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Abstract

A significant body of empirical studies demonstrates sizable national border effects in foreign trade of Canadian provinces throughout the 1980s and 1990s. This paper revisits and expands the scope of the border effects analysis by estimating the border effect in trade with U.S. states as well as countries in the European Union (EU) and the G 20 using more recent data from 2001–10. Furthermore, we perform the Blinder-Oaxaca nonlinear decomposition (Bauer and Sinning, 2008) to decompose the border effects into various components, including the transaction costs, the tariff and non-tariff measures, and the unexplained component.

Results from the Poisson pseudo-maximum likelihood model show that, compared to existing estimates from the 1980s and 1990s, the size of the border effect in trade between Canadian provinces and U.S. states has declined. The border effects for Canada–EU and Canada–G 20 bilateral trade flows sit at somewhat elevated levels. About a third of the border effects in overall trade with EU and G-20 countries can be attributed to the variables related to transaction costs in foreign trade.

While the significance of tariffs has declined, the prevalence of non-tariff measures seems to be on a rise. That said, we find that the welfare-changing measures combined—tariff and non-tariff measures—play a limited role in explaining the border effects in comparison with the role of transaction costs and the unexplained component.

JEL classification: F14, F15
Bank classification: International topics

Résumé

Un important corpus de travaux empiriques fait ressortir la présence d’effets frontière considérables qui ont influé sur le commerce extérieur des provinces canadiennes tout au long des années 1980 et 1990. Dans la présente étude, l’auteur réexamine l’analyse de ces effets, et en élargit la portée, en estimant, à partir de données plus récentes (2001-2010), les effets frontière dans le cas des échanges avec des États américains ainsi qu’avec des pays de l’Union européenne (EU) et du G20. L’auteur procède en outre à une décomposition non linéaire de Blinder-Oaxaca (Bauer et Sinning, 2008) afin de dissocier différentes composantes des effets frontière, notamment les coûts de transaction, les tarifs douaniers et les mesures non tarifaires, ainsi que la composante inexpliquée.

Les résultats obtenus en estimant un modèle de Poisson par la méthode du pseudo-maximum de vraisemblance montrent que, comparativement aux estimations antérieures fondées sur les données des années 1980 et 1990, la taille des effets frontière sur le commerce entre les provinces canadiennes et les États américains a diminué. Pour ce qui est des échanges bilatéraux entre le Canada et les pays de l’UE, d’une part, et les pays du

G20, d’autre part, les effets frontière se situent à des niveaux relativement élevés. Les variables relatives aux coûts des transactions transfrontières peuvent expliquer environ le tiers des effets frontière touchant l’ensemble des échanges avec les pays de l’UE et du G20.

Bien que l’importance des tarifs douaniers ait diminué, celle des mesures non tarifaires semble s’accroître. Cela dit, l’auteur constate que les mesures ayant une incidence sur le bien-être (les mesures tarifaires combinées aux mesures non tarifaires) jouent un rôle limité pour expliquer les effets frontière comparativement aux coûts de transaction et à la composante inexpliquée.

Classification JEL : F14, F15
Classification de la Banque : Questions internationales

Non-technical summary

The observation that trade is higher between two regions within a country than it is between two countries even after controlling for the sizes of trading partners and the geographic distances separating them is referred to as "border effects." A significant body of empirical studies finds the existence of sizable national border effects in foreign trade of Canadian provinces throughout the 1980s and 1990s.

This paper revisits and expands the scope of the analysis of border effects by estimating the border effect in trade for Canadian provinces and U.S. states as well as with the European Union and G-20 countries using more recent data for 2001–10. We also perform a decomposition of the border effects into several components, including transaction costs, tariff and non-tariff measures and an unexplained component.

Results from the model show that compared to existing estimates from the 1980s and 1990s, the size of the border effect in trade between Canadian provinces and U.S. states has declined. The border effects for Canada–EU and Canada–G-20 bilateral trade flows sit at more elevated levels. About a third of the border effects in overall trade with EU and G-20 countries can be attributed to the variables related to transaction costs in foreign trade. While the significance of tariffs has declined, the prevalence of non-tariff measures seems to be on a rise. That said, it is not clear whether the rise of non-tariff measures is a sign of increased protectionism in foreign trade or simply reflects increased production fragmentation, complexity of global supply chains and changing consumer preferences. We also find that the combined role of tariff and non-tariff measures in explaining the border effects is estimated to be limited compared to the role of transaction costs and unexplained component of the border effects.

1 Introduction

National borders reduce trade flows. When income, distance and alternative trading opportunities are considered, two different countries trade far less with each other than do two regions in the same country. In his seminal study, McCallum (1995) uses a basic gravity model to determine that interprovincial trade in Canada is, on average, 21 times larger than trade between Canadian provinces and U.S. states, after controlling for the sizes of the economies and the geographic distance between them.[1] That result is surprising given the intensive supply chains and the gradual elimination of trade barriers across the continent. The two countries also share a common language as well as many historical, institutional, political, social and cultural features. In light of these factors, McCallum's result was unexpected.

In the wake of McCallum's study, the "border effect" has been referred to in literature as the observation that trade is higher between two regions within one country than it is between two countries. A plethora of successive studies has followed in an effort to explore the puzzle[2] of such a strong home bias. The studies generally report results that are smaller than but comparable to McCallum's border effects in North America. Noteworthy, Anderson and Smith (1999) first reported that border effects were not uniform across the Canadian provinces. The bias toward interprovincial trade ranged between 10 in British Columbia to 49 in Prince Edward Island.[3] According to the study, interprovincial trade was more than 15 times larger than cross-border trade with U.S. states, for Canada as a whole, after controlling for size of an economy and geographic distance. More recently, Chen et al (2012) suggest that border effects have somewhat declined but continued to persist since the Canada–U.S. Free Trade Agreement (FTA) and the North American Free Trade Agreement (NAFTA) were ratified in 1988 and 1994, respectively. For the period from 1995 to 2005, the study reports an average estimate of 13.8 for border effects.

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[1] Based on 1988 data.

[2] Obstfeld and Rogoff (2001) viewed McCallum's findings as one of the major puzzles in international macroeconomics.

[3] Using the same set of data for 2013, Query (2014) reports that border effects ranged between 11.5 for British Columbia and 114.0 for Prince Edward Island.

According to Evans (2003), there are three groups of factors that can cause the volume of domestic trade to exceed that of international trade. First, there exists a high elasticity of substitution between domestic and imported products. Second, transaction costs of doing business abroad are different than they are at home. Third, bilateral trade barriers between two countries tend to create an impediment to external trade. Clearly, the economic implications vary in each case. In the first case, the magnitude of the border effect is largely due to a high degree of similarity between imports and domestic goods and is related to the concept of consumers' tendency toward domestic products. It implies neither unrecognized barriers to trade nor material welfare costs that needed to be mitigated. In this context, Helliwell and Schembri (2005) suggest that the tendency toward domestic product is consistent with the efficient organization of consumption within nations reflecting the appropriate matching of local goods to local tastes. In the second case, welfare consequences and policy implications are also limited. The price wedge giving rise to border effects reflects a differential in transaction costs caused by business procedures and regulations on export and imports, customs, transportation as well by a cost of doing business in foreign language. Intranational trade also benefits from a tighter business and social networks, which tend to reduce transaction costs and diffuse similar preferences (Helliwell and Schembri, 2005). In the third case, border effects are frequently driven by tariff and non-tariff measures that may imply somewhat higher barriers to trade, a broad range of welfare effects and a potential role for policy intervention. With the dramatic decline in tariffs through the successive rounds of multilateral negotiation and bilateral liberalization, the focus of the trade policy agenda has gradually shifted toward non-tariff measures (NTMs). While tariffs are more transparent and scrutinized, NTMs are more complex and harder to monitor. They tend to be broadly defined in scope and product coverage and can thereby increase the reluctance of firms to engage in international trade.

The focus of this study is to revisit national border effects in foreign trade in goods between Canadian provinces and U.S. states for the more recent period of 2001–10 as well as to estimate the border effects in bilateral trade with EU and G-20 countries. [4,5] We explore the border effects for the overall economy as well as for manufacturing sector specifically. As shown in Figure 1, international trade consistently underperformed interprovincial trade in terms of growth rates between 2001 and 2010. In this context, the study also contributes to the discussion on the relatively subdued performance of Canada's international trade over the period reviewed.[6]

In this paper, the unit of measure is a Canadian province. We first assess the magnitude of the border effects in foreign trade for Canadian provinces with U.S. states and countries in the EU and G-20. Once the size of the border effects is estimated, we explain the underlying factors. We apply the Blinder-Oaxaca nonlinear decomposition (Bauer and Sinning, 2008) to decompose the border effect into the role played by transaction costs, tariff- and non-tariff measures and unexplained factors, controlling for exchange rate and flows of foreign direct investment (FDI).

This study is novel in several respects. First, most of the existing literature on border effects for Canada use somewhat dated data from late 1980s and 1990s. Yet, throughout the 2000s, the global and Canadian economies experienced many economic events and structural changes. Recalculating the size of the border effects would help understand to what extent these events changed the magnitude of home bias in trade.

Second, this study used a different methodology than previous studies did. Many studies that place border effects in the framework of a gravity equation ignore zero value trade flows between some of the Canadian provinces and U.S. states by running log-linear OLS or other models on filtered data. Recent evidence suggests, however, that this approach may generate inconsistent and biased results. To avoid

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[4] The time period selected for the analysis was determined based on the limited availability of consistently collected data by Statistics Canada.

[5] Group of countries in G-20 in this paper excludes France, Germany, Italy and the United Kingdom because they are included in the group of EU countries. The United States is also excluded from the G-20 group. The list of EU and G-20 member countries included is provided in Table A.1 in the appendix.

[6] "Over the past decade, the value of exports has increased at only a modest pace. This is despite significant price premiums received by Canadian producers of energy, mineral and agricultural commodities. If these price increases are excluded, the volume of merchandise exports shipped in 2012 was actually five per cent lower than in 2000 despite a 57 per cent increase in trade worldwide." (Canadian Chamber of Commerce. "Turning it Around: How to Restore Canada's Trade Success." May 2014)

this, we estimated the border effects using Poisson pseudo-maximum likelihood following Santos and Tenreyro (2006).

Third, existing studies on border effects only consider Canada's trade with the United States. We extend the analysis to include the EU and G-20 member countries. Many Canadian businesses had previously been reluctant to explore trade opportunities with Europe and Asia, citing fluctuating exchange rates, the high cost of shipping and prohibitively high tariffs and duties as key obstacles. However, since the early 2000s, the Canadian federal government has, in the context of its bilateral trade negotiations, made an effort to emphasize the elimination of trade barriers and create a more harmonized approach to regulations in trade. In partnership with commercial agencies, trade authorities have also been providing on-site support to Canadian businesses interested in exploring European and Asian markets, offering them more information about opportunities and potential challenges they might encounter and introducing them to prospective business partners in their target markets. Estimating the border effects with EU and G-20 nations would indicate to what extent such efforts have yielded a reduction in the bias of bilateral trade with these regions.

