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GLOBALIZATION AND REGIONAL TRADE DYNAMICS. AN EMPIRICAL STUDY OF THE CANADIAN PROVINCES

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STRESZCZENIE

GLOBALIZACJA I REGIONALNA DYNAMIKA HANDLU: STUDIUM EMPIRYCZNE PROWINCJI KANADYJSKICH

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Niniejsza rozprawa bada handel z subnarodowej perspektywy prowincji Kanady. Analizy w ramach dysertacji wypełniają lukę badawczą w istniejącej literaturze dotyczącej badań handlu zagranicznego. Wskazał na nią przegląd literatury. Luka ta dotyczy czynników determinujących handel regionów, szczególnie w kontekście globalizacji. Badanie dostarcza teoretycznego uzasadnienia i wykorzystuje model grawitacyjny do zbadania wpływu mechanizmów globalizacji na wyniki handlowe regionów. Analiza koncentruje się na dziesięciu kanadyjskich prowincjach i ich handlu z 212 globalnymi partnerami w latach 1999–2022. Estymacje ekonometryczne przeprowadzono przy użyciu modelu grawitacji z wykorzystaniem estymatorów Poissona Pseudo-Maximum Likelihood (PPML) z alternatywnymi szacunkami, Gamma Pseudo-Maximum Likelihood (GPML) oraz Hausmana-Taylora (HT). Z niniejszej rozprawy można wyciągnąć szereg wniosków i zaleceń dotyczących polityki gospodarczej. Uzyskane wyniki wnoszą wkład do literatury wykazując, że globalizacja wpływa na wyniki handlu prowincji Kanady, a także ujawniając, że efekt ten jest w dużym stopniu zależny od stopnia dysproporcji dochodów między partnerami. Podsumowując, uzyskane wyniki wskazują, że globalizacja sprzyja integracji handlu, ale z asymetrycznymi efektami. RTA, wolność gospodarcza i status metropolitalny pozytywnie wpływają na eksport oraz całkowity handel, podczas gdy cła i zmienność kursów walutowych nadal utrudniają handel, szczególnie tam, gdzie między partnerami handlowymi istnieją luki dochodowe i różnice instytucjonalne. Analiza efektu granicy Kanada-USA potwierdza, że chociaż jego negatywny wpływ na handel zmniejszył się, to prowincje Kanady nadal wykazują silne preferencje dla handlu krajowego. Czynniki specyficzne dla prowincji, takie jak PKB, zasoby pracy oraz zdolność do innowacji mają znaczący wpływ na handel wewnątrzgałęziowy (IIT). Wyższy PKB per capita i silniejsze instytucje są związane ze zwiększoną specjalizacją, zmniejszając wzajemny IIT. Przedsiębiorstwa wielonarodowe odgrywają kluczową rolę, wzmacniając IIT poprzez inwestycje kapitałowe, zatrudnienie i produkcję o wysokiej wartości dodanej. Uzyskane wyniki podkreślają potrzebę skoordynowanych strategii handlowych, które dostosowują zewnętrzną liberalizację do wewnętrznych reform w celu zwiększenia konkurencyjności i odporności kanadyjskich prowincji.

***Słowa kluczowe**: globalizacja, handel prowincji Kanady, model grawitacji, handel wewnątrzgałęziowy (IIT), efekt granicy*

ABSTRACT

GLOBALIZATION AND REGIONAL TRADE DYNAMICS: AN EMPIRICAL STUDY OF THE CANADIAN PROVINCES

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This dissertation examines the regional trade dynamics, offering a subnational perspective that addresses a gap in existing trade literature. The literature review reveals a research gap concerning the determinants of regional trade, particularly in the context of globalization. The study provides a theoretical rationale and employs a gravity model to examine the influence of globalization mechanisms on trade performance. The analysis focuses on ten Canadian provinces and their trade with 212 global partners from 1999 to 2022. Estimation is conducted using Poisson Pseudo-Maximum Likelihood (PPML), with alternative estimates from Gamma Pseudo-Maximum Likelihood (GPML) and Hausman-Taylor (HT) models. Several conclusions and policy recommendations can be drawn from this dissertation. The dissertation contributes to the literature by demonstrating that globalization affects provincial trade performance and by further revealing that the effect is highly contingent upon the degree of income disparities between partners. On balance, the findings suggest that globalization promotes trade integration, albeit with asymmetric effects. RTAs, economic freedom, and metropolitan status significantly boost exports and total trade, while tariffs and ERV continue to hinder trade, especially where income and institutional gaps exist between trade partners. The Canada-U.S. border analysis confirms that while border effects have declined, trade frictions persist, with provinces still showing a strong preference for domestic trade. On the domestic front, province-specific factors such as GDP, labor composition, and innovation capacity are shown to influence intra-industry trade (IIT) significantly. However, higher GDP per capita and stronger institutions are associated with increased specialization, reducing reciprocal IIT. MNEs play a critical role by enhancing IIT through capital investment, employment, and value-added production. Furthermore, the findings underscore the importance of developing coordinated trade strategies that integrate external liberalization with internal reforms to boost provincial competitiveness and resilience.

Keywords: *Globalization, Provincial trade performance, Gravity model, IIT, Border Effect*

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LIST OF ABBREVIATIONS AND ACRONYMS

BEA	Bureau of Economic Analysis
CBRs	Cross-border regions
CEECs	Central and Eastern European Countries
CES	Constant elasticity of substitution
CETA	Comprehensive Economic and Trade Agreement
CUSFTA	Canada-United States Free Trade Agreement
ECB	European Central Bank
Ec Fredom	Economic Freedom
EEG	Evolutionary Economic Geography
EGO	European History Online
ERV	Exchange rate volatility
EU	European Union
FDI	Foreign direct investment
FTA	Free Trade Agreement
GATT	General Agreement on Tariffs and Trade
GCF	Gross Capital Formation
GDP	Gross Domestic Product
GDPpc	GDP per capita
GL	Grubel-Llyod
GLS	General Least Squares
GPML	Gamma Pseudo Maximum Likelihood
GVCs	Global Value Chains
HHI	Herfindahl-Hirschman Index
HIIT	Horizontal Intra-Industry Trade
H-O	Heckscher–Ohlin
HS	Harmonized System
HT	Hausman-Taylor
ITA	Internal Trade Agreements
ITC	International Trade Centre
LQ	Location quotients
MC	Marginal cost
MNCs	Multinational corporations
MNEs	Multinational National Enterprises
MOFAs	Majority-owned, with foreign affiliates
MRTs	Multilateral resistance terms
NAFTA	North American Free Trade Agreement
NEG	New Economic Geography
NNTT	New New Trade Theory
NTBs	Non-Tariff Barriers
NTMs	Non-Tariff Measures
NTT	New Trade Theory
OECD	Organization for Economic Co-operation and Development
PPMLHDFE	Poisson Pseudo Maximum Likelihood estimator with high-dimensional fixed effects

RCA	Revealed Comparative Advantage
REM	Remoteness
RoW	Rest of the World
RTAs	Regional Trade Agreements
SEZs	Special Economic Zones
SITC	Standard International Trade Classification
SME	Small and Medium Enterprise
SOEs	Small open economies
SUPC	Supply and Use Product Classification
UNCTAD	United Nations Conference on Trade and Development
USCB	United States Census Bureau
USMCA	United States-Mexico and Canada Agreement
VAT	Value-added taxes
VIIT	Vertical Intra-Industry Trade
WGI	Worldwide Governance Indicators
WTO	World Trade Organization

INTRODUCTION

Background

Over the past three decades, globalization[1] has reconfigured national economies, the spatial organization of production within them, and the way they trade internationally and participate in global value chains (Chiquiar, 2008). In economies such as Canada, where jurisdictional and structural differences across regions are pronounced, global integration has manifested unevenly, producing distinct patterns of specialization, competitiveness, and vulnerability. Understanding these intra-national dynamics is essential to grasp how international forces permeate local economies and, conversely, how regional characteristics mediate global linkages.

Canada constitutes a distinctly revealing case. It is one of the world's most open economies, yet its provinces exhibit heterogeneous trade orientations arising from varied resource endowments, industrial bases, demographic structures, and policy regimes. Some provinces are deeply embedded in manufacturing and high-value supply chains, while others rely more heavily on commodities and primary exports. These divergences indicate that the effects of trade liberalization, foreign direct investment, and shifting global demand are distributed unevenly across the country, with implications for regional growth, employment, and competitiveness.

Moreover, the current phase of globalization differs qualitatively from earlier waves. Digitalization, fragmentation of production networks, the rise of new trade powers, and the growing salience of environmental and social standards are altering the terms and geography of exchange. At the same time, resurgent protectionism, supply-chain realignments, and evolving trade agreements are reshaping the incentives and constraints faced by subnational economies. For Canadian provinces, these changes create both new opportunities for integration and heightened exposure to external shocks.

Against this backdrop, this study examines how globalization interacts with regional trade dynamics in Canada. It aims to identify the mechanisms through which global forces are mediated by provincial economic structures and to assess the implications for subnational trade

[1] Globalization refers to the economic integration between countries as a result of increasing cross-border trade and capital movements.

performance. Central to this study is the question: ***what aspects of the current transformation in global trade are truly new at the regional level, and what range of forces are bending and stretching the links of the region's foreign trade in the new paradigm of globalization?*** This inquiry is essential for informing targeted and effective policy interventions that support inclusive regional development in an increasingly interconnected world.

Research gaps/problem statement

Despite decades of research on globalization and trade, a critical tension persists. Most analyses remain at the national level, yet globalization operates through subnational channels that produce markedly different outcomes across regions. This creates an empirical and theoretical gap between how globalization is typically modeled at the level of the nation-state and how it is actually experienced at the levels of regions, states, and metropolises. These regions possess distinct economic structures, comparative advantages, and policy frameworks that influence their degree of integration into international markets. As a result, regional trade dynamics are not merely passive outcomes of globalization, but rather active components in shaping the broader global economic architecture.

In Canada, where provinces possess distinct economic structures, policy frameworks, and trade linkages, this tension manifests as persistent asymmetries in trade performance and integration into global markets. Understanding these differences is essential for both theory, which must account for subnational heterogeneity, and policy, which must address uneven regional outcomes within an increasingly interconnected world.

Moreover, existing studies often overlook the complex, non-linear, and dynamic nature of the relationship between globalization and regional trade. Critical dimensions, including temporal variation, interactions between structural and institutional factors, and the mediating role of region-specific characteristics such as economic size, innovation capacity, institutional quality, and the presence of multinational enterprises, remain underexplored. In addition, little empirical research investigates how subnational trade adapts to evolving mechanisms of globalization, such as changes in global value chains, new trade agreements, exchange rate volatility, and geopolitical realignments. Addressing these gaps is essential for developing a richer and more context-sensitive understanding of global integration and for designing effective, inclusive trade policies attuned to the distinct capacities and needs of regional economies within a globalized world.

Research goals

The primary goal of this research is to empirically investigate the intersection of globalization and regional trade dynamics in Canada. It seeks to identify the mechanisms through which global forces interact with provincial economic structures and to assess the implications for provincial trade performance. Specifically, the study aims to:

- Examine the trends in global trade and the evolution of provincial trade.
- Investigate the influence of globalization mechanisms on provincial trade performance.
- Analyze the non-linear effects of liberalization mechanisms and currency fluctuations on provincial trade performance.
- Determine whether globalization weakens or reinforces border barriers across provinces, in the context of the Canada-U.S. border effect on provincial trade.
- Analyze the effect of province-specific characteristics and multinational enterprise activities (MNEs) on provincial IIT patterns.
- Formulate evidence-based policy recommendations to enhance the international competitiveness of Canadian provinces.

Ultimately, this research seeks to contribute to the literature by bridging the gap between macro-level globalization studies and regional-level studies of trade. It further aims to support evidence-based policymaking by providing insights into how Canadian provinces can strengthen their position within the evolving global trade environment, thereby promoting more equitable and resilient regional economic development.

Rationale for the regional perspective

The importance of analyzing trade from a regional perspective has grown significantly in recent years. One of the primary reasons for this shift is grounded in theoretical insights that conceptualize regions as small open economies, and as entities capable of engaging in international economic exchange and formulating policies that support their economic welfare (e.g., Chen et al., 2008; Gil-Pareja et al., 2015; Lafourcade & Paluzie, 2011; Márquez-Ramos, 2015; Brodzicki & Umiński, 2017). This theoretical framing suggests that the core principles

traditionally used to explain trade at the national level, such as comparative advantage, factor endowments, and specialization, can be meaningfully extended to the subnational level.

Secondly, regions are increasingly recognized as critical components of the development process. As argued by Scott and Storper (2003), regions are not merely passive recipients of national economic dynamics but rather active and causal agents in shaping economic growth trajectories. Despite this, much development theory has historically privileged macroeconomic perspectives, often overlooking the economic diversity and strategic importance of regions. In practice, regions vary significantly in their economic structures, factor endowments, production systems, labor markets, and trade orientation. They also differ in their proximity to foreign markets, availability of infrastructure, human capital, and institutional frameworks. These differences result in varying degrees of sensitivity to globalization (OIR, 2011). They may lead regional trade patterns to deviate from the predictions of traditional trade theories such as Heckscher-Ohlin (H-O). Moreover, highly competitive regions tend to host the most productive and globally engaged firms, thereby capturing a disproportionate share of the gains from globalization.

A third rationale for emphasizing the regional dimension arises from the principle of subsidiarity, a core concept in federalism literature that supports decentralizing decision-making authority to the most immediate or local level capable of addressing a given issue. Kukucha (2009) highlights that provinces in Canada possess meaningful capacity to develop and implement independent trade-related initiatives. Indeed, activities such as export promotion, foreign investment attraction, trade representation, and participation in international negotiations are often conducted more efficiently at the provincial level. Moreover, the impact of national trade agreements often manifests through regional trade structures and capacities. Regional trade agencies, by their proximity to local firms and institutions, are better positioned to identify export bottlenecks, provide targeted support, and foster strategic trade development. When these efforts fall short, higher levels of government can intervene, justifying a bottom-up rather than top-down logic of policy coordination and governance.

Canada, as one of the world's most open and globally integrated economies, presents a compelling case for this type of subnational analysis. Its proximity and extensive trade relationship with the United States, one of the world's largest markets, create a natural setting for examining cross-border trade dynamics. Moreover, Canada and its provinces are widely recognized for their liberalized trade regimes, characterized by the removal of entry barriers, the facilitation of competitive market mechanisms, and strong support for private enterprise and

foreign direct investment (FDI). These attributes make Canadian provinces particularly suitable for exploring the differentiated impacts of globalization at the regional level.

Crucially, trade performance across Canadian provinces is far from uniform. Differences in industrial composition, innovation capacity, institutional quality, and degrees of integration into global markets contribute to substantial variation in export and import behavior. This dissertation is premised on the understanding that international trade does not emerge from a homogenous national entity but from geographically distinct regions, each with its own economic and structural features. As Courant and Deardorff (1992) argue, international economics has for a long-time treated countries as singular units, largely ignoring their internal diversity or "lumpiness". This research challenges that assumption by demonstrating meaningful insights into trade dynamics that must account for regional heterogeneity.

Given this context, it is both surprising and revealing that international trade analysis has long neglected the fundamental question of where exports originate. Exports and imports are not generated by undifferentiated national units but rather by distinct subnational economies with diverse trade profiles. This dissertation directly engages with this oversight by offering a regionally disaggregated approach to trade and globalization. In doing so, it not only addresses key gaps in existing literature but also contributes to a more comprehensive and policy-relevant understanding of global integration from below.

Research contributions

This dissertation makes a significant and novel contribution to the study of globalization and international trade by conducting a comprehensive disaggregated regional analysis focused specifically on the Canadian provinces. To the best of the author's knowledge, no existing study offers an in-depth and systematic investigation of the trade effects of globalization at the subnational level within Canada. This absence reflects a notable gap in the literature and a missed opportunity in the current discourse concerning Canada's trade strategy and regional economic development. By focusing on the provincial scale, the dissertation addresses this gap and extends the frontier of empirical trade research in the context of developed economies.

A major contribution of this study lies in its application of globalization mechanisms typically employed in country-level analyses to provincial-level trade. To the author's knowledge, it specifically represents the first empirical attempt to incorporate indices of economic integration and economic freedom into a panel gravity model of trade for Canadian

provinces. This approach provides a more refined understanding of how global economic openness and institutional characteristics influence trade flows at the subnational level, thereby capturing regional heterogeneities that national aggregates may obscure.

The empirical framework is built on a novel dataset constructed using 22 years of annual export and import data (1999-2020) for ten Canadian provinces across 212 global trading partners. By using export, import, and total trade as dependent variables in a panel gravity regression model, the study operationalizes the claim that the traditional gravity model must be restructured to account explicitly for globalization mechanisms. This methodological extension is not only theoretically grounded but also enables a more dynamic and high-dimensional estimation of trade relationships. The gravity model, widely used due to its intuitive appeal and empirical robustness, is particularly suited for policy counterfactuals, such as evaluating the impact of globalization mechanisms and institutions on trade performance. While existing literature confirms the model's effectiveness in explaining international trade (Vaillant, Flores, and Moncarz, 2020), it is visibly lacking in detecting the imprint of globalization at the regional level. In contrast to the notion that the "missing globalization puzzle" only exist in estimated distance coefficient (which shows no evidence of decline in absolute value over time), this dissertation finds clear evidence of globalization's influence on provincial trade flows, challenging the assertion by Coe et al. (2002), which echoed Solow's well-known quip[2] that "globalization is everywhere except in estimated gravity models".

An additional and important contribution of this research is the investigation of IIT and its components at the provincial level. This analysis highlights the relevance of province-specific characteristics and the activities of multinational enterprises in shaping trade patterns. In doing so, the dissertation demonstrates that provinces with distinct economic profiles, innovation capacities, and institutional capabilities experience different degrees and forms of trade integration. This aspect of the study provides critical insights into comparative advantage, specialization, and the nature of provincial competitiveness.

A distinctive feature of this dissertation lies in its broader empirical strategy, which departs from traditional studies of provincial trade. Firstly, it analyzes trade flows between Canadian provinces and a wide range of global trading partners, rather than limiting the scope to intranational comparisons. Secondly, the study incorporates a newly developed dataset on

[2] In 1987 MIT economist Robert Solow, who won that year's Nobel Prize for defining the role of innovation in economic growth, quipped to the New York Times "You can see the computer age everywhere but in the productivity statistics."

globalization mechanisms to establish a direct empirical relationship between globalization and regional trade. This regional-level perspective offers a more granular and realistic depiction of how trade policies and global forces affect provincial economies.

Finally, the methodological framework employed in the study offers a more instructive and robust approach to modeling foreign trade. The study addresses potential endogeneity concerns often present in cross-sectional studies by leveraging a balanced panel dataset that spans a broad temporal and spatial dimension. This framework not only enhances the reliability of the findings but also contributes a valuable tool for policymakers interested in designing targeted and inclusive trade policies that account for regional economic structures.

General hypotheses

Building upon a thorough review of the existing literature and the recognition of key research gaps, this study formulates two overarching hypotheses to structure the empirical inquiry. These general hypotheses are subsequently elaborated into a set of more specific sub-hypotheses, which are presented and discussed in detail in Chapter Two.

The first general hypothesis *is that globalization impacts Canadian provinces' foreign trade in a heterogeneous way*

The hypothetical proposition is grounded in both theoretical reasoning and the recognition that globalization is a multifaceted and uneven process. The effects of globalization on trade are mediated by both external and internal factors, including institutional arrangements, economic structures, historical legacies, and geographic positioning. These dimensions interact asymmetrically across provinces, generating variation in the degree and manner in which provinces integrate into the global economy.

One important mechanism underlying this heterogeneity is the degree of institutional openness of a province's trading partners. Provinces that trade more intensively with institutionally globalized economies, those embedded in international treaties, regulatory standards, and multilateral trade frameworks, tend to benefit from reduced transaction costs and increased trade flows. Conversely, provinces trading with less open economies may encounter institutional rigidities, increasing the cost and uncertainty of cross-border exchange.

Moreover, the economic freedom and liberalization profile of the province and its external partners play a critical role. Trading partners with low tariffs and extensive participation in Regional Trade Agreements (RTAs) foster favorable trade conditions. Provinces such as Ontario and Quebec, which are strongly integrated into North American trade networks such as NAFTA/USMCA, experience distinct advantages compared to provinces with fewer liberalized trade connections. These variations in external market openness interact with provincial export structures to yield differential globalization effects. Income disparities, particularly the GDPpc gap between a Canadian province and its trading partners, further shape trade relationships. Provinces engaged in trade with high-income economies are often involved in IIT or participate in complex global value chains (GVCs), whereas those linked with lower-income economies may rely on resource extraction and low-value-added trade. This stratification reinforces unequal access to the gains from globalization.

Exchange rate dynamics introduce another layer of heterogeneity. Provinces whose exports are concentrated on globally traded commodities (e.g., Alberta and Newfoundland and Labrador) are more vulnerable to currency volatility and external price shocks. In contrast, provinces with more diverse export baskets or more stable trade partners may be shielded from such fluctuations. Furthermore, urbanization and the presence of metropolitan trade hubs shape provincial trade capacity. Provinces with large metropolitan areas (e.g., Ontario with Toronto, British Columbia with Vancouver) often benefit from agglomeration economies, better infrastructure, and global connectivity, facilitating higher volumes and complexity in international trade. These urban hubs serve as gateways to global markets and tend to attract FDI, thereby amplifying globalization's impact. In contrast, less urbanized or peripheral provinces may lack similar institutional and logistical advantages, limiting their global integration.

Additionally, historical trade linkages and path dependence continue to influence contemporary trade patterns. Provinces such as Quebec, with long-standing cultural and linguistic ties to France and other Francophone countries, or British Columbia, with its proximity and historical orientation toward Asia-Pacific markets, have maintained enduring trade relations that shape their modern globalization trajectories. These historical affinities, such as cultural familiarity, institutional memory and established business networks, reduce information and institutional costs, thereby sustaining persistent trade flows. Canada’s federal structure also allows provinces to deploy distinct institutional and policy strategies in areas such as trade facilitation, infrastructure development, and regional economic promotion. These

differences shape how globalization is experienced regionally and contribute to divergent trade outcomes even under a shared national trade regime.

Given the multidimensional reach of globalization, this dissertation is poised to also investigate a hypothesized impression that the effect of globalization mechanisms reflects the extent to which international borders support or impede trade more than domestic (interprovincial) borders. Drawing on foundational contributions in the border effects literature (e.g., McCallum, 1995; Anderson and van Wincoop, 2003), this analysis interrogates whether globalization has weakened the trade-friction role of international borders between Canadian provinces and U.S. states, being the closest southern neighbor and the largest trading partner. It investigates the extent cross-border trade with U.S. states may be less impeded than interprovincial trade. This implies that globalization mechanisms such as partner institutional openness, economic freedom, or tariff liberalization may have spatially differential impacts depending on whether trade is international or domestic. The dissertation, therefore, assesses how globalization not only reshapes provincial trade patterns but also reconfigures the functional relevance of national borders in shaping economic integration.

In conclusion, the impact of globalization on Canadian provincial foreign trade is mediated by a combination of external partner characteristics, internal structural factors, and the geopolitical positioning of provinces to the Canada-U.S. border. From formal global integration mechanisms to historical legacies, local capacities, and the nature of international versus domestic borders, the evidence strongly supports the view that globalization does not exert a uniform influence across provinces. This diverse effect underlies the rationale for this dissertation's focus and justifies further empirical examination of the mechanisms through which globalization and borders shape provincial trade performance.

The second general hypothesis is *that the provinces' trade performance is determined by their idiosyncratic characteristics*

This hypothesis is grounded in the recognition that provinces, as subnational units of economic activity, exhibit significant heterogeneity in structural, institutional, and policy dimensions that directly shape their international trade performance. In the Canadian federal context, provinces not only differ in their economic endowments and production structures but also retain a considerable degree of autonomy in formulating trade-relevant policies. These

idiosyncratic characteristics are central to understanding the spatial differentiation of trade outcomes across the country.

One important source of heterogeneity is the variation in production and import taxation policies across provinces. Differences in tax rates and structures directly influence the cost of production and the competitiveness of both domestic and imported goods. Provinces that maintain lower production or import taxes can attract greater industrial activity and facilitate more cost-effective integration into global value chains. In contrast, provinces with relatively higher tax burdens may impose constraints on the competitiveness of local industries, affecting their ability to engage in international markets.

Another defining factor is the intensity of research and development (R&D) activity at the provincial level. Investment in R&D enhances innovation capacity, increases the sophistication of exported products, and supports the development of new technologies and processes that improve productivity. Provinces such as Ontario and Quebec, which invest heavily in R&D, tend to have more knowledge-intensive exports and are better positioned to compete in high-value segments of global trade. In contrast, provinces with lower levels of R&D may remain reliant on resource-based or less technologically advanced exports, limiting their adaptability to global market shifts. R&D intensity is also closely linked to multinational presence, with many multinational firms locating R&D facilities in regions where skilled labor and supportive infrastructure exist.

Moreover, industrial composition and sectoral specialization differ widely across Canadian provinces. While Alberta and Saskatchewan are characterized by natural resource extraction and energy exports, provinces like Ontario and Quebec feature more diversified economies with advanced manufacturing and service sectors. These structural distinctions shape the types of goods exported, their sensitivity to global demand fluctuations, and the provinces' responsiveness to trade policy shifts.

Provinces also differ in their institutional capacities and trade promotion strategies. Some provincial governments actively engage in international trade through targeted policies, trade missions, and the establishment of overseas trade offices, while others adopt a more passive role. The decentralization of trade-related competencies under Canadian federalism enables provinces to pursue tailored export promotion strategies, foreign investment initiatives, and regulatory frameworks aligned with their specific economic goals.

Human capital endowment is another critical determinant of trade performance. Provinces with higher educational attainment, urban density, and skilled labor availability are better equipped to participate in complex production networks and to attract high-tech

investment. These conditions also reinforce the effectiveness of R&D investment and innovation-driven trade.

Lastly, the presence and intensity of multinational enterprises' (MNEs) activity vary markedly across provinces, contributing to disparities in trade outcomes. MNEs serve as critical vehicles of globalization by facilitating FDI, value-added production, capital formation, and employment creation. Provinces with higher concentrations of MNEs are more likely to experience positive spillovers in the form of technology transfer, knowledge diffusion, and enhanced export capacity. These enterprises often possess the scale, capital, and networks needed to access and compete in international markets, reinforcing regional trade performance.

Taken together, these multidimensional factors ranging from tax regimes, R&D investment, sectoral specialization, geographic location, institutional arrangements, human capital capacity, and MNE activity provide strong justification for the hypothesis that provincial trade performance is fundamentally shaped by regional economic, institutional, and spatial characteristics. Recognizing and analyzing these differences is essential for understanding how globalization impacts provincial trade dynamics within a highly decentralized national economy like Canada.

Empirical scope and analytical depth of the study

This dissertation is anchored in a robust empirical framework that utilizes a comprehensive body of provincial and international trade data, spanning multiple decades and structured across various geographic and product dimensions. Two gravity models are central to the analysis, one capturing international bilateral trade between Canadian provinces and their global trading partners, and the other focused on subnational trade between Canadian provinces and U.S. states. These models are estimated using a combination of advanced econometric techniques, including Poisson Pseudo-Maximum Likelihood (PPML), Gamma Pseudo-Maximum Likelihood (GPML), and the Hausman-Taylor (HT) estimator. While PPML and GPML are employed to address the challenges of zero trade flows, heteroskedasticity, and model non-linearity, the Hausman-Taylor estimator allows for the consistent estimation of time-invariant variables in the presence of unobserved heterogeneity, thereby serving as a useful benchmark for comparison. This methodological triangulation enhances the robustness of the analysis and provides a multidimensional understanding of the differential effects of globalization mechanisms on trade outcomes across provinces.

In addition to the gravity-based estimations, the study integrates a detailed IIT analysis using highly disaggregated product-level data at both the four-digit and six-digit levels of the Harmonized System (HS) classification. This allows for a nuanced assessment of trade structure, vertical and horizontal IIT patterns, and the evolution of trade specialization over time. The use of granular data supports the identification of sectoral asymmetries and provincial comparative advantages, offering insights into how globalization influences trade composition beyond aggregate flows. Collectively, the dissertation's empirical strategy, marked by the use of large and detailed datasets, multiple estimation techniques, and a dual-level trade framework, demonstrates both analytical depth and methodological rigor in assessing the heterogeneous impacts of globalization and the idiosyncratic economic structure of provinces on trade performance.

Summary of research findings

This dissertation explores the impact of globalization on provincial trade in Canada, revealing how global economic integration through reduced transaction costs, technological advancement, and liberalization has reshaped subnational trade. The study fills a critical research gap by shifting focus from national aggregates to provincial trade dynamics, constructing a nuanced narrative of how globalization affects exports and imports across Canada's ten provinces. By incorporating contemporary globalization indicators and trade theory, the analysis builds a comprehensive regional framework that enhances understanding of subnational trade behavior in the global economy. Employing two general hypotheses, the dissertation rigorously investigates the effects of globalization mechanisms and province-specific characteristics on trade performance. Hypothesis 1 evaluates how globalization through trade agreements, economic openness, institutional quality, and exchange rate stability affects provincial trade. Hypothesis 2 examines how internal structural factors, such as GDP, labor composition, taxation, and multinational enterprise (MNE) activity, influence IIT. Using a rich gravity panel dataset covering 49,220 province-country pairs from 1999-2022, and employing PPML as the primary estimator, the study integrates multiple control variables, including distance, language, colonial ties, and regional economic indicators, to model bilateral trade flows accurately.

The results strongly support general Hypothesis 1, showing that economic size and institutional openness are critical determinants of trade, while distance, tariffs, and Exchange

rate volatility (ERV) pose persistent barriers. The findings also show that globalization's benefits are not uniformly distributed; RTAs and trade liberalization yield larger gains for high-income partners, while income disparities reduce the effectiveness of such mechanisms. ERV was found to suppress total trade, especially in relationships marked by structural dissimilarity, reinforcing the fragility of trade with developing partners under financial uncertainty. The Canada-U.S. case analysis confirms the broader hypothesis that the effect of globalization mechanisms reflects the extent to which international borders impede trade more than domestic (interprovincial) borders. The result illustrates the persistence of home bias in trade, with provinces trading 7.1 times more with each other than with U.S. states. Although border effects have declined since the early 2000s, the international borders have continued to impede trade more than the domestic (interprovincial) borders, especially in the case of imports, not primarily due to tariffs, but as a result of deeper and more complex non-tariff factors. Land-border proximity was shown to increase trade flows by nearly threefold, affirming the importance of geographic closeness and integrated supply chains in reducing transaction costs. Economic freedom and income similarity further enhance cross-border trade, confirming the importance of institutional alignment and structural convergence in facilitating integration under agreements like NAFTA and currently USMCA.

Confirming general Hypothesis 2, the study shows that IIT is heavily influenced by province-specific characteristics. Higher GDP increases IIT and its components, while GDP per capita (GDPpc) positively correlates with all forms of IIT, suggesting that wealthier regions not only focus on specialization but also on reciprocal trade. R&D intensity boosts all forms of IIT, highlighting the importance of innovation. Equatorial distance and institutional quality also show a positive association across all IIT components. Taxation exerts differentiated effects: higher production taxes dampen IIT and HIIT, while import taxes promote all forms of IIT through domestic substitution effects. The study also finds that both low- and high-skill labor contribute positively to IIT and HIIT, while VIIT exhibits stronger dependence on skill asymmetry, reaffirming the role of human capital in trade specialization. These results point to the need for targeted fiscal and labor policies that enhance competitiveness without distorting trade structure. Finally, MNEs are shown to significantly increase all forms of IIT through value-added activities, capital investments, and job creation. The strongest impacts were observed in HIIT, indicating that foreign firms operating in Canadian provinces play a crucial role in fostering horizontally structured trade. These findings align with extensive literature on FDI, production networks, and trade expansion, reinforcing the need for provincial strategies that attract, retain, and integrate MNE activity into local value chains.

Overall, this study provides compelling empirical evidence that globalization mechanisms and the structure of province-specific factors jointly shape Canadian provincial trade outcomes. While globalization enhances trade integration, its effects are asymmetrically distributed across regions and trade partners. Institutional alignment, income convergence, and macroeconomic stability are key to maximizing the gains from trade liberalization. Likewise, domestic reforms, especially in innovation, education, and the investment climate, are essential for fostering trade resilience. The findings underscore the importance of adopting nuanced, region-specific trade policies that balance openness with structural preparedness, ensuring that Canadian provinces can thrive in a complex and evolving global trade landscape.

Structure of the dissertation

The remainder of this dissertation is organized into five major chapters. The first chapter, *Descriptive Analysis*, presents the trend analysis of global trade and globalization, providing an overview of provincial trade patterns and trends in the context of globalization. It illustrates the distribution of trade activities across individual provinces and sectors. In addition, it identifies the evolution and the patterns of provincial trade

The second chapter, *Literature Review*, comprehensively reviews the existing literature on regional trade and globalization. This dissertation further discusses existing trade literature on Canadian provinces. It synthesizes key findings from previous studies, identifies gaps in the literature, and presents points of departure from past literature. The first part of this chapter ends with a table summarizing several of the most relevant empirical studies. The second part of the chapter discusses the basic theoretical foundations linking the region's trade to the global market. Finally, it reflects on the theories and their reflections (unification) on the concept of the gravity framework.

The third chapter, *Methodology and Data,* discusses the analytical framework and data used in the study. It describes the econometric models used to examine how globalization has affected provincial trade and discusses the rationale behind choosing these models. This chapter describes the data collection process, with a nuanced discussion of the construction of the narrative dataset and provides summary tables and charts depicting the main characteristics of the data. Additionally, it elaborates on the research hypotheses developed by this dissertation, providing sub-hypotheses with the necessary theoretical rationale.

The fourth chapter, *Empirical Analysis*, elaborates on the estimation strategy via the econometric analysis of the panel gravity model and IIT panels. This chapter operationalizes the research hypothesis using the highlighted econometric models. Finally, this chapter discusses the empirical results and examines their robustness.

The fifth and final chapter presents an integrated synthesis of the dissertation's key empirical and theoretical findings, situating them within the broader context of policy relevance and scholarly discourse. It is organized into three interrelated sections: the *conclusion*, which distills the principal insights emerging from the analysis; *policy recommendations*, which translate these insights into context-specific and actionable strategies; and *further research opportunities*, which outline potential avenues for extending the scope and depth of inquiry in this field.

Research conceptualization model

This section presents the logical sequence of analysis of the dissertation. The introduction establishes the context, research problem, and objectives. It highlights the importance of globalization as a transformative force in trade dynamics and frames the key research questions. It unveils the complexity of globalization, focusing on the region's integration into the global markets, its influence on trade patterns, and its impact on the region's competitiveness. Theoretical and empirical literature synthesizes existing knowledge. Whereas the theoretical literature explores foundational and contemporary trade theories to conceptualize the trade-globalization nexus, the empirical literature reviews previous studies on regional trade and globalization-trade linkages, thereby identifying gaps and informing model development.

At the core of the research is the construction of a dual analytical approach: the Gravity Model and the IIT framework. These models are designed to test hypotheses about the influence of globalization and province-specific characteristics on provincial trade performance. Both theoretical and empirical insights feed directly into this framework. The empirical testing and analysis part operationalizes the hypotheses. General Hypothesis 1 is tested through empirical gravity analysis, while General Hypothesis 2 is examined through IIT analysis. Both are employed to assess the provincial trade performance outcomes, thereby generating empirical evidence on the effects of globalization and regional factors.

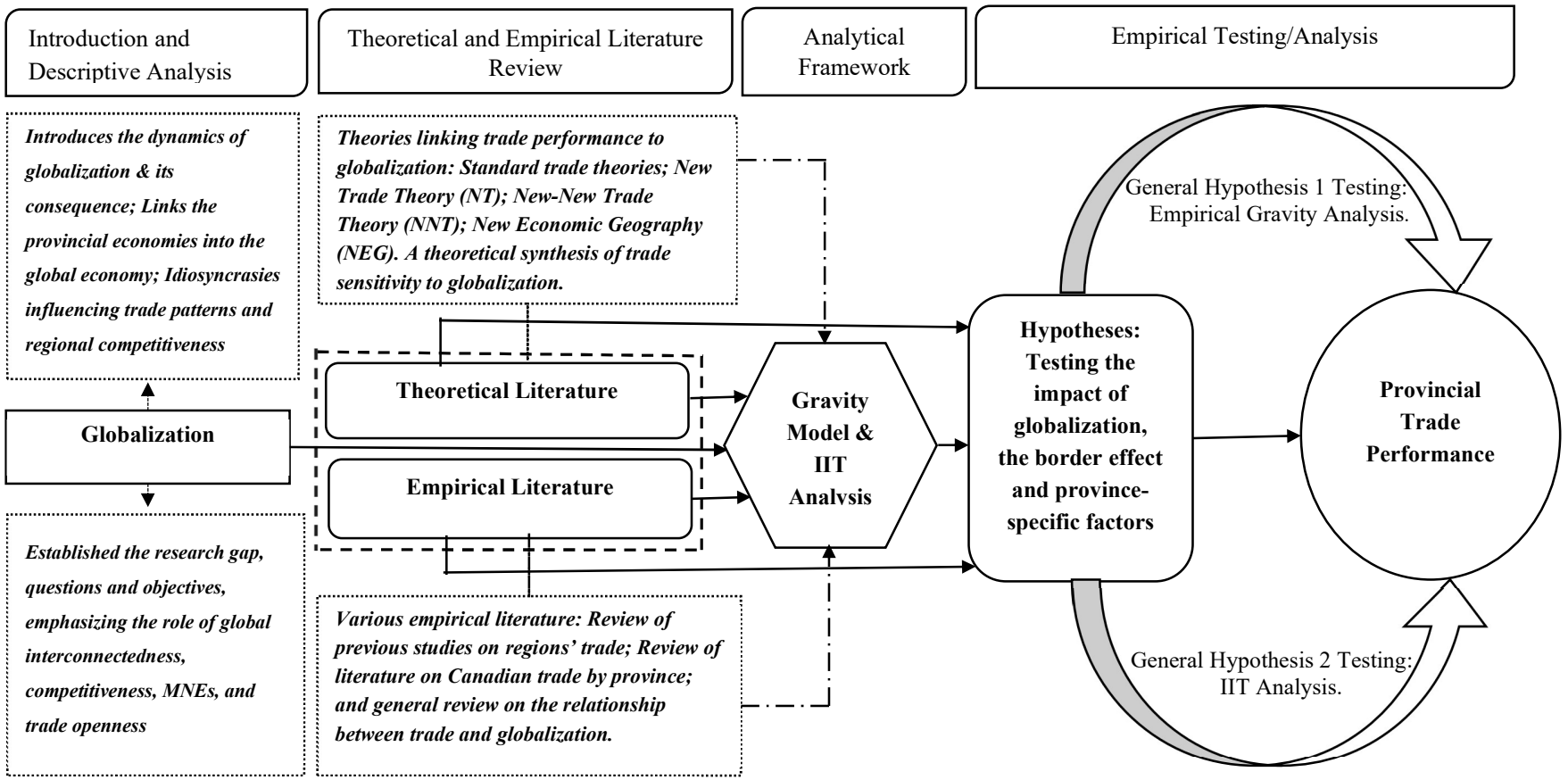


Figure 0.0 Visual conceptualization of the dissertation's research flow
Source: Own elaboration

Justification for analyzing the IIT pattern

Analyzing IIT at the provincial level in Canada offers critical insights into the evolving nature of trade in advanced economies. Unlike traditional inter-industry trade, which reflects comparative advantage in distinct sectors, IIT captures the simultaneous export and import of similar but differentiated products within the same industry. This pattern is increasingly prevalent in high-income, diversified economies, particularly those engaged in global value chains and knowledge-intensive production. Given Canada's federal structure and the economic heterogeneity across its provinces, examining IIT provides a nuanced understanding of how regions with varying levels of development, industrial specialization, and technological capacity integrate into international markets.

From an empirical standpoint, focusing on IIT allows for the assessment of trade dynamics beyond aggregate trade volumes or commodity flows. It enables the identification of patterns linked to product differentiation, economies of scale, and firm-level heterogeneity factors that are often obscured in inter-industry trade analysis. For Canadian provinces, which differ significantly in their factor endowments, labor composition, and exposure to FDI, IIT analysis reveals the extent to which these regions engage in sophisticated trade practices. Moreover, IIT reflects deeper forms of economic integration, such as cross-border production sharing and intra-firm trade by multinational enterprises (MNEs), which are increasingly central to Canada's participation in global trade.

Finally, investigating IIT at the subnational level contributes to both academic and policy-oriented debates on regional trade competitiveness and economic diversification. While national-level studies provide a broad picture of Canada's trade relations, provincial-level IIT analysis uncovers region-specific drivers of trade performance and structural transformation. This is particularly relevant in light of trade agreements, globalization, and technological shifts that affect provinces differently. Understanding the determinants and distribution of IIT can thus inform targeted industrial and trade policies, support regional innovation strategies, and enhance the equitable distribution of globalization's benefits across Canada.

CHAPTER 1 DESCRIPTIVE ANALYSIS

This chapter sets the scene, offering a comprehensive overview of key dimensions relevant to the study of regional trade in Canada. It examines the global trends in trade openness and the evolving nature of liberalization, followed by an analysis of Canada's overall trade openness and the provincial trade landscape. Specific attention is given to provincial exports and imports dynamics, sectoral trade profiles, patterns of revealed comparative advantage, regional openness to FDI, and overall provincial trade performance. The section concludes by synthesizing the key insights drawn from these analyses.

1.1 Globalization and global trade openness

The first era of globalization came with rapid growth in international trade (Ortiz-Ospina & Beltekian, 2018). This opening up to trade or liberalization has been undertaken by several countries. Events in the last decades have also shown that former socialist countries have turned away from central planning to link up with the world economy. International trade dropped persistently in the period before 1800, when the globalization index never exceeded 10%. However, the trend changed over the 19th century, when growth in world trade was mostly attributed to technological advances, marking the so-called “first wave of globalization”. When the first wave ended with the beginning of World War I, openness fell below the early 19th-century level, before rising again after 1960, marking the new globalization movement. Openness to trade returned to the levels already reached a century before, only in the late 1970s. Currently, the share of total global trade in world GDP amounts to over 50% of the value of total global output, a more than twofold increase in its share since 1950. The impact of globalization on world trade is profound, altering trade patterns, economic structures, and the competitive landscape of global markets.

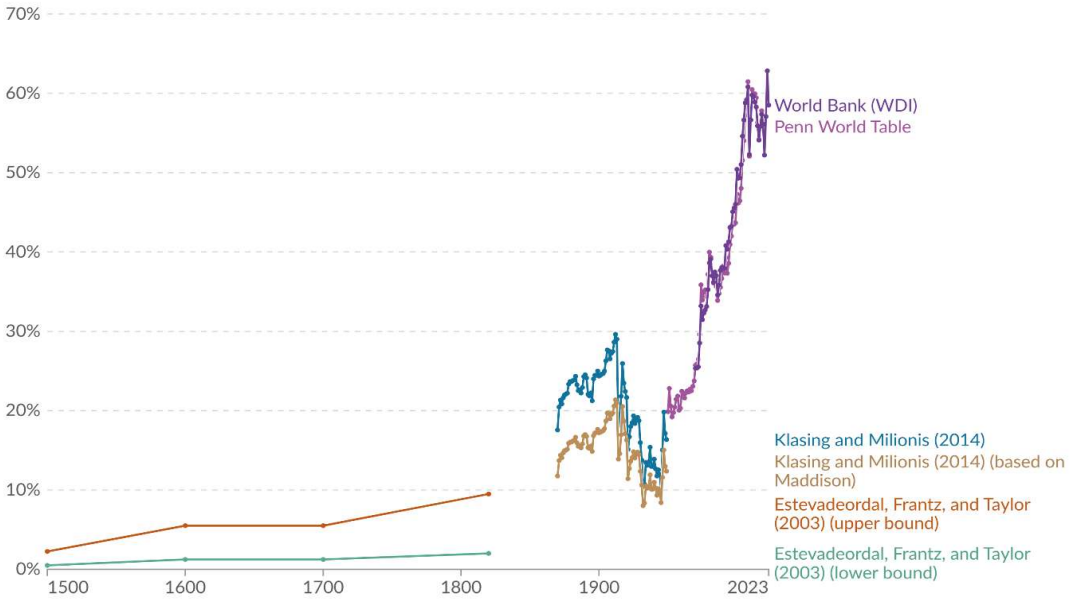


Figure 1.1 World trade openness over centuries, defined as the sum of world imports and exports divided by world GDP
Source: OurWorldinData.org/trade-and-globalization

The major forces driving the growth of cross-border flows have been largely attributed to reductions in transaction costs resulting from advancements in technology, such as the development of commercial transportation systems and the improvement in the mode of communication around the world. The second factor is increased production due to the activities of the multinational corporations through FDI and the establishment of subsidiaries, integrating national economies into global value chains, reducing transaction costs, and enhancing market access, thereby intensifying trade linkages between countries. The third is the liberalization foundation, which expunged many trade barriers, leading to further geographic and economic openness in international trade. Akin to this phenomenon are the findings of Novy, Meissner, and Jacks (2008) on declining trade costs accounting for more than half of the growth in international trade, with the rest attributed to secular increases in output, leading to expanded exports.

However, international trade has also been adversely affected by a series of challenges, including macroeconomic instability, disruptions in financial markets, volatility in energy prices, the global impact of the Covid-19 pandemic, and ongoing military conflicts in various parts of the world. These shocks have permeated the real sector of the economy and ultimately contributed to the onset of global recessions (Klein, 2007). Whereas many governments have

consistently applied different economic policies to mitigate these sudden occurrences, some have tried to keep up with the existing trade liberalization commitments made under the WTO and respective FTAs. These ongoing contradictory policy positions among countries have prevented fuller global integration. Consequently, the result has been deflation, unemployment, and slow or negative growth in many countries of the South. However, the increasing volume of world trade provides an important qualification to the fact that today's globalization is unprecedented, large, and increasing (see Streeten, 1989; Wade, 1996; Baldwin, 2006; Atkin & Donaldson, 2013; Surugiu & Surugiu, 2015; WTO, 2023; FT, 2025).

Figure 1.2 illustrates the heterogeneous export performance of major global economies by comparing their average annual export growth between 2019–2023 and 2022–2023. The United Arab Emirates stands out as a high-growth outlier, recording robust export expansion in both periods, likely reflecting successful diversification strategies and enhanced trade capacity. In contrast, economies such as the United States, China, Canada, and India exhibit moderate medium-term growth with relatively flat recent performance, suggesting stabilization following the initial post-pandemic recovery. Traditional export leaders like Germany, the United Kingdom, France, and Japan register comparatively lower growth, indicative of mature trade profiles and possible structural constraints on short-term export acceleration.

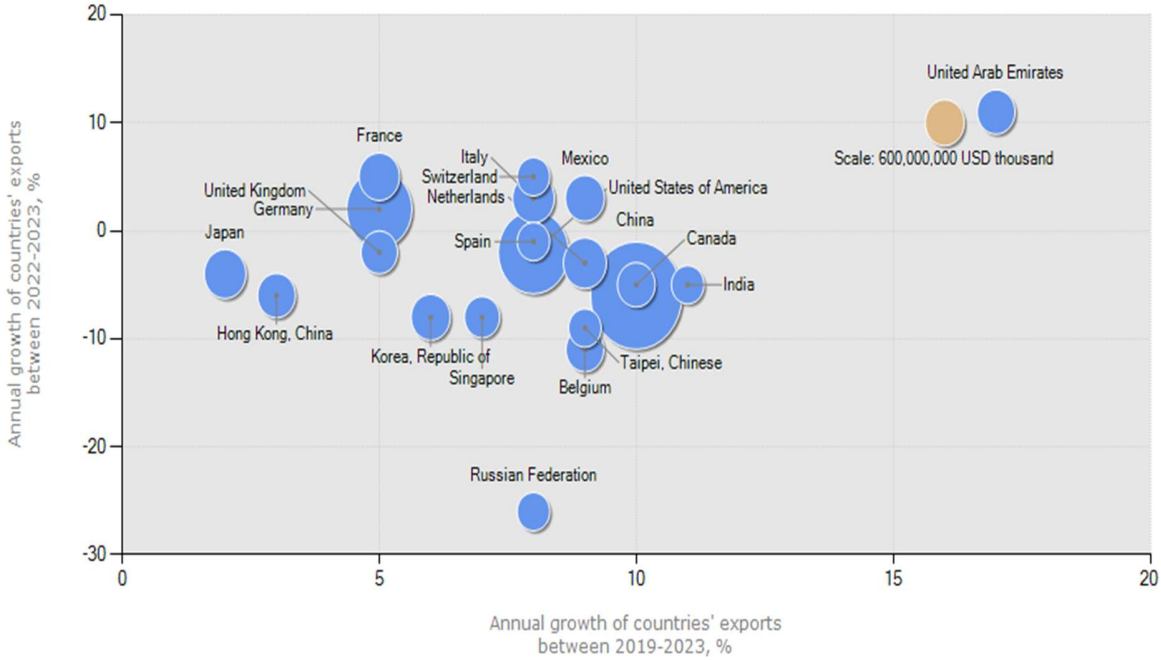


Figure 1.2: Export growth of selected countries
Source: International Trade Centre (ITC), 2024

A distinct contraction in short-term exports is observed among economies like Singapore, Korea, Belgium, and Taiwan, likely driven by sector-specific shocks, particularly in high-tech and manufacturing industries. The Russian Federation presents a unique case, experiencing sustained export decline in both periods, consistent with the effects of geopolitical sanctions and trade isolation. These patterns underscore the differentiated impacts of globalization and trade policy shifts on national export performance. For countries like Canada, whose performance lags slightly behind key partners such as the U.S. and Mexico, these dynamics call for a reassessment of national and provincial trade strategies in light of evolving global trade conditions.

1.2 Globalization and MNEs' presence in Canada

Multinationals have fundamentally shaped world trade through their flow of capital, goods, and services. They have been drivers of globalization and have expanded rapidly in recent decades because of falling trade barriers, the search for new markets, expanding global supply chains, and outsourcing operations to lower-cost regions. MNEs can bring benefits like job creation, infrastructure investment, and improved quality of goods in the countries where they operate. In Canada, a hostile attitude to multinationals has been replaced by measures to promote the inflow of FDI. MNEs are an important source of investment in innovation, technology, and skilled labor in Canada. At the end of 2016, Canadian MNEs had increased by 0.8%, holding about 67% of all assets in the Canadian economy. The Canadian majority-owned, with foreign affiliates (MOFAs), owns 49% more assets than foreign majority-owned, with Canadian affiliates (FMOCAs), which account for 18% of the total.

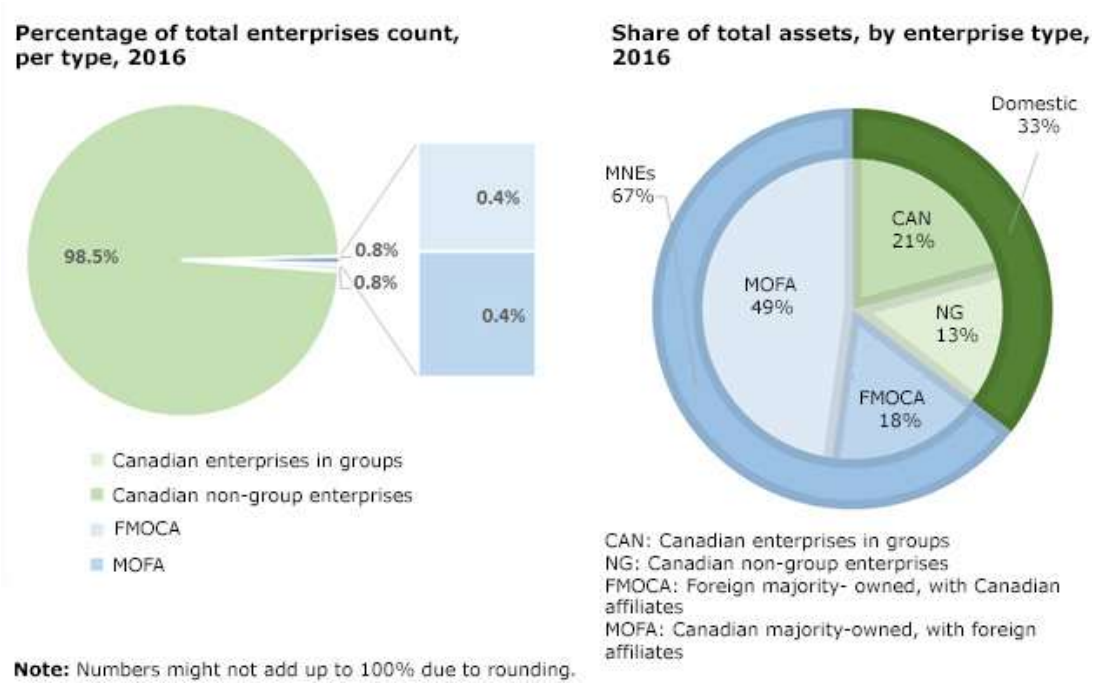


Figure 1.3 MNEs' presence in the Canadian economy
Source: Statistics Canada

Foreign multinational firms play an important role in the Canadian economy. First, the production of foreign affiliates represents a significant portion of Canadian business production. Their affiliates accounted for about 50% of manufacturing production and 30% of total business production in Canada. However, despite the huge penetration and acclaimed importance in the Canadian economy and today's global economy, empirical evidence on MNEs is not widely available. It is largely incomplete, with information on MNE activities only available in a subset of OECD economies and at the national level. Thus, understanding the linkage between foreign multinational enterprises in Canada and trade performance (including provincial foreign trade performance) can provide useful insights for policy development.

