related Products	Printed
324	Petroleum and Coal Products	Petroleum
325	Chemicals	Chemicals
327	Nonmetallic Mineral Products	Minerals
331, 332	Primary Metal, Fabricated Metal	Metals
333	Machinery, Except Electrical	Machinery
334, 335	Electrical Equipment, Appliances, Computer, Electronics	Equipment
336	Transportation Equipment	Transportation
337	Furniture, Fixtures	Furniture

Figure 4: Three-Digit Industry Inter-provincial Trade Shares by Province for Select Years



3.1.3 Internal Rest of the World Trade Flows

For each level of product aggregation described above, we also seek to estimate internal trade flows for the rest of the world (ROW) for use in our analysis. For aggregate manufacturing and three-digit manufacturing industries, we collected data on gross production (output) from the UNIDO Industrial Statistics 2 Database (INDSTAT2) for twenty-three three-digit manufacturing industries for 147 countries from 1997 to 2018. For each year, we aggregate these observations across all countries excluding Canada to construct a time series for output of the various industries for the ROW. From this measure of ROW output, we then subtract Canadian international imports for each industry, taken from the trade flows described above, giving us a measure of internal manufacturing trade flows for the ROW.

For sectors other than manufacturing, we must rely on different data sources for sectoral level world outputs. For services and agriculture, we use world value-added output data from the World Development Indicators from the World Bank. For mining, we use the MINSTAT 2022 data base from the United Nations Industrial Development Organization for world output estimates of mining.[6] For each sector, once we have an estimate of world output, we follow the method described in the previous paragraph to estimate internal ROW trade flows.

3.2 Distances

We obtained population, latitude, and longitude data for the year 2000 from the Global Rural-Urban Mapping Project (GRUMP) administered by the Socioeconomic Data and Applications Center (SEDAC) for the 67,933 locations contained in that data set.[7] We calculate the great circle distance between any two relevant locations, a and b, in our data set, d_{ab}, using the latitude and longitude data.

We then apply the methodology used by CEPII for calculating population-weighted distances between any two relevant regions, i and j:

$$d_{ij} = \sum_{a \in i} \sum_{b \in j} \left(\frac{pop_a}{pop_i} \right) \left(\frac{pop_b}{pop_j} \right) d_{ab}, \tag{1}$$

where pop_a is the population of location a, $pop_i = \sum_{a \in i} pop_a$ is the total population of region i, and pop_b and pop_j have analogous definitions. Summary statistics for distance measures are presented in Table 10 in Appendix A.

4 Measuring Inter-Provincial Trade Frictions

In this section, we seek to estimate differences in relative trade frictions for the various types of trade flows, with a particular focus on inter-provincial frictions relative to intra-provincial trade frictions. We also present

[6] Country-level output data is more limited for mining than for the other three sectors. For mining, we have data for 105 countries but observations are missing for several of those countries in some years, particularly in the latter years of our sample, 2016-2018. We note, however, that this data is used to construct only one trade flow observation per year, ROW to ROW. Hence, the impact of missing country-level mining outputs on our estimates should be limited.

[7] This includes the following number of locations for each of the regions under study: Newfoundland and Labrador: 36; Prince Edward Island: 7; Nova Scotia: 37; New Brunswick: 33; Quebec: 220; Ontario: 248; Manitoba: 42; Saskatchewan: 65; Alberta: 106; British Columbia: 93; Rest of the World: 67,046.

analyses which seek to quantify differences in those frictions across provinces, across broad sectors, and across manufacturing industries.

4.1 Baseline Structural Gravity Approach

We use a standard set of structural gravity equations for trade flows as the foundation for our analysis. Our approach is based on the prototypical theoretical foundations of the Armington-Constant Elasticity of Substitution version of a structural gravity model as described in Yotov et al. (2016). The general equations for that model are as follows:

$$X_{ijt} = \left(\frac{Y_{it}E_{jt}}{Y_t}\right) \left(\frac{\tau_{ijt}}{\Pi_{it}P_{jt}}\right)^{1-\sigma} \tag{2}$$

$$\Pi_{it}^{1-\sigma} = \sum_{j=1}^{N} \left(\frac{\tau_{ijt}}{P_{jt}}\right)^{1-\sigma} \left(\frac{E_{jt}}{Y_t}\right) \tag{3}$$

$$P_{jt}^{1-\sigma} = \sum_{i=1}^{N} \left(\frac{\tau_{ijt}}{\Pi_{it}}\right)^{1-\sigma} \left(\frac{Y_{it}}{Y_t}\right). \tag{4}$$

The variables in the equations above at time t are as follows: X_{ijt} is the value of shipments of goods and services in destination prices from source region i to destination region j, Y_{it} is the total sales at destination prices from source region i to all destinations, E_{jt} is total expenditure of region j on goods from all destinations, Y_t is world output expressed in destination prices, Π_{it} is the outward multilateral resistance term for source region i, P_{jt} is the inward multilateral resistance term for destination region j, τ_{ijt} is the bilateral resistance term between source region i and destination region j, and $\sigma > 1$ is the elasticity of substitution between goods. In our analysis, a region is either a Canadian province or the rest of the world, therefore, our analysis includes eleven regions.

We follow current best practices in estimating the structural gravity equations above using the trade flows data discussed in the data section above. Thus, we have the following general equation for applying Poisson Pseudo Maximum Likelihood (PPML) estimation techniques:

$$X_{ijt} = exp\left[\Gamma_{it} + \chi_{jt} + \varphi_{ijt}\boldsymbol{\beta}\right]\epsilon_{ijt}, \tag{5}$$

where Γ_{it} are source-time fixed effects, χ_{jt} are destination-time fixed effects, the bilateral resistance term, φ_{ijt}, is defined for various specifications which follow, $\boldsymbol{\beta}$ is a vector of coefficients to be estimated, and ϵ_{ijt} is the error term.

4.2 Two-Digit Sectoral Trade Flows

In this section, we separately analyze trade flows and trade frictions for four two-digit sectors; manufacturing, services, agriculture, and mining. As a reference point, we begin by following a portion of the methodology presented in Agnosteva et al. (2019) which exploits intra-provincial trade fixed effects for quantifying relative inter-provincial trade frictions. We then present analysis and results from a novel method we develop which is based on estimates of the multilateral resistance terms which pervade the modern structural gravity approach.

4.2.1 Measuring Relative Inter-Provincial Trade Frictions Using Estimates of Intra-Provincial Fixed Effects

To follow the methodology presented in Agnosteva et al. (2019), we modify the baseline structural gravity approach described in the previous section so that *size-adjusted* trade is the dependent variable:

$$\frac{X_{ijt}Y_t}{Y_{it}E_{jt}} = exp\left[\Gamma_{it} + \chi_{jt} + \varphi_{ijt}\beta\right]\epsilon_{ijt}. \quad (6)$$

This specification is also consistent with the theoretical structural gravity equation given by equation (2). The variables in this equation are as defined above and we follow the first two approaches taken in Agnosteva et al. (2019) by considering particular specifications for the bilateral term.

The first specification includes pair fixed effects and the bilateral term specified as follows:

$$\varphi_{ijt}\boldsymbol{\beta} = \beta_1 INTERPR\_T_{ijt} + \beta_2 INTRAPR\_T_{ijt} + \gamma_{ij}. \quad (7)$$

Here $INTERPR_{ij}$ is an indicator variable for inter-provincial trade which equals one if i and j are provinces and $i \neq j$ and equals zero otherwise and $INTERPR\_T_{ijt}$ is that indicator variable interacted with a time trend. Similarly, $INTRAPR_{ij}$ is an indicator variable for intra-provincial trade which equals one if i is a province and $i = j$ and equals zero otherwise and $INTRAPR\_T_{ijt}$ is that indicator variable interacted with a time trend. These variables are designed to capture changes in within-Canada trade costs relative to international trade costs over the time period of study.

We also include constant pair fixed effects, γ_{ij}, to account for time-invariant bilateral trade costs. In contrast to Agnosteva et al. (2019), we allow all pair fixed effects to be asymmetric.[8] We substitute equation (7) into equation (8) and estimate the resulting equation using Poisson Pseudo Maximum Likelihood

[8] Those authors consider a specification with fully asymmetric pair fixed effects in a robustness exercise and find little differences in results relative to their baseline specification with symmetric fixed effects for inter-provincial pairs.

(PPML) methods which correct for bias in estimates and standard errors due to incidental parameter issues.[9] Estimation results for this specification are presented in Columns 1, 3, 5, and 7 of Table 4.

Table 4: Estimation Results for Two-Digit Sectors Using Size-Adjusted Trade Flows

PPML Estimation of Size-Adjusted Bilateral Trade Flows	**Manufacturing**		**Services**		**Agriculture**		**Mining**	
	Pair Fixed Effects	Gravity Variables	Pair Fixed Effects	Gravity Variables	Pair Fixed Effects	Gravity Variables	Pair Fixed Effects	Gravity Variables
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
β_1: Inter-Provincial ($INTERPR\_T_{ijt}$)	0.311***	0.238**	0.059	0.050	-0.164	-0.117	0.336***	0.173
Trade Trend	(0.123)	(0.121)	(0.060)	(0.055)	(0.316)	(0.242)	(0.298)	(0.657)
β_2: Intra-Provincial ($INTRAPR\_T_{ijt}$)	0.095	0.050	-0.049	-0.036	-0.289	-0.246	-0.940***	-1.435**
Trade Trend	(0.102)	(0.107)	(0.057)	(0.052)	(0.317)	(0.231)	(0.287)	(0.684)
β_3: Log of First Quantile of Distance ($ln(d^1_{ij})$)		-1.301***		-1.415***		-1.241***		-2.112***
		(0.195)		(0.155)		(0.219)		(0.863)
β_4: Log of Second Quantile of Distance ($ln(d^2_{ij})$)		-1.396***		-1.248***		-1.227***		-1.965***
		(0.176)		(0.138)		(0.189)		(0.709)
β_5: Log of Third Quantile of Distance ($ln(d^3_{ij})$)		-1.378***		-1.246***		-1.356***		-1.781***
		(0.156)		(0.117)		(0.170)		(0.644)
β_6: Log of Fourth Quantile of Distance ($ln(d^4_{ij})$)		-1.332***		-1.251***		-1.359***		-1.936***
		(0.154)		(0.121)		(0.170)		(0.597)
β_7: Contiguous (C_{ij})		-0.129		-0.242		0.687**		0.620
		(0.185)		(0.172)		(0.271)		(0.876)
$\gamma_{AB,AB}$		-7.979***		-5.403***		-5.883***		-10.043*
		(1.272)		(0.994)		(1.387)		(5.414)
$\gamma_{ON,ON}$		-7.919***		-6.494***		-5.449***		-9.888*
		(1.293)		(1.074)		(1.471)		(5.220)
$\gamma_{MB,MB}$		-7.769***		-4.229***		-5.319***		-7.700
		(1.272)		(1.347)		(1.055)		(5.230)
$\gamma_{BC,BC}$		-7.480***		-5.283***		-3.868***		-10.225*
		(1.279)		(1.094)		(1.469)		(5.306)
$\gamma_{QC,QC}$		-7.023***		-4.298***		-4.264***		-10.592
		(1.290)		(1.036)		(1.435)		(5.866)
$\gamma_{SK,SK}$		-6.986***		-3.967***		-4.672***		-7.686
		(1.276)		(1.025)		(1.364)		(5.398)
$\gamma_{NB,NB}$		-6.691***		-3.660***		-4.499***		-6.706
		(1.098)		(0.914)		(1.178)		(5.345)
$\gamma_{NL,NL}$		-6.558***		-4.387***		-5.873***		-11.661**
		(1.362)		(1.057)		(1.444)		(5.014)
$\gamma_{NS,NS}$		-6.092***		-3.371***		-4.408***		-7.845
		(1.103)		(0.904)		(1.127)		(4.802)
$\gamma_{PE,PE}$		-4.730***		-1.558*		-2.691**		-9.023**
		(1.178)		(0.916)		(1.284)		(4.533)
Source-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Destination-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pair FE	Yes	Partial	Yes	Partial	Yes	Partial	Yes	Partial
R^2	0.993	0.985	0.999	0.999	0.999	0.992	0.999	0.994
Observations	2662	2662	2662	2662	2630	2630	2076	2076

Notes: (1) Robust standard errors (adjusted for clustering at the province pair level) in parentheses. (2) Coefficient estimates and standard errors in Columns 1, 3, 5, and 7 have been corrected for bias due to an incidental parameters problem following the methods of Weidner and Zylkin (2021). (3) Significance indicated by a *** at the 1% level, a ** at the 5% level, and a * at the 10% level.

Focusing on manufacturing, examining the estimate for $INTERPR\_T_{ijt}$, we find evidence that trade frictions for inter-provincial size-adjusted trade may have fallen relative to frictions associated with international trade over the period we study. However, our estimate for $INTRAPR\_T_{ijt}$ suggests no significant change in intra-provincial trade costs relative to international ones.

These results stand somewhat in contrast to those of Agnosteva et al. (2019) who focus exclusively on manufacturing trade. Using data from 1997 to 2007, those authors do not find significant differences in trend for either type of within-Canada trade relative to international trade. We speculate that the divergence in

[9] We use the Stata commands ppmlhdfe and ppml_fe_bias for estimation as these are well-suited for regressions with multiple high-dimensional fixed effects.

our findings from theirs is driven primarily by differences in the time periods we study. By including data from 2008-2018 in our study, our results should reflect the effects of the recession from 2008-2009 and its effects on trade flows during the later years.[10]

For services and agriculture, we do not find evidence of significant differences in trends for trade frictions for within-Canada size-adjusted trade relative to international trade. However, our results indicate that the mining sector may have experienced a significant decrease in the trends for inter-provincial trade frictions relative to international ones but a large significant increase in the trends for relative frictions associated with within-province trade flows.[11]

In the interest of brevity, we do not present our estimates of across-provinces pair fixed effects as Agnosteva et al. (2019) do but we note that all of our estimates are negative, large in absolute value, statistically significant, and vary considerably across pairs. These results are qualitatively consistent with Agnosteva et al. (2019) and provide evidence of significantly higher trade frictions for across-province size-adjusted flows relative to within-province ones.

We also undertake analysis similar to another approach taken in Agnosteva et al. (2019) with the following specification of the bilateral terms in the gravity equation:

$$\varphi_{ijt}\boldsymbol{\beta} = \beta_1 INTERPR\_T_{ijt} + \beta_2 INTRAPR\_T_{ijt} + \delta_{ij}\gamma_{ii} + (1-\delta_{ij})\left(\sum_{m=1}^{4}\beta_{m+2}ln(d_{ij}^{m}) + \beta_7 CONT_{ij}\right). \quad (8)$$

Here δ_{ij} in an indicator for within-province observations and equals 1 if $i = j$ and i is a province and equals zero otherwise. In addition, d_{ij}^{m} is the distance between regions i and j if that distance falls within quantile m of the distance distribution in the data. Finally, $CONT_{ij}$ is an indicator variable which equals one if $i \neq j$ and provinces i and j share a land border and equals zero otherwise.[12]

An important advantage of this approach is that it allows for estimation of province-specific intra-provincial fixed effects, γ_{ii}. As Agnosteva et al. (2019) point out, the level of the estimates of these variables are difficult to interpret but comparing the magnitude of estimates across provinces is useful for understanding the degree of variation across provinces of within-province trade frictions relative to inter-provincial trade frictions, after controlling for distance and contiguity. In particular, the appropriate interpretation is that provinces with a lower value tend to face lower inter-provincial frictions relative to intra-provincial frictions. Based on Figures 2, and 16-18 and the importance of distance in inhibiting trade, we generally expect these fixed effects to be negative.

[10] When we perform this regression on data from 1997 to 2007 only, we do not find significant results for either of these indicator variables. Those results are presented in Appendix B.

[11] For the mining sector, the estimates suggest considerable asymmetries within pairs for inter-provincial trade and a relatively large bias due to an incidental parameters problem.

[12] This variable equals zero if i or j is the rest of the world.

The results of these regressions are presented in Columns 2, 4, 6, and 8 of Table 4. We note that the estimates for relative trade costs trends are generally very close to those from the first specification except in the mining sector. For all sectors except mining, our results for the distance variables are generally qualitatively consistent with the findings in Agnosteva et al. (2019) for the manufacturing sector.[13] It is interesting to note that the negative effect of distance on services trade is lower than that for manufacturing and agriculture which accords with perceived differences in the methods of delivery between goods and services.

The estimate for shared borders is insignificant for manufacturing in keeping with the results of Agnosteva et al. (2019). We also do not find evidence of a significant relationship between shared borders and trade flows in services and mining. However, we do estimate a significant positive coefficient for this variable for agriculture and this may be partially explained by the perishable nature of agricultural goods.

The within-province relative trade frictions estimates, γ_{ii}, are listed in the table in increasing order for the manufacturing sector. For this sector, the ordering is broadly consistent with our general priors regarding the relative openness of larger provinces: Alberta, British Columbia, Ontario, and Quebec tend to exhibit smaller relative frictions for inter-provincial trade. We also note that the ranking of these estimates across provinces for manufacturing flows generally accords with the results of Agnosteva et al. (2019).