Finally, the paper is the first to use the Blinder-Oaxaca nonlinear decomposition (Bauer and Sinning, 2008) of the border effects to determine the role played by various components. Indeed, the sheer existence of border effects does not provide rationale for policy intervention. To fully study the issue, we must distinguish between the border effects caused by trade barriers and those caused by cross-border differences in tastes and more efficient local transaction networks that, together, generate more intranational trade (Helliwell and Schembri, 2005). By using the Blinder-Oaxaca nonlinear decomposition, we attempt to shed some light on border effects in foreign trade and contribute to the discussion on whether they are relevant to policy-making.

The paper is organized as follows: Section 2 provides an overview of existing studies on Canada's border effects in foreign trade in goods as well as of economic theory relevant to border effects in trade. In Section 3, we illustrate our modelling strategy.

In Section 4, we illustrate and discuss our findings. In Section 5, we outline some of the limitations of the analysis and provide our conclusion.

2 Existing measures of border effects in Canada's international trade

McCallum (1995) estimated the following gravity equation using 1988 data for Canadian provinces and the 30 largest (or adjacent to Canada) U.S. states:[7]

$$ln\, x_{ij} = a + b * lnY_i + c * lnY_j + d * \ln dist_{ij} + e * Border_{ij} + \varepsilon_{ij} \qquad (1)$$

Above, x_{ij} are exports from province (state) i to state (province) *j*. $Border$ takes the value 0 for interprovincial trade and value of 1 for trade between a province and a U.S. state. The point estimate for e was around 3.0. McCallum interpreted this to mean that trade between two provinces is more than *exp* [3.0]=21 times larger than trade between a province and a U.S. state. That result was surprisingly high given the fact that the two countries share many historical, institutional, political, social and cultural features, including a common language. Helliwell (1996, 1998) subsequently produced a series of papers reporting border effects that were lower than but comparable those McCallum observed. Based on data for 1988–1990, Helliwell (1996) shows that Quebec trades more than 20 times as much with other provinces than it does with U.S. states of comparable size and distance. According to Helliwell (1998), though, between 1990 and 1996 the border effect dropped to 11.9. This drop is largely attributed to the ratification of the Canada–U.S. Free Trade Agreement in 1988 and improved modelling of the gravity equation as a result of taking multilateral trade resistance (MTR) into consideration.

The concept of MTR was originally suggested and implemented into the theory of gravity in 1979 by Anderson, who laid out the theoretical foundation of the gravity model based on a consumer utility function with constant elasticity of substitution of traded products, differentiation of products by country of origin and distance as a

[7] The states are Alabama, Arizona, California, Florida, Georgia, Idaho, Illinois, Indiana, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, Tennessee, Texas, Vermont, Virginia, Washington and Wisconsin.

measure of a transportation cost.[8] The MTR concept captures the third-country effects. In other words, when two countries are deciding how much to trade with each other, their decisions are not only affected by the bilateral trade costs between them, but also by the average trade costs faced by each of the two countries with respect to all other countries. For example, consider trade between Belgium and the Netherlands as well as between Australia and New Zealand. Since the former pair of countries is surrounded by other large trading economies, such as France and Germany, they are likely to trade less between themselves than if they were surrounded by oceans, as is the case for Australia and New Zealand.

Anderson's theory has been widely adopted and further developed in a series of prominent papers. Andersen and van Wincoop (2003) proposed a multi-country general equilibrium model of international trade that is particularly intuitive. It assumes that each country is endowed with a single good that is differentiated from those produced by other countries. The supply volume of each type of this product is fixed. Individual consumers derive utility from a large variety of domestic and foreign goods. The model also assumes that consumer preferences are identical across countries and are captured by constant elasticity of substitution. Border and trade costs are exogenously defined with the price of the product shipped from country i faced by consumers in country j equal to $p_{ij} = p_i t_{ij}$. They obtain the following form of the gravity equation for x_{ij}, exports from country i to$j$ after maximization of the consumer's utility function:

$$x_{ij} = \frac{y_i y_j}{y^w} \left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma} \qquad (2)$$

where y_i and y_j are income in country i and j , $y^w = \sum_j y_j$is a world income, t_{ij} is unobservable trade costs, and $\sigma > 1$ is elasticity of substitution where low value indicates a high degree of differentiation across products. Π_i and P_j are MTRs.

[8] Theoretical derivation of trade costs and border effects in bilateral trade does not exclusively hinge on Andersen and van Wincoop's (2003) model. Eaton and Kortum (2002) developed a Ricardian-type model emphasising the supply side whereas Melitz (2003), Chaney (2008), and Melitz and Ottaviano (2008) established a stream of trade literature that accommodated the role of border effects through the model of heterogeneity of firms in productivity and trade. Both streams of literature conclude that, all things held constant, a rise in border related costs in international trade reduces bilateral trade flows.

Andersen and van Wincoop further assume trade cost function $t_{ij} = d_{ij}^{k}\, b_{ij}$, where d_{ij}^{k} is bilateral distance and b_{ij} are border-related trade costs. Equation (2) shows that an increase in border-related costs is associated with a decline in exports from country i to j. With MTR accounted for and using 1993 data, Anderson and van Wincoop (2001) recalculated the border effects between Canada and the 30 U.S. states at 10.7.

Some recent critics of McCallum's and other earlier gravity studies focus on the issue of zero flows in bilateral trade. Indeed, in the analysis of bilateral trade flows, zero trade flows or missing observations are quite common. Ignoring such values or replacing zeros with a small positive number tends to create a bias in the parameter estimates (Flowerdew and Aitkin, 1982; Eichengreen and Irwin, 1998; Linders and de Groot, 2006; and Burger et al., 2009). Specifically, Melitz (2003) and Chaney (2008), Helpman et al. (2008) argue that the bias emerges because zero trade flows result from prohibitive trade costs. Firms differ in terms of their productivity, and there are fixed costs that prevent less productive firms from exporting.

Estimation of the log-linear form of gravity equations seems to be problematic as well. Santos and Tenreyro (2006) showed that log-linearizing the gravity equation may have an important consequence for the estimation of parameters. The problem arises if the errors in the original nonlinear model are heteroscedastic. Log-linearization of such a model creates endogeneity problems in the linear model. One of the proposed strategies to circumvent the zero-trade problem was to use two-part models where probit (or logit) and main models are estimated independently. Using this approach, Hillberry (1998) showed that the border effect between 1990 and 1996 declined from 19.5 to 11.9. The paper attributes the decrease to the Canada–U.S. FTA. After controlling for the zero trade issue and MTR, Coulombe (2005) also reports a decline in the border effect from 18 in 1988 to 11 in 1996. These findings are similar to those in Helliwell's study (1998), which used a log-linearized form of the gravity equation. For the period from 1988 to 1993, nonlinear estimation by Dias (2011) resulted in a border effect of 11.1. By contrast, Chen et al (2012) consider a longer period, from 1992 to 2005, and report a decline of the Canada–U.S.

border effect to 9.7 by the late 1990s, followed by a thickening of the border effect to 19.1 in 2005, in the wake of 9/11 attacks. That said, Chen et al.'s study accounts neither for MTR nor for potential endogeneity problems caused by a log-linearization of the gravity equation. Table 1 summarizes some of the estimates from existing studies.

The existing literature also shows that the border effects are not uniform across Canadian provinces. In a study by Andersen and Smith (1999) that uses 1988 data and incorporates controls for MTR, the size of the border effects ranges between 6.0 for British Columbia and 51.6 for Prince Edward Island. The study suggests that British Columbia is an export platform, while Ontario and Quebec serve as import platforms. In Wall's (2000) study, he employs a panel data regression that results in the border effects ranging from 9.0 for British Columbia to 25.3 for Nova Scotia.

Most of the studies on border effects follow McCallum's tradition by including 10 provinces in Canada and the 30 adjacent or largest states in the United States that account for more than 90 per cent of Canada–U.S. trade. By contrast, the results by Query (2014) show that the estimated border effect is significantly larger when adding the 20 smaller states typically excluded in the border effect studies. Using data from Statistic Canada's Input-Output Division, the Canadian International Merchandise Trade Database for the year 1993, Query estimates significantly larger border effects at the provincial level (Table 2). Once again, the home bias in trade for British Columbia is the lowest at 11.5. Similar to the findings by Andersen and Smith (1999), Prince Edward Island was found to have the thickest border in international trade.

Overall, the estimates of the border effect in Canada–U.S. trade from the existing literature remain sizable. The border effect decreased following the signing of the FTA and NAFTA. However, this trend seems to have ceased in the wake of 9/11 attacks. At the same time, it is important to note that the data in most of the studies, particularly at a provincial level, is somewhat outdated.

3 Methodology

First, we applied McCallum's (1995) specification within a pooled OLS framework [equation (1)] to 2001–10 data. McCallum's study included the 10 provinces in Canada and 30 states in the United States that accounted for more than 90 per cent of Canada–U.S. trade in 1988. The purpose of this estimation was to update the seminal findings which, in a sense, prompted development of the literature on border effects in trade. Using McCallum's original methodology also ensures that our analysis of evolution in the border effects between Canada and the United States is a proper comparative exercise.

Next, we expanded the analysis to reflect developments in estimating gravity models and to incorporate the remaining U.S. states as well as countries in the EU and the G-20. Following Andersen and van Wincoop (2003), the simplest version of the augmented equation can be written as follows:

$$lnX_{ij} = ln\beta_0 + \beta_1 lnY_i + \beta_2 lnY_j + \beta_3 ln\,dist_{ij} + \beta_4 border_{ij} + \beta_5 ln\Pi_i + \beta_6 lnP_j + ln\varepsilon_{ij} \quad (3)$$

where i is an exporting province (country or U.S. state) and j is an importing province (country or U.S. state). X_{ij} are exports from i to j, Y_i and Y_j are income in i and j, $lndist_{ij}$ is a log of a distance between most populous cities[9] in i and j, $border_{ij}$ is a dummy variable for international trade, and Π_i and P_j are MTRs for the exporter and importer, respectively.

There are three practical issues with estimating equation (3). First, MTRs are not directly observable. There are different views on how to treat them empirically in the literature. Many studies use Head's (2003) suggestion and proxy them with so-called remoteness terms: $\Pi_i = \sum_j \frac{dist_{ij}}{Y_{it}/Y_{Wt}}$ for outward (exporter) flows and $P_j = \sum_i \frac{dist_{ij}}{Y_{jt}/Y_{Wt}}$ for inward (importer) flows where Y_{it} and Y_{jt} are exporter's and importer's GDP in year t, whereas Y_{Wt} is a global GDP in year t. Another approach to capture MTRs is to include exporter and importer dummies (Harrigan, 1996;

[9] The list of most populous is in the Table A.1 of the appendix.