1.3 Liberalization and evolution of Canadian trade openness

Since the 1980s, Canada's trade policy has been characterized by a strategic shift toward liberalization, initiated with the Canada-United States Free Trade Agreement (CUSFTA) in 1989 and subsequently deepened through the North American Free Trade Agreement (NAFTA) in 1994 and its successor, the United States, Mexico and Canada Agreement (USMCA) in 2020. These agreements signaled a significant reduction in tariff and non-tariff barriers and

institutionalized Canada's commitment to rules-based trade. In parallel, the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) and the Canada-European Union Comprehensive Economic and Trade Agreement (CETA) reflect an explicit policy emphasis on trade diversification, aiming to reduce overreliance on the U.S. market by strengthening economic linkages with Asia-Pacific and European partners. This dual approach to liberalization and diversification underpins Canada's broader strategy of enhancing resilience and competitiveness in an increasingly multipolar global trading system.

Figure 1.4 illustrates the share of global GDP by Canada's trade agreement partners in 2021, indicating the extensive access to global markets provided by Canada's RTAs network.

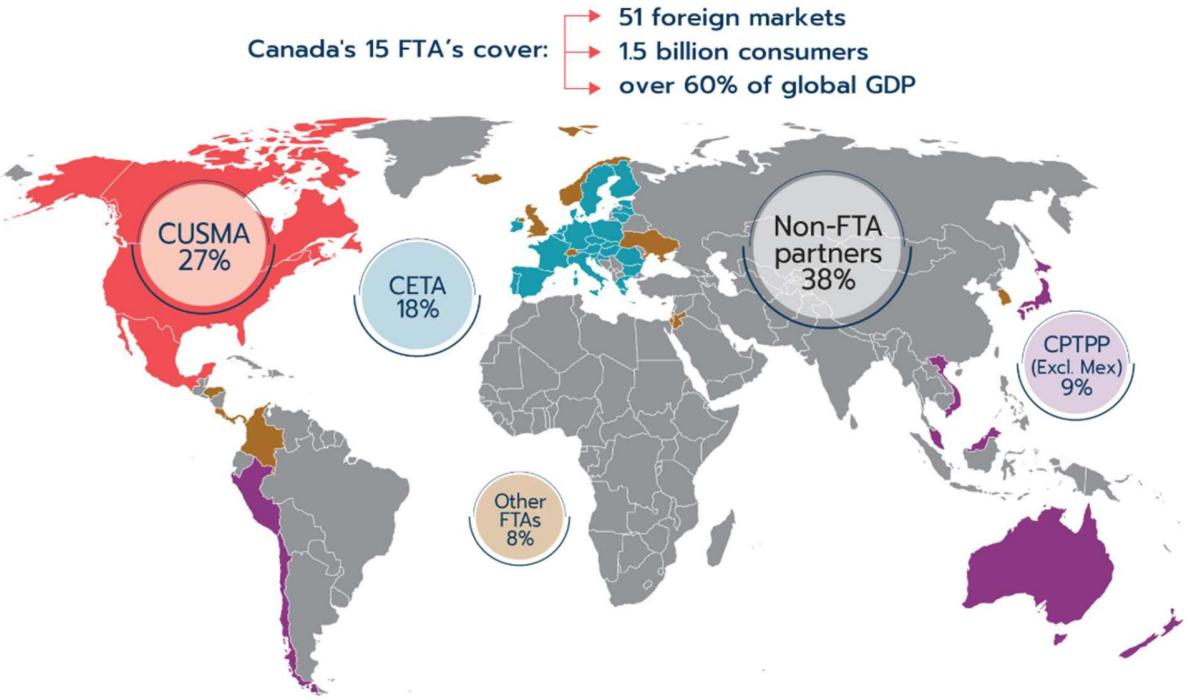


Figure 1.4 Network of Canada's FTA and share of global GDP, 2021
Source: Statistics Canada

Trade agreements serve as a critical instrument for enhancing market access and fostering Canada's integration into the global economy. As of the most recent data, Canada is a party to 15 RTAs encompassing 51 foreign markets, collectively representing approximately 61% of global GDP. These agreements are designed to reduce trade barriers, promote regulatory cooperation, and strengthen Canada's commercial presence in key international markets. The evolution of trade patterns and the diversion hypothesis is well documented in Coulombe

(2003), Subramanian and Wei (2007), Mattoo, Mulabdic, and Ruta (2019), and Bekkers, Corong, Métivier, and Orlov (2023).

Figure 1.5 illustrates the dynamics of the two trade patterns to different functional institutions of trade liberalization, using the latest available data. The comparative evolution of Canada's trade share is provided for 1981-2020 annual data on goods and services, which is also useful in identifying some important structural changes that took place in Canada's trade patterns. Trade openness, calculated as the ratio of total trade to GDP, was utilized to analyze the links between the two trade patterns. Over the past three decades, the ratio of inter-provincial trade steadily declined to less than 40 percent and stayed constant at that level until 2020. Over the same period, international trade expanded to more than 80 percent of the GDP. The boom in international trade came to a halt with a series of trade collapses in the early 2000s, and the volume of international trade came down to about 61 percent of the GDP in 2020.

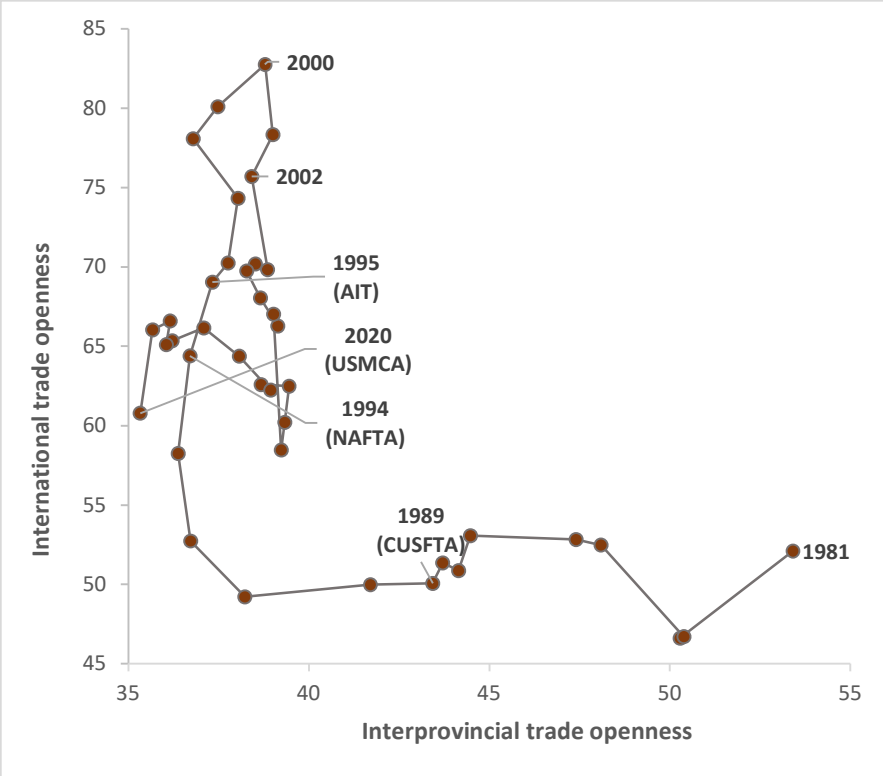


Figure 1.5 Aggregate Canadian intra-national and international trade openness
Source: Own elaboration based on data from Statistics Canada

Following this trend, two central questions often arise: Why did the share of international trade increase during a period when intra-national trade was in decline? And what role did geographic proximity and trade agreements, such as the Canada-United States Free Trade Agreement (CUSFTA), the North American Free Trade Agreement (NAFTA), and its successor, the United States, Mexico, and Canada Agreement (USMCA) play in shaping the structure of Canadian trade flows? These questions are most effectively addressed through the lens of gravity models, which illuminate how trade diversion and reallocation between domestic and international markets are influenced by economic size, distance, and institutional arrangements.

1.4 Liberalization and evolution of provincial trade openness

Trade agreements (including CUSFTA, NAFTA, and other FTAs) as liberalization mechanisms also brought remarkable changes to the mode of production and organization of trade for the Canadian provinces. Reduced trade barriers opened new markets in the United States, Mexico, and other global partners through agreements. Stiffer competition faced by producers domestically due to Internal Trade Agreements (ITA), coupled with the low dollar and strong foreign demand, led to an increase in total international exports.

The increasing provincial openness led to a significant structural break in the relationship between interprovincial and international trade and resulted in relative changes in the share of international trade across Canadian provinces. In real terms, international trade increased for all the Canadian provinces. Consequently, as the contribution of provincial international trade to GDP roughly increased, the contribution of interprovincial trade to GDP decreased steadily. Thus, from a cross-sectional standpoint, the dynamics imply that provinces with a higher international trade share have a lower interprovincial trade share.

Figures 1.6-1.8 illustrate the nature of trade diversion from interprovincial trade to international trade patterns. This information is analyzed using the annual time-series data on provincial openness, calculated as the ratio of total trade to GDP. The two-time series explains the trade diversion in each of the provinces. The dynamics are explained using scatter plots linking the shares of the two trade patterns over the 1981-2020 period.

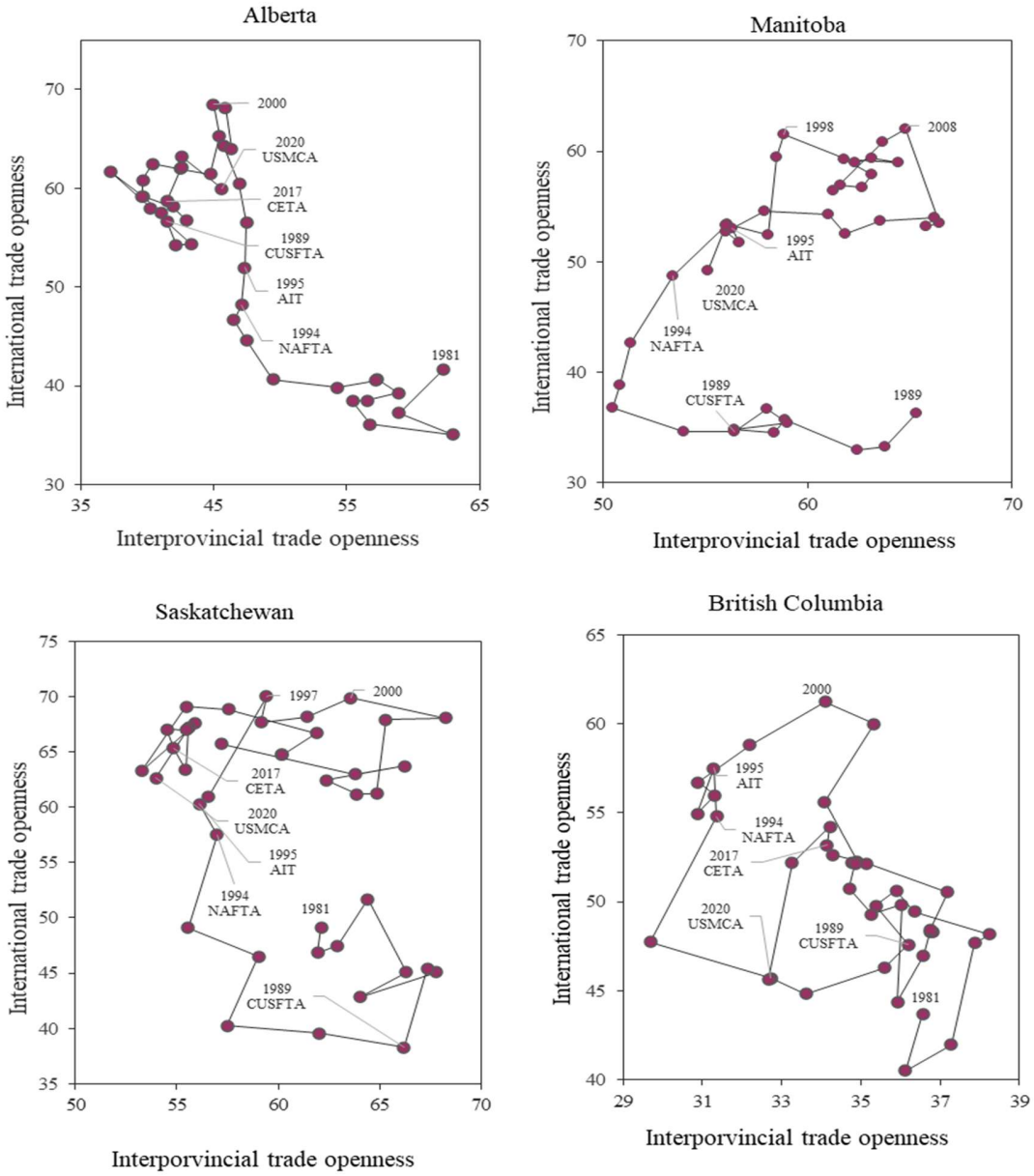


Figure 1.6 Intra-national and international trade openness of Western provinces
Source: Own elaboration based on data from Statistics Canada

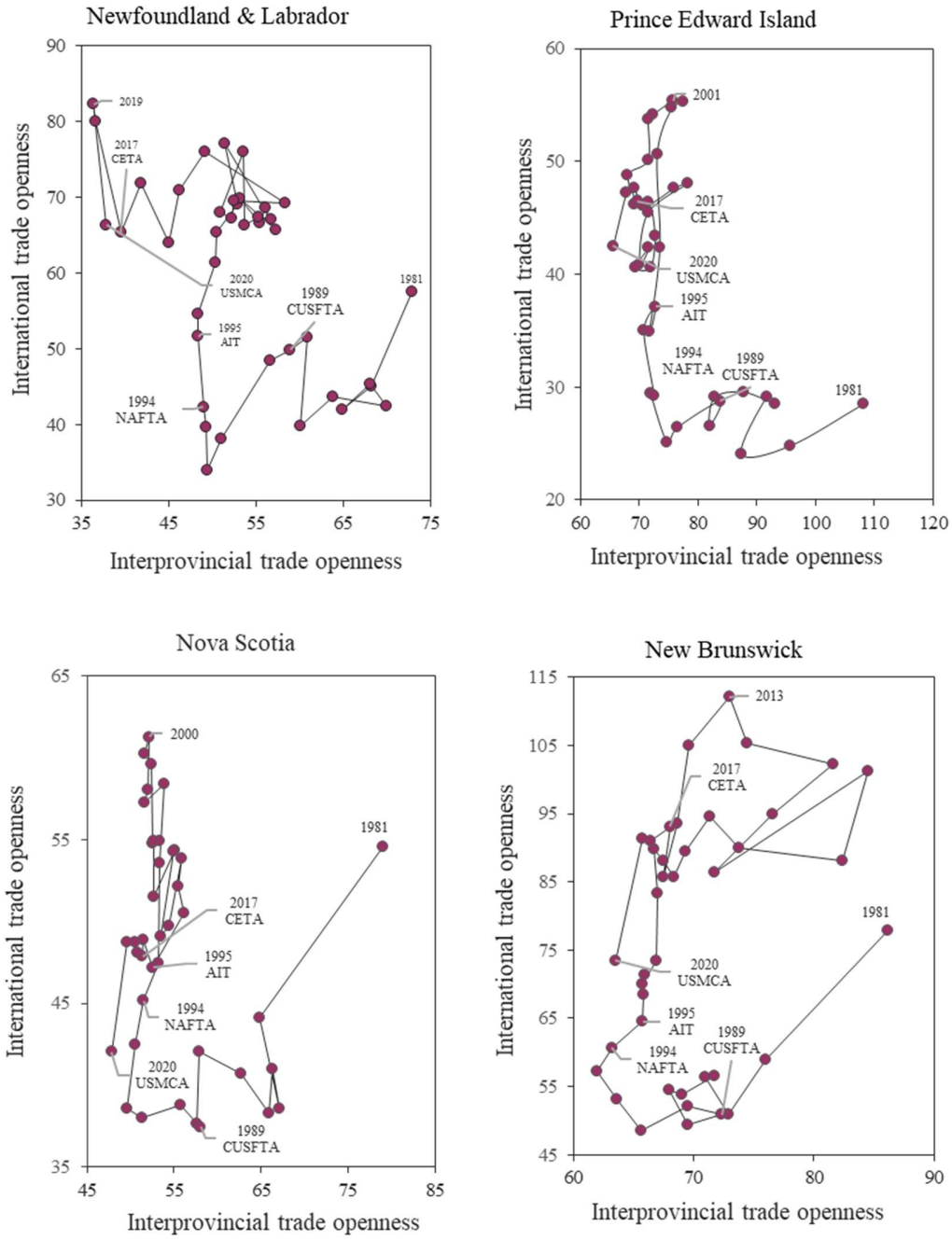


Figure 1.7 Intra-national and international trade openness of Atlantic provinces
Source: Own elaboration based on data from Statistics Canada

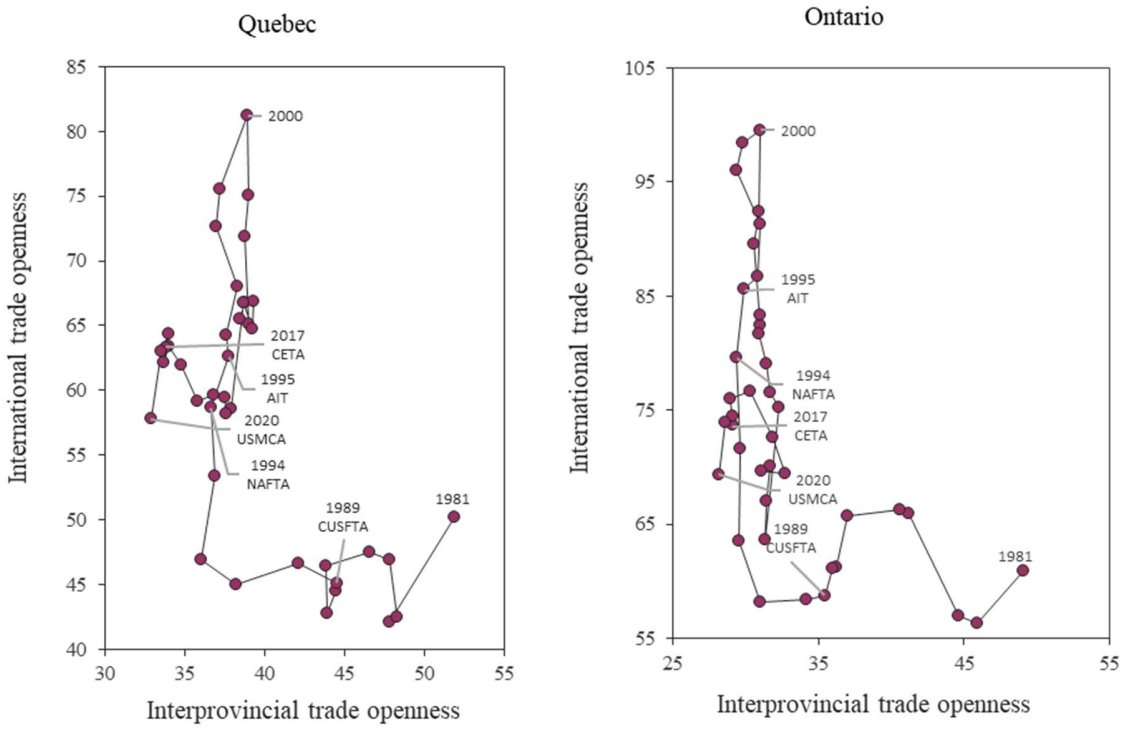


Figure 1.8 Intra-national and international trade openness of Central provinces
Source: Own elaboration based on data from Statistics Canada

Generally, the dynamics of diversion in interprovincial and international openness were mostly pronounced in two large central provinces, Ontario and Quebec. Trade patterns in these two provinces appear to follow the pattern for overall Canada in Figure 1.5. The pattern manifested differently for all other provinces.

Across the four Western provinces, the international trade share was consistently higher than the interprovincial trade share for British Columbia throughout the 1981-2020 period. In contrast, Alberta, Saskatchewan, and Manitoba began to pursue more international openness over interprovincial openness starting from 1993, 1995, and 1997, respectively. Both the international and the interprovincial trade shares increased after 1992 for Manitoba, and 1993 for Saskatchewan and British Columbia. The scatter indicates that the share of interprovincial trade did not decrease substantially for the provinces of Saskatchewan and British Columbia. However, increases in international trade appear to have diverted interprovincial trade for Alberta, Saskatchewan, and British Columbia during the 90s and 2000s.

The four Atlantic provinces depended mostly on interprovincial trade. During the 1981-1991 period, the region experienced a severe drop in both interprovincial and international trade

shares. The international trade shares expanded thereafter, with the interprovincial trade shares staying roughly at the same rate. Coincidentally, most of the decrease in the region's openness domestically and internationally happened during the recession of the early 1980s. The decline in international openness during this time was particularly huge for Newfoundland, Nova Scotia, and New Brunswick. After the enforcement of NAFTA in 1994 and, more recently, the Canada-European Union: Comprehensive Economic and Trade Agreement (CETA) in 2017, the international trade share has expanded in the coastal provinces, especially for Newfoundland and Labrador.

The displacement of interprovincial trade in favor of international trade (for example, province-U.S. states) is the underlying premise in Anderson and van Wincoop's (2003) structural gravity framework of trade, in an attempt to solve the puzzle surrounding Canada-U.S. border effect literature. The dynamics associated with the trade are also an important element in the study of institutional effects, such as the impacts of FTAs on Canadian trade patterns. The FTAs were instrumental in easing both tariffs and non-tariff trade barriers between Canada and countries with trade agreements. The first Canada-U.S. trade agreement came into force on January 1, 1989, and transformed into NAFTA on January 1, 1994, with the inclusion of Mexico. NAFTA was renegotiated immediately after the election of Donald Trump as U.S. president in 2016 and was signed into force on July 1, 2020, as the United States-Mexico-Canada Agreement (USMCA). Among many others, Canada also has a Comprehensive and Economic Trade Agreement (CETA) with the European Union, which provisionally came into force on September 21, 2017. Thus, the empirical analysis of trade patterns in response to changes in trade barriers is a long-standing topic of study in economics (Balassa, 1967).

1.5 Dynamics of provincial exports

Apart from British Columbia, openness to international trade (exports) increased nationally and for the individual provinces in the past three decades, between 1990 and 2022. This is mostly due to the reduction in trade barriers following the signing of the Canada-U.S. Free Trade Agreement (FTA) in 1989, NAFTA (in 1994), and other subsequent FTAs. Inter-provincial trade is continuously giving way to international trade. Generally, this development signals a strong shift to foreign markets in almost all provinces. Figure 1.9 depicts this evolutionary change in the trade (export) pattern for three decades, spanning from 1990 to 2022.

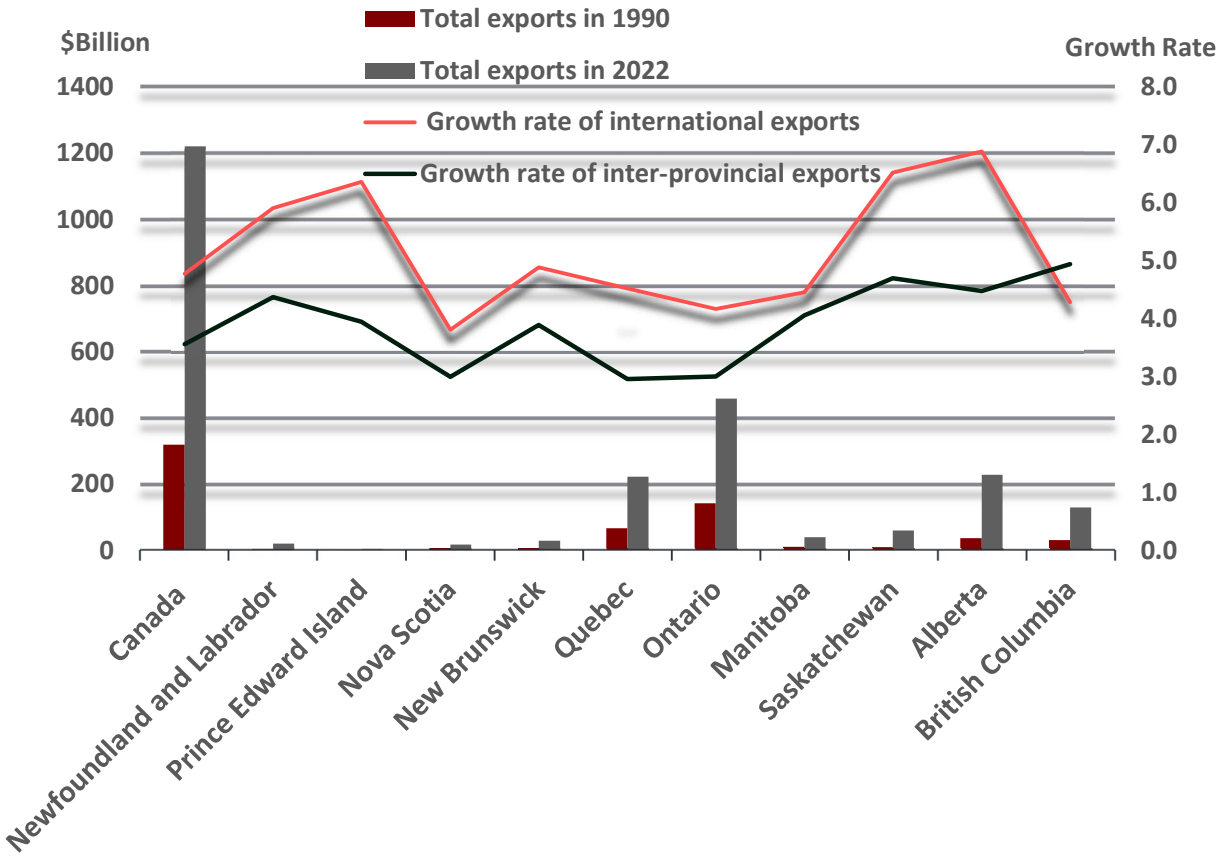


Figure 1.9 Total volume and growth rate of exports by provinces, 1990 and 2022
Source: Own elaboration based on data from Statistics Canada

A look at the frontiers of aggregate evolutionary changes in international and inter-provincial export patterns reveals the two large central provinces of Ontario and Quebec as the key drivers of total Canadian exports, followed by Alberta and British Columbia. Export patterns in these two provinces followed a similar trend to the overall Canadian pattern. The growth of inter-provincial exports in the period from 1990 to 2022 has mainly been driven by British Columbia, Saskatchewan, Alberta, and Newfoundland and Labrador. These provinces are the most open to internal trade (based on the growth rate of internal trade). This is likely to reflect an increase in the value of internal trade in natural resources (crude petroleum, potash, and other minerals).

1.6 Dynamics of provincial imports

The growth pattern in imports also indicates a strong shift to foreign markets in all the provinces. The evolution is such that growth in international imports significantly exceeded that of inter-provincial imports in all the provinces and Canada as a whole. The fastest growth rate in international imports was recorded in the four western and Atlantic provinces, led by Alberta.

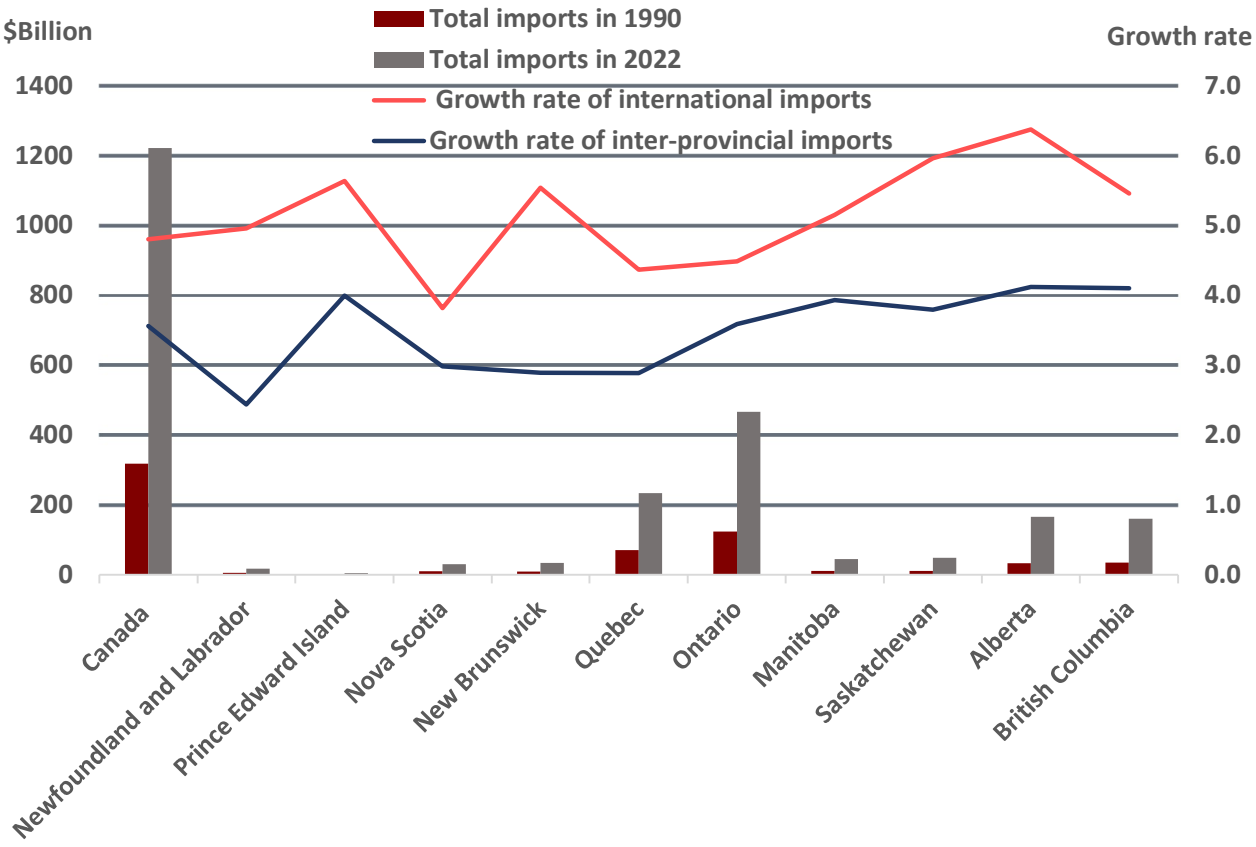


Figure 1.10 Total imports and growth rate for the Canadian provinces, 1990 and 2022
Source: Own elaboration based on data from Statistics Canada

The international-to-inter-provincial import ratio increased between 1990 and 2022 for all the provinces and Canada. Inter-provincial imports have contributed significantly to international imports, indicating the extent to which the provinces have become increasingly open to foreign markets. Figure 1.10 shows that Ontario, Quebec, British Columbia, and Alberta imported more from external sources than from their domestic counterparts. The evolutionary

trend in provincial trade indicates that international trade is gaining more ground than Inter-provincial trade.

1.7 Sectoral profiles of provincial foreign trade

Table 1.1 outlines provincial exports and imports at 4-digit product classification and the resultant balance of trade (with the external partners). Generally, Canada has gained so much from exports of natural resources – thanks to Alberta, Saskatchewan, and British Columbia. Particularly, the current product diversification levels of provinces based on customs data show the western coast of British Columbia as historically known for relying on natural resources such as mining and timber. However, the economy is now benefiting much more from manufacturing, and the province has also recorded tremendous growth from services.

Table 1.1 Top products in exports and corresponding imports by province, 2022

Geography: 4-Digit Product Classifications	Exports (Million $)	Imports (Million $)	Balance of Trade (Millions $)
Canada			
2709 - Crude Petroleum Oils and Minerals	102,742.2	14,732.3	88,009.9
8703 - Motor Vehicles	36,537.1	34,635.3	1,901.8
2711 - Liquefied Petroleum	18,927.4	3,364.5	15,562.9
Newfoundland & Labrador			
2709 - Crude Petroleum Oils and Minerals	7,568.7	-	-
2601 - Iron Ores and Concentrates	3,866.6	-	-
0306 - Crustaceans	1,128.9	5.8	1,123.2
Prince Edward Island			
2004 - Potatoes and Other Vegetables	364.6	-	-
0306 - Crustaceans (in Shell)	327.3	-	-
8411 - Turbojets, propellers, and gas turbines	130.6	0.02	130.6
Nova Scotia			
0306 - Crustaceans	1,749.7	11.6	1,738.1
4011 - New Pneumatic Tires of Rubber	1,136.6	32.5	1,104.1
0307 - Molluscs	264.7	0.5	264.2
New Brunswick			
2710 - Non-Crude Petroleum Oils and Minerals	7,254.2	619.5	6,634.7
0306 - Crustaceans	1,178.6	560.4	618.2
4407 - Lumber (Thickness >6Mm)	979.2	25.6	953.6
Quebec			
7601 - Unwrought Aluminum	8,885.3	115.6	8,769.7
8802 - Helicopters, Airplanes, and Spacecraft	7,218.8	676.4	6,542.4
2601 - Iron Ores and Concentrates	5,204.1	7.1	5,197.0
Ontario			
8703 - Motor Vehicles	34,185.5	27,349.5	6,836.0
7108 - Gold	16,431.3	7,462.4	8,968.9
8708 - Motor Vehicle Parts	12,473.3	15,180.0	(2,706.7)
Manitoba			
3004 - Medicaments	2,184.7	55.2	2,129.5

1001 - Wheat	1,314.6	2.1	1,312.5
0203 - Meat of Swine	1,255.5	67.6	1,187.9
Saskatchewan			
2709 - Crude Petroleum Oils and Minerals	8,632.3	310.7	8,321.7
3104 - Mineral or Chemical Fertilizers, Potassic	7,133.5	1.1	7,132.4
1001 - Wheat	4,126.9	6.3	4,120.6
Alberta			
2709 - Crude Petroleum Oils and Mineral Oils Minerals	84,763.5	2.0	84,761.5
2711 - Liquefied Petroleum	12,070.1	182.3	11,887.8
3901 - Polymers of Ethylene in Primary Forms	5,017.0	165.1	4,851.8
British Columbia			
4407 - Lumber (Thickness > 6Mm)	8,909.6	253.1	8,656.5
2701 - Coal and Solid Fuels Manufacturers	7,095.5	0.1	7,095.4
2711 - Liquefied Petroleum	5,490.0	17.8	5,472.2

Source: Own elaboration based on Canada's Trade Data Online

Alberta has gained significantly from its natural resources, including oil and natural gas. It also has an abundance of zinc, silver, nickel, and uranium. On the other hand, the provinces of Manitoba and Saskatchewan supply over 20% of the world's wheat. These two provinces, including Alberta, also engage in some notable forms of farming that contribute to the national economy. Manitoba has also expanded tremendously in manufacturing in the recent period. Interestingly, today, Canada is on record as the highest producer of potash in the world, all because of the province of Saskatchewan.

Importantly, the central Canadian provinces of Ontario and Quebec form the industrial hub of Canada. They are leaders in a variety of manufactured goods. Ontario is also widely known for its orchards and wine production. The Atlantic provinces of New Brunswick, Nova Scotia, Newfoundland & Labrador, and Prince Edward Island have benefited immensely from fishing and natural resources such as timber and potatoes in Prince Edward Island (PEI). PEI and Nova Scotia have gained more from services when compared to their counterparts in the Atlantic. Lastly, the three Canadian territories are purely driven by natural resources, such as minerals, precious metals, and stones.

The national gain from crude petroleum oil and minerals exports is driven by the 82.5 per cent share from Alberta, 8.4 per cent share from Saskatchewan, and 7.3 per cent gain from Newfoundland & Labrador. Whereas over 93 per cent of national gain from motor vehicles was driven by the province of Ontario, national performance in liquified petroleum was strongly accounted for by Alberta (64 per cent) and British Columbia (29 per cent). Where there were corresponding imports of similar products, all the provinces benefited from the two-way trade, except in the case of motor vehicle parts, in which Ontario imported more than it exported – this

experience is often attributed to increased population-related demand and the recent changes to NAFTA, which took effect in 2020.

High-tech export products with a high intensity of expenditures on R&D, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery. Performance in high-tech exports was led by provinces where the manufacturing sector is the key component of the total exports. High-tech exports stem from motor vehicles and unwrought gold exports from Ontario; unwrought aluminum and aircraft exports from Quebec; pharmaceutical sales from Manitoba; and turbopropeller shipments from Prince Edward Island. These provinces are the leaders in the shipment of manufactured high-tech products to the global markets. At both the national and provincial levels, IIT is strongest for motor vehicles and parts as well as for aircraft, pointing to the strong influence of Ontario and Quebec in the overall Canadian trade.

1.8 Trade pattern and revealed comparative advantage

Several economic studies have reviewed the nature and pattern of provincial trade, especially in terms of North American regional economies and the provinces' trading activities with global partners. Table 1.2 outlines the trade share between top destinations and the rest of the world. The provinces recorded a substantial trade share of the global market. The U.S. is a strategic and important destination for all Canadian provinces. The significant body of evidence in the U.S. market underscores the importance of adjacency, the role of trade policy (especially the NAFTA, currently negotiated under a new name – USMCA), and other key favorable gravity forces such as the large economy and diminishing distance. Newfoundland & Labrador is the main Canadian exporter to both the European Arctic States and the rest of the world. Thus, while the mineral export of Alberta went to the United States, that of Newfoundland & Labrador headed to the European Arctic States and the rest of the world.

The Revealed Comparative Advantage (RCA) accounts for the differences in relative intensity of trade links attributed to each of the provinces in geographical terms. The RCA index was calculated as the ratio of trade with a particular destination to total provincial trade, divided by the share of total trade with a particular destination at the national level. The RCA index shown in Table 1.2 is computed based on:

$$RCA = \left(X_{pj}/X_{pw}\right) \Big/ \left(X_{cj}/X_{cw}\right)$$

Where X_{pj} denotes provincial exports to a particular destination j, X_{pw} is the total provincial exports to the world, X_{cj} denotes national exports to a particular destination j,, nd X_{cw} is Canada's total exports to the world. When the value of RCA exceeds unity (1), province p is said to have a revealed comparative advantage (comparative disadvantage) in destination j. The index revealed a substantial comparative advantage for the provinces in many markets. For example, British Columbia was found to be comparable or better in exports to Japan and China. Saskatchewan and Manitoba also gained an advantage in China, Mexico, Japan, and the Rest of the World (RoW). Among all the provinces, the Atlantic provinces of Newfoundland & Labrador, Nova Scotia, and Prince Edward Island are comparatively stronger in the EU markets. The central provinces of Ontario and Quebec were also revealed to be comparatively better in the EU market. Interestingly, no strong comparative advantage was revealed for many of the provinces in the southern neighbor (United States) market, except for the provinces of Alberta, New Brunswick, Ontario, and Prince Edward Island.

Table 1.2 Export performance and trade specialization indicators for Canadian provinces, 2022

Total exports	**Percentage share of exports to:**						**Revealed comparative advantage (RCA)**						**Export concentration***	
Geography	U.S.	EU-28	China	Japan	Mexico	ROW	U.S.	EU-28	China	Japan	Mexico	ROW	Product	Market
Canada	75.4	7.5	4.4	2.3	1.3	9.1							0.09	0.56
NFD&L	47.2	31.9	7.3	3.3	0.1	10.3	0.6	4.3	1.6	1.4	0.0	1.1	0.37	0.25
PEI	77.0	10.2	1.8	1.1	0.1	9.9	1.0	1.4	0.4	0.5	0.1	1.1	0.17	0.68
NS	63.6	11.1	11.1	1.8	0.9	11.6	0.8	1.5	2.5	0.8	0.7	1.3	0.19	0.44
NB	92.1	1.2	1.1	0.4	0.1	5.1	1.2	0.2	0.2	0.2	0.1	0.6	0.38	0.85
QC	70.6	10.6	4.2	1.9	1.9	10.8	0.9	1.4	0.9	0.8	1.5	1.2	0.05	0.52
ON	80.4	9.4	1.3	0.9	1.2	6.8	1.1	1.3	0.3	0.4	0.9	0.8	0.10	0.61
MB	70.0	2.9	5.5	5.8	3.8	12.0	0.9	0.4	1.2	2.5	2.9	1.3	0.07	0.50
SK	53.7	4.8	11.2	3.7	2.7	24.0	0.7	0.6	2.5	1.6	2.1	2.7	0.15	0.31
AB	88.6	1.1	3.3	1.8	1.1	4.1	1.2	0.1	0.7	0.8	0.8	0.5	0.53	0.79
BC	54.5	4.0	16.5	8.9	0.2	15.8	0.7	0.5	3.7	3.9	0.2	1.7	0.15	0.35

* - Herfindahl-Hirschman Index
Source: Own calculation based on data obtained from Statistics Canada

Canada has a highly concentrated destination market and more diversified products, with most of its exports going to its neighbor and principal trading partner, the United States.

Provincially, Ontario, Quebec, and Manitoba are significantly diversified product-wise, but more concentrated market-wise. Alberta and New Brunswick are indicated to be more concentrated in both product and market-wise. Among all the provinces, Saskatchewan, Newfoundland & Labrador, British Columbia, and Nova Scotia enjoyed a more diversified export market.

Generally, Canada and its provinces have shown strong trade performance with a relatively less diversified export market. Over 75% of foreign sales are still destined for the U.S. alone. Obtained Herfindahl-Hirschman Index (HHI) calculations aligned with expectations, showing a high correlation with the U.S. share in exports. However, in recent years, Canadian exporters have enjoyed remarkable success in penetrating other international markets, with much of the additional growth coming from shipments to Asia and Europe. Sales to China have increased, as have exports to the UK and several other countries.

The United States is far more important to Canada than any other destination. The concentration of Canadian trade with the U.S. is in line with what economic theory predicts. The gravity model of trade tells us that economic size and geographical proximity are the most important determinants of bilateral trade patterns. The reflections are spread across all Canadian provinces, although the story differs in Newfoundland & Labrador, Saskatchewan, and British Columbia, which appear to be more geographically diverse. There is limited evidence indicating the impact of NAFTA on many provinces' trade relationships with Mexico. However, the single-year information representing the provinces' data may not represent a true and comprehensive interpretation of the effect of the FTA.

1.9 Provincial openness to foreign direct investment

Canadian provinces have also seen tremendous openness and growth in global FDI. As a result, production has become increasingly unrestricted by geography. These cross-border investments have produced a strong presence of MNEs that have grown to define the modern economy. By engaging in outward investment, provincial firms have also gained access to foreign markets and achieved better integration into global value chains. Taking advantage of these global value chains can provide firms with productivity and competitiveness benefits that help support the rest of their activities (Poloz, 2012). FDI attraction significantly depends on appropriate policies, infrastructure, and skill base to take advantage of foreign investment.

Figure 1.11 illustrates the shares of enterprise activities[3] in each of the Canadian provinces and the economy as a whole. Multinational firms account for a substantial number of economic activities, including the creation of jobs, the provision of revenues, and the contribution to total value added.

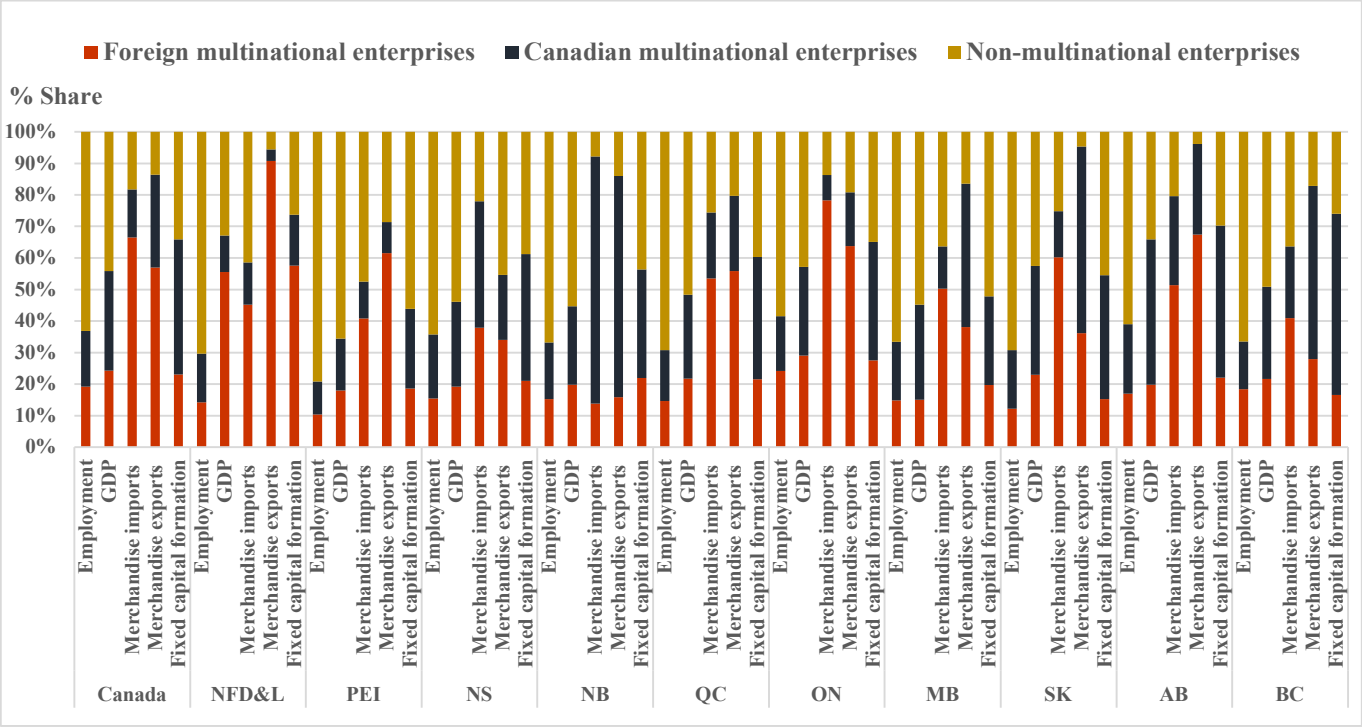


Figure 1.11 Business structure and multinational enterprise activities in Canada by province, 2022
Source: Own elaboration based on data from Statistics Canada

However, two important questions surrounding FDI are whether the investment comes at the cost of domestic jobs or whether it helps support firms' competitive positions as they access new markets and resources. These are important questions, as determining the impact of FDI can have significant implications for the design of investment and trade policies aimed at promoting economic growth. The data on foreign MNEs provides further insight into the effects of FDI in provinces and the impact of foreign MNEs on the provincial economy, while data on Canadian MNEs provide information on the domestic activities of internationally oriented Canadian firms and can be analyzed in conjunction with data on their global activities.

[3] Foreign multinational enterprises (FMNEs) are foreign majority-owned, with Canadian affiliates. Canadian multinational enterprises (CMNEs) are Canadian majority-owned, with foreign affiliates. While non-multinational enterprises are Canadian domestic enterprises that do not control businesses outside the country.

Aggregated data on MNEs is useful for measuring the extent of the globalization phenomenon within the provincial economy, including trade performance.

1.10 Globalization and key performance indicators

Trade openness and FDI are the two major trajectories for the influence of globalization. Through these components, globalization can yield numerous benefits, but it also creates economic and cultural consequences that can be challenging to navigate. The international trade channel has become a fundamental factor influencing the region's economic performance, including the dynamics and volatility of economic growth as well as labor market performance. Increased trade to larger and more diverse markets results in greater revenues and a substantial increase in regional income. One remarkable implication is the continuous reduction in the share of the population living in extreme poverty. GDPpc is a standard metric used for measuring average income. The high inflow of FDI to the regional economy contributes to increased fixed capital formation and employment, resulting in reduced unemployment.

Table 1.3 Key performance indicators by province in 2022

Geography	Trade openness	Capital formation (% of GDP)	Employment rate (%)	Unemployment rate (%)	Multifactor productivity	GDP per capita
NFD & L	1.02	19	49	14	93	86,296
PEI	1.10	22	58	10	113.5	65,654
NS	0.92	23	55	10	115.6	63,579
NB	1.51	19	55	10	104.7	66,941
QB	0.91	22	58	9	105.3	70,862
ON	0.97	25	58	10	106.9	77,622
MB	1.07	20	60	8	100.5	76,272
SK	1.25	22	62	8	94.7	98,797
AB	1.06	23	61	11	98.4	104,725
BC	0.83	29	58	9	106.2	84,058

Source: Own elaboration based on data from Statistics Canada

Table 1.3 summarizes key economic indicators across Canadian provinces in 2022, revealing substantial regional variation in trade openness, capital formation, labor market performance, productivity, and GDPpc. The data indicate that New Brunswick recorded the highest level of trade openness, followed by Saskatchewan and Prince Edward Island, suggesting stronger international trade integration relative to other provinces. In contrast, British

Columbia exhibited the lowest trade openness despite leading in capital formation, implying a more investment-driven domestic economic orientation. Employment rates were lowest in Newfoundland and Labrador and highest in Saskatchewan, while unemployment remained elevated in Newfoundland and Labrador, highlighting persistent labor market vulnerabilities in that province.

Concerning multifactor productivity (MFP), Nova Scotia and Prince Edward Island registered the highest indices, reflecting relatively efficient utilization of capital and labor inputs. Although Alberta and Saskatchewan recorded some of the highest GDPpc figures, their MFP scores were comparatively lower, suggesting a potential disconnect between output levels and productive efficiency. In comparison, Ontario and Quebec demonstrated moderate productivity alongside relatively strong GDPpc, indicating more balanced economic performance. Notably, the relatively high levels of GDPpc across all provinces, despite modest trade openness ratios, suggest that the full benefits of globalization remain underutilized. This points to a significant opportunity for provinces to expand their trade openness in order to enhance competitiveness, leverage global market access, and more effectively integrate into global value chains.

1.11 Conclusion

This chapter offered a comprehensive descriptive analysis of Canada's regional trade dynamics within the broader context of globalization and liberalization. By tracing historical shifts in global trade openness and examining Canada's strategic orientation toward international markets, the chapter establishes a foundational understanding of how trade patterns have evolved. The analysis highlighted the influence of major trade agreements, such as the CUSFTA, NAFTA, its successor, the USMCA, and the CETA, in reshaping Canada's external trade profile. The chapter further emphasized how declining transaction costs, increasing FDI, and institutional liberalization mechanisms contributed to a marked shift in trade orientation from interprovincial to international trade, with trade openness rising strongly since the 1980s.

At the subnational level, the findings revealed considerable heterogeneity in provincial trade responses to globalization. Ontario and Quebec exhibited trade patterns consistent with national trends, underscoring their dominant role in shaping aggregate Canadian trade. Western provinces such as British Columbia, Alberta, Saskatchewan, and Manitoba displayed more

pronounced shifts toward international trade. In contrast, the Atlantic provinces remained more reliant on interprovincial exchanges until the implementation of later trade agreements. The structural evolution of trade openness demonstrated a persistent trend of increasing international trade shares relative to interprovincial trade across most provinces. Sectoral trade profiles and revealed comparative advantage indicators further underscored the distinct economic specializations and market orientations of each province, reflecting both geographic and policy-driven trade trajectories.

The chapter also contextualized the role of multinational enterprises and FDI in facilitating provincial integration into global value chains. Multinational firms were shown to contribute significantly to capital formation, employment, and productivity gains across provinces, reinforcing the economic importance of external engagement. Despite some diversification toward Asia and Europe, Canada's export profile remains heavily reliant on the U.S. market. Provincial trade openness, productivity, and capital formation indicators confirmed the uneven but growing influence of globalization across regions. These insights offer a valuable empirical foundation for the subsequent chapters, which will explore the determinants of trade flows and the institutional effects of globalization through formal econometric modeling.

CHAPTER 2 LITERATURE REVIEW

This section discusses the review of existing literature on regional trade, with a particular focus on the influence of globalization. **The first part** explores the theoretical literature on trade, analyzed using three main steps: The basic theoretical foundations of trade, which elaborates on the basic frameworks linking regions to international trade; The theoretical linkage of the region's foreign trade to globalization, which explains the usefulness of theories in region's trade interpretation and relations to globalization; The theoretical unification, which discusses the convergence of various trade theories to the framework of gravity to analyze the region's trade dynamics; and the foundation of IIT and its components. **The second part** discusses empirical literature, which is divided into three empirical reviews and provides a comprehensive outline of existing empirical evidence. It includes the empirical review of the foreign trade of regions, the empirical review of foreign trade of the Canadian provinces, and the empirical review of the region's foreign trade with a focus on the impact of globalization. **The third part** provides the analytical framework, which outlines the hypotheses drawn from the reviewed theoretical and empirical literature. **The final part** is the conclusion that summarizes the sections.