Turning to other sectors, Figure 5 provides a visual depiction of the ranking of the estimates of the intra-provincial fixed effects for each of the first three sectors under consideration. We see that Prince Edward Island consistently exhibits the highest relative frictions for inter-provincial trade while Alberta and Ontario are consistently ranked among the lowest three provinces. There is variation in the rankings of the other provinces across sectors and perhaps, surprisingly, British Columbia ranks second-highest in agriculture. We also note that there is more dispersion across provinces in the estimates for services than in the other two sectors depicted here. We have not included the estimates for the mining sector in this graph both because none of those coefficients are significant at the one percent level and because their values would distort the scale in this figure.[14]

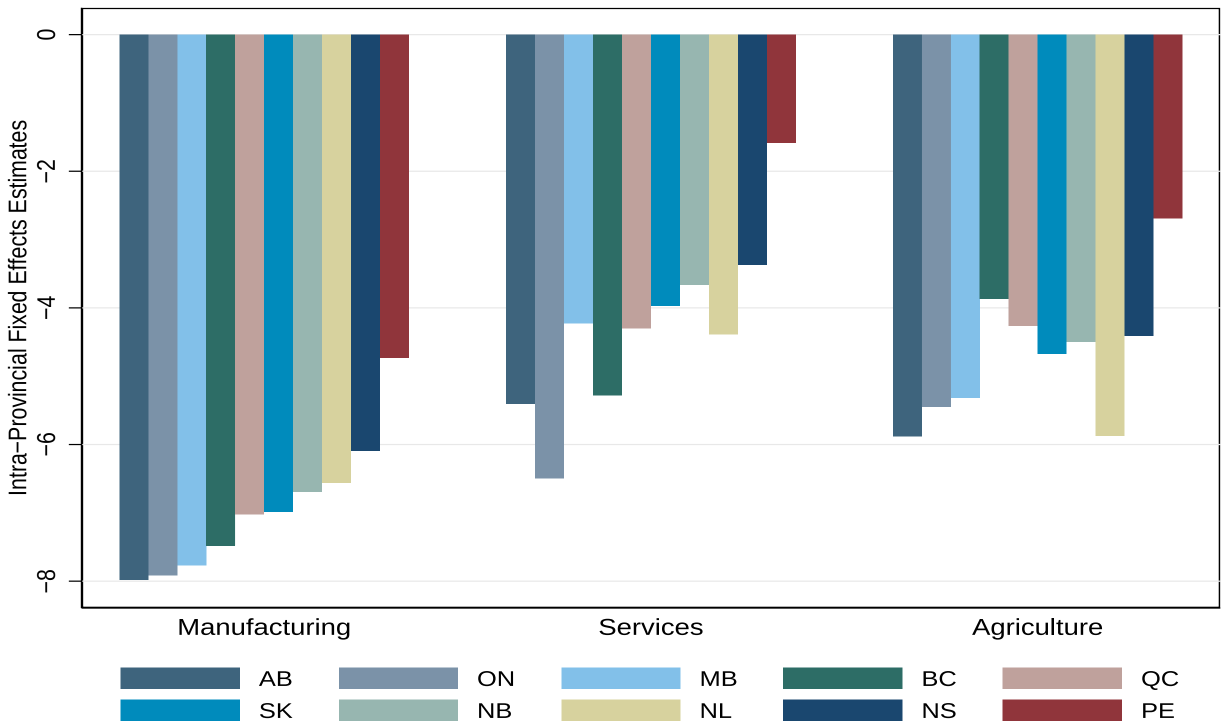
To summarize, we have used methods that Agnosteva et al. (2019) applied to aggregate manufacturing to quantify differences across provinces in the magnitudes of inter-provincial trade frictions relative to intra-provincial ones for four broad sectors. We find that in manufacturing and services, the larger provinces (Alberta, British Columbia, and Ontario) exhibit the lowest relative inter-provincial trade frictions while the smaller maritime provinces tend to have the highest. We do not generally find such a pattern in agriculture

[13] For comparative purposes, we report results for manufacturing using data from 1997 to 2007, the years those authors considered, in Appendix B.

[14] We note that estimates of intra-provincial fixed effects are significant at the five or ten percent level in the five provinces listed here in ascending order: Newfoundland and Labrador, British Columbia, Alberta, Ontario, and Prince Edward Island.

nor in mining, where, for example, Newfoundland and Labrador exhibits the lowest relative frictions in both industries.[15] Furthermore, we find that the service sector generally shows a higher level of geographic dispersion in relative inter-provincial trade frictions than the other sectors.

Figure 5: Estimated Intra-Provincial Fixed Effects: 1997-2018



4.2.2 Measuring Relative Inter-Provincial Trade Frictions Using Estimates of Multilateral Resistance Terms

An advantage of using a structural gravity approach is that the multilateral resistance terms included in the structural gravity system provide a relative measure of trade frictions facing a province. In equations (2)-(4), the outward multilateral resistance term for source region i is given by Π_{it} and the inward multilateral resistance term for destination region j is given by P_{jt}. Importantly, $\Pi_{it}^{\sigma-1}$ and $P_{jt}^{\sigma-1}$ can be estimated, up to a scalar, for each province using the iterative techniques developed by Anderson and van Wincoop (2003), Guimaraes and Portugal (2010), Larch et al. (2019), and others.[16]

Importantly, the multilateral resistance terms present in the structural gravity system allow us to provide a bliateral measure for each province and each time period that summarizes the effect of inter-provincial and

[15]Newfoundland and Labrador is basically tied with Alberta in agriculture.
[16]We use the Stata command ppml_panel_sg developed by Larch et al. (2019) to estimate our structural gravity system as this command estimates these multilateral resistance terms, up to a scalar.

intra-provincial trade frictions on actual trade relative to a frictionless (RTF) benchmark.[17] In what follows, we focus on the ratio of a province's trade with itself to its bilateral inter-provincial trade flow with every destination and with every source. Henceforth, we refer to these ratios as provinces' *relative* inter-provincial trade flows.

We begin by noting that frictionless trade is captured by the case where $\tau_{ijt} = 1, \ \forall i, j, t$ and in that case, all outward and inward multilateral resistance terms equal one. Hence, according to equation (2), the frictionless benchmark for our relative inter-provincial trade flow measure for exports from i to j is given by

$$\frac{X_{iit}}{X_{ijt}} = \frac{E_{it}}{E_{jt}}. \tag{9}$$

Similarly, the frictionless benchmark for imports into j from i is given by

$$\frac{X_{jjt}}{X_{ijt}} = \frac{Y_{jt}}{Y_{it}}. \tag{10}$$

Using equation (2), we see that the structural gravity model implies that the ratio of an actual relative inter-provincial trade flow to its frictionless benchmark is as follows:

$$\frac{\left(\frac{X_{iit}}{X_{ijt}}\right)}{\left(\frac{E_{it}}{E_{jt}}\right)} = \left(\frac{\tau_{iit}}{\tau_{ijt}}\right)^{1-\sigma} \left(\frac{P_{it}}{P_{jt}}\right)^{\sigma-1}. \tag{11}$$

We refer to the right-hand side of this equation as the *outward relative to frictionless measure* for exports from source i to destination j at time t and denote it as

$$ORTF_{ijt} \equiv \left(\frac{\tau_{iit}}{\tau_{ijt}}\right)^{1-\sigma} \left(\frac{P_{it}}{P_{jt}}\right)^{\sigma-1}. \tag{12}$$

Similarly, we can derive an analogous *inward relative to frictionless measure* for imports into destination j from source i at time t denoted as

$$IRTF_{ijt} \equiv \left(\frac{\tau_{jjt}}{\tau_{ijt}}\right)^{1-\sigma} \left(\frac{\Pi_{jt}}{\Pi_{it}}\right)^{\sigma-1}. \tag{13}$$

We note that both of these measures are uniquely determined because the scalar associated with the non-determinancy of the multilateral resistance terms cancels out in the ratios of the multilateral resistance terms.

Below, we estimate bilateral and multilateral resistance terms (up to a scalar) and we use those to

[17] The measure we develop is tangentially related to the Constructed Home Bias measure presented in Anderson and Yotov (2010).

construct estimates of our RTF measures. We note here that a higher value for our *outward* measure, $ORTF_{ijt}$, should be associated with a lower ratio of inter-provincial exports to intra-provincial *exports* than the frictionless benchmark, and, hence is associated with relatively higher inter-provincial trade frictions for *selling* goods and services. Similarly, a higher value for our *inward* measure, $IRTF_{ijt}$, is associated with relatively higher inter-provincial trade frictions for *purchasing* goods and services.

Our regression specification for estimating the bilateral and multilateral resistance terms is fairly general and is specified as follows:

$$X_{ijt} = exp\left[\Gamma_{it} + \chi_{jt} + \gamma_{ij} + \beta_1 INTERPR\_T_{ijt} + \beta_2 INTRAPR\_T_{ijt}\right]\epsilon_{ijt}. \tag{14}$$

All variables are as defined in previous sections and here we do not impose symmetry on any pair fixed effects. Using the results from estimating this equation, we can then construct the following estimates of our outward and inward relative to frictionless measures from equations (12) and (13) as follows:

$$\widehat{ORTF}_{ijt} = exp\left(\hat{\gamma}_{ii} - \hat{\gamma}_{ij}\right) \times exp\left(t(\hat{\beta}_2 - \hat{\beta}_1)\right) \times \left(\frac{\hat{\Phi}_{jt}}{\hat{\Phi}_{it}}\right). \tag{15}$$

$$\widehat{IRTF}_{ijt} = exp\left(\hat{\gamma}_{jj} - \hat{\gamma}_{ij}\right) \times exp\left(t(\hat{\beta}_2 - \hat{\beta}_1)\right) \times \left(\frac{\hat{\Psi}_{it}}{\hat{\Psi}_{jt}}\right), \tag{16}$$

where $\hat{\Phi}_{it}$ is the estimated outward multilateral resistance term for source i at time t and $\hat{\Psi}_{jt}$ is the estimated inward multilateral resistance term for destination j at time t.[18]

We estimate equation (14) for each sector separately using our trade flow data from 1997 to 2018 and present regression results in Table 5. Similar to our results in the previous section using size-adjusted trade flows, using *trade levels* here we also note considerable variation across sectors in the trends of inter-provincial trade frictions and intra-provincial frictions relative to international trade frictions. For manufacturing, we find evidence that both inter- and intra-provincial trade frictions have fallen relative to international ones. In the service sector, however, we do not find strong evidence of a significant change in the relationship between within-Canada flows and international flows. In contrast, for agriculture, our results suggest that frictions associated with intra-provincial trade have increased over time relative to frictions associated with international flows. We estimate that frictions associated with both types of within-Canada trade have increased relative to international ones in the mining sector.

A primary objective of the analysis in this section is to compare the estimated relative to frictionless

[18] Comparing equation equation (14) to equation (2), we note the following: $exp(\Gamma_{it}) = \left(Y_{it}/\sqrt{Y_{wt}}\right)\Pi_{it}^{\sigma-1}$, $exp(\chi_{jt}) = \left(E_{jt}/\sqrt{Y_{wt}}\right)P_{jt}^{\sigma-1}$, $\tau_{ij}^{1-\sigma} = exp(\gamma_{ij}) \times exp(\beta_1 INTERPR\_T_{ijt}) \times exp(\beta_2 INTRAPR\_T_{ijt})$. The estimated multilateral resistance terms from the Stata command ppml_panel_sg are related to the terms in equation (2) as follows: $\hat{\Psi}_{it} = \Pi_{it}^{1-\sigma}$ and $\hat{\Phi}_{jt} = P_{jt}^{1-\sigma}$ (see Larch et al. (2019)).

Table 5: Estimation Results for Two-Digit Sectors Using Trade Flow Levels

PPML Estimation of Bilateral Trade Flows	**Manufacturing**	**Services**	**Agriculture**	**Mining**
β_1: Inter-Provincial ($INTERPR\_T_{ijt}$)	0.226***	0.118*	0.037	-0.357***
Trade Trend	(0.039)	(0.067)	(0.102)	(0.078)
β_2: Intra-Provincial ($INTRAPR\_T_{ijt}$)	0.325***	0.008	-0.234***	-0.712***
Trade Trend	(0.037)	(0.064)	(0.081)	(0.083)
Source-Time FE	Yes	Yes	Yes	Yes
Destination-Time FE	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes
R^2	0.999	0.999	0.999	0.999
Observations	2662	2662	2630	2076

Notes: (1) Robust standard errors (adjusted for clustering at the province pair level) in parentheses. (2) Significance indicated by a *** at the 1% level, a ** at the 5% level, and a * at the 10% level. (3) Estimates were generated using the Stata command ppml_panel_sg which implements the estimation methods developed by Larch et al. (2019). (4) All samples include international flows for each province and internal ROW flows.

measures for each sector across provinces.[19] This approach allows us to rank provinces according to their estimated relative inter-provincial frictions as captured by this measure. It also allows us to compare the levels and dispersion in these relative frictions across the sectors we study.

Figure 6 provides a graphical depiction of the long-run ranking of our estimates of outward relative to frictionless measures across provinces. In particular, for each province (i), that figure plots the average over all other provincial destinations (j) and over the time period 1997 to 2018 of the log of the estimated $ORTF_{ijt}$ within each sector. Figure 7 does the same for the estimated $IRTF_{ijt}$ terms, with averages calculated over all other provincial sources. For ease of comparison, we have ordered the provinces in this figure in the same order as in Figure 5.

We first discuss the results for the outward measures which focus on the relative inter-provincial trade frictions that provinces face as exporters. We first note that, as with the measure presented above based on the methods of Agnosteva et al. (2019), services exhibits more dispersion across provinces in inter-provincial trade frictions for selling than the other three sectors. We also see that the detailed rankings across provinces by this measure do not align directly with the previous measure for any of the sectors with particularly striking differences for Newfoundland and Labrador in both services and agriculture and for Alberta and Quebec in agriculture.

Examining each sector, starting with manufacturing, we see a broad similarity here with our earlier findings and the results of Agnosteva et al. (2019) in that both measures have the same five provinces exhibiting

[19] Estimates for pair fixed effects and multilateral resistance terms, which are used to construct the RTF measures, are reported in Appendix B. In the interest of space, we present only time-averaged estimates for the multilateral resistance terms in that appendix.

lowest inter-provincial trade frictions (Alberta, British Columbia, Manitoba, Ontario, and Quebec). We also note that the smaller maritime provinces of Newfoundland and Labrador and Prince Edward Island exhibit among the highest relative trade frictions. For services, Ontario again exhibits the lowest relative frictions, while Prince Edward Island shows the highest. The magnitude of the differences between this measure for Ontario and the other provinces may seem surprisingly large, suggesting that Ontario faces considerably lower relative barriers for providing services to other provinces. In agriculture, British Columbia and Prince Edward Island face the largest frictions, a finding consistent with our earlier method. A contrasting finding is that this measure suggests that Alberta and Newfoundland and Labrador face relatively high inter-provincial frictions in exporting agricultural products to other provinces.

We next turn to our inward measures which focus on the relative inter-provincial trade frictions that provinces face as importers. We first note that ignoring Newfoundland and Labrador, we estimate considerably less dispersion in relative inter-provincial trade frictions across provinces in their roles as buyers as compared to when they are sellers. With that said, agriculture and mining exhibit the highest level of dispersion across provinces in this measure reflecting relative frictions facing provinces as importers of goods from other provinces.

Newfoundland and Labrador stands out in all sectors except mining as facing considerably larger relative frictions when importing goods and services from other provinces. We also see that some provinces in manufacturing and mining exhibit an inward RTF measure which is less than one (the average of the log values is negative). This suggests that for those provinces, the ratio of their inter-provincial imports to their purchases of goods produced within the province is *larger* than the frictionless benchmark. Perhaps not surprisingly, this is most pronounced in the smaller maritime provinces in the mining sector.

Finally, Figures 8 and 9 depict trends in these measures of relative inter-provincial trade for each provinces for each sector. The left panel of each figure presents the outward RTF measures while the right panel depicts the inward RTF measures. For the outward measures, the graph depicts the average outward RTF across all other destination provinces for a province's exports in each year while the inward measure is the average of the inward RTF across all other source provinces from which a province is importing.

Those figures suggest general downward trends in relative inter-provincial trade frictions in services, agriculture, and mining but an upward trend in manufacturing for most provinces. In comparing across the two figures, we see that our estimates for manufacturing and services exhibit much less volatility over time than our estimates for the other two sectors. We also note that there is very little change in the rankings of these measures across provinces over time in the manufacturing and services sector.

Figure 6: Estimated Two-Digit Sectors Inter-Provincial Outward Relative to Frictionless Measures

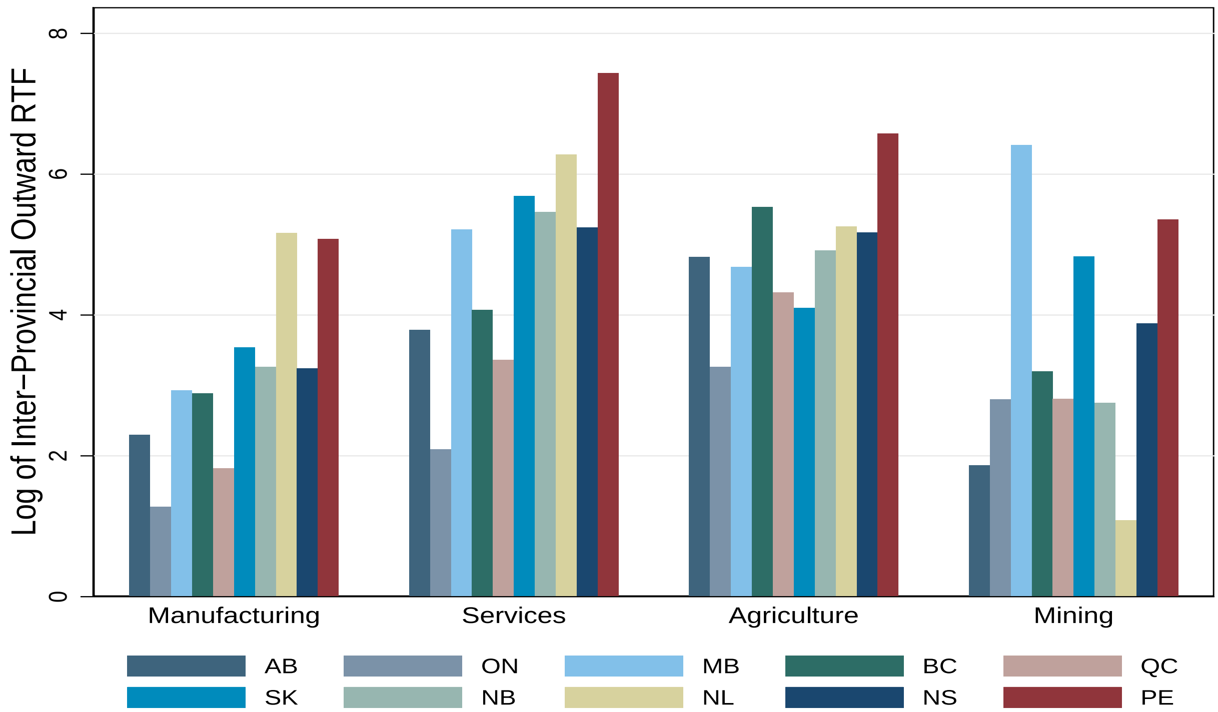


Figure 7: Estimated Two-Digit Sectors Inter-Provincial Inward Relative to Frictionless Measures