Feenstra, 2004). Both approaches lead to consistent estimates of the gravity equation in the log-linear and nonlinear forms (Head and Mayer, 2013). Unobserved heterogeneity caused by MTR or other unobserved factors in panel data setting can also be controlled for by using random effects model or a linear Taylor approximation method (Baier and Bergstrand, 2009). In this study, we used proxies for MTRs in the form of the remoteness term as defined by Head (2003).

The second challenge in estimating equation (3) is the treatment of zero trade flows. Zero trade flows are quite common in international trade. This creates a problem when estimating log-linear gravity equations. Ignoring zero bilateral trade flows or replacing zeros with a small positive number creates a bias in the parameter estimates (Flowerdew and Aitkin, 1982; Eichengreen and Irwin, 1998; Linders and de Groot, 2006; and Burger et al., 2009). Specifically, Melitz (2003) and Chaney (2008), Helpman et al. (2008) argue that zero trade flows result from prohibitive trade costs. Firms differ in terms of their productivity, and there are fixed costs that prevent less productive firms from exporting. The models proposed by Tobin (1958), Heckman (1979) and Helpman et al. (2008) were used to tackle the problem. The Tobit model has been applied in the series of gravity studies, including Rose (2004) and Baldwin and DiNino (2006). More recently, however, the appropriateness of using the Tobit model was scrutinized, most prominently by Linders and de Groot (2006). Linders and de Groot argued that hypothetical trade cannot be negative and that, as a result, censor trade flows cannot be censored from below zero. Sample selection models by Heckman (1979) and Helpman et al. (2008) also attempted to prevent the bias resulting from the non-random elimination of zeros. Such sample selection models have been criticized on two grounds—complexity of satisfying the exclusion restriction imposed by two-stage models and lack of controls against heteroscedasticity, which tends to be present in international trade data (Santos Silver and Tenreyro, 2009; and Flam and Nordstrom, 2011).

Finally, Santos and Tenreyro (2006) argue that, in estimating equation (3), the issue of endogeneity may also occur if the errors in the original model are heteroscedastic.

This is due to the fact that the expected value of the logarithm of a random variable depends on high-order moments of its distribution, which makes OLS or two-stage (including Heckman sample selection) models inefficient. Conventional White-Huber standard errors do a poor job in correcting this problem.

Santos and Tenreyro (2006) published an influential paper that offers a solution to the zero trade issue and also avoids log-linearization of the gravity equation. They suggested that nonlinear estimators, specifically the Poisson pseudo-maximum likelihood (PPML), should be used to deal with zero trade observations in the gravity equation. PPML provides unbiased estimates and is robust to the presence of heteroscedasticity. Despite some criticism by Martin and Pham (2008), Burger et al., (2009) and Martinez-Zarzoso (2013), PPML has steadily developed into an industry benchmark for the empirical estimation of gravity equations. Given this evidence, we use PPML as our baseline model.

To explain the underlying reason for border effects, we assess the role played by transaction costs for international trade and tariff and non-tariff measures, controlling for nominal exchange rate fluctuations and FDI flows from the exporting to the importing country.

First, we estimate our baseline equation (5) to derive an aggregate border effect. Following the methodology of Fontagné et al. (2005) and Olper and Raimondi (2008), we then gradually introduce variables for the different determinants of border effects. By measuring the resulting reduction in the estimated border effects, we have a gauge for the overall importance of these variables that we can use to explain the trade-reduction effect of national borders. Initially, we introduced controls for nominal exchange rate (ER) and FDI flows from an exporter to importer country (FDI).

$$X_{ijt=} \beta_0 + \beta_1 lnY_{it} + \beta_2 lnY_{jt} + \beta_3 ln\, Dist_{ij} + \beta_4 border_{ij} + \beta_5 ln\Pi_{it} + \beta_6 lnP_{jt} + \beta_7\, ER_{ijt} + \beta_8 FDI_{ijt} + +\varepsilon_{ijt} \quad (4)$$

Empirical studies show that the relationship between the exchange rate and bilateral trade is important and multi-faceted (Eichengreen, 2007; and Rodrik, 2008). According to Auboin and Ruta (2011), the impact of nominal exchange rate changes depends on a complex set of variables that may or may not lead domestic firms to increase exports or domestic consumers to increase imports. These variables include the extent of imported inflation, the price-setting mechanisms of firms and the currency in which domestic producers invoice their products.

Whether FDI is relevant to changes in bilateral trade is also still debated. Motivated by Mundell (1957), Buckley and Casson (1981), Markusen (1984) and Caves (1996), the standard theory of multinational corporations assumes substitution between export and foreign affiliate production. However, the findings from the empirical studies are mixed. While Braconier and Ekholm (2000), Egger and Pfaffermayr (2004) and Mitze et al. (2008) confirm a negative relationship between foreign affiliate production and exports, some studies, including Blomstrom, Lipsey, and Kulchycky (1988), Grubert and Mutti (1991), Pfaffermayr (1996), Head and Ries (2001), Clausing (2000), Narayanan et al (2010), and Oberhofer and Pfaffermayr (2012) suggest strong evidence of complementarity.

According to the latter group of studies, foreign affiliate production tends to tap into new growth and market opportunities rather than substitutes for operation at home. According to Khan and Kim (1999), production by a firm's affiliates abroad frequently generates demand for other products, such as capital or intermediate goods. These products may be provided by other parts of a parent company, its suppliers, or other firms in a home country.

Next, we enrich the specifications by adding variables that may capture transaction costs associated with the foreign trade. These transaction costs in foreign trade are frequently related to business procedures and regulations on customs, freight and cross-border transportation. An extensive line of literature provides evidence that the onus of transaction costs in foreign trade is determined in part by the search cost of information, common language, and common understanding of legal and cultural institutions. In the gravity equations, therefore, such factors are conventionally controlled for by dummy variables for common official language ($Lang$), contiguity of two trading partners ($Cont$) and common colonial history (Col):

$$X_{ijt=} \beta_0 + \beta_1 lnY_{it} + \beta_2 lnY_{jt} + \beta_3 ln\, Dist_{ij} + \beta_4 border_{ij} + \beta_5 ln\Pi_{it} + \beta_6 lnP_{jt} + \beta_7\, ER_{ijt} + \beta_8 FDI_{ijt} + \beta_9\, Lang_{ij+}\beta_{10}\, Cont_{ij+}\beta_{11}\, Col_{ij+}\varepsilon_{ijt} \quad (5)$$

$Lang_{ij}$ takes the value of 1 if i and j share at least one official language. $Cont_{ij}$ takes a value of 1 if i borders j. Similarly, Col_{ij} takes a value of 1 if i and j were in a colonial power and a colony relationship or were colonies of a single colonial power.

Afterward, we add the variables that account for tariff-related barriers: dummy variables for WTO membership of trade partners, WTO_i and WTO_j , and a bilateral average tariff rate, Tar_{ij} , applied to exports from i to j:

$$X_{ijt=} \beta_0 + \beta_1 lnY_{it} + \beta_2 lnY_{jt} + \beta_3 ln\, Dist_{ij} + \beta_4 border_{ij} + \beta_5 ln\Pi_{it} + \beta_6 lnP_{jt} + \beta_7\, ER_{ijt} + \beta_8 FDI_{ijt} + \beta_9\, Lang_{ij+}\beta_{10}\, Cont_{ij+}\beta_{11}\, Col_{ij+}\beta_{12} Tar_{ijt} + \beta_{13} WTO_{it} + \beta_{14} WTO_{jt} + \varepsilon_{ijt} \quad (6)$$

where WTO_{it} (WTO_{jt}) takes the value of 1 if an exporter (importer) is a member of WTO in year t. Tar_{ijt} is a weighted mean for applied tariff rates across all products exported from i to j.

Finally, we introduce the frequency of non-tariff measures NTM_{ijt} applied to exports from i to j in year t to arrive at a final model specification:

$$X_{ijt=} \beta_0 + \beta_1 lnY_{it} + \beta_2 lnY_{jt} + \beta_3 ln\, Dist_{ij} + \beta_4 border_{ij} + \beta_5 ln\Pi_{it} + \beta_6 lnP_{jt} + \beta_7\, ER_{ijt} + \beta_8 FDI_{ijt} + \beta_9\, Lang_{ij+}\beta_{10}\, Cont_{ij+}\beta_{11}\, Col_{ij+}\beta_{12} Tar_{ijt} + \beta_{13} WTO_{it} + \beta_{14} WTO_{jt} + \beta_{15} NTM_{ijt} + \varepsilon_{ijt} \quad (7)$$

The problem of endogeneity may arise in augmented gravity models when estimating the impact of variables related to trade policies[10] (Baier and Bergstand,

[10] While the endogeneity may be also sourced in other explanatory variables, such as GDP, its effect on a bias of parameter estimates in the gravity model has been estimated to be limited (Cyrus, 2002).

2007). Countries are likely to introduce favourable trade policies for partners with which they already trade frequently. If this is the case, Tar_{ijt} , NTB_{ijt}, WTO_{it} , and WTO_{jt} in equation (7) may be correlated with the error term ε_{ijt}. To explore whether endogeneity of trade policy variables is a problem in our model, we re-estimate equation (6) and equation (7) using one-period lagged levels of potentially endogenous variables (i. e., Tar_{ijt-1}, NTM_{ijt-1}, WTO_{it-1}, and WTO_{jt-1}) as instruments in the Poisson IV model. Next, we use the Wald test to compare estimated coefficients from the Poisson IV regressions with the original estimates from equation (6) and equation (7).

Under the hypothesis of no endogeneity, the estimates are not expected to differ significantly. The technique has been frequently applied in the literature on endogeneity in panel data. The detailed treatment of this technique may be found in Holtz-Eakin et al. (1988), Angrist and Krueger (2001), Kristensen and Wawro (2003), and Cameron and Triverdi (2008). Another safeguard against possible endogeneity problem in our models stems from the use of the panel data. According to Cameron and Triverdi (2008), the main advantage of panel data is that it can be used to control for an omitted variables problem that frequently causes endogeneity.

Through the evolution of estimated β_4 in the equations (3) through (7), we track to what extent the size of the border effects shrinks as a result of additional controls in the regression. That being said, while a gradual introduction of additional explanatory variables to the specification helps identify a set of key constructs, it does not allow the difference in an outcome variable between groups to be quantitatively decomposed into several components because that magnitude of a reduction of parameter estimate β_4 varies depending on the sequence in which new variables are introduced to the right-hand side of the gravity equation (3).