2.1 Theoretical foundation of trade

This sub-section establishes the theoretical basis for analyzing how Canadian provinces participate in international trade. It outlines key frameworks linking regional economies to global markets, synthesizes trade theories in the context of globalization, and traces the evolution of the gravity model. It then introduces the conceptual foundations of IIT, its decomposition into horizontal and vertical components, and the main determinants influencing its variation across regions. This foundation supports the empirical analysis that follows.

2.1.1 Basic theoretical foundations linking regions to international trade

The underlying concepts linking regions to the international market can be drawn from the base economic theories and models originally drafted to explain trade at the country level. Starting with the sixteenth-century pre-Smithian Mercantilism, which resonated

with many manufacturers and advocated for a favorable balance of trade, seems somewhat useful for the regions as small open economies (SOEs) participating in the global market (Landreth, Szeworski, Godłów-Legiędź, Dzionek-Kozłowska, &Colander, 2013). The complete application of the concept to regional analysis poses some difficulty due to its domineering monetary policy component, which is not determined at the regional level. Through an active foreign trade policy, mercantilists advocate a favorable balance in trade by increasing exports and decreasing imports. While these policy pursuits are still relevant today, such policies relating to foreign trade are not conducted at the regional level. However, regions with strong production bases can influence national trade policies. The implication is that regions are not completely barred from pursuing the aspiration of achieving a trade balance to attain their competitiveness (Umiński & Fornalska-Skurczyńska, 2020). In line with the mercantilist model, regions hosting many firms participating in global trade can engage in protectionist policies such as antidumping or anti-subsidy procedures to safeguard their interests from threatening foreign competitors. Although the era of mercantilist economic philosophy has passed, it remains an interesting concept for understanding the regions' participation in world trade.

Free trade, as opposed to the Mercantilist policies of protection, was championed by both Smith and Ricardo to achieve production efficiency at a global level. The Ricardian model explains the volume and patterns of trade and supports the idea that trade is mutually beneficial (Feenstra & Taylor, 2014; Gandolfo, 2014). The model is consistent with the analysis, revealing the extent to which economies are competitive in the global market. Ideally, countries should not be held to absolute advantages due to impediments such as high production costs or low productivity. However, countries can engage in comparative patterns of specialization that offer products to the external market, in which they can benefit from trade engagement. Comparatively, both absolute and comparative advantages produce an equilibrium that generates benefits from trade in an open economy rather than autarkic states. One of the problems here is that the model also accounts for a closed-economy situation, though in the real world, no country is completely closed to absolute self-sufficiency. However, regional economies dominated by low export-oriented industrial sectors may be considered as being closer to an autarkical state. In other words, it is easier to find an almost autarkical region than a country, especially if the analysis is performed at a low level of region delimitation (Umiński & Fornalska-Skurczyńska, 2020). The world's demand for goods determines the equilibrium relative price ratio of goods in free trade and, therefore, the split of the gain from trade between

countries. The international price ratio (terms of trade) and the relative wage ratio are closely related to each other.

Ricardo's cost calculations, despite his concerns about the introduction of machinery on a large scale, were based on labor hours, which were treated as a single homogeneous input with production (in a two-commodity world) subject to constant costs. With any given quantity of labor L_1, t ,is possible to obtain an amount of cloth (x) as $[x = \frac{L_1}{a_1}]$ where a_1 is the unit cost of producing cloth – a constant because of the assumption of fixed technical coefficients. With the same amount of labor, we can obtain $[y = \frac{L_1}{b_1}]$ of wine (y). If we divide y by, x we get:

$$\frac{y}{x} = \frac{\frac{L_1}{b_1}}{\frac{L_1}{a_1}} = \frac{a_1}{b_1}$$

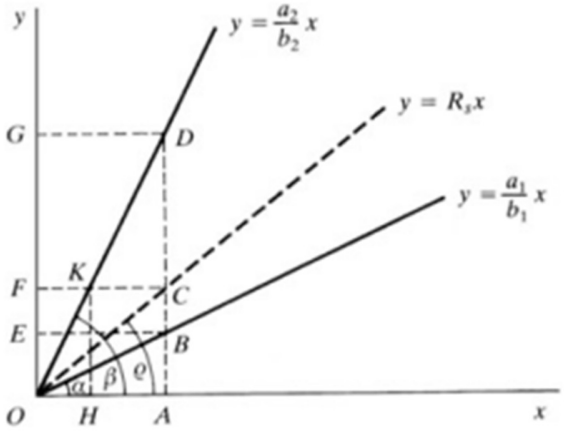
such that:

$$y = \frac{a_1}{b_1}x$$

where a_1/b_1 is the comparative cost expressing the exchange ratio of the two commodities, analogously, the same result could be arrived at for the second country, as:

$$y = \frac{a_2}{b_2}x$$

There is a difference between the comparative costs such that $a_1/b_1 \neq a_2/b_2$ as indicated in the graphical representation below:



The primary properties of straight lines show that while ${}^{a_1}/_{b_1} = \tan\alpha$, ${}^{a_2}/_{b_2} = \tan\beta$. The comparative costs are given by the slopes of the straight lines. The necessary condition for international trade is drawn from the fact that the two comparative cost boundary lines cannot coincide. There are terms of trade denoted by R_s that define the nature of exchange and are assumed to be the line at which the sufficient condition for international trade is met. Hence:

$$\frac{y}{x} = R_s$$

Figure 2.1 Comparative costs representation
Source: Giancarlo Gandolfo (2014)

such that:

$$y = R_s x$$

The assumption is that ${}^{a_1}/_{b_1} < {}^{a_2}/_{b_2}$ holds, then the inequality ${}^{a_1}/_{b_1} < R_s < {}^{a_2}/_{b_2}$ also holds. Conversely, if ${}^{a_1}/_{b_1} > {}^{a_2}/_{b_2}$ then the condition would be ${}^{a_1}/_{b_1} > R_s > {}^{a_2}/_{b_2}$. The assumed inequality is the same as $\tan\alpha < \tan\varrho < \tan\beta$.

If this condition is satisfied, international trade will take place, and it will be profitable for country 1 to specialize in the production of x and for country 2 to specialize in the production of y. The country whose line representing its comparative cost lies between the line indicating the terms of trade and the horizontal axis will find it profitable to specialize in the production of (and in any case to export) the good measured on this axis, while the country whose comparative-cost line lies between the terms-of trade line and the vertical axis will find it profitable to specialize in the production of (and in any case to export) the good measured on this axis.

The Ricardian model, while originally designed to explain trade between countries, can be adapted to analyze trade dynamics at the regional level. This adaptation provides useful insights into how regions within a country or across borders engage in trade based on differences in productivity. This concept helps explain why certain areas develop specific industrial clusters (e.g., Silicon Valley for technology, Alberta for energy production) (Krugman, 1991). Regions often have distinct comparative advantages due to differences in resource endowments, labor productivity, or industrial expertise. For example, differences in natural resource endowments and productivity lead to trade, where regions specialize based on comparative advantage

(Brown, 2003). The Ricardian model can explain why regions concentrate on producing goods where they have relative efficiency and engage in trade for other goods. By isolating productivity differences as the driver of trade, the Ricardian model provides a clear and straightforward framework to examine trade patterns at the regional level. It is particularly useful for introductory analysis and theoretical exploration of regional trade (Samuelson, 2001). However, the practical application of the Ricardian model to regional analysis requires adjustments to address real-world complexities such as factor mobility, economies of scale, and trade costs. By integrating the Ricardian model with insights from economic geography and multi-factor trade models, it remains a valuable tool for regional economic analysis and policy formulation.

The Heckscher-Ohlin (H-O) model extends the concept of comparative advantage by incorporating factor endowments, suggesting that countries will export goods that use their abundant factors intensively and import goods that use their scarce factors intensively (Bowen et al., 2012). The model considers the international exchange of commodities as indirect factor arbitrage, transferring the services of otherwise immobile factors of production from locations where these factors are abundant to locations where they are in short supply (Leamer, 1995). As a neo-classical model, the theory draws from the four components comprising the factor price equalization theory[4], Stolper-Samuelson theory[5], Rybczynski theorem[6], and the base trade model of Heckscher-Ohlin[7]. Relative factor intensity is the core of the H-O model, often employed to analyze inter-industry trade types. As earlier stated, H-O theory depends on the assumption that trading partners are different in terms of their essential disparities relating to factor endowment. Two approaches can be deduced on how the differences can be defined, which, though, is a complete departure from the strict interpretation of the basic H-O theorem. As expressed by Umiński and Fornalska-Skurczyńska (2020): (i) a

[4] The factor-price equalization theorem states that, under certain conditions, free trade in final goods is sufficient to bring about complete international equalization of factor prices. The general version can be illustrated by the dual relations due to Jones (1965).

[5] Stolper and Samuelson (1941) state that an increase in the relative price of a good increases the real return to the factor used intensively in the production of that good and reduces the real return to the other factor. The model assumes that the economies always remain incompletely specialized.

[6] Rybczynski (1955) states that an increase in the relative endowment of a factor will increase the ratio of production of the good that uses the factor intensively and decrease the output of the other good, at unchanged commodity and factor prices. The model likewise assumes that the economies always remain incompletely specialized. Rybczynski's theorem presented the point of departure for analyzing the impacts of an increase in factor endowments.

[7] According to Heckscher (1919) and Ohlin (1933), "a country having capital in abundance will produce goods that are capital-intensive, and a country having abundant labor will produce labor-intensive goods".

region can be compared to other regions within a country, participating in international trade; (ii) or it can be compared to the "rest of the world", which obviously would require the much more comprehensive and larger dataset to be included in the analysis. Empirical research can display flexible approaches to applying the framework. H-O is one of the most important conceptual frameworks, constituting the fundamentals of international trade analysis. One important question, however, borders on the extent to which the H-O model is useful to explain contemporary international trade, in which trade shifts more towards trading partners with similar ("less different") levels of endowment or development.

One of the problems with the H-O model lies in its inability to allow for generalization beyond the assumption of two industries and two-factor inputs (Helpman and Krugman, 1985). However, Deardorff (1982) made a slim attempt to portray a generalizable H-O theorem by arguing that countries are most likely to export those goods they produce with intensive use of their abundant factors. The H-O theory was expanded to incorporate capital and differentiated labor factors, such as skilled and unskilled labor. The neo-technological theorists have also highlighted the technological differences as an important complement to the H-O model. Analysts such as Hufbauer (1970) and Krugman (1979) have argued that international trade is observed due to different levels of specific knowledge and technology advancement as well as the inability of other countries to fast-track and freely gain access to technical knowledge. The set of neo-technological theories is often referred to when analyzing trade flows of regions. According to Umiński and Fornalska-Skurczyńska (2020), differences in the technological advancement of production might be observed between regions, constituting the base of competitive advantages.

The regional differences seem to be captured in the initial H-O model following the lumpy country concept attributed to Courant and Deardorff (1992). The implication is that factor proportions, which are mostly unequal, as maintained by each country's regions, can lead the individual regions to specialize in exports and imports of different products. Consequently, this trend reveals an important specialization of individual regions' trade. Courant and Deardorff (1992) have argued that a nation's foreign trade with equal distribution of factors among its regions will be different from a situation in which there is significant disparity among regions in terms of their factor endowments. Thus, regional differences in factor endowment determine a nation's foreign trade. Due to the resulting differences in the relative marginal cost of production, countries export goods in which they have abundant factors. Relative factor intensity is the core of the H-O model, often employed to analyze inter-industry trade types.

In a perfectly competitive market, a country abundant in a given factor has a production bias favoring the commodity that uses that factor more intensively. Thus, under a market with zero economic profit and full-employment relations, the factor abundance can physically be defined as:

$$P_j = \omega a_{Lj} + r a_{Kj}, \qquad j = A, B$$
$$a_{KA}A + a_{KB}B = K,$$
$$a_{LA}A + a_{LB}B = L,$$

All factors earn the values of their marginal products obtained such as:

$$\frac{a_{KA}A}{L} + \frac{a_{KB}B}{L} = \frac{K}{L},$$
$$\frac{a_{LA}A}{L} + \frac{a_{LB}B}{L} = \frac{L}{L} = 1.$$

The productivity of labor (L) in products A&B, respectively, can be expressed as: A/L and B/L in terms of the remaining quantities, namely:

$$A/L = \frac{a_{LB}K/_L - a_{KB}}{a_{KA}a_{LB} - a_{KB}a_{LA}}, \qquad B/L = \frac{a_{KA} - a_{LA}K/_L}{a_{KA}a_{LB} - a_{KB}a_{LA}}$$

Where the output ratio (A/B) can be expressed in terms of the factor endowment ratio (K/L), given the technical coefficients a_{ij}.

$$\frac{A/L}{B/L} = \frac{A}{B} = \frac{a_{LB}K/_L - a_{KB}}{a_{KA} - a_{LA}K/_L}$$

The coefficients depend on the factor-price ratio, which is constant for any output level owing to the assumption of constant returns to scale. If there are no incidents of factor intensity reversal, that is, if the relative price of goods $(P_B/P_A)$for the relative price of factors (P_L/P_K) is either always positive or always negative (i.e., monotonic), and if and only if ϱ_A is either always greater or always smaller than ϱ_B (i.e., either $\varrho_A > \varrho_B$ *or* $\varrho_A < \varrho_B$). Therefore, for any factor-price ratio, we can compute the derivative as:

$$\frac{d(A/B)}{d(K/L)} = \frac{a_{KA}a_{LB} - a_{LA}a_{KB}}{(a_{KA} - a_{LA}K/L)^2} = a_{LA}a_{LB}\frac{\varrho_A - \varrho_B}{(a_{KA} - a_{LA}K/L)^2}$$

holds for both countries. If we assume that commodity A is capital intensive, the derivative under consideration turns out to be positive, that is, the greater the factor endowment ratio (K/L) the higher the output of A relative to B, and vice versa. Since the production functions are assumed to be internationally identical, the above result holds for both countries.

Factor prices and terms of trade can affect the general equilibrium in open economies and international Trade. It can be easily shown that when trade is opened up, exchanges are possible only if the international price ratio or terms of trade lie somewhere between the two internal equilibrium price ratios. With free trade, perfect competition, and no transport costs, the same commodity must have the same price everywhere (the law of one price), so that the international and the national price ratios are the same (the factor price equalization theorem).

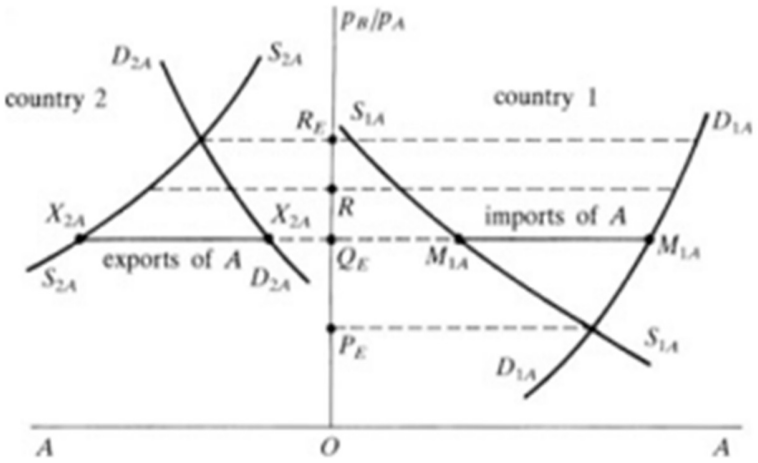


Figure 2.2 Determination of international equilibrium
Source: Giancarlo Gandolfo (2014)

If terms of trade are higher than OR_E , both countries would demand commodity A internationally, because in both, there would be an excess demand for this commodity, and no equilibrium would be possible. Similarly, if terms of trade are lower than OP_E, both countries would supply commodity A internationally, since both countries would face an excess supply of this commodity. Therefore, only intermediate terms of trade are to be considered, since

between OP_E, and OR_E, country 1 will demand, and country 2 will supply, commodity A. International equilibrium will be established at the terms of trade OQ_E, where $M_{1A}M_{1A} = X_{2A}X_{2A}$, where the excess demand for good A by country 1 (country 1's demand for imports) is exactly matched by the excess supply of the same commodity by country 2 (country 2's supply of exports). This can be seen as a stable equilibrium under the usual assumption of dynamic behavior, implying that price varies according to excess demand. There is an equilibrium between demand and supply in the terms of trade OQ_E. When the term of trade is OR, in country 1 there is still an excess demand for commodity A (and so an excess supply for commodity B) though smaller than before, whereas in country 2 an excess supply of A (and so an excess demand for B) has appeared. As earlier stated, the terms of trade which equate demand and supply in the international market for commodity A must necessarily equate it in the other market. In each country, the total value of demand equals the total value of supplies. In keeping with the assumption that the subscripts 1 and 2 refer to countries 1 and 2, we have:

$$P_A D_{1A} + P_B D_{1B} = P_A S_{1A} + P_B S_{1B}$$
$$P_A D_{2A} + P_B D_{2B} = P_A S_{2A} + P_B S_{2B}$$

By summing up the two equations:

$$P_A(D_{1A} + D_{2A}) + P_B(D_{1B} + D_{2B}) = P_A(S_{1A} + S_{2A}) + P_B(S + S_{2B})$$

International trade requires that the total value of world demand equals the total value of world supplies.

$$P_A[(D_{1A} - S_{1A}) + (D_{2A} - S_{2A})] + P_B[(D_{1B} - S_{1B}) + P_B(D_{2B} - S_{2B})] = 0$$

Indicating that the sum of the values of the world's excess demands must equal zero for any admissible value of P_A and P_B.

So, at the level of regions, it is highly probable that a region relatively endowed with labor will import goods that require intensive use of the scarce (and relatively expensive) factor (Feenstra & Taylor, 2014). Most likely, another region specializes in producing and exporting capital-intensive goods. The extent of factor endowment constitutes a strong precondition for competitiveness that enables the region to benefit from international trade.

However, "overlapping demand" patterns of trade due to preference similarity can cause disequilibrium in the terms of trade (Linder, 1961). The model predicts that in countries with

similar demand, the same (or similar) industries will develop. As demand appears to stimulate trade between countries, producers yearn for a market in which they can satisfy demand, which resembles the one they know from their domestic market. Thus, the intensity of trade is positively associated with the similarity in the structure of demand. Linder's notion of trade overrides the earlier emphasis on supply-based explanations of trade in terms of comparative cost or factor endowments. To capture the similarity in demand preferences, the model introduced GDPpc as an important proxy and claimed that if markets are similar, the so-called transfer costs of reaching these markets can be reduced, especially where the scope of necessary product adaptation is lower. The model has rich potential for explaining IIT, product differentiation (or "sophistication", as Linder puts it), or even South-South trade of recent years; the theory, however, was rather neglected in the literature. The frontier of demand and supply explains the equilibrium of the market, illustrating the quantity supplied and demanded by trade partners. These two-way interaction curves could be useful if regions are considered small open economies (Umiński & Fornalska-Skurczyńska, 2020). It points to the realization that an indifferent map could be constructed for regions as much as they are created for individual consumers and national economies in the international economics literature.

The traditional trade theories were unable to explain the huge proportion of trade between nations with similar factor endowments and intra-industry types, which dominate the trade of developed economies. In contrast to the "old trade theories", the New Trade Theory (NTT) does not base its explanations of trade patterns and gains from trade on a given comparative advantage. It sets the focus on IIT patterns – the simultaneous exports and imports of similar goods and attempts to explain observable specializations and patterns of trade between countries that do not differ in terms of technology and endowments. The NTT explained world trade based on flexible trade assumptions and certain market situations, including factor endowments, product differentiation and homogeneity, economies of scale, monopolistic competition, or oligopolistic behavior (Krugman & Obstfeld, 2005). NTT relies on the markets for commodities that exhibit purely competitive behavior, and production processes that are not characterized by constant returns to scale. Seminal contributions in this regard were made by Krugman (1979; 1980, 1981) as well as Lancaster (1980), Helpman (1981), and Helpman and Krugman (1985). Krugman mentioned Balassa (1967) and others for that insight and revealed that "the role of economies of large-scale production is a major sub-candidate in the work of Ohlin (1933)" (Krugman, 1979). The proposition by Ohlin is mostly known for having combined Heckscher-Ohlin's theory of international trade, based on the relative scarcity of

factors of production, with Cassel's (1924) general equilibrium framework to yield the theorems of factor proportions and factor price equalization. Krugman (2002) indicates that internal economies of scale imply imperfect competition, arguing that there were no general equilibrium models of imperfect competition (Krugman, 2008). However, the advent of the Dixit-Stiglitz (1977) model of monopolistic competition changed everything. Dixit-Stiglitz's model relates to IIT on account of its recognition of horizontal differentiation of goods, which occurs when the manufactured product varieties differ in their actual or perceived characteristics. Each country produces half of the range of product varieties. Moreover, because of the identical production cost for all the varieties and the possibility to dispose of the quantity of any new variety produced, a firm in the first country that was producing a previous variety identical to one produced in the second country, can undertake the production of those varieties that any other firm does not produce. So, if the total fixed labor supply is L, then the number of firms (n) involved can be determined as:

$$n = \frac{L}{l} = \frac{L}{\alpha + \beta x_k}$$

As each country produces (n)varieties at a similar production cost and disposing at the earlier price, the free trade equilibrium will be equal to the equilibrium in a state of autarky. All the consumers gain from trade due to the availability of a wider variety of goods, made possible as a result of their “love of variety”. Production by firms increases, with real wages remaining exactly equal in the two countries. This implies that both countries gain in terms of welfare increase, due to the resulting IIT. In general, the model suggested by Krugman was able to infer how each of the countries will produce one-half of the range of product varieties and engage in trade (especially within the same industry) but fails to tell which of the varieties will be produced by each country. Venables (1984, 1985, and 1987) extended the Krugman-type model, with the assumption of identical goods produced through constant production costs. The author modeled the possibility of multiple equilibria even in such a scenario where one country specializes in the production of identical goods. In contrast, the other country specializes in the production of differentiated goods. In the model of Lawrence and Spiller (1983), two key conclusions were reached that are almost similar to the basic H-O model and the model proposed by Falvey (1981). First, they observed that whereas in the capital-abundant country, the number of varieties will increase, in the labor-abundant country, the number diminishes. Second, the authors propose that the scale of production of identical goods increases in labor-abundant

countries. In contrast, a similar expansion in the scale of production of differentiated products takes place in capital-abundant countries. Helpman (1987) produced pioneering work that, for the first time, confronted the monopolistic competition model with data and showed that its main predictions were consistent with manufacturing trade between advanced industrial economies.

In a Neo-Hotelling Model, Lancaster (1979; 1980) explained the existence of IIT based on a product differentiation model. The model assumes that there are two identical countries. It also assumed the existence of two sectors – the manufacturing sector, which produces differentiated goods (produced under increasing returns to scale), and the agricultural sector, which specializes in the production of homogeneous goods (produced under constant returns to scale). While the market for homogeneous agricultural goods is perfectly competitive, the market for differentiated manufactured goods is oligopolistic. There are two production factors, of which one is immobile labor, and the other is a sector-specific factor. Firms are free to enter and exit the industry and have the flexibility to engage in the production of any variety of their choice. The cost of producing any variety is the same. On the demand side, the individual consumer is said to have the ideal variety for which he expresses maximum willingness to pay. Demand for variety depends on its market price, the income of the consumer, and the availability of other varieties (i.e., the degree of entry and competition). As observed by Lancaster, because firms are free to enter and exit the industry at will, including their possession of equal preferences and coupled with an identical cost function, the long-run equilibrium will result, such that the actual varieties produced by firms, which make up the whole array of varieties, are evenly spaced. Firms produce each variety equally and sell at the same price, to ensure that all firms only obtain normal profits. This situation is what Lancaster referred to as 'perfect monopolistic competition'. Consumers in both countries consume all varieties. Each country produces exactly half of the varieties in line with the symmetric assumption upon which the model is based. Half of what each firm produces is sold domestically, while the remaining half is shipped to other countries as an export. This implies that consumers in each country have dual preferences inclined to home variety and variety from the other country. While there is no trade in agricultural goods, trade is expected to balance since each country exports the same number and quantity of goods at the same price. Like the model proposed by Krugman, it is almost impossible in this model to predict which of the countries will produce what varieties. As trade occurs, the increased output drags down the average cost, leading to firms posting super-normal profits. However, the entry of new firms will result in a new equilibrium with a large number of

varieties, which are still identified evenly throughout the product series. The effect can be explained by the trade equilibrium for a typical firm pre- and post-trade in the manufacturing sectors.

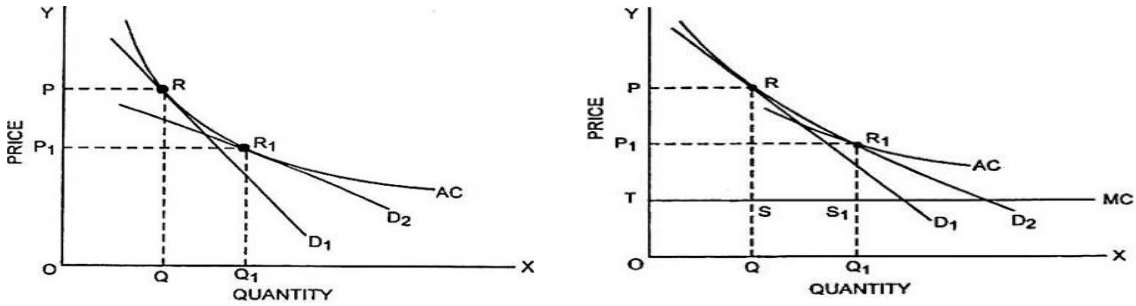


Figure 2.3 Demand/supply-side manufacturing trade equilibrium
Source: Own elaboration

From the price and the marginal cost (MC), the before- and after-trade producers' surplus are equal:

$$(P - MC)Q = (P_1 - MC)Q_1$$

The before-trade and after-trade producers' surplus have remained similar. However, in a situation of a non-linear cost function, the possibilities are that the level of the producer's surplus may rise or fall. Granted that the distribution of gains from free international trade engagement is complex, yet the total consumer surplus after trade is likely to be larger than the pre-trade level, due to the increased number of varieties available at a lower price (also connected to the horizontal differentiation).

In what is referred to as the Neo-Heckscher-Ohlin Model, Falvey and Kierzkowski (1987), and Flam and Helpman (1987) attempted to explain the IIT based on the concept of factor endowments, such that product specifications were linked to different combinations of basic factors such as labor (W) and capital (r), considered to be homogenous. Whereas industries with similar factor endowment produce identical products, industries with different factor endowment produce differentiated goods, based on quality. The implication is that vertical differentiation leads to product differentiation. In a world of two countries (capital-abundant A

and labor-abundant B) and differences in unit costs of production (C), the marginal product quality ($\emptyset$) differentiating Country A and Country B can be defined:

$$C_B(\emptyset) - C_A(\emptyset) = \frac{W_A - W_B}{r_B - r_A}(\emptyset - \widetilde{\emptyset})$$

Intuitively, differences in the unit costs of producing the product of quality $\emptyset$ between the two countries determines comparative advantage. If the production cost per unit is lower in country A than in country B, i.e., $C_A(\emptyset) < C_B(\emptyset)$, then country A will have a comparative advantage over B in the production of the given variety of good N. Considering the quality uniqueness of both countries, if $\widetilde{\emptyset} < \emptyset$, the comparative advantage of A over B will continue to hold since the $C_B(\emptyset) > C_A(\emptyset)$ and $W_A > W_B$. The capital-abundant country A, with relatively cheap capital, has a comparative advantage in the production of those varieties of good N comparably having a quality that is far above the marginal quality (Falvey and Kierzkowski, 1987). In this case, country A exports capital-intensive superior product varieties, while country B with labor abundance ships labor-intensive goods and lower quality capital-intensive good varieties. This type of trade between country A and Country B in a particular industry explains the applicability of the H-O model in the explanation of IIT between different countries.

The development of international trade theories based on imperfectly competitive behavior has likewise made great strides in recent years, with manifested scenarios along two different lines. The first analysis examines international competition between large firms with monopolist tendencies in each country. In contrast, the second analysis focuses on oligopolistic behavior, where new firm entry is made difficult, leading to equilibrium profits. The intervention of governments is important because they may act to protect their local firms, which could lead to a strategic advantage over competitors in other countries, thereby securing profits from international markets. These points to the reasons for which a nation's commercial policy (tariffs, subsidies, and other ways in which countries interfere with free trade) is appraised. Krugman (1987) argues that the new trade theory "has given at least the appearance of greater concreteness to the theoretical case for government intervention to promote external benefits.

One of the questions of interest borders on how the crucial market and technological characteristics on which the new trade theory builds are identified features of regions such as the Canadian provinces. These are questions about market structure, economic size, and the technological character of exports. NTTs suggest that regions with

industries benefiting from increasing returns to scale can dominate specific trade sectors, even without inherent resource advantages. Thus, regions specializing in manufacturing due to large-scale production capacity can emerge as global suppliers despite limited natural resources, which implies that NTT provides a framework to boost trade by leveraging economies of scale and investing in industry-specific innovation. Policies that reduce transport costs or enhance connectivity can integrate these regions into global value chains. Under monopolistic competition, regions can develop niches by producing differentiated products and attracting foreign markets. Technological advancements and innovation are central to NTT, emphasizing that regions investing in R&D gain a competitive edge in high-tech and knowledge-intensive industries. NTT also links trade patterns to the spatial concentration of industries. Regions with established industries can create "agglomeration economies", attracting more firms and fostering trade competitiveness. This explains why some regions dominate certain export categories due to their ability to maintain a comparative advantage through innovation and industrial clustering. Federations like Canada, where provinces have varied industrial bases, illustrate NTT's relevance. Provinces can specialize in industries where they have scale advantages or comparative efficiencies, such as Alberta's energy exports versus Ontario's manufacturing exports. New Trade Theories provide a robust framework for analyzing how regions engage in foreign trade. By considering factors like economies of scale, product differentiation, and strategic policy interventions, these theories shed light on both the opportunities and challenges faced by regions in an interconnected global economy.

The New Economic Geography (NEG) analyses the spatial distribution of economic activity and trade, emphasizing the effects of agglomeration and reduced transportation costs (Krugman, 1991; Krugman & Venables, 1995; Venables, 1996). The model provides a general hypothesis for the centrifugal and centripetal forces that lead to the core/periphery dynamics observed in the concentration of firms (Fujita & Krugman, 2004) and maintains that agglomeration, or the clustering of economic activity, occurs at many geographical levels with a variety of compositions. NEG was built on the stronger role of the firm, complemented by imperfect competition, transportation costs, and increasing returns at the firm level. This shows how the interactions among transport costs, increasing returns at the firm level, and supply and demand linkages shape and change the location of economic activity. The model argues that the distribution of firms in a given region will depend on economies of scale and transportation costs. NEG explains spatial concentration and specializations leading to persistent regional economic differences and offers an interpretation of the interactions between the global and

regional economies. The model builds location theory with international trade theory into a comprehensive, universal analytical tool (Cieślik, 2005). The propositions of NEG perfectly align with the analysis of the region's international trade, as it tackles how agglomeration and dispersion forces interact to generate observed spatial configurations and uneven distributions of economic activity, including trade. The agglomeration of exporters and export volumes in the metropolitan areas and the regions is best interpreted by the NEG approach. These regions are located close to the most important export markets due to lower trade costs. The heterogeneous operations of the Canadian provinces in foreign markets point to the reference of NEG by Venables and Krugman (1990). Consequently, the concentration of activities in the metropolitan provinces has diminished the positions of the peripheral provinces, from which many firms have retreated. The associated detrimental risks on the economic activity of peripheral regions have been well documented in Brakman, Garretsen, Gorter, van der Horst, and Schramm (2005). Moreover, the large infrastructural base of the metropolitan regions can hurt peripheral ones, due to the potential for maximum utilization of the infrastructure. Gil, Llorca, and Serrano (2008) argued that the level of empirical research revealing the NEG phenomenon is an indication of how difficult it is to predict the actual trends in the distribution of economic activity and foreign trade. For example, in studies of Mexico and Japan, respectively, Krugman and Elizondo (1996) and Tomiura (2003) demonstrate an interesting effect of dispersion of economic activity due to increasing imports, in a situation where the regional industrial structure was said to be initially highly concentrated. Fujita and Gokan (2005) and Fujita and Thisse (2006) presented the theoretical frontiers of NEG, which characterizes the operations of multi-unit firms, and the nature of spatial fragmentation. The NEG is more aligned with the micro-heterogeneous aspects related to firms' performance and exposes the complexity of the relationship between the region and the global economy. This is the function of the agglomeration forces, changing trade costs, and the productivity of the firm. Trade activity remains the connecting link between regional differences and heterogeneous firms, which legitimizes the calls for a serious inquiry into the region's foreign trade activity. The combination of the home-market effect with partial factor mobility produced the "simple models of regional divergence" that developed into the structure of Krugman (1991a and 1991b), extreme spatial disparities of a manufacturing industrialized core and an agricultural periphery. The illustration below presents the structure of Krugman's core-periphery model (1991a) in a way that brings out the standard features of NEG modeling.

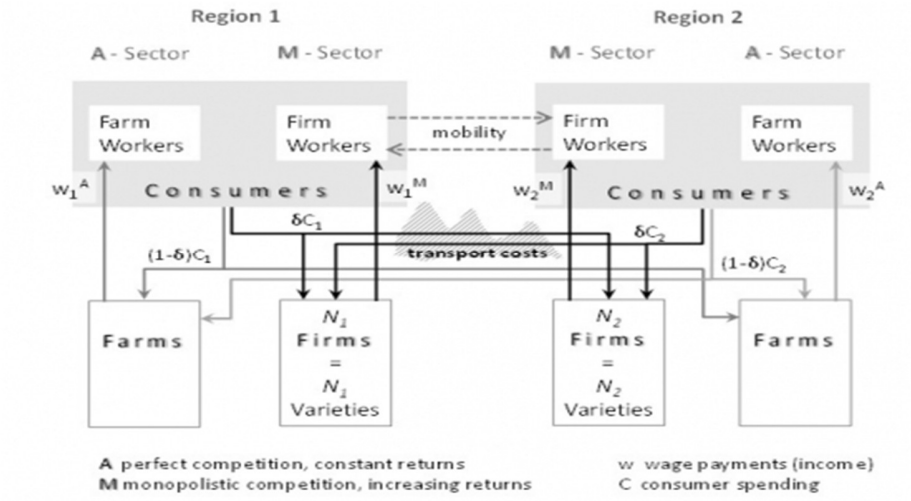


Figure 2.4 Core model of the New Economic Geography
Source: Dirk Ehnts et Hans-Michael Trautwein (2012)

The core-periphery model[8] represents two sectors, A (for agriculture) and M (for manufactures, or industry), located in regions 1 and 2. The supply of a single and specific factor employed by each of the sectors is fixed. Thus, there are agricultural (farm) workers in A and manufacturing (firm) workers in B, and labor is immobile between the sectors. The aggregate income of the consumers spent on manufactures (δC_n) and the agricultural produce $[(1-\delta)C_n]$ from domestic production and/or from imports are those generated from work engaged by both groups. The agricultural sector operates with constant returns to scale and produces a single homogeneous good in perfect competition. The manufacturing sector produces N_1 varieties of industrial goods in *Region 1 and N_2 varieties in *Region 2. There are several N_1 firms in 1, and several N_2 firms in 2, such that one firm produces each variety, with increasing returns to scale at the firm level. This is in line with the Dixit-Stiglitz model of monopolistic competition. Many potential firms can each produce differentiated products $i = 1, \dots, I$; where the products are symmetrical, and consumers are indifferent over the choice of products. However, consumers prefer variety. Thus, for a consumer that consumes N_i of product i, the utility derived from the consumption of $(N_1, \dots, N_I)$ can be captured through the CES form:

[8] Brakman et al. (2009) provided a similar graphical illustration as the "core model of Geographical Economics" and referred explicitly to the core-periphery model in Krugman (1991a). More detailed discussions of the key characteristics of the NEG core model are presented in Fujita et al. (1999) and Baldwin et al. (2003).

$$N_M \left[\sum_{i=1}^{I} N_i^{\sigma-1/\sigma} \right]^{\sigma/\sigma-1}$$

where according to Krugman (1991b), $\sigma > 1$. Total utility from the consumption of the vector $(\mathrm{N}_1, \ldots, \mathrm{N}_I)$ of manufacturing goods and N_A units of the agricultural goods is given as:

$$U(N_{A,}\, N_M) = N_M^{\mu} N_A^{1-\mu}$$

where $\mu \in (0,1)$. Subjecting the household's maximization problem to the first-order conditions shows that with this specification of utility, the share of consumer expenditures devoted to manufacturing goods in household equilibrium is μ and the constant (σ) returns the elasticity of substitution between different manufacturing goods. If labor is the only factor input in the economy, then there would be two types – the workers who produce the manufactured goods and farmers who produce the agricultural products, and in which case produce the manufactured goods and farmers who produce the agricultural good. The supply of agricultural (manufacturing) labor is given exogenously as $L_A(L_M)$, such that workers never become farmers and farmers never become workers.

As already noted, the NEG discusses localization issues, agglomeration, and international trade. It is based on the notion that firms agglomerate in specific areas within a country to take advantage of knowledge-generating activities and reap knowledge spillovers (Duranton & Puga, 2005), as well as to benefit from the best pools of labor and the best formal and informal institutional conditions (Storper, 1997). The model allows for the implementation of the concept of heterogeneity (Baldwin & Toshihiro, 2006; Ottaviano, 2011), which tends to eliminate the so-called destructive agglomeration effect, as their impact becomes more realistic. In terms of gain from trade, Monfort and Van Ypersele (2003) have examined how both the integration and the regional agglomeration process affect the pattern of specialization and international trade. The authors have also noted that with the full workings of the market forces, agglomeration proves to be a source of comparative advantages in industries featuring economies of scale. The regional trade analysis seems to align properly with the framework of NEG. This is because understanding is poised to tackle the mechanics of agglomeration processes and see the world as a mosaic of regions. Canada has witnessed a declining trade cost and pursued more trade liberalization, especially as it relates to the renegotiated NAFTA, as well as the refashioned FTAs with the European Union and Asia. Within Canada, the provinces

are different; while some of them are peripheral, others are more central. Consequently, whether the provinces are peripheral or central, they often encounter the activities of foreign-owned enterprises, which tend to agglomerate in the most core and competitive provinces. In a nutshell, and as captured in Umiński (2014), the regional analysis of exports represents a domain in which heterogeneity of regions and heterogeneity of firms meet. To buttress this more, Levy and Moscona (2022) have also rationalized their findings by the confirmation that national export specialization emerges endogenously from the distribution of factors within countries, which are subdivided into a series of networks that link a few capitalist metropolises to the periphery. This network of metropolises and their satellites contains several levels of surplus appropriation. According to Frank (1969), the national metropolises appropriate the surpluses of regional centers, with the possibility of the chain of surplus appropriation continuing down the chain to local centers, then to large landowners or merchants, then to small peasants or tenants, and sometimes even to landless laborers.

One of the important goals of the NEG literature was to show that agglomeration could arise endogenously and argued that regions characterized by large metropolitan cities possess the capacity to host many corporate businesses, which can create trade networks and expansion (see Rauch, 1999). Krugman observed that in a world of mobile capital and labor, metro areas remain critical nodes for trade, because their exporting firms can benefit from both scale economies and access to large local markets. This notion emphasizes that cities, not nations, are the original global commercial nodes; hence, city-regional economies and trade are inextricably linked. On this, Berube and Perilla (2012) noted that cities were the indispensable actors of global trade before the rise of the nation-state. They supported trade by providing physical space and constant interaction and needed economic specialization to facilitate exchange. Home market effects, as captured by Head, Mayer, and Ries (2002), imply that a relatively small number of locations within a country can generate the bulk of exports. Thus, the large production and distribution centers located in metropolitan areas can significantly influence the trade flow. Wahl (2016) identified the consequences of the existence of historical trade centers and changes that are transmitted through agglomeration processes, which tend to underscore the role of economic geography in the determination of regional exports.

The emergence of Evolutionary Economic Geography (EEG) as an alternative framework to the NEG expanded the interest in trade modeling (Boschma, 2005; Boschma & Frenken, 2011). The model emphasized path dependency, institutional quality, related variety, and regional spin-offs as strong drivers of regional trade. Recent interests in trade

literature have emphasized the importance of transport costs and infrastructure in explaining trade and access to international markets. Technically, access to foreign markets is seen as a form of the foreign market potential of a country and, among other things, relates inversely to transportation costs. According to the UNCTAD Report (2015), proximity and access to maritime transportation can significantly aid trade since over 80 per cent of the global trade is carried by sea, and it is considered by far the most cost-effective way to move goods and raw materials en masse around the world. Overall, not much theoretical and empirical attention has been devoted to its impact on bilateral trade.

NEG has been criticized by economic geographers for its parsimonious assumptions, indicating that NEG operates with crude and highly simplistic and idealized conceptions of the economic geography across space and time, and that its conceptualization of time as logical rather than historical is equally restrictive. Unambiguously, critical scholars have argued that even if one believed that real-world regional and urban systems tend towards equilibrium states and configurations, NEG models tell us nothing about the time taken to achieve such states, nor about the actual adjustment and evolutionary paths which real-world economic landscapes follow. However, like earlier works in regional science, the NEG deals with variants of one basic question: how to explain the riddle of uneven spatial development and which factors have influenced and continue to influence the geographical distribution of economic activity.

NNTT emphasizes the role of firm-level differences, such as productivity, innovation capacity, and scale economies, in shaping trade flows and market outcomes. It begins with the observation that firms within the same industry react differently towards the challenges of globalization, where in the process, some of the firms exit (disappear), some produce for the home market (local players), and some others produce for both domestic and export markets (global players). The theory essentially originated from Melitz (2003). The model considers consumers to be heterogeneous in their preferences and industries to differ in terms of the production cost function. Like in Krugman's (1980) model, the representative agent has constant elasticity of substitution (CES) preferences:

$$\cup = \left[\int_{V\in\Omega}^{*} C(V)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

where $\sigma > 1$ is the elasticity of substitution

Consumption and expenditures for each variety are given by:

$$C(V) = \mathrm{Q}\left[\frac{P(V)}{P}\right]^{-\sigma}$$

$$r(V) = \mathrm{R}\left[\frac{P(V)}{P}\right]^{1-\sigma}$$

where:

$$P \equiv \left[\int_{V\in\Omega}^{*} P(V)^{1-\sigma} d(V)\right]^{\frac{1}{1-\sigma}}, R \equiv \int_{V\in\Omega}^{*} r(V), and\ Q \equiv \frac{R}{P}$$

Generalizing the work of Melitz in a way that is suitable for multiple countries, Chaney (2008) and Helpman et al. (2008) superimposed the heterogeneous firms in a Dixit-Stiglitz framework, to obtain an expression for the aggregate share of the market. Dixit-Stiglitz demand functions:

$$C(V) = \left(\frac{P(V)}{P}\right)^{-\sigma} W/P$$

where w is the individual worker's wage (income) - the sum of which translates to the country's nominal revenue (R), P is the ideal price index, and goods are indexed by the productivity of the firm producing it (N) rather than the variety they produce (V). Like in Krugman, labor is the only factor in production $W = 1 \equiv wage$.

The model of Melitz recognizes the role of firms in international trade and develops a general equilibrium model where firms differ in their productivity levels. According to the model, firms are major actors in international trade since exports to foreign consumers are undertaken directly by the firms. So, with perfect competition, representatives can be adopted in the model, making it possible to consider country/industry characteristics as determinants of trade and specialization. The crucial mechanisms of this model can be better grasped if one considers the profit-maximizing price (P) for any firm to be a multiple of the marginal cost (ℵ):

$$P \equiv \frac{\aleph}{\phi}$$

where $\phi \equiv {}^{1}/_{L}$ is the marginal productivity of labor (L), which varies across firms. Moreover, L are the units of labor needed to produce one unit of output? In this context, the model assumes

the presence of an iceberg trade cost. Firms can choose their marginal productivity (ϕ) from a probability distribution, which ranges from zero to infinity $(0, \infty)$. At a chosen level of ϕ, the firm can compute its domestic and foreign profit, defined as revenue minus variable costs minus fixed costs, and the operating profit is given by revenue minus variable costs. As the Firms encounter a fixed cost of production, $w\mathrm{F}$, and a fixed cost of exporting $w\mathrm{F_x}$, the domestic and foreign profits for a firm in the country i would be:

$$\pi_{ii} = \pi_{ii}^{0}(\phi^{+}) - w\mathrm{F}$$

$$\pi_{ij} = \pi_{ij}^{0}(\phi^{+}) - w\mathrm{F_x}$$

The notation $\pi_{ii}^{0}(\phi)$ and $\pi_{ij}^{0}(\phi)$ indicates that domestic and foreign operating profits as a function of productivity. The positive algebraic superscript on ϕ implies that operating (and total) profits increase as productivity rises.

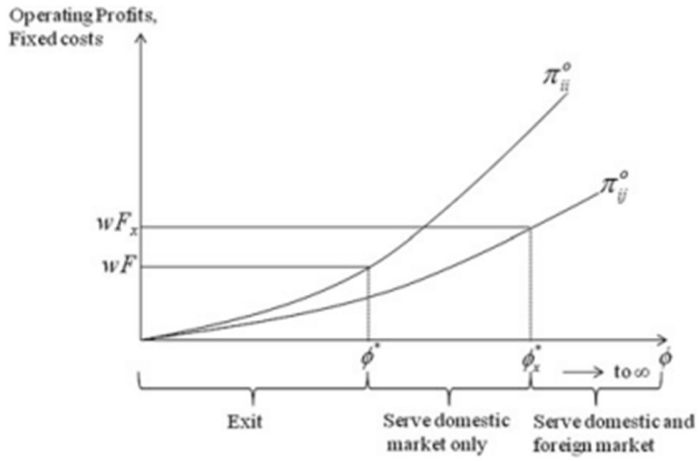


Figure 2.5 Home and foreign profit conditions
Source: Giancarlo Gandolfo (2014)

By choosing the marginal productivity ϕ, the firm has two separate decisions to make, given that domestic and foreign profits are independent: either to stay or not to stay, to export, or not to export. Given the zero-profit productivity cutoff as ϕ^* (and in the case of export as ϕ_x^*), a firm will stay in the market if it draws a value of ϕ larger than or equal to ϕ^* and will exit otherwise. Under foreign trade, a firm will export if it draws a value of ϕ larger than or equal to ϕ_x^* and will not export otherwise. The curves starting from the origin represent domestic and foreign operating profits as functions of productivity, ϕ. The horizontal lines represent fixed

production costs and fixed export costs. The intersection between each operating profit line and its corresponding fixed cost line gives the cutoff values ϕ_x^* and ϕ^*. In this figure, $\phi_x^* > \phi^*$. This ranking is consistent with the fact that while some firms do not export, exporting firms typically also supply the domestic market. This ranking of cutoffs is conditional on the relative size of fixed costs, which is assumed to be satisfied. In a monopolistic competition model, when firms are heterogeneous in costs, not all of them make zero profit. Only the firms that have drawn a productivity level equal to ϕ^* will make zero profit. Low-cost firms thrive, increasing their profits and market share, while high-cost firms contract, and the highest-cost firms persist. The larger the market, the more profitable it is for firms to invest in productivity-enhancing activities. Firms incur the high costs of innovation if the expected cost reduction in absolute terms covers the innovation costs. Lowering trade costs will tip the balance in favor of innovation. The heterogeneous firm-level analysis of Melitz has become the fundamental concept for international trade analysis. From a normative point of view, Melitz (2003) may also provide a "new" source of gains from trade if trade induces the reallocation of labor from least to most productive firms.

2.1.2 Trade and globalization – basic theoretical synthesis

Globalization, by expanding access to international markets, intensifies competition and specialization, and creates opportunities for regions to exploit their comparative and competitive advantages, leading to higher trade volumes. The integration of regions into global trade can enhance their ability to capitalize on comparative advantages by reducing trade barriers, which facilitates the flow of trade and capital. This process is critical for improving efficiency and overall productivity. By participating in global value chains, regions can better allocate resources, leverage technology transfer, and improve production processes, which ultimately boosts their foreign trade and competitiveness (Lopez Gonzalez, Kowalski, and Achard, 2015). These dynamics also create opportunities for regions to specialize in areas where they have a comparative advantage, further promoting integration into the global market. Different regions may develop distinct comparative advantages based on local resources, infrastructure, and skills. Integration into the global economy allows regions to specialize and trade more efficiently. In Canada, the province of Alberta specializes in oil and gas production, while British Columbia focuses on technology and services, reflecting regional comparative advantages enhanced by globalization. As trade barriers diminish, the

interconnectedness of markets deepens, leading to increased efficiency and higher productivity levels across participating regions. Market access of regions can expand, enabling them to export goods to global consumers. The increase in trade volume is consistent with the predictions of comparative advantage theory. Comparative advantages tend to be temporary characteristics that can change with the evolution of labor costs and technology. Thus, regions may develop distinct comparative advantages based on local factor endowments. This allows the regions to trade more efficiently with foreign markets.

As globalization progresses, it enables regions with different factor endowments, such as labor, capital, and natural resources, to trade more efficiently (Rodrigue, 2024). Labor-abundant regions may export labor-intensive goods, while capital-abundant regions export capital-intensive goods, thereby optimizing global production. Factor endowments can be improved through capital and human resources investments. Globalization facilitates the concentration of production in large, efficient firms that can exploit economies of scale (Hanson, 2001). This results in increased IIT and the proliferation of MNEs, which can lead to greater product variety and lower prices for consumers. Firms can further specialize and improve operational efficiency, which maximizes their productivity and competitive advantage in the global market. Improvement in transportation and communication infrastructure is a globalization process that reduces the effective distance between trading partners and facilitates higher trade volumes, especially between large economies. In contrast, RTAs can further enhance trade flows by reducing barriers. By integrating into the global economy, regions and countries can benefit from technology transfer, increased investment in human capital, and innovation, which in turn can lead to sustained growth in international trade (UNCTAD, 2003; Canuto, 2018). According to the World Bank (2018), globalization has accelerated the diffusion of technology across borders, enabling regions to enhance their productivity and engage more effectively in international trade. Globalization influences regions to improve their institutional quality to attract foreign investment and participate effectively in international trade (Khan et al., 2023). Better institutions can reduce transaction costs, enhance trust, and provide a stable environment for economic activities and trade. As globalization progresses, regions transform into economic hubs due to advantages such as infrastructure, skilled labor, and access to markets. Thus, a high level of a region's integration into the global economy can lead to the concentration of economic activity, creating economic hubs that benefit from agglomeration economies (Blomström et al., 2002). This can result in uneven development and the formation of powerful economic centers that drive regional and global trade. The standard H-O model

suggests that increased globalization can lead to a convergence in wages and capital returns between countries, although differences in technology, institutions, and other factors moderate this.

Regional integration has reinforced dynamics, which have led to increased trade volumes, greater product variety, regional specialization, and intensified global competition. However, it also raises important considerations for trade policy, regional development, and the distribution of benefits coming from the global market. Globalization has enabled firms to expand their markets, thereby reducing average costs through higher production scales. Regions take advantage of economies of scale to produce on a larger scale, which lowers the average cost of production. Regions engage in trade because they can produce goods more efficiently due to economies of scale rather than resource differences. By recognizing that consumers demand variety, firms produce differentiated products, which leads to IIT, where countries export and import similar products, with different models. Globalization can lead to the concentration of industries in specific regions, driven by agglomeration economies where firms benefit from their network (Fujita, Krugman, and Venables, 1999). This type of regional specialization is often seen in high-tech industries. It can lead to the formation of global value chains (GVCs), where different stages of production are located in different regions. As certain regions integrate more fully into GVCs than others, this may lead to more engagement in trade, but it may also worsen regional inequality (Baldwin, 2016). Globalization reinforces innovation, talent, and capital concentration in different regional clusters. As the regions become more integrated into the global economy, they face more competition, which drives innovation and investment in research and development (Grossman & Helpman,1991). Firms are incentivized to innovate to maintain their competitive edge in the global market. Regional integration has reinforced dynamics, which have led to increased trade volumes, greater product variety, regional specialization, and intensified global competition. However, it also raises important considerations for trade policy, regional development, and the distribution of benefits coming from the global market.

2.1.3 History and theoretical unification in gravity

This section provides a brief history of the gravity model and traces the model as a unified framework that incorporates insights from several trade theories.

The gravity model of international trade owes its origin to Newtonian physics on universal gravity. Carey (1865) applied the gravity model in the study of migration, making it the very first time it was used in the field of social science. Isard (1960) also contributed to the regional science study through the application of the concept of gravity. The applicability of the gravity model in the analysis of international economics is the theoretical success that puts the law of universal gravity into an economic context. Tinbergen (1962), Pöyhönen (1963), and Linneman (1966) presented the first application of the standard gravity model to analyze foreign trade flows. The model marks the first time the law of universal gravity was treated in an economic context by further introducing trade elasticities into the Newtonian model. The early work of Tinbergen provided a simple yet powerful empirical framework for understanding trade patterns.

$$T_{ij} = \mathrm{K}\frac{Y_i^{\alpha} Y_j^{\beta}}{D_{ij}^{\rho}}$$

The model explains bilateral trade flows (T_{ij}) between two countries $i\ and\ j$ as an increasing function of their respective economic size ($Y_i\ and\ Y_j$), represented by each country's GDP and a decreasing function of distance (D_{ij}) between them, which proxies for trade costs, as well as the gravitational constant captured by the K (Head and Mayer 2014). α is the exporter's GDP elasticity, β is the importer's GDP elasticity, and ρ represents the elasticity of distance. The elasticities $\alpha, \beta\ and\ \rho$ can take any different values other than 1 and reveal the nature and how much influence each of the variables can exert on trade flows. In general, the model was developed to portray the amount of exports country i can supply depending on the size of the economy and the amount of goods the country j can demand from the country i depending on its expenditure capability, given the level of income, as well as the diminishing function of costs imposed by the distance between trading countries. Economic size underscores both the production capacity and market potential of each country. It represents the supply and demand conditions of each country in trade flows. Distance is a trade barrier with similar effects to various trade costs.