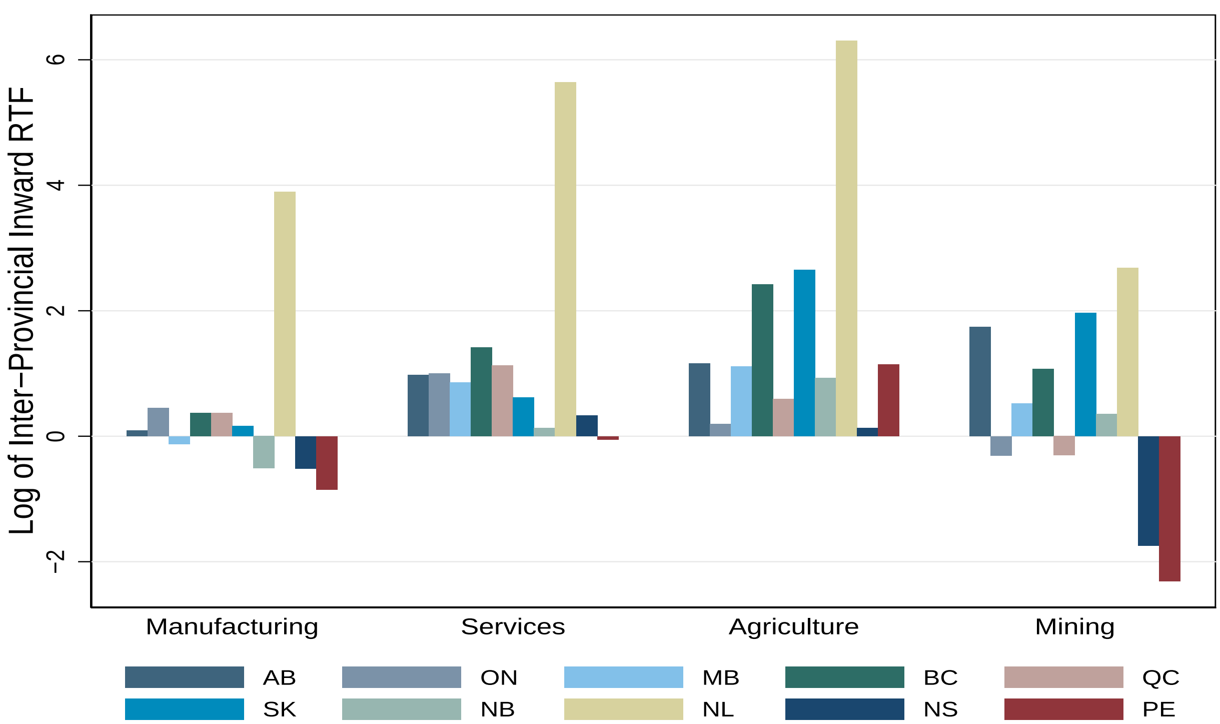


Figure 8: Relative to Frictionless Measures: Manufacturing and Services

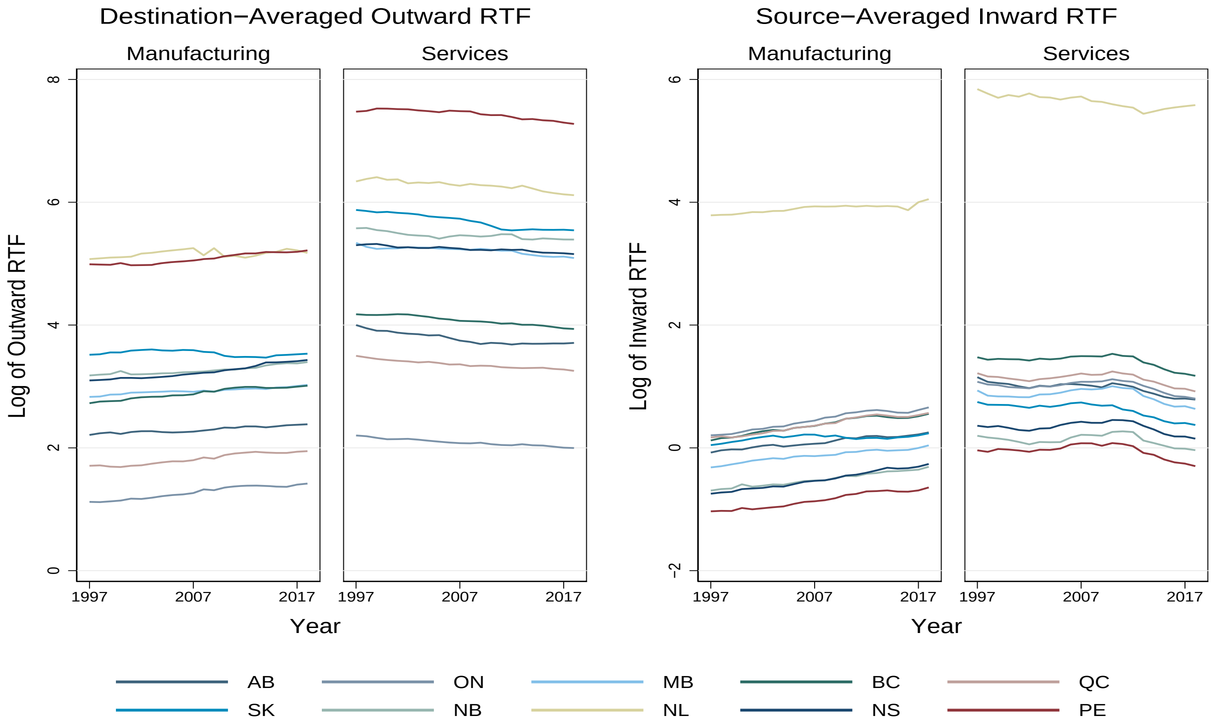
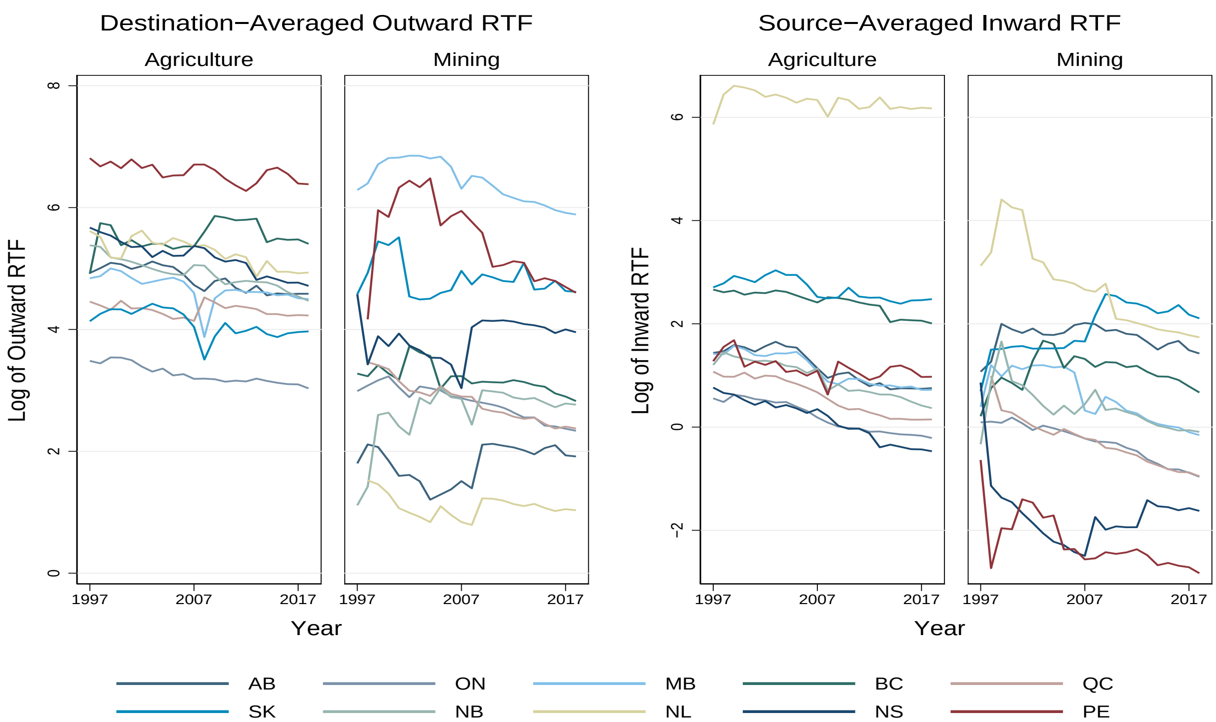


Figure 9: Relative to Frictionless Measures: Agriculture and Mining



In this section, we have used a novel measure based on estimates of bilateral and multilateral resistance

Table 6: Estimation Results for Three-Digit Manufacturing Industries

PPML Estimation of Industry Bilateral Trade Flows	Food	Textiles	Wood	Paper	Print	Petro.	Chem.	Minerals	Metals	Mach.	Equip.	Transp.	Furn.
β_1: Inter-Provincial Trade Trend	-0.047	0.122***	0.515***	0.067	-0.226	-0.698***	-0.207***	0.841***	-0.033	0.355***	0.587***	0.037	-0.354***
	(0.716)	(0.041)	(0.092)	(0.091)	(0.212)	(0.097)	(0.056)	(0.097)	(0.074)	(0.051)	(0.082)	(0.168)	(0.090)
($INTERPR\_T_{ijt}$)													
β_2: Intra-Provincial Trade Trend	-0.245***	0.369***	0.507***	0.239***	-0.084	-0.620***	-0.064	0.783***	-0.023	0.469***	0.676***	0.701***	0.065
	(0.067)	(0.035)	(0.072)	(0.084)	(0.237)	(0.062)	(0.052)	(0.081)	(0.078)	(0.051)	(.068)	(0.076)	(0.081)
($INTRAPR\_T_{ijt}$)													
Source-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Destination-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Observations	2662	2582	2562	2452	2540	2186	2578	2369	2633	2597	2493	2570	2209

Notes: (1) Robust standard errors (adjusted for clustering at the province pair level) in parentheses. (2) Significance indicated by a *** at the 1% level, a ** at the 5% level, and a * at the 10% level. (3) Estimates were generated using the Stata command ppml_panel_sg. (4) All samples include international flows for each province and internal ROW flows.

terms to uncover interesting patterns across provinces in relative inter-provincial trade frictions associated with selling and purchasing goods and services. Our results suggest that the regional dispersion apparent in these frictions differs across the four broad sectors that we study, with the highest degrees of dispersion in services. We also find that the rankings in the severity of these frictions across provinces differs across sectors and also varies depending on whether a province is facing these frictions as an exporter or as an importer. These results suggest that trade policies aimed at lowering inter-provincial trade frictions may have stronger impacts in some sectors and provinces relative to others. We examine such barriers in Section 5.

4.3 Three-Digit Manufacturing Industrial Trade Flows

In this section, we analyze differences across provinces in trade frictions for a set of thirteen three-digit manufacturing industries. Table 6 presents the results of estimating equation (14) for each industry separately over the time period 1997 to 2018. We note that for five industries (textiles, wood, minerals, machinery and equipment) we estimate a decrease in both types of within-Canada frictions relative to international trade frictions while for only one industry (petroleum), we estimate the opposite. For two industries (chemicals and furniture), our results suggest an increase in inter-provincial trade frictions relative to international ones. For food, we find a decrease in relative intra-provincial frictions and for transportation, we estimate the opposite relationship. For all other industries and trade flow types, we do not find a significant difference in trends.

For each manufacturing industry and each year, we also estimate an outward RTF for each province-destination pair in a province's role as an exporter and we estimate an inward RTF for each province-source pair in a province's role as an importer. We summarize these results by graphing these measures averaged over time and over provincial trading partners as depicted in Figures 10-12.

For the outward RTF measures, we see that Ontario and Quebec typically exhibit the lowest relative inter-provincial trade frictions for exporting while Newfoundland and Labrador usually display the highest relative frictions. There are differences across the industries in the rankings of our estimates across the remaining provinces. The printing, petroleum, and equipment industries exhibit the highest degree of regional dispersion in these estimates of the inter-provincial frictions associated with exporting.

Turning to the inward RTF measures, as with the sectoral results, we see that some provinces in some sectors exhibit ratios of inter-provincial imports to intra-provincial imports which are estimated to be above the frictionless benchmark. We also note that Newfoundland and Labrador consistently exhibits relatively high levels of inter-provincial frictions when importing manufacturing goods of all types. Finally, we observe considerably less regional dispersion in inter-provincial frictions when provinces are purchasing manufacturing goods compared to when they are selling manufacturing goods.

Figure 10: Estimated Three-Digit Industries Inter-Provincial Outward Relative to Frictionless Measures

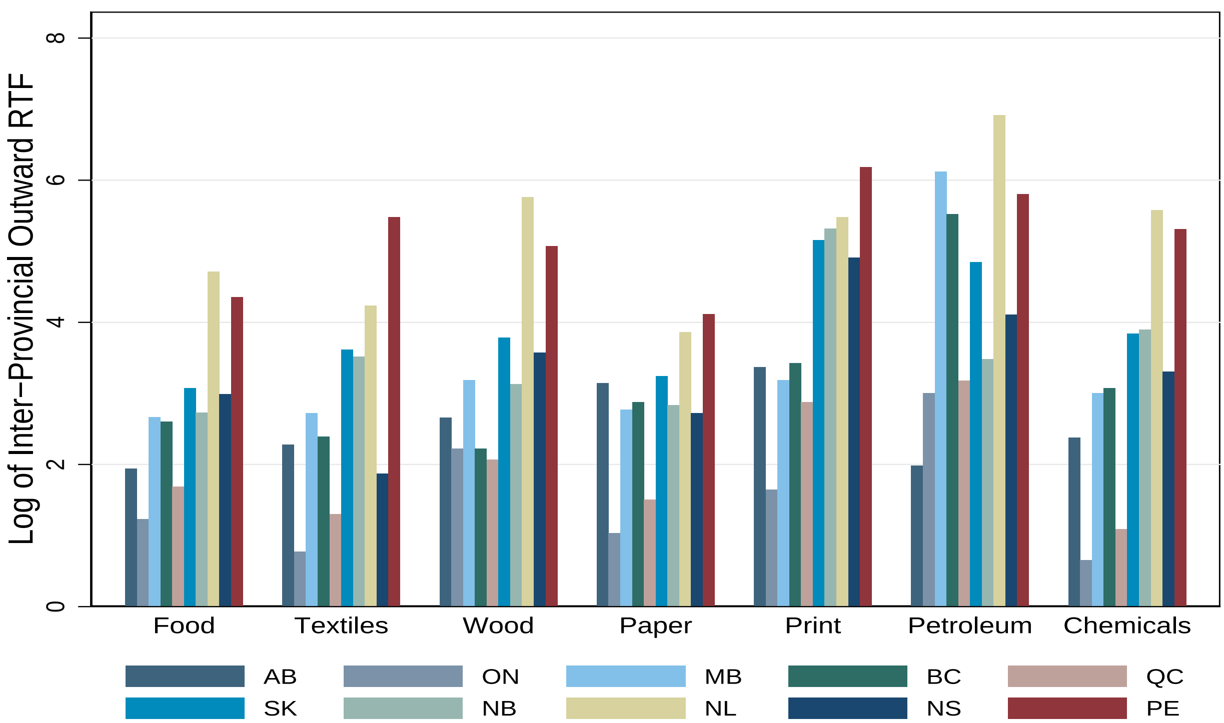


Figure 11: Estimated Three-Digit Industries Inter-Provincial Outward Relative to Frictionless Measures

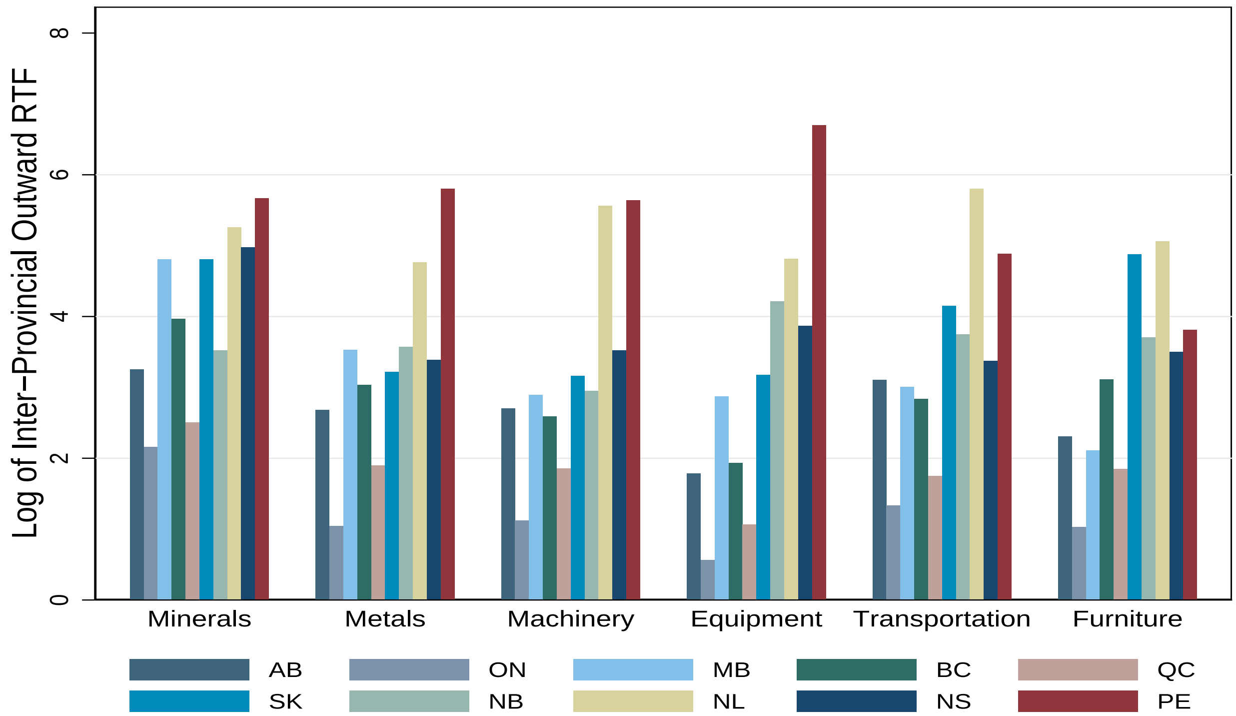


Figure 12: Estimated Three-Digit Industries Inter-Provincial Inward Relative to Frictionless Measures