To explore these issues further, we employ the Blinder-Oaxaca technique of decomposing inter-group differences in the means of the dependent variable into those caused by different observable variables across groups and those caused by unexplained determinants of differences in outcome (Blinder, 1973; Oaxaca, 1973), including the residual disparity driven by unobserved heterogeneity. This econometric technique has traditionally been employed in labour economics to estimate how much of the wage differential between men and women can be explained by the differences in age, years of education and other observables. However, the method is also useful in other fields. In general, the technique can be employed to study group differences in any outcome variables. Historically, decomposition methods have mainly been applied in the context of linear regression models:

$$\bar{T}_{PT} - \bar{T}_{IT} = \underbrace{\left[\left(\bar{V}^{PT} - \bar{\bar{V}}^{IT}\right)\hat{\beta}^{PT}\right]}_{\substack{\text{Difference in the}\\ \text{mean of observed}\\ \text{variables}\\ \text{(explained}\\ \text{portion)}}} + \underbrace{\left[\bar{V}^{IT}\left(\hat{\beta}^{PT} - \hat{\beta}^{IT}\right)\right]}_{\substack{\text{Difference in}\\ \text{the coefficient}\\ \text{(unexplained}\\ \text{portion)}}} \tag{8}$$

where $\bar{T}_{PT} - \bar{T}_{IT}$ is the difference in mean of interprovincial and international trade. $\bar{V}^{PT}$ and $\bar{V}^{IT}$ are the row vectors of average values of the independent variables. $\hat{\beta}^{PT}$ and $\hat{\beta}^{IT}$ are the vectors of coefficient estimates for groups. Applying a linear decomposition to a Poisson model would lead to misleading decomposition results because the parameter estimates of non-linear models typically differ from the marginal effects of the latent outcome variable. More recently, a decomposition method for models with nonlinear-dependent variables has been developed by Fairlie (2005) and Bauer and Sinning (2008). We therefore use the Bauer and Sinning (2008) framework for the Oaxaca-Blinder decomposition of differences in group means to explain the differences in the scale in interprovincial and international trade. In our analysis, the first group contains interprovincial trade flows, while the second group is limited to trade flows between Canadian provinces and U.S. states or EU and G-20 countries. The decomposition can be expressed as follows:

$$\bar{T}_{PT} - \bar{T}_{IT} = \underbrace{\left[\sum_{i=1}^{N_{PT}} \frac{F(V_i^{PT}\hat{\beta}^{PT})}{N^{PT}} - \sum_{i=1}^{N_{IT}} \frac{F(V_i^{IT}\hat{\beta}^{PT})}{N^{IT}}\right]} + \underbrace{\left[\sum_{i=1}^{N_{IT}} \frac{F(V_i^{IT}\hat{\beta}^{PT})}{N^{IT}} - \sum_{i=1}^{N_{IT}} \frac{F(V_i^{IT}\hat{\beta}^{IT})}{N^{IT}}\right]} \quad (9)$$

Difference in the mean of observed variables (explained portion)

Difference in the coefficient (unexplained portion)

F is a nonlinear (e.g., Poisson) function. V_i^{PT} and V_i^{IT} are vectors of control variables in the gravity equation (9) for interprovincial and international trade, respectively. N^{PT} and N^{IT} are the numbers of paired observations for interprovincial and international trade, respectively. Finally, $\hat{\beta}^{PT}$ and $\hat{\beta}^{IT}$ are the vectors of coefficients from the nonlinear (Poisson) gravity regressions for interprovincial and international trade.

Similar to most recent studies employing the Blinder-Oaxaca decomposition technique, we further decompose the explained portion in equation (9) into the contribution from each set of independent variables included in equation (7). Following Oaxaca and Ransom (1998), Fairlie (2005) and Bauer and Sinning (2008), the delta method is used to approximate the standard errors.

4 Data

The data used in this paper come from different sources. Canadian interprovincial trade flows are drawn from the matrix of interprovincial trade produced by the Input-Output Division of Statistics Canada. The data is available from CANSIM Tables 386-0002 and 386-0003. The data on international trade in goods are from the Canadian International Merchandise Trade database available through its Trade Data Online generator on Industry Canada's website. The data are sourced from Statistics Canada's records of all goods entering and leaving Canada collected through customs documents. The data track the province of origin, province of destination, country of origin and country of destination based on customs declarations.

Provincial gross domestic product (GDP) data are drawn from Statistics Canada's CANSIM, Table 384-0038. U.S. state GDPs are provided by the Bureau of Economic

Analysis at the U.S. Department of Commerce. Country GDP estimates come from the World Bank[11] and are converted into Canadian dollars using annual average exchange rate. Distance is measured using the great-circle distance formula between two geographic locations (i.e., most populous cities) that is the shortest distance over the earth's surface. More details on data sources for other explanatory variables are discussed in the section A.1 of the appendix. The summary statistics for the variables used in the regressions are provided in Table 3.

5 Results and discussion

5.1 The size of border effects in Canadian trade with the United States as well as EU and G-20 countries

The results of gravity regressions for exports from and to Canadian provinces are shown in Table 4. Column 1 lists the estimates of the border effect between Canada and the United States generated using McCallum's (1995) specification and 2001–10 data. Interpretation of the border effect results is as follows. After controlling for the size of an economy and the distance between the most populous cities, bilateral trade between Canadian provinces is, on average, 13.5 times larger than trade between Canadian provinces and U.S. states. This represents a decline of 35.7 per cent from the original estimates in McCallum's study that used data from 1988. Clearly, some of the reduction in the border effects is driven by the realization of the full consequences of NAFTA. That said, it is difficult to attribute direct causation, particularly given that Canada and the United States had a free-trade deal that predated NAFTA and that the economies were already well integrated before the agreement was ratified.

Column 2 contains results for provincial trade with all U.S. states as well as with EU and G-20 nations, as established in equation (3) estimated by the PPML model. In this model, we employ data for all U.S. states. The estimates of border effects are therefore not directly comparable with those in Column 1. The remoteness variable in Table 3 points to an importer's remoteness from other countries. Remoteness of

[11] http://data.worldbank.org/indicator/NY.GDP.MKTP.CD

an exporter has been omitted from the regressions due to identified multicollinearity with an importer's remoteness. To test the model specifications in Column 2 (PPML model), we performed two model specification tests: White's test of functional form and the heteroscedasticity-robust Ramsey's RESET (regression specification error test). The model passes these tests at conventional levels of statistical significance.

In our PPML model for overall trade, the border effect for Canada–U.S. trade is 9.0. In other words, after controlling for size of an economy and geographic distance, trade between Canadian provinces is, on average, nine times larger than trade it is between Canadian provinces and U.S. states. The border effect for Canada–G-20 bilateral trade is twice as large at 19.0. For Canada–EU trade, the size of the border effect is estimated at 45.7.[12] The result is quite notable: on average, after controlling for the size of an economy, geographic distance and alternative trading opportunities, Canadian provinces are five times more likely to trade with a U.S. state than with an EU member nation. Estimated coefficients for other constructs in the regression have the expected sign. The GDP of the importing and exporting regions is positively associated with trade flows, while a larger geographic distance depresses trade.

Our findings also indicate that the border effects in trade with EU countries are considerably larger than the ones between Canadian provinces and G-20 countries. To a significant extent, this result is driven by increased trade flows of Canadian provinces with Mexico and China. Omitting these two countries from the sample of G-20 nations would increase the border effects from 19.0 to 26.6. For trade with EU countries, a large size of the border effect is partly caused by relatively small trade volumes between Canadian provinces and EU 2004- and 2007-expansion countries (the Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia). Estimation of the PPML for the overall trade in

[12] Column (1) in Table A.2 in the appendix presents the findings for the manufacturing sector. The results are broadly in line with the findings for overall trade.

goods without this group of EU countries would result in a reduction of the border effects from 45.7 to 31.4.

The estimated border effect of 9.0 for Canada–U.S. bilateral trade is lower than estimates from the existing literature from the 1980s and 1990s (see Table 1), once again indicating a decline in the home bias for trade by Canadian provinces. The result is even more encouraging because this specification integrated trade flows from all the U.S. states instead of only the 30 largest or adjacent U.S. states considered in the existing literature. Our parameter estimate for the Canada–U.S. border effect is significantly smaller than the results by Query (2014), one of the few existing studies that features a full set of U.S. states.

While the border effects with the United States in our study are lower than those in previous estimates, the breakdown of the border effects within the analyzed time frame 2001–10 (Figure 2) indicates that the border effect has edged up from 8.4 in 2001 to 9.4 in 2010. The post–9/11 spike in the border effect between the United States and Canada is documented in the literature. Chen et al (2012) suggest that the increase in border security on the U.S. side may have contributed to the widening of the border effects.

For trade with G-20 countries, the border effect has declined slightly from 18.7 in 2001 to 17.5 in 2010. The border effects in trade with EU countries remained very elevated over the entire time frame of the analysis. There is significant variation in provincial border effects (Table 5). For the Canada–U.S. trade, the smallest bias for domestic trade is found in Alberta and Saskatchewan. By and large, this reflects a growing role of crude oil and natural gas in international trade of these provinces. In line with the existing literature, British Columbia's border effect for the trade with the U.S. is among the smallest among all provinces, while Prince Edward Island's home bias is the most elevated. Ontario, Quebec and New Brunswick are also estimated to have smaller than average border effects.

Border effects in trade with EU countries are elevated for all provinces. This indicates that goods produced in Canada and EU countries have more challenges in accessing each other's markets. Quebec has the smallest border effect: a Quebec firm is three times more likely to be engaged in trade with partners in the EU than the Canadian average. Largely as a result of intensive trade links with East Asia, British Columbia also features the lowest border effect in trade with G-20 member nations (3.6). Ontario, Quebec and Manitoba also have below-average border effects with G-20 economies. Interestingly, we find that most of the provinces are better integrated with G-20 economies than with EU member countries. Once again, these findings are likely to reflect the growing role of China and Mexico in the foreign trade of Canadian provinces.

5.2 Decomposition of border effects in Canadian trade with the U.S. as well as EU and G-20 countries

Table 6 reports the estimates for overall trade[13] from a series of augmented gravity models defined by equations (4) through (7). Additional controls for the exchange rate and flow of FDI (Column 2) reduce the size of the border effects to 8.0 for the Canada–U.S. trade, 43.4 for the Canada–EU trade and 18.4 for the Canada–G-20 trade (Column 2). As expected, depreciation of a currency is associated with increased shipments of goods abroad. A negative and statistically significant estimate for the coefficient of FDI implies the presence of a substitution effect between export and FDI.

Next, Column 3 lists estimated coefficients of indicative variables that account for transaction costs: a common official language, contiguity of two trading partners and colonial links. In line with existing estimates from gravity models, the parameter estimates for the added variables have positive signs. In other words, two regions trade more if they share an official language, a physical border or a colonial history. Once we introduce these variables, the border effect in Canada–U.S. bilateral trade declines by an additional 30.0 per cent from 8.0 to 5.6. The border effect between Canada and EU member countries declined by a sizable 57.4 per cent,

[13] Table A.2 in the appendix displays results for trade in manufacturing products. The findings for the manufacturing sector are broadly in line with the results for the overall trade in goods.

from 43.4 to 18.5. An impressive reduction of the border effect (by 61.4 per cent) is also observed for the trade with G-20 countries.