There have been a variety of studies concerning the gravity model as an absorption framework for many of the trade theories. Starting from Anderson (1979), a series of alternative micro-foundation frameworks emerged, with monopolistic competition: a H-O model

(Bergstrand, 1985; Deardoff, 1998); a Ricardian framework (Eaton and Kortum, 2002); entry of heterogeneous firm's selection into markets (Melitz, 2003; Chaney, 2008; Helpman et al., 2008); a single economy model (Anderson and van Wincoop, 2003); a sectoral Armington-model (Anderson and Yotov, 2016); a sectoral Ricardian model (Costinot et al., 2012; Chor, 2010); a sectoral input-output linkages gravity model based on Eaton and Kortum (2002) (Caliendo and Parro, 2015), a dynamic frame work with asset accumulation (Olivero and Yotov, 2012, Anderson et al. 2015C, and Eaton et al., 2016); the isomorphic gravity equations of Arkolakis et al. (2012) – inclined with the gains from trade; and most recently, the sufficient conditions derivative by Allen et al. (2014), which preserves the existence and uniqueness of the trade equilibrium for a wide class of general equilibrium trade models.

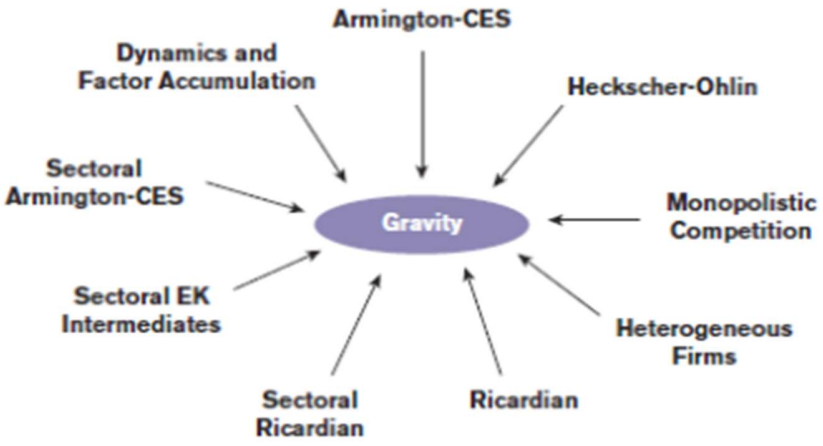


Figure 2.6 Theoretical foundations of the gravity model
Source: adopted from Yotov et al., 2016

Trade and product differentiation

The model of Anderson (1979) marks the first theoretical support for the gravity framework. Anderson provided the prelude to the development of theoretical gravity. The model leveraged Armington's assumption [9] of imperfect substitutes, identical Cobb-Douglas

[9] Armington (1969) distinguishes products not only by their peculiarity, but also by their place of formation, implying that the supplier's origin is an important factor in determining the characteristics of the product. Armington argued that the demand of two products of similar characteristics but originating from different places are imperfect substitutes. This is an ad hoc assumption, and it completely ignores the "classical" trade forces such as increased specialization due to comparative advantage.

preferences[10], and the equality of income and expenditure system of trading partners to provide a theoretical gravity framework that compares bilateral trade to the world trade average.

$$X_{ij} = \frac{Y_i Y_j}{\sum_j Y_j}$$

Export supplies (X_i) from the origin countries are conditioned by the multiple values of income attributed to both the exporter and importer. When Anderson further argues that each country produces tradable and non-tradable goods, he provides a more exact representation of factors influencing trade flows. By incorporating the expenditure portion spent on tradable goods by country j, multiplied by the share spent on tradable goods from country i, the exports of tradable goods from country i to country j can be explained. Anderson considers expenditure on tradable goods to be a function of income Y_i, population N_i and/or other size factors, including constant and stochastic terms. where the expected error term [E($In\mathcal{U}_{ij}$)] = 0, hence the equation becomes:

$$X_{ij} = \left(\frac{K}{Y_w}\right) {Y_i}^{\alpha_1}, {N_i}^{\alpha_2} {Y_j}^{\beta_1} {N_j}^{\beta_2} \mathcal{U}_{ij}$$

This initial proposition disregarded distance, shipment cost, or trade barriers. However, the assumption of a world without borders and by implication trade relations without barriers, is not well-grounded in economic theory and cannot be said to be very helpful when examining the holistic determinants of trade. Thus, with gradual modification to incorporate the friction factors, Anderson extended his model to include transportation costs, which define the value of export shipments of goods produced in country i to country j.

$$T_{ij} = \frac{\emptyset_i Y_i}{\sum_j \emptyset_j Y_j \frac{1}{\mathrm{f}(D_{ij})}} \frac{\emptyset_j Y_j}{\mathrm{f}(D_{ij})} = \frac{\emptyset_i Y_i \emptyset_j Y_j}{\mathrm{f}(D_{ij})} \left[\sum_j \emptyset_j Y_j \frac{1}{\mathrm{f}(D_{ij})}\right]^{-1}$$

[10] Cobb-Douglas utility functions take the form $\cup (T, NT) = A\, x_1^{\alpha} x_2^{\beta}$ where A is a constant term and x_1 and x_2 represents the tradable and non-tradable goods. As a homothetic preference, the elasticities are such that $\alpha + \beta = 1$, indicating that trading regions with a rising income spends the same proportion in tradable goods in relation to their total income due to a constant marginal rate of substitution (Varian, 2004; Pepall, Richards and Norman, 2008).

Anderson (1979)[11] argued that bilateral trade flows between countries depend on their income relative to a trade-weighted average of the economic distance. By leveraging on the equality of income and expenditure system of trading partners, the gravity model tries to compare bilateral trade to a world trade average. At this point, the analysis of bilateral trade gained consideration for all other possible trade flows, and the gravity of the trade equation became empirically flexible to accommodate a comparative analysis of bilateral trade relationships in a variety of possible trade flows, thereby overcoming its former shortcomings of analyzing trade as an absolute construction of relating bilateral trade partners. Before the work of Anderson (1979), the study by Leamer (1974) utilized the resource endowments factor. Overall, the conceptual base of the gravity derivation proposed by Anderson was underpinned by the expenditure systems, which are considered equal to income depending on the directions of trade (imports or exports). More importantly, the gradual theoretical modification of Anderson was intended to defray inherent complexities.

Trade and monopolistic competition

Helpman and Krugman (1985) have relied on Ricardian comparative advantage and factor endowments of Heckscher-Ohlin in explaining trade patterns. At the firm level, the approach assumes increasing returns to scale and a condition based on monopolistic competition between firms[12]. The model is said to be significantly suited for analyzing IIT types, where the traded products are those belonging to the same industry. The analysis, on the contrary, revealed that the application of the H-O approach to the gravity model is theoretically unfounded. Bergstrand (1985, 1989) proposed a model that captures monopolistic competition, with differentiated products and economies of scale. Bergstrand's gravity equation combines both factor endowments, relating to H-O models and the CES preferences, reflecting Lindner's propositions of identical countries with similar preferences.

$$PX_{ij} = \varkappa_0 Y_i^{\varkappa_1} \left(\frac{K_i}{L_i}\right)^{\varkappa_2} Y_j^{\varkappa_3} \left(\frac{K_j}{L_j}\right)^{\varkappa_4} D_{ij}^{\varkappa_5} Z_{ij}^{\varkappa_6} \cup_{ij}$$

[11] For the full derivation of CES preferences, refer to Anderson, 1979, pp. 114-115 (Appendix).
[12] Monopolistic competition is an idea that goes back to Chamberlain (1933). Dixit-Stiglitz (1977) developed the model of monopolistic competition, which has become a remarkable workhouse in many areas of economics. It is a simple equilibrium model that deals with the study of optimum product diversity (where goods are close substitutes within the market but are not necessarily substitutes for the rest of the goods in the economy).

Bergstrand assumes that the measure of the GDP in units of capital can serve as a proxy for the income Y_i of the exporter and thus gives information about the relative factor endowment (capital-labor ratio) of each country, which resonates with the inter-industry trade theory of H-O. Changes in the level of expenditure Y_j of the importer (often proxied by the GDP) is seen to be a function of changes in the preference defined by taste, and points to the IIT model of Helpman and Krugman. As mentioned earlier, the micro-level model of Bergstrand (1985) provides the gravity of trade equation that reflects a reduced form derivation from a partial equilibrium subsystem with nationally differentiated products. He argued that if aggregate trade flows are differentiated by national origins, then it must be that a well theoretically sound gravity model includes the factor prices, which strongly vary from country to country.

The study of Bergstrand (1989), however, extends the micro-based model to incorporate the factor proportion theory of trade by including the factor endowment variable. This reflects the H-O inter-industry trade models and CES preferences in the spirit of Lindner's (1961) assumption of national similarity in preferences. Bergstrand assumes that each firm produces either a differentiated manufactured product or a non-manufactured product in a manner that characterizes the Chamberlinian monopolistic competition, with its counter-players. From the standpoint of the industry, the model assumes that technology among firms is identical and uses fixed capital (K) and labor (L) input factors, with an associated cost function for all production input requirements. Firms are assumed to be subdivided into stages in the production process. The first stage firms produce with increasing returns to scale, and those in the second stage export to foreign markets with decreasing returns to scale, which reveals an associated iceberg shipment cost. Firms maximize profits and export to the foreign market part of their goods under a constant elasticity of transformation function. With further assumption that the market price for goods is competitively determined, the final and extended gravity equation from Bergstrand (1989) yields:

$$PX_{ij} = \varkappa_0 Y_i^{\varkappa_1} \left(\frac{K_i}{L_i}\right)^{\varkappa_2} Y_j^{\varkappa_3} \left(\frac{K_j}{L_j}\right)^{\varkappa_4} C_{ij}^{\varkappa_5} \mathcal{T}_{ij}^{\varkappa_6} E_{ij}^{\varkappa_7} P_i^{\varkappa_8} P_j^{\varkappa_9} \cup_{ij}$$

In the model, trade flow PX_{ij} from country i to destination j is dependent on the respective income (Y_I and Y_j) of the trading partners, the exporter's capital-labor ratio $\left(\frac{K_i}{L_i}\right)$, the importers' per capita income $\left(\frac{K_j}{L_j}\right)$, C_{ij} represents the c.i.f./f.o.b. geographical distance factor, $\mathcal{T}_{ij}$

is the imposed tariff rate, E_{ij} stands for the exchange rate – denominated in the exporter's currency, and P_i *and* P_j captures the exporter's and importer's price indexes, and by convention, a log-normally distributed stochastic term is included.

The gravity model of Bergstrand relies basically on bi-industry and bi-factor inference, a reminiscent and an appendage of the H-O inter-industry model. One of the problems with the H-O model lies in its inability to allow for generalization beyond the assumption of two industries and two-factor inputs. Leamer and Bowen (1981) argued that the gravity equation of the type provided in Bergstrand cannot guarantee evidential conclusions on the intensity of relative factors of industries, since there are multi-factors and more than two industries in a production economy. However, Deardorff (1982) made a slim attempt to portray a generalizable H-O theorem by arguing that countries are most likely to export those goods they produce with intensive use of their abundant factors. Comparatively, some studies have shown that generalization can be realized with the Rybczynski theorem, to show that in a world of many industries, an increase in the capital (labor) endowment of a country tends to result in increased output of relative capital-intensive (labor-intensive) industries. Thus, the income per capita factor for the exporter (utilized as a proxy for the exporter's $\frac{K_i}{L_i}$ ratio) has much to explain about the flexibility of the gravity model in estimating a capital-intensive or labor-intensive industry.

Trade and relative factor endowments

Contrary to the flaws presented by Helpman and Krugman that the application of the H-O approach to the gravity model is theoretically unfounded, Deardorff (1998) provided a refutation by arguing that two scenarios in trade pursuit exist: one that is frictionless and another with impediment. In the case of trade without friction, there are no shipment costs or other trade barriers. Thus, due to product homogeneity in perfect competition with zero shipment cost for trading partners, the origin of the product and efforts to make the products available in any required location do not face hindrances. In the discernment of Deardorff, a world pool of goods is the sum of individual producers' goods. Individual consumers explore their preferences by choosing from the pool of available goods. The equilibrating price for each good clears the world market pool of goods, because of perfect competition[13]. The very tenet of Deardorff's

[13] The main contribution under this circumstance is that the gravity model can essentially evolve from a Heckscher-Ohlin world (without any recourse to monopolistically competitive settings - as in Bergstrand (1989).

frictionless model is that income must equal expenditure (defined as the multiplication of price and quantity of goods). Hence the frictionless gravity model:

$$Y_i = \hat{p}x_i = \hat{p}c_i$$

The vector x_{I} and c_{I} are the production and consumption capabilities of the country i $\hat{p}$ is the world price. Given the assumption that preferences are identical and homothetic for all countries, it is inferred that they spend the same amount of income, β_{k}, on good k. The demand of the country j for good k to meet its consumption needs becomes:

$$C_{jk} = \beta_k \frac{Y_j}{p_k}$$

And out of the world basket of good k from all manufacturing countries A, the contribution x of country i to the pool

$$\varphi_{ik} = \frac{x_{ik}}{\sum_A x_{Ak}}$$

Thus, the actual consumption-meeting demand of the country j from country i represents:

$$C_{ijk} = \varphi_{ik} C_{jk} = \frac{x_{ik}}{\sum_A x_{Ak}} \left[\beta_k \frac{Y_j}{p_k}\right]$$

For simplicity, let's assume that the aggregated (world) output of good k, is given by $x_{\mathrm{k}}^w = \sum_A x_{A\mathrm{k}}$, and with recourse to the identical proportion of income expended by respective countries on good k, the fraction of world expenditure on good k must equal the aggregate income of the world Y_{w} represented as: $\beta_{\mathrm{k}} = p_{\mathrm{k}} x_{\mathrm{k}}^w$. Then, the value of imports of country j from country i can be given as

$$X_{ij} = \sum_k p_k C_{ijk} = \sum_k p_k \left[\frac{x_{ik}}{\sum_A x_{Ak}} \beta_k \frac{Y_j}{p_k}\right] = \sum_k \varphi_{ik} \beta_k Y_j = \sum_k \frac{x_{ik}}{x_k^w} \frac{p_k x_k^w}{Y_w} Y_j = \sum_k x_{ik} p_k \frac{Y_j}{Y_w}$$

$$X_{ij} = \frac{Y_i Y_j}{Y_w}$$

There are no geographical barriers. The distance barrier is not considered in the model, which signifies zero transportation cost. This equation is the simple frictionless gravity model, which is the same as the initial derivation by Anderson (1979). Deardorff proceeded further to

depict another form of frictionless trade with arbitrary preferences and argued that with non-homothetic preferences, the equilibrium may condition each country to spend a different share of its income on the good k. The exporter produces (importer consumes) goods k at a disproportionate amount to the world, such that the value of exports from the country i to j is with arbitrary preferences expressed by the importer as:

$$X_{ij} = \frac{Y_i Y_j}{Y_w} \sum_k \frac{\alpha_{ik}\beta_{jk}}{\lambda_k}$$

And equation (12) can further be rewritten as:

$$X_{ij} = \frac{Y_i Y_j}{Y_w}\left(1 + \sum_k \lambda_k \, \alpha_{ik}\beta_{jk}\right)$$ [14]

Where λ_k is the proportion of world income, utilized in the production of good k, α_{ik} is the fraction of country i in the production of good k, and β_{jk} is the country's j proportion of consumption in good k. According to Deardorff, similarity in each of the exporter's share of production α_{ik} and in each of the importer's consumption β_{jk} is equal to what the simple frictionless gravity equation portrays.

In the case of impeded trade, Deardorff assumes a complete specialization with trade barriers (such as transportation cost) existing for every good and are considered strictly positive on all country pairs (i, j) bilateral trade. According to Deardorff, it is consistent with Armington's preference and any monopolistic competition (the basis for which Bergstrand (1989) used the "iceberg" form of transport costs). If there is a single price for all markets, the pattern of bilateral trade will be such that countries specialize in the production of goods for which they have a relative cost advantage and then engage in trade. Samuelson's "iceberg" form, with the transport factor, applies, such that the importing country j pays the market price plus transport cost. With identical Cobb-Douglas preferences, each country spends a fixed share β_i of its income on the purchase of goods from country i. The country's output and income are represented by:

[14] Deardorff noted that, similarity in the production α_{ik} share of individual exporters and in each of the importer's consumption β_{jk} is equal to what the simple frictionless gravity equation portrays. See Deardorff (1998), for a detailed derivation of the equation.

$$Y_i = p_i x_i = \sum_j \beta_i Y_j = \beta_i Y_w$$

If $\beta_i = \frac{Y_i}{Y_w}$, trade can either be c.i.f. reflecting a frictionless gravity of trade equation (i.e., zero trade restrictions with homogeneous preferences) or an f.o.b. representing a gravity equation with an impediment that reduces bilateral trade flows by the amount of the transport cost:

$$T_{ij}^{c.i.f} = \frac{Y_i Y_j}{Y_w} \quad ; \quad T_{ij}^{f.o.b} = \frac{Y_i Y_j}{t_{ij} Y_w}$$

where t_{ij} is the transport factor, defined as (1 + transport cost between country *i* and country *j*). Transport costs relate to distance and tend to diminish trade. Though with the Cobb-Douglas preference, the bilateral trade flourishes with distance. However, Deardorff considered preference underscored by CES utility function to arrive at the H-O world:

$$T_{ij}^{f.o.b} = \frac{Y_i Y_j}{t_{ij} Y_w} \left[\frac{\left(\frac{t_{ij}}{p_j^I}\right)^{1-\sigma}}{\sum_A \theta_A \left(\frac{t_{ij}}{p_j^I}\right)^{1-\sigma}} \right] = \frac{Y_i Y_j}{t_{ij} Y_w} \left[\frac{p_{ij}^{1-\sigma}}{\sum_A \theta_A p_{iA}^{1-\sigma}} \right]$$ [15]

The p_{ij} represents the distance between importing country *j* and exporting country *i*, θ_A is the fraction of total world income attributed to the country A, and σ denotes the elasticity of substitution. Under impeded trade, the expression for (c.i.f) trade is the same as the country *i*'s output or income equation with a multiplicative inclusion of the transport cost (t_{ij}). The term $\frac{p_{ij}^{1-\sigma}}{\sum_A \theta_A p_{iA}^{1-\sigma}}$ is the distance factor (the multilateral resistance term), that defines the relative distance from the destination country *j* (the importer) to the origin country *i* (the exporter), and there with a representation of the average of all destinations (importing countries') relative distance to the origin (exporter *i*). The similarity in the size of the distances (to and from) is regarded as homogenous of degree one, and the gravity equation will be consistent with the Cobb-Douglas case. This is similar to the c.i.f. trade defined by the simple frictionless gravity equation. In terms of f.o.b., trade is restricted by the amount of transport factors from country *i*

[15] The term p_j^I is the CES index, representing the transport cost factors of county j denoted as $p_j^I = \left(\sum_{\mathrm{i}} \beta_{\mathrm{i}} {t_{\mathrm{ij}}}^{1-\sigma} {p_{\mathrm{ij}}}^{1-\sigma}\right)^{1/1-\sigma}$, and defined as the average of the supplier's distance $\delta_j^S = \left(\sum_{\mathrm{i}} \beta_{\mathrm{i}} {t_{\mathrm{ij}}}^{1-\sigma}\right)^{1/1-\sigma}$. For more clarification on the derivation, (see Deardorff, 1998, 18-20).

to country *j,* such that the impact of distance is measured by the standard gravity equation with a 1+ transport cost defining the transport factor. According to Deardorff 1998, If the relative distance between the origin country *i* and destination country *j* is smaller (greater) than the average, trade between the two countries will be more (less) than trade in the standard gravity equation.

Again, with a higher elasticity of substitution among goods, closer countries tend to trade more with each other, which can create a trade level that will be more than accessible through the standard gravity equation. Conversely, far-reaching countries will trade less than the predicted trade level. Furthermore, a reduction in the costs of shipment, due to advancements in global transportation, will bring trade flows closer to the value that is expected by the simple frictionless gravity equation. In this case, trade between far-apart countries will expand, while that of closer countries will shrink (Deardorff, 1998). Overall, the derivations presented by Deardorff deliver the theoretical consistency of the gravity equation with the trade model by H-O.

Trade and differentiated production technology

Eaton-Kortum (2002) developed the Ricardian model of bilateral trade (with a continuum of goods) to motivate an approach that captures the tension between comparative advantage (promoting trade) and geographic barriers (impeding it), through the instrumentality of differences in production technology. The authors combined the nature of technology in each country (reflecting the absolute advantage), the differences in technology (reflecting the comparative advantage), and the geographic barriers (reflecting the iceberg transportation cost due to distance)[16] to estimate the elasticity of trade. They assumed that labor as a production factor is internationally immobile and argued that the sensitivity of trade to costs and geographic barriers depends on the Fréchet distribution that governs the dispersion in productivity, which varies across countries in a Ricardian sense. According to Eaton-Kortum (2002), the position of the distribution of productivity is determined by the technological capability of countries, such that the number of goods the country i sells to country j, measured by country j's expenditure

[16] Samuelson (1952) assumed that to export goods produced in a particular origin location to another destination location a constant fraction of the good melts away in transit depending on the size of the iceberg, such that total transportation costs equal the cost of producing the melted goods (see Eaton and Kortum, 2002). The iceberg transportation cost has become one of the key ingredients of contemporary trade and economic geography models. Krugman (1998, 164) referred to the concept as an important "trick of the genre" in his treatment of the economic geography model.

on goods from the country i, underscores the bilateral representation of the trade flows expressed as:

$$X_{ij} = \frac{\left(\overline{A}_j d_{ij}\right)^{-\theta} X_j}{\sum_M \left(\overline{A}_m d_{im}\right)^{-\theta} X_m} \mathbb{Q}_i = \frac{X_j \left(\frac{d_{ij}}{p_j}\right)^{-\theta}}{\sum_M \left(\frac{d_{im}}{p_m}\right)^{-\theta} X_m} \mathbb{Q}_i$$

Where, X_j total spending of the country j on purchase of goods from the country i, X_{ij} is the fraction of goods that the country j buys from country i, $\mathbb{Q}_i$ is the exporter's total quantity of goods sold (which reflects country i's income Y_i), d_{ij} is the geographic barrier (the bilateral resistance term) between the exporter and the importer and is deflated by the importer's price level p_j (the multilateral resistance term) – both of which are raised to the power of the variability factor $-\theta$, and the denominator $\left(\frac{d_{im}}{p_m}\right)^{-\theta} X_{\text{m}}$ represents the size of individual destination market m as perceived by the origin country i and $\sum_M X_{\text{m}}$ can be perceived as the world's income Y_{w}. A higher X_{m} means that country i has a larger export market. On the other hand, higher bilateral trade costs d_{im} and a lower price level p_{m} in the destination, market m, reduce the country i's exports to m. Thus, the share of county j in the country i's exports represent the country j's share of the country i's effective world market – that is, the size of the world market perceived by the country i, after taking into consideration the inherent transportation costs, external prices, and size of the market in all other countries.

Eaton and Kortum emphasized four main facts regarding bilateral trade: trade decreases with distance, price varies across countries, factor costs are not equal across locations, and relative production techniques vary by country. And out of the basic facts, they tried to establish the connection between trade flows and price differences. Analogously, they considered the share of the country i in the total market of the country j to its home market share, expressed by the equation:

$$\frac{X_{ij}/X_j}{X_{ii}/X_i} = \frac{\Phi_i}{\Phi_j} d_{ij}^{-\theta} = \left(\frac{p_i d_{ij}}{p_j}\right)^{-\theta}$$

According to Eaton-Kortum (2002), the higher the variability factor (i.e., lower $-\theta$), the greater the likelihood of comparative advantage to exert a stronger force on some goods to escape the geographical barriers. Alternatively, as the force of comparative advantages weakens

(i.e., higher θ), the shares of normalized imports become more elastic to the average relative price and geographic barriers. Lower prices of goods in the destination market reduce trade to the geographic barriers between the importing country j and the exporting country i. This phenomenon underscores the high consideration of import costs when the destination market is more competitive.

Eaton and Kortum made further theoretical moves to establish the final framework, which can be interpreted as a gravity equation - they explained how trade flows relate to geography and prices, taking factor costs as given. The basis of empirical estimations by Eaton and Kortum becomes:

$$\ln \frac{X'_{ij}}{X'_{jj}} = -\theta \ln d_{ij} + S_i - S_j$$

where S_i is equated to the competitiveness of the origin country i, properly defined by its labor-adjusted costs of technology[17], d_{ij} is the distance between the origin country i and the destination country j, defined as all the barriers that create impediments in moving goods from the exporting country i to the importing country j. In general, the S reflects production by countries relative to the total world market from its perspective. Given the geographic barrier to a particular destination, the origin countries will export more to such a country when it is more remote from third markets (Eaton and Kortum, 2002).

Trade and heterogeneous firms' model

Melitz (2003) insisted on the importance of the export behaviors of heterogeneous firms. All firms are seen to be identical and exporters in a standard monopolistically competitive trade model. However, a firm's size and level of productivity (which is seen to be highly correlated with participation) are major characteristics that distinguish firms. Melitz combined differentiated firm-level productivity and fixed cost of shipment to develop a model that captures the presence of these features. Firms are major actors in international trade since exports to foreign consumers are undertaken directly by the firms. So, with perfect competition, representatives can be adopted in the model, making it possible to consider country/industry characteristics as determinants of trade and specialization. The model considers consumers to

[17] $S_i \equiv \frac{1}{\beta} \ln T_i - \theta \ln w_i$ is a measure of country i's competitiveness, defined by its technology-adjusted labor costs (Eaton-Kortum, 2002).

be heterogeneous in their preferences and industries to differ in terms of production cost function. Given that there exist some active firms in the country i denoted by N_i and uniquely identified by their unit of input requirement α, with the CDF of unit input requirements given by $\mathrm{G}(\alpha)$. The variable α_{ij}^{*} in heterogeneous firm models is the threshold that limits the entry of firms into the market. According to Head and Mayer (2013), the variable is dyadic since the threshold must depend on trade costs between i and j.

Generalizing the work of Melitz (2003) in a way that is suitable for multiple countries, Chaney (2008) and Helpman et al. (2008) superimposed the heterogeneous firms in a Dixit-Stiglitz framework to obtain an expression for the aggregate share of the market. The pricing equation specific to each firm to their α is now:

$$P_{ij} = \frac{\sigma}{\sigma - 1} w_i \tau_{ij} \alpha$$

where w_i is the wage in the firm i and τ_{ij} is the trade cost. Given the cost function, the market share of the firm $i$to the firm j is, therefore:

$$\pi_{ij} = \frac{N_i \int_{\alpha}^{\alpha_{ij}^{*}} P_{ij}(\alpha)^{1-\sigma}\, d\mathrm{G}(\alpha)}{\sum_{\ell} N_{\ell} \int_{\alpha}^{\alpha_{ij}^{*}} P_{\ell j}\,(\alpha)^{1-\sigma} d\mathrm{G}(\alpha)} = \frac{N_i w_i^{1-\sigma} V_{ij} \tau_{ij}^{1-\sigma}}{\sum_{\ell} N_{\ell}\, w_{\ell}^{1-\sigma} V_{\ell j} \tau_{\ell j}^{1-\sigma}}$$

where ℓ denotes the activities of each (individual) firms i and V_{ij} is represented in Helpman et al. (2008) as:

$$V_{ij} \equiv \int_{\alpha}^{\alpha_{ij}^{*}} \alpha^{1-\sigma}\, dG_i(\alpha)$$

If the level of entry costs α_{ij}^{*} are lower than the least support, $\underline{\alpha}$ then $V_{ij} = 0$, implying that there will be no export from the firm i to firm j. Thus, assuming a zero-profit condition and the fixed cost (f_{ij}) incurred by firm i to service firm j , the equilibrium threshold α_{ij}^{*}, can be obtained as:

$$\alpha_{ij}^{*} = \sigma \frac{\sigma}{\sigma - 1} (\sigma - 1) \left(\frac{X_j}{f_{ij} \Phi_j} \right)^{\frac{1}{\sigma - 1}} \frac{1}{w_i \tau_{ij}}$$

where X_j and Φ_j are special features characterizing the destination firm j and both of which are a function of fixed trade cost and influence the threshold entry cost α_{ij}^{*}. This part in the

bracket is considered as the intensive margin. The term out of the bracket is a function of fixed trade cost (f_{ij}) - conditional on the cut-off productivity X_j, and captures the size of the firm, which can be thought of as the extensive margins following Redding (2011). The entry cost of the firm i is also dependent on i -specific distribution parameters in $G_i(\alpha)$.

Following Helpman et al. (2008) to set $G_i(\alpha) = {\alpha^\theta - \underline{\alpha}^\theta}\Big/{\alpha_i^\theta - \underline{\alpha}^\theta}$, and adopting Chaney (2008) and Arkolakis et al. (2012) to impose Pareto (with a lower bound $\underline{\alpha} = 0$ and country-specific input requirements support $\bar{\alpha}_\iota$), one can show the aggregate market share of i firms in j as:

$$\pi_{ij} = \frac{N_i (w_i \bar{\alpha}_\iota)^{-\theta} {\tau_{ij}}^{-\theta} {f_{ij}}^{-\left[\frac{\theta}{\sigma-1}-1\right]}}{\sum_\ell N_\ell \, (w_\ell \bar{\alpha}_\iota)^{-\theta} {\tau_{\ell j}}^{-\theta} {f_{\ell j}}^{-\left[\frac{\theta}{\sigma-1}-1\right]}}$$

Arkolakis et al. (2012) define $f_{ij} = \xi_{ij} w_i^{\mu} w_j^{1-\mu}$, where $w_i \; and \; w_j$ are the respective costs incurred in the home economy and destination market in a Cobb-Douglas function, and by substituting into the firm entry-level threshold (α_{ij}^*), yields the structural gravity model, given as:

$$S_i = N_i (w_i \bar{\alpha}_\iota)^{-\theta} (w_i)^{-\theta-\mu\left[\frac{\theta}{\sigma-1}-1\right]} \text{ and } \phi_{ij} = {\tau_{ij}}^{-\theta} {\xi_{ij}}^{-\left[\frac{\theta}{\sigma-1}-1\right]}$$

Where S_i relates to the activities of the exporter (firm i) and ϕ_{ij} denotes the bilateral relationship between the firm i and j. According to Chaney (2008), the implication of the model represented by ϕ_{ij} is that the cost-related elasticity of trade is now $-\theta$ rather than $1 - \sigma$, which is the preference parameter that determines the elasticity of trade for each firm. The model reveals bilateral trade as a function of both variable and fixed trade costs. Many of the determinants that project trade costs, τ_{ij}, such as distance, common language, and colonial links, can also exert significant influence on ξ_{ij}.

Contemporary refinement in theoretical gravity

To extend the non-linear version of Anderson (1979), Anderson and van Wincoop (2003) provided a refined demand-side analysis that sees countries as representative agents that export and import goods. The model assumes that goods are differentiated by their place of origin, according to Armington preferences, where individual countries specialize in the

production of one good. Secondly, they assumed the existence of trade separability, indicating that agents maximize their utility by consuming tradable goods, which are allocated and separately analyzed across countries. Third is that countries possess identical and homothetic preferences, implying that countries maintain similar demand structures and, given their income, spend the same amount on the goods from the exporting countries.

They suggested the demand-side preferences lead to a utility function that exhibits a constant elasticity of substitution (CES), with the trade elasticity being σ > 1, over all the national products, such that the importer country j region (the consumer) maximizes utility given as:

$$\cup_j = \left(\sum_i \left(A_i Q_{ij}\right)^{\frac{(\sigma-1)}{\sigma}}\right)^{\frac{\sigma}{(\sigma-1)}}$$

where A_i represent a utility distribution parameter that can be thought of as an index of the quality of the country i's product (technology). For the sake of simplicity, this parameter is neglected here since its suppression does not change the interpretation of the resulting gravity equation. Hence, the new CES utility function now takes the form:

$$\cup_j = \left(\sum_i \left(Q_{ij}\right)^{\frac{(\sigma-1)}{\sigma}}\right)^{\frac{\sigma}{(\sigma-1)}}$$

Subject to the budget constraint:

$$\sum_i P_i Q_{ij} t_{ij} = y_j$$

The budget constraint represents the total expenditure of country j for the purchase of goods from country i. In the equation, P_i represents the selling price charged by the suppliers in the country i, excluding the transportation costs. While t_{ij} (said to be $t_{ij} > 1$) is the trade cost factor between origin i and destination j. Thus, the total expenditure of country j on all the goods imported from other countries i is represented by the multiple of $P_i Q_{ij} t_{ij}$ - as the total cost, which is equal to the total income y_j earned in country j. Maximizing the CES utility function subject to the budget constraint:

$$\left(P_i t_{ij}\right)^{1-\sigma} = \frac{P_i t_{ij} Q_{ij} Y_j^{-\sigma}}{\sum_i Q_{ij}^{\left(\frac{\sigma-1}{\sigma}\right)^{-\sigma}}}$$

As a demand-side approximation, the CES utility function is price characteristic. The CES price index determines the equilibrium prices, which defines the price level. The price is obtained by summing up all the i from the left-hand side of the equation and substitute $\sum_i P_i Q_{ij} t_{ij}$ with Y_j. The simplified equivalence is given as:

$$P_j^{1-\sigma} = \frac{Y_j^{1-\sigma}}{\sum_i Q_{ij}^{\left(\frac{\sigma-1}{\sigma}\right)^{-\sigma}}} \equiv \sum_i Q_{ij}^{\left(\frac{\sigma-1}{\sigma}\right)^{-\sigma}} = \frac{Y_j^{1-\sigma}}{P_j^{1-\sigma}}$$

Considering the expenditure and income equilibrium of the importer and the exporter, where: $P_i t_{ij} Q_{ij} = X_{ij,}$ we can determine the demand function for the country $j's$ imports from country i as:

$$X_{ij} = \frac{\left(P_i t_{ij}\right)^{1-\sigma}}{P_j^{1-\sigma}} Y_j$$

Restoring the shift parameter A_i into the demand (import) equation makes it equivalent to the equation of Anderson and van Wincoop (2004) given as: $X_{ij} = \left(\frac{A_i P_i t_{ij}}{P_j}\right)^{1-\sigma} y_j$. The main purpose here is to determine the aggregate demand and the general equilibrium trade flows. Through the market clearing conditions, all the countries can be aggregated. Thus, substituting the above equation into the equation of the market clearing condition: $Y_i = \sum_j X_{ij}$, and from which the market equilibrium price can be determined as an equivalence:

$$Y_i = \sum_j \left(\frac{P_i t_{ij}}{P_j}\right)^{1-\sigma} Y_j \equiv (P_i)^{1-\sigma} = \frac{Y_i}{\sum_j \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} Y_j}$$

Putting the price $(P_i)^{1-\sigma}$ back into the import demand equation X_{ij}, and considering that expenditures of individual countries (Y_j) and the income of each country (Y_i) are both shares in the world's aggregate income (Y_w), the next step becomes:

$$X_{ij} = \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} \frac{Y_j\, Y_i}{Y_w} \left(\sum_j \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} \frac{Y_j}{Y_w}\right)^{-1}$$

Expressing the equation in terms of Y_w: i.e., $\frac{1}{Y_w}\left(\frac{1}{Y_w}\right)^{-1} = 1$, and to keep the unfolding equations simple and easy, the term $\left(\frac{t_{ij}}{P_j}\right)^{1-\sigma}$ on the right-hand side of the equation is defined as $(\Pi_i)^{1-\sigma}$ (see Anderson and van Wincoop 2004). Putting back the term $(\Pi_i)^{1-\sigma}$ into the demand function, the equation gives the final structural gravity model

$$X_{ij} = \frac{Y_j\, Y_i}{Y_w}\left(\frac{t_{ij}}{P_j \Pi_i}\right)^{1-\sigma} \qquad (I)$$

$$(\Pi_i)^{1-\sigma} = \sum_j \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} \frac{Y_j}{Y_w} \qquad (II)$$

$$\left(P_j\right)^{1-\sigma} = \sum_i \left(\frac{t_{ij}}{\Pi_i}\right)^{1-\sigma} \frac{Y_i}{Y_w} \qquad (III)$$

By interpretation, equation (I) represents the theoretical gravity equation, and equations (II) and (III) are the inward and outward multilateral resistance terms. This implies that trade flow between countries i and j depends on three resistances, including trade cost t_{ij}, reflecting the foremost trade impediment (Anderson and van Wincoop 2004).

Summary

As mentioned earlier, this subsection discussed major trade theories and their various empirical regularities in the analysis of foreign trade of regions. The review has shown evidence of theoretical equivalence, as the H-O model also discussed another means of comparative advantage, indicating the similarity of the H-O framework and the Ricardian model under certain conditions (Ford, 1982). Krugman (1981a), Helpman and Krugman (1985), and Krugman (1994) indicate that the NTT is compatible with the standard 2x2x2 framework of neoclassical trade theory – a combination considered suitable to explain the observable coexistence of inter- and IIT. NEG analysis seeks to explain the uneven spatial distribution of economic activity, particularly the formation of urban centers and regional agglomerations

within a unified framework of increasing returns and transportation costs. It integrates insights from trade theory, location theory, and urban economics, which are considered important elements in contemporary trade research (Umiński and Fornalska-Skurczyńska, 2020). In what seems an advantage to this dissertation, NEG has been criticized for being highly inclined towards the analysis of the region's trade. The novelty of the foundational NEG model as presented by Krugman in 1991, is that it combined transport costs, increasing returns to scale, and imperfect competition in a general equilibrium framework in which the location of both supply and demand was endogenized. The model is just one step away from the standard model of IIT, as developed by Krugman (1980). The gravity model complements and extends traditional and modern trade theories by providing a practical, empirical framework to quantify trade flows. It accounts for factors like economic size, distance, and geographic proximity, often implicit or under-emphasized in classical and neoclassical theories, while supporting the predictions of newer trade theories. The empirical regularity and consistency of the gravity model are quite extensive. The gravity framework has been empirically successful in both cross-sectional and panel analysis.

2.1.4 Foundation of IIT and its components

The NTT has offered an extensive explanation of the theoretical foundations of IIT and its components. The first theoretical foundation of IIT assumes an H-O model with perfect competition to explain how individual countries' skill intensity differences result in different production functions, which in turn define the chances of countries to participate in trade, based on comparative advantage. Countries now specialize in producing the same good but of different quality based on their factor endowments. Thus, the differences in prices of the goods across countries imply differences in quality (also referred to as vertical differentiation). The second model used a Chamberlinian model with monopolistic competition to construct the existence of IIT as a function of consumers' motivation towards consuming as many different varieties as possible of the same good (i.e., the so-called "love of variety"). The model assumes that, due to differing product varieties in their actual and perceived characteristics, IIT, which recognizes horizontal differentiation of goods, tends to occur. The third theory relied on the neo-Hotelling models with a 'perfect monopolistic competition' to model IIT on the account of product differentiation. The model assumes that a specific variety (i.e., a "diversity of taste") as defined by individual consumer preference drives IIT between countries.

Given all the models presented in the NTT, it can be understood how complex developing a straightforward theoretical base for IIT can be. So, there is no single class of model that can completely explain the concept of IIT. Each model tends to explain only a part of the complete phenomenon of ITT and may all be considered as partial equilibrium (Al-Mawali, 2005). Despite the different underlying market assumptions, each of these categories of models provided a theoretically consistent explanation as to why trade within the same industry and between countries of similar factor endowment takes place. Whereas the neo-Heckscher-Ohlin Model emphasizes vertical differentiation of products to become the first theoretical foundation for Vertical Intra-industry Trade (VIIT), the neo-Chamberlinian models and neo-Hotelling emphasize horizontal differentiation of products to be the early theoretical connections for Horizontal Intra-industry Trade (HIIT). The difference between HIIT and VIIT is that there is less consensus regarding the motivation and theoretical grounding for the vertical part of IIT. In terms of definition, while HIIT explains trade between developed countries, VIIT is the type of trade that takes place between developed and developing countries (Al-Mawali, 2005). The second theoretical model emphasizes vertical differentiation anchored on the oligopolistic market structure to explain VIIT. The model relates VIIT to trade in goods belonging to the same industry but coming from different stages of production. The importance of differences in factor endowments characterizing production in each firm or country only happens at the sub-industry level, where the level of fixed cost in R&D determines and leads to specialization. So, according to Jaskold-Gabszewicz and Thisse (1980), Dixit and Grossman (1982), and Shaked and Sutton 1984, given the different factor endowments, different countries decide to produce final homogeneous goods, either at the intermediate or final stage. The implication is that the vertical specialization of IIT treats both the intermediate and final goods as part of the same industry. Drawing from the various reviews (and the theoretical split in the foundational treatment) of IIT and its components, the following chart is presented to give a summary of the theoretical evolution and guiding steps in the rest of the paper[18].

[18] Chart is an elaboration based on Fontagne and Freudenberg (1997), Al-Mawali (2005) and Freidman et al. (2020)

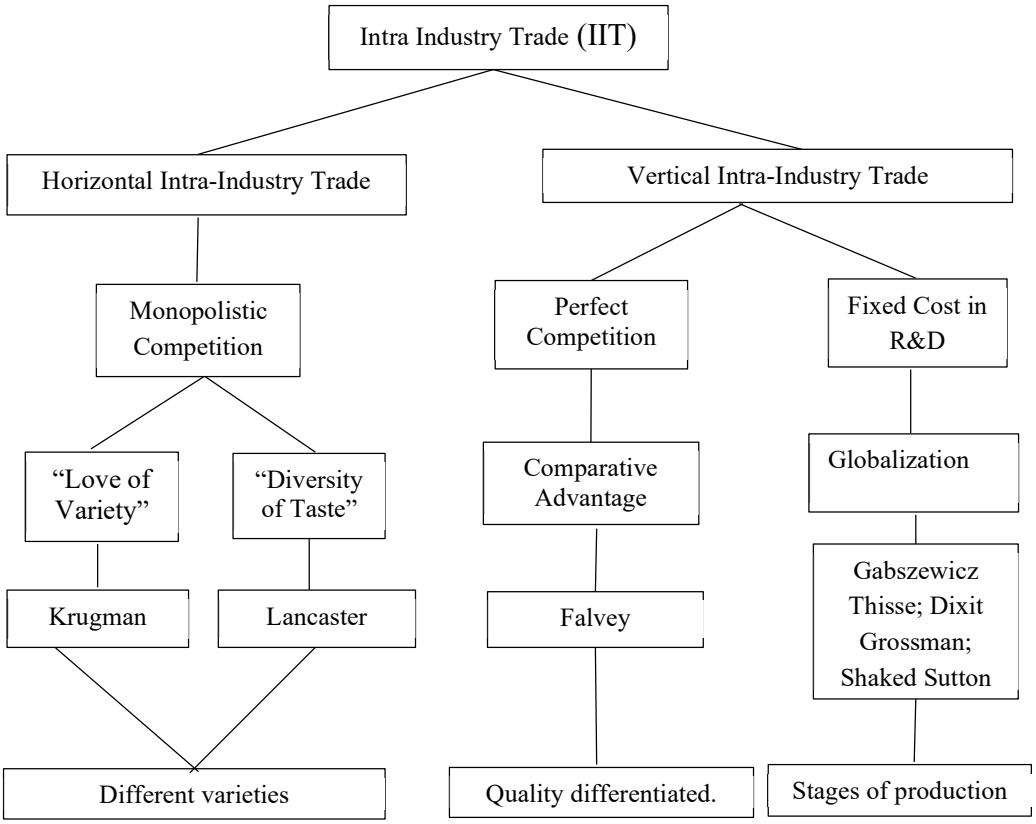


Figure 2.7 Evolutionary development of theoretical IIT
Source: Own elaboration

Whereas theoretical literature has extensively revealed the foundation for and the existence of IIT, empirical studies have focused on testing the determinants of IIT and its components (Ekanayake et al., 2009). Early empirical studies on the determinants of IIT are inspired by the "new" trade theories. The varied theoretical models and the diverse market assumptions that each model makes result in a series of variables used as determinants of IIT (Lloyd and Grubel, eds, 2003; Thorpe and Zhang, 2005). Following the emergence of the neo-classical model and the growth of theoretical literature, it became clear that there are two types of IIT – horizontal and vertical. Importantly, Greenaway et al. (1994, 1995) illustrate that empirical studies that fail to distinguish between HIIT and VIIT are likely to have extremely biased coefficients for product differentiation and scale economies since the two IIT categories are driven by different factors and adjustment costs. Specifically, HIIT occurs between countries of similar factor endowments trading similar goods of different varieties, while on the other hand, VIIT happens between countries of different factor endowments at different points in the

global production process (Falvey and Kierzkowski, 1987; Jambor, 2014). More empirical studies have made efforts to maintain this separation of IIT into HIIT and VIIT and investigate their determinants accordingly. Despite the large volume of empirical studies, some consistent factors affect IIT and its components. It is important to note that when considering the determinants of IIT, HIIT, and VIIT, the volume of literature has identified that empirical variables can be further segregated into country and industry-level factors. However, as a single entity non-gravitational analysis, this part of the dissertation is mainly concerned with province-specific factors, since disaggregated firm-level data are not sufficiently available.

2.1.5 IIT decomposition and modeling

Following the various theoretical developments for IIT and its components, there are no uniform statistics separating what is and isn't IIT. Therefore, any empirical work must first decompose IIT, as well as HIIT and VIIT, from available trade data. The 1975 Grubel-Lloyd index is uniformly employed in delineating inter-industry from IIT.

$$GL_{it} = IIT_{it} = 1 - \frac{|(X_i - M_i)|}{X_i + M_i} = 1 - B_k$$

where: the IIT for any industry or product category i is calculated in terms of their exports of that industry or product (X_i) and imports of that industry or product (M_i). The measure takes a value between one and zero, where values closer to one denote a higher degree of IIT within the industry.

There is considerable consensus regarding the application of the Grubel-Lloyd index, although less consensus exists regarding the separation of HIIT and VIIT from IIT. Greenaway et al. (1994) proposed the first of two general methodologies used in empirical investigations that break down HIIT and VIIT. According to Greenaway et al., vertically differentiated goods are those whose unit values at the SITC 5-digit level differ by more than 15%. They separated the Grubel-Lloyd index results into HIIT and VIIT. This was further developed by Hine et al. (1998). Formally, the bilateral trade of horizontally differentiated products can be expressed as follows:

$$1 - \alpha \leq \frac{UV_i^x}{UV_i^m} \leq 1 + \alpha$$

where UV_i^x (UV_i^m) are the unit value of exports (imports) for product i, and $\alpha = 15\%$ - *represents the* dispersion factor, and $\frac{UV_i^x}{UV_i^m}$ represents the relative unit price of exports and imports. Thus, Greenaway-Hine-Milner argued that a product is horizontally differentiated if the ratio of comparative unit value of export to import lies within a 15 per cent level, otherwise, the Greenaway-Hine-Milner (GHM) method is considered vertically differentiated products. The second approach was developed by Fontaine et al. (2006) and Fontaine and Freudenberg (1997) and is based on Abd-el-Rahman (1991). These studies established a methodology that carefully classifies each trade flow as either vertical (based on quality differential) or horizontal (based on diverse variety) and then calculates the share of total trade by each category. The modified views on the HIIT proposal satisfy the equation:

$$\frac{1}{1 + \alpha} \leq \frac{UV_i^x}{UV_i^m} \leq 1 + \alpha$$

While VIIT should satisfy either of the following equations, where:

$$\frac{UV_i^x}{UV_i^m} < \frac{1}{1 + \alpha} \quad or \quad \frac{UV_i^x}{UV_i^m} > 1 + \alpha$$

The unit value index of products below the 85% threshold (i.e., those exchanged at a lower average price level) is regarded as a feature of low-quality products, while an index limit of 1.15 (i.e., those traded at a higher average price) is considered as an indicator of high-quality products. Thus, from the logic in the equations of the horizontally differentiated products by Hine et al. (1998), the GHM index formally becomes as follows:

$$GHM^A = \frac{\left(X_i^A + M_i^A\right) - \left|X_i^A - M_i^A\right|}{(X_i + M_i)}$$

where X and M denotes export and import, respectively. Whereas A distinguishes horizontal or vertical IIT, $(i = 1 \ldots \mathrm{n})$ is the number of product categories. The nature of the equation (GHM^A) implies that the Grubel-Lloyd index could easily be applied to compute the intensity of IIT in horizontal and vertical differentiation.

The main area of concern and criticism about the unit value dispersion method approach pertains to its way of establishing a correlation between observed unit values and utilizing that correlation to ascertain the quality ranking of individual goods. When the difference between export and import values is greater than a predetermined threshold, the unit value dispersion method suggests that products are vertically differentiated. According to Lloyd and Grubel, eds. (2003) and Kien and Thao (2016), the value threshold is criticized for being "arbitrary" and for having the potential to inflate VIIT readings (Kandogan, 2003a; Zhang and Clark, 2009; Thorpe and Leitao, 2013). It is believed that in quality vertically differentiated items, the over-measurement of VIIT results from confusing actual VIIT with IIT (Schuler, 1995). In short, utilizing a definition of quality differentiated products leads to possibly over-counting a component of IIT.

A recent approach that has gained attention in the literature is the method presented by Kandogan (2003b), which does not involve the use of unit values. The author approached the method by first determining VIIT based on production stages. Kandogan used two different levels of aggregation based on the Standard International Trade Classification (SITC), where higher levels of aggregation (2-digit SITC) are used to represent industries and lower levels (4-digit SITC) to represent products within that industry. Based on this method, Kandogan can extract the values of exports and imports without recourse to data on quantity not setting any threshold value to decompose IIT into HIIT and VIIT. Kandogan's method has some advantages since it does not depend on the relative unit value, which is only a rough measure of product quality. Furthermore, data on the values of exports and imports are readily available. To obtain an explicit measurement, Kandogan started by defining a system of equations that characterizes an industry as:

$$\mathrm{X}_i = \sum_{\mathrm{p}} \mathrm{X}_{i\mathrm{p}} \; ; \mathrm{M}_i = \sum_{\mathrm{p}} \mathrm{M}_{i\mathrm{p}}$$

where X is exports, M is imports, i represents a given industry, and p is a particular product in the referred industry. From the equation, the exports and imports in each industry are summed up to give the total trade in each industry (TT_i). Following Grubel and Lloyd (1975), the IIT_i for each industry is obtained by matching exports and imports at higher levels of aggregation for each industry and further subtracted from total industry trade to determine the inter-industry portion (INT_i). The volume of trade of similar products, i.e., the $HIIT_i$ is calculated using the amount of matched trade in each product of an industry at lower levels of aggregation. lastly,

the vertical intra-industry trade $VIIT_i$ is obtained as the remainder of the IIT_i in this industry, it is derived from the trade of different products or products at various stages of production in an industry, the illustration of the equations is given below:

$$TT_i = \sum_p X_{ip} + M_{ip} = X_i + M_i$$

$$IIT_i = TT_i - |X_i - M_i|$$

$$INT_i = TT_i - IIT_i$$

$$HIIT_i = \sum_p X_{ip} + M_{ip} - |X_{ip} - M_{ip}|$$

$$VIIT_i = IIT_i - HIIT_i$$

The Kandogan system of equations supports a uniform way to decompose all the components of trade and also tends to limit the frequency of over-biasing any of the measures. Furthermore, the resulting system of equations can be used to explain the different effects of trade by industry. Finally, the method is flexible, to sum up trade in an industry and different categories to obtain a country's total trade. The flexibility characteristics of the index have resulted in a plethora of its utilization in different models. However, one of the points of departure is that of the many papers that utilized the index, none has applied it for the provincial level study. At the country level, while Konno (2016) and Freidman et al. (2020) use a gravity model to apply the index, other papers employed different methods, such as a Tobit with random effects (e.g., Zhang and Clark, 2009), a pooled OLS model with random effects (e.g., Thorpe and Leitao, 2013), and a GLS (e.g., Kien and Thao, 2016).

This dissertation adopts the adjusted Grubel-Lloyd (1975) model to derive the IIT index, complemented by the Kandogan (2003) method to decompose the IIT into HIIT and VIIT. The joint application of the two methods is mainly to adequately decompose IIT into its HIIT and VIIT components, since there is no available information on the value of trade in kilograms or any form of quantity for Canadian trade flows. While the Kandogan method is widely recognized for its practical applicability in such data-constrained contexts, its adoption here is not predicated on its superiority over other decomposition techniques, but rather on its operational suitability given the limitations of the available dataset. Consistent with the

theoretical underpinnings of Grubel and Lloyd (1975) is that products are similar in HIIT, and quality differentiated in VIIT.