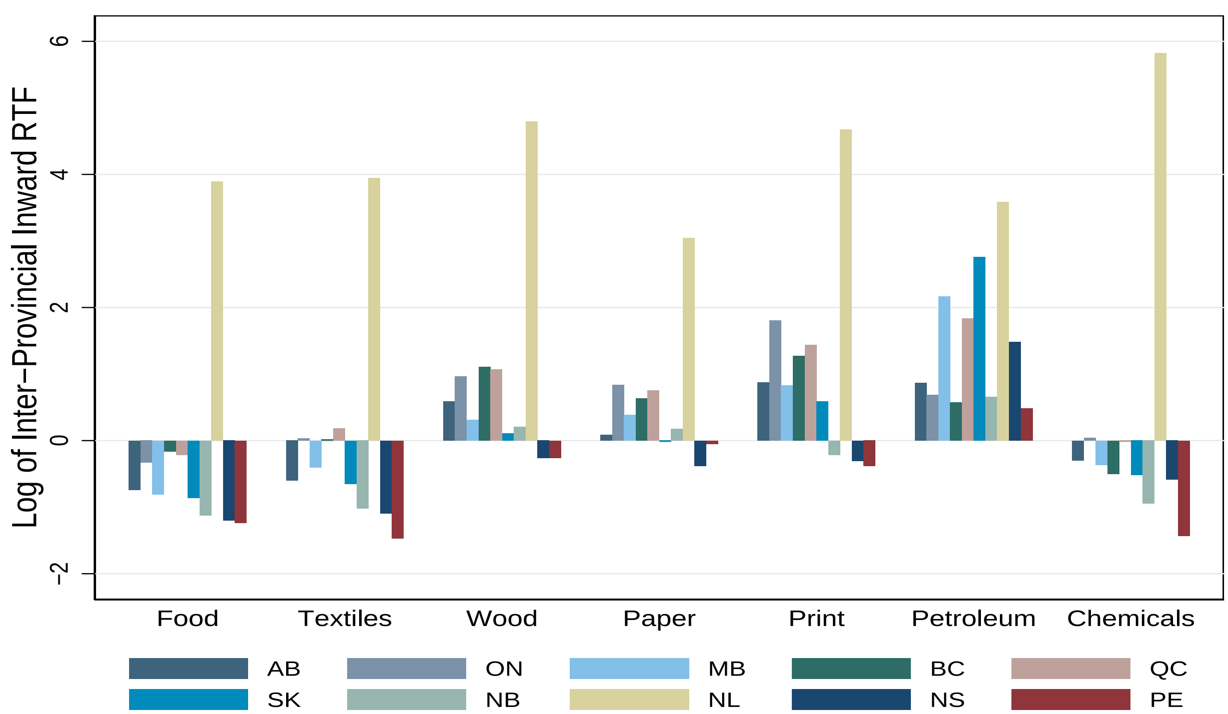
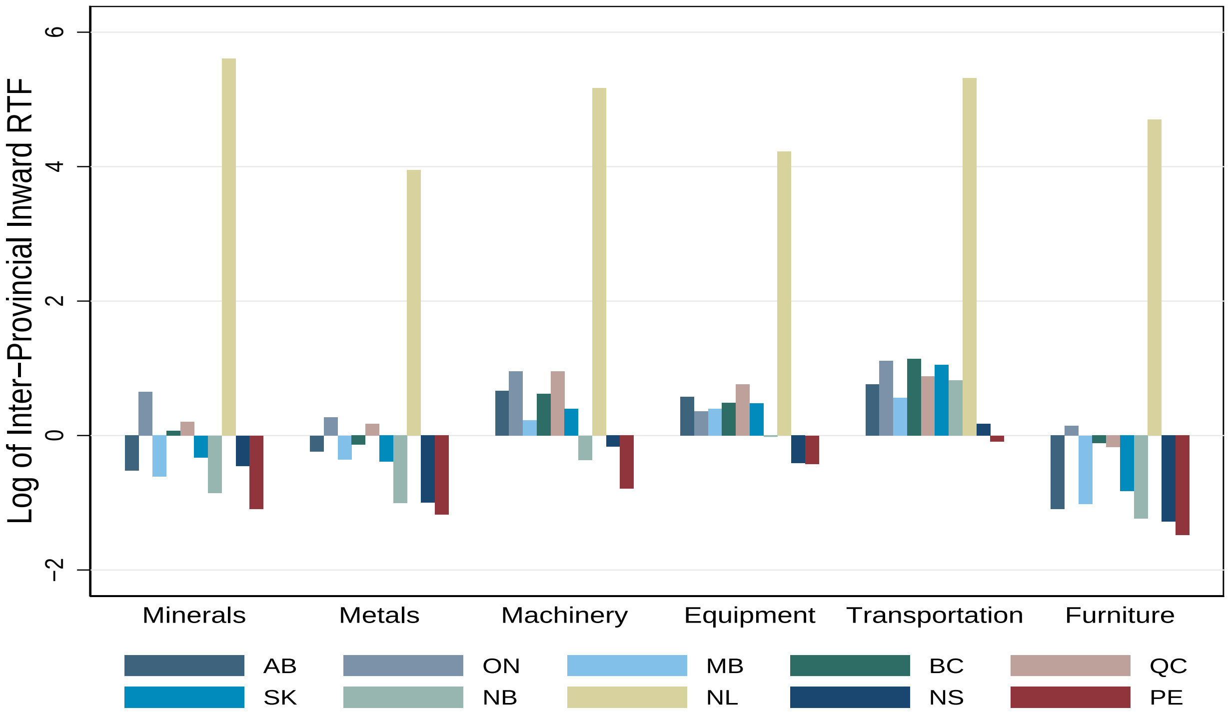


Figure 13: Estimated Three-Digit Industries Inter-Provincial Inward Relative to Frictionless Measures



In the next section, we seek to quantify relationships between inter-provincial trade agreements and provincial trade flows. There we undertake analysis for trade flows for two-digit sectors and three-digit manufacturing industries.

5 Effects of Inter-Provincial Trade Agreements on Trade Flows

5.1 Empirical Specification

To analyze the impact of inter-provincial trade liberalizations, we follow Egger et al. (2022) by using consecutive-year data rather than interval data to avoid biased estimates of trade-policy effects and to improve the efficiency of our estimates.[20] We begin by analyzing the relationships between two-digit sectoral trade and two of the inter-provincial trade agreements listed in Table 1: (1) the combined Trade, Investment and Labour Mobility Agreement and the New West Partnership Trade Agreement (TILMA/NWPTA) and (2) the Trade and Cooperation Agreement (TCA). As described in Table 1, TILMA/NWPTA included Alberta and British Columbia beginning in 2007 and was joined by Saskatchewan in 2010 and Manitoba in 2017. The TCA was signed by Ontario and Quebec in 2009. We chose these agreements as they contain a

[20] It is sometimes argued that interval data should be used to allow for adjustments in bilateral trade flows in response to trade policies as these policy changes are not instantaneous (Cheng and Wall, 2005). We explore this specification in Appendix B.

significant amount of provisions, fit our period of study, and cover a wide range of goods.[21]

To examine the relationships between Canadian trade and these two agreements, we estimate the structural gravity system presented in equation (5) with the following specification for the bilateral resistance term:

$$\phi_{ijt}\boldsymbol{\beta} = \sum_{s=-1}^{9} \beta_1^S TILMA/NWPTA_{ij,t-s} + \sum_{s=-1}^{9} \beta_2^S TCA_{ij,t-s} + \beta_3 INTERPR\_T_{ijt} + \beta_4 INTRAPR\_T_{ijt} + \gamma_{ij}. \quad (17)$$

Here, $TILMA/NWPTA_{ij,t-s}$ is an indicator variable which equals one if i and j were members of the TILMA or NWPTA in year t-s and equals zero otherwise while $TCA_{ij,t-s}$ is an indicator variable which equals one if i and j were members of the TCA in year t-s and equals zero otherwise. The remainder of the specification is unchanged from (5).

The lagged terms for the trade agreements we are studying allow for phasing-in of the agreements, non-linear effects of the agreements, and capture the possibility that the effects of those agreements change over time. In particular, Baier and Bergstrand (2007) note that virtually every trade agreement is phased-in typically over ten years, thus additional lagged terms up to nine periods have been added. In addition, a lead term of one period has been added to test for strict exogeneity and to capture any anticipatory effects as trade agreements are ordinarily announced before they come into force (Moser and Rose, 2014; Egger et al., 2022). The average cumulative effect of the trade agreements on trade after accounting for these effects can be constructed as $\beta_n \equiv \sum_{s=-1}^{9} \beta_n^s$, for $n \in \{1, 2\}$.

We note that due to the presence of time-varying exporter and importer fixed effects, the impact of these trade agreements are only identifiable when trade increases between i and j relative to each province's trade with all other partners. The inclusion of pair fixed effects is to account for endogeneity of trade policy variables by including observable and unobservable time-invariant bilateral trade costs Baier and Bergstrand (2007). We adjust for asymptotic bias in the coefficient estimates and standard errors by using the methodology developed by Weidner and Zylkin (2021).

5.2 Two-Digit Sectoral Trade Flows

Table 7 presents the results of this estimation and Figure 14 provides a visual representation of our estimates of the total effect of these trade agreements across time for our four two-digit sectors. A notable result from Table 7 is the heterogeneous effect of these trade agreements across sectors, which is similar to the effect of trade agreements at the international level (Baier et al., 2019).

The TILMA/NWPTA agreement estimates indicate that this agreement is associated with no significant change in trade flows between partners in the manufacturing and services sectors over a ten-year period. However, it is associated with a fall in trade flows of $[exp(-0.73) - 1]^{*}100 = 51.81\%$ in the agriculture sector. Conversely, over a nine-year period, the agreement is shown to increase trade flows by 177.32% in the mining sector. The estimates for

[21] Because our data spans 1997-2018, we do not study the Atlantic Procurement Agreement/Atlantic Trade and Procurement Partnership (APA/ATPP) and the Agreement on the Opening of Public Procurement (OPP).

the TCA agreement suggest that this agreement is associated with a 22.12% decrease in trade flows for the services sector and an increase of 85.89% for the mining sector.

Figure 14 shows the estimated cumulative effect of these agreements on trade over time. These agreements follow similar trends to the three phases of the long-run impact of RTAs on trade as identified in Egger et al. (2022). For the services and agriculture sectors, there is a period of adjustment in the early years after the trade agreements come into force and then our results suggest that after a short (negative) growth phase the agreements reach maturity around eight years after entry. The mining sector presents some positive and significant results for the TILMA/NWPTA prior to coming into force, which may suggest firms adjusted their behavior in anticipation of the agreement.[22] The effect of this agreement on trade flows reaches maturity quickly, at around three years after its entry. Finally, there is some evidence from Figure 14 that the TCA positively impacted trade flows in the mining sector starting three years after coming into force, although the cumulative effect is only significant at the 10% level by the end of our period of study.

The absence of an impact from the trade agreements on the manufacturing sector as a whole is perhaps not a surprising result. Provisions in these agreements may have impacted sub-industries quite differently, such as the exception of barriers present in the food manufacturing industry. To disentangle these potential heterogeneous effects on the manufacturing sector, we examine our thirteen three-digit manufacturing industries in the next section.

As can be seen from Figure 3, trade in the services sector has grown to account for the majority of inter-provincial exports over time in our sample. The AIT mainly focused on trade in goods, leaving improvements in this sector to be the imperative of future trade agreements. The TILMA/NWPTA adopts a negative list approach, so barring listed exceptions, the general rules in Section II of the agreement apply to this sector.[23] In addition, the TILMA/NWPTA lowered government procurement thresholds for services further than what was outlined in the AIT, while the TCA did not include any new provisions to lower thresholds in the services sector. In contrast, the positive list approach of the TCA only contains one chapter covering the harmonization of regulatory practices in financial services, but is otherwise lacking extensive provisions to address the shortfalls of the AIT in this sector.[24]

It is interesting that we estimate a negative relationship between the TILMA/NWPTA and trade in the agriculture sector. This industry is cited as having some of the most pervasive internal trade impediments. Indeed, the agreement maintains several exceptions for this sector; most notably measures adopted to maintain supply-managed commodities, such as poultry, dairy products and eggs. Additionally, regulatory measures adopted in the Natural Products Marketing (BC) Act in British Columbia are excepted from the agreement, which provides effective regulation and control in all respects of the marketing of natural products within British Columbia, including the prohibiting of such marketing in whole or in part.[25] The TILMA/NWPTA Agreement maintains restrictions in the

[22] TILMA was signed on April 28, 2006, nearly a year prior to it coming into force.

[23] These include government procurement of health and social services, services provided by lawyers and notaries, and treasury services. Additionally, services and investments pertaining to water, and commercial transportation of passengers are excepted.

[24] *TCA*, Chapter Seven, online: https://www.ontario.ca/document/trade-and-cooperation-agreement-between-ontario-and-quebec/part-iv-specific-commitments-and-rules

[25] Natural Products Marketing (BC) Act, RSBC 1996, c 330; Similarly, Chapter 12 of the TCA excepted measures adopted in the Ontario Farm Products Marketing Act and the Quebec Act Respecting the Marketing of Agricultural, Food and Fish Products.

forestry sector, which constitutes around a quarter of British Columbia's commodity exports, requiring that timber be used or manufactured within the territory of a Party.[26] In addition, the licensing, registration and leasing requirements for the harvesting of forest and fish resources is maintained as an exception within this agreement.[27]

The large positive relationship between trade flows and TILMA/NWPTA in the mining sector may be primarily due to the agreement containing provisions on the energy sector, where the AIT failed to conclude an agreement. In particular, the TILMA/NWPTA agreement made energy and investment markets open and accessible to producers and distributors in the other provinces (Macmillan and Grady, 2007). The list of exceptions pertaining to this sector in the agreement is also small, and mainly protect hydroelectric facilities. Regarding the TCA, Chapter Four of that agreement outlined enhanced cooperation in energy policies as an objective, which included the formation of an Energy Cooperation Committee.

5.3 Three-digit Manufacturing Industrial Trade Flows

In this section, we examine relationships between the two trade agreements studied above and trade for thirteen three-digit manufacturing industries from Table 3 using the same estimation approach as in equations (5) and (17). Table 8 and Figure 15 present the results from this estimation. It is not surprising to observe the heterogeneous effects of the agreements on trade flows across industries. Consistent with the aggregate results, the agreements are associated with no significant change in nine of thirteen industries for both TILMA/NWPTA and TCA. However, some TILMA/NWPTA estimates indicate that the agreement is associated with an increase in bilateral trade flows in the textile (75.07%), petroleum (56.83%) and transportation (301.49%) manufacturing industries, with a decrease in the food manufacturing industry by 27.39%. The TCA estimates indicate a decrease in bilateral trade flows in the food (34.30%), petroleum(59.34%), chemical (35.60%) and metal (43.45%) manufacturing industries.

Figure 15 shows the estimated cumulative effect of these agreements across time on trade for these thirteen industries. Consistent with the inter-provincial sectoral results, the industries that experienced positive or negative impacts on trade flows exhibit growth phases after a period of adjustment before reaching maturity around eight years after entry into force.

Notably, both agreements show evidence of decreasing trade flows in the food manufacturing industry. As shown in the previous section, this industry has some of the most pervasive internal trade barriers and the two agreements continue to maintain many exceptions that hinder trade.

[26] BCStats, Annual B.C. Origin Exports, 2022.

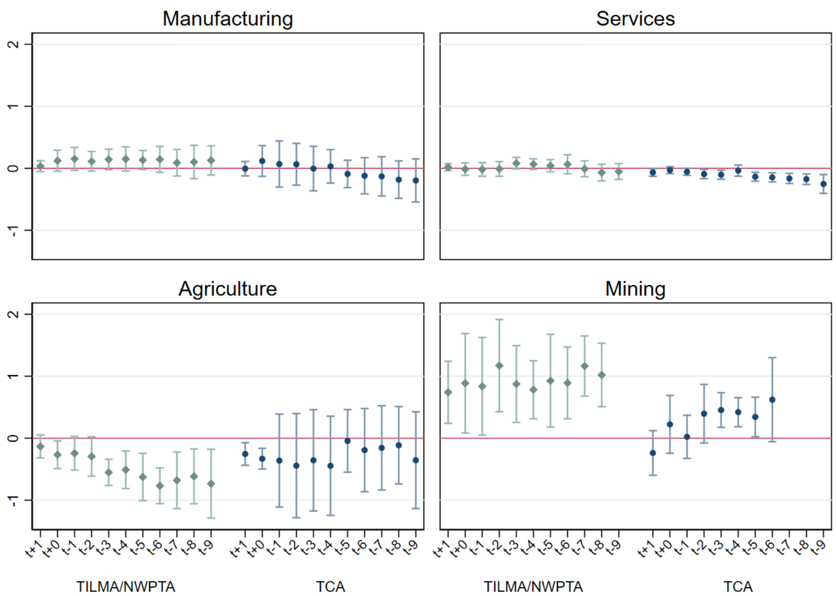
[27] *NWPTA*, Section V(G), online: http://www.newwestpartnershiptrade.ca/pdf/NWPTA_May_26_2022.pdf.

Table 7: Provincial Trade Agreements and Sectoral Trade: 1997-2018 Consecutive Years

	Manufacturing (1)	Services (2)	Agriculture (3)	Mining (4)
β_1^{-1} : TILMA/NWPTA at t+1 ($TILMA/NWPTA_{ij,t+1}$)	0.03	0.02	-0.13	0.74***
	(0.05)	(0.03)	(0.09)	(0.26)
β_1^{0} : TILMA/NWPTA at t+0 ($TILMA/NWPTA_{ij,t+0}$)	0.09	-0.03	-0.13	0.15
	(0.06)	(0.04)	(0.09)	(0.22)
β_1^{1} : TILMA/NWPTA at t-1 ($TILMA/NWPTA_{ij,t-1}$)	0.03	-0.01	0.02	-0.05
	(0.03)	(0.01)	(0.08)	(0.07)
β_1^{2} : TILMA/NWPTA at t-2 ($TILMA/NWPTA_{ij,t-2}$)	-0.04	0.01	-0.05	0.33*
	(0.04)	(0.02)	(0.07)	(0.20)
β_1^{3} : TILMA/NWPTA at t-3 ($TILMA/NWPTA_{ij,t-3}$)	0.03	0.09*	-0.26**	-0.30
	(0.05)	(0.05)	(0.12)	(0.26)
β_1^{4} : TILMA/NWPTA at t-4 ($TILMA/NWPTA_{ij,t-4}$)	0.01	-0.01	0.04	-0.09
	(0.03)	(0.02)	(0.11)	(0.13)
β_1^{5} : TILMA/NWPTA at t-5 ($TILMA/NWPTA_{ij,t-5}$)	-0.02	-0.03	-0.12	0.15
	(0.04)	(0.03)	(0.14)	(0.21)
β_1^{6} : TILMA/NWPTA at t-6 ($TILMA/NWPTA_{ij,t-6}$)	0.01	0.02	-0.14	-0.03
	(0.04)	(0.05)	(0.11)	(0.12)
β_1^{7} : TILMA/NWPTA at t-7 ($TILMA/NWPTA_{ij,t-7}$)	-0.05**	-0.07***	0.09	0.27
	(0.03)	(0.02)	(0.15)	(0.17)
β_1^{8} : TILMA/NWPTA at t-8 ($TILMA/NWPTA_{ij,t-8}$)	0.01	-0.06	0.06	-0.14**
	(0.05)	(0.04)	(0.10)	(0.07)
β_1^{9} : TILMA/NWPTA at t-9 ($TILMA/NWPTA_{ij,t-9}$)	0.02	0.02	-0.12	
	(0.10)	(0.03)	(0.27)	
β_2^{-1} : TCA at t+1 ($TCA_{ij,t+1}$)	-0.01	-0.07**	-0.25***	-0.24
	(0.06)	(0.03)	(0.09)	(0.18)
β_2^{0} : TCA at t+0 ($TCA_{ij,t+0}$)	0.12*	0.04**	-0.08*	0.46
	(0.07)	(0.02)	(0.04)	(0.40)
β_2^{1} : TCA at t-1 ($TCA_{ij,t-1}$)	-0.05	-0.03**	-0.03	-0.20
	(0.10)	(0.01)	(0.32)	(0.16)
β_2^{2} : TCA at t-2 ($TCA_{ij,t-2}$)	-0.00	-0.04***	-0.08	0.37
	(0.02)	(0.01)	(0.05)	(0.29)
β_2^{3} : TCA at t-3 ($TCA_{ij,t-3}$)	-0.07***	-0.01**	0.09***	0.06
	(0.01)	(0.00)	(0.03)	(0.25)
β_2^{4} : TCA at t-4 ($TCA_{ij,t-4}$)	0.04	0.07**	-0.09***	-0.03
	(0.05)	(0.03)	(0.02)	(0.12)
β_2^{5} : TCA at t-5 ($TCA_{ij,t-5}$)	-0.12***	-0.10***	0.40**	-0.08
	(0.04)	(0.03)	(0.18)	(0.10)
β_2^{6} : TCA at t-6 ($TCA_{ij,t-6}$)	-0.03	-0.01	-0.15*	0.28
	(0.06)	(0.01)	(0.09)	(0.30)
β_2^{7} : TCA at t-7 ($TCA_{ij,t-7}$)	-0.01	-0.02	0.04**	
	(0.02)	(0.02)	(0.02)	
β_2^{8} : TCA at t-8 ($TCA_{ij,t-8}$)	-0.05*	-0.01	0.04	
	(0.03)	(0.01)	(0.04)	
β_2^{9} : TCA at t-9 ($TCA_{ij,t-9}$)	-0.01	-0.08*	-0.24**	
	(0.06)	(0.04)	(0.10)	
β_3 : Inter-Provincial Trend ($INTERPR\_T_{ijt}$)	0.24***	0.15	0.14	-0.45***
	(0.06)	(0.09)	(0.14)	(0.10)
β_4 : Intra-Provincial Trend ($INTRAPR\_T_{ijt}$)	0.33***	0.01	-0.26**	-0.56***
	(0.08)	(0.10)	(0.11)	(0.16)
Total ATE				
TILMA/NWPTA	0.13	-0.05	-0.73***	1.02***
	(0.12)	(0.06)	(0.28)	(0.26)
TCA	-0.20	-0.25***	-0.36	0.62*
	(0.18)	(0.08)	(0.40)	(0.35)
R^2	0.99998	0.99999	0.99990	0.99983
Observations	2662	2662	2630	1761