Column 4 contains the results for the gravity specifications with controls for tariff-related barriers (equation 6). Estimated coefficients for average applied tariff rates, Tar, and dummy variables for WTO membership of trade partners are in line with expectations. Higher tariff rates for the products of country i in country j tend to reduce trade flows from country i to country j. WTO membership of the exporter and importer encourages trade; the exporter's membership has a stronger effect. The border effect for Canada–U.S. trade now sits at 5.1. The limited role of tariffs in the border effects is the result of a tariff phase-out between the United States and Canada in the wake of the FTA and NAFTA. That said, trade between the United States and Canada is not tariff-free given that the bilateral Canada–U.S. NAFTA agreement contains significant restrictions and tariff quotas on agricultural products; mainly sugar, dairy and poultry products. Controlling for tariffs reduced the border effects for trade with EU and G-20 countries to 17.0 and 6.1, respectively.

Finally, the results for the gravity models with non-tariff measures (equation 7) are reported in Column 5.[14] The findings suggest that the frequency of sanitary and phytosanitary measures, technical measures and other NTMs in the importer country reduce exports to it. In addition to more sanitary and phytosanitary measures, the coefficient for NTM_{ij} captures the effect of regulations and product standards, domestic subsidies, domestic content requirements for products purchased by various levels of governments. With the controls for the NTMs, the border effects for Canadian provinces with all trading partners further narrowed to 4.8 for U.S. trade, 15.2 for EU trade and 5.5 for trade with the G-20.

We now turn to the results of the border effect decomposition. Figure 3 displays results of the Blinder-Oaxaca nonlinear decomposition of the border effects for

[14] We have also estimated equation (6) and equation (7) using one-period lagged values of potentially endogenous variables Tar_{ijt}, NTM_{ijt}, WTO_{it} , and WTO_{jt} as instruments in the Poisson IV model. Results from the Wald test indicate that the differences in estimated coefficients for trade policy variables in the Poisson IV model and the original equation (6) and equation (7) are not statistically significant at 5 per cent significance level (see Table A.3 in the Appendix).

overall trade in goods.[15] Our results show that 54.6 per cent of the aggregate border effect of 9.0 in Canada–U.S. bilateral trade can be explained by the observable variables that account for transaction costs, tariff and non-tariff measures, the exchange rate and FDIs. That said, 45.5 per cent of the border effects remains unexplained. The analysis indicates that the most important explained factor contributing to the gaps in international and bilateral trade are the transaction costs of foreign trade. This is the case both for the overall and manufacturing trade flows (Figure A.1 in the appendix) between Canada and the United States. Specifically, about one fifth of the border effects in Canada–U.S. trade is attributed to such costs. These costs are greater for Canada–EU and Canada–G-20 bilateral trade.

The results are intuitive and speak to the fact that Canadian exporters face much lower transaction costs of doing business with American partners. Similarly, American exporters seem to find it quite convenient to navigate in Canada's familiar political, cultural and legal environment. By contrast, these challenges are more critical in Canada–EU and Canada–G-20 bilateral trade, where transaction costs account for about a third of the border effects (32.7 and 31.0 per cent, respectively). However, we also find that between 2001 and 2010 the role of transaction costs has been steadily declining both for Canada–EU and Canada–G-20 trade flows (Figure 4). While information-related factors and exchange rates explain 34.4 and 34.8 per cent of the border effects with EU and G-20 countries between 2001–03, respectively, by 2008–10 their role declined to 31.9 and 30.0 per cent.

Once again, such findings emphasize the role of continued trade promotion activities. These activities may include organizing trade delegations and fairs, workshops on doing business abroad, as well as providing industry and country guides for Canadian and foreign businesses. Such activities intensified under the Government of Canada's Global Commerce Strategy (2007), a comprehensive plan

[15] Figure A.1 displays the results of Blinder-Oaxaca nonlinear decomposition of the border effects in manufacturing trade.

aimed at expanding Canada's international trade.[16] The strategy included sector-specific, multi-year plans for 13 priority markets, including the following G-20 countries: China, India and Brazil. In addition, throughout the 2000s, Canada expanded its global network through the Canadian Trade Commissioner Service offices. By the end of 2009, the network included over 900 offices in over 150 cities around the world and 17 regional offices in Canada. Under the mandate of the Trade Commissioner Service, various federal departments, provincial and territorial representatives and commercial agencies, such as Export Development Canada, have been providing businesses with information and support for cross-border trade and investment activities, both in Canada and respective partner countries.

Next, we turn to the discussion of tariff and non-tariff measures. Tariffs account for 12.2 per cent of the border effects in trade with the United States, 15.9 per cent with the EU and 12.3 per cent with the G-20 (Figure 3). For manufacturing products, we find that tariff barriers appear to explain 10.4, 14.4 and 11.1 per cent of the border effects in provincial trade with the U.S. states and EU and G-20 member countries, respectively. We also find solid evidence that the contribution of tariffs to the overall scale of trade barriers has been steadily declining throughout the 2000s (Figure 4), since the Uruguay Round of negotiations of the General Agreement on Tariffs and Trade (GATT) / World Trade Organization (WTO) . As with other tariff commitments, the Uruguay Round obliged each participating country to apply tariff cuts equally to exports from all WTO members, even from members that did not make commitments. As a result, tariff rates on industrial products of participating countries were cut by 40 per cent, from an average of 6.3 per cent to 3.8 per cent between 1994 and 2005.

The contribution of NTMs to the size of the border effect is considerable. For the Canada–U.S. trade, NTMs explain 15.6 per cent of the border effects in overall trade (Figure 3) and 16.7 per cent in trade of manufacturing products (Figure A.1). Similarly, 16.1 per cent of the border effects in the Canada–EU trade and 21.0 per

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[16] Detailed description of the strategy can be found in *Seizing Global Advantage: A Global Commerce Strategy for Securing Canada's Growth & Prosperity*. Ottawa. Public Works and Government Services Canada. Government of Canada. 2009, available at http://www.international.gc.ca/commerce/assets/pdfs/gcs-en.pdf.

cent of the border effects in the Canada–G-20 trade can be attributed to the NTMs. For all trading partners, the contribution of NTMs to the total border effects exceeded that of tariff barriers for overall trade in goods and trade in manufacturing products. In bilateral trade between Canadian provinces and U.S. states, the contribution of NTMs to the border effects grew from 12.8 per cent in 2001–03 to 17.2 per cent in 2008–10. Likewise, the increased importance of NTMs in reducing international trade is documented for Canada–EU (up from 14.6 to 18.4 per cent) and Canada–G-20 trade (up from 16.0 to 23.6 per cent). In fact, in terms of the overall contribution, the changes in contribution of NTMs to the border effects exceeded the reduction in tariff barriers.

Use of NTMs to regulate trade has intensified since the 1990s, both in terms of countries adopting such measures as well as in their variety (Ciuriak, 2003; Devadason and Chenayah, 2011; and Nicita and Gourdon, 2013). The number of NTM notifications received by the WTO rose between 2001 and 2010 (Figure 5). Steady growth in the use of NTMs in the United States is of a particular relevance to Canada because the number of active NTMs applied by the United States toward foreign products increased from 701 in 2001 to 2,701 in 2010. These findings are in line with the recent literature on the subject (Hufbauer and Hart, 2008; Baldwin and Evenett, 2009; Watson and James 2013). The number of NTM notifications by Canada also increased, but their frequency and the rate of change were significantly less than those of other WTO members, the United States in particular.

The story behind the rise in NTMs is multi-dimensional. While some of them point to the existence of protectionist policies by the importing country,[17] others are implemented for legitimate reasons and reflect increased heterogeneity of trading partners, global supply chains and consumer preferences. In this context, the increased frequency of NTMs is not surprising. In fact, the growing prevalence of NTMs may simply be a reflection of the rapid globalization of supply chains since the

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[17] According to Grundke and Moser (2014), some of the NTMs imposed by the United States recently are consistent with the existence of counter-cyclical protectionism. Some of the recent examples of protectionist regulations in the United States include imposing mandatory labelling of the country of origin on beef; inspecting imported catfish; expanding the Lacey Act (2008) to include lumber and other forestry products; banning clove cigarettes; and restricting the shrimp-tuna trade.

early 2000s and the desire for consumer protection and integrity throughout the supply chain.

Indeed, in recent decades, it has become more common to produce goods in a number of geographically dispersed stages. This evolution of supply chains has been described by economists as a production fragmentation. The implication of this change in the organization of production is that it takes many more export and import transactions with firms from many more jurisdictions with varying degrees of technical and sanitary and phytosanitary standards. In addition, consumers are also becoming increasingly demanding about the attributes of products they purchase. Other examples of frequently cited rationale for NTMs include expectations related to the protection of the environment. In response to these changes, additional trade measures may be often necessary to ensure food safety as well as animal, plant and health protection. Such NTMs are frequently imposed for reasons that are perfectly valid in terms of WTO agreements. Accordingly, the fact that the use of NTMs in the United States has increased more swiftly may be because the United States has many more diversified trade connections than Canada does. It could be expected, then, that the recent increase in the border effect will be temporary and will diminish over time as producing countries steadily adopt those practices and standards that are in line with the technical standards and consumer preferences in importing countries.

NTMs are also expected to decline as a result of ongoing multilateral negotiations. Non-agricultural market access (NAMA) negotiations under the Doha Development Round, supported by a number of countries, including Canada, could deliver meaningful improvements in some areas, including promoting transparency in export licensing; labelling textiles, apparel, footwear and travel goods across the member countries; unifying technical barriers to trade for automotive products; and agreeing on safety and electromagnetic compatibility for electrical and electronic products.

Our results also indicate that welfare changing trade barriers—tariff and non-tariff measures together—account only for 27.8 per cent of the border effects in bilateral trade between Canada and the United States, 32.2 per cent of the border effects between Canada and the EU member nations and 33.3 per cent of the border effects between Canada and G-20 countries. These results confirm the suggestions by Helliwell (2003) and Helliwell and Schembri (2005) that border effects do not represent solely costly trade barriers. Despite a recent rise in NTMs, by and large, border effects embody differences in transaction costs and unobservable characteristics that are likely to reflect consumer preferences for home products and efficiency in organization of production.

6 Conclusion

Based on the analysis of bilateral trade flows between Canadian provinces and U.S. states during the period from 2000 to 2010, we find that border effects in foreign trade decreased in comparison to the previously reported estimates in existing literature. An estimated border effect of 9.0 is lower than estimates from existing literature that use data for the 1980s and 1990s, which demonstrated a decline in the home trade bias for Canadian provinces. This result most likely reflects the consequences of full NAFTA implementation.

Overall, the findings are reassuring, given the fact that our study integrated trade flows from all the U.S. states rather than only the 30 largest or adjacent U.S. states that were used in the existing literature. Having said that, we also report that the border effects for trade by Canadian provinces with the United States has gradually edged up from 8.4 in 2000 to 9.4 in 2010. In line with existing studies, we find significant variation in provincial border effects. The border with the United States is quite thin for Alberta, Saskatchewan and British Columbia. It is much thicker, however, for Prince Edward Island and Nova Scotia.