2.1.6 Determinants of IIT and its components

Across the literature, there are variables widely and consistently used as metrics for the determinants of IIT and its components.

Economic/market size

The variable often listed as first in this group is the **size factor**, which specifically defines the size of the market created by the bilateral trade between nations. If the average market scale of the trading partners is large, then the IIT between them is large. According to Lancaster (1980), scale economies will allow the home market to supply a greater variety of goods as the size of the domestic economy increases. On the demand side, as the economy grows, so will the demand for foreign varieties of goods. The implication is that larger markets have the potential for greater differentiation in products, which is conducive to the model of IIT, whether such a model follows the love of variety or the love of a particular variety approach. Larger economic sizes also have greater potential to exploit gains associated with economies of scale. The size determinant is very important, and often proxied by the GDP, especially in those studies focusing on single-country trade (Zhang and Clark, 2009; Thorpe and Leitao, 2013; Lapinska, 2016). Given the theoretical precedence for this variable, the literature expects that HIIT and VIIT will be positively correlated with economic size.

Factor endowment

The second determinant from the empirical literature is factor endowments. As articulated by Helpman and Krugman (1985), factor endowments are important due to the nature of international trade. The impact of factor endowment on IIT has been analyzed both in the models of horizontal and vertical differentiation. According to the model of horizontal differentiation, an increase in the level of development/endowment negatively correlates with HIIT & IIT. The implication is that as regions in trade attain similar and higher development or endowment levels, the more likely for the regions to specialize in horizontally differentiated products, which discourages IIT. In terms of vertical differentiation, the model assumes that

development or endowment difference between two regions leads to production specialization, which encourages more differentiated products and more IIT (Kim and Marion, 1997). Some authors (Thorpe and Leitao, 2013) have argued about whether GDPpc proxies for factor endowments or consumer tastes and preferences. Other studies have argued that the difference in GDPpc is a metric for similarity in per capita income (Al-Mawali, 2005; Thorpe and Zhang, 2005; Thorpe and Leitao, 2013). Drawing from Helpman (1987), the literature proxies factor endowment using the GDPpc since both indicators were found to have similar effects. The argument is that increased similarity results in overlapping of consumer tastes and preferences, as well as levels of development. This means that a negative relationship exists between the GDPpc difference between regions and HIIT & IIT, while a positive relationship exists with VIIT.

Technology is another form of factor endowment, which often underscores the role of quality upgrading in determining the intensity of IIT. However, in the horizontal differentiation model, the concept is not well-defined because quality is not a factor to differentiate products by assumption. In the vertical differentiation model, Flam and Helpman (1987) suggest that quality upgrading in the labor-abundant country contributes to IIT, as the quality spectrum of specialization in the economy shifts upward. Therefore, the effect of quality upgrading on vertical IIT is expected to be positive. Helpman and Hoffmaister (1995) calculated technological capital using the perpetual inventory method. This dissertation uses the gross domestic expenditures on research and development as a measure of advancement in technological capital. Shaked and Sutton (1984) have suggested that R&D expenditure is a good indicator of product quality upgrading. Empirically, Kim and Marion (1997) have also shown expenditure on research and development (R&D) to be a promoter of IIT in the agri-food sector.

Transaction costs

The third determinant of region-wide IIT is transaction cost, often proxied by the distance between trading partners, which directly affects the feasibility and intensity of IIT. This means that factors such as distance place an additional cost burden on IIT and its components. Time zone differences add significantly to the cost of doing business abroad due to the double coincidence. Krugman (1979, 1980) argues that distance is not only a proxy for the transportation cost of goods but also for cultural differences between bilateral trading partners. Zhang and Clark (2009) additionally argue that larger cultural divides make it more costly to

import foreign goods, thus compounding distance's effects. Some studies have been interested in disentangling some of the cultural divides captured by distance. Studies have looked at similar language (Kandogan, 2003b; Lapinska, 2016; Aggarwal and Chakraborty, 2017), but most have focused on common borders as a way to disentangle distance effects. In the studies that look at the effect of a common border, they find that it has a positive effect on IIT, HIIT, and VIIT (Balassa and Bauwens, 1988; Ekanayake, 2001; Lapinska, 2016; Konno, 2016; Aggarwal and Chakraborty, 2017). The aforementioned authors argue that common borders reduce the cost captured in geographic distance, but do not provide a theoretical justification as to why. As a single-entity analysis, this dissertation identifies the role of distance from the equator as a proxy for the transaction costs in the facilitation of IIT. Distance from the equator is likely to be correlated with distance from major trading partners, which provides a possible way of influencing IIT. Latitude has also been considered a likely valid proxy for factors that might be directly correlated with trade as a source of trade costs. According to Desmet and Rossi-Hansberg (2015), the potential negative economic effects of latitudes are the result of frictions that prevent the free movement of goods in space.

Production and import taxes, such as value-added taxes (VAT) or excise duties, are some of the other transaction costs that directly impact the cost structure of local producers/importers. The cost of manufacturing items domestically rises with higher production taxes, which reduces their competitiveness when compared to identical products made in regions with lower tax burdens. As a result, there may be IIT if domestic firms choose to import certain parts or completed goods from outside markets with lower production taxes. Secondly, the multinational firms have an incentive to locate in low-tax regions, and this foreign investment acts to stimulate IIT to a greater extent. Further, firms acting to minimize their worldwide tax burden have an incentive to alter prices and quantities of trade to shift income to more lightly taxed locations. Clausing's (1998) finding of U.S. trading displeasure with low-tax countries is congruent with tax minimization incentives. Clausing's (2000b) study also established export prices to be lower for low tax countries, while import prices remained higher, a finding that is also consistent with tax-minimizing behaviors. Thus, there is an incentive for exporting firms to move income to more lightly taxed locations by underpricing goods shipped to low-tax countries and overpricing goods sold to high-tax countries. Ceteris paribus, this would lead one to expect lower (higher)amounts of exports (imports) to (from) low tax countries.

Economic openness

A fourth standard empirical determinant is the **openness** of the economy to international trade. Although increased trade orientation of a country would lead to an increase in both inter- and intra-industry trade. Falvey (1981) expresses that while a country's greater trade orientation would result in more trade between and within industries, it also correlates with a decrease in protectionist policies, which raises all three IIT variables. Much of the literature, following Stone and Lee (1995), approximates this using population regression and the residuals from a per capita trade on per capita income. Many other country-level studies, such as Oshota and Wahab (2022), have utilized the Worldwide Governance Indicators (WGI) produced by the World Bank, following the work of Kaufmann and Kraay, which was updated in 2023. This dissertation uses the Economic Freedom Index (defined as indicators of institutional quality) to represent openness. Economies with high economic freedom tend to engage more in IIT, suggesting that openness due to strong institutions plays a significant role in facilitating the exchange of goods characterized by the simultaneous export and import of similar products within the same industry (e.g., Rauch,1999; Helpman, Melitz, and Rubinstein, 2008). High economic freedom is therefore expected to have a positive effect on IIT and its components. Studies, including Rodrik et al. (2004) and Heo et. al (2022), have shown that a higher level of economic freedom leads to increased levels of IIT by reducing transaction costs. In contrast, inefficient institutions can lead to serious obstacles for IIT. Bigsten et al. (2000), for example, explain how the lack of an effective legal framework impedes communication between manufacturing companies in some African nations and prospective international buyers. The implication is that institutions that support freedom matter a great deal, especially to the North, which has better institutions (Acemoglu, Johnson, and Robinson, 2002). Empirical literature has shown that institutional quality is a crucial determinant of trade performance (Oshota and Wahab, 2022). Regions with better institutions experience higher trade volumes, lower trade costs, more diversified trade patterns, and greater benefits from trade agreements. These findings underscore the importance of institutional reforms in promoting international trade and, by extension, economic development.

Trade imbalance

The fifth determinant of IIT is **trade imbalance**. Due to the way that the Grubel-Lloyd index is constructed, as trade imbalance rises, the index reflects lower IIT (Grubel and Lloyd, 1975). As a nation develops a trade deficit (excess), the lower number of similar products exported (imported) can make up the total trade. Therefore, trade imbalance is seen to be negatively correlated with all three components of IIT, and as such, several studies create a variable to measure trade imbalance (Stone and Lee, 1995; Clark and Stanley, 1999; Thorpe and Zhang, 2005; Zhang and Clark, 2009). As enumerated in the next section, the decomposition of IIT and its components does not rely upon a defined threshold to designate an industry as IIT. Thus, based on the methodology employed in this dissertation, the issue of trade imbalance does not arise, and there is no need to control for such an imbalance to account for the so-called omitted variable bias.

MNEs activities

The final determinant of IIT is traced to the activities of the MNEs. They play a pivotal role in this transformation through their investments and operations across various locations. The dynamic effects of MNE activities across various industries and regions allow us to capture temporal variations and industry-specific differences in trade patterns. Helpman and Krugman (1985) extended the New Trade Theory to incorporate firm-level behavior, showing how MNEs' decisions to specialize and trade can lead to IIT. This centralization of production in specific regions creates two-way trade flows of differentiated goods, a core feature of IIT. In their influential paper, Helpman, Melitz, and Yeaple (2004) further developed a theoretical model that highlights the role of multinational firms in shaping trade patterns, including IIT. They argue that MNEs engage in both horizontal and vertical specialization, leading to increased IIT. Indeed, multinational firms dominate international trade, as they constitute the large exporters to and importers from the global market (Miroudot and Rigo, 2021). Foreign enterprises exert significant influence on the competitiveness and welfare levels of the regions in which they operate through their investments in capital and technology-intensive sectors. Some academic literature (e.g., Ramondo et al., 2015; Alviarez, 2019; Arkolakis et al., 2018; Miroudot and Rigo, 2021) utilized “multinational production” to quantify the real activity of MNEs’ affiliates. Other researchers, such as Antràs and Yeaple (2014), use the share of affiliates in manufacturing employment, output, and FDI to represent the activity of the MNC. In this dissertation, key

indicators such as investments in physical capital, level of employment, and the amount of value-added have been utilized to capture MNEs' influence on the Canadian provinces' IIT.

Investments in **physical capital** often facilitate technological advancement within industries (OECD, 2015). This can improve productivity, increase product quality, and lead to greater specialization in specific industry segments. As countries invest in upgrading their production technologies, they may engage more in IIT to exploit their comparative advantages in specialized product lines. Physical capital may also influence the degree of vertical integration and the structure of supply chains within industries (OECD, 2015; 2024). Higher levels of capital investment may encourage firms to expand their operations vertically, leading to increased IIT as intermediate goods are traded between vertically integrated firms across borders. Investments in infrastructure can improve transportation, communication, and logistical capabilities within industries (OECD, 2019). This can reduce trade costs and facilitate the exchange of intermediate and final goods within the industry, thereby promoting IIT. Leamer (1984) measures physical capital by calculating the cumulated gross domestic investment at a constant rate of depreciation using the perpetual inventory method. This dissertation measured physical capital using the foreign MNEs' gross capital formation, defined as the total value of acquisitions of fixed assets (such as machinery, equipment, and non-residential buildings, including R&D spending) by MNEs during a specific period.

MNEs' **employment level** plays a crucial role in shaping patterns of international trade, including IIT. MNEs often engage in intra-firm trade, where subsidiaries or affiliates located in different countries exchange intermediate goods, components, and services within the same industry. MNEs create jobs in their foreign affiliates, which leads to increased trade in intermediate goods and components between parent firms and their affiliates (Helpman, Melitz, and Yeaple, 2004). Intra-firm trade can facilitate knowledge transfer, technology diffusion, and specialization, leading to IIT intensity as economic entities focus on producing specific parts of the industry's value chain. MNEs, by their size and global reach, can exploit scale economies and create global production networks. MNEs can facilitate technology spillovers and knowledge diffusion across borders, enhancing the productivity and competitiveness of local firms. This can create more jobs, which further stimulates IIT as countries leverage their enhanced technological capabilities to participate in specialized segments of the industry (Markusen and Venables, 1999; Yeaple, 2003). MNEs may engage in outsourcing and offshoring activities to access cheaper labor, raw materials, or intermediate inputs. This can lead to the creation of integrated supply chains spanning multiple countries, with IIT occurring as

intermediate goods and components are sourced from different locations within the MNE's network. In line with existing literature, this dissertation employs foreign MNEs' jobs to construct employment measures.

MNEs' **value-added** is measured by the corporation's contribution to the total GDP, which positively influences IIT and provides a crucial understanding of the dynamics of international trade within industries (Javorcik, 2004; Altomonte and Pennings, 2009). MNEs play a significant role in global value chains, contributing to value-added activities such as research and development, design, branding, and marketing (Dunning,1990; 1992). MNEs often engage in vertical specialization, where different stages of production are distributed across multiple countries to take advantage of cost differentials and specialized capabilities (Baldwin and Taglioni, 2006). As MNEs contribute value-added activities to global production networks, they facilitate the fragmentation of production processes, leading to increased IIT as intermediate goods and components are traded within and between MNEs' subsidiaries or affiliates (Helpman, Melitz, and Yeaple, 2004). By investing in R&D activities, MNEs develop new technologies, processes, and products that are disseminated throughout their global operations. This technology transfer can enhance the productivity and competitiveness of local firms and stimulate IIT as countries specialize in producing technologically advanced components or products within the same industry (Debaere, Mostashari, and Nilsen, 2014). MNEs' value-added activities can contribute to efficiency gains and the development of comparative advantage within industries. By optimizing production processes, improving product quality, and enhancing supply chain management, MNEs can reduce costs and increase competitiveness (Altomonte and Pennings, 2009). This can lead to increased IIT as countries specialize in producing specific segments of industry where they have a comparative advantage. MNEs often integrate their global supply chains by outsourcing certain stages of production to specialized suppliers located in different countries. As MNEs coordinate production activities across borders, they stimulate IIT by sourcing intermediate goods, components, and services from various suppliers within the same industry (Bernard, Jensen, and Schott, 2006).

2.2 Empirical literature

This section reviews the empirical literature relevant to the study of regional trade, with a focus on how globalization and structural factors shape subnational trade dynamics. It begins

with a survey of key international studies on regional foreign trade, followed by an overview of empirical research specific to Canada. The section concludes with a critical synthesis of scholarly perspectives on how globalization influences regional trade patterns, offering a foundation for the analytical framework developed in subsequent chapters.

2.2.1 Previous studies on the foreign trade of regions

This section presents selected, and the most important literature focused on regional aspects of foreign trade.

For the U.S. states, Fieleke (1970) and Golladay and Sandova (1972) are probably the first two of the earliest studies to make inquiries into the trade at the sub-national level, particularly on exports of regions. While the former analyzed the consequences of the Kennedy Round session of GATT on the manufacturing of New England, the latter authors researched the nature of an optimal development policy for a region open to international trade - specifically, they probed into what policy instruments should be used to reduce social costs and provide a solution to cushion exogenous economic shocks. DeKaser and Sneddon (1994) analyzed exports of New England to ascertain the reasons for its low competitiveness in the 80s and 90s vis-a-vis nations with comparable development that dominated the U.S. market. The growing role of services in GDP and employment has been identified as the main structural reason negatively affecting export performance. Coughlin and Fabel (1988) and Coughlin and Mandelbaum (1990), respectively, studied the relationship between factor endowments and the nature of U.S. states' exports. While their conclusion recognized the applicability of the H-O model and its extensions in regional trade analysis, human and physical capital were found to be sources of comparative advantage, although unskilled labor proved an alternative. Erickson and Hayward (1991) researched the export flow patterns of nine U.S. regions. They established the validity of spatial interaction models of international trade at the regional scale and identified the patterns and determinants of U.S. regional manufacturing exports (such as overlapping demand structures, political and cultural factors, and FDI ties) as potentially important differences in regional industrial impacts that may lead to contemporary developments in international trade.

In the same U.S. region, research by Lewandowski (1996) looked at the sources of the export performance for the U.S. states. Productivity, agglomeration economies, and export performance were linked within a comparative advantage concept. Differences among regions

(productivity of capital, the productivity of labor, and R&D) were recorded as the source of their export performance. Leichenko and Erickson (1997) examine the relationship between FDI and the performance of state exports, suggesting that FDI positively contributes to states' long-term industrial competitiveness in the global markets. These positive impacts have been identified to be driven by the durable goods industrial sectors (which include metals, machinery, and electronics), and in non-durables (such as food products), FDI influence on export performance proved weaker. Aitken, Hanson, and Harrison (1997) also established the positive influence of FOEs on the export performance of the closer domestic companies through the mechanism of information technology, technical know-how, and distribution channels, which work interconnectedly to reduce foreign market entry costs. Furthermore, the authors found that the probability that a domestic plant becomes an exporter is positively correlated with the proximity to a FOE. Levy and Moscona (2022) researched the density and the pattern of trade for the U.S. states and countries with more spatially concentrated ("denser") populations that disproportionately export in density-loving sectors. The authors also rationalized their findings on the importance of R&D and collaborative/interactive tasks in production, to the confirmation that national export specialization emerges endogenously from the distribution of factors within countries and further indicates that it is the within-country spatial distribution of factors that explain a large share of patterns of trade. Leichenko and Erickson (1997) researched the relationship between FDI and the performance of state exports, revealing the positive contribution of FDI to the state's long-term industrial competitiveness in the global market. Specifically, the authors identified the positive effect as being predominantly for durable goods in the industrial sectors (i.e., metals, machinery and electronics). While in terms of non-durables (such as food products), FDI influence on export performance appeared to be weaker. Aitken, Hanson, and Harrison (1997) also established the positive influence of foreign enterprises on the export performance of nearby domestic companies, through information dissemination about foreign markets and the technology and distribution channels that reduce the costs of entry into the foreign markets. They found a positive correlation between the proximity advantage of foreign enterprise and the probability that a domestic plant becomes an exporter. Levchenko (2007) derives a theoretical model where incomplete contracts explain the existence of institutional differences. Using data for U.S. imports, he finds how institutional differences impact patterns of trade. A thorough study on exports of the U.S. regions can be attributed to Cassey (2010b), who has formulated seventeen stylized facts on U.S. states' exports, and reminiscence on the principle of comparative advantage: to the implication that "nearly all states

are relatively specialized in exporting something somewhere". By applying the location quotients (LQ) that relate a state's share in U.S. exports to its share in the national value-added, the author concludes that there exist specialized exporters. They maintained that regional industrial mix does not necessarily have to be the primary determinant of export specialization and further concluded that regions having access to the sea and possessing ports tend to export to relatively more distant countries, which points to the role of infrastructure and the role of intermediaries in foreign trade. In another publication, Cassey (2011) studied the foreign export patterns of the U.S. states, intending to find a unified description of facts characterizing exports for all states, destinations, and manufacturing subsectors. The author relied on a cross-section of state export data to establish a more unifying nine stylized facts. In general, the research established the peculiarity of each country in terms of the patterns of its regions' exports, which is a function of its political/ administrative framework (centralization vs decentralization being one of the most important questions from the point of view of export analyses).

The U.S. is a relatively less open economy, and it is not a surprise that a particular state's exports represent a small fraction of the total shipment. Cassey (2014) further studied the trajectory implications of operating an overseas trade office, defined as the net difference between aggregate savings and operating costs. The model assumes offices facilitate exports by reducing the transaction cost of exporting overseas and estimates the impact on exports of the likelihood that a trade office exists. Santacreu and Peake (2020) evaluated the effect of changes in trade policy during the 2018-2019 trade war on U.S. economic activity at the state level. They assessed how different states were affected by tariffs and trade tensions, providing insights into the varying economic impacts across the country, including highlights on the importance of geographic proximity, sectoral productivity, and policy changes in shaping trade dynamics. Torres and Carrillo (2021) analyzed the determinants of trade between U.S. states and Mexico under the United States-Mexico-Canada Agreement (USMCA). The study finds that geographic proximity plays a significant role, with U.S. states closer to the Mexican border engaging in higher levels of trade. Additionally, factors such as economic size, infrastructure, and historical trade relationships are identified as important determinants influencing trade volumes. In a more recent study, Santacreu, Sposi, and Zhang (2023) developed a structural framework to identify the sources of cross-state heterogeneity in response to U.S. tariff changes. The authors quantify the effects of unilaterally increasing U.S. tariffs by 25 percentage points across sectors, finding that welfare changes range from −0.8% in Oregon to 2.1% in Montana. The study highlights that states gain more when their sectoral comparative advantage covaries negatively with that

of the aggregate U.S., indicating the importance of transfers in aligning state preferences over trade policy.

For the European Union, Nicolini (2003) examined the role of the home market effect and the level of transport costs in driving regional export flows of the six European regions. In line with Head, Mayer, and Ries (2002), the home market effects imply that a relatively small number of locations within a country can generate the bulk of exports – this explains the concept of industry concentration mechanism and strongly reflects the country's lumpiness, which is represented by the agglomeration of export potential around cities (Brakman and van Marrewijk, 2013).

In terms of transportation costs, Nicoini's (2003) findings indicate that while physical distance smoothens the intensity of trading flows, local transport facilities as well as local demand intensify them. The exchange of commodities does not only require the frequent knowledge spread of the production technology among firms within a given regional production system but also a comprehensive set of information, skills, and capabilities that make an international transaction possible. Barbero, Mandras, Rodriguez-Crespo, and Rodríguez-Pose (2021) researched the quality of government impacts on trade flows of the European Union (EU) regions. Using cross-sectional gravity to analyze the region's trade, the authors show that trade across EU regions is highly influenced by differences in regional government quality. This influence varies by both sectors of economic activity and the level of economic development of the region. The results indicate the importance of institutional quality in regional trade flows.

In an innovative study relating to five European cities, Simmie (2002) reports that the growth circle is made up of innovation and trade as externalities found in core metropolitan cities with international corridors. Extending the study further, Simmie (2003) considered urban regions as international nodes through which competitiveness and exports are generated. Becchetti, Panizza, and Oropallo (2007) reached a similar conclusion and stated that Firms located in industrial districts export and generate value-added more than firms located elsewhere.

For Poland's regions, Ciżkowicz, Rzońca, and Umiński (2013) analyzed the determinants of Poland region exports, with findings showing regional export performance to be positively influenced by the labor productivity, the employment share of foreign-owned corporations, educational level of the population, location at the border of the country and maritime access, but negatively related to population density and location in the country's border region. Brodzicki and Umiński (2017) examine the impact of metropolises and history on the

international trade of the Polish regions. They identified the critical importance of a historical metropolis in determining the intensity of trade flows. The analysis provided a strong empirical connection to the earlier position of Berube and Parilla (2012) that Cities traditionally exhibit their role as major commercial nodes in international trade, in the world economy.

Brodzicki and Umiński (2017) also identified the negative role of higher exchange rate volatility on the region's exports. Gajewski and Tchorek (2017), probed into what drives the export performance of firms in Eastern and Western Poland, and found factors such as family ties in business, product innovation, and non-price competitiveness as drivers of export performance in the Eastern part, while the West was found to be associated mostly with size and foreign ownership. Nazarczuk and Umiński (2018) researched the role of Special Economic Zones (SEZs) in firm-level export performance, with findings confirming the positive and statistically significant impact of Labor productivity, employment level, foreign capital, and importing effect on the scale of exports.

Antunes and Andreia (2011) analyzed the relevance of human capital on the foreign trade of the NUTS3 regions in Poland. The authors found the importance of human capital in trade facilitation, and the competitiveness of the regional economy to be highly associated with human capital qualifications. The finding relates significantly to the knowledge and technology diffusion hypothesis. Studies by Cadot, Carrere and Strauss-Kahn (2011), and Agosin, Alvarez and Bravo-Ortega (2012) identified a negative and significant correlation between the level of human capital and export concentration measure. While the result from Parteka and Tamberi, (2013) indicates no significant correlation. Faggian, Modrego and McCann (2019) elaborated on the endogenous concentration of skilled human capital in cities and established its strong association with regional differences in productivity growth, which in turn determines the intensity of trade.

In a comparative analysis of the Spanish and Polish regions, Brodzicki, Jurkiewicz, Márquez-Ramos, and Umiński (2020) examined the patterns and determinants of the horizontal and vertical intra-industry trade, where some factors were considered, which includes traditional factors and several unconventional factors such as regional path dependence, quality of regional institutions, the core or peripheral status of the reporting region. Also, for the Spanish regions, Marquez-Ramos (2016) analyzed the effect of the institutional environment on international trade. The author identified better institutional quality of trade agreements to be associated with an increase in both the intensive and the extensive margins of trade – the factors were found to result in differential effects on regional exports.

In a study of the Polish province of Podkarpackie, Tomasz and Czapiewski (2020) explored the reasons why this marginally located region is lagging in economic terms and indicated the endogenous factors that can positively improve the regional situation and its potential to engage in economic activities, including trade. Rosik, Pomianowski, Tomasz, Goliszek, Szejgiec-Kolenda, and Duma (2020) analyzed the regional differences in the level of accessibility and GDPpc with the level of potential quotient, focusing on the analysis of the core-periphery pattern. As a typology, the authors presented the relationship between GDPpc and the level of potential quotient at different spatial scales and for different trip durations, allowing the identification of regions particularly exposed to migration or interregional commuting flows, serving as a potential for reduction in trade costs due to proximity.

In the Central and Eastern European context, Michałek (2012) applies a gravity framework to estimate the trade effects of euro adoption, thereby illustrating how policy shocks manifest in cross-border flows between subnational entities. Extending this line of inquiry, Cieślik and Michałek (2017) demonstrate that distinct forms of innovation influence firms' export performance, highlighting the heterogeneity of actors within regional economies. Komornicki (2011) offers a complementary geographical perspective, showing that the participation of Polish local units in global markets is highly uneven and shaped by transport and spatial linkages. Gajewski (2017) likewise compares export performance across Eastern and Western Poland, revealing the importance of regional characteristics for firms' external orientation. Together, these studies underscore that both regional context and firm-level attributes condition trade outcomes, providing a substantive and methodological foundation for the present dissertation's analysis of Canadian provincial trade patterns under globalisation.

For every other region: Sun (2001) found a substantial and positive effect of foreign enterprises on provincial exports of coastal Chinese. Whereas a weaker relationship was identified for the central ones, the impact was found to be statistically insignificant for the western region. Impact analysis shows that the influence is dependent on the region's structural characteristics (level of development, industrial structure, openness). Sun and Parikh (2010) also identified the nexus between regional exports, FDI, and economic growth in a similar research setting. An investigation by Ma (2006) found that exporting activities driven by foreign investment flows contributed to the inequalities among the Chinese provinces. However, in analyzing trade and investment flows between the southern Chinese region and the rest of China, Wu (2000) concluded with findings that seem more like a refutation - strong growth in exports from coastal regions positively contributes to the development of inland regions. The analysis

further identified the positive impact of "advantages from backwardness" for midland China, due to cooperation with the coastal, export-oriented provinces. Consequently, the initiated cooperation linkages by the coastal regions' exporters awaken the catching-up effects in less developed regions of China.

For the Swedish region, Andersson and Johansson (2010), analyzed the determinants of export flows by juxtaposing human capital with the structure of regional exports. The result shows that regional variations in human capital influence the structure of exports, thereby affecting the intensive margin. Similarly, for Sweden at the level of the regions, Johansson and Karlsson (2007) examine the effect of R&D accessibility on the regional diversity in export and justify the positive impact of R&D accessibility on several exported products, exporting destinations, and industries. Thus, Lovely, Rosenthal, and Sharma (2005) note that the bulk of this specialized knowledge is concentrated in the largest cities. In a study of the Brazilian states, Daumal and Özyurt (2011) identified the intensity of trade openness to be in favor of more industrialized states, which are well-endowed in human capital, rather than states whose economic activity is mainly based on agriculture and farming.

Summary: Essentially, this section cannot guarantee the review of all empirical literature on the region's foreign trade. However, the literature discussed so far corroborates the existence of different trade province-specific factors affecting the foreign trade of regions. From the reviewed literature, both the endogenous and exogenous factors have been applied to determine the trade competitiveness of different regions. Many of the factors are yet to be analyzed for the Canadian provinces. Again, a closer look at all the reviewed literature, none has comprehensively considered the influence of globalization on the region's trade. Thus, in contrast to the existing body of literature, this dissertation identifies and accounts for globalization's impact on the provinces' trade competitiveness. This dissertation is further motivated to examine the role of the province's specific factors in the performance of the provincial IIT.

2.2.2 Empirical studies on regional trade in Canada

Most of the research effort on Canada has primarily focused on the country level. Only a few studies have been carried out at the provincial level. A large portion of existing literature on provincial trade is predominantly devoted to the identification of the border effect, which

mainly focuses on provincial trade with the United States relative to interprovincial trade (e.g., McCallum, 1995; Helliwell, 1996 &1998; Anderson & Smith, 1999; Wall, 2000; Downs & Sawchuk, 2007). Ceglowski (2000) revisited the work of Anderson and Smith and corroborated the findings that there was no bias towards the United States in Canada's international trade, based on the 1988 trade data. Brown and Anderson (2002) and Brown (2003) compared province-state to state-state trade flows. They showed that the Canada-U.S. border remains a significant barrier to trade, but using state-state trade as the benchmark, the border effect is less, but still significantly sizable.

Anderson and van Wincoop (2003) examined provincial trade with U.S. states and other industrialized countries with interprovincial trade and found that national borders reduce trade. Suvankulov (2015) also expanded the scope of the early literature on border effects analysis to include U.S. states, the European Union (EU) countries, and the G20 member nations. By decomposing the border effects, the author identified variables related to transaction costs as key determinants of overall provincial trade with the EU and G-20 countries. Helliwell and Schembri (2005) identified an estimated coefficient of the distance variable that was larger than would be predicted from transport costs alone, which means that there must be other costs that increase with distance, such as communication and information. The difference between Canada's border effect with the United States and the rest of the world has changed over time since the Canada-U.S. FTA and FTAs with other countries came into effect. Andresen (2010) examined the geographical dimension of the Canada-United States border effect, with most of the provinces showing insignificant or positive effects from the border.

In a similar research, Anderson, Milot, and Yotov (2014) estimated geographic barriers to trade in nine service categories for Canada's provinces and found geography to have resulted in services trade decline, up to seven times more than in merchandise trade. Specifically, they find border directly reduces average provincial trade with the United States relative to interprovincial trade to 2.4% of its borderless level. The multilateral resistance factor was also found to reduce foreign trade relative to interprovincial to 0.1% of its frictionless potential.

Wagner, Head and Ries (2002) considered the relationship between provincial trade and immigration and found a significant positive effect of immigration on exports and imports. Similarly, Agur (2016) applied a basic panel regression approach to analyze the structural factors behind the export competitiveness of Canadian provinces and products - the findings indicate that R&D, capital stock, and other supply-side variables significantly affect export growth, more than the impact of the exchange rate. Rafiquzzaman (2003) examined the extent

to which Canadian manufacturing exports are sensitive to national differences in patent rights. The author shows that Canadian provinces tend to export more to those countries where their patent rights are highly safeguarded. The analysis also indicated that Canadian provinces exported more to countries with relatively high-income countries than to low-income countries, due to the former's strong patent protection. Exports to countries with a greater threat of imitation increased, while exports decreased for countries with less threat of imitation.

Coulome (2003) analyzes the relationship between the two regional trade channels (north-south vs east-west) and estimates the long-run effects of increased economic integration on living standards, labor productivity, and employment of regions, within a convergence-growth framework. In another research, Coulombe (2003) compared interprovincial trade with Canada's international trade, most of which involves trade between Canadian provinces and the United States. The analysis explored the importance of trade policy and trade agreements in the evolution of provincial trade patterns.

Similarly, Wall (2003) examined the effects of NAFTA on aggregate trade flows between subnational regions within North America and between North American regions and the non-NAFTA world, with results showing significant effects of NAFTA on the volume and pattern of trade of North American regions. The geographical approach reveals interesting regional differences in the effects of NAFTA, also indicating how the wake of NAFTA has changed the trade volume and pattern of North American regions with Europe and Asia (Wall, 2003). On a similar pattern of analysis, Andresen (2009) analyzed the effects of NAFTA on the trade of the Canadian provinces, with findings indicating the existence of a geographical component to the effect of NAFTA, which varies from province to province. Wall (2003) discovered significant effects of NAFTA on the volume and pattern of North American trade, based on regional geography. The geographical approach reveals interesting regional differences in the effects of NAFTA.

Beaulieu and Zaman (2019) researched the implications of subnational trade agreements for provincial trade. The authors find that although most agreements facilitated trade for the provinces. They also find a decline in the massive provincial trade barriers by 15 per cent over the past two decades in Canada, which has changed the volume and pattern of provincial trade.

Kukucha (2004) distinguished between national and sub-national interests when evaluating Canada's foreign trade policy and found institutional, sectoral, and ideational factors most prominent in the case of Canadian provinces.

2.2.3 Scholarly discourse on trade dynamics under globalization

This section reviews previous studies on the influence of globalization on trade volumes and patterns. Many studies have documented the growth in trade volumes due to globalization, with regions becoming more interconnected (Baier and Bergstrand, 2001).

Globalization has made it easier for GVCs to emerge, whereby regions with specialized industries at various stages of production are integrated into international trade networks. One of the distinctive features of globalization in recent decades has been the strong support for global value chains (GVCs). As a primer, Gereffi and Fernandez-Stark (2011) provided an empirical overview of the structure and dynamics of GVCs, with emphasis on the role of regions in global production networks. Global integration has significantly increased the fragmentation of production processes, leading to the rise of GVCs**.** Baldwin (2012) presents empirical evidence on the emergence of global supply chains and their impact on international trade patterns, highlighting the role of regions in these networks. Baldwin and Lopez-Gonzalez (2015) highlight the importance of GVCs in transforming international trade by allowing countries to specialize in different stages of production processes. Their findings show that the integration of global value chains has transformed international trade, emphasizing the importance of intermediate goods and the interdependence of economies. Timmer et al. (2014) provided evidence on how participation in GVCs boosts productivity and trade. Their findings show evidence of a rapid increase in international fragmentation, as measured by the foreign value-added content of production. Johnson and Noguera (2012) analyzed the value-added content of trade. They found that the rise of GVCs has significantly changed the nature of international trade, such that intermediate goods now account for a large proportion of global trade. This indicates strong efforts made in advancing GVCs, due to the fragmentation of production caused by globalization across national borders, to the extent that trade in intermediate commodities is constantly replacing trade in final goods across nations. Cornia and Popov (2001) analyzed transition economies and found evidence of a shift from centrally planned economies to market economies, leading to significant changes in trade patterns. On the contrary, Kaplinsky and Morris (2001) studied developing economies and indicated that globalization has enabled some developing regions to integrate into global markets, it often resulted in a dependence on a narrow range of exports. In a study of industrialized economies, Dicken (2015) found shifts towards high-value-added industries, such as technology due to globalization, which tends to cause a decline in traditional manufacturing and trade patterns.

Cattaneo, Gereffi and Staritz (2010) provided an edited study on how different regions have integrated into GVCs and the subsequent impact on their trade and economic development. They found a significant increase in GVC-based trade. Taglioni and Winkler (2016) examine how participation in GVCs affects regional trade and economic outcomes, providing insights into the benefits and challenges of integration. Their analysis provided insight into how the integration of regions into GVCs has had significant implications for their trade performance. Crescenzi, Pietrobelli and Rabellotti (2014) examined the role of multinational corporations (MNCs) in driving regional trade through GVCs. The authors found how MNCs' global strategies influence regions' economic geography and trade patterns. Baldwin and Lopez-Gonzalez (2015) also examined the global supply chains and their impact on regional trade. Their findings highlight the role of globalization in shaping the trade networks that connect regions and countries through complex production processes. Capello and Lenzi (2015) examined the impact of globalization on regional innovation systems and trade. The authors provided evidence on how regions that effectively integrate into global knowledge networks can enhance their trade performance. Feenstra (1998) analyzes the integration of trade and disintegration of production in the global economy. The finding shows how globalization has changed the nature of trade, particularly through the disintegration of production processes across borders.

Globalization has been linked to significant increases in trade volumes worldwide, particularly as trade barriers have been reduced through trade liberalization. Wacziarg and Welch (2008) studied the comprehensive analysis of trade liberalization and found a significant impact of trade policy liberalization on the actual level of openness. Autor, Dorn and Hanson (2016) explored the regional impacts of trade liberalization with China, known as the "China shock". The authors' findings showed how regions in the U.S. have been differentially affected by increased trade exposure, particularly in terms of labor market outcomes. Krugman (1995) studied the causes and consequences of growing world trade. The findings indicate how trade liberalization and economic integration have driven the expansion of global trade, with specific attention to the roles of economies of scale and product differentiation. In their 2017 study, Handley and Limão examined how trade policy uncertainty affected export choices and found that increased uncertainty can result in considerable declines in trade flows. Topalova (2010) analyzed factor immobility and the regional impacts of trade liberalization in India. Their findings show evidence of differential regional impacts of trade liberalization on trade. Keller and Olney (2021) examine the executive compensation of globalization's effect on trade. They

found not only the influence of globalization on trade but also how trade liberalization has affected income distribution within regions, due to globalization.

Many studies on the trade impact of globalization have indicated that RTAs also have a major impact on trade patterns because they lower trade barriers between participating nations and promote greater economic integration. Baier and Bergstrand (2007) analyzed the effects of free trade agreements (FTAs) on trade flows and found that RTAs substantially increase trade among member countries. Johnson and Noguera (2012) investigated the trade-creating and trade-diverting effects of RTAs, highlighting their complex impact on global trade flows. Baier and Bergstrand (2001) studied the determinants of global trade growth from 1958 to 1988 and found that reductions in tariffs and transportation costs significantly contributed to trade expansion. Frankel and Rose, A. K. (2002) analyzed the effect of common currencies on trade and income. The authors show that regional integration, particularly through common currencies, has boosted intra-regional trade and economic convergence. This highlights the role of economic unions in enhancing regional trade. Freund and Ornelas (2010) reviewed the impact of preferential trade agreements on global trade. They found evidence of increased trade among member countries of such agreements, while having mixed effects on non-members. Baier and Bergstrand (2004) investigated the economic factors leading to the formation of free trade agreements and their impact on regional trade flows. They found that country pairs that have bilateral FTAs tend to have those economic characteristics that enhance trade flows. Anderson and Yotov (2016) investigate the impact of FTAs on regional trade patterns and global efficiency. The authors use empirical data to show how FTAs, as a feature of globalization, have altered trade flows and economic outcomes for regions. **Some** studies also investigated various trade policies adopted by regions to mitigate the adverse effects of globalization. Rodrik (2008) analyzed the interconnectedness of the regions in the global economy. The analysis revealed how regions have developed strategic trade policies in response to the effects of globalization on trade. Brakman, Garretsen and Kohl (2018) analyzed the potential impact of Brexit on regional trade within the UK and with the EU. The authors showed how the disintegration of trade agreements might reverse some of the globalization effects that have shaped regional trade patterns. Baldwin (2016) discusses the policy implications of the new wave of globalization. The analysis established evidence on how regions can adapt to and benefit from global trade dynamics. Research has also demonstrated that deeper trade integration can influence productivity and wage outcomes at the sectoral and regional level. For example, Parteka and Wolszczak-Derlacz (2013) show that accession to the European Union raised productivity

across Polish manufacturing sectors, while Wolszczak-Derlacz (2013) documents how increased trade openness and competition affected gender wage differentials. These findings provide a relevant comparative backdrop for assessing how Canadian provinces respond to liberalized trade under NAFTA and CUSMA.

Specifically, some studies have explored how changes in tariffs influence trade volumes, market access, and global economic dynamics (Irwin, 2019; Amiti, Redding, and Weinstein, 2019). Bown (2021) analyzed WTO and antidumping in developing countries. The author discovered that the imposition of tariffs on intermediate items causes production to be disrupted, which raises costs and creates inefficiencies that can lower trade (Handley and Limao, 2017). Tariffs typically result in lower consumer welfare since they drive up the cost of imported goods. Fajgelbaum et al. (2020) found that higher costs from tariffs are often passed on to consumers, leading to a decrease in trade volume. Trade partners may respond to tariffs with retaliatory actions, which can lead to a tit-for-tat escalation that limits exporters' access to partners' markets. This reprisal may worsen the effects on trade volumes (Blanchard, Bown, and Johnson, 2019). Due to its reliance on export markets, the agricultural sector is frequently affected by tariff measures. Grant et al. (2019) analyzed the impact of trade conflict on U.S. agricultural exports. The authors found a significant decline in the U.S. soybean exports to China during the trade war, due to the nature of tariff measures on agricultural products. Tariffs can also have a significant adverse effect on the manufacturing sector, especially on industries that rely on imported intermediate goods. Nicita (2019) examined the trade diversion effects of U.S. tariffs in China. The author noted that tariff-related increases in input costs can lower home producers' competitiveness in international markets, which can result in a drop in output and exports. Countries and firms may engage in trade diversion in reaction to tariff measures, moving their imports and exports to other markets with lower tariffs. Cadot et al. (2018) noted in their finding that although this can lessen some of the negative effects, it frequently results in less effective trade patterns and raises the price of goods overall. Prolonged tariffs have the potential to affect where innovation and investment are located in the long run. Firms may move their manufacturing plants to locations with more advantageous trade policies, altering international trade patterns and possibly eroding the advantages of comparative advantage (Rodrik, 2018).

Other literature has also shown the influence of globalization on technological breakthroughs, which has changed the nature of trade, especially with the rise of e-commerce and the digital economy. Feyrer (2019) highlighted the role of trade in spreading technology and increasing productivity, thereby contributing to increased trade. Topalova (2010) analyzed

factor immobility and the regional impacts of trade liberalization in India. Their findings show evidence of differential regional impacts of trade liberalization on trade. Freund and Weinhold's (2004) study of the Internet's effects on global trade indicates that Internet penetration positively impacts trade flows. In their study of the effects of e-commerce platforms on trade, Brynjolfsson, Hui, and Liu (2019) discovered that these platforms increase market access and reduce barriers to entry for small exporters.

Studies have also shown that international trade is a type of cross-border economic transaction that is strongly impacted by exchange rates. Obstfeld and Taylor (2003) analyzed the link between financial globalization and international trade and found that financial integration facilitates trade by providing the necessary capital for investment in trade-related infrastructure and industries. The implication is that the integration of financial markets brought forth by globalization affects trade through changes in capital flow, investment patterns, and exchange rates. With increased interconnectedness, the factors influencing exchange rates, such as capital flows, trade balances, and policy coordination, become more globalized. This interconnectedness leads to greater ERV, reflecting the sensitivity of domestic economies to external demand, supply chain disruptions, and changes in the terms of trade (Rose, 2011). International trade and ERV have a complicated and nuanced relationship. ERV can hinder trade, but how much influence it has depends on the industry, the situation, and how well-equipped firms are to manage currency risk. Consequently, Arize, Osang, and Slottje (2000) found increased ERV to be often associated with reduced trade volumes. Clark, Tamirisa, and Wei (2004) examined the volatility of exchange rates and trade flows and indicated that uncertainty in the exchange rate can discourage international trade, particularly in industries with low-profit margins or long production cycles. Larger multinational firms that engage in currency hedging or function in markets with adaptable pricing structures might lessen the negative consequences of fluctuations in exchange rates (Broll and Eckwert, 1999). Sectors with shorter production cycles or those that can quickly adjust prices in response to currency fluctuations are more likely to withstand the adverse effect of volatility in exchange rates (Baum, Caglayan, and Ozkan, 2004; Grier and Smallwood, 2007) analyzed the impact of uncertainty on export performance. The authors found larger multinational firms, in particular, to be more likely to hedge against exchange rate fluctuations, which depends on the nature of the financial market. According to Auboin and Ruta, (2013), Robust financial markets can give firms the means to protect themselves from exchange rate fluctuations, lessening the negative impact of market volatility on trade. Some studies have also indicated that companies can make long-term

adjustments by moving their production to regions with more stable currencies or by diversifying their markets. To stabilize income, firms may move their trade focus to regions with fixed exchange rate regimes or use currency invoicing techniques (Campa and Goldberg, 1999). Prolonged volatility in exchange rates has the potential to cause structural changes in trade patterns over time. As investigated by Osakwe and Verick (2007) firms might choose to relocate production plants or alter supply chains to minimize exposure to volatile currencies, which will eventually affect trade flows in the long term. Rose, 2011; Broda and Romalis, 2011). The nature of the exchange rate regime in effect determines how ERV affects trade. Whereas fixed exchange rate regimes tend to be associated with lower volatility, which can promote more trade flows, floating regimes may lead to greater fluctuations in trade flows due to exchange rate uncertainty (Rose, 2011; Broda and Romalis, 2011).

There are also conflicting pieces of evidence in the literature about globalization's influence on trade patterns through the lens of economic disparities. While some research implies that global inequality decreases, others suggest that it increases within-country disparity, particularly in developed economies, by increasing the wage gap between skilled and unskilled workers. According to empirical data presented by Milanovic (2016), globalization has exacerbated inequality within countries while decreasing it between them. McCann (2016) examines the UK's regional development policies in the context of globalization. The findings showed evidence of the effectiveness of the policies in addressing regional disparities, which enhances trade volume. Autor, Dorn, and Hanson (2013) examined the impact of rising import competition from China on local labor markets in the United States. The authors found that regions more exposed to Chinese imports experienced significant declines in manufacturing employment, leading to increased income inequality within those regions. The study highlights how globalization can exacerbate regional inequalities by disproportionately affecting certain areas based on their industrial composition and trade exposure. Rodríguez-Pose (2018) examined the issue of unevenly distributed benefits across regions, where some regions experience significant participation in global trade, while others may suffer from deindustrialization or marginalization. They argue that globalization has led to increasing regional inequalities, particularly in areas that have been left behind by global economic integration. The evidence shows that regions not well integrated into global trade networks often face economic decline and rising inequality. The study also emphasizes the need for policies that address the spatial disparities exacerbated by globalization. Ezcurra and Rodríguez-Pose (2017) investigate the relationship between economic globalization and regional inequality. The

authors find that while globalization can enhance regional trade, it also exacerbates disparities between more and less-developed regions. Iammarino, Rodríguez-Pose, and Storper (2019) reviewed the evidence on regional inequality in Europe, with a focus on the role of globalization. The authors' findings indicate how global economic integration has led to divergent regional economic outcomes, contributing to spatial inequalities, and affecting trade patterns. Gereffi and Lee (2016) examined the effects of globalization on regional trade and inequality through the lens of global value chains and industrial clusters. They found that regions involved in GVCs can achieve economic upgrading, often leading to social and income inequalities within and between regions. Topalova (2010) analyzed the regional impacts of trade liberalization in India, focusing on the nature of the effects of globalization on different regions. The study finds that regions with lower labor mobility experienced greater increases in poverty and inequality following trade liberalization, while regions with more flexible labor markets were better able to adapt and benefit from global economic integration, which influences trade patterns. Gennaioli, La Porta, Lopez-de-Silanes and Shleifer (2014) examined the impact of globalization on regional economic growth and inequality, using a large dataset of regions across the world. They found that regions that are more integrated into global markets tend to grow faster, but are often accompanied by rising regional inequalities that impact trade patterns.

Recent literature also emphasized the crucial role of metropolises as globalization nodes in facilitating and enhancing trade activities. The metropolises, also known as "global cities," serve as the hubs of the global economy, hosting significant economic activities, sophisticated communication networks, infrastructure, and skilled labor. In an analysis of the cities in a world economy, Sassen (2018) discovered that cities with large resources are associated with lower transaction costs, which enhances the efficiency of cross-border trade. Studies have shown that cities with higher levels of connectivity, both in terms of transportation and digital infrastructure, tend to have higher trade volumes. Derudder and Taylor (2016) explored the comparative analysis of global urban connectivity and found cities hosting major ports and high-speed internet connectivity to be attractive for international business, which improves their trade performance. Henderson and Venables (2009) also found that investments in ports, airports, and transportation networks within the metropolis directly impact their ability to engage in and expand international trade. Research has also shown the connection between metropolises and the benefit of increased productivity, due to agglomeration economies, achieved through firms and industrial clustering. This increase in productivity makes businesses more competitive in the global market, which results in increased trade levels (Combes &

Gobillon, 2015). Metropolises often specialize in certain industries, creating a comparative advantage that drives trade. According to Storper (2013), cities' diversity enables them to adjust to shifts in demand and sustain strong trade connections. Some literature has also indicated that large urban centers are often hubs of innovation due to the concentration of various research institutions and a skilled labor force, which in turn fosters new products and contributes to increased trade volume. In an analysis of how the city has triumphed innovatively, Glaeser (2011) revealed the growth of global trade due to the impact created by metropolises with innovative capacity. The presence of highly skilled labor in major cities enhances the firms' global competitiveness. Florida (2002) explored "The Rise of the Creative Class". The author found the concentration of talent and expertise in large urban centers to be associated with high productivity and enhanced trade volume. Metropolises often benefit from strong institutions that can implement and enforce trade-friendly policies. Policies such as free trade zones, efficient customs procedures, and supportive regulatory frameworks are largely found to encourage international trade (Rodrik, 2008).

Some literature examining the influence of economic freedom on international trade reveals that higher levels of economic freedom are linked to heightened trade flows, enhanced export performance, and increased integration into the global economy (Haan and Sturm, 2000; Faria and Montesinos, 2009; Bergh and Karlsson, 2010). In a panel of data from 75 countries, Justesen (2008) examines the relationship between economic freedom and international trade. The findings indicate that countries with higher levels of economic freedom tend to experience higher levels of trade. This phenomenon can be attributed to reduced trade barriers, improved market efficiency, and increased investor confidence in economies that possess strong economic freedom. A study by Ayal and Karras (1998) found a significant positive relationship between economic freedom and trade openness. The study showed that freer economies are more integrated into global trade, with higher trade-to-GDP ratios. Busse and Hefeker (2007) found that countries with greater economic freedom, especially regarding market openness, attract more FDI, boosting their international trade participation. In their analysis of Latin American countries, Bengoa and Sanchez-Robles (2003) find a positive relationship between economic freedom and trade as well as FDI. Gwartney and Lawson (2004) analyzed part of the Economic Freedom of the World project using data from over 100 countries and found a strong positive correlation between economic freedom and export performance. The authors found that more efficient regulatory environments are associated with reduced costs of exporting and increased competitiveness. Vijayaraghavan and Ward (2001) investigate the

impact of economic freedom on trade in developing countries. The results indicate that greater levels of economic freedom, defined by property rights and freedom from excessive regulation, have a crucial role in determining export performance. Cebula (2011) examines the relationship between economic freedom and trade openness with a focus on the United States. The results suggest that states with greater economic freedom exhibit greater levels of trade openness, demonstrating the beneficial influence of economic freedom on trade policies and outcomes. In a most current publication, the Heritage Foundation (2023) shows a positive correlation between economic freedom and trade openness. Countries with higher scores on economic freedom tend to have lower trade barriers, stronger property rights, and more open markets, which promote international trade.

Many of the contemporary views on trade theory and international economics predict that globalization will lead to more intra-industry specialization because of locational concentration and the level of economic development. IIT has increased significantly as a result of globalization, especially in advanced economies, a trend that was found to be driven by the differentiation of products and scale economies. Grubel and Lloyd (1975) analyzed the IIT theory and measurement and provided the foundational work on the empirical framework for understanding the growth of trade within the same industry, which has been amplified by globalization. Helpman and Krugman (1985) studied market structure and foreign trade. The authors show how globalization has fostered IIT through economies of scale and product differentiation. Falvey and Kierzkowski (1987) examined the relationship between economic development and IIT, focusing on differentiated products. They found a strong positive relationship between economic development and IIT due to the capacity to produce and trade differentiated goods. Balassa (1986) analyzed the role of economic development in promoting IIT, particularly in manufactured goods. The author found that increasing IIT is correlated with higher levels of economic development, particularly due to diversified industrial bases. Fidrmuc (2004) investigated the impact of economic development on IIT in Central and Eastern Europe and found a significant positive relationship between economic development, as measured by GDPpc, and IIT. The study exposed a shift from inter-industry trade (based on comparative advantage) to IIT, reflecting the growing complexity and diversification trend. Zhang and Li (2022) analyzed the impact of economic development on IIT in emerging markets and found significant evidence of a relationship between economic development and IIT, particularly in the high-tech and consumer goods sectors. Hummels, Ishii and Yi (2001) analyzed the nature and growth of vertical specialization in world trade. They provided evidence of the rise of vertical specialization, where regions and countries increasingly participate in

specific stages of the production process, contributing to global trade flows. Ito and Okubo (2012) analyzed the evolution of IIT in the context of globalization, with a specific focus on the rise of vertical IIT due to the fragmentation of production processes and the offshoring of manufacturing stages to different countries. They found a rise in the quality ladder of Eastern European countries' trade vis-à-vis China's trade. Kimura and Ando (2005) investigated the role of production fragmentation in driving IIT in East Asia. They showed evidence of how the regional integration and globalization of production networks have led to a significant increase in IIT within the region. Durkin and Krygier (2000) analyzed the relationship between income differences and IIT in vertically differentiated goods. Their finding provided evidence of how globalization affects the trade patterns of countries with varying income levels. Specifically, they found a positive and significant relationship between per capita GDP differences and the trade share. Stone and Lee (1995) analyzed the determinants of IIT with a focus on the U.S. auto industry. The authors found that the reduction of tariffs and non-tariff barriers, along with increased global competition, has led to a significant rise in IIT. The study also notes that multinational corporations (MNCs) play a crucial role in promoting IIT by standardizing production processes across different countries. Crespo and Fontoura (2007) investigated how the integration of Central and Eastern European Countries (CEECs) into the European Union has influenced their IIT. The findings show that globalization, particularly through economic integration and market liberalization, has led to a structural transformation in these economies, resulting in increased IIT. They argue that the convergence of production structures and consumer preferences within the EU has been a significant factor driving this trend. Veeramani (2009) analyzed the impact of trade liberalization and multinational corporation involvement on IIT in India. The study finds that the reduction of trade barriers and the entry of MNCs into the Indian market significantly increased IIT, particularly in industries where product differentiation is high. The results suggest that globalization, through trade policy reforms and FDI, has been a key driver of IIT. Brülhart (2009) studied the trends in IIT over more than four decades due to the influence of globalization. The analyses highlighted the role of trade liberalization, technological advancements, and the reduction of transportation costs as key drivers of this growth. The author finds that IIT is particularly prominent in manufacturing sectors where economies of scale and product differentiation are significant. Azhar and Elliott (2006) examined the empirical measurement of product quality within IIT and analyzed how globalization influences the trade of similar goods that differ in quality. They found that globalization has led to an increase in IIT in industries where product quality is a significant differentiator, especially in advanced economies where consumer demand for quality is higher.