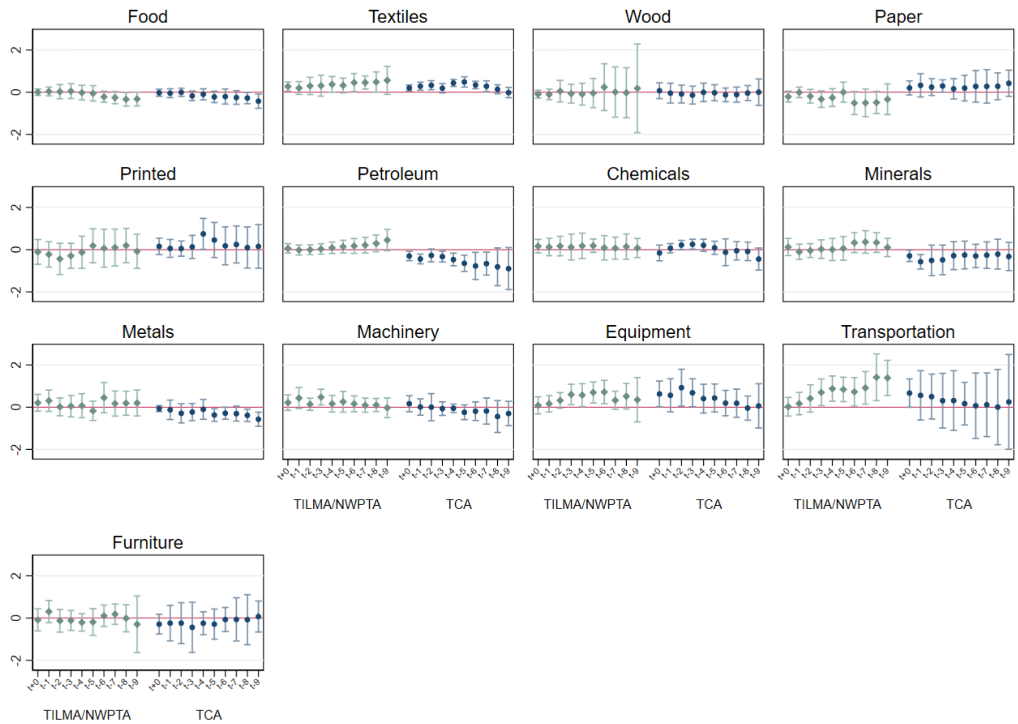
Notes: (1) All coefficient estimates and standard errors are bias-corrected using the methodology of Weidner and Zylkin (2021). (2) The estimates of the five sets of fixed effects are omitted for brevity. (3) Standard errors are clustered at the province pair level and given in parentheses. (4) Significance indicated by a *** at the 1% level, ** at the 5% level, and a * at the 10% level. (5) Total ATE tests whether the sum of all the RTA coefficient estimates is significant.

Figure 14: Inter-provincial Trade Agreements Estimated Cumulative Effects on Sectoral Trade



Notes: (1) This figure presents the estimated cumulative impacts of the two inter-provincial trade agreements examined in Table 7. These cumulative effects are the sums of the leads, lags and contemporaneous trade agreement coefficient estimates up to the relevant lead or lag point. For example, "$t-1$" for the TCA equals $\hat{\beta}_2^1 + \hat{\beta}_2^0 + \hat{\beta}_2^{-1}$. (2) 95% confidence intervals are given.

Figure 15: Inter-provincial Trade Agreement Estimated Cumulative Effects on Three-Digit Manufacturing Trade



Notes: (1) This figure presents the estimated cumulative impacts of the two inter-provincial trade agreements examined in Table 7. These cumulative effects are the sums of the leads, lags and contemporaneous trade agreement coefficient estimates up to the relevant lead or lag point. For example, "$t-1$" for the TCA equals $\hat{\beta}_2^1 + \hat{\beta}_2^0 + \hat{\beta}_2^{-1}$. (2) 95% confidence intervals are given.

Table 8: Provincial Trade Agreements and 3-digit Manufacturing Trade (Consecutive Years)

	Food (1)	Textile (2)	Wood (3)	Paper (4)	Print (5)	Petro (6)	Chem (7)	Mineral (8)	Metal (9)	Machine (10)	Equip (11)	Transp (12)	Furn (13)
β_1^{-1} : TILMA/NWPTA at t+1 ($TILMA/NWPTA_{ij,t+1}$)	0.03	0.24**	0.05	-0.18**	-0.13	0.00	0.09	0.06	0.04	0.00	0.39***	0.36**	-0.05
	(0.05)	(0.11)	(0.10)	(0.09)	(0.12)	(0.04)	(0.12)	(0.14)	(0.06)	(0.09)	(0.14)	(0.17)	(0.08)
β_1^{0} : TILMA/NWPTA at t+0 ($TILMA/NWPTA_{ij,t+0}$)	-0.03	0.03	-0.14	-0.02	0.02	0.06	0.08	0.07	0.17	0.21	-0.30	-0.34**	-0.04
	(0.05)	(0.08)	(0.11)	(0.13)	(0.23)	(0.10)	(0.07)	(0.10)	(0.19)	(0.15)	(0.22)	(0.15)	(0.26)
β_1^{1} : TILMA/NWPTA at t-1 ($TILMA/NWPTA_{ij,t-1}$)	0.03	-0.07	-0.01	0.20***	-0.12***	-0.08	-0.04	-0.23**	0.10	0.21	0.08	0.15	0.39
	(0.04)	(0.09)	(0.07)	(0.06)	(0.04)	(0.06)	(0.06)	(0.11)	(0.08)	(0.17)	(0.08)	(0.14)	(0.24)
β_1^{2} : TILMA/NWPTA at t-2 ($TILMA/NWPTA_{ij,t-2}$)	-0.01	0.10	0.16	-0.18**	-0.21*	0.02	0.05	0.06	-0.29*	-0.29*	0.16	0.25*	-0.43**
	(0.08)	(0.07)	(0.16)	(0.09)	(0.13)	(0.06)	(0.06)	(0.07)	(0.16)	(0.17)	(0.15)	(0.15)	(0.18)
β_1^{3} : TILMA/NWPTA at t-3 ($TILMA/NWPTA_{ij,t-3}$)	0.02	0.01	-0.12	-0.13	0.15	0.03	-0.05	0.07	0.03	0.34***	0.28	0.29	0.01
	(0.07)	(0.10)	(0.11)	(0.12)	(0.42)	(0.06)	(0.15)	(0.10)	(0.11)	(0.11)	(0.18)	(0.31)	(0.16)
β_1^{4} : TILMA/NWPTA at t-4 ($TILMA/NWPTA_{ij,t-4}$)	-0.07**	0.06	-0.02	0.07	0.17	0.06	0.06	-0.02	0.02	-0.31*	-0.03	0.18	-0.09
	(0.03)	(0.09)	(0.09)	(0.17)	(0.18)	(0.03)	(0.07)	(0.09)	(0.07)	(0.17)	(0.15)	(0.24)	(0.15)
β_1^{5} : TILMA/NWPTA at t-5 ($TILMA/NWPTA_{ij,t-5}$)	-0.04	-0.05	0.05	0.26	0.31***	0.06	0.01	0.05	-0.24	0.09	0.13	-0.04	0.02
	(0.04)	(0.07)	(0.15)	(0.25)	(0.11)	(0.05)	(0.23)	(0.06)	(0.21)	(0.13)	(0.08)	(0.16)	(0.21)
β_1^{6} : TILMA/NWPTA at t-6 ($TILMA/NWPTA_{ij,t-6}$)	-0.16	0.14**	0.28	-0.51**	-0.11	0.03	-0.10	0.27*	0.62*	-0.10	0.02	-0.11	0.29
	(0.10)	(0.07)	(0.26)	(0.22)	(0.08)	(0.06)	(0.19)	(0.16)	(0.35)	(0.18)	(0.14)	(0.13)	(0.23)
β_1^{7} : TILMA/NWPTA at t-7 ($TILMA/NWPTA_{ij,t-7}$)	-0.04	0.00	-0.23***	0.01	0.03	0.04	-0.02	0.03	-0.28**	-0.07	-0.39**	0.19	0.07
	(0.05)	(0.09)	(0.08)	(0.21)	(0.05)	(0.04)	(0.06)	(0.05)	(0.13)	(0.12)	(0.19)	(0.12)	(0.15)
β_1^{8} : TILMA/NWPTA at t-8 ($TILMA/NWPTA_{ij,t-8}$)	-0.08	0.03	-0.03	0.02	0.09	0.08	0.07	-0.03	0.02	0.01	0.19	0.50**	-0.19
	(0.05)	(0.10)	(0.03)	(0.17)	(0.12)	(0.09)	(0.11)	(0.10)	(0.14)	(0.08)	(0.21)	(0.24)	(0.21)
β_1^{9} : TILMA/NWPTA at t-9 ($TILMA/NWPTA_{ij,t-9}$)	0.02	0.08	0.21	0.15	-0.27	0.16	-0.06	-0.23*	0.01	-0.13	-0.17	-0.03	-0.28
	(0.03)	(0.18)	(0.49)	(0.23)	(0.19)	(0.11)	(0.18)	(0.13)	(0.14)	(0.20)	(0.41)	(0.38)	(0.53)
β_2^{-1} : TCA at t+1 ($TCA_{ij,t+1}$)	-0.08**	-0.17*	0.03	0.10	-0.03	-0.15	-0.32***	-0.16	-0.20***	0.05	0.14	0.27	-0.01
	(0.03)	(0.10)	(0.18)	(0.12)	(0.09)	(0.14)	(0.09)	(0.13)	(0.06)	(0.30)	(0.19)	(0.29)	(0.26)
β_2^{0} : TCA at t+0 ($TCA_{ij,t+0}$)	0.06	0.37***	0.04	0.10	0.19	-0.15	0.16	-0.14	0.13**	0.11	0.48**	0.39***	-0.28
	(0.07)	(0.12)	(0.19)	(0.12)	(0.18)	(0.18)	(0.16)	(0.18)	(0.05)	(0.15)	(0.20)	(0.15)	(0.45)
β_2^{1} : TCA at t-1 ($TCA_{ij,t-1}$)	-0.02	0.08	-0.11	0.12	-0.10***	-0.14***	0.23**	-0.28***	-0.06	-0.16	-0.07	-0.11	0.05
	(0.02)	(0.10)	(0.10)	(0.14)	(0.02)	(0.04)	(0.11)	(0.05)	(0.21)	(0.33)	(0.12)	(0.32)	(0.26)
β_2^{2} : TCA at t-2 ($TCA_{ij,t-2}$)	0.04***	0.04	-0.04	-0.08	-0.01	0.17*	0.15***	0.07	-0.16*	-0.01	0.36***	-0.06	0.00
	(0.02)	(0.03)	(0.10)	(0.12)	(0.05)	(0.10)	(0.05)	(0.23)	(0.09)	(0.16)	(0.08)	(0.08)	(0.09)
β_2^{3} : TCA at t-3 ($TCA_{ij,t-3}$)	-0.17***	-0.14***	-0.05	0.05	0.08	-0.06	0.04	0.02	0.06	-0.07	-0.24**	-0.19	-0.20
	(0.03)	(0.02)	(0.03)	(0.10)	(0.11)	(0.12)	(0.08)	(0.03)	(0.07)	(0.19)	(0.12)	(0.12)	(0.13)
β_2^{4} : TCA at t-4 ($TCA_{ij,t-4}$)	0.07	0.25***	0.13	-0.13	0.62***	-0.14	-0.05	0.20***	0.13	0.01	-0.28***	0.01	0.19
	(0.06)	(0.06)	(0.29)	(0.23)	(0.11)	(0.09)	(0.12)	(0.03)	(0.33)	(0.08)	(0.07)	(0.08)	(0.36)
β_2^{5} : TCA at t-5 ($TCA_{ij,t-5}$)	-0.12***	0.05	-0.02	0.03	-0.29***	-0.18*	-0.12	0.03	-0.27**	-0.19	0.03	-0.15	-0.04
	(0.03)	(0.05)	(0.32)	(0.08)	(0.06)	(0.10)	(0.10)	(0.03)	(0.11)	(0.12)	(0.13)	(0.24)	(0.11)
β_2^{6} : TCA at t-6 ($TCA_{ij,t-6}$)	0.02	-0.15	-0.10	0.08	-0.28***	-0.12	-0.21	-0.05	0.08*	0.05	-0.24***	-0.10	0.22**
	(0.05)	(0.11)	(0.19)	(0.11)	(0.04)	(0.17)	(0.19)	(0.07)	(0.04)	(0.07)	(0.06)	(0.31)	(0.10)
β_2^{7} : TCA at t-7 ($TCA_{ij,t-7}$)	-0.05	-0.06	0.01	0.00	0.06**	0.11	0.07	0.04	-0.02	0.01	-0.01	0.05	0.01
	(0.03)	(0.11)	(0.11)	(0.03)	(0.03)	(0.14)	(0.11)	(0.07)	(0.06)	(0.11)	(0.07)	(0.09)	(0.25)
β_2^{8} : TCA at t-8 ($TCA_{ij,t-8}$)	-0.03	-0.14***	0.07**	0.00	-0.14***	-0.16	-0.03	0.05	-0.08	-0.26***	-0.23***	-0.11	-0.01
	(0.03)	(0.04)	(0.03)	(0.10)	(0.05)	(0.21)	(0.06)	(0.04)	(0.08)	(0.08)	(0.07)	(0.15)	(0.09)
β_2^{9} : TCA at t-9 ($TCA_{ij,t-9}$)	-0.15***	-0.15*	0.04	0.14	0.05	-0.08	-0.36**	-0.11	-0.18**	0.14	0.10	0.25	0.15
	(0.04)	(0.09)	(0.25)	(0.12)	(0.11)	(0.12)	(0.18)	(0.10)	(0.08)	(0.21)	(0.25)	(0.25)	(0.37)
β_3 : Inter-Provincial Trend ($INTERPR\_T_{ijt}$)	0.02	0.03	0.50***	0.01	-0.28	-0.67***	-0.22**	0.91***	0.05	0.36***	0.49***	-0.03	-0.32**
	(0.09)	(0.07)	(0.14)	(0.13)	(0.17)	(0.14)	(0.10)	(0.14)	(0.11)	(0.07)	(0.10)	(0.21)	(0.13)
β_4 : Intra-Provincial Trend ($INTRAPR\_T_{ijt}$)	-0.25**	0.38***	0.51***	0.26*	-0.07	-0.64***	-0.06	0.81***	-0.03	0.48***	0.69***	0.72***	0.07
	(0.10)	(0.06)	(0.13)	(0.15)	(0.24)	(0.07)	(0.08)	(0.13)	(0.15)	(0.08)	(0.11)	(0.22)	(0.16)
Total ATE													
TILMA/NWPTA	-0.32*	0.56*	0.18	-0.34	-0.08	0.45*	0.08	0.10	0.20	-0.03	0.35	1.39***	-0.29
	(0.17)	(0.34)	(1.07)	(0.37)	(0.41)	(0.26)	(0.23)	(0.22)	(0.31)	(0.24)	(0.54)	(0.43)	(0.68)
TCA	-0.42**	-0.02	0.00	0.42	0.15	-0.90*	-0.44*	-0.32	-0.57***	-0.30	0.06	0.25	0.07
	(0.17)	(0.13)	(0.32)	(0.32)	(0.53)	(0.51)	(0.27)	(0.34)	(0.17)	(0.29)	(0.54)	(1.14)	(0.38)
R^2	0.99995	0.99996	0.99969	0.99981	0.99970	0.99988	0.99995	0.99991	0.99994	0.99994	0.99995	0.99990	0.99990
Observations	2662	2582	2562	2452	2540	2184	2577	2368	2633	2597	2492	2568	2207

Notes: (1) All coefficient estimates and standard errors are bias-corrected using the methodology of Weidner and Zylkin (2021). (2) The estimates of the five sets of fixed effects are omitted for brevity. (3) Standard errors are clustered at the province pair level and given in parentheses. (4) Significance indicated by a *** at the 1% level, ** at the 5% level, and a * at the 10% level. (5) Total ATE is the sum of all the RTA coefficient estimates.

6 Conclusions

We have applied modern structural gravity estimation techniques to detailed Canadian provincial level trade flow data from 1997 to 2018 for four two-digit sectors and thirteen three-digit manufacturing industries. We used estimates of outward and inward multilateral resistance terms to provide novel measures of provinces' relative inter-provincial trade frictions. These measures were estimated for each sector and industry, each time period, and for each province in its role as an exporter and separately in its role as an importer.

We document considerable regional and sectoral dispersion in our estimates of relative inter-provincial trade frictions. For services and for both aggregated and disaggregated manufacturing industries, we find that the four largest provinces (Alberta, British Columbia, Ontario, and Quebec) tend to have the lowest relative frictions for exporting to other provinces. However, we do *not* observe that this pattern holds for agriculture and mining. Furthermore, for relative frictions associated with *importing* goods and services from other provinces, we do *not* generally find that the largest provinces tend to exhibit the smallest relative frictions for inter-provincial trade. We also find that there are higher levels of regional dispersion in inter-provincial trade frictions associated with exporting as compared to importing. Finally, within manufacturing industries, printing, petroleum, and equipment demonstrate the highest levels of geographic dispersion in relative inter-provincial exporting frictions.