The border effects in Canada–EU bilateral trade remain elevated. The Blinder-Oaxaca nonlinear decomposition of the border effects shows that the variables that stand for the cost of obtaining information about foreign markets and other transaction costs account for about one third of the border effects with EU member nations. Possible effective ways to overcome these information gaps are trade delegations, fairs and workshops. These activities tend to contribute to the dissemination of information on markets, local customers and supply chains, export and import procedures, regulation, taxes and country risk factors in foreign markets. Similar to the trade between Canadian provinces and EU nations, bilateral trade with G-20 countries seems to face significant transaction costs. That said, between 2001 and 2010, the border effects in Canada–G-20 trade have been gradually decreasing. In fact, once we account for transaction costs, tariff and non-tariff measures, the thickness of the border is approaching the one between Canada and the United States.

The study also reports a decline in the prevalence of tariffs and an increase in WTO notifications on the introduction of NTMs, pointing to a growing trend around the world to regulate trade through technical barriers for product standards and sanitary and phytosanitary restrictions. That said, more research is needed to explore whether the rise NTMs is a sign of increased protectionism or simply reflects increased production fragmentation, complexity of supply chains and changing consumer preferences. Yet, even the latter case, the current study shows that, while many NTMs may, in fact, be desirable for the aforementioned reasons, their implementation is not free and has imposed a measurable cost among trading partners.

While we document an increase in the prevalence of NTMs and decrease in the use of tariff measures, their combined impact on the border effects is estimated to be significantly smaller than the effect of the transaction costs and unobservable characteristics that capture consumer tastes for local products, tighter domestic supply chains and other aspects of organization of production. Taken together, the study provides further evidence that border effects do not solely represent costly trade-distorting barriers.

There are some avenues for future research on the topic. In a series of papers, Anderson and Yotov (2010 a, b; 2012) argue that estimating gravity models at the industry level is likely to reduce aggregation bias because sector-level trade would provide reflection of heterogeneity in trade costs and border effects across industries and, therefore, improve policy implications of the exercise. While we shed some light on the trends for the manufacturing sector, future research efforts on the topic may incorporate more comprehensive analysis of product- or sector-level trade flows enabling a better consideration of the supply chain and other intra-industry links.

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Tables and Figures

Table 1: Estimated Canada–U.S. border effects in the existing literature

Study	CAN–U.S. border effect	Data	Zero trade issue	Multilateral trade resistance	Number of U.S. states in the model
McCallum (1995)	20.9	Cross-sectional, 1988	Not addressed	Not accounted	30 largest or adjacent to Canada
Helliwell (1998)	11.9	Panel, 1990–96	Not addressed	Accounted	30 largest or adjacent to Canada
Wall (2000)	15.1	Panel, 1994–96	Not addressed	Not accounted	30 largest or adjacent to Canada
Anderson (2001)	15.2	Cross-sectional, 1988	Not addressed	Accounted	30 largest or adjacent to Canada
Anderson and van Wincoop (2001)	10.7	Cross-sectional, 1993	Not addressed	Accounted	30 largest or adjacent to Canada
Hillberry (2002)	11.5	Cross-sectional, 1994	Addressed	Accounted	30 largest or adjacent to Canada
Coulombe (2005)	From 18 (1988) to 11 (1996)	Panel, 1988–96	Addressed	Accounted	30 largest or adjacent to Canada
Dias (2011)	11.1	Panel, 1988–93	Addressed	Accounted	30 largest or adjacent to Canada
Chen, Rus and Sen (2012)	From 9.3 (1994) to 19.1 (2005)	Longitudinal cross-section, 1992–2005	Not addressed	Not accounted	30 largest or adjacent to Canada
Query, 2014	31.2	Cross-sectional, 1993	Addressed	Accounted	50

Table 2: Estimated Canada–U.S. border effects across the provinces in the existing literature

	Andersen and Smith, 1999 (Data 1988)	Wall, 2000 (Data 1994–96)	Query, 2014 (Data 1993)
AB	10.1	10.4	18.9
BC	6.0	9.0	11.5
MB	8.2	11.1	14.8
NB	5.7	13.8	22.0

NL	8.5	22.4	46.5
NS	9.2	25.3	46.7
ON	14.6	9.5	15.0
PE	51.6	15.2	114.0
QC	10.1	14.7	16.0
SK	9.4	12.6	17.0

Table 3: Summary statistics

Variable	Mean	Median	Standard deviation	Skewness	Kurtosis
Exports (in millions of CAD)	439.322	31.196	1924.87	14.429	330.17
Exporter GDP (in millions of CAD)	308122.1	142565. 0	586838.9	5.022	36.565
Importer GDP (in millions of CAD)	308122.1	142565.0	586838.9	5.022	36.565
Distance (in kilometers)	4755.350	3920.46	3344.147	0.956	3.754
Exchange rate (exporter's currency for a unit of importer's currency)	41.708	1.0	501.578	15.259	246.031
FDI (in millions of CAD)	129.925	188.481	122.973	0.042	1.210
Common language (dummy)	0.684	1.0	0.465	-0.791	1.626
Contiguity (dummy)	0.029	0.0	0.168	5.612	32.494
Colonial history (dummy)	0.031	0.0	0.174	5.404	30.199
Tariff rate (percentage points)	1.943	1.620	1.813	7.108	75.179
Non-tariff measures (frequency)	0.098	0.075	0.084	1.459	4.448
Exporter's WTO membership	0.993	1.0	0.085	-11.613	135.864
Importer's WTO membership	0.993	1.0	0.085	-11.613	135.864
Exporter's remoteness	4777.544	4608.387	1939.359	1.793	8.986
Importer's remoteness	4736.889	4427.236	1910.574	1.737	9.111

Table 4: Aggregate border effects for Canadian provinces for 2001–10

	(1) McCallum (1995) specification	*(2) PPML*
Log GDP-exporter	1.482***	0.584***
	(0.077)	(0.002)
Log GDP-importer	2.315***	0.583***
	(0.094)	(0.003)
Log of distance	-0.510***	-0.136***
	(0.146)	(0.005)
Border base (United States)	-2.606***	-2.193***
	(0.315)	(0.173)
Border effect CAN–United States	**13.5**	**9.0**
CAN–EU border		-1.629***
		(0.090)
Border effect CAN–EU		**45.7**
CAN–G-20 border		-0.754***
		(0.115)
Border effect CAN–G-20		**19.0**
Remoteness (MTR)		-0.607***
		(0.072)
Observations	6,849	19,300
Number of Pair ID		1,930

Robust standard errors are in parentheses with *** p<0.01, ** p<0.05, * p<0.1.
Each regression includes a common intercept (not shown).

Table 5: Estimates of the aggregate border effects for Canadian provinces for 2001–10

Province	U.S.	EU	G-20
AB	3.0	140.0	26.0
BC	4.3	37.7	3.6
MB	10.6	30.1	10.7
NB	3.8	107.4	51.9
NL	23.8	95.0	75.5
NS	27.0	17.7	18.4

ON	3.5	29.7	10.8
PE	47.5	130.9	180.3
QC	7.7	15.1	10.9
SK	3.0	84.9	17.2
Canada	**9.0**	**45.7**	**19.0**

Table 6: Border effects in Canadian trade with the U.S., EU and G-20 countries

VARIABLES	(1) aggregate border effects	(2) border effects with the controls for exchange rate and FDI	(3) border effects with the controls for exchange rate, FDI and transaction costs	(4) border effects with the controls for exchange rate, FDI and transaction costs and tariffs	(5) border effects with the controls for exchange rate, FDI and transaction costs, tariffs and non-tariff measures
Log GDP-exporter	0.584***	0.603***	0.603***	0.597***	0.651***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Log GDP-importer	0.583***	0.576***	0.577***	0.540***	0.500***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Log of distance	-0.136***	-0.135***	-0.135***	-0.133***	-0.134***
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Border effect (CAN–USA)	-2.193***	-2.079***	-1.714***	-1.628***	-1.577***
	(0.173)	(0.174)	(0.167)	(0.169)	(0.169)
Border effect CAN–USA	**9.0**	**8.0**	**5.6**	**5.1**	**4.8**
CAN-EU border	-1.629***	-1.692***	-1.205***	-1.207***	-1.146***
	(0.090)	(0.090)	(0.137)	(0.139)	(0.140)
Border effect CAN–EU	**45.7**	**43.4**	**18.5**	**17.0**	**15.2**
CAN–G-20 border	-0.754***	-0.835***	-0.249*	-0.183	-0.120
	(0.115)	(0.116)	(0.145)	(0.147)	(0.149)
Border effect CAN--G-20	**19.0**	**18.4**	**7.1**	**6.1**	**5.5**
Exchange rate		0.015***	0.015***	0.020***	0.004**
		(0.002)	(0.002)	(0.002)	(0.002)
FDI		-0.009***	-0.009***	-0.010***	-0.011***
		(0.001)	(0.001)	(0.001)	(0.001)
Common language			0.418***	0.429***	0.494***
			(0.118)	(0.119)	(0.120)
Contiguity			2.120***	2.114***	2.093***
			(0.206)	(0.208)	(0.208)
Colonial history			0.555**	0.574**	0.499**
			0.015***	(0.229)	(0.230)
Tariff rate				-0.021***	-0.024***
				(0.001)	(0.001)
WTO membership exporter				0.172***	0.150***
				(0.019)	(0.019)
WTO membership importer				0.047	0.040
				(0.029)	(0.029)
Non-tariff measure frequency					-0.439***
					(0.009)
Remoteness (MTR)	-0.607***	-0.596***	-0.627***	-0.593***	0.004**
	(0.072)	(0.072)	(0.072)	(0.073)	(0.002)
Observations	19,300	19,300	19,300	19,300	19,300

Robust standard errors are in parentheses with *** p<0.01, ** p<0.05, * p<0.1.
Each regression includes a common intercept (not shown).