Ito and Fukao (2005) explore the role of R&D in fostering IIT, particularly in Japanese high-tech industries. The authors found R&D to be a crucial factor in increasing IIT, particularly in advanced manufacturing sectors, and argued that R&D leads to greater product differentiation, which is essential for sustaining IIT in technology-intensive industries. Falvey et al. (2004) examine the influence of R&D and innovation on IIT patterns in OECD countries. Their finding indicates that R&D expenditure significantly increases IIT, especially in industries with a high degree of technological innovation. The authors further suggested that R&D enhances product differentiation and international competitiveness in terms of innovation. Literature has also indicated that Skilled labor enhances product differentiation, promotes technological advancements, and improves firms' productivity, all of which contribute to higher levels of IIT. Falvey et al. (2006) examined the role of human capital (as a proxy for skill level) in IIT and found a strong correlation between higher skill levels and IIT. Blanes and Martín (2000) investigate how human capital influences the patterns of IIT in Spain. Their findings indicate a significant positive relationship between skill level and IIT, particularly in industries characterized by high levels of product differentiation and innovation. Mayer and Ottaviano (2008) analyze the impact of labor skills on the structure of trade, including IIT. Their findings show regions with higher levels of skilled labor to be more likely to engage in IIT due to the capacity to innovate and produce differentiated goods.

2.3 Analytical hypotheses

Drawing on the reviewed theoretical and empirical literature, two general hypotheses concerning provincial trade dynamics have been developed. They will be examined through subsequent empirical analysis. To facilitate a more rigorous investigation, each general hypothesis has been further disaggregated into specific, testable sub-hypotheses, which are directly integrated into the empirical framework of this dissertation. The principal hypotheses, along with their corresponding sub-hypotheses, are outlined below:

Hypothesis 1: Globalization impacts Canadian provinces' foreign trade in a heterogeneous way.

In testing this hypothesis, five sub-hypotheses were analyzed.

Hypothesis (1_A): *Global economic openness impacts trade performance among Canadian provinces*

While limited empirical research exists on the relationship between economic openness and trade performance at the subnational level, this hypothesis seeks to address this gap by exploring the extent to which openness to the global economy fosters international trade outcomes within the Canadian provincial context. It posits that global interconnectedness and a higher degree of economic freedom, characterized by openness to international markets, secure property rights, minimal regulatory burdens, and the rule of law, is positively associated with increased trade flows, improved export performance, and deeper integration into the global economy (see Literature Review). This proposition builds upon institutional economics, which underscores the role of strong institutions in facilitating economic exchanges. According to North (1990), institutional quality, such as effective legal systems and transparent trade policies, creates a stable environment conducive to international trade. Likewise, the works of Coase (1960) and Williamson (1979) emphasize that reducing transaction costs through streamlined regulations and clearly defined property rights enhances economic efficiency and, by extension, trade performance. This dissertation adopts the perspective that economically freer regions, characterized by limited government intervention and reliance on market mechanisms to allocate resources, are more likely to experience robust international trade outcomes. In contrast, excessive governmental restrictions and interventions are expected to constrain trade by undermining the autonomy of economic agents. The hypothesis aligns with the view advanced by Acemoglu and Robinson (2012) that institutional arrangements supporting economic freedom are integral to facilitating broader participation in the global economy. Therefore, it is expected that global interconnectedness and a higher degree of economic freedom will exert a positive and statistically significant influence on provincial trade flows and diversification, enhancing integration into global value chains.

Hypothesis (1_B): *The implementation of RTAs and the concurrent tariff liberalization enhance provincial trade performance*

According to 1_B, liberalization measures such as RTAs and, by extension, reduced tariffs, enhance provincial trade performance. Trade liberalization reflects the extent of economic integration in the global economy. It involves reducing or eliminating tariffs and non-tariff barriers (such as subsidies and regulatory restrictions), which lowers trade costs across

borders (Krugman, Obstfeld, and Melitz, 2018). Therefore, as nations open their economies to foreign trade, a decline in tariff levels may signal rising globalization and greater interconnectedness that promotes trade. This has been reflected in the multilateral efforts to reduce tariffs through organizations such as the World Trade Organization (WTO), which promotes open markets. Following the already vast literature, this dissertation uses tariff measures, complemented by the indicators of trade agreements and regional trade blocs (RTAs), to explore the hypothesis. Trade agreements tend to eliminate or reduce trade barriers among beneficiary regions, fostering closer economic cooperation and expanding market access. It encourages greater trade within the region by harmonizing standards, reducing tariffs, and facilitating the movement of goods. The imposition of tariffs can violate the H-O model by altering the relative prices of commodities and the directions of trade, and they can also disrupt Ricardian specialization by raising the cost of foreign goods. Higher tariffs can result in reduced specialization, decreased efficiency, and declining trade (Bhagwati, 2004). These constatations leave no doubts in trade between countries; however, they deserve to be verified for the province-country framework. In this dissertation, the tariff indicator is measured by the World Bank's average applied tariffs, defined as the weighted mean tariff rates applied across all products exported, reflecting existing trade agreements between partners. Thus, while it is expected that liberalization will have a positive and significant effect on provincial trade, tariff barriers are anticipated to moderate or offset these gains by restricting the full realization of cross-border trade flows.

Hypothesis (1_C): *Fluctuations in the exchange rate adversely affect the foreign trade of the provinces*

The hypothesis stems from existing literature on the impact of exchange rate volatility (ERV), reflecting the sensitivity of domestic economies to external demand, supply chain disruptions, and changes in the terms of trade (see Literature Review). Higher degrees of globalization usually result in more trade between nations, with transactions taking place in many currencies. The risks and uncertainties inherent in these cross-border trade engagements are undoubtedly reflected in ERV. The question remains, however, whether the reflection is positive or adverse. Bahmani-Oskooee and Hegerty (2007) state that although the ERV is assumed to reduce trade by increasing risk, it might in turn also boost trade. An anticipated decrease in traders' revenue due to volatility might be offset by a prior increase in the volume of trade. Similar conclusions are formulated by Clark, Tamirisa, and Wei (2004). Thus, a

universal assumption stating that ERV affects trade adversely cannot be formulated because it is sometimes empirically rejected (e.g., by Tenreyro, 2007). Sauer and Bohara (2001) find that the impact of ERV on exports varies between developing and industrialized countries. Analyses focused on regional exports bring no comprehensive results either because the ERV is not always included in the model specifications (Cassey, 2011; Márquez-Ramos, 2016). Cronovich and Gazel (1998) found that the ERV adversely affects the exports of various US states if proper sub-national trade weights are used. To determine the nature of the effect that ERV necessarily places on the level of trade, one must appeal to some stringent assumptions, which are beyond the scope of this analysis and subject to further research. This is because the price effects are mostly ambiguous, depending on (i) the structure of the market, (ii) the contracts defining the currency denomination, and (iii) the price-setting mechanisms and availability of the exchange rate (at which the bank is ready to exchange one currency to another at a future date) covered by the forward contract, and (iv) the extent of imported inflation. Given these ambiguities associated with the effect of the exchange rate on global trade (Eichengreen, 2007; Rodrik, 2008; Auboin and Ruta, 2011), it is worth examining to what extent it still influences trade at the provincial level.

Hypothesis (1D): *Urban economic agglomeration enhances provincial trade*

This hypothesis provides a foundation for analyzing how urbanization and economic agglomeration influence trade dynamics and the broader implications for regional development policies. It strives to examine metropolises as globalization nodes that determine the extent of trade performance (see Literature Review). It reflects the complex and multifaceted role of metropolises in shaping global trade flows, due to superior technological advancements, transportation infrastructure, larger markets, and greater integration into global supply chains. The theoretical implication is that metropolitan provinces attract higher levels of FDI, which further enhances their foreign trade by fostering export-oriented production and technology transfer. These provinces benefit more from liberalization and trade facilitation policies due to their stronger institutional frameworks and administrative capacities. Metropolises reduce transaction costs, offer economies of scale, and provide easy access to global markets, enhancing international trade activities. The analysis provides an indirect way of testing the Sassen (1991) global city hypothesis, which emphasizes metropolises as command centers for the global economy, responsible for coordinating international business and trade. The hypothesis will extend and verify existing evidence on the role of metropolises (e.g., Brodzicki

and Umiński, 2017). All things equal, it is expected that the provinces' metropolitan status will positively impact provincial trade performance.

Hypothesis (1_E). *Disparities in development levels between trading partners adversely influence the foreign trade of the provinces*

This hypothesis investigates the relationship between the gap in the level of development and international trade dynamics. More importantly, it tests the notion that increasing globalization accentuates the gap in the level of development between trading partners, creating heterogeneous impacts on the foreign trade of provinces. The theoretical rationale stems from the notion that globalization can exacerbate income inequality, influencing comparative advantage and trade patterns. The income per capita difference is a widely used variable and appeals to the knowledge that a rising differential in the partner's level of development can influence trade. The analysis provides an indirect way of testing the Linder (1961) hypothesis. As suggested in the literature, partners characterized by a similar level of development should trade more intensively than partners characterized by a significant gap in the level of development (e.g., Markusen, 1986; Brodzicki and Umiński, 2017; NBER, 2023). The findings of these studies align with the H-O model, which posits that trade patterns are driven by differences in factor endowments (IMF, 2023). This indicates that trade can help reduce income disparities by enabling lower-income partners to access higher-value markets and technologies from higher-income partners. However, the extent of this convergence depends on various factors, including trade policies and institutional quality (NBER, 2023). In examining this hypothesis, this dissertation uses the GDPpc difference of partners to capture the measure of the gap in the level of development. To construct the data and capture the full incidence of globalization, an interaction term is developed where the GDPpc difference interacts with the RTAs, tariff measures, and ERV, as globalization metrics. If the variations in the group are not large enough to affect trade flows, the coefficient of the interaction term is expected to be insignificant. On the other hand, if the variations in the group are large enough to affect trade flows, the coefficient should be positive.

Hypothesis 2: The provinces' trade performance is determined by their idiosyncratic characteristics

In testing this hypothesis, the following specific hypotheses are developed.

Hypothesis (2_A): *Greater factor endowment positively affects the foreign trade of Canadian provinces*

This hypothesis appeals to classical and contemporary trade theories to provide a nuanced understanding of how factor endowments shape the foreign trade performance of provinces in a globalized economy. Increasing globalization might amplify the link between factor endowment level and all trade patterns, including IIT. The elasticity of provincial foreign trade to changes in global demand is higher for regions with abundant factors in global demand, such as skilled labor or natural resources. The export baskets of the regions reflect their factor endowments, with variations in trade patterns linked to differences in labor productivity, technological advancement, and resource availability. There is already some evidence in the literature (e.g., Falvey and Kierzkowski, 1987; Fidrmuc, 2004; Zhang and Li, 2022), which has consistently shown that as regions develop economically, they tend to engage more in trade due to higher factor endowment or income (Linder, 1961), increased industrial diversification (Balassa, 1986), technological advancement (Krugman 1980), and greater product differentiation capacity. This dissertation examines the influence of factor endowment (as measured by GDPpc) on trade. While this hypothesis has been tested for countries, it is worth investigating for the provinces since there are variations in their GDPpc. As a single-entity analysis, if the variations in the panel are not large enough to affect trade, the coefficient of GDPpc is expected to be insignificant or even negative. On the other hand, if the variations among the provinces are large enough to affect trade, the coefficient should be positive.

Hypothesis (2_B): *Trade frictions such as institutional, regulatory, or logistical barriers, adversely influence the foreign trade of Canadian provinces*

This hypothesis integrates elements from new trade theory, institutional economics, and logistics literature to emphasize the important role of trade costs (such as weaker institutional quality, greater geographic distance, and higher production and import taxes) in shaping the foreign trade dynamics of regions. Reduction in all forms of the aforementioned trade costs

improves regional export competitiveness by lowering logistical and administrative costs, thereby enhancing the price competitiveness of exports. The impact of trade costs on foreign trade is moderated by the quality of regional institutions, including the efficiency of customs procedures, regulatory transparency, and trade facilitation policies. High institutional quality guarantees economic freedom and creates an environment that supports the expansion of all trade patterns by reducing trade barriers, enhancing market competitiveness, fostering innovation, and promoting product differentiation. The negative impact of high trade costs is also said to be more pronounced in regions where geographical barriers can further increase the cost of engaging in trade. Excessive production and import taxes, low institutional quality, and unfavorable equatorial location can further amplify the cost of foreign trade engagement (Grossman & Helpman, 1991). To investigate the impact of friction factors (trade costs) on foreign trade, this dissertation incorporates variables such as production and import taxes, the index of institutional quality, and distance from the equator to estimate their impact on trade flows. In line with existing studies that have shown a positive/negative relationship between production/import tax and trade (Blonigen and Davies, 2004; Greenaway et al.,1995). We expect the production tax to have a negative and statistically significant effect on trade, including IIT. Again, following existing studies that are indicative of a stronger link between institutional quality and trade (e.g., Feenstra and Kee, 2004; Ranjan and Raychaudhuri, 2008; Dutt, Mihov, and Van Zandt, 2013), it is expected that stronger institutional quality, characterized by an index of economic freedom, should minimize transaction costs and boost trade performance. There are also frictions associated with geographical variations. Distance from the equator is likely to be correlated with distance from major trading partners, which provides a possible way of influencing trade. Further equatorial regions, which frequently have temperate climates, typically have greater trade networks, better institutional frameworks, and higher levels of economic growth, all of which encourage the conduct of trade, especially in sectors that create differentiated products. Conversely, regions nearer the equator can have lower trade because they rely on primary sectors and lack industrial diversification. There are conflicting claims in the literature in this regard. While some studies find that distance from the equator and latitude positively influence trade (Diamond 1997; Hall and Jones,1999), others find evidence of the declining effect of distance from the equator and latitude (Frankel and Rose, 2002; Venables and Limao, 2002; Desmet and Rossi-Hansberg, 2015).

Hypothesis (2c): *Technological capabilities enhance the foreign trade performance of the Canadian provinces*

This hypothesis strives to explore the impact of investment in technology on trade. This hypothesis aligns with endogenous growth theories and trade literature, emphasizing the transformative role of technology in enhancing regional competitiveness and foreign trade integration. Investment in technology significantly improves the foreign trade performance of regions by enhancing efficiency, fostering innovation, improving access to information, and enabling participation in global value chains, with the magnitude of the impact influenced by regional absorptive capacity, sectoral composition, and access to international markets. Technological capital is another factor that is considered, underscoring the role of quality upgrading in determining the intensity of trade. In the vertical differentiation model, Flam and Helpman (1987) suggest that quality upgrading in the labor-abundant country contributes to IIT, as a quality spectrum of specialization in the economy shifts upward. Therefore, the effect of quality upgrading on vertical IIT is expected to be positive. Furthermore, Glass (1997) demonstrates that the quality-based product cycle is likely to result in south-penetrating high-quality differentiated product markets, which were previously dominated by developed countries. Therefore, quality upgrading (technological capital) is expected to have a positive effect on HIIT. Using the provincial R&D expenditure as a proxy, this hypothesis extends and verifies existing evidence at the country level (Loertscher and Wolter, 1980; Greenhalgh,1990; Falvey et al., 2004; Ito and Fukao, 2005). Shaked and Sutton (1984) have suggested that R&D expenditure is a good indicator of product quality upgrading, which encourages the intensity of trade. In this provincial case, increased investment in technology is expected to have a positive and statistically significant effect on provincial trade.

Hypothesis (2_D): *The foreign trade performance of the Canadian provinces is positively affected by the human capital quality*

This hypothesis examines the postulation that higher skill levels within the labor force positively impact trade. The hypothesis leverages insights from endogenous growth and trade theories, emphasizing the critical role of human capital in driving comparative advantage, innovation, and sustained trade growth in the global economy. The hypothesis is well-supported by economic theories of specialization, innovation, and product differentiation. It affirms that

countries with better-educated and highly skilled labor forces are more capable of producing and trading sophisticated differentiated products within industries, which drives the growth of trade. Human capital contributes to firms' ability to exploit economies of scale by improving worker productivity (Helpman and Krugman, 1985; Blanes-Cristóbal, 2004) and determining the mode of international trade (Helpman, Melitz and Yeaple, 2004). Skilled labor is a major factor that drives technological advancement in expanding trade, especially in high-tech industries where product differentiation is crucial for trade (Grossman & Helpman, 1991). It can adjust to new manufacturing methods more easily, which boosts competitiveness in international markets. Human capital is a theoretical concept that cannot be measured directly but only through the use of proxies. In most cases, skill level is measured by educational and professional variables such as occupation, field of study, educational attainment, years of schooling or years of work experience, enrolment rates, or educational expenditure. Bombardini, Gallipoli and Pupato (2012) use the scores of common literacy tests gathered from households across a large sample of countries to measure skill level. Further than the aforementioned standards, this dissertation uses detailed data linking workers to their level of educational qualification by decomposing the measures into two categories, namely, low- and high-skilled levels. In line with Blanes and Martín (2000) and Mayer and Ottaviano (2008) on the role of human capital in determining trade patterns, it is expected that the impact of skill levels will be positive and statistically significant in the case of the provincial-level analysis.

Hypothesis (2_E): *MNEs' activity enhances provincial trade performance*

MNEs play a central role in linking regions to international markets by specializing in cross-border production networks, which boost export and import flows of intermediate and final goods. MNEs introduce advanced technologies and management practices, increasing regional productivity and competitiveness in foreign trade. This activity is further expected to accentuate disparities in trade profiles across provinces, as regions hosting higher concentrations of MNE operations gain a comparative advantage in sectors aligned with global value chains. Consequently, the heterogeneity in trade patterns reflects varying levels of IIT fostered by MNE-driven innovation, specialization, and market access. Higher productivity leads to greater export intensity and trade diversification (Rodrik, 2018). By creating jobs and training local workforces, MNEs strengthen the capacity for export-oriented production, expanding the trade potential (Blomström & Kokko, 1998). MNE investments also stimulate capital accumulation

and innovation, enabling provinces to produce competitive export goods while optimizing import efficiency. The relationship between the activities of MNEs and various trade patterns, including IIT, has been extensively studied in economic literature (e.g., Keller, 2004; Egger and Pfaffermayr, 2004; Hummels and Klenow, 2005). Some available empirical literature suggests that MNEs contribute to GDP growth in developing countries, which fosters trade by creating larger and more dynamic markets for differentiated products (Borensztein, De Gregorio, and Lee, 1998; Baldwin and Ottaviano, 2001; Markusen, 2002). Fontagné, Freudenberg, and Péridy (1997), and Markusen and Venables (1999) discuss the role of MNEs in promoting capital formation in host countries, enhancing local production capabilities, and fostering trade by enabling the production of differentiated goods. Other literature analyzes how MNEs contribute to employment in host countries, particularly in high-tech industries, by bringing advanced production techniques and creating demand for skilled labor, which correlates with trade performance (Caves, 1996; Feenstra and Hanson, 1997; Markusen, 2002; Dunning and Lundan, 2008). The existing literature has provided some indications of what to expect at the country level, leaving a wider research vacuum to fill at the level of the provinces. This dissertation fills this gap by comprehensively exploring, for the first time in the case of Canadian provinces, the role of MNE activities in facilitating trade. In the narrative part, this dissertation controlled for MNEs' value-added (proxied by the GDP attributed to MNEs) to investigate the hypothesized trade impact of economic values generated by the MNEs. The dissertation also assessed the impact of investment in physical capital (proxied by gross fixed capital formation) to capture the influence of MNEs' investment in trade infrastructure and innovation in driving the foreign trade growth of the provinces. In addition, the dissertation controlled for MNEs' employment to assess the impact of increased labor market efficiency and export readiness on provincial trade performance. Overall, it is expected that higher levels of multinational enterprise (MNE) activity will be positively associated with provincial trade performance. Specifically, provinces exhibiting greater MNE activity are anticipated to demonstrate higher export volumes, deeper integration into global value chains, and more diversified trading partners, reflecting the role of MNEs as conduits of technology transfer, market access, and international networks.

2.4 Conclusion

This section summarizes the theoretical and empirical underpinnings of foreign trade and globalization, analyzing their interrelations and broader implications. The theories of international trade provide a foundation for understanding the economic benefits of specialization and exchange, while globalization underscores the mechanisms that facilitate such exchange on an unprecedented scale. There is therefore no doubt that globalization influences trade flows. The question, however, remains by how much and the dimension of the impacts, which can either be positive or negative. The constituent elements and multidimensional character of globalization have yet to be adequately and comprehensively explored for the Canadian provinces. How globalization shapes trade may also be affected by factors such as the sectoral specialization of a particular place or its level of development. Some economic geographers have argued that localized agglomerations of economic activity are a product of globalization. Many of the contemporary views on trade theory and international economics predict that globalization will lead to more intra-industry specialization because of locational concentration. This important aspect of foreign trade engagement is also yet to be analyzed in the context of the Canadian provinces. Thus, to incorporate this sectoral structure into the analysis, this dissertation also analyzed the IIT framework of the Canadian provinces. Given the existence of productivity differences across sectors, which determine comparative advantages (Levchenko & Zhang, 2012), it is expected that the sectoral specialization of any economy will affect the impact of globalization on trade. Thus, the globalization of production is concomitant to the globalization of trade, as one cannot function without the other. In the final part, it sets out research hypotheses testing the influence of globalization measures, province-specific factors, and activities of MNEs, which were deduced from the reviewed trade theories and empirical literature.

CHAPTER 3 ANALYTICAL METHODOLOGY AND DATA

This chapter discusses the method of analysis and data used in the dissertation. The analytical methodology outlines the base models for gravity and panel IIT analyses, the decomposition of the IIT pattern, the general specifications, and the estimation method. The second subsection presents the data and associated statistical properties, outlining the measures and sources. It presents the baseline gravity data and discusses the stylized facts of globalization mechanisms, Canada-U.S. trade data, and the IIT data and determinants. This part ends with a conclusion summarizing key points in the chapter.

3.1 Analytical method

This section outlines the analytical approach employed to investigate the determinants of provincial international trade in Canada. It begins by presenting the base model guiding the empirical analysis, followed by the general econometric specification. The section concludes with a discussion of the estimation method, with particular emphasis on techniques suited to addressing the structural features of trade data.

3.1.1 The base model for analysis

First, this dissertation employs the standard gravity model to analyze the foreign trade dynamics of the Canadian provinces and their trading partners. Gravity is a concept derived from Newtonian physics and applied to the notion of spatial relationships in economic systems. It defines trade intensity between two partners as positively proportional to their economic size and inversely proportional to their distance. Tinbergen (1962) and Linneman (1966) contributed to using the concept of gravity in economics. An additional contribution was made to regional science (Isard, 1960). As stated earlier, Anderson and van Wincoop (2003) provided a refined gravity framework, often considered the most theoretically consistent model to analyze international trade flows. The gravity model has been very effective in modeling trade between trading partners. The model relates trade (exports and imports) between country i and country j (X_{ij}), as a function of own and partner's income (Y_i, Y_j), world income (Y_w), elasticity of

substitution (σ), trade costs (t_{ij}), and outward (Π_i) and inward (P_j) multilateral resistance terms: The model can be represented as:

$$X_{ij} = \left(\frac{Y_i\, Y_j}{Y_w}\right)\left(\frac{t_{ij}}{P_j \Pi_i}\right)^{1-\sigma}$$

As stated earlier, the basic gravity model relates trade flows to a country's GDP and the distance between its trading partners. The gravity model represents a realistic general equilibrium system that simultaneously accommodates multiple entities (Yotov et al., 2016). The most compelling characteristic of the gravity model lies in its empirical regularity and predictive capacity for both inter-industry and IIT patterns (see Leamer and Levinsohn, 1995; Van Bergeijk and Brakman, 2010). The flexible structure of gravity can be integrated within a wide class of broader general equilibrium frameworks to study trade links. Most studies have augmented the gravity model with a few other variables, which have been shown to influence trade. Including these variables is important given the heterogeneity of factors across regions, which individually influence trade. As already mentioned, this dissertation reiterates that a well-specified gravity in trade model should take the process of globalization into account and must be altered to include mechanisms that transmit the influence of globalization and must be analyzed using the most consistent estimation methods.

Secondly, this dissertation utilizes a panel IIT regression model to examine the provincial IIT pattern. The Grubel-Lloyd index is employed to compute the total IIT, using a four-digit Harmonized System (HS) product classification to represent broader industry-level trade flows. For the analysis of HIIT, a more disaggregated six-digit HS classification is used to capture product-level variations within industries. To decompose the overall IIT index into its horizontal and vertical components, the four-digit and six-digit classifications are systematically matched following the methodology proposed by Kandogan (2003), as outlined below.

$$IIT_{i=4digit} = GL_{4d} \quad = 1 - \frac{\sum_{i=4}|(X_4 - M_4)|}{\sum_{i=4}(X_4 + M_4)}$$

$$HIIT_{pi=6digit} = GL_{6digit} = 1 - \frac{\sum_{ip=6}|(X_6 - M_6)|}{\sum_{ip=6}(X_6 + M_6)}$$

$$VIIT_{i=(4digit-6digit)} = GL_{4digi} - GL_{6digit}$$

$$VIIT_{i=} \frac{\sum_{i=4}|(X_4 - M_4)|}{\sum_{i=4}(X_4 + M_4)} - \frac{\sum_{ip=6}|(X_6 - M_6)|}{\sum_{ip=6}(X_6 + M_6)}$$

Importantly, due to the construction of both the Grubel-Lloyd and Kandogan indices, the measure inherently accounts for trade imbalances. As trade imbalance increases, the index yields lower values of IIT (Grubel and Lloyd, 1975), thereby embedding the imbalance within the calculation. Consequently, this approach accounts for concerns about omitted variable bias related to trade imbalance, and there is no need to introduce separate controls for trade balance in the empirical analysis. As earlier mentioned, the joint application of these two approaches is intended to facilitate a meaningful decomposition of IIT into its horizontal and vertical components, particularly in the absence of product-level quantity or weight data (e.g., kilograms) for Canadian trade flows. While the Kandogan method is widely recognized for its practical applicability in such data-constrained contexts, its adoption here is not predicated on its superiority over other decomposition techniques, but rather on its operational suitability given the limitations of the available dataset. Grubel and Lloyd (1975) have shown that products are similar in HIIT, and quality differentiated in VIIT.

3.1.2 General econometric specification

Following Silva and Tenreyro's advice, we employ a PPML specification with a panel of total trade volume over the period the data is observed. The specification takes the multiplicative functional form:

$$T_{ijt} = exp\left[\mathrm{X}_{ij}^{\mathrm{SG}} + \mathrm{Z}_{ij}^{\mathrm{AV}} + \Phi_{ij} + \gamma_{\mathrm{t}}\right] * e_{ijt}$$

where T_{ijt} is the conditioning set of variables describing the bilateral trade flow. The main bilateral trade expressions used as the dependent variables are the total exports from region i to region j, total imports of region i from j and total trade between region i and j. $\mathrm{X}_{ijt}^{\mathrm{SG}}$ = exp $[\alpha In(Y_{it}) + \alpha In(Y_{jt}) + \alpha In(D_{ij})]$ represents the main explanatory variables in line with the structural gravity framework. The time-variant economic size (Y_{it} and Y_{jt}) is measured by the real GDP of trading partners. The distance captures the trade barriers D_{ij} measured by the geographical remoteness between the capital of trading partners and non-iceberg trade costs,

such as tariffs. Z_{ij}^{AV} = exp $[\alpha In(N_{ijt}) + \alpha K_{ij}]$ represents the augmented explanatory variables, subdivided into: N_{ijt} as the set of time-variant variables, and K_{ij} representing the time-invariant partner-pair vector of variables. The exporter-importer Φ_{ij} and time γ_t fixed effects controls for any potentially observable and unobservable multilateral characteristics that vary over time for each trading partner, and e_{ijt} is the time-variant regression residual.

To specify the model for the analysis of the IIT pattern, the specification for the gravity of trade equation is modified into a single-entity general equilibrium model:

$$IIT_{it} = exp\left[X_i^{PSF} + \gamma_t\right] * e_{it}$$

where IIT_{it} is the dependent variable index of IIT or its components (HIIT and VIIT). The explanatory variables are defined by X_i^{PSF}, representing the various province-specific factors influencing provincial IIT flows. γ_t is the time fixed effect controls for any potentially observable and unobservable characteristics that vary over time for each province. and e_{it} is the time-variant stochastic term.

3.1.3 Estimation method

Given the highly disaggregated and large panel structure of the provincial trade dataset characterized by a significant number of zero trade observations, this dissertation employs the Poisson Pseudo Maximum Likelihood estimator with high-dimensional fixed effects (PPMLHDFE) as the baseline estimation method. This approach is flexibly suited to gravity models of trade and the panel IIT regression model, as it effectively addresses two persistent econometric challenges: the presence of zero trade flows and heteroskedasticity in trade data.

The PPML estimator, as recommended by Santos Silva and Tenreyro (2006), provides consistent and unbiased estimates in the presence of heteroskedasticity, which typically renders log-linearized models problematic. A key advantage of PPML is its capacity to handle zero trade values directly, without resorting to ad hoc treatments such as dropping observations or adding arbitrary constants, as such practices can bias results and lead to loss of valuable information. Moreover, PPML is robust to statistical separation and convergence issues and allows for the inclusion of multi-level fixed effects, making it well-suited to controlling for unobserved heterogeneity across provinces and trade partners (Correia, Guimarães, & Zylkin, 2019a).

In line with trade theory and empirical best practices, the model includes high-dimensional fixed effects to control for time-invariant heterogeneity. The use of fixed effects also ensures consistent parameter estimates by accounting for unobserved characteristics that may be correlated with the explanatory variables. While the fixed effects approach is widely supported in the literature (Baier & Bergstrand, 2009), some critics highlight potential over-parameterization and estimation inefficiency (Lombardia & Sperlich, 2012). On the other hand, random effects models, which assume no correlation between unobserved heterogeneity and covariates, are more parsimonious but rest on stronger assumptions of exogeneity.

To navigate this trade-off, this dissertation conducts a Hausman test to determine the appropriateness of fixed versus random effects (Wooldridge, 2010). Further, to account for potential endogeneity among the regressors, particularly in the context of trade policy variables such as RTAs and tariffs, the Hausman-Taylor estimator (Hausman & Taylor, 1981; Egger, 2002, 2005) is employed as a robustness check. This method allows for the inclusion of time-invariant variables while addressing endogeneity concerns through the use of internal instruments derived from within the model structure.

Additionally, the GPML estimator is utilized as a complementary estimator for a robustness check. GPML is particularly effective in modeling skewed trade data with strictly positive outcomes and provides an alternative specification to validate the consistency and robustness of the PPML results, especially when dealing with variations in the distributional assumptions of the dependent variable (e.g., Manning & Mullahy, 2001).

3.2 Variables, data, and descriptive statistics

This subsection outlines the variables, data sources, and descriptive statistics employed in the empirical analysis. It introduces the dependent variables related to provincial foreign trade and IIT, the explanatory variables capturing globalization mechanisms and province-specific factors, and the relevant control variables. In addition, it presents the stylized facts illustrating key trends in globalization and trade dynamics.

3.2.1 Gravity data and descriptive statistics

The baseline trade data

The fundamental variables used in this section are consistent with those in several other related studies (e.g., Anderson and van Wincoop, 2003; Helpman et al., 2008; Brodzicki and Umiński, 2017; Freidman et al., 2020). Two dependent variables were adopted in this section. The first is approximated by the provincial total bilateral trade (exports + imports), and the second uses the provincial exports.

One of the central issues of regional trade analysis is embodied in the question: Where do exports originate from, and what is the method of data collection and quality due to the so-called entry and exit statistics? Two principal data points make up provincial exports: domestic exports and re-exports. The domestic exports are goods grown, produced, extracted, or manufactured in Canada, including goods of foreign origin that have been materially transformed in Canada. While re-exports are goods of foreign origin that are exported in either the same condition in which they were originally imported into Canada, or after undergoing some minor operations. Exports from Canada are specifically identified as coming from the province where they were "grown, extracted, or manufactured". However, the "last known destination" of the commodities at the time of customs clearance, which may or may not be the state of final use, is assigned as the destination of Canadian exports in such destination. This dissertation used domestic exports since re-export data are only available at the federal (Canada) level. The customs-based international merchandise trade by province was used to construct all trade data – exports and total trade (exports + imports). Provincial export statistics for Canada reflect the spatial distribution of a set of industrial, commercial, and other service-related activities that facilitate exportation (manufacturing, international marketing, logistics, distribution).

Thus, the gravity panel is constructed for exports and total trade of 10 Canadian provinces to and between 212 world trading partners from 1999-2021. This gives 2120 province-country pairs and 49,220 observations. However, the panel is unbalanced – trade data are unavailable for every province-country-year triplet. While the number of observed data for exports is 36,007 (indicating a deficit of 13,213 observations), the import observation shows 33,651 (indicating a deficit of 15,569 observations). Furthermore, the use of different data sets and variables excludes some observations. Therefore, the number of observations falls considerably due to insufficient data in some of the specifications considered. All data on export

and import values are captured in Canadian dollars. Finally, all standard gravity variables are estimated in natural logarithms, so the estimated coefficients can be interpreted as relevant elasticities. The export and import data were obtained from Statistics Canada's records of all goods entering and leaving Canada, collected based on customs declarations.

The baseline explanatory variables and stylized facts

The basic explanatory variables in line with the gravity framework are the province and partner size, and distance. To investigate the impact of size on trade, the real GDP (measured at market prices in Canadian dollars) and the provincial population are obtained from Statistics Canada, while the partner's population and GDP data are collected from the World Bank database. The partners' GDP values captured in the current USD are converted into Canadian dollars using the annual average exchange rate between Canada and the United States. This dissertation considers the distance between respective provinces and the capital city of their trading partner, measured in kilometers, generated using online maps. In line with the theoretical foundation of gravity, a greater distance between trading partners is expected to reduce trade volume, and regions with higher income levels would tend to trade more with the Canadian provinces.

To explain the underlying impact of globalization on the foreign trade of the Canadian provinces, this dissertation focuses on key determinants such as the degree of economic freedom, the extent of trade liberalization, including tariff and non-tariff measures, similarity/dissimilarity in the level of economic development, the level of fluctuations in the nominal exchange rate tariffs, exchange rates, and the role of metropolises. Each of these elements plays a crucial role in shaping the foreign trade dynamics of provinces, influencing their economic performance and integration into the global market.

Firstly, the dissertation considers the role of **partners' interconnectedness** and **economic freedom**. The two indices serve as a critical measure of openness and how conducive the provinces and partners' economic environments are to international trade. To provide a measure of partners' interconnectedness, the 2023 revised version of the KOF trade globalization index[19] is used, which measures policies and conditions that enable, facilitate, and

[19] KOF index was originally introduced by Dreher (2006) and updated in Dreher et al. (2008). Gygli, Savina, Florian Haelg, Niklas Potrafke and Jan-Egbert Sturm in 2019 provided the current version. KOF de jure trade globalization index is defined by a combined number of variables: Trade regulations - defined as prevalence of non-tariff trade barriers and compliance costs of importing and exporting (Gwartney et al., 2023). Trade taxes – accounting for income from taxes on international trade as a percentage of revenue, inverted (World Bank WDI,

stimulate cross-border trade flows. The variable comprises several indicators, namely: trade regulations – defined as prevalence of non-tariff trade barriers and compliance costs of importing and exporting (Gwartney et al., 2023); trade taxes – accounting for income from taxes on international trade as percentage of revenue, inverted (World Bank WDI, 2023); tariffs – calculated as the unweighted mean of tariff rates (Gwartney et al., 2023); trade agreements, representing the number of bilateral and multilateral free trade agreements (Egger and Larch, 2008). The index of economic freedom measures the degree of openness and regulatory efficiency in an economy, focusing on factors such as trade freedom, investment freedom, financial freedom, and overall ease of doing business. This dissertation argues that provinces characterized by higher levels of economic freedom and susceptible to partners' openness tend to experience greater foreign trade activity. This assertion is supported by empirical studies that demonstrate a positive correlation between economic freedom and trade openness (Gwartney et al., 2018). The data came from the Fraser Institute, following the work of Stansel, Torra, and McMahon (2023). The institute ranks regions based on 15 qualitative and quantitative metrics[20], which broadly fall into the categories of (i) rule of law, (ii) government size and policy, (iii) regulatory efficiency, or (iv) open markets. Each of the fourteen categories is scored from 0 to 10, where higher scores indicate more "freedom". This dissertation employs the overall score referred to by the institutes as an all-government index, which is the average of the respective scores of each of these 15 categories. A priori, the expectation is that the freedom index of provinces and trading partners will positively impact the trade performance of the Canadian provinces.

Next, the dissertation examines the influence of **liberalization mechanisms** such as tariffs and non-tariff measures. Tariffs are one of the most direct and traditional measures of trade policy, representing taxes on imported goods, which can significantly affect trade patterns. When the government implements high tariffs, it can stifle foreign trade by increasing the cost of imported goods, thereby reducing market access for consumers and businesses. This situation could lead to retaliatory measures from trading partners, further complicating the trade landscape. Conversely, lower tariffs generally promote trade by making foreign products more accessible, encouraging competition, and enabling entities to benefit from global supply chains.

2023). Tariffs – calculated as the unweighted mean of tariff rates (Gwartney et al., 2023). Trade agreements, representing the number of bilateral and multilateral free trade agreements (Egger and Larch, 2008).

[20] The twelve individual categories include property rights, government integrity, judicial effectiveness, government spending, tax burden, fiscal health, trade freedom, investment freedom, financial freedom, labor market and business regulations.

A balanced tariff policy is essential for fostering sustainable foreign trade relationships. Small reductions in already-low tariffs often result in significant trade increases due to reduced administrative burdens and the signaling of policy openness (Bagwell & Staiger, 1999). The tariff measure is defined as the weighted mean tariff rates applied across all products exported, reflecting existing trade agreements between Canada and global trade partners. The variable is exogenous and can adequately reflect the incidents and degree of globalization. The tariff data is obtained from the World Bank Database. However, considering the pair of regions, this dissertation captured the differences in the level of tariff rates between trading partners. The rates are computed following the formula:

$$\tau D_{ij} = \frac{t_i + t_j - |t_i - t_j|}{t_i + t_j}$$

where τD_{ij} is the index of the difference in the level of tariff rates between regions; t_i, t_j represents the level of tariff rates imposed by trading regions. Pagoulatos and Sorensen (1975), as well as Toh (1982), applied a similar approach to tariff rates and non-tariff barriers for a pair of countries. A study by Wacziarg and Welch (2008) finds that trade liberalization, characterized by reduced tariffs, leads to an average increase of 1.5% in annual GDP growth, largely driven by expanded trade flows. **RTAs** represent another critical aspect of liberalization that significantly impacts international trade. RTAs are treaties between two or more partners that reduce or eliminate trade barriers, promoting easier access to markets. By participating in these agreements, trading partners can gain preferential access to larger markets, attract foreign investment, and foster economic growth (Peters & Schneider, 2019). Canada has entered into several other trade agreements with many global trading partners. Therefore, this dissertation follows previous literature to define RTAs as a measure of liberalization factor depicting a certain level of globalization. The variable takes the value of one (1) if Canada (as representative of the provinces on trade policy decisions) and trading partners are members of the same trade agreement, and zero (0) otherwise. The data on RTAs is obtained from the WTO database. Including this indicator variable in the gravity model enables us to observe two effects: the border effect (the absence of borders due to globalization) and the effect of trading agreements. The long-term nature of the data also allows us to observe the change in these effects over time.

Another mechanism is the partners' **level of economic development.** Economic development leads to improvements in physical infrastructure (e.g., ports and transportation systems) and technological capabilities, both of which reduce trade costs and improve

competitiveness. However, globalization itself plays a significant role in shaping the relationship between economic development and international trade. It can facilitate the integration of economies into the global marketplace, creating opportunities for partners to expand their trade networks. As economies become more interconnected with the global economy, they can access new markets, attract foreign investment, and participate in global supply chains. Conversely, globalization can likewise present challenges for less-developed economies. Partners with lower levels of economic development may struggle to compete with more developed economies, leading to disparities in trade outcomes. According to Rodrik (2011), globalization can exacerbate inequalities between partners. Thus, the difference in the partner's economic development is a facet of globalization that projects the level of inequality and reveals the extent to which the international similarity/gap in the level of economic development is linked to the changing world trade patterns. Economic development encompasses various indicators, including GDPpc, education levels, infrastructure quality, and technological advancement, all of which significantly influence a partner's ability to engage in international trade. This dissertation considers the partner's GDPpc difference to capture the degree of inequality in economic development and is included in the base specification of the gravity model. Considering the pair of provinces and their trading partners, the development gap is measured according to the following formula:

$$diff\_GDPpc_{\mathrm{ijt}} = \ln |ypc_{\mathrm{jt}} - ypc_{\mathrm{it}}|$$

where ypc_{jt} is the GDPpc of the trading partners; and ypc_{it} is the GDPpc of a given province. The question to be answered is: to what extent are the changing patterns of provincial trade linked to the observed changes in international inequality in the level of development and interplay of globalization? The a priori expectation is that declining demand, due to a gap in the level of development, can adversely affect trade flows, and vice versa. The provincial GDPpc is obtained from Statistics Canada, and the partner's GDPpc is sourced from the World Bank. to measure the difference.

ERV is yet another significant factor affecting trade dynamics, as it directly influences the relative price of goods across borders. Unpredictable fluctuations deter trade by increasing the risk of financial losses and complicating pricing strategies (Ethier, 1973). According to Goldberg and Knetter (1997), the degree to which exchange rate changes influence domestic prices can either amplify or dampen their effect on trade. The exchange rate determines the value of a partner's currency to others, significantly impacting export and import activities. A

strong currency may make exports more expensive and imports cheaper, potentially leading to a trade deficit. In contrast, a weaker currency can enhance export competitiveness but increase the cost of imports. Stable and favorable exchange rates facilitate foreign trade (Campa and Goldberg, 2005). Moreover, fluctuations in exchange rates can create uncertainty for businesses engaged in international trade, making it imperative for provincial governments to implement measures that stabilize their currencies. For example, partners adopting sound monetary policies and maintaining low inflation rates are better positioned to achieve stable exchange rates, enhancing their international trade prospects. ERV in this dissertation is measured by the standard deviation of the average yearly exchange rates (obtained from the Beyond 2020 UNCTAD database) between the Canadian dollar and a currency of trading partners if the trading partner is abroad. It is measured according to the following formula:

$$ERV_{ijt} = \sqrt{\frac{\sum_{ij=1}^{n}\left(ExR_{ij} - \overline{ExR_{\iota J}}\right)^2}{n-1}}$$

where ERV_{ijt} is the standard deviation defining the ERV between currencies of trading partners, ExR_{ij} is the exchange rate between trading partners, $\overline{ExR_{\iota J}}$ is the average yearly exchange rates observed between trading partners. Exchange rate movements can have differential impacts on various sectors of the economy. For instance, industries that rely heavily on imported raw materials may be adversely affected by a strong currency, while export-oriented sectors may benefit. Therefore, if the measures are stable over time, they are expected to impact trade volume positively (Bacchetta and van Wincoop, 2000). Conversely, if the measures are highly volatile, the phenomenon will lead to reduced trade volume. Clark, Tamirisa, and Wei (2004) demonstrate that ERV has a statistically significant negative effect on trade volumes, particularly for smaller economies with limited hedging instruments.

Metropolises act as hubs of economic activity, innovation, and trade facilitation due to their strategic geographic location, infrastructure, and market size. Metropolitan areas are better positioned to engage in foreign trade due to their infrastructure, connectivity, and access to resources (Henderson, 2002). Large cities benefit from concentrated industries, skilled labor, and advanced technology, which enhance their capacity for export-oriented production. Metropolises typically have advanced transportation networks, facilitating international trade. Hanson (2005) finds that urban centers contribute disproportionately to national exports, with metropolitan regions accounting for the majority of high-value-added trade. To measure the role

of the metropolis, this dissertation utilized dummy variables to capture the indicator reflecting the spatial concentration of economic activity and global connectivity. The dummy for the metropolis investigates whether Canadian provinces with two or more industrial hubs significantly contribute to the intensity of provincial foreign trade. It takes the value 1 if a given province has two or more industrial cities, and zero (0) otherwise.

Historical facts (path dependency) between countries shape institutional, cultural, and linguistic ties, influencing contemporary trade patterns. These factors contribute to reducing transaction costs, fostering trust, and facilitating trade flows over time. Historical factors such as language similarity and formerly belonging to a given colonial lineage identify the differences in trade of possessing similar characteristics and not possessing them. While common language constitutes a means of verifying the trade impacts of reduced communication costs, such as lower transaction costs, cultural proximity, and information flow (Melitz, 2008; Rauch and Trindade, 2002), **colonial history** reflects the means of verifying the impact of long-lasting trade networks and institutional linkages that persist over a long period. Therefore, persistence, whether in the form of longstanding ties or path-dependence, institutional legacy, preferential trade policies, and cultural and business networks, could be investigated using dummy variables, for example, in the case of former British colonies (e.g., for France, see Head & Mayer, 2014). The linkages do not always have to facilitate trade – invariably, there can be situations of adverse effects because of past animosities, which may have persisted over prolonged periods. However, there is a common consensus in the literature that countries in former colonies were shaped, at least partially, by their colonization experience. Countries with colonial links are expected to trade more based on this affinity level (e.g., Frankel and Romer, 1999; Nunn, 2007; Head, Mayer, and Ries, 2010). Thus, considering the former British colonies, it is likely that the Canadian provinces, ceteris paribus, traded most intensely with countries with long-term ties, such as a common language and colonial links. The first variable draws from the colonial history and indicates if the provinces, as Canadian regions, and trading partners have colonial links (1 for all former British colonies and zero otherwise). Another variable relates to language similarity and indicates if the provinces and trading partners have a common official language (1 for language similarity members and zero otherwise). The two indicators are measures of historical patterns provided by the CEPII's database. As mentioned earlier, the variables make it possible to consider path dependence.

TABLE 3.1 Variables description and descriptive statistics of trade and globalization measures - the baseline trade data and explanatory variables

Variable	Description	#	Mean	SD.	Min	Max	Source	Expected impact
Exports	Total annual provincial merchandise exports in Canadian $millions.	49,220	201.8	3895	0	172,468	Statistics Canada	*
Imports	Total annual provincial merchandise exports in Canadian $millions.	49220	207.9	3743	0	198,002	Statistics Canada	*
Trade	Total annual provincial merchandise trade in Canadian $millions.	49,220	409.7	7420	0	359,413	Statistics Canada	*
lnGDP_pr	Annual provincial nominal GDP.	49,220	11.21	1.416	8.061	13.771	Statistics Canada	+
lnGDP_tp	Annual nominal GDP of trading partners.	46,340	10.03	2.357	2.639	16.951	World Bank	+
lnDistance.	Distance in km between the capital cities of provinces and trading partners.	49,220	8.975	0.456	6.280	9.785	Online Map	-
lnGDPpc_diff	Similarity/dissimilarity in economic development variable (derived as the absolute difference between the GDPpc of provinces and that of their trading partners).	46,340	10.81	0.705	3.951	12.254	Statistics Canada/World Bank	-/+
Ec_fredom_pr	An indicator of provincial economic openness proxied by the index of provincial economic freedom.	47,080	7.832	0.194	7.387	8.343	Fraser Institute database	+
Ec_fredom_tp	An indicator of the economic openness of trading partners proxied by their respective index of economic freedom.	31,140	6.719	1.075	2.470	9.19	Fraser Institute database	+
lnGlo_dj_tp	An indicator of globalization, defined by the KOF index of de jure globalization of the trading partners.	42,650	3.808	0.749	1.140	4.540	KOF Swiss Economic Institute	+
Lib_Tarif_df	The indicator of trade liberalization - defined by the index of weighted mean difference of applied tariff rates across all products traded in and out of the Canadian provinces.	30,880	0.555	0.272	0.112	1.000	World Bank	-
ERV	Variable for exchange rate volatility based on the Standard Deviation of the annual exchange rate	49,220	0.914	0.732	0.577	4.244	UNCTAD Database.	-/+
Metrop_node	Dummy variable for the metropolis. Provinces with Mega 2 or 3 industrial location nodes, 1 and zero otherwise	49,220	0.600	0.490	0	1	Dummy	+
Lib_RTA	A dummy variable for RTAs with all trading partners accounts for the indicator of trade liberalization	49,220	0.078	0.267	0	1	Dummy	+
Com_Lang	Dummy for a common language variable, and captures the effect of the historical pattern	49,220	0.463	0.499	0	1	Dummy	+
Col_Link	Dummy variable for colonial links, depicting the effect of the historical pattern	49,220	0.435	0.496	0	1	Dummy	+
lnRM_HD_pr	The provincial remoteness index accounting for the outward multilateral resistance to trade.	49,220	13.358	1.056	6.346	15.151	Calculated based on Head and Mayer (2014)	-/+
lnRM_HD_tp	The trading partner's remoteness index accounting for the inward multilateral resistance to trade.	46,340	10.495	0.821	6.346	12.087	Calculated based on Head and Mayer (2014)	-/+

Source: Own elaboration, using STATA 17.0 software. Note: Nominal values are all in current Canadian dollars

Canada and the U.S. trade data

The second gravity panel data is constructed for trade between the Canadian provinces and the U.S. states. This provides information covering a sample of 10 Canadian provinces and 51 states, from 2002 to 2020. The overall province-states pair observations are 11,400, where 1710 is the dataset for interprovincial trade pairs and 9,690 is the pair of the Canada-U.S. dataset. The sample for the Canada-U.S. dataset is reduced to 11,319 for exports and 10,918 for imports, due to missing data, captured by Statistics Canada as zero (0) trade, where trade data are not available for every province-state-year triplet. All data on exports and import values are captured in Canadian dollars, and all standard gravity variables receive a natural logarithmic transformation so that the estimated coefficients can be interpreted as relevant elasticities. Two primary sources of data were used. The first is data on trade between each Canadian province and individual U.S. states derived from the administrative records exchanged by Statistics Canada with the United States Census Bureau (USCB). The data are matched and combined with the data matrix of interprovincial trade, which consists of estimates of total goods commodity shipments from each province to every other province, derived from Statistics Canada, based on the Supply and Use Product Classification (SUPC) at the detailed level of aggregation. Controlling for interprovincial trade provides the empirical opportunity to revisit current dynamics in the Canada-U.S. border effect analysis. The common border data are system-generated; it takes a value of 1 for trade between the Canadian provinces and the U.S. states and zero (0) for interprovincial trade (i.e., province-to-province trade). The data analysis will determine the size of Canada-U.S. trade vis-à-vis interprovincial trade, thereby revealing the extent of the border effect based on the new data. The indicator for the border effect is measured by the dummy variable that takes a value of 1 for trade between Canadian provinces and U.S. states and zero (0) for interprovincial trade.

U.S. state data on the real GDP, population, and income per capita came from the Bureau of Economic Analysis (BEA) at the U.S. Department of Commerce. All values in current U.S. dollars are converted into Canadian dollars using the annual average nominal exchange rates for 2002 and 2020, available from the Bank of Canada. The World Bank provides data on the applied tariff rates between Canada and the U.S. trade.