Given our findings of evidence of considerable geographic and industrial dispersion of inter-provincial trade frictions, we speculate that regional inter-provincial trade agreements may affect trade in different sectors quite differently. With this is mind, we used structural gravity methods to estimate relationships between two inter-provincial regional trade agreements and sector- and industry-level inter-provincial trade flows.

We find evidence that the combined Trade, Investment and Labour Mobility Agreement and the New West Partnership Trade Agreement signed by Alberta, British Columbia, Manitoba and Saskatchewan is positively related to inter-provincial trade flows for mining, textiles, petroleum and transportation. In contrast, our results indicate a negative relationship between that combined agreement and inter-provincial trade in agriculture and in food manufacturing. For the Trade and Cooperation Agreement signed between Ontario and Quebec, we document a negative relationship for several sectors including services, food manufacturing, petroleum, chemicals and minerals and a positive relationship for only the mining sector.

We conclude by briefly discussing policy implications of our findings. Our novel quantitative measure of relative inter-provincial trade frictions is a useful tool for guiding policy makers concerned with implementing targeted policies to lower inter-provincial trade barriers. This is because our method provides these measures at a highly detailed level: reported specifically for each province, for each trading partner province, separate measures depending on whether the province is exporting or importing, for each year, and at the sector or industry level. Another positive feature of our methods which makes it accessible to policy makers is that its implementation requires data only on provincial-level trade flows.

Our empirical findings, based on a theoretically grounded structural gravity approach, that the combined TILMA and NWPTA positively impacted several industries while the TCA negatively impacted several industries is broadly consistent with the priors of some policy makers regarding differences in the nature of these two agreements. As discussed in Section 2, policy makers suggested that TILMA/NWPTA would have a more positive impact on inter-provincial trade flows primarily because the TILMA/NWPTA is characterized by fairly comprehensive coverage of the economy due to its negative list approach. In contrast, the TCA is limited to a subset of sectors and industries and primarily uses a positive list approach. Our research studying sector- and industry-level trade flows, allows policy makers to compare and contrast the effectiveness of the agreements at the sectoral and industry level and use that information to guide the structure of future internal trade agreements.

In future work, our novel approach for quantifying geographic, sectoral, and temporal dispersion in inter-regional trade frictions can be applied to other settings. For example, our methods are particularly well-suited for empirically evaluating trading frictions within the European Union using bilateral trade flows across countries. Furthermore, our analysis and policy implications apply more generally to other inter-regional trading frictions, such as those in Europe, Asia, Africa, and South America.

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A Data Information

Provincial level imports and exports are available from 1997 to 2008 quoted in *producer prices* from Statistics Canada Cansim Tables 121-000-85 and 121-000-86. From 2007 to 2018 these flows are quoted in *basic prices* and are taken from Statistics Canada Cansim Table 121-000-88. The producer price is the amount received by the producer for a unit of a good or service minus any value-added tax or similar deductible tax, invoiced to the purchaser. The basic price is the amount received by the producer for a unit of a good or service minus any tax payable plus any subsidy receivable.

We seek to use trade flows series with consistent pricing throughout the time period studied but we do not have access to tax and subsidy data. In this paper, we use trade flow data directly from the Cansim tables above for 1997 to 2008 in producer prices. We then estimate trade flows in producer prices from 2009 to 2018 by exploiting the overlapping data from 2007 and 2008 quoted in both prices to determine a relationship between producer price and basic price trade flows for each sector or industry and trading pair combination.

In particular, let the exports in sector or industry n between region i and region j in year t expressed in producer prices be denoted at $X^P_{n,ij,t}$ and let $X^B_{n,ij,t}$ be the analogous variable expressed in basic prices. For the overlapping years, $s \in \{2007, 2008\}$, we compute the following:

$$v_{n,ij,s} = \frac{X^B_{n,ij,s}}{X^P_{n,ij,s}} - 1. \tag{18}$$

Denote the average over the two overlapping years for these variables as $\bar{v}_{n,ij}$. Then we estimate producer prices for the years $t \in \{2009, 2010, ..., 2018\}$ as follows:

$$\hat{X}^P_{n,ij,t} = \frac{X^B_{n,ij,t}}{1 + \bar{v}_{n,ij}}. \tag{19}$$

B Supplementary Results

B.1 Supplementary Data Summaries

Figure 16: Services Trade Fractions By Province: 1997-2018

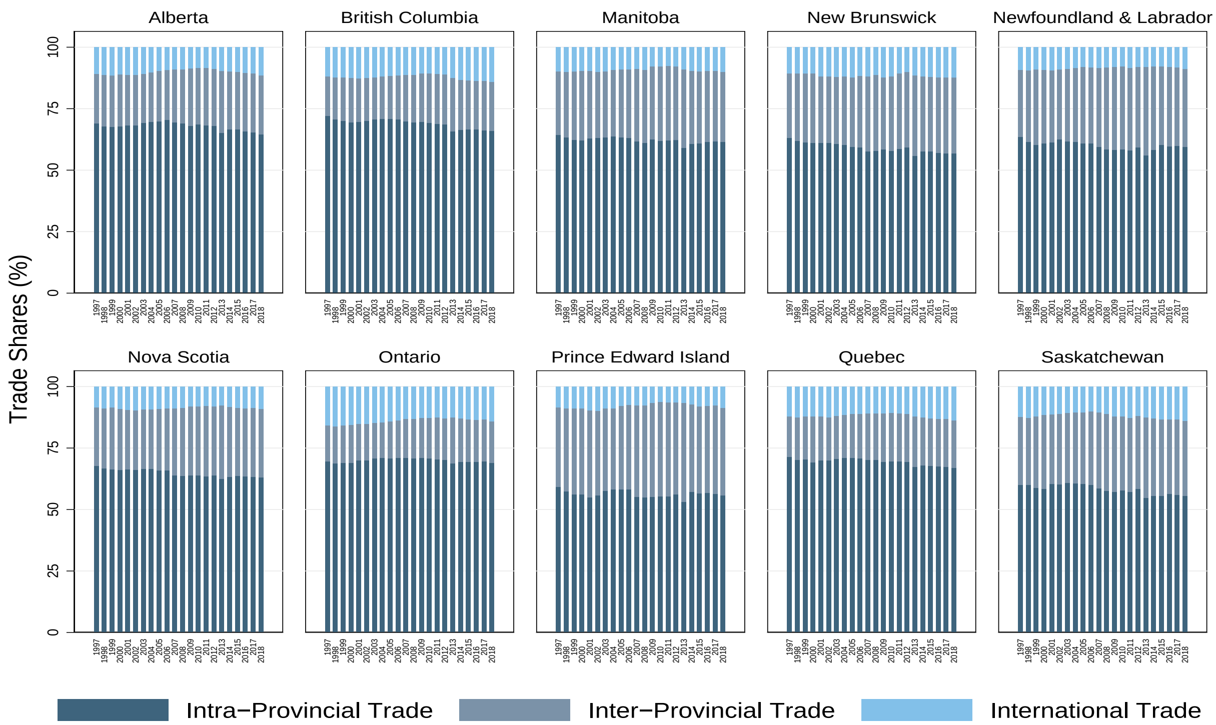

Figure 17: Agriculture Trade Fractions By Province: 1997-2018

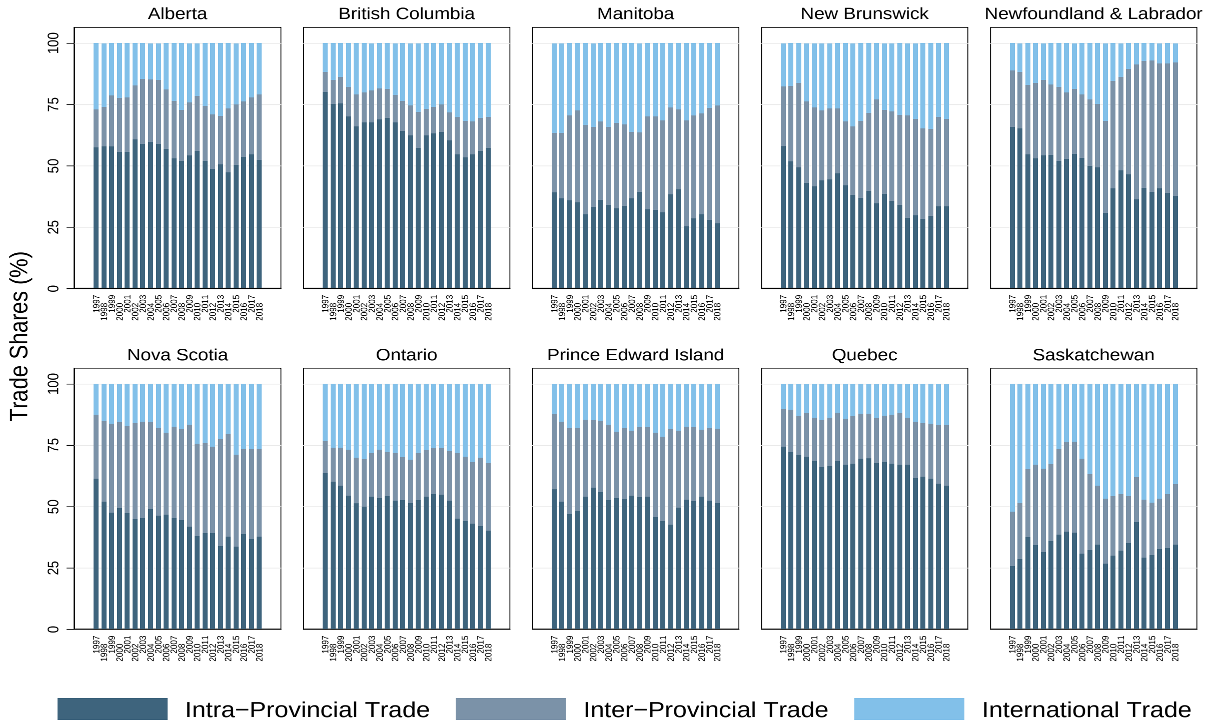

Figure 18: Mining Trade Fractions By Province: 1997-2018

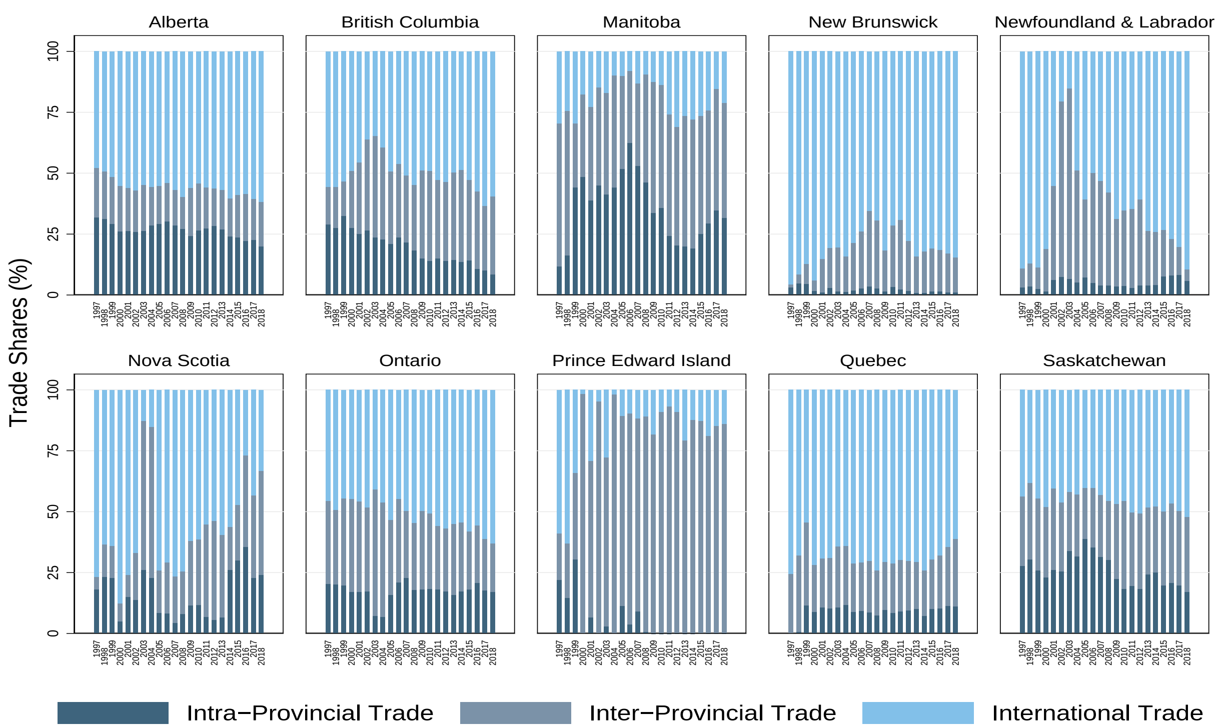

Table 9: Summary Statistics for Three-Digit Manufacturing Industries Trade Flows

Trade Flow	Mean	Median	SD	Min	Max	N
Food						
Inter-Provincial	3.51	0.97	7.47	0.00	66.22	1,980
Intra-Provincial	45.31	9.07	65.70	0.64	267.26	220
International	22.28	10.35	26.44	0.24	145.95	440
Internal ROW	48,828.98	43,249.12	16,745.81	31,127.01	78,886.04	22
Textiles						
Inter-Provincial	0.75	0.16	1.99	0.00	20.10	1,900
Intra-Provincial	8.91	1.35	13.64	0.01	49.24	220
International	22.71	6.00	35.20	0.00	200.36	440
Internal ROW	29,321.00	25,605.93	9,270.40	20,386.78	46,665.28	22
Wood						
Inter-Provincial	0.60	0.13	1.32	0.00	12.34	1,887
Intra-Provincial	11.70	2.32	14.56	0.00	54.90	220
International	8.58	2.03	16.46	0.00	89.85	440
Internal ROW	5,242.91	4,699.63	1,431.10	3,706.13	7,972.66	22
Paper						
Inter-Provincial	0.67	0.17	1.71	0.00	13.61	1,783
Intra-Provincial	8.45	1.86	12.63	0.00	47.55	219
International	13.79	4.55	18.80	0.00	81.23	439
Internal ROW	8,321.70	7,780.40	1,636.78	6,343.75	11,664.62	22
Printed						
Inter-Provincial	0.47	0.07	1.16	0.00	10.75	1,858
Intra-Provincial	15.16	2.89	22.81	0.23	93.45	220
International	3.39	0.87	5.18	0.00	28.51	440
Internal ROW	6,083.91	6,623.09	1,314.25	4,270.27	7,854.23	22
Petroleum						
Inter-Provincial	2.25	0.21	5.96	0.00	54.79	1,639
Intra-Provincial	35.94	12.38	47.19	0.00	179.42	210
International	15.76	6.17	22.46	0.00	145.81	409
Internal ROW	24,135.26	23,882.18	10,657.65	8,609.89	38,940.78	22
Chemicals						
Inter-Provincial	1.20	0.14	2.89	0.00	28.02	1,896
Intra-Provincial	14.72	4.33	19.86	0.09	73.16	220
International	31.43	8.90	47.36	0.00	250.72	440
Internal ROW	38,241.20	34,601.04	14,132.61	21,498.88	60,686.68	22
Minerals						
Inter-Provincial	0.28	0.06	0.62	0.00	5.73	1,699
Intra-Provincial	8.84	1.74	11.92	0.10	48.34	220
International	3.80	1.19	5.76	0.00	29.74	428
Internal ROW	12,798.98	11,375.93	5,391.29	7,295.43	22,413.72	22
Metals						
Inter-Provincial	1.82	0.21	5.40	0.00	51.14	1,953
Intra-Provincial	30.76	4.69	51.32	0.06	215.19	220
International	36.10	10.09	56.30	0.01	250.69	438
Internal ROW	45,363.73	44,124.73	17,986.29	23,817.70	75,363.16	22

Notes: (1) Based on annual data for 1997 to 2018 for ten provinces and the rest of the world (ROW). (2) Trade flows are expressed in 100 million Canadian dollars.

Table 9: Summary Statistics for Three-Digit Manufacturing Industries Trade Flows (Cont.)

Trade Flow	Mean	Median	SD	Min	Max	N
Machinery						
Inter-Provincial	0.46	0.07	0.97	0.00	11.23	1,918
Intra-Provincial	8.11	2.17	12.78	0.00	66.27	219
International	31.42	10.75	45.37	0.07	222.61	439
Internal ROW	27,206.53	25,722.46	9,019.81	17,386.22	42,516.55	22
Equipment						
Inter-Provincial	0.46	0.05	1.27	0.00	12.01	1,820
Intra-Provincial	4.21	0.73	7.33	0.00	31.90	219
International	29.99	8.39	45.78	0.00	248.92	437
Internal ROW	34,502.64	23,188.54	21,976.58	14,291.35	72,722.96	22
Transportation						
Inter-Provincial	1.05	0.13	2.89	0.00	27.70	1,891
Intra-Provincial	28.70	2.65	70.18	0.00	325.95	220
International	91.37	11.58	190.92	0.00	904.63	437
Internal ROW	41,955.60	36,058.00	14,815.33	25,018.10	71,666.70	22
Furniture						
Inter-Provincial	0.23	0.04	0.57	0.00	5.21	1,612
Intra-Provincial	3.30	0.54	4.90	0.00	19.89	206
International	5.11	1.58	8.18	0.00	44.53	423
Internal ROW	9,022.08	7,309.28	3,267.20	5,684.87	15,203.49	22

Notes: (1) Based on annual data for 1997 to 2018 for ten provinces and the rest of the world (ROW). (2) Trade flows are expressed in 100 million Canadian dollars.

Table 10: Summary Statistics for Distances

Distance Categories	Mean	Median	SD	Min	Max	N
Intra-Provincial	160.60	168.82	62.84	28.45	256.37	220
Inter-Provincial	2,130.07	1,983.20	1,325.44	193.92	4,801.07	1,980
International-Province	8,957.19	9,010.51	188.63	8,533.79	9,196.71	440
Internal ROW	7,749.61	7,749.61	0.00	7,749.61	7,749.61	22

Notes: (1) Based on annual data for 1997 to 2018 for ten provinces and the rest of the world (ROW). (2) Distances are expressed in kilometers.

B.2 Results for 1997-2007 Sample for Manufacturing

To facilitate comparison of our findings with those of Agnosteva et al. (2019), we perform the analysis in Section 3 using manufacturing trade flow data over the same time period as those authors, 1997-2007. Our data differs in other dimensions from theirs such as they include the Canadian territories while we do not.