Figure 1: Canadian trade in goods (index: 2000=100)

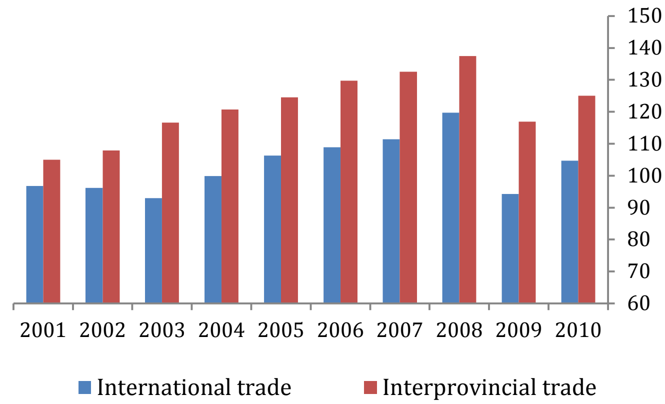
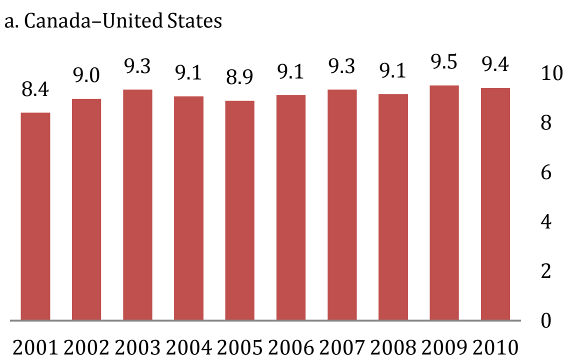
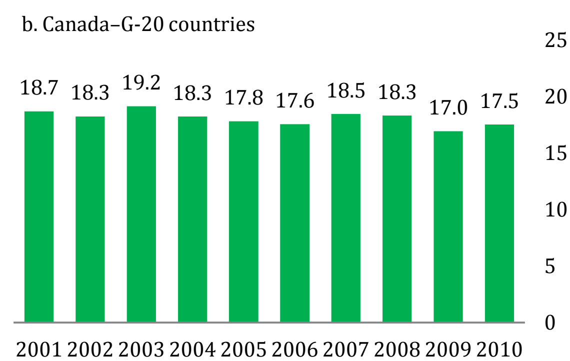


Figure 2: Evolution of border effects in Canadian trade with the U.S., EU and G-20 economies





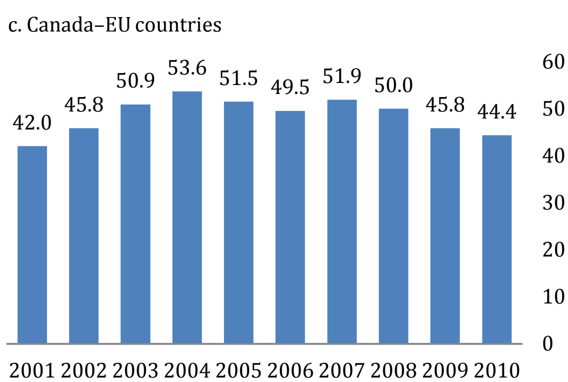


Figure 3: Results of Blinder-Oaxaca nonlinear decomposition of border effects in provincial trade with the U.S., EU and G-20 economies in 2001–10.

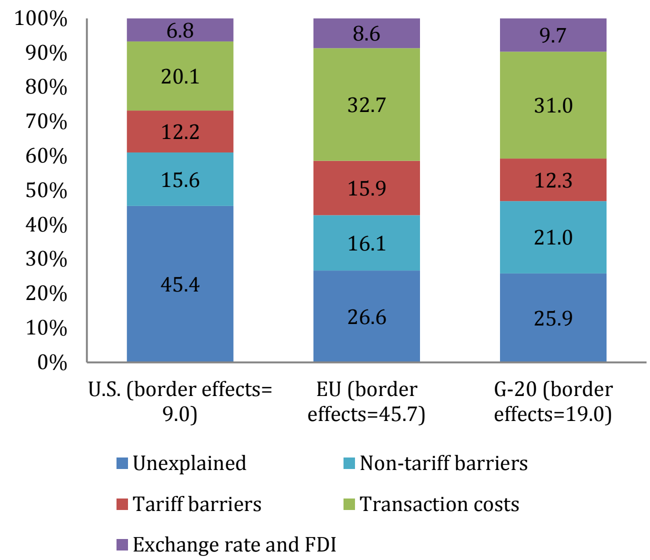


Figure 4: Blinder-Oaxaca nonlinear decomposition of border effects in provincial trade with the U.S., EU and G-20 economies by time periods

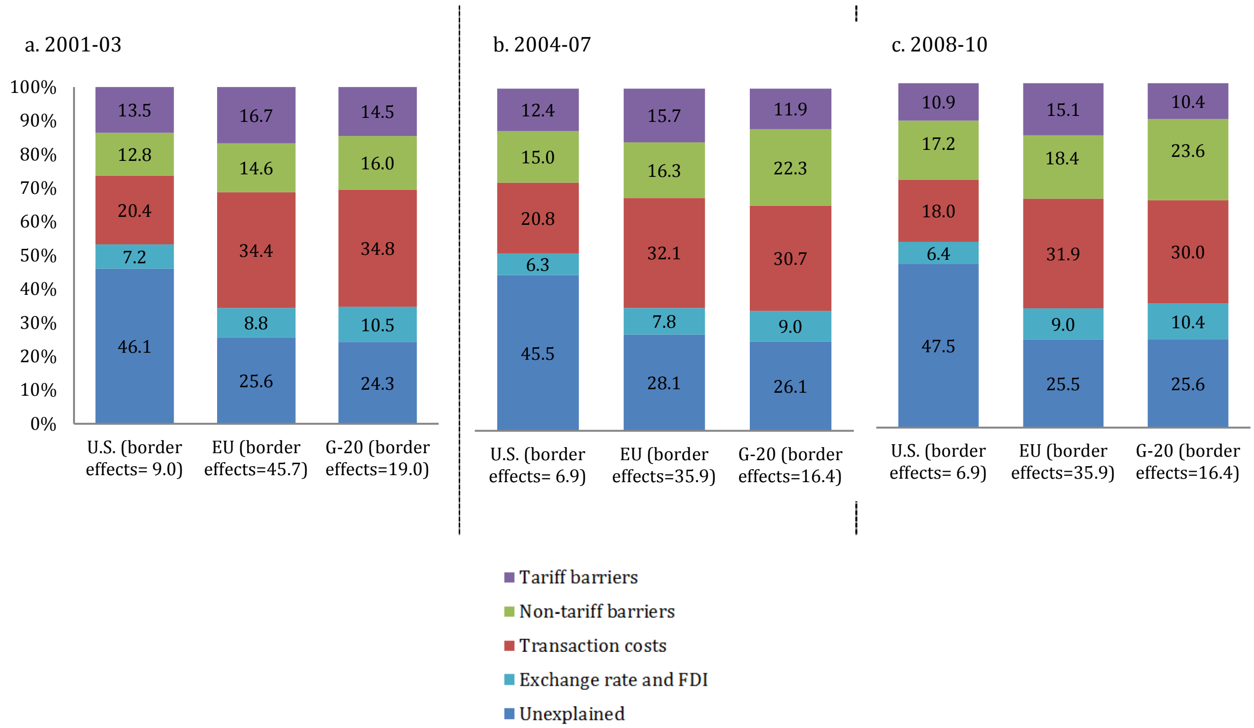
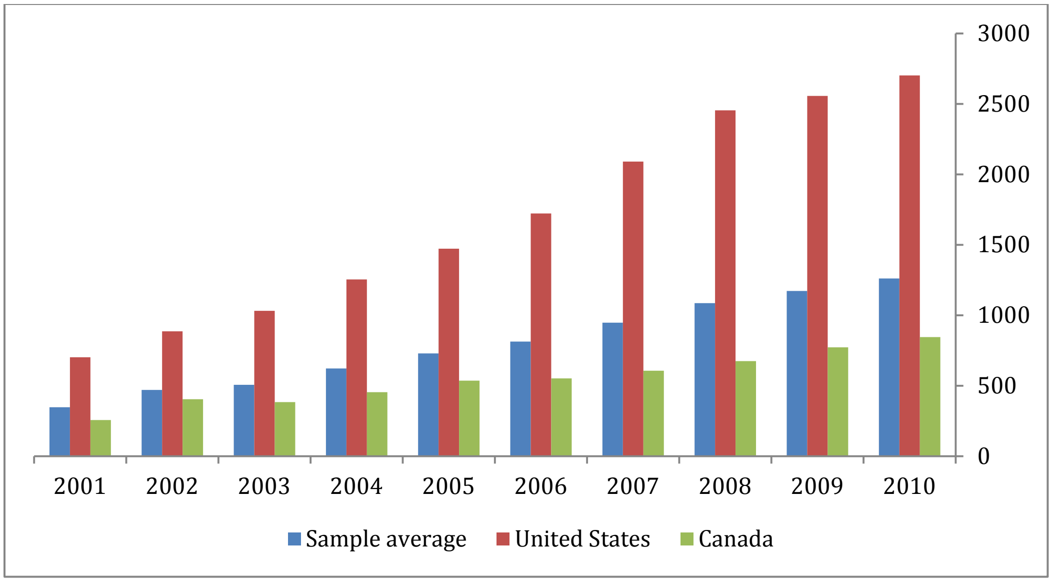


Figure 5: Number of active NTM notifications received by WTO (based on notifications of initiated and withdrawn non-tariff measures applied to all WTO member countries since 1995)



Source: WTO I-TIP Goods dataset

Appendix

Table A.1: List of countries, Canadian provinces and U.S. states with most populous cities

EU Member countries	
Country	**Centre**
Austria	Vienna
Belgium	Brussels
Bulgaria	Sofia
Cyprus	Nicosia
Czech Republic	Prague
Germany	Berlin
Denmark	Copenhagen
Estonia	Tallinn
Spain	Madrid
Finland	Helsinki
France	Paris
United Kingdom	London
Greece	Athens
Croatia	Zagreb
Hungary	Budapest
Ireland	Dublin
Italy	Rome
Lithuania	Vilnius
Luxemburg	Luxemburg
Latvia	Riga
Malta	Valetta
Netherlands	Amsterdam
Poland	Warsaw
Portugal	Lisbon
Romania	Bucharest
Sweden	Stockholm
Slovenia	Ljubljana
Slovakia	Bratislava

G-20 major economies	
Country	**Centre**
Argentina	Buenos Aires
Australia	Sydney
Brazil	Sao Paolo
China	Shanghai
Indonesia	Jakarta
India	Mumbai
Japan	Tokyo
Korea Republic	Seoul
Mexico	Mexico City
Russian Federation	Moscow
Saudi Arabia	Riyadh
South Africa	Johannesburg
Turkey	Istanbul

Canadian Provinces	**Centre**
Alberta	Calgary
British Columbia	Vancouver
Manitoba	Winnipeg
New Brunswick	Saint John
Newfoundland and Labrador	St. John’s
Nova Scotia	Halifax
Ontario	Toronto
Prince Edward Island	Charlottetown
Quebec	Montréal
Saskatchewan	Regina

U.S. State	**Centre**		**U.S. State**	**Centre**
Alaska	Anchorage		Montana	Billings
Alabama	Birmingham		North Carolina	Charlotte
Arkansas	Little Rock		North Dakota	Fargo
Arizona	Phoenix		Nebraska	Omaha
California	Los Angeles		New Hampshire	Manchester