TABLE 3.2 Variables description and descriptive statistics of Canada-U.S. trade

Variable	Description	#	Mean	Std. dev.	Min	Max	Sources	Expected impact
Exports	Annual provincial merchandise exports in millions of CAN$	11,400	814.2	2879	0	65,000	Statistics Canada	*
Imports	Annual provincial merchandise imports in millions of CAN$	11,400	658.3	2177	0	30,000	Statistics Canada	*
Trade	Annual provincial trade (exports + imports) in millions of CAN$	11,400	1472	4794	0	95,000	Statistics Canada	*
lnGDP_pr	Annual provincial nominal GDP	11,400	11.26	1.404	8.220	13.703	Statistics Canada	+
lnGDP_us	Annual nominal GDP of trading partners	11,400	12.13	1.170	8.220	15.227	U.S. Department of Commerce	+
Ec_fredom_pr	Provincial openness proxied by the index of provincial economic freedom	11,400	7.830	0.191	7.39	8.34	Fraser Institute database	+
Ec_fredom_us	U.S states' openness proxied by the index of economic freedom	11,210	8.059	0.208	7.39	8.61	Fraser Institute database	+
lnDistance	Distance in km between the capital cities of provinces and trading partners	11,400	7.582	0.659	4.787	9.143	Online Map	-
lnGDPpc_diff	Similarity/dissimilarity in economic development variable (derived as the absolute difference between the GDPpc of provinces and that of their trading partners	11,400	8.98	1.169	0	11.206	Statistics Canada &U.S. Department of Commerce	-/+
Border	Dummy variable for international trade flow: It takes a value of 1 for trade between Canadian provinces and U.S. states and zero (0) for interprovincial trade.	11,400	0.85	0.357	0	1	Dummy	-
Cross_border	Dummy variable for the international borderland advantage between provinces and U.S states	11,400	0.085	0.27	0	1	Dummy	+
Tariff_diff	The weighted mean difference of applied tariff rates across all products traded in and out of the Canadian provinces	11,400	0.129	0.134	0.000	0.611	World Bank	-
Exch_rate	The annual average exchange rate between the Canadian dollar and the U.S dollar	11,400	1.175	0.161	0.989	1.571	UNCTAD database	-/+
lnRM_HD_x	The provincial remoteness index reveals the level of outward multilateral resistance to trade.	11,400	10.726	1.104	5.193	13.150	Calculated based on Head and Mayer (2014)	-/+
lnRM_HD_m	The trading partner's remoteness index accounts for the inward multilateral resistance to trade.	11,400	9.079	0.962	4.787	11.445	Calculated based on Head and Mayer (2014)	-/+

Source: Own elaboration, using STATA 17.0 software. Note: Nominal values are all in current Canadian dollars

3.2.2 IIT data and descriptive statistics

IIT data

The IIT analysis is based on total provincial exports and imports, provided at four-digit and six-digit Harmonized System product classification. The annual export and import values of the products in both classifications were obtained from Industry Canada Trade Data Online from 2000 to 2022. All trade values are obtained in current Canadian dollars.

Excluding exhibitions, gifts, and services, 1,177 four-digit and 6,033 six-digit product categories were exported and/or imported by businesses in each province. Due to missing values, the observation recorded some incidence of trade imbalance, indicating that some trade data are unavailable for every export-imports-year triplet.

Explanatory variables

To examine the impact of province-specific factors on trade performance, this dissertation employs a range of independent variables that reflect economic structure, factor endowments, transaction costs, institutional quality, geographical characteristics, and MNEs' activities. The selection and construction of these variables are motivated by established theoretical frameworks and empirical stylized facts in the literature.

First, factor endowments are proxied using GDPpc, which serves as an indicator of provincial income levels and resource availability. GDPpc is widely recognized as a primary measure of economic prosperity (Al-Mawali, 2005; Thorpe & Zhang, 2005) and, consistent with Thorpe and Leitão (2013), captures effects similar to those of factor endowments in influencing IIT. Higher GDPpc levels are associated with stronger supply-side capacities and a greater ability to produce differentiated products. Provincial GDPpc data are sourced from Statistics Canada. Second, technological advancement is measured through the gross domestic expenditure on Research and Development (R&D). R&D spending reflects the level of technological capital and innovation capacity, both crucial determinants of IIT. Data on provincial R&D expenditures are obtained from Statistics Canada; however, it should be noted that information for the most recent year may be incomplete or pending release. Third, human capital is captured by the educational attainment of the workforce, classified into two categories: low-skilled and high-skilled labor ratios. Higher proportions of high-skilled workers are expected to correlate positively with the production of sophisticated, differentiated goods, thus enhancing IIT. Educational attainment data are sourced from Statistics Canada. Fourth, capital

intensity is proxied by the ratio of business sector gross fixed capital formation (K) to total labor costs (L), following the methodology of Clark and Stanley (2001). This ratio serves as an indicator of the extent to which provinces rely on capital versus labor in their production structures. Data for both gross fixed capital formation and labor costs are collected from Statistics Canada.

To account for transaction costs, the analysis incorporates measures of production and import tax rates. High tax rates are associated with greater trade barriers and are expected to dampen IIT performance. Data for these tax indicators are sourced from Statistics Canada. Additionally, institutional quality is included as a control variable, given its critical role in reducing transaction costs and providing a stable environment for trade. Institutional quality is measured using the Fraser Institute's all-government index, which captures key aspects such as regulatory efficiency, property rights protection, and governance quality.

Geographical variation is accounted for through distance from the equator, calculated using provincial latitude and longitude coordinates. Greater distance from the equator has been associated in the literature with higher levels of economic development and stronger institutional frameworks. The data for latitude and longitude are obtained from LatLong.net and computed using tools available on the Meridian Outpost website.

Finally, the impact of MNEs' activities is captured through three variables: capital formation, employment, and value-added by MNEs. Physical capital formation by MNEs is defined as the total value of fixed asset acquisitions, including machinery, equipment, non-residential buildings, and R&D expenditures, during a given period. Employment is measured by the number of jobs provided by foreign MNEs. Value-added reflects the GDP contribution generated by MNE operations within provinces. All three MNE-related datasets – capital formation, employment, and value-added are sourced from Statistics Canada.

Table 3.3 Variables description and descriptive statistics of IIT and province-specific factors

Variable	Description	#	Mean	SD	Min	Max	Sources	Expected impact
IIT_glk	IIT index	230	23.717	17.713	0.6	63.6	Industry Canada	*
HIIT_glk	HIIT index	230	19.853	16.374	0.2	59	Industry Canada	*
VIIT_glk	VIIT index	230	3.865	2.702	0.1	10.2	Industry Canada	*
lnGDP	Annual GDP is a proxy for economic size	230	11.259	1.419	8.130	13.863	Statistics Canada	+
lnGDPpc	Annual GDPpc measures	220	10.750	0.282	10.122	11.427	Statistics Canada	+
lnsr_low	Low-skilled human capital indicator	230	11.690	1.227	9.116	13.917	Statistics Canada	+
lnsr_high	High-skilled human capital indicator	230	13.113	1.357	10.401	15.565	Statistics Canada	+
lnR&D	Technological Endowment measured by annual R&D spending	220	6.918	1.625	3.434	9.975	Statistics Canada	+
lnTx_prod	Production tax indicator	160	10.269	0.192	10.054	10.672	Statistics Canada	-
lnTx_imp	Import tax indicator	160	8.620	1.282	6.052	11.027	Statistics Canada	-
inst_qlity	An indicator of institutional quality	220	7.832	0.193	7.4	8.3	Fraser Institute database	-/+
lndist	A measure of distance from the equator	230	6.928	0.806	5.412	7.796	Online Map	-/+
lnMNEs_cf	Indicator of MNE Physical Capital Investment	80	7.860	1.648	3.871	10.329	Statistics Canada.	+
lnMNEs_job	Indicator of MNE employment level	130	11.277	1.585	7.459	14.088	Statistics Canada.	+
lnMNEs_va	Indicator of MNE value-added	110	9.248	1.649	5.147	11.974	Statistics Canada.	+

Source: Own elaboration, using STATA 17.0 software. Note: Nominal values are all in current Canadian dollars

3.3 Conclusion

This chapter describes the data and analytical approach used in my work. It clarifies the different elements of the analytical framework, giving insight into the methodology for examining how globalization affects provincial trade. The analytical model, model specification, IIT decomposition, estimating techniques, data sources, and descriptive statistics are some of the essential components of the methodology. Each of these elements is essential in forming the overall analysis and ensuring that the findings are robust and reliable. The methodology employed, such as the gravity model, is grounded in both theoretical and empirical frameworks that seek to understand the dynamics of globalization and its effects on provincial trade. The gravity model has the advantage of incorporating various factors influencing provincial trade, including economic freedom, tariff rates, and free trade agreements.

The model is designed to capture the interactions between these variables and their collective impact on trade performance. IIT is a critical concept in understanding the

complexities of trade dynamics in a globalized economy. I employ the Grubel-Lloyd index to measure the extent of IIT across provinces. IIT enables a robust analysis of bilateral trade flows, trade intensities, and the underlying drivers of trade specialization. The chapter utilized the Grubel-Lloyd index to measure the extent of IIT across provinces. The use of decomposition methods (e.g., Kandogan, 2003) allows for distinguishing horizontal and vertical IIT, offering nuanced insights into the nature of trade integration and specialization. The data utilized in this dissertation is sourced from reputable databases and institutions to ensure accuracy and reliability. These diverse data sources were employed to ensure that all analyses are grounded in high-quality information, to aid in the drawing of meaningful conclusions. Various statistical measures, including means, medians, standard deviations, and ranges, were used to summarize the key characteristics of the variables included in the analysis. Overall, integrating these methodological elements into the analysis ensures a robust empirical framework that aligns theoretical insights with the practical realities of provincial trade dynamics.

CHAPTER 4 EMPIRICAL ANALYSIS

This section presents the empirical estimation results used to test the high-dimensional fixed effects associated with the research hypotheses outlined in the preceding chapters. It details the empirical strategies applied to operationalize the general analytical framework of the dissertation and discusses the corresponding estimation outcomes. Additionally, it introduces alternative estimation techniques employed to conduct robustness checks and validate the consistency of the findings.

4.1 Empirical strategy

This subsection outlines the empirical strategies employed to investigate the research hypotheses of the dissertation. The analytical framework begins with a general model specification, which is subsequently disaggregated into more specific empirical models aligned with the individual hypotheses. The preliminary analysis presents an overview of the composition and direction of provincial trade flows with key international partners. This is followed by an examination of trade and globalization indicators, providing baseline insights into the relationship between globalization and provincial trade, primarily addressing Hypothesis 1, including the assessment of potential non-linear effects. The subsequent section focuses on the role of province-specific characteristics in shaping foreign trade performance, corresponding to the empirical testing of Hypothesis 2.

4.1.1 Preliminary analysis – an initial look at the trade data

The analysis is based on the provincial trade dataset consisting of annual observations of 23 years between 212 trading partners, from 1999 to 2021, drawn from Statistics Canada databases. An initial investigation of the trade data shows that provincial exports maintained a greater spread than imports, which explains the level of dispersion experienced in total trade.

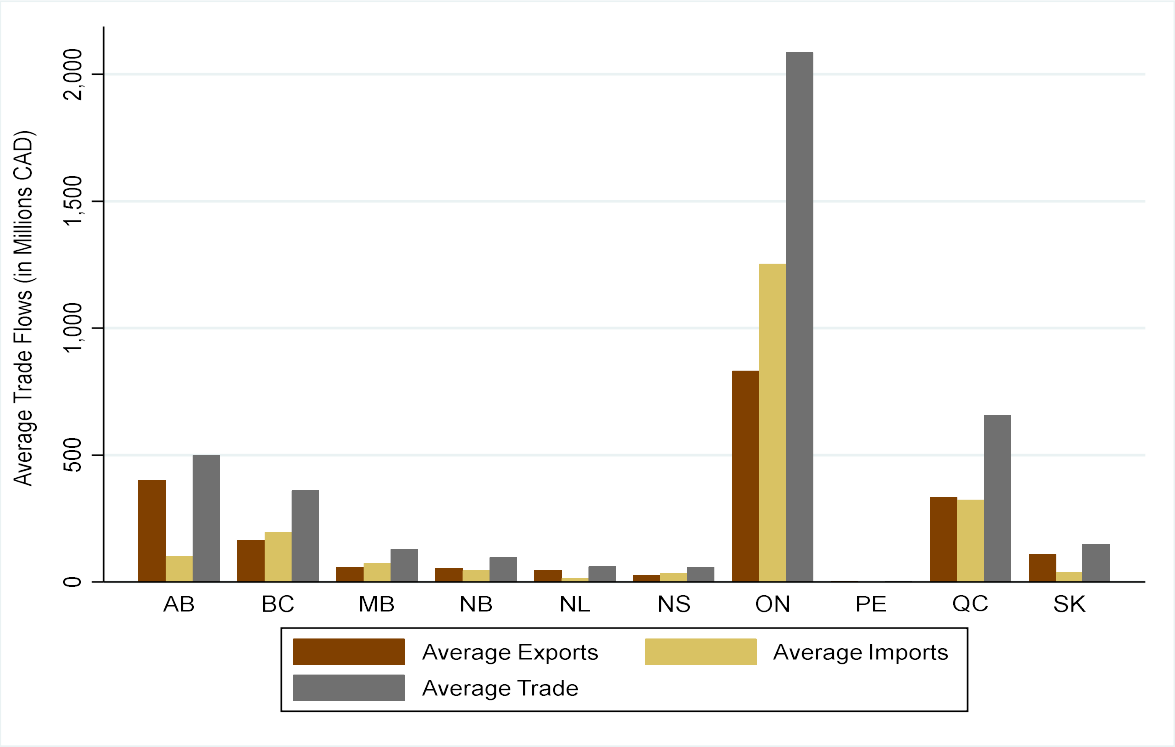


Figure 4.1 The structure of provincial trade, 1999-2021
Source: Own elaboration based on STATA analysis

Similarly, exports and imports appeared to be more concentrated, with a domineering role played by the Central Canadian provinces of Ontario and Quebec, followed by the Western Canadian provinces of Alberta and British Columbia. The degree of skewness can be attributed to the registration location of business entities, which may have been made possible through trade intermediation. In terms of exports, evidence indicates a stronger provincial production base and individual resource endowment. The key stylized fact deduced from this figure is that the trade imbalance is such that exports exceed imports in many of the provinces, while other provinces, such as Prince Edward Island and Newfoundland and Labrador, exhibit relatively lower trade volumes and asymmetries between their export and import levels.

Table 4.1 provides a comprehensive list of the 212 trading partners included in the analysis of the impact of globalization on provincial trade. These partners represent the international markets with which the provinces engage in trade activities, encompassing both major global economies and smaller trading entities. The composition of trading partners reflects the diverse nature of provincial trade networks and captures a wide spectrum of trade dynamics influenced by globalization. Including this broad range ensures that the analysis

accounts for variations in trade intensity and partner-specific effects, offering a robust understanding of globalization's impact at the provincial level.

Table 4.1 List of countries – trading partners

Afghanistan	Djibouti	Lao PDR	Saint Helena
Albania	Dominica	Latvia	St. Pierre and Miquelon
Algeria	Dominican Republic	Lebanon	Samoa
American Samoa	Ecuador	Lesotho	San Marino
Andorra	Egypt	Liberia	Sao Tome and Principe
Angola	El Salvador	Libya	Saudi Arabia
Anguilla	Equatorial Guinea	Liechtenstein	Senegal
Antigua and Barbuda	Eritrea	Lithuania	Serbia
Argentina	Estonia	Luxembourg	Seychelles
Armenia	Eswatini	Macao SAR	Sierra Leone
Aruba	Ethiopia	Madagascar	Singapore
Australia	Faroe Islands	Malawi	Slovakia
Austria	Fiji	Malaysia	Slovenia
Azerbaijan	Finland	Maldives	Solomon Islands
Bahamas	France	Mali	Somalia
Bahrain	Gabon	Malta	South Africa
Bangladesh	Gambia	Marshall Islands	South Sudan
Barbados	Georgia	Mauritania	Spain
Belarus	Germany	Mauritius	Sri Lanka
Belgium	Ghana	Mexico	St. Kitts and Nevis
Belize	Gibraltar	Moldova	St. Lucia
Benin	Greece	Monaco	St. Vincent and the Grenadines
Bermuda	Greenland	Mongolia	Sudan
Bhutan	Grenada	Montenegro	Suriname
Bolivia	Guam	Morocco	Sweden
Bosnia and Herzegovina	Guatemala	Mozambique	Switzerland
Botswana	Guinea	Myanmar	Syrian Arab Republic
Brazil	Guinea-Bissau	Namibia	Taiwan
British Virgin Islands	Guyana	Nauru	Tajikistan
Brunei Darussalam	Haiti	Nepal	Tanzania
Bulgaria	Honduras	Netherlands	Thailand
Burkina Faso	Hong Kong	New Caledonia	Timor-Leste
Burundi	Hungary	New Zealand	Togo
Cabo Verde	Iceland	Nicaragua	Tonga
Cambodia	India	Niger	Trinidad and Tobago
Cameroon	Indonesia	Nigeria	Tunisia
Cayman Islands	Iran	North Macedonia	Turkey
Central African Republic	Iraq	Norway	Turkmenistan
Chad	Ireland	Oman	Turks and Caicos Islands
Chile	Isle of Man	Pakistan	Tuvalu

China	Israel	Palau	Uganda
Colombia	Italy	Panama	Ukraine
Comoros	Jamaica	Papua New Guinea	United Arab Emirates
Congo	Japan	Paraguay	United Kingdom
Congo, Dem. Rep.	Jordan	Peru	United States
Costa Rica	Kazakhstan	Philippines	Uruguay
Cote d'Ivoire	Kenya	Pitcairn	Uzbekistan
Croatia	Kiribati	Poland	Vanuatu
Cuba	Korea DPR	Portugal	Venezuela, RB
Curacao	Korea, Rep.	Qatar	Vietnam
Cyprus	Kosovo	Romania	Yemen, Rep.
Czechia	Kuwait	Russian	Zambia
Denmark	Kyrgyz Republic	Rwanda	Zimbabwe

Source: Own elaboration on STATA analysis

Figures 4.2 and 4.3 highlight the heterogeneity in the volume of provincial exports and imports across trading partners. Trade volumes are significantly higher with certain countries, such as the United States, China, and the United Kingdom, while considerably lower with others.

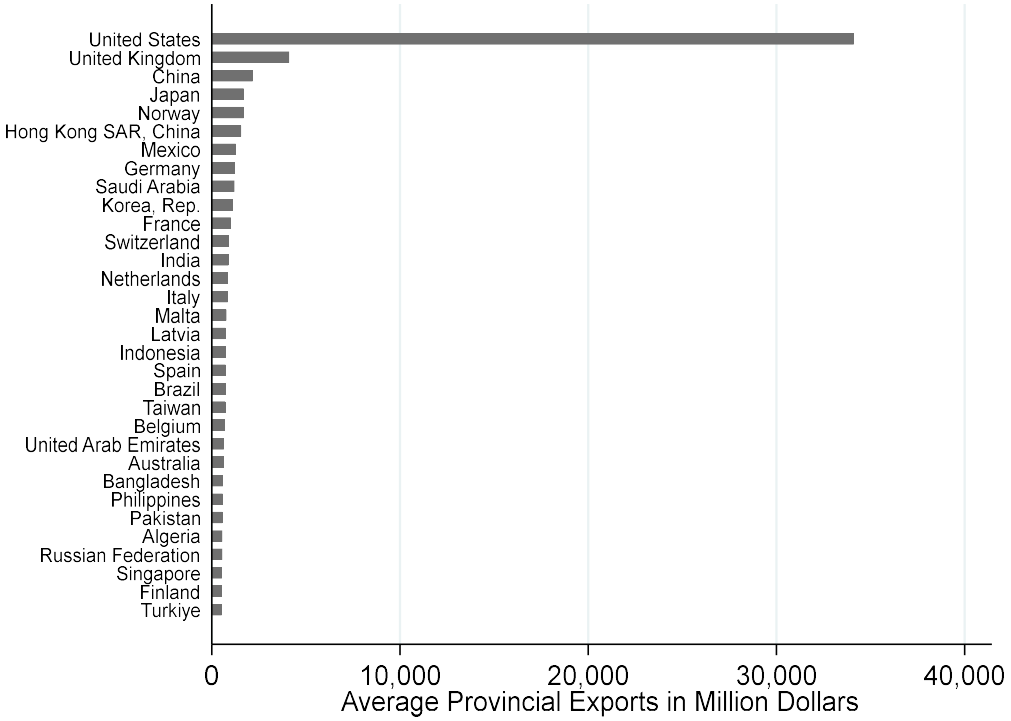


Figure 4.2 Average provincial exports to key trading partners, 1999-2021
Source: Own elaborate on based on STATA analysis

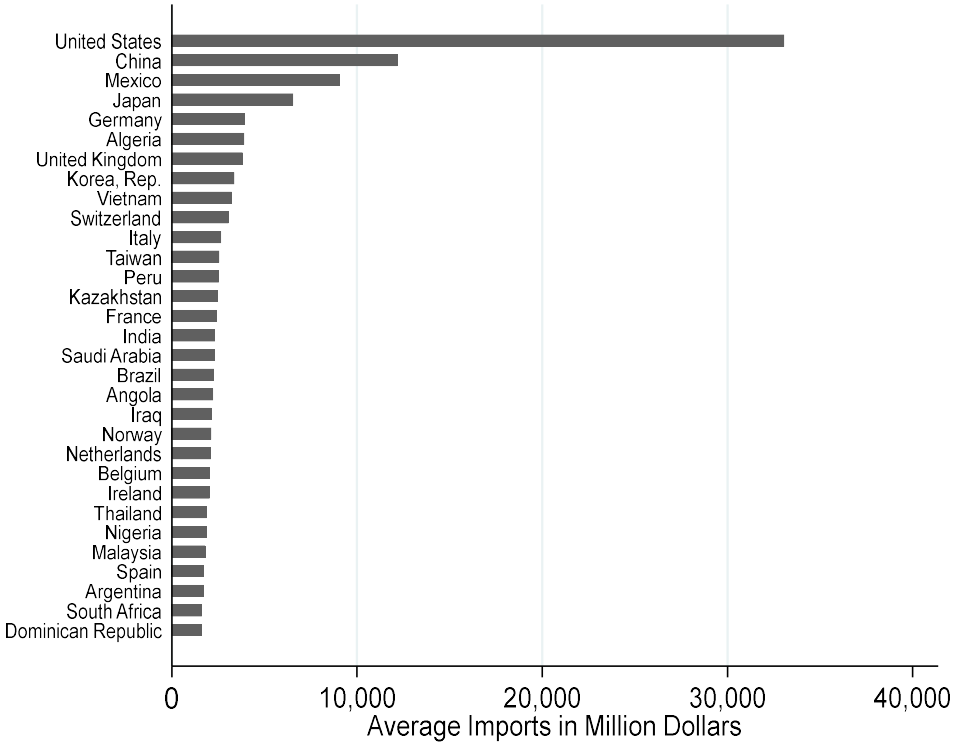


Figure 4.3 Average provincial imports from key trading partners, 1999-2021
Source: Own elaboration based on STATA analysis

This variability underscores the uneven distribution of trade relationships, reflecting the influence of geographical proximity, economic size, trade agreements, and sectoral complementarities between Canadian provinces and their trading partners. This heterogeneity is a critical consideration in understanding the dynamics of provincial trade and underscoring the interconnectedness of Canadian provinces with these economic hubs within the broader context of globalization. Given the high trade concentration between Canadian provinces and the United States, a separate analysis is conducted to examine provincial trade specifically with U.S. states. This focused approach allows for a detailed reassessment of the border effect in trade analysis, shedding light on how proximity and cross-border dynamics influence the volume and patterns of trade. By isolating trade with the U.S., the analysis provides a deeper understanding of the economic interdependencies between Canadian provinces and their most significant trading partner (the U.S.).

4.1.2 Gravity of provincial trade and globalization mechanisms – baseline model

This section extends the general analysis of the relationship between the foreign trade dynamics of Canadian provinces and various measures of globalization, primarily about hypothesis 1. To examine this relationship, a panel gravity model is estimated using annual trade data covering 212 global trading partners over the period 1999 to 2022. The estimation of the base and extended specifications of the model is performed using the high-dimensional fixed-effects method. The analysis is expanded to reflect developments in estimating gravity models and to incorporate explanatory globalization measures. As mentioned in the previous section, the underlying impact of globalization on the foreign trade of the Canadian provinces is assessed through the role played by transaction costs for international trade, the degree of economic freedom, partner's globalization index, the extent of trade liberalization, similarity/dissimilarity in the level of economic development, the level of fluctuations in the nominal exchange rate, and the role of metropolises. The baseline augmented gravity panel specification has the following functional form:

$$
\begin{aligned}
T_{ijt} = [\exp \beta_0 &+ \beta_1 \ln GDP_{ıt} + \beta_2 \ln GDP_{jt} + \beta_3 \ln Distance_{ij} \\
&+ \beta_4 \ln GDPpc\_diff_{ijt} + \beta_5 \mathrm{Ec\_Fredom}_{it} + \beta_6 \mathrm{Ec\_Fredom}_{jt} \\
&+ \beta_7 \mathrm{lnGlo\_dj}_{jt} + \beta_8 \mathrm{Lib\_RTA}_{ij} + \beta_9 \mathrm{Lib\_Tariff\_df}_{ijt} + \beta_{10} \mathrm{ERV}_{ij} \\
&+ \beta_{11} \mathrm{Metrop\_node}_{i} + \beta_{12} \mathrm{Com\_Lang}_{ij} + \beta_{13} \mathrm{Col\_Link}_{ij} \\
&+ \beta_{14} lnRM\_HD_{it} + \beta_{15} lnRM\_HD_{jt} + \Phi_{ij} + \gamma_t] * e_{ij\,t} \qquad (1)
\end{aligned}
$$

where $T_{ij,t}$ is the dependent variable representing the exports, imports, and the total trade that combines exports and imports between the Canadian provinces (i) and the trading partners (j) at a given year (t) interval. The results will be discussed simultaneously because the models have the same structure. The overall fit of the models is high. The standard gravity predictor variables are the real GDP of provinces and trading partners (GDP_{ijt}) and the distance between the capital of the provinces and the capital of the trading partner ($Distance_{ij}$). The variable $GDPpc\_diff_{ijt}$ is the GDPpc difference between the provinces and the trading partners, it is a measure of the relative gap in development. The variable EC_Fredom_{ijt} is the index of

economic freedom of the provinces and their trade partners. $\ln\text{Glo\_dj}_{jt}$ is the trade partner's globalization index. While the non-dummy composite tariff measures ($Lib\_Tarif\_df_{ijt}$) and the dummy-captured trade agreement (Lib_RTA_{ijt}) denotes the measure of liberalization. ERV_{ijt} is an indicator of fluctuation in exchange rate. Metrop_node_i are the metropolitan provinces representing the nodes of the global trade networks. Com_Lang_{ij} and Col_Link_{ij} represents the dummy variables denoting common language and colonial links. RM_HD_{ijt} denotes the reduced form multilateral resistance terms (MRTs) calculated based on Head and Mayer (2014). Lastly are the province-partner-specific effects Φ_{ij}, time effect γ_t and the error term e_{ijt}.

The baseline panel equation (1) is further examined through a set of progressively extended specifications applied across all trade models. The initial specification focuses on the core gravity variables. In contrast, subsequent specifications incorporate additional dimensions such as measures of trade openness, metropolitan connectivity, and liberalization-related factors, including RTAs, tariff measures, and ERV. This stepwise approach allows for a systematic assessment of how the inclusion of different explanatory dimensions influences the estimation results.

There are three empirical solutions required to estimate equations (1) and any other gravity model: **First**, the MRTs are not directly observable in a gravity trade model. They are a theoretical construct, and as such must be generated. The original MRTs described in Anderson and van Wincoop (2003) were a custom non-linear least squares program that generated values of the MRT after repeated simulations until convergence. Luckily, the broader literature has developed two easily deployable empirical solutions to construct MRT for researchers (Yotov et al., 2016). Many studies use Head's (2003) suggestion and proxy them with so-called remoteness terms. Unobserved heterogeneity caused by MRT or other unobserved factors in a panel data model can also be controlled by using a random effects model or a linear Taylor approximation method (Baier & Bergstrand, 2009). This dissertation used proxies for MRTs in the form of the remoteness term as defined by Head (2003). These remoteness indices are output and expenditure-weighted averages of bilateral distance. They are constructed via the so-called "remoteness indexes", as output and expenditure weighted averages of bilateral distance.

The remoteness terms based on Head (2003) can be illustrated as:

$$REM\ EXP(\Pi_i) = \left(\sum_j \frac{Y_{it}/Y_{wt}}{distance_{ij}} \right)^{-1}$$

$$REM\ IMP(P_j) = \left(\sum_i \frac{Y_{jt}/Y_{wt}}{distance_{ij}} \right)^{-1}$$

,where REM_i is the remoteness index accounting for the outward multilateral resistance term, $REM_j$is the remoteness index that captures the inward multilateral resistance term, Y_{it} and Y_{jt} denotes the GDP of the exporter and the importer in year t, while Y_{wt} denotes the world GDP in year t. As described by Anderson and van Wincoop (2003), trade resistance between any two countries (i and j) can be decomposed into three specific effects: (i) bilateral trade barriers between regions i & j, (ii) i's resistance to trade with all regions in the world, and (iii) j's resistance to trade with all regions in the world. In general, the "remoteness" terms explain that the level of bilateral trade flows between two trading partners depends not only on their economic size and the geographical distance from each other, but also on the size and the geographical distance to other trading partners. Another approach to capture MRTs is to include exporter and importer paired-time fixed effect variables (Harrigan, 1996; Feenstra, 2004), where an indicator variable is created for trading partners when they engage in trade in time (t). These fixed effects capture the "special" underlying factors that resulted in these two partners trading at this particular time. In line with the proposed method of analysis, this dissertation deployed the PMLHDFE to absorb all variations in the data. Both approaches lead to consistent estimates of the gravity equation in the log-linear and non-linear forms (Head & Mayer, 2013).

Second is the handling of zero trade flows, which can present a difficulty in estimating equation (1). Zero trade flows are quite common in international trade, especially given the disaggregated nature of provincial trade. This creates a problem when estimating log-linear gravity equations. The parameter estimates are biased if zero bilateral trade flows are ignored or if zeros are substituted with a modest positive value (Flowerdew & Aitkin, 1982; Eichengreen and Irwin, 1998; Linders and de Groot, 2006; Burger et al., 2009). Melitz (2003), Chaney (2008), and Helpman et al. (2008) specifically contend that prohibitive trade costs lead to zero trade flows. Productivity varies throughout organizations, and lower-productivity firms cannot

export due to fixed costs. The Heckman (1979), Tobin (1958), and Helpman et al. (2008) models were employed to address the problem. Many gravity investigations have used the Tobit model, such as Baldwin and DiNino (2006) and Rose (2004). However, Linders and de Groot (2006) were the most notable to examine the suitability of applying the Tobit model in recent times. Because hypothetical trade cannot be negative, Linders and de Groot contended, trade flows cannot be controlled below zero. Heckman (1979) and Helpman et al. (2008) tried to avoid the bias from the non-random removal of zeros in their sample selection models. These sample selection models have been challenged for two reasons: they lack controls against heteroscedasticity, which is often present in international trade data, and they are difficult to comply with the exclusion restriction provided by two-stage models (Santos Silver & Tenreyro, 2009; Flam & Nordstrom, 2011). Traditional White Huber standard errors are also not very effective at fixing this issue. An important study by Santos and Tenreyro (2006) avoids the log-linearization of the gravity equation and provides a solution to the zero-trade problem. As mentioned in the previous section (Estimation method), they recommended using nonlinear estimators to handle zero trade observations in the gravity equation, particularly the Poisson pseudo-maximum likelihood (PPML). PPML is resilient to the presence of heteroscedasticity and offers unbiased estimates. 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. In gravity analysis, the PPML approach is considered highly appropriate (Brodzicki, Ciołek, and Śledziewska, 2017; Brodzicki & Umiński, 2018; Head & Mayer, 2014; Martin & Pham, 2020; Nguyen, Haug, Owen, and Genç, 2020; Silva & Tenreyro, 2006). Fixed effects control for the unobserved heterogeneity, further lowering the bias of trade.

Third, it is also likely that endogeneity issues may occur in augmented gravity models when estimating the effects of trade policy-related variables[21] (Baier & Bergstrand, 2007). Countries are inclined to implement favorable trade policies for partners with whom they already have high trade volumes. Consequently, the inclusion of RTAs and tariff measures in equation (1) might correlate with the error term. If one or more explanatory variables are correlated with the error term, estimates are inconsistent and subject to endogeneity bias. Many sources of endogeneity are discussed in Greene (2017). A simple solution to the policy change issue is to use panel data over multiple-year intervals (Yotov et al., 2016). Since the regressions

[21] Although endogeneity may also arise from other explanatory variables, such as GDP, its impact on parameter estimate bias within the gravity model has been found to be minimal (Cyrus, 2002).

are over multiple years, the tariff measures and RTA dummies are again interacted with a time indicator variable.

To assess whether the endogeneity of trade policy variables poses an issue in the model, this dissertation re-estimated the specifications with RTAs and tariffs, including the GDP as instruments in the Hausman-Taylor (HT) estimator. Next, the Wald test was utilized to compare estimated coefficients from the Hausman-Taylor regressions with the PPML HDFE coefficient, the primary estimator. Under the hypothesis of no endogeneity, the estimates are not expected to show significant differences. This technique has been widely used in the literature on endogeneity in panel data analysis. Detailed discussions of the approach can be found in Cieślik and Nguyen (2016), Egger (2005), Gouveia et al. (2018), Khan et al. (2023), and Manocha (2023). Additionally, the use of panel data provides a safeguard against potential endogeneity issues. As noted by Cameron and Trivedi (2008), a key advantage of panel data is its ability to address omitted variable problems, which are a common source of endogeneity.

To address the limitations of the Hausman-Taylor estimator in handling zero and negative trade values, particularly those arising from the logarithmic transformation of trade flows less than unity, all trade observations are uniformly adjusted by adding a constant value of 1.0. This approach ensures compatibility with the estimator, which, unlike the PPML estimator, does not accommodate zeros or negative values. The constant is applied to the full distribution of trade flows, rather than selectively to zero observations, to avoid systematic bias in the coefficient estimates resulting from unequal treatment in the transformation process.

In contrast, the **GPML** estimator is employed for robustness checks on PPML, and implemented using the Poisson specification to account for the presence of zero trade flows explicitly. This approach is chosen due to the Poisson family's robustness to both zero values and various forms of heteroskedasticity, making it particularly well-suited for the distributional characteristics of bilateral trade data.

4.1.3 Gravity of provincial trade and non-linear determinants – model insight

This section explores the non-linear relationship between globalization mechanisms and provincial trade performance. To analyze hypothesis 1_C and provide more in-depth insight into overall hypothesis 1, equation 4.1 was altered to control for interaction terms. There are three country-level variables (RTAs, Tariff measures, and ERV), which interact with the GDPpc difference between provinces and trade partners. The reason for this interaction variable is that

the indicator variables of RTAs, tariffs, and exchange rates are measured at the country level and tend to influence provinces differently based on their individual productivity level or factor endowment. Thus, the inclusion of the interaction terms offers deeper insight into how the variables jointly influence trade flows. It captures the level of sensitivity of provincial competitiveness to RTAs, tariffs, and ERV and their combined impact on trade.

First, the dissertation introduced the interaction between RTAs and tariff measures, and the GDPpc difference to determine how the relationship between the liberalization factors and trade performance changes depending on the level of economic disparity between trading partners. Secondly, it estimated the interaction between GDPpc difference and ERV to determine how economic disparities and currency fluctuations jointly influence international trade

performance.

$$
\begin{aligned}
T_{ijt} = exp\,[\beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln Distance_{ij} + \beta_4 \ln \text{GDPpc\_diff}_{ijt} \\
+ \beta_5\, Lib\_RTA_{ijt} + \beta_6\, Lib\_Tarif\_df_{ijt} + \beta_7\, ERV_{ijt} + \beta_8 \ln \text{Ineq\_RTA}_{ijt} \\
+ \beta_9 \ln \text{Ineq\_Tarif\_df}_{ijt} + \beta_{10} \ln \text{Ineq\_ERV}_{ijt} + \beta_{11} \text{Com\_Lang}_{ij} \\
+ \beta_{12} \text{Col\_link}_{ij} + \Phi_{ij} + \gamma_t] * e_{ijt} \qquad (2)
\end{aligned}
$$

where β_8 and β_9 are interaction coefficients defining the nonlinear trend and the joint effect of differences in development level and liberalization factors. The interaction coefficient β_{10} defines the scope of the compounded effects of economic divergence and financial instability on trade dynamics. The interaction terms answer the question of whether the effect of globalization (proxied by the trade agreements, tariff measures, and ERV) on trade performance is conditional on the similarity/dissimilarity in the economic development of provinces and their trading partners, and whether such interactions amplify or mitigate the effects of RTAs, tariff measures, and ERV on trade.

4.1.4 Gravity of Canada-U.S. trade – the border effect model

This section examines whether globalization reinforces or weakens border effects within the framework of Canada-U.S. trade (a complement to the general hypothesis 1). Given the dominant role of the United States in Canadian international trade, this dissertation provides a dedicated analysis of Canada-U.S. trade flows in the context of the border effect. Specifically, it estimates a Canada-U.S. gravity model to assess the border effect, focusing on exports, imports, and total trade between Canada's ten provinces and the 50 U.S. states plus the District of Columbia over the period 2002-2020. A key contribution of this analysis is the incorporation of historical cross-border regional linkages to evaluate their influence on contemporary provincial trade dynamics. Table 4.2 provides a comprehensive list of the U.S. states included in the analysis.

Table 4.2 List and summary statistics of U.S. states

Alabama	Kentucky	North Dakota
Alaska	Louisiana	Ohio
Arizona	Maine	Oklahoma
Arkansas	Maryland	Oregon
California	Massachusetts	Pennsylvania
Colorado	Michigan	Rhode Island
Connecticut	Minnesota	South Carolina
Delaware	Mississippi	South Dakota
District of Columbia	Missouri	Tennessee
Florida	Montana	Texas
Georgia	Nebraska	Utah
Hawaii	Nevada	Vermont
Idaho	New Hampshire	Virginia
Illinois	New Jersey	Washington
Indiana	New Mexico	West Virginia
Iowa	New York	Wisconsin
Kansas	North Carolina	Wyoming

Source: Own elaboration based on STATA analysis

To explain the underlying reason for border effects, this dissertation assesses the role played by transaction costs (proxied by the geographical distance) for international trade and tariff measures, the level of economic disparities (proxied by the GDPpc difference), nominal ERV, and the degree of economic freedom that supports engagement in foreign trade.

First, the dissertation estimates the baseline equation to derive an aggregate border effect. Following the methodology of Fontagné et al. (2005) and Olper and Raimondi (2008), the dissertation then gradually introduces variables for the different determinants of border effects. By assessing the extent to which the estimated border effects are reduced, we obtain an indicator of the overall significance of these variables in explaining the trade-reducing impact of national borders.

Secondly, the dissertation incorporated controls for the cross-border dummy to capture the impact of borderland regions on trade performance. An intriguing question that remains underexplored in the literature concerns cross-border regions. These areas represent the core of Canada-U.S. economic and trade interactions. Drawing on economic, socio-cultural, and organizational dimensions, Downs and Sawchuk (2007) delineate five relatively distinct province-state groupings, termed cross-border regions (CBRs).

- In the West: British Columbia, Alberta, and Yukon, with Alaska, Washington, Idaho, Oregon, and Montana,
- In the Prairies-Great Plains area: Alberta, Saskatchewan, and Manitoba, with Montana, Wyoming, North Dakota, South Dakota, and Minnesota,
- In the Great Lakes-Heartland area: Ontario, with Michigan, Indiana, and Ohio
- In the East:
    - Quebec with Vermont, Maine, New Hampshire, and New York,
    - Atlantic Canada with Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut.

In general, the volume and diversity of trade between individual provinces and neighboring or nearby states within these CBRs are significantly higher, accompanied by notable recent growth in trade volumes (Downs, 2005). Furthermore, cross-border social and business networks, known to promote trade (Rauch, 2001; Combes, Lafourcade, and Mayer, 2004), are both strongest and increasingly influential in these borderland regions. These networks facilitate connections, lower information costs, address border-related challenges, and foster cross-border trade. A significant share of this trade may involve interconnected firms, as highlighted by Yi (2006), with cross-border trade in intermediate goods between companies likely being most prominent within CBRs. Border effects are likely to be less pronounced within these borderland areas. As the North American economies become increasingly interconnected and interest grows in exploring new strategies for Canada to enhance trade opportunities across

the entire U.S., the experiences of CBRs will serve as valuable references and benchmarks for comparison.

Next, the specification is enriched by adding variables that capture the level of economic disparities that may impact foreign trade. As is suggested in the literature, partners characterized by a similar level of development should trade more intensively than partners characterized by a significant gap in the level of development. As noted earlier, an extensive line of literature provides varied evidence on the trade effects of gaps in the development level of trading partners. These gaps are often proxied by the GDPpc difference. Therefore, the measure of the gap in the level of development ($GDPpc\_diff$) is included in the model. It is measured according to the following formula: $GDPpc\_diff = \ln|\text{ypc\_u} - \text{ypc\_p}|$.

Afterwards, the gravity model is augmented with controls for nominal exchange rates and variables that account for tariff-related barriers. Empirical studies show that the relationship between the exchange rate and bilateral trade is important and multifaceted (Eichengreen, 2007; 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.

The relevance of tariffs to changes in bilateral trade remains a contested issue in economic literature, with divergent perspectives, often shaped by empirical and contextual factors. Studies, including Baier and Bergstrand (2007), confirm that tariff reductions under free trade agreements have significantly boosted trade volumes between member countries. Studies have also shown that in some cases, changes in tariffs do not result in proportional changes in trade volumes. If demand for a product is inelastic, higher tariffs might not significantly deter imports. Again, Tariff changes might lead to shifts in sourcing rather than outright reductions in trade, as observed in studies on trade under regional agreements (Magee, 2008). Thus, changes in tariffs often reflect deliberate trade policy shifts. For example, the imposition of tariffs during the U.S.-China trade conflict significantly reduced bilateral trade volumes between the two countries, demonstrating tariffs' direct impact on trade (Amiti, Redding, and Weinstein, 2019). The reduction or elimination of tariffs among Canada, the U.S., and Mexico under the USMCA Free Trade Agreement is anticipated to significantly boost trade within the region (Trefler, 2004). This debate reflects the complexity of modern trade dynamics and underscores the need for nuanced approaches when analyzing the' role of tariffs in bilateral trade.

Considering their magnitude of influence, ERV and the structure of global supply chains often exert a more pronounced effect than tariff measures. For instance, even with high tariffs, integrated supply chains may sustain trade flows due to production interdependence (Yi, 2003).

Finally, the gravity model is augmented with the index of economic freedom. It measures the extent to which policies and institutions in a region support economic freedom. It includes indicators such as trade freedom, property rights, government integrity, and regulatory efficiency. While the theoretical basis suggests a strong connection between economic freedom and trade, empirical findings are more nuanced. Empirical evidence abounds on the role of economic freedom in determining trade flows. Rodrik (2000) and Anderson & van Wincoop (2003) emphasized that greater economic freedom is associated with lower costs of cross-border transactions, thereby encouraging bilateral trade. The index was developed by the Fraser Institute and captured for the Canadian provinces and the U.S. states, respectively.

$$
\begin{aligned}
T_{pu,t} = [exp\ \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln Dis_{ij} + \beta_4\, Border_{ij} \\
+ \beta_5 \ln \mathrm{RM\_HD}_{it} + \beta_6 \ln \mathrm{RM\_HD}_{jt} + \beta_7\, Cross - border_{ij} \\
+ \beta_8 \ln GDPpc\_diff_{ijt} + \beta_9 \mathrm{Exch\_rate}_{ijt} + \beta_{10} Tariff\_diff_{ijt} \\
+ \beta_{11}\, Ec\_Fredom_{it} + \beta_{12}\, Ec\_Fredom_{jt} + \gamma_t] * e_{ijt} \quad (3)
\end{aligned}
$$

To determine the border effect, the absolute value of the estimated border coefficient (β_4) is expressed as a natural exponential function [exp (β_4)]. This represents the ratio of domestic to international flows, conditional on the other variables being equal. Regression is run separately for Canada and each of the provinces, as well as the U.S. states. Using province-specific data allows for the estimation of a province-specific border dummy. Running province-specific regressions for exports, imports, and total trade separately estimates province-specific and direction-specific (exports versus imports) border dummies. By this, we can see if the border has a bigger impact on provinces' exports to the U.S states than on their imports from the U.S states.

Decomposition of the border effect

This subsection presents a decomposition analysis to examine the extent to which tariff measures, representing a key globalization mechanism, contribute to the persistent trade barriers associated with the Canada-U.S. border. The objective is to assess whether tariffs still play a significant role in border-related trade frictions or whether other institutional and non-tariff factors have become more dominant in shaping cross-border trade dynamics.

To isolate the share of the border effect attributable specifically to tariff measures, this study employs a **semi-structural decomposition approach** within a gravity model framework. The analysis relies on interaction terms between tariff rates and a border dummy variable to capture the marginal impact of tariffs on trade flows that occur across international boundaries. Specifically, the interaction term allows for the estimation of how tariff barriers exacerbate the trade-reducing effect typically associated with crossing a political border, conditional on other trade cost factors. The derivative is based on the estimated result from the model below:

$$T_{pu,t} = [exp\ \beta_0 + \beta_1 ln\ GDP_{it} + \beta_2 ln\ GDP_{jt} + \beta_3 ln\ Dis_{ij} + \beta_4\ Border_{ij} + \beta_5 Tariff\_diff_{ijt} + \beta_6 Border * Tariff\_diff_{ijt} + \beta_7 lnRM\_HD_{it} + \beta_8 lnRM\_HD_{jt} + \gamma_t] * e_{ijt} \quad (4)$$

Where (β_4) is the overall border effect, which captures the average effect of crossing a border when tariffs are zero, and (β_6) is the coefficient of interaction terms between tariff rates and a border dummy variable, which captures the additional impact of tariffs when trade occurs across a border – it defines the marginal effect of tariffs across borders (i.e., the tariff-induced component to the overall estimated border effect). A significant and positive coefficient implies that tariffs magnify the border effect. Following the estimation, a counterfactual simulation approach is employed: predicted trade flows are calculated under two scenarios: (i) with observed tariff levels, and (ii) assuming zero tariffs. The difference in the border effect coefficients across these scenarios quantifies the tariff-induced component of the total border effect. The proportional share due to tariffs is then computed as the ratio of the tariff-induced component to the overall estimated border effect. For simplicity, Tariff is used in place of Tariff_diff in the decomposition framework as follows:

$$\text{Share due to Tariffs} = \frac{\exp\left(\beta_4 + \beta_6 * \overline{Tariff}\right) - \exp\left(\beta_4\right)}{\exp\left(\beta_4 + \beta_6 * \overline{Tariff}\right)}$$

$$= 1 - \frac{\exp\left(\beta_4\right)}{\exp\left(\beta_4 + \beta_6 * \overline{Tariff}\right)}$$

$$= 1 - \exp\left(-\beta_6 * \overline{Tariff}\right)$$

Where $\overline{Tariff}$ Is the mean value of tariff differentials across all Canada-U.S. trade pairs. $\beta_6 * \overline{Tariff}$ gives you the expected additional log difference in trade caused by tariffs on top of the general border effect (β_4). A higher value of β_6 or larger $\overline{Tariff}$ increases the share of the border effect attributable to tariffs. If the share is close to 1, it implies that most of the observed border effect arises from tariff barriers. If close to 0, the border effect is mainly explained by other factors, such as non-tariff barriers (NTBs), institutional differences, transport costs, consumer preferences, and other unobserved determinants.

This approach builds on established techniques in the trade literature that utilize interaction terms and counterfactuals for policy evaluation within gravity models (Anderson & van Wincoop, 2003; Head and Mayer, 2014; Yotov et al., 2016). It offers an analytically tractable and policy-relevant decomposition without requiring fully structural estimation of general equilibrium effects, while still capturing the relative contribution of tariff policies to the overall observed border-related trade frictions.

4.1.5 IIT pattern and province-specific determinants – model insight

This section explores the panel-data models on the provincial IIT pattern to examine (hypothesis 2) on the trade influence of province-specific characteristics. Before reviewing the empirical model employed, it is worth discussing how this paper constructs the dependent variables utilized in the analysis. At the same time, the four-digit product classification is used to approximate the industries, and the harmonized six-digit classification is utilized to define the products. The six-digit classification was selected because the difference between each commodity can be considered a distinct good. As discussed in section 3.1.1, this dissertation employed the Grubel-Lloyd methodology complemented by the Kandogan decomposition method to identify the IIT, HIIT, and VIIT.

To test hypothesis 2, the dissertation estimates the impact of province-specific characteristics on provincial IIT and its components. To achieve this, the dissertation employs the panel specification of the following functional form:

$$IIT_{it} = exp\Big[\beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln \text{Equat}_{dist_i} + \beta_3 \ln \text{GDPpc}_{it} + \beta_4 \ln R\&D_{it} + \beta_5 \ln \text{st}_{\text{qlity}_{it}} + \beta_6 \ln \text{sr}_{\text{low}_{it}} + \beta_7 \ln \text{sr}_{\text{high}_{it}} + \beta_8 \ln \text{Tx}_{\text{prod}_{it}} + \beta_9 \ln \text{Tx}_{imp_{it}} + \beta_{10} \ln \text{MNEs}_{\text{va}_{it}} + \beta_{11} \ln \text{MNEs}_{\text{job}_{it}} + \beta_{12} \ln \text{MNEs}_{\text{cf}_{it}} + \gamma_t\Big] * e_{it} \quad (5)$$

where IIT_{it} is the dependent variable defined as the index of the provincial (i) IIT and its components in the year t. The panel regression equation is systematically deconstructed and analyzed in different specifications for all the components of IIT. Across specifications, the explanatory variables include the GDP ($lnGDP_{it}$) – a proxy for provincial economic size and the equatorial distance ($lnEquat\_dist_i$) derived from the latitude and longitude of the provincial centroid. Since we are only concerned with looking at a one-directional and non-gravitational trade, only the provinces' GDPs are used to proxy the market size. A priori, all trade is expected to be positively correlated with GDP and negatively correlated with distance. The GDPpc ($lnGDPpc_{it}$) variable proxies for income level and factor endowment, the research and development spending ($lnrd_{it}$) variable represents technological endowment, the index of economic freedom stands in proxy for the level of institutional quality ($inst\_qlity_{it}$) with the expectation of a positive correlation to all trade measures, the variables of the low ($lnsr\_low_{it}$) and high ($lnsr\_high_{it}$) skill ratios capture the level of educational attainment and account for the degree of human capital development, the production ($lnTx\_prod_{it}$) and import ($lnTx\_imp_{it}$) tax variables are friction factors, which are expected to adversely correlate with any trade variables. Another form of explanatory variables relates to the activities of the MNEs, which include the GDP variable ($lnMNEs\_va_{it}$) - a proxy for the total MNEs' value-added, the employment variable ($lnMNEs\_job_{it}$) representing the number of MNEs' jobs, and the total gross capital formation ($lnMNEs\_cf_{it}$) representing the total capital investments by MNEs. The estimation results on the role of province-specific factors can be found in 4.2.4.

4.2 Empirical estimation and discussion of results

This subsection presents and discusses the empirical findings of the dissertation. It begins with an examination of the baseline gravity model estimates, focusing on the relationship between globalization and provincial foreign trade (primarily addressing Hypothesis 1). It then explores the estimated effects of non-linearities in the gravity model and their implications for provincial trade performance (pertinent to Hypothesis 1_E). Next, the analysis turns to the Canada-U.S. trade estimates, with particular attention to the border effect (related to the complementary hypothesis). Finally, the subsection considers the influence of province-specific characteristics on trade performance (related to hypothesis 2).

The empirical analysis is conducted using three alternative estimators: PPML, HT, and GPML, with minor differences in the treatment of trade values. Whereas PPML and GPML estimations use trade values in levels[22], a log-transformed trade data is utilized in the case of HT estimations.

Before estimation, diagnostic testing was exhaustively conducted. Panel stationarity was first examined using the Fisher-type unit root test, applying both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) based approaches. The diagnostic results from both methods are satisfactory, confirming that all panels are stationary at level (I (0))[23], thereby satisfying the prerequisite conditions for panel regression analysis. Following this, the Hausman's (1978)[24] test was conducted to determine the appropriate specification between fixed and random effects models, with the results supporting the adoption of the fixed-effects specification. To assess and exclude potential multicollinearity, both the Variance Inflation Factor (VIF) measures and the correlation matrix were computed. Results from both tests are satisfactory and do not reveal any issues. Whereas the tested VIF for each estimation is less than the 10.0 threshold[25], the correlation coefficients are below the 0.8 level[26] in the baseline and the border effect gravity models. Visual sequence of the estimation strategies is presented below.