Table 11: Estimation Results for Manufacturing Using Size-Adjusted Trade Flows: 1997-2007

PPML Estimation of Bilateral Trade Flows	Pair Fixed Effects (1)	Gravity Variables (2)
β_1: Inter-Provincial ($INTERPR\_T_{ijt}$)	0.256	0.250
Trade Trend	(0.156)	(0.161)
β_2: Intra-Provincial ($INTRAPR\_T_{ijt}$)	0.231	0.225
Trade Trend	(0.152)	(0.158)
β_3: Log of First Quantile of Distance ($ln(d^1_{ij})$)		-1.009***
		(0.148)
β_4: Log of Second Quantile of Distance ($ln(d^2_{ij})$)		-1.023***
		(0.128)
β_5: Log of Third Quantile of Distance ($ln(d^3_{ij})$)		-1.061***
		(0.111)
β_6: Log of Fourth Quantile of Distance ($ln(d^4_{ij})$)		-1.045***
		(0.113)
β_4: Contiguous (C_{ij})		-0.057
		(0.114)
$\gamma_{AB,AB}$		-5.512***
		(0.930)
$\gamma_{ON,ON}$		-5.403***
		(0.983)
$\gamma_{MB,MB}$		-5.107***
		(0.919)
$\gamma_{BC,BC}$		-4.967***
		(0.976)
$\gamma_{QC,QC}$		-4.564***
		(0.937)
$\gamma_{SK,SK}$		-4.436***
		(0.927)
$\gamma_{NB,NB}$		-4.257***
		(0.814)
$\gamma_{NL,NL}$		-4.459***
		(1.076)
$\gamma_{NS,NS}$		-4.186***
		(0.839)
$\gamma_{PE,PE}$		-2.264***
		(0.801)
Source-Time Fixed Effects	Yes	Yes
Destination-Time Fixed Effects	Yes	Yes
Pair Fixed Effects	Yes	Partial
R^2	0.999	0.996
Observations	1331	1331

Notes: (1) Robust standard errors, adjusted for clustering at the province pair level, are in parentheses. (2) Significance indicated by a *** at the 1% level, a ** at the 5% level, and a * at the 10% level.

B.3 Estimates of Pair Fixed Effects and Multilateral Resistance Terms for Two-Digit Sectors

In this section, we present results arising from estimation of equation (14) for estimates of pair fixed effects and multilateral resistance terms for each of the two-digit sectors we study. For the pair fixed effects, the within province pair fixed effects are normalized to zero (dropped) and so, as expected, all estimates of across-province pair fixed effects are negative. These results are reported in Tables 12-15.[28] For the multilateral resistance terms, in Table 16 we present the averages over our time series for each location and for each two-digit sector.

Table 12: Estimates of Pair Fixed Effects: **Manufacturing**

	AB	BC	MB	NB	NF	NS	ON	PE	QC	SK	ROW
AB	0	-0.528	-0.485	-1.136	-1.145	-1.176	-1.184	-1.279	-1.296	-0.377	-2.614
BC	-0.758	0	-1.067	-1.359	-1.373	-1.206	-1.447	-1.105	-1.469	-1.037	-2.491
MB	-1.020	-1.214	0	-1.358	-1.325	-1.339	-1.388	-1.172	-1.504	-0.693	-2.793
NB	-1.919	-2.080	-1.812	0	-0.707	-0.523	-1.839	-0.190	-1.169	-2.065	-2.883
NL	-2.500	-2.824	-2.704	-1.842	0	-1.273	-2.244	-1.327	-2.480	-2.475	-3.102
NS	-1.802	-1.803	-1.593	-0.719	-0.689	0	-1.750	- 0.306	-1.612	-1.884	-3.156
ON	-0.549	-0.592	-0.440	-0.480	-0.494	-0.428	0	-0.410	-0.453	-0.626	-1.765
PE	-2.757	-2.856	-2.431	-1.039	-1.585	-1.351	-2.446	0	-2.343	-2.684	-3.750
QC	-0.967	-0.952	-0.813	-0.478	-0.618	-0.599	-0.745	-0.541	0	-0.988	-2.195
SK	-0.753	-1.096	-0.411	-1.664	-1.961	-1.982	-1.843	-1.699	-2.009	0	-3.015
ROW	-0.237	-0.205	-0.249	-0.248	-0.199	-0.238	-0.188	-0.327	-0.233	-0.237	0

Table 13: Estimates of Pair Fixed Effects: **Services**

	AB	BC	MB	NB	NF	NS	ON	PE	QC	SK	ROW
AB	0	-1.537	-1.431	-1.914	-1.552	- 1.909	-1.836	-1.925	-2.064	-1.053	-3.514
BC	-1.407	0	-1.634	-1.913	-2.157	-1.980	-1.902	-1.9906	-2.008	-1.468	-3.400
MB	-2.149	-2.317	0	-2.526	-2.477	-2.650	-2.237	-2.527	-2.406	-1.611	-4.162
NB	-2.940	-3.202	-2.852	0	-1.777	-1.681	-2.857	-1.236	-2.533	-2.804	-2.237
NL	-3.109	-3.450	-3.246	-2.218	0	-2.155	-2.928	-1.947	-2.967	-3.070	-4.598
NS	-2.819	-3.006	-2.826	-1.587	-1.476	0	-2.626	-1.308	-2.679	-2.686	-4.333
ON	-1.060	-1.132	-0.967	-0.892	-0.783	-0.908	0	-0.852	-1.031	-0.974	-2.959
PE	-3.948	-4.023	- 3.800	-2.216	-2.430	-2.353	-3.424	0	-3.497	-3.933	-5.191
QC	-1.731	-1.765	-1.670	-1.174	-1.308	-1.415	-1.514	-1.377	0	-1.637	-3.313
SK	-2.051	-2.508	-1.790	-2.679	-2.867	-2.959	-2.474	-2.608	- 2.791	0	-3.932
ROW	-1.275	-1.252	- 1.286	-1.304	- 1.370	-1.371	-1.091	-1.412	-1.188	-1.317	0

[28] We do not report standard errors but note that all estimates are significant at the 1% level.

Table 14: Estimates of Pair Fixed Effects: **Agriculture**

	AB	BC	MB	NB	NF	NS	ON	PE	QC	SK	ROW
AB	0	-1.639	-1.072	-3.755	-2.608	-2.791	-1.679	-3.110	-2.162	-1.265	-2.834
BC	-1.225	0	-2.190	-2.827	-3.899	-3.002	-2.243	-3.396	- 2.488	-1.872	-1.225
MB	-1.500	-2.545	0	-3.212	-2.750	-1.988	-1.286	-3.145	-1.866	-1.494	-3.045
NB	-2.948	-3.144	-2.462	0	-1.377	-1.037	-1.998	-1.376	-1.844	-4.480	-3.672
NL	-3.595	-3.309	-2.415	-1.510	0	-1.343	-2.208	-1.806	-2.196	-3.497	-4.188
NS	-2.534	-3.120	-3.310	-1.039	-1.486	0	-2.122	-1.448	-2.281	-4.149	-3.636
ON	-1.891	- 2.155	-1.402	-1.734	-1.338	-1.164	0	-1.476	-1.068	-1.952	-2.870
PE	-3.536	-2.348	-3.687	-1 691	-1.951	-1.652	-2.658	0	-2.697	-4.620	-4.276
QC	-2.415	-2.904	-2.868	-1.145	-1.278	-1.255	-1.423	-2.005	0	-3.558	-3.455
SK	-1.113	-2.206	-0.949	-2.476	-2.969	-1.707	-1.620	-2.264	-1.804	0	-2.725
ROW	-1.788	-1.416	-1.169	-0.743	-1.570	-1.908	-0.774	-1.901	-1.119	-1.788	0

Table 15: Estimates of Pair Fixed Effects: **Mining**

	AB	BC	MB	NB	NF	NS	ON	PE	QC	SK	ROW
AB	0	–	-0.719	-1.241	-1.350	-1.289	-0.640	-0.373	-0.991	-0.562	–
BC	-1.213	0	-2.311	–	–	–	-1.667	–	-1.333	-1.337	-2.623
MB	-3.374	-2.178	0	-4.750	–	–	-2.109	–	-1.869	-3.035	-3.718
NB	-1.459	-3.468	-2.720	0	-1.569	-0.690	-1.950	–	-0.486	-3.218	-3.358
NL	-2.364	–	-0.533	-0.291	0	-0.096	-1.204	-0.693	-0.742	–	-2.511
NS	-2.676	-2.768	-2.700	-1.323	-1.909	0	-2.269	–	-2.225	-4.862	-3.529
ON	-1.842	-1.660	-0.662	-2.170	-1.143	-1.086	0	-0.964	-0.961	-2.206	-2.328
PE	–	–	–	-3.264	-1.883	-1.597	–	0	–	–	-4.801
QC	-2.819	-1.369	-1.011	-1.551	-1.488	-1.535	-0.820	-0.531	0	-2.366	-2.401
SK	-1.938	-2.229	-1.758	-2.537	-4.085	-2.806	-1.038	-0.898	-3.536	0	-2.579
ROW	-1.620	-0.943	-1.687	-0.104	-0.197	-0.188	-0.556	-1.310	-0.277	-2.846	0

Table 16: Time-Averaged Estimates of Multilateral Resistance Terms

	Manufacturing		**Services**		**Agriculture**		**Mining**	
	Outward MRT	Inward MRT	Outward MRT	Inward MRT	Outward MRT	Inward MRT	Outward MRT	Inward MRT
AB	35.849	2.878	70.411	3.309	53.609	3.720	18.090	6.482
BC	41.085	2.952	70.661	3.289	72.649	3.923	85.697	4.918
MB	79.890	2.922	285.529	3.236	119.781	3.556	516.986	5.658
NB	114.140	2.940	534.729	3.221	307.330	3.516	151.126	2.943
NL	233.826	2.979	826.504	3.209	675.841	3.831	70.610	3.415
NS	158.945	2.971	427.062	3.226	348.712	3.690	601.946	2.714
ON	8.928	2.976	22.926	3.300	43.022	3.540	37.336	4.107
PE	746.427	2.875	3066.283	3.200	1156.402	3.830	12791.331	5.269
QC	19.838	2.912	48.953	3.283	64.801	3.756	90.810	3.528
SK	95.890	2.923	294.936	3.276	76.099	3.913	79.159	5.825
ROW	0.290	3.482	0.306	3.350	0.340	3.013	0.369	2.757

B.4 Alternative Inter-Provincial Trade Agreements Estimation Results

B.4.1 Interval Structure

To address the issue that gravity specifications over consecutive years cannot fully adjust in a single year's time raised in Cheng and Wall (2005), we estimate the structural gravity system as presented in equation (5) with the following specification for the bilateral resistance term:

$$\phi_{ijt}\boldsymbol{\beta} = \sum_{S=0}^{3} \beta_1^S TILMA/NWPTA_{ij,t-S} + \sum_{S=0}^{3} \beta_2^S TCA_{ij,t-S} + \beta_3 INTERPR\_T_{ijt} + \beta_4 INTRAPR\_T_{ijt} + \gamma_{ij}. \quad (20)$$

Here, $S \in \{2000, 2003, 2006, 2009, 2012, 2015, 2018\}$ in the first two terms, reflecting the use of interval data.

Table 17 and Table 18 presents the results of these estimations. These results are consistent with our preferred specification in equation (17), although the magnitudes have decreased in some sectors and industries.

Table 17: Provincial Trade Agreements and Sectoral Trade: 1997-2018 (Intervals)

	Manufacturing (1)	Services (2)	Agriculture (3)	Mining (4)
β_1^0 : TILMA/NWPTA at t+0 ($TILMA/NWPTA_{ij,t+0}$)	0.10	-0.01	-0.23*	0.87**
	(0.06)	(0.05)	(0.14)	(0.36)
β_1^3 : TILMA/NWPTA at t-3 ($TILMA/NWPTA_{ij,t-3}$)	0.03	0.05	-0.36***	-0.26***
	(0.05)	(0.04)	(0.10)	(0.07)
β_1^6 : TILMA/NWPTA at t-6 ($TILMA/NWPTA_{ij,t-6}$)	-0.04	-0.11**	0.08	0.10
	(0.06)	(0.05)	(0.15)	(0.29)
β_1^9 : TILMA/NWPTA at t-9 ($TILMA/NWPTA_{ij,t-9}$)	0.03	0.00	-0.22	
	(0.14)	(0.05)	(0.25)	
β_2^0 : TCA at t+0 ($TCA_{ij,t+0}$)	0.13	-0.03	-0.36***	0.08
	(0.13)	(0.03)	(0.08)	(0.43)
β_2^3 : TCA at t-3 ($TCA_{ij,t-3}$)	-0.11	-0.07***	-0.03	0.22
	(0.10)	(0.02)	(0.35)	(0.20)
β_2^6 : TCA at t-6 ($TCA_{ij,t-6}$)	-0.11	-0.04	0.16	0.15
	(0.09)	(0.03)	(0.12)	(0.30)
β_2^9 : TCA at t-9 ($TCA_{ij,t-9}$)	-0.06*	-0.04	0.08	
	(0.03)	(0.03)	(0.06)	
β_3 : Inter-Provincial Trend ($INTERPR\_T_{ijt}$)	0.17***	0.13	0.12	-0.35***
	(0.06)	(0.09)	(0.13)	(0.10)
β_4 : Intra-Provincial Trend ($INTRAPR\_T_{ijt}$)	0.27***	-0.01	-0.31***	-0.51***
	(0.08)	(0.09)	(0.10)	(0.13)
Total ATE				
TILMA/NWPTA	0.12	-0.07	-0.74**	0.71***
	(0.13)	(0.06)	(0.30)	(0.19)
TCA	-0.15	-0.18***	-0.15	0.23
	(0.14)	(0.05)	(0.30)	(0.70)
R^2	0.99998	0.99999	0.99991	0.99982
Observations	968	968	955	645

Notes: (1) All coefficient estimates and standard errors are bias-corrected using the methodology of Weidner and Zylkin (2021). (2) Standard errors are clustered at the province pair level and given in parentheses. (3) Significance indicated by a *** at the 1% level, ** at the 5% level, and a * at the 10% level. (4) Total ATE tests that the sum of all the RTA coefficient estimates is significant.

Table 18: Provincial Trade Agreements and NAICS-3 digit Manufacturing Trade: 1997-2018 (Intervals)

	Food (1)	Textile (2)	Wood (3)	Paper (4)	Print (5)	Petro (6)	Chem (7)	Mineral (8)	Metal (9)	Machine (10)	Equip (11)	Transp (12)	Furn (13)
β_1^0 : TILMA/NWPTA at t+0 ($TILMA/NWPTA_{ij,t+0}$)	0.03	0.16	0.09	-0.08	-0.28	-0.01	0.09	-0.06	0.05	0.11	0.26	0.25	-0.03
	(0.15)	(0.14)	(0.22)	(0.15)	(0.35)	(0.12)	(0.15)	(0.11)	(0.22)	(0.12)	(0.17)	(0.30)	(0.25)
β_1^3 : TILMA/NWPTA at t-3 ($TILMA/NWPTA_{ij,t-3}$)	-0.06	0.09	-0.08	0.16	0.74	0.14	0.03	0.13	-0.17	0.11	0.48**	0.56**	-0.02
	(0.08)	(0.08)	(0.16)	(0.17)	(0.58)	(0.09)	(0.16)	(0.20)	(0.13)	(0.16)	(0.24)	(0.23)	(0.42)
β_1^6 : TILMA/NWPTA at t-6 ($TILMA/NWPTA_{ij,t-6}$)	-0.29***	0.10	0.01	-0.44***	0.08	0.15*	-0.09	0.28	0.31	-0.15	-0.31*	0.53	0.22**
	(0.06)	(0.08)	(0.25)	(0.16)	(0.14)	(0.08)	(0.09)	(0.25)	(0.20)	(0.18)	(0.17)	(0.41)	(0.10)
β_1^9 : TILMA/NWPTA at t-9 ($TILMA/NWPTA_{ij,t-9}$)	-0.03	0.02	0.16	0.29	-0.38	0.14	-0.09	-0.24	-0.17	-0.12	-0.32	-0.26	-0.28
	(0.04)	(0.16)	(0.45)	(0.25)	(0.30)	(0.09)	(0.15)	(0.22)	(0.18)	(0.11)	(0.39)	(0.34)	(0.59)
β_2^0 : TCA at t+0 ($TCA_{ij,t+0}$)	-0.02	0.19**	0.08	0.22	0.18	-0.26***	-0.17	-0.26**	-0.05	0.21	0.75*	0.72**	-0.34*
	(0.09)	(0.07)	(0.19)	(0.17)	(0.38)	(0.10)	(0.18)	(0.13)	(0.07)	(0.26)	(0.39)	(0.35)	(0.17)
β_2^3 : TCA at t-3 ($TCA_{ij,t-3}$)	-0.14***	-0.00	-0.20***	0.10	0.01	-0.02	0.43*	-0.18	-0.16	-0.21	0.09	-0.33	-0.13
	(0.04)	(0.11)	(0.06)	(0.10)	(0.17)	(0.08)	(0.24)	(0.26)	(0.17)	(0.28)	(0.12)	(0.37)	(0.44)
β_2^6 : TCA at t-6 ($TCA_{ij,t-6}$)	-0.02	0.16	0.02	-0.01	0.07	-0.44	-0.36	0.19*	-0.06	-0.11	-0.46***	-0.21	0.38
	(0.09)	(0.12)	(0.16)	(0.39)	(0.38)	(0.30)	(0.36)	(0.10)	(0.19)	(0.14)	(0.10)	(0.16)	(0.36)
β_2^9 : TCA at t-9 ($TCA_{ij,t-9}$)	-0.13***	-0.18*	0.11*	0.05	-0.00	0.02	0.01	0.14	-0.09	-0.14	-0.26***	-0.07	0.17
	(0.05)	(0.11)	(0.07)	(0.06)	(0.07)	(0.16)	(0.22)	(0.14)	(0.08)	(0.25)	(0.06)	(0.07)	(0.26)
β_3 : Inter-Provincial Trend ($INTERPR\_T_{ijt}$)	-0.05	-0.06	0.43***	-0.06	-0.38	-0.70***	-0.30***	0.75***	0.06	0.27***	0.41***	-0.14	-0.43***
	(0.09)	(0.07)	(0.12)	(0.12)	(0.24)	(0.13)	(0.09)	(0.13)	(0.09)	(0.07)	(0.12)	(0.20)	(0.13)
β_4 : Intra-Provincial Trend ($INTRAPR\_T_{ijt}$)	-0.29***	0.28***	0.47***	0.19	-0.11	-0.67***	-0.15*	0.69***	-0.01	0.39***	0.60***	0.65***	-0.01
	(0.10)	(0.05)	(0.11)	(0.13)	(0.34)	(0.08)	(0.09)	(0.12)	(0.11)	(0.07)	(0.13)	(0.22)	(0.18)
Total ATE													
TILMA/NWPTA	-0.36***	0.37	0.19	-0.08	0.16	0.42*	-0.08	0.10	0.02	-0.05	0.12	1.08**	-0.12
	(0.13)	(0.28)	(0.98)	(0.34)	(0.55)	(0.23)	(0.19)	(0.22)	(0.27)	(0.13)	(0.42)	(0.46)	(0.74)
TCA	-0.31**	0.17	0.01	0.35	0.26	-0.70*	-0.10	-0.11	-0.36***	-0.24	0.12	0.10	0.08
	(0.15)	(0.11)	(0.19)	(0.35)	(0.97)	(0.40)	(0.17)	(0.36)	(0.13)	(0.39)	(0.45)	(0.85)	(0.45)
R^2	0.99995	0.99996	0.99972	0.99982	0.99972	0.99990	0.99995	0.99992	0.99994	0.99995	0.99996	0.99991	0.99991
Observations	968	939	928	880	921	781	938	858	960	939	896	936	817

Notes: (1) All coefficient estimates and standard errors are bias-corrected using the methodology of Weidner and Zylkin (2021). (2) Standard errors are clustered at the province pair level and given in parentheses. (3) Significance indicated by a *** at the 1% level, ** at the 5% level, and a * at the 10% level. (4) Total ATE tests that the sum of all the RTA coefficient estimates is significant.