Colorado	Denver		New Jersey	Newark
Connecticut	Bridgeport		New Mexico	Albuquerque
Washington DC	Washington DC		Nevada	Las Vegas
Delaware	Wilmington		New York	New York City
Florida	Miami		Ohio	Columbus
Georgia	Atlanta		Oklahoma	Oklahoma City
Hawaii	Honolulu		Oregon	Portland
Iowa	Des Moines		Pennsylvania	Philadelphia
Idaho	Boise		Rhode Island	Providence
Illinois	Chicago		South Carolina	Columbia
Indiana	Indianapolis		South Dakota	Sioux Falls
Kansas	Wichita		Tennessee	Memphis
Kentucky	Louisville		Texas	Houston
Louisiana	New Orleans		Utah	Salt Lake City
Massachusetts	Boston		Virginia	Virginia Beach
Maryland	Baltimore		Vermont	Burlington
Maine	Portland		Washington	Seattle
Michigan	Detroit		Wisconsin	Milwaukee
Minnesota	Minneapolis		West Virginia	Charleston
Missouri	Kansas City		Wyoming	Cheyenne
Mississippi	Jackson			

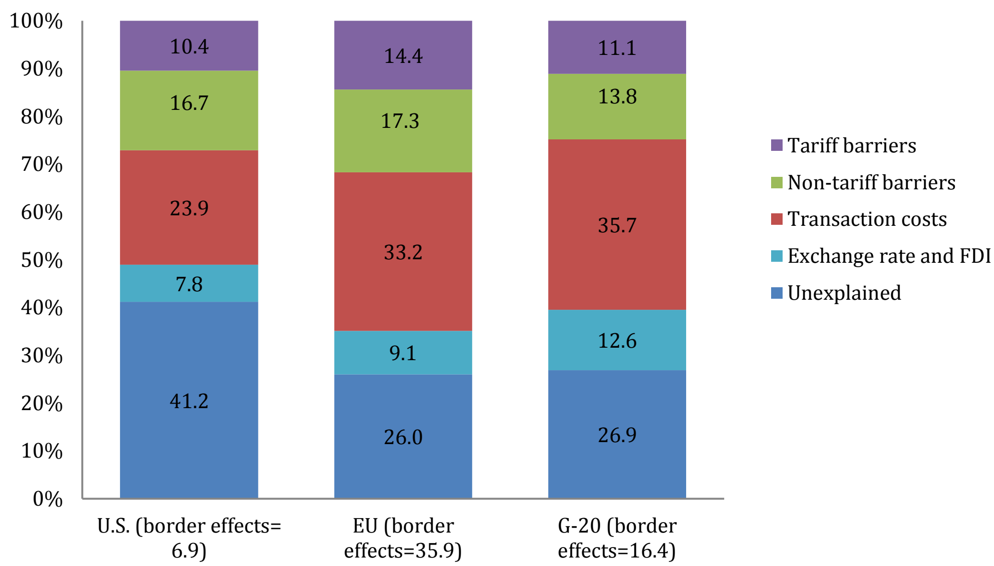
Table A.2: Border effects in Canadian trade in the manufacturing sector with the U.S. EU and G-20 countries

VARIABLES	(1) aggregate border effects	(2) border effects with the controls for exchange rate and FDI	(3) border effects with the controls for exchange rate, FDI and transaction costs	(4) border effects with the controls for exchange rate, FDI, transaction costs and tariffs	(5) border effects with the controls for exchange rate, FDI, transaction costs, tariffs and non-tariff measures
Log GDP-exporter	0.445***	0.455***	0.455***	0.452***	0.570***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Log GDP-importer	0.606***	0.561***	0.561***	0.535***	0.437***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Log of distance	-0.127***	-0.123***	-0.122***	-0.121***	-0.122***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Border effect (CAN-USA)	-1.929***	-1.908***	-1.708***	-1.645***	-1.507***
	(0.180)	(0.181)	(0.175)	(0.176)	(0.174)
Border effect CAN-USA	**6.9**	**6.7**	**5.5**	**5.2**	**4.5**
CAN-EU border	-1.651***	-1.604***	-1.151***	-1.150***	-1.089***
	(0.091)	(0.092)	(0.142)	(0.143)	(0.142)
Border effect CAN-EU	**35.9**	**33.5**	**17.4**	**16.4**	**13.4**
CAN-G-20 border	-0.869***	-0.835***	-0.300**	-0.267*	-0.196
	(0.118)	(0.116)	(0.143)	(0.144)	(0.146)
Border effect CAN-G20	**16.4**	**15.5**	**7.4**	**6.8**	**5.5**
Exchange rate		0.812***	0.074***	0.078***	0.034***
		(0.118)	(0.002)	(0.002)	(0.002)
FDI		0.006***	0.006***	0.006***	0.003***
		(0.001)	(0.001)	(0.001)	(0.001)
Common language			0.353***	0.360***	0.450***
			(0.123)	(0.124)	(0.123)
Contiguity			2.127***	2.133***	2.091***
			(0.215)	(0.217)	(0.214)
Colonial history			0.554**	0.565**	0.514**
			(0.239)	(0.241)	(0.237)
Tariff rate				-0.017***	-0.026***
				(0.001)	(0.001)
WTO membership exporter				-0.341***	-0.375***
				(0.067)	(0.067)
WTO membership importer				-0.061*	-0.087***
				(0.033)	(0.033)
Non-tariff measure frequency					-1.177***
					(0.010)
Remoteness (MTR)	-0.607***	-0.237***	-0.298***	-0.288***	-0.684***
	(0.072)	(0.083)	(0.083)	(0.083)	(0.080)
Observations	19,300	19,300	19,300	19,300	19,300

Table A.3: Comparison of estimated coefficients from the Poisson pseudo-maximum likelihood model and Poisson IV model

VARIABLES	Model with the controls for exchange rate, FDI, transaction costs and tariffs			Model with the controls for exchange rate, FDI, transaction costs, tariffs and non-tariff measures		
	Poisson pseudo-maximum likelihood model	*Poisson IV model*	Wald test p-value (the null hypothesis of equality)	*Poisson pseudo-maximum likelihood model*	*Poisson IV model*	Wald test p-value (the null hypothesis of equality)
Tariff rate	-0.021	-0.021	0.7613	-0.024	-0.024	0.8182
WTO membership—exporter	0.172	0.148	0.2548	0.150	0.137	0.5411
WTO membership—importer	0.047	0.042	0.7795	0.040	0.033	0.7078
Non-tariff measure				-0.439	-0.428	0.689

Figure A.1: Results of Blinder-Oaxaca nonlinear decomposition of border effects in manufacturing trade of Canadian provinces with the U.S., EU and G-20 economies in 2001–10



A.1 Description of data sources and regression variables

Sample period: 2001–10 annual
Sample size: 19,300 observations (1,930 per year)
Common notation: i is an exporting province (country or U.S. state),
j is an importing province (country or U.S. state)
t identifies a year

Variable name	Symbol	Description	Sources
Exports	X_{ijt}	Nominal exports from i to j in year t in millions of Canadian dollars	Canadian interprovincial trade flows are drawn from the matrix of interprovincial trade produced by the Input-Output Division of Statistics Canada. The data are available from CANSIM Tables 386-0002 and 386-0003. The Canadian International Merchandise Trade database is available through its Trade Data Online at Industry Canada's website http://www.ic.gc.ca/eic/site/tdo-dcd.nsf/eng/home. The data are sourced from Statistics Canada's records of all goods entering and leaving Canada collected through customs documents. The data track the province of origin, province of destination, country of origin and country of destination based on customs declarations.
GDP	Y_{it}	Gross domestic product in i in year t, current prices in millions of Canadian dollars	Provincial GDP estimates are drawn from Statistics Canada's CANSIM, Table 384-0038. U.S. state GDPs are provided by the Bureau of Economic Analysis at the U.S. Department of Commerce available at http://www.bea.gov converted into Canadian dollars using annual average exchange rate. Country GDP estimates come from the World Bank http://data.worldbank.org converted into Canadian dollars using annual average exchange rate.
Distance	$dist_{ij}$	Distance between the most populous cities in i and j	Distance is measured using the great-circle distance formula between two geographic locations that is the shortest distance over the earth's surface.
Dummy variable for international trade	$border_{ij}$	Dummy variable for international trade flow: It takes a value of 1 if the i and j are located in different countries and 0 otherwise	

Exporter's remoteness term	Π_{it}	Exporter remoteness term calculated as $\Pi_i = \sum_j \frac{dist_{ij}}{Y_{it}/Y_{Wt}}$ where Y_{it} is exporter's GDP in year t in millions of Canadian dollars. Y_{Wt} is a global GDP in year t in millions of Canadian dollars.	Statistics Canada's CANSIM, Table 384-0038 World Bank http://data.worldbank.org
Importer's remoteness term	P_{jt}	Importer remoteness term calculated as $\Pi_i = \sum_j \frac{dist_{ij}}{Y_{it}/Y_{Wt}}$ where Y_{it} is importer's GDP in year t in millions of Canadian dollars. Y_{Wt} is a global GDP in year t in millions of Canadian dollars.	Statistics Canada's CANSIM, Table 384-0038 World Bank http://data.worldbank.org
Exchange rate	ER_{ijt}	Annual average exchange rate between Canadian dollar and a currency of trading partner if trading partner is abroad.	Bank of Canada
Foreign direct investment	FDI_{ijt}	Nominal foreign direct investment between originating from i into j in year t in millions of Canadian dollars at a country level.	UNCTAD's Bilateral FDI Statistics http://unctad.org/en/Pages/DIAE/FDI%20Statistics/FDI-Statistics-Bilateral.aspx
Common language	$Lang_{ij}$	Dummy variable for common language. It takes a value of 1 if i and j shares at least one official language.	CEPII's gravity dataset (http://www.cepii.fr/CEPII/en/welcome.asp)
Contiguity	$Cont_{ij}$	Dummy variable for common language. It takes a value of 1 if i and j share a geographic border.	CEPII's gravity dataset (http://www.cepii.fr/CEPII/en/welcome.asp)
Colonial history	Col_{ij+}	Dummy variable for colonial history. It takes a value of 1 if i and j were in colony relationship or	CEPII's gravity dataset (http://www.cepii.fr/CEPII/en/welcome.asp)

		were colonies of a single colonial power.	
Tariff rate	Tar_{ij}	The weighted mean for applied tariff rates across all products exported from i to j.	World Bank's data on average applied tariffs. The data reflect existing trade agreements between trading partners.
Exporter's WTO membership	WTO_i	Dummy variable for exporter's WTO membership	CEPII's gravity dataset (http://www.cepii.fr/CEPII/en/welcome.asp)
Importer's WTO membership	WTO_j	Dummy variable for importer's WTO membership	CEPII's gravity dataset (http://www.cepii.fr/CEPII/en/welcome.asp /)
Non-tariff measures	NTB_{ij}	A frequency index defined as the percentage of products in the export nomenclature of i that are subject to NTMs in j in year t.	Data are extracted from WTO's I-TIP Goods dataset. The dataset tracks WTO member's notifications of issued, enforced and withdrawn sanitary and phytosanitary barriers, technical barriers and other NTMs. There are various approaches to quantify the incidence of the NTMs. In this paper, we use the simple inventory approach by calculating a frequency index defined as the percentage of products in the trade nomenclature that are subject to NTMs in bilateral trade in a given year.