B.4.2 Border-Year Interactions

In this section, we include an alternative specification when controlling for inter-provincial and intra-provincial borders. We address this issue following the guidelines in Yotov et al. (2016) and present the following specification:

$$\phi_{ijt}\boldsymbol{\beta} = \sum_{S=-1}^{9} \beta_1^S TILMA/NWPTA_{ij,t-S} + \sum_{S=-1}^{9} \beta_2^S TCA_{ij,t-S} + \sum_{S=1998}^{2018} \beta_3^S INTERPR_{ij}^S + \sum_{S=1998}^{2018} \beta_4^S INTRAPR_{ij}^S + \gamma_{ij}. \tag{21}$$

Here $INTERPR_{ij}^S$ and $INTRAPR_{ij}^S$ are indicator variables taking the value of one for inter-provincial and intra-provincial trade for each year S, and zero otherwise. Because of perfect collinearity, the year 1997 is dropped.

Table 19 and Table 20 presents the results from these estimations for our broad sectors and thirteen manufacturing industries respectively. The results are mostly consistent with our preferred specification in equation (17), with some results falling out of the 10% significance level.

Table 19: Provincial Trade Agreements and Sectoral Trade: 1997-2018

	Manufacturing (1)	Services (2)	Agriculture (3)	Mining (4)
β_1^{-1} : TILMA/NWPTA at t+1 ($TILMA/NWPTA_{ij,t+1}$)	-0.00	0.01	-0.17*	0.76***
	(0.04)	(0.03)	(0.10)	(0.22)
β_1^{0} : TILMA/NWPTA at t+0 ($TILMA/NWPTA_{ij,t+0}$)	0.11*	-0.02	-0.07	0.07
	(0.06)	(0.03)	(0.09)	(0.20)
β_1^{1} : TILMA/NWPTA at t-1 ($TILMA/NWPTA_{ij,t-1}$)	0.03	-0.02	0.04	0.01
	(0.03)	(0.01)	(0.09)	(0.11)
β_1^{2} : TILMA/NWPTA at t-2 ($TILMA/NWPTA_{ij,t-2}$)	-0.04	0.01	-0.06	0.20
	(0.03)	(0.02)	(0.07)	(0.18)
β_1^{3} : TILMA/NWPTA at t-3 ($TILMA/NWPTA_{ij,t-3}$)	0.01	0.02	-0.18	-0.43
	(0.05)	(0.05)	(0.13)	(0.30)
β_1^{4} : TILMA/NWPTA at t-4 ($TILMA/NWPTA_{ij,t-4}$)	0.03	0.02	-0.17	0.01
	(0.03)	(0.03)	(0.14)	(0.14)
β_1^{5} : TILMA/NWPTA at t-5 ($TILMA/NWPTA_{ij,t-5}$)	-0.00	0.00	-0.06	0.17
	(0.05)	(0.03)	(0.15)	(0.23)
β_1^{6} : TILMA/NWPTA at t-6 ($TILMA/NWPTA_{ij,t-6}$)	-0.02	-0.07**	-0.05	-0.12
	(0.05)	(0.03)	(0.13)	(0.19)
β_1^{7} : TILMA/NWPTA at t-7 ($TILMA/NWPTA_{ij,t-7}$)	-0.03	-0.00	-0.06	0.33*
	(0.02)	(0.01)	(0.11)	(0.20)
β_1^{8} : TILMA/NWPTA at t-8 ($TILMA/NWPTA_{ij,t-8}$)	0.01	-0.04	0.10	-0.17
	(0.05)	(0.04)	(0.10)	(0.14)
β_1^{9} : TILMA/NWPTA at t-9 ($TILMA/NWPTA_{ij,t-9}$)	0.02	0.03	-0.07	
	(0.10)	(0.03)	(0.25)	
β_1^{-1} : TCA at t+1 ($TCA_{ij,t+1}$)	-0.02	-0.09***	-0.01	-0.04
	(0.05)	(0.03)	(0.11)	(0.22)
β_1^{0} : TCA at t+0 ($TCA_{ij,t+0}$)	0.02	0.03	-0.29**	0.10
	(0.05)	(0.02)	(0.11)	(0.47)
β_1^{1} : TCA at t-1 ($TCA_{ij,t-1}$)	0.01	-0.02	0.01	-0.26
	(0.10)	(0.01)	(0.33)	(0.17)
β_1^{2} : TCA at t-2 ($TCA_{ij,t-2}$)	-0.01	-0.04***	-0.05	0.54*
	(0.02)	(0.01)	(0.08)	(0.31)
β_1^{3} : TCA at t-3 ($TCA_{ij,t-3}$)	0.00	0.01*	0.14*	0.05
	(0.02)	(0.01)	(0.08)	(0.26)
β_1^{4} : TCA at t-4 ($TCA_{ij,t-4}$)	-0.03	-0.08***	-0.08	-0.14
	(0.06)	(0.02)	(0.09)	(0.28)
β_1^{5} : TCA at t-5 ($TCA_{ij,t-5}$)	-0.07**	0.00	0.05	-0.02
	(0.03)	(0.02)	(0.18)	(0.12)
β_1^{6} : TCA at t-6 ($TCA_{ij,t-6}$)	-0.05	0.02**	-0.07	0.23
	(0.05)	(0.01)	(0.10)	(0.32)
β_1^{7} : TCA at t-7 ($TCA_{ij,t-7}$)	-0.02	-0.00	0.16***	
	(0.03)	(0.02)	(0.05)	
β_1^{8} : TCA at t-8 ($TCA_{ij,t-8}$)	-0.05*	-0.00	0.00	
	(0.03)	(0.01)	(0.06)	
β_1^{9} : TCA at t-9 ($TCA_{ij,t-9}$)	0.02	-0.10**	0.04	
	(0.05)	(0.05)	(0.12)	
Total ATE				
TILMA/NWPTA	0.10	-0.05	-0.75**	0.83***
	(0.12)	(0.07)	(0.30)	(0.21)
TCA	-0.18	-0.28***	-0.08	0.47
	(0.17)	(0.07)	(0.39)	(0.38)
R^2	0.99998	0.99999	0.99991	0.99985
Observations	2662	2662	2630	1761

Notes: (1) All coefficient estimates and standard errors are bias-corrected using the methodology of Weidner and Zylkin (2021). (2) The estimates of the five sets of fixed effects are omitted for brevity. (3) Standard errors are clustered at the province pair level and given in parentheses. (4) Significance indicated by a *** at the 1% level, ** at the 5% level, and a * at the 10% level. (5) Total ATE tests that the sum of all the RTA coefficient estimates is significant.

Table 20: Provincial Trade Agreements and Three-Digit Manufacturing Trade: 1997-2018

	Food (1)	Textile (2)	Wood (3)	Paper (4)	Print (5)	Petro (6)	Chem (7)	Mineral (8)	Metal (9)	Machine (10)	Equip (11)	Transp (12)	Furn (13)
β_1^{-1} : TILMA/NWPTA at t+1 ($TILMA/NWPTA_{ij,t+1}$)	-0.02	0.16	0.04	-0.19**	-0.13	-0.02	0.05	0.06	-0.03	-0.06	0.34**	0.31	0.05
	(0.06)	(0.11)	(0.10)	(0.10)	(0.15)	(0.07)	(0.11)	(0.16)	(0.08)	(0.10)	(0.13)	(0.22)	(0.11)
β_1^{0} : TILMA/NWPTA at t+0 ($TILMA/NWPTA_{ij,t+0}$)	-0.01	0.06	-0.17	-0.01	0.04	0.11	0.10	0.07	0.17	0.32*	-0.34	-0.26*	-0.14
	(0.05)	(0.09)	(0.11)	(0.13)	(0.28)	(0.10)	(0.08)	(0.09)	(0.18)	(0.19)	(0.22)	(0.15)	(0.27)
β_1^{1} : TILMA/NWPTA at t-1 ($TILMA/NWPTA_{ij,t-1}$)	0.03	-0.01	-0.02	0.14**	-0.10	-0.12	-0.08	-0.15	0.12	0.15	0.04	0.13	0.34
	(0.04)	(0.08)	(0.10)	(0.06)	(0.06)	(0.08)	(0.07)	(0.12)	(0.10)	(0.17)	(0.09)	(0.14)	(0.23)
β_1^{2} : TILMA/NWPTA at t-2 ($TILMA/NWPTA_{ij,t-2}$)	-0.03	0.10*	0.22	-0.24*	-0.13	0.11	0.03	0.02	-0.27*	-0.17	0.08	0.27	-0.32*
	(0.07)	(0.06)	(0.15)	(0.13)	(0.21)	(0.08)	(0.07)	(0.08)	(0.16)	(0.16)	(0.17)	(0.17)	(0.20)
β_1^{3} : TILMA/NWPTA at t-3 ($TILMA/NWPTA_{ij,t-3}$)	-0.01	-0.08	-0.17	-0.23	0.18	0.05	-0.05	-0.02	-0.04	0.32**	0.28	0.21	-0.05
	(0.08)	(0.11)	(0.13)	(0.15)	(0.59)	(0.10)	(0.15)	(0.11)	(0.11)	(0.13)	(0.18)	(0.30)	(0.15)
β_1^{4} : TILMA/NWPTA at t-4 ($TILMA/NWPTA_{ij,t-4}$)	-0.02	0.05	0.09	0.19	0.20	0.00	0.07	0.08	0.07	-0.43**	-0.08	0.15	-0.10
	(0.03)	(0.09)	(0.10)	(0.16)	(0.25)	(0.06)	(0.09)	(0.11)	(0.09)	(0.19)	(0.14)	(0.24)	(0.12)
β_1^{5} : TILMA/NWPTA at t-5 ($TILMA/NWPTA_{ij,t-5}$)	-0.02	-0.04	0.18	0.25	0.42*	0.06	0.03	0.10	-0.29	0.11	0.16	0.09	0.11
	(0.05)	(0.08)	(0.15)	(0.26)	(0.23)	(0.07)	(0.22)	(0.07)	(0.23)	(0.16)	(0.14)	(0.18)	(0.26)
β_1^{6} : TILMA/NWPTA at t-6 ($TILMA/NWPTA_{ij,t-6}$)	-0.23**	0.11	-0.05	-0.37	-0.21	0.02	-0.10	0.04	0.56	0.03	-0.04	-0.13	0.12
	(0.11)	(0.08)	(0.23)	(0.24)	(0.22)	(0.09)	(0.16)	(0.14)	(0.35)	(0.12)	(0.17)	(0.16)	(0.23)
β_1^{7} : TILMA/NWPTA at t-7 ($TILMA/NWPTA_{ij,t-7}$)	0.05	0.06	-0.12	0.07	0.03	-0.01	-0.05	0.06	-0.19	-0.15	-0.22	0.15	0.06
	(0.05)	(0.07)	(0.08)	(0.21)	(0.11)	(0.06)	(0.09)	(0.05)	(0.12)	(0.11)	(0.17)	(0.12)	(0.16)
β_1^{8} : TILMA/NWPTA at t-8 ($TILMA/NWPTA_{ij,t-8}$)	-0.10*	-0.04	0.07	0.03	0.29	0.10	0.14	0.03	0.01	-0.03	0.17	0.67***	-0.03
	(0.06)	(0.10)	(0.06)	(0.18)	(0.21)	(0.08)	(0.13)	(0.09)	(0.14)	(0.07)	(0.23)	(0.23)	(0.23)
β_1^{9} : TILMA/NWPTA at t-9 ($TILMA/NWPTA_{ij,t-9}$)	0.03	0.21	0.10	0.05	-0.31	0.11	-0.12	-0.29*	-0.02	-0.01	-0.19	-0.07	-0.37
	(0.04)	(0.19)	(0.49)	(0.25)	(0.32)	(0.13)	(0.17)	(0.16)	(0.16)	(0.18)	(0.40)	(0.36)	(0.53)
β_2^{-1} : TCA at t+1 ($TCA_{ij,t+1}$)	-0.15***	-0.17	-0.05	0.01	-0.12	-0.12	-0.16*	-0.01	-0.20**	0.02	0.12	0.20	-0.19
	(0.03)	(0.11)	(0.11)	(0.13)	(0.08)	(0.17)	(0.10)	(0.16)	(0.10)	(0.35)	(0.20)	(0.33)	(0.28)
β_2^{0} : TCA at t+0 ($TCA_{ij,t+0}$)	-0.03	0.37***	0.10	0.06	0.40	-0.15	-0.05	-0.22	0.02	0.02	0.22***	0.09	-0.06
	(0.08)	(0.09)	(0.21)	(0.09)	(0.43)	(0.19)	(0.18)	(0.21)	(0.09)	(0.19)	(0.08)	(0.13)	(0.44)
β_2^{1} : TCA at t-1 ($TCA_{ij,t-1}$)	0.03	0.01	-0.07	0.01	-0.16	-0.05	0.16	-0.34***	-0.04	-0.14	0.01	0.06	0.06
	(0.04)	(0.10)	(0.11)	(0.16)	(0.15)	(0.08)	(0.10)	(0.10)	(0.23)	(0.34)	(0.13)	(0.32)	(0.25)
β_2^{2} : TCA at t-2 ($TCA_{ij,t-2}$)	0.05**	0.01	0.06	0.05	0.05	0.07	0.10**	0.22	-0.15	-0.04	0.16*	-0.09	0.07
	(0.02)	(0.04)	(0.09)	(0.14)	(0.14)	(0.07)	(0.04)	(0.24)	(0.10)	(0.17)	(0.10)	(0.12)	(0.10)
β_2^{3} : TCA at t-3 ($TCA_{ij,t-3}$)	-0.11***	-0.09***	0.08**	0.03	0.07	0.10	0.02	0.06	0.13*	0.12	-0.08	-0.06	-0.18
	(0.03)	(0.03)	(0.04)	(0.12)	(0.25)	(0.12)	(0.09)	(0.06)	(0.07)	(0.21)	(0.10)	(0.17)	(0.15)
β_2^{4} : TCA at t-4 ($TCA_{ij,t-4}$)	-0.07	0.13**	-0.27	0.05	0.46	-0.18	0.04	-0.10	0.03	-0.07	-0.27***	0.03	-0.03
	(0.07)	(0.06)	(0.34)	(0.26)	(0.31)	(0.14)	(0.13)	(0.13)	(0.36)	(0.12)	(0.09)	(0.13)	(0.36)
β_2^{5} : TCA at t-5 ($TCA_{ij,t-5}$)	0.05	0.07	0.12	0.13	-0.28**	-0.22**	-0.03	0.04	-0.20	-0.21	0.19**	-0.16	-0.08
	(0.03)	(0.06)	(0.33)	(0.12)	(0.14)	(0.10)	(0.07)	(0.03)	(0.15)	(0.13)	(0.10)	(0.25)	(0.11)
β_2^{6} : TCA at t-6 ($TCA_{ij,t-6}$)	-0.04	-0.20	0.03	0.05	-0.05	-0.20	-0.16	0.02	0.01	0.02	-0.30***	0.17	0.39**
	(0.07)	(0.13)	(0.20)	(0.11)	(0.12)	(0.16)	(0.20)	(0.10)	(0.06)	(0.08)	(0.07)	(0.31)	(0.16)
β_2^{7} : TCA at t-7 ($TCA_{ij,t-7}$)	-0.04	0.07	-0.12	-0.07	0.03	0.09	-0.02	-0.06	-0.09	0.21	-0.14	-0.06	-0.12
	(0.04)	(0.12)	(0.10)	(0.08)	(0.13)	(0.11)	(0.11)	(0.10)	(0.10)	(0.15)	(0.12)	(0.09)	(0.26)
β_2^{8} : TCA at t-8 ($TCA_{ij,t-8}$)	0.01	0.03	0.10*	-0.08	-0.08	-0.23	-0.11*	0.12**	0.04	-0.24**	-0.03	-0.11	-0.00
	(0.04)	(0.04)	(0.05)	(0.09)	(0.13)	(0.21)	(0.06)	(0.05)	(0.10)	(0.11)	(0.10)	(0.16)	(0.10)
β_2^{9} : TCA at t-9 ($TCA_{ij,t-9}$)	-0.15***	-0.18*	-0.04	0.08	0.01	0.06	-0.06	0.05	-0.09	0.19	0.20	0.39	-0.03
	(0.04)	(0.10)	(0.19)	(0.14)	(0.09)	(0.20)	(0.17)	(0.15)	(0.11)	(0.29)	(0.27)	(0.28)	(0.38)
Total ATE													
TILMA/NWPTA	-0.35**	0.59*	0.18	-0.32	0.28	0.41	0.01	-0.00	0.08	0.08	0.21	1.52***	-0.32
	(0.17)	(0.35)	(1.08)	(0.38)	(0.66)	(0.29)	(0.22)	(0.23)	(0.32)	(0.25)	(0.52)	(0.45)	(0.70)
TCA	-0.46***	0.08	-0.06	0.33	0.33	-0.83	-0.26	-0.22	-0.55***	-0.12	0.09	0.46	-0.18
	(0.17)	(0.14)	(0.30)	(0.33)	(0.94)	(0.52)	(0.21)	(0.31)	(0.15)	(0.30)	(0.55)	(1.17)	(0.33)
R^2	0.99995	0.99996	0.99971	0.99982	0.99970	0.99989	0.99995	0.99992	0.99994	0.99994	0.99996	0.99991	0.99991
Observations	2662	2582	2562	2452	2540	2184	2577	2368	2633	2597	2492	2568	2207

Notes: (1) All coefficient estimates and standard errors are bias-corrected using the methodology of Weidner and Zylkin (2021). (2) The estimates of the five sets of fixed effects are omitted for brevity. (3) Standard errors are clustered at the province pair level and given in parentheses. (4) Significance indicated by a *** at the 1% level, ** at the 5% level, and a * at the 10% level. (5) Total ATE tests that the sum of all the RTA coefficient estimates is significant.