[22] Log-values are not applied in the case of PPML and GMPL approaches due to the specification of the estimation procedure.
[23] Fisher-type Unit Root Test indicates that panel is stationary if p-value < 0.05, otherwise non-stationary if p-value > 0.05
[24] Hausman (1978) indicates that FE is appropriate if p-value < 0.05, otherwise RE if p-value >= 0.05.
[25] Variance Inflation Factor (VIF) < 10 ⇒ indicates minimal presence of multicollinearity issue among explanatory variables.
[26] According to Hailer et al. (2006) correlation coefficient below 0.9 may not cause serious multicollinearity problem

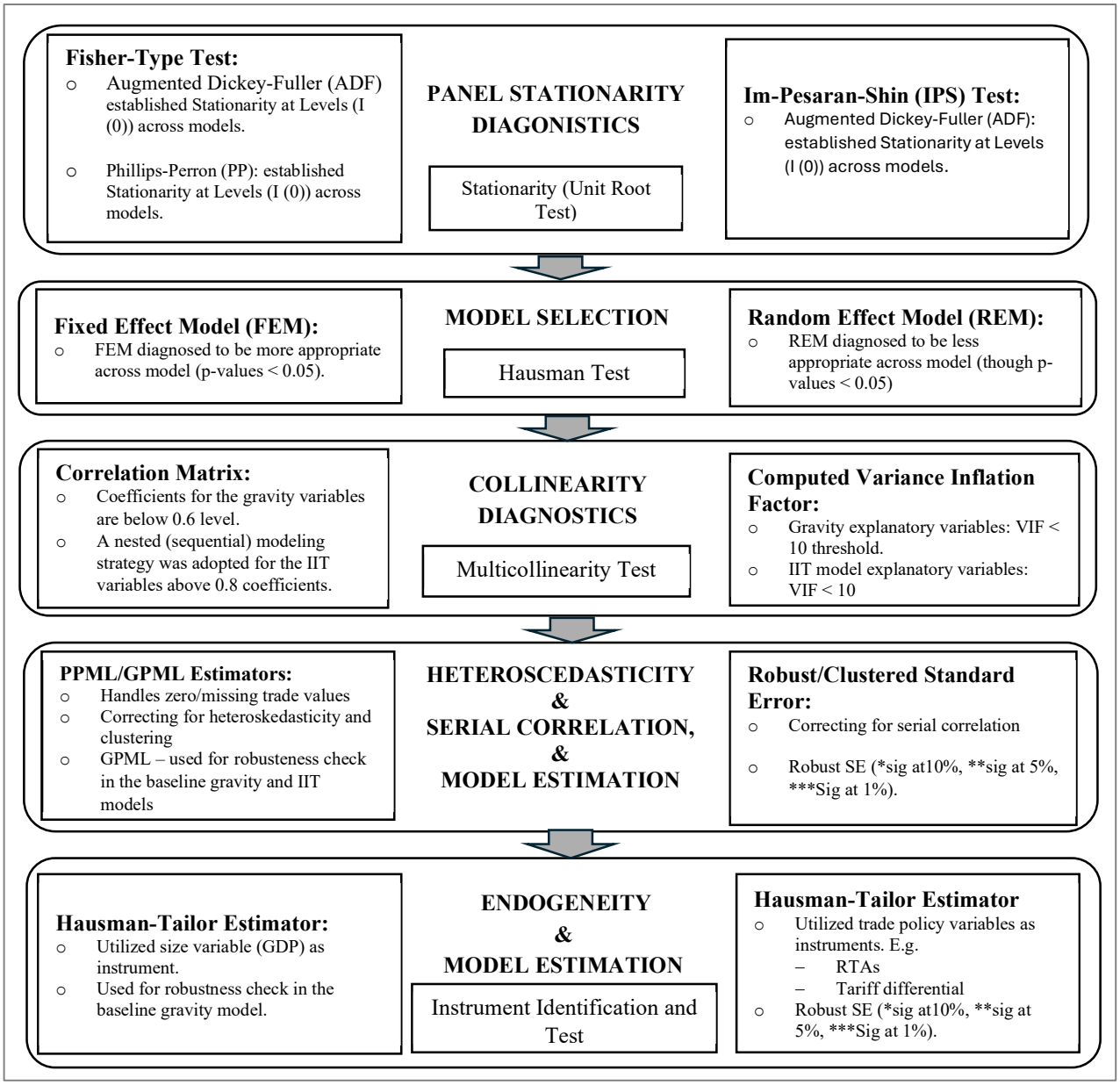


Figure 4.4 Estimation strategy
Source: own elaboration

In terms of the IIT model, the correlation matrix reveals a number of high pairwise correlations among certain province-specific variables, indicating possible overlapping explanatory power. To address this issue, the analysis adopts a nested modeling strategy, whereby related variables are introduced sequentially across alternative specifications. This approach enables robustness checks, mitigates distortions due to multicollinearity, and allows clearer interpretation of marginal effects while preserving theoretically relevant constructs. Panel diagnostics also indicated potential issues with heteroscedasticity and serial correlation. However, the PPML

estimations across all panel-data models (unless specified otherwise to preserve time-invariant variables) incorporate high-dimensional time fixed effects and robust standard errors to correct for heteroskedasticity and clustering. Comparable time fixed effects structures are employed similarly in the HT and GPML models to enable consistent cross-methodological comparison.

Time fixed effects were included to account for unobserved, time-specific shocks and global macroeconomic fluctuations that may influence all province-country trade flows simultaneously, including common policy changes, international commodity price shifts, or financial crises that are not captured by the explanatory variables but could otherwise bias the estimates. However, origin (province), destination (country), and province-country pair fixed effects were deliberately excluded due to several econometric considerations. First, including origin or destination fixed effects would absorb all time-invariant characteristics of provinces and countries, such as geographic location and metropolis indicator, including institutional quality and average tariff rates, which are central to this study's explanatory framework. Since the model already includes such time-invariant or slowly changing covariates (e.g., distance, metropolis and historical trade links), the inclusion of fixed effects would introduce perfect collinearity, rendering it impossible to estimate the coefficients of interest. Second, the inclusion of origin fixed effects would also eliminate between-province variation that is essential for identifying the role of province-specific characteristics (e.g., R&D intensity, MNE activity, and human capital composition) on IIT. Third, destination country fixed effects were excluded to retain cross-region variation that may be relevant for understanding trade dynamics, especially when province-level trade frictions or demand-side factors are not directly observable. Finally, pair fixed effects were not considered due to the one-directional structure of the trade data and limited within-pair temporal variation. Including pair fixed effects would absorb all time-invariant bilateral variables such as physical distance, dummies for metropolis and historical trade links and could result in a significant loss of degrees of freedom and estimation efficiency in the presence of sparse trade data. The specification thus reflects a deliberate balance between accounting for common temporal shocks and preserving identification of the structural province- and country-level determinants across the models.

Estimations are carried out using STATA. Across all specifications, the reported coefficients represent the average marginal impact of each covariate on provincial trade performance. For models proceeded with the PPML and GPML estimators, which employ a log-link function, coefficients are interpreted as semi-elasticities, computed as $[\exp(\beta) - 1] \times 100$, while coefficients on log-transformed independent variables are interpreted as elasticities.

4.2.1 Gravity of provincial trade and globalization mechanisms – empirical estimates

This section presents the estimation of the baseline specification (Equation 4.1), which links provincial exports and total trade to standard gravity variables and key globalization mechanisms. As the estimation strategy outlines, three analytical approaches are employed – the PPML, HT, and GPML, with PPML as the primary estimator. The results across all three approaches are largely consistent, with minor differences observed in a few cases where coefficients are statistically insignificant or deviate from expected signs. The estimation results of the base and extended specifications of the baseline model are provided in Table 4.3. Various extended specifications of the basic model have been tested. The number of specifications shown in the paper has been restricted for obvious reasons. The dependent variable, as already indicated in the previous section, includes the value of exports from the provinces to the countries and the value of total trade between provinces and their trading partner. The results will be discussed simultaneously since the models have similar structures. All the specifications in the exports and total trade models are estimated with time-fixed effects. The time-fixed effects help control for cyclical changes (Baldwin & Taglioni, 2006).

The main gravity variables remain robust and statistically significant across both export and total trade models. Additionally, the globalization indicators, including economic freedom (provincial and partner), trading partners' de jure globalization index, RTAs, tariff levels, ERV, and metropolitan status, show significant effects in both sets of estimations. Excluding the statistical significance, the different signs on the coefficients of export and total trade specifications corroborate existing literature on the findings that globalization can produce both positive and adverse effects on trade performance (e.g., Baier and Bergstrand, 2007; Wooldridge, 2010; Anderson and Yotov, 2011; Bergstrand et al., 2015; Góes and Bekkers, 2022; Naoaj, 2023; Kumari, 2024; Sowrov, 2024; Suparjo and Masduki, 2025). Thus, across the baseline estimates, the results consistently affirm the structural validity of the gravity model and the significant role of globalization mechanisms in determining trade flows.

Estimates of the standard gravity variables

The base specifications of the gravity model are given in columns E-1A and T-1A, and then further extended with augmented variables across the specifications. The impact of the size

of the provincial economies and that of the trading partners is positive and statistically significant. Models containing a log of the population of trading partners as a proxy for the size of the economy have also been tested. The results are robust and consistent. As expected, the coefficients on the log of real GDP of both provinces and trading partners are statistically significant and are either approximately or more than 1, except in a few cases where it is less. The economic size of trading partners has a greater effect on both the export and total trade models. This implies a strong sensitivity of trade flows to the economic size of the trading partner, supporting the theoretical gravity model and consistent with findings in Anderson and van Wincoop (2003). As expected, the coefficient on the log of distance is negative and statistically significant across specifications. The magnitude of this effect is more pronounced in specification E-1B and T-1B for export and total trade models (e.g., -1.79 and -1.85, respectively). These estimates are similar to some earlier findings, such as those by Friedman (2020), Suvankulov (2015), Frankel and Rose (2002), Rauch and Trindade (2002), Martínez-Zarzoso (2003), Rose (2004), and Disdier and Head (2008). The implication of the results is that distance puts downward pressure on trade, regardless of the other traits of the partners. The differences in the effects of size and distance across specifications are due to the number of controlled variables in each specification.

The estimates for the remoteness indexes are small and highly insignificant across specifications, confirming that, all else equal, Canadian provinces and trading partners are open to international trade, given the small coefficients of the multilateral trade resistance or remoteness terms. Partners that are far from global suppliers face high import costs due to transportation and logistics constraints. Exporters are less affected by the importer's remoteness, as they can adjust prices or find alternative markets.

Finally, the effects of common language and colonial links indicators are statistically significant. The coefficient of common language is positive for both export (0.34) and total trade specification (0.32), which indicates more trade if partners share an official language. The coefficient of the colonial link is mixed (as shown in specifications E3 and T3). While it is significantly positive for export (0.62), it appears insignificantly negative for total trade (-0.09). This implies more exports with less trade reciprocity due to a significant decline in import demand from partners with shared colonial history. The empirical result demonstrates strong institutional persistence in the case of exports; however, the historical trade ties seem to be decaying monotonically in the case of imports, resulting in total trade decline. The implication is that the institutional legacy of being a former member of the British colony is decaying much

more rapidly for the provincial imports. This limited contemporary influence suggests economic fundamentals and globalization mechanisms are more pivotal. The effect remains consistent in the HT and GPML results.

Table 4.3 Panel gravity regression – baseline estimates of the export model

Estimation Method	**PPML**	**PPML**	**PPML**	**PPML**	**PPML**	**HT**	**HT**	**HT**	**GPML**	**GPML**
Variable/Specification	**E-1A**	**E-2A**	**E-3A**	**E-4**	**E-5**	**E-1B**	**E-2B**	**E-3B**	**E-1C**	**E-2C**
lnGDP_pr	0.782***	0.649***	0.838***	0.882***	0.730***	0.601***	1.335***	0.352*	0.860***	0.675***
	(0.018)	(0.020)	(0.019)	(0.022)	(0.028)	(0.202)	(0.090)	(0.181)	(0.030)	(0.019)
lnGDP_tp	1.305***	1.154***	1.254***	1.240***	1.268***	1.061***	0.992***	1.046***	1.236***	1.136***
	(0.042)	(0.018)	(0.034)	(0.031)	(0.036)	(0.024)	(0.041)	(0.029)	(0.031)	(0.017)
lnDistance	-0.670***	-0.721***	-0.405***	-0.347***	-0.634***	-1.798***	-1.420***	-1.601***	-0.356***	-0.625***
	(0.047)	(0.029)	(0.089)	(0.056)	(0.051)	(0.120)	(0.131)	(0.116)	(0.056)	(0.051)
lnRM_HD_pr			0.001			-0.003				-0.008
			(0.048)			(0.008)				(0.030)
lnRM_HD_tp			-0.057			0.025**				-0.022
			(0.042)			(0.012)				(0.027)
Ec_fredom_pr		2.403***					-0.287			2.266***
		(0.202)					(0.429)			(0.181)
Ec_fredom_tp		0.388***					0.402***			0.244***
		(0.032)					(0.062)			(0.031)
lnGlo_dj_tp		0.236***						0.0001		0.193***
		(0.030)						(0.014)		(0.028)
Lib_RTA				1.285***		0.028		0.026	1.275***	
				(0.093)		(0.064)		(0.059)	(0.092)	
Lib_Tarif_df				-0.120		0.050			-0.121	
				(0.132)		(0.057)			(0.131)	
ERV				0.171***		-0.321***	-0.240***		0.169***	
				(0.022)		(0.040)	(0.036)		(0.021)	
lnGDPpc_diff					-0.147***			0.081***		0.038
					(0.032)			(0.021)		(0.025)
Metrop_node					0.312***	1.864***		2.283***	0.096	
					(0.072)	(0.434)		(0.393)	(0.066)	
Com_Lang			0.344***				0.650			0.046
			(0.073)				(0.474)			(0.099)
Col_Link			0.620***				0.223			0.653***
			(0.092)				(0.473)			(0.097)
Constant	-2.05*	-20.8***	-4.22***	-5.60***	0.010	3.575*	-6.250**	3.328*	-5.96***	-19.3***
	(1.139)	(1.805)	(1.153)	(1.142)	(0.972)	(2.062)	(2.969)	(1.980)	(1.196)	(1.520)
Observation	46,340	29,280	46,340	30,820	46,340	30,820	30,800	41,960	30,820	29,280
Log-Pseudo Likelihood	-2.70E+12	-1.70E+12	-2.30E+12	-1.80E+12	-2.60E+12				-1.80E+12	-1.70E+12
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.94	0.96	0.95	0.96	0.9451		No			
Prob > chi^2	0	0	0	0	0	0	0	0		
Wald chi^2	33557	38470	37829	40447	29171	24016	24225	18345		
AIC									1.19E+08	1.13E+08

Source: Own elaboration using STATA/MP Version 17. Explanatory variables are as defined in Table 3.1. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%. E represents the exports model, estimated using PPML (as the primary estimator); HT and GPML are alternative estimators

Table 4.4 Panel gravity regression (baseline estimates of the total trade model)

Estimation Method	**PPML**	**PPML**	**PPML**	**PPML**	**PPML**	**HT**	**HT**	**HT**	**GPML**	**GPML**
Variable/Specification	**T-1A**	**T-2A**	**T-3A**	**T-4**	**T-5**	**T-1B**	**T-2B**	**T-3B**	**T-1C**	**T-2C**
lnGDP_pr	0.951***	0.910***	0.966***	1.016***	0.997***	0.602***	1.382***	0.430**	1.099***	0.919***
	(0.014)	(0.017)	(0.014)	(0.017)	(0.023)	(0.186)	(0.088)	(0.176)	(0.026)	(0.017)
lnGDP_tp	1.105***	1.075***	1.096***	1.081***	1.110***	1.060***	0.986***	1.059***	1.089***	1.075***
	(0.018)	(0.015)	(0.016)	(0.017)	(0.016)	(0.027)	(0.046)	(0.032)	(0.016)	(0.014)
lnDistance	-0.668***	-0.692***	-0.563***	-0.458***	-0.658***	-1.848***	-1.630***	-1.680***	-0.427***	-0.619***
	(0.022)	(0.019)	(0.055)	(0.030)	(0.026)	(0.120)	(0.129)	(0.116)	(0.030)	(0.043)
lnRM_HD_pr			-0.006			0.001				-0.016
			(0.028)			(0.008)				(0.023)
lnRM_HD_tp			-0.039			0.028**				-0.028
			(0.030)			(0.012)				(0.025)
Ec_fredom_pr		0.905***					-0.260			0.862***
		(0.171)					(0.401)			(0.162)
Ec_fredom_tp		0.028					0.293***			0.007
		(0.025)					(0.056)			(0.026)
lnGlo_dj_tp		0.091***						-0.018		-0.140***
		(0.023)						(0.013)		(0.035)
Lib_RTA				0.863***		0.174***		0.167***	0.896***	
				(0.059)		(0.057)		(0.054)	(0.058)	
Lib_Tarif_df				-0.372***		0.157***			-0.366***	
				(0.090)		(0.055)			(0.088)	
ERV				-0.099*		-0.212***	-0.152***		-0.076	
				(0.057)		(0.048)	(0.044)		(0.048)	
lnGDPpc_diff					0.001			0.100***		0.033
					(0.022)			(0.019)		(0.022)
Metrop_node					0.216***	2.187***		2.419***	-0.370***	
					(0.072)	(0.402)		(0.383)	(0.069)	
Com_Lang			0.319***				0.254			0.259***
			(0.058)				(0.452)			(0.069)
Col_Link			-0.088				-0.092			-0.064
			(0.062)				(0.451)			(0.067)
Constant	-0.364	-6.957***	-0.941	-2.679***	-0.901*	4.524**	-3.372	3.491*	-4.383***	-7.248***
	(0.491)	(1.495)	(0.573)	(0.597)	(0.461)	(1.959)	(2.734)	(1.947)	(0.646)	(1.370)
Observation	46,340	29,280	46,340	30,820	46,340	30,820	30,800	41,960	30,820	29,280
Log-Pseudo Likelihood	-4.50E+12	-3.70E+12	-4.50E+12	-3.30E+12	-4.50E+12				-3.20E+12	-3.70E+12
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.95	0.95	0.95	0.96	0.95		No			
Prob > chi^2	0	0	0	0	0	0	0	0		
Wald chi^2	53978	63998	58664	56636	57811	29330	31544	22409		
AIC									2.09E+08	2.53E+08

Source: Own elaboration using STATA/MP Version 17. Explanatory variables are as defined in Table 3.1. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%. T represents the total trade model, estimated using PPML (as the primary estimator); HT and GPML are alternative estimators.

Estimates of globalization/institutional mechanisms

The main variables of interest in this part are the indicators that indirectly translate the impact of globalization. To interpret the importance of these variables, we must look at the primary specifications [PPML E-2A, E-4, T-2A, and T-4]. In specification E-2A, both provincial and partners' economic freedom exhibit statistically significant and positive coefficients on export performance, supporting the theoretical expectation that liberal economic institutions facilitate trade by reducing regulatory barriers and enhancing competitiveness. The estimated coefficient for provincial economic freedom is 2.4, while that of the trading partners is 0.39, indicating that, all else equal, greater economic freedom is associated with higher levels of provincial exports. These findings align with those of Beverelli, Keck, and Larch (2018) and are robustly confirmed by the GPML estimate (2.27), which is also significant at the 1% level. The alternative estimation, such as the HT model, yields mixed results: while partners' economic freedom remains positive and significant (0.40) at the 5% level, the provincial coefficient is unexpectedly negative (–0.29) and statistically insignificant, likely due to HT's limitations in handling zero-inflated trade data. This negative result aligns with an existing empirical study (e.g., Friedman, 2020). In the case of total trade (T-2A), the coefficient for provincial economic freedom is 0.91 and is statistically significant at the 1% level, whereas the coefficient for partners' economic freedom is 0.03. The specification T-2C coefficient for provincial economic freedom (0.86) closely mirrors the T-2A result, reinforcing the importance of institutional quality at the provincial level in shaping trade performance, as supported by Gwartney, Lawson, and Hall (2023). However, the effect of partners' economic freedom is less consistent: Specification T-2B reports a significant positive coefficient (0.29), whereas specification T-2C finds a negligible effect (0.01), suggesting that partners' institutions may be less influential when imports are included in the trade measure. Given HT's sensitivity to functional form and unobserved heterogeneity, greater interpretive weight is assigned to the PPML and GPML results. The positive and significant impact of provincial economic freedom on both exports and total trade is confirmed by both PPML and GPML estimations, reinforcing the policy implication that strengthening institutional quality and economic liberties within provinces fosters trade engagement. While partners' economic freedom is strongly significant in the exports model, its effect is marginal and statistically insignificant in the total trade model under the more reliable nonlinear estimators (PPML and GPML). This suggests that partner institutions may influence export market access more than import activity. The inconsistencies

and occasional negative signs in the HT results, especially for provincial-level indicators, underscore the limitations of using log-linear models that inadequately account for zero or missing trade flows. This further justifies the preference for PPML as the primary estimation strategy, with GPML serving as a robust nonlinear alternative.

The effect of the partners' globalization index is robust. The evidence indicates that the effect on exports is significantly positive by about 0.24, and the impact on total trade indicates a positive and significant coefficient of approximately 0.09. These findings suggest that greater integration of trade partners into the global economy, characterized by openness to international capital, trade, and information flows, substantially enhances their propensity to engage in bilateral trade with Canadian provinces. A higher globalization score implies fewer restrictions on trade and investment, more efficient cross-border logistics, and stronger institutional linkages with the global economy, all of which reduce transaction costs and increase market accessibility. The stronger effect observed in the export model underscores the particular importance of partner openness in facilitating Canadian provincial exports, where firms must navigate foreign regulatory environments, standards, and distribution channels. These results are in line with Dreher (2006), who finds that globalization positively impacts economic performance through expanded trade channels, especially when supported by domestic reforms. It also aligns with empirical findings that globalization fosters economic integration (Gygli et al., 2019). The implication is that the global connectivity of trade partners is not merely a background indicator but a strategic determinant of export success, and trade-boosting policies should prioritize engagement with globally integrated economies.

Estimates of liberalization mechanisms

The estimates of RTA and tariff measures sought to verify the hypotheses on the role of liberalization factors (as globalization mechanisms) on trade performance. The estimated presence of trade agreements and tariff measures also shows expected effects. The specifications E-4 and T-4 confirm a consistently large, positive, and statistically significant effect of RTA on exports and total trade, underscoring the pro-trade effects of formal trade agreements. The strongest effect is observed in the exports model, where RTA participation is associated with a coefficient above 1.28, indicating a major expansion of outbound trade, likely through tariff elimination, improved market access, and regulatory alignment. Total trade models also return significant coefficients (0.86), highlighting that RTAs facilitate not only outbound, but also

market openness and integration into global value chains. The positive and significant coefficients across all estimators in the total trade model imply that RTAs not only boost exports but also increase imports, suggesting a general trade-expanding effect rather than merely a redirection of trade. These estimates indicate that partners under trade agreements export significantly more than those outside such agreements, aligning with classical trade theory that emphasizes the role of preferential agreements in expanding market access and reducing transaction costs. Results from alternative specifications T-1B and T-3B also indicate positive and significant coefficients in total trade, while severely underestimating the export effect, indicating limitations in log-linear models and reinforcing the preference for PPML and GPML in trade contexts.

The tariff coefficient reflects the joint effect of tariff measures adopted by both trading partners on bilateral trade. As expected, the estimated coefficients for tariff differentials are generally negative, indicating that greater relative tariff burdens are associated with lower trade flows. The export coefficients are not statistically significant across the specifications, possibly due to the lower sensitivity of provincial exporters to partner-imposed tariffs in the studied period or due to export support mechanisms mitigating tariff effects (including new trade agreements). In the total trade model, coefficients near -0.37 suggest that tariff liberalization is broadly trade-enhancing. The significant effect on total trade and weak impact (-0.12) on the exports model implies the largest effect is found in the imports model, which is consistent with the notion that tariffs raise the cost of imported goods and discourage inward trade. The HT estimator yields positive coefficients across all models, which contradict theoretical expectations and the more robust nonlinear estimates.

The findings confirm **hypothesis 1B** by providing robust empirical evidence that RTAs, especially when paired with tariff liberalization, enhance provincial trade performance. This aligns with established trade theories, including:

- Vinerian customs union theory, which posits that trade creation (through lower internal tariffs) outweighs trade diversion under well-designed RTAs,
- New trade theory, which emphasizes economies of scale, network effects, and reduced uncertainty within regional agreements.

Further, the trade-promoting effects of trade agreements and tariff reductions are consistent with empirical studies such as Baier and Bergstrand (2007), who find that deep RTAs increase trade significantly over time, and Beverelli et al. (2018), who show that institutional and policy openness are key to realizing RTA benefits.

Since tariffs increase the cost of goods traded internationally, higher import and export duties create disincentives for trade. This confirms that high tariff levels reduce trade, even if they are balanced across both trading partners. Trade agreements such as the USMCA, the EU customs union, and ASEAN free trade agreements are successful because they eliminate tariffs on both sides, rather than selectively reducing them.

Estimates of other determinant variables

The estimation result for the ERV is mixed across estimations, indicating the ambiguity surrounding the impact of ERV on trade. The specifications [E-4 and T-4] shows that the impact of the ERV, as measured by the standard deviation of the average yearly exchange rates observed over 23 years is positive and statistically significant (0.17) for the export model, and significantly negative (-0.09) for the total trade model, suggesting that currency stability enhances export competitiveness while uncertain exchange rates deter imports (as a reflection of total trade component). The counterintuitive result for export may reflect:

- Depreciation-driven price competitiveness, where volatility coincides with weaker Canadian dollar periods, boosting export attractiveness. The flexible pricing strategies (e.g., pricing in the importer's currency) may allow exporters to benefit from volatility,
- Effective hedging strategies and contract structures that allow firms to manage currency risks. Hedging against volatility is costly, making imports more uncertain and expensive,
- High adaptability of exporting firms, which may be more experienced in navigating volatile environments. Firms relying on imported goods may reduce purchases to avoid financial losses from unfavorable exchange rate movements.

This finding is supported by the ERV result in specification E-1C. However, the estimated coefficients in specifications E-1B and E-2B, for the export model, show a significant negative effect (-0.32 and -0.24, respectively), aligning more closely with conventional theory. The net effect on total trade is slightly negative, not because both trade components shrink, but because imports are more adversely affected than exports are positively stimulated. Alternatively, specification T-1C is also negative but not statistically significant, indicating minor variation across estimations, which can be attributed to functional sensitivity. The negative impact on imports outweighs the positive effect on exports, leading to a net decline in overall trade.

Volatility dampens the consistency of trade flows, especially when provinces rely on imported goods for production. The relatively small overall impact also reflects the partial offset between export gains and import losses, supporting the interpretation that volatility distorts the composition of trade rather than eliminating it outright.

The next specifications (E-5 and T-5) evaluate the hypothesis on the role of metropolises in determining the performance of provincial trade. To analyze this, a dummy variable is introduced for provinces hosting MEGA 3 or 4 metropolises, in line with Brodzicki and Umiński (2017) and seminal work by ESPON (Duhr, 2005). The results indicate that the metropolitan status of exporting provinces is positively associated with export performance. Using E-5 as the primary specification, the export model returns a statistically significant coefficient of 0.31, suggesting that provinces with metropolitan characteristics, such as advanced infrastructure, industrial diversification, and greater integration with global markets, contributed to higher export volumes. This finding is consistent with expectations about urban economic agglomeration fostering outward trade (e.g., Brakman, Garretsen, and van Marrewijk, 2009; Hanson, 2010; Crozet & Koenig, 2010). This direction is supported by alternative specifications E-1B and E-3B with strong statistically significant coefficients (1.86 and 2.28, respectively). The alternative [E-1C] estimate (0.09) is also positive but statistically insignificant, indicating some sensitivity across specifications. Nonetheless, the E-5 result remains robust and affirms metropolitan provinces as key nodes in export facilitation.

In the total trade model, the T-5 coefficient remains positive and significant (0.22), indicating that metropolitan provinces are also more engaged in aggregate trade activity. However, the magnitude of this effect is lower than in the export model, which may reflect the influence of the import component. Specifically, metropolitan provinces, while strong in exports, may rely less on imports due to higher local production capacity or self-sufficiency in intermediate goods, thereby dampening total trade gains. This finding is strongly supported by specifications T-1B and T-3B, which proved a strong positive effect (2.19 and 2.42, respectively), while specification T-1C returns a significant negative estimate, indicating estimator sensitivity. On balance, the PPML [T-5] estimates provide the most reliable evidence that metropolitan status significantly enhances trade through export dominance. In contrast, its effect on total trade is moderated by comparatively lower import dependence.

The results also reveal an asymmetric effect of GDPpc differences on provincial trade flows. In the exports model, the coefficient (–0.15) captured in specification E-5 is negative and significant, indicating that provinces are more likely to export to partners with similar income

levels. This finding is consistent with the Linder hypothesis, which posits that trade in differentiated products is more intense between economies with comparable levels of development. While the result from the HT estimation [E-3B] reports a significant positive coefficient (0.08) and GPML [E-2C] yields an insignificant positive estimate (0.04), the superior robustness of the T-5 result for trade analysis lends greater credibility to the negative relationship, underscoring the importance of economic similarity in export performance. For total trade, however, the coefficient captured in the T-5 estimate is small and statistically insignificant (0.001), reflecting the offsetting effects of export aversion and import attraction due to income differences. This finding aligns with traditional comparative advantage theory, where countries benefit from importing goods produced more efficiently in lower-income economies. Generally, these findings highlight the asymmetric influence of income disparity on different trade flows, constraining exports while promoting imports, thus underscoring the importance of distinguishing between trade components when evaluating the developmental dimensions of trade patterns.

Alternative size (population) estimations

To evaluate the robustness of the findings, an alternative specification of the gravity model was estimated using population instead of GDP as a measure of economic size (see **Appendix 1B** for the estimated results). Several studies have employed population as a proxy for economic size in place of GDP (e.g., Sehic, 2015; Frankel & Romer, 1999), arguing that it may more accurately reflect the scale of potential labor markets and consumer base factors that can significantly influence trade flows, especially in the context of international demand. This alternative approach helps assess the sensitivity of the estimated relationship between economic size and trade to changes in the size variable and other explanatory factors. Moreover, using population as a control for economic size reduces potential bias, as trade volume is more directly linked to GDP as an accounting identity. In contrast, population offers a conceptually distinct measure less prone to endogeneity concerns. Nevertheless, GDP is employed as the primary measure of economic "mass" in the gravity equation because it captures both production capacity and purchasing power, which jointly determine trade flows. This practice follows the standard formulation of the gravity model in international trade (Tinbergen, 1962; Anderson & van Wincoop, 2003) and is supported by extensive empirical evidence demonstrating that GDP-based measures consistently outperform population in explaining bilateral trade values (Baier

& Bergstrand, 2007; Head & Mayer, 2014). Population-based estimates are nevertheless reported as robustness checks to illustrate that the key coefficients and policy implications remain qualitatively stable under alternative size specifications.

In our estimations, the modification does not invalidate the initial results (both for the export and total trade models in Table 4.3 and Table 4.4); rather, the estimated alternative method is more robust for preserving the significance of all explanatory variables of interest. Both the openness variable (economic freedom, and partners' globalization index) and liberalization factors (RTA and tariff measures), including the metropolitan nodes and ERV remain statistically significant, with parameter estimates larger than the baseline specification (though the estimates point out to slightly smaller impact of partners' globalization index on exports and negative relationship with imports). The tariff coefficient became positive across models and their respective specifications. For exports, this can reflect the case of 'tariff escalation and export promotion', indicating that if tariffs are higher on raw materials but lower on processed goods, domestic firms may shift toward exporting higher-value-added goods, leading to an observed positive relationship between tariffs and exports. Secondly, estimates of total trade and population as size variables seem to be more robust. However, the results for tariff measures proved somewhat challenging, as the coefficient of the parameter estimate by the variable returned a positive sign, providing a shred of evidence that suggests reverse causality in tariff rises due to responses to growing imports. The two trade models also yield similar parameter estimates for colonial links, which correspond in signs with the baseline total trade model.

4.2.2 Gravity of provincial trade and non-linear determinants – empirical estimates

Economic disparity (measured by GDPpc difference) between trading partners impacts the magnitude of the links between globalization mechanisms (such as RTA, tariff measures, and ERV) and trade. Estimating the modified baseline model specified in Equation (2), which incorporates selected non-linear factors, allows for the testing of hypothesis 1_C and offers additional insight into the broader hypothesis 1.

The estimation results show that the interaction between GDPpc difference and trade agreements exerts a significant negative effect on export performance, with a coefficient of approximately -0.28. This suggests that the trade-enhancing effects of RTAs are diminished

when Canadian provinces engage with partners whose income levels differ substantially, aligning with the Linder hypothesis, which posits that trade in differentiated goods is more likely between economically similar regions. The result implies that even under preferential trade conditions, structural dissimilarities, such as regulatory divergence, demand preferences, and institutional gaps, may limit the ability of provinces to capitalize on export opportunities fully. In the total trade model, the interaction term remains negative and significant at approximately (-0.20), but the estimated effect is smaller in magnitude than in the export model. This occurrence may reflect the offsetting influence of imports, which are less sensitive to income similarity and often driven by cost-efficiency or comparative advantage. As such, the presence of dissimilar trade partners may still foster import flows under trade agreements, thereby moderating the overall negative effect observed in exports. These findings underscore the importance of structural compatibility and institutional alignment in ensuring that the benefits of trade liberalization are fully realized, particularly in terms of outward trade performance. A major reinforced view is that 'deep integration', not just tariff elimination, is key to effective trade relationships. These results align with empirical literature indicating that economic similarity enhances the performance of trade agreements (e.g., Beverelli, Keck, & Larch, 2018), as well as theories suggesting that the effectiveness of trade agreements depends not just on tariff reductions but also on institutional and developmental proximity. Trade agreements with high-income partners may provide less trade benefit to lower-income provinces if the latter cannot fully leverage market access opportunities, or vice versa.

The results indicate that the interaction between GDPpc difference and tariff measures significantly dampens export performance with a (-108) coefficient in the export model. This suggests that the negative effect of tariffs on provincial exports is amplified when trading with partners of dissimilar income levels, possibly due to greater institutional frictions, market incompatibility, or heightened sensitivity to trade costs in structurally distant economies. These findings support the notion that tariff barriers are particularly restrictive when economic differences exist, thereby limiting the ability of firms to penetrate foreign markets under such conditions. In the total trade model, the interaction effect remains negative (-0.12) but is statistically insignificant, indicating a weaker and less consistent relationship. This episode likely reflects the offsetting effect of imports, where the influence of GDPpc disparity on tariff sensitivity may differ from that observed in exports. In particular, imports may be more resilient to tariff costs when sourced from lower-income countries offering essential or cost-competitive goods, thereby weakening the overall trade-diminishing effect captured in the aggregate model.

As such, the discrepancy between export and total trade estimates underscores the importance of disaggregating trade flows, as the dynamics of structural dissimilarity and policy instruments like tariffs can affect exports and imports in fundamentally different ways. These findings demonstrate that income disparity modifies the trade response to tariffs and that the effect is asymmetric across trade flows. In the export context, high income differences exacerbate the trade-suppressing impact of tariffs, likely due to compounded market access challenges. As earlier mentioned, the non-significant effect in the total trade model highlights the importance of disaggregating trade flows when assessing the nuanced impact of structural and policy variables.

The estimation results reveal that the interaction between GDPpc difference and ERV has a statistically significant negative effect on exports, with a coefficient of -0.59. This suggests that exchange rate instability becomes more detrimental to export flows when Canadian provinces trade with economically dissimilar partners. In such cases, greater structural and institutional differences may compound the uncertainty caused by volatile currency movements, raising transaction costs and limiting firms' ability to manage price risk or maintain competitiveness. The finding aligns with theoretical expectations that economic asymmetry exacerbates the challenges posed by macroeconomic volatility, particularly in markets where risk-mitigation tools may be less accessible or effective.

Table 4.5 Panel gravity estimations of the non-linearities in trade-globalization links

Variable/Specification	Export [1]	Export [2]	Export [3]	Trade [1]	Trade [2]	Trade [3]
lnGDP_pr	0.861***	0.896***	0.841***	0.971***	1.014***	0.962***
	(0.022)	(0.020)	(0.020)	(0.016)	(0.015)	(0.014)
lnGDP_tp	1.267***	1.134***	1.239***	1.109***	1.063***	1.090***
	(0.035)	(0.021)	(0.033)	(0.018)	(0.013)	(0.015)
lnDistance	-0.412***	-0.274***	-0.451***	-0.609***	-0.437***	-0.624***
	(0.062)	(0.053)	(0.057)	(0.038)	(0.030)	(0.034)
lnGDPpc_diff	1.056***	0.164***	0.035	0.149	0.188***	0.209***
	(0.281)	(0.033)	(0.034)	(0.222)	(0.029)	(0.032)
Lib_RTA		3.886***			2.854***	
		(0.407)			(0.346)	
lnIneq_RTA		-0.276***			-0.203***	
		(0.039)			(0.034)	
Lib_Tarif_df	2.329***			0.202		
	(0.558)			(0.441)		
lnIneq_tarif_dif	-1.084***			-0.120		
	(0.284)			(0.222)		
ERV			6.536***			13.190***
			(1.786)			(1.985)
lnIneq_ERV			-0.589***			-1.264***
			(0.164)			(0.186)
Com_Lang	0.102	0.288***	0.305***	0.175**	0.260***	0.322***
	(0.095)	(0.069)	(0.073)	(0.075)	(0.058)	(0.057)
Col_Link	0.744***	0.401***	0.567***	0.096	-0.148**	-0.120*
	(0.102)	(0.073)	(0.091)	(0.077)	(0.059)	(0.061)
Constant	-6.976***	-6.912***	-4.602***	-1.764*	-4.858***	-2.939***
	(1.633)	(0.955)	(1.094)	(0.956)	(0.639)	(0.601)
Observation	30,820	46,340	45,970	30,820	46,340	45,970
Log-Pseudo Likelihood	-2.00E+12	-2.00E+12	-2.30E+12	-3.60E+12	-4.00E+12	-4.40E+12
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.95	0.96	0.95	0.95	0.95	0.95
Prob > chi^2	0	0	0	0	0	0
Wald chi^2	33397	55720	35955	56565	75563	63727

Source: Own elaboration. The main explanatory variables of focus include the log interaction between GDPpc difference and RTAs (InIneq_RTA), the log interaction between GDPpc difference and tariff difference (lnIneq_tarif_dif), and the log interaction between GDPpc difference and ERV (lnIneq_ERV). Exports and total trade models are estimated using the PPML with high-dimensional time fixed effects. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%

In the total trade model, the interaction term remains negative and statistically significant, with a larger coefficient of (-1.26) indicating a stronger adverse effect on aggregate trade flows. This greater magnitude likely reflects the influence of the import component, which is especially vulnerable to exchange rate fluctuations when sourced from income-dissimilar partners. Unlike exporters, importers may have limited flexibility to adjust prices or hedge against currency risk, particularly when importing essential or price-sensitive goods. The difference in magnitude of effect between exports and total trade highlights that the negative

impact of ERV under conditions of income disparity is driven in part by the heightened sensitivity of imports, reinforcing the need to disaggregate trade flows when assessing macroeconomic and structural determinants of trade performance. These findings are consistent with both transaction cost economics and gravity-based trade theory, which suggest that macroeconomic volatility and structural distance jointly increase the friction of cross-border transactions. ERV alone may hinder trade, but its impact is significantly magnified when income levels and, by extension, institutions, demand structures, and financial maturity differ substantially. This aligns with empirical research showing that volatility is more detrimental in asymmetric partnerships, especially where currency fluctuations cannot be managed through established financial instruments or policy credibility is weak.

4.2.3 Heterogeneous effect across provinces

Common patterns across provinces

Across all provinces, provinces' and partners' economic size (GDP) are consistently positive and significant, confirming that larger economies trade more. Distance exerts a strong negative effect everywhere, showing that trade costs remain a critical barrier at the provincial level. Differences in GDP per capita are negative and significant, indicating that provinces export more intensively to partners with similar income levels (supporting the Linder hypothesis). The provinces and partners' economic freedom indices are positive across provinces, reflecting that liberal economic institutions enhance both exports and total trade. Likewise, the partners' globalization index is strongly positive for all provinces, underlining the role of partners' openness in facilitating trade.

RTAs have large and significant coefficients in most provinces, especially Ontario, Alberta, and Quebec, indicating that preferential agreements substantially boost provincial trade performance. Tariff measures are generally negative, strongly so in the Atlantic provinces and Manitoba, implying that higher tariffs sharply dampen trade. ERV effects are mixed but mostly negative and significant for imports, highlighting the sensitivity of provincial trade to currency fluctuations.

Western provinces (AB, BC, MB, and SK)

The Western provinces generally show strong positive effects from provincial economic freedom and partner globalization index, with large RTA gains in Alberta and British Columbia, and moderate but significant effects in Saskatchewan and Manitoba. Manitoba exhibits weaker RTA effects than Alberta or BC but stronger negative tariff effects, indicating its exports are more vulnerable to tariff barriers. ERV is mild in Alberta and BC but more negative in Saskatchewan and Manitoba because of their agricultural and manufacturing composition. Alberta continues to display a strong and significant metropolitan coefficient, underscoring the importance of urban agglomeration effects in facilitating trade.

Central provinces (ON and QC)

Ontario and Quebec display the strongest positive coefficients for RTAs and partners' economic openness in both export and total trade models, confirming their central role in global value chains (automotive, aerospace, high-tech). Ontario's RTA coefficient in the export model (5.57) is particularly high, reflecting deep integration with U.S. and EU markets, as well as diversification efforts towards the Asia-Pacific. ERV is modest and positive in Ontario but negligible in Quebec. Ontario and Quebec also show the highest metropolitan coefficients, aligning with the view that urban agglomeration fosters trade. Historical factors such as common language and colonial links are all highly significant, consistent with their diverse export portfolios and integrated supply chains

Atlantic provinces (NB, NL, NS, PE)

The Atlantic provinces generally show smaller RTA effects and much stronger negative tariff differentials and ERV coefficients than central or western provinces. For example, Nova Scotia's total trade model records a large negative ERV coefficient (-12.41), indicating high vulnerability to exchange rate instability. Tariff effects are sharply negative across the Atlantic provinces (-1.44 to -6.68), reflecting their reliance on imported intermediate goods and limited diversification of exports. Prince Edward Island shows the weakest economic size (GDP) coefficient and an extreme ERV effect in the exports and total trade models, underscoring its structural vulnerability. These patterns suggest that Atlantic provinces benefit less from RTAs and are more exposed to tariff and currency shocks.

Cross-cutting determinants

Metropolis effects are significant and positive for the large provinces (Ontario, Alberta, Quebec), reinforcing the finding that urban economic agglomeration enhances trade. Common language and colonial ties are mostly insignificant or weak, implying these historical links are less decisive than institutional quality and market size. Remoteness terms are negative across all provinces, confirming that geographic isolation reduces trade intensity.

Interpretively, the province-level breakdown reveals distinct comparative advantages and vulnerabilities. Ontario and Quebec derive the largest gains from RTAs, partners' economic openness, and metropolitan agglomeration. Western provinces also benefit from these factors but show more mixed responses to tariffs and ERV due to commodity-heavy trade profiles. The Atlantic provinces remain most exposed to external shocks, with weaker institutional linkages and heavier reliance on traditional export markets. These heterogeneities underscore the dissertation's core hypothesis that globalization affects provinces differently, and that policy measures such as RTAs, tariff liberalization, exchange rate stabilization, and investment in metropolitan hubs must be tailored to provincial contexts.

The heterogeneity uncovered in Canadian provincial trade patterns mirrors findings from European research on regional integration and firm export behaviour. Komornicki (2011) documents strong spatial disparities in Polish regions' participation in global markets, while Gajewski (2017) highlights differing export drivers across Eastern and Western Poland. Similarly, Michałek (2012) shows that policy frameworks, such as currency unions, can alter regional trade flows. These parallels suggest that the uneven effects of globalization observed in Canada are not unique but reflect broader processes documented in other jurisdictions, reinforcing the need for regionally tailored trade and innovation policies.

Table 4.6 summarizes each province's key strengths, vulnerabilities, and suggested policy focus which are explained in detail in the next chapter.

Table 4.6 Provincial trade profiles: strengths, vulnerabilities, and policy focus

Province	Key Strengths	Key Vulnerabilities	Suggested Policy Focus
Ontario	Strong positive RTA effect; robust metropolis-node benefits; high integration into automotive & high-tech GVCs.	Moderate sensitivity to tariff barriers in some sectors; exposure to U.S. policy shifts.	Maintain and expand preferential access; support SME export finance; invest in innovation clusters and logistics hubs.

Quebec	Large RTA gains; positive metropolis effects; strong performance in aerospace/high-tech exports.	Limited market diversification beyond the U.S.; moderate ERV sensitivity.	Strengthen non-U.S. market linkages; develop specialized innovation clusters; upgrade port and airport infrastructure.
Alberta	High RTA and globalization index effects; benefits from metropolitan agglomeration in energy and agri-food.	High exposure to commodity prices and ERV volatility; uneven gains across sectors.	Diversify export markets; expand commodity hedging and logistics resilience; develop value-added processing.
British Columbia	Significant partner globalization effect; strategic Pacific gateway position.	Sensitivity to port congestion and distance; moderate ERV exposure.	Modernize port infrastructure; support SME readiness for Asian markets; invest in green shipping and innovation clusters.
Saskatchewan	Positive globalization and economic-freedom effects; resource export strength.	Negative tariff effect; limited metropolis benefits; moderate ERV sensitivity.	Expand agri-food processing; improve transport corridors; strengthen R&D in agri-tech and clean fertilizers.
Manitoba	Positive economic-freedom effect; diversified manufacturing base.	High tariff sensitivity; weak metropolis-node effect; strong ERV vulnerability.	Launch SME export-readiness programs; invest in digital trade infrastructure; diversify beyond U.S. markets.
New Brunswick	Positive effect from partner openness; potential in ocean-tech exports.	High ERV vulnerability; weak RTA gains; high transport costs.	Improve port efficiency; offer hedging/trade finance support; diversify into renewable energy and ocean-tech.
Nova Scotia	Some positive effects from partner openness; seafood/ocean-tech niche.	Large negative distance coefficient; ERV vulnerability; limited metropolis effect.	Upgrade port and cold-chain infrastructure; expand SME support for risk management; foster high-value marine exports.
Newfoundland & Labrador	Resource export base; some globalization benefits.	Strong ERV and distance sensitivity; limited diversification; weak metropolis effects.	Support risk management for energy/fisheries exporters; invest in renewable energy export infrastructure; strengthen workforce skills.
Prince Edward Island	Niche agri-food exports: potential for SME scaling.	Extremely high ERV vulnerability; narrow export base; tariff exposure.	Provide hedging and certification micro-grants; scale up small exporters; develop logistics hubs to reduce shipping costs.

Source: Own elaboration

4.2.4 Stylized counterfactual policy scenarios

This subsection presents two counterfactual policy scenarios drawn from the baseline gravity model to complement the empirical estimates in the preceding sections. These scenarios translate estimated coefficients into tangible outcomes, illustrating how key policy measures may influence provincial trade performance under alternative conditions. By simulating the

withdrawal of a major liberalization mechanism and a substantial rise in macroeconomic instability, the analysis provides an intuitive framework for assessing the sensitivity of provincial exports and total trade to external shocks. This approach both deepens the interpretation of the model's results and underscores their policy relevance by highlighting the potential effects of changes in trade agreements and exchange rate stability. Specifically, the analysis examines two scenarios: (i) a counterfactual in which Canada does not participate in RTAs and (ii) a scenario in which ERV rises by 50% relative to current levels.

Scenario 1: Withdrawal from RTAs

Based on the preferred PPML estimates, the removal of Canada's trade agreements with its major partners would result in a dramatic contraction of provincial trade flows. In the export model, the coefficient for RTAs translates into roughly a 70% drop in exports if such agreements were withdrawn, while total trade (exports plus imports) would fall by approximately 60%, holding constant other determinants such as distance, market size, and partners' institutional quality. This magnitude is consistent with large "formal integration" effects, tariff elimination, rules-of-origin certainty, dispute settlement, regulatory alignment, and scale economies along cross-border value chains. In practice, ending the agreements would also raise effective trade costs through renewed tariff exposure (with the total-trade tariff semi-elasticity estimated at -0.37) and higher policy uncertainty, so realized losses could exceed the partial effect above. The contraction would be uneven across provinces and sectors: those deeply embedded in automotive, aerospace, and agri-food global value chains (Ontario, Quebec, and the Prairie energy and agriculture sectors) would experience the largest declines, while more domestically oriented or services-heavy provinces may experience smaller proportional effects. Import compression arising from non-tariff frictions and rules-of-origin slippage would likely amplify the fall in total trade relative to exports. To mitigate such losses, governments could expand mutual-recognition arrangements, improve border procedures, offer export-credit support to firms, and develop new standards or trade-facilitation measures to substitute for lost disciplines formerly embedded in RTAs.

Scenario 2: Higher ERV

The PPML estimates also indicate that a 50% rise in ERV would modestly reduce total trade flows by about 4 percent overall while exerting a more ambiguous effect on exports. In the main

export model, the coefficient suggests exports might rise slightly (around 7%) because periods of a weaker Canadian dollar enhance price competitiveness; however, in alternative specifications, the effect is negative (between -9 and -12%), implying that greater volatility probably reduces exports as well, but with considerable sectoral variation. The negative impact on total trade is driven largely by import sensitivity to exchange rate swings, which increase input costs and uncertainty, leading firms to delay or reduce purchases of imported goods. Exporters of primary commodities may benefit from a weaker currency, but manufacturers dependent on imported parts and materials face tighter margins and higher production costs. Policy measures to contain these risks include improving access to hedging instruments for small and medium-sized enterprises, promoting stable-currency invoicing for long-term contracts, creating liquidity backstops for trade finance, and streamlining customs and logistics to reduce the non-price frictions that ERV tends to magnify.

Synopsis of the baseline vs counterfactual scenarios

The synopsis illustrates the baseline and counterfactual scenarios for the RTAs and ERV estimates. For ease of interpretation, the results are presented in index form, with the baseline scenario (current conditions) normalized to 100. Values below 100 indicate a reduction in trade relative to the baseline, while values above 100 indicate an increase. This format allows the magnitude of change under each counterfactual scenario to be easily compared with current trade performance. The indices reveal the relative importance of trade agreements and exchange rate stability for provincial trade performance. In the absence of RTAs, the export index falls from 100 to 28, a contraction of approximately 70%, while total trade drops to 42, or about 60 percent below the baseline. This sharp decline underscores the pivotal role of preferential market access, tariff elimination, and regulatory alignment in sustaining Canadian provincial exports and total trade. By contrast, a 50% rise in ERV produces more moderate but still significant effects: the export index declines to 93 and total trade to 96, reflecting the costs of heightened uncertainty, price fluctuations, and hedging requirements. The steeper reduction in exports compared to total trade in both scenarios highlights how external market access and stable currency conditions disproportionately affect outbound trade. Collectively, these findings demonstrate that preserving and deepening trade agreements remains the most powerful policy lever for maintaining provincial trade competitiveness, while measures that mitigate exchange rate risk, such as hedging facilities, stable-currency invoicing, or improved trade finance, can

help cushion the adverse effects of currency volatility. A table summary of the scenarios is shown below.

Scenario	Export Index (Baseline = 100)	Total Trade Index (Baseline = 100)
Baseline (current conditions)	100 (100%)	100(100%)
No RTAs	28 (≈ –70%)	42 (≈ –60%)
ERV +50% (central estimate)	93 (≈ –7%)	96 (≈ –4%)

Note: Alternative export specifications under ERV +50% show effects between –9% and –12%.

These counterfactuals point to two complementary policy priorities. First, maintaining and deepening comprehensive trade agreements is essential to protect the competitiveness of Canadian provinces, especially those embedded in cross-border supply chains such as automotive, aerospace, and energy. Preserving preferential access and minimizing regulatory divergence should therefore remain at the forefront of federal and provincial trade strategies. Second, as ERV increasingly affects production costs and contract stability, governments can strengthen risk-management tools for firms by improving access to affordable hedging, promoting stable-currency invoicing for long-term contracts, and expanding trade-finance and insurance mechanisms. Together, these measures would not only mitigate vulnerability to macroeconomic shocks but also enhance the resilience and inclusiveness of Canada's provincial trade performance in the evolving global economy.

Summary of findings and corresponding hypotheses

This analysis highlights the profound influence of globalization on provincial trade by examining the effect of key factors such as partners' degree of economic freedom and openness, liberalization mechanisms, and metropolitan status.

First, the results indicate that economic freedom of both provinces and trading partners significantly facilitates export growth and total trade (hypothesis 1_A). Increased globalization among trading partners also enhances both exports and imports. The findings further established the influence of globalization in shifting trade composition, particularly in import patterns. The result also revealed that while liberalization factors, such as RTAs, have contributed to increasing globalization of the world economy, enhancing trade performance, the adverse effect of tariff measures on trade performance has continuously undermined this effort, reducing both exports and imports (hypothesis 1_B), reinforcing the trade-restricting effect of tariffs. ERV has a mixed effect, stimulating exports but discouraging total trade due to uncertainty (hypothesis

1_C). The role of metropolises as export hubs and the importance of stable exchange rates further highlight the structural effects of globalization. From the findings, metropolitan status strongly influences trade performance (hypothesis 1_D), with major cities significantly increasing exports and total trade while reducing import reliance, suggesting that metropolitan hubs enhance domestic production capacity. In terms of the effect on exports and total trade, these findings are consistent with the results of Brodzicki and Umiński (2017). The unexpected negative coefficient on the colonial link variable reflects institutional decay and shifting global trade patterns. While colonial-era institutions initially facilitated trade, their weakening alongside structural economic shifts has contributed to a decline in trade intensity between former colonies. This underscores the need for institutional modernization and diversified trade strategies in the new globalization paradigm. The result also captured remoteness as an insignificant barrier to trade, highlighting globalization, the increasing dominance of technology, global supply chains, and trade liberalization in shaping modern trade patterns. Robustness checks using alternative estimations and variables confirm the stability of these findings. These results highlight the importance of economic openness, trade agreements, and metropolitan infrastructure in driving trade performance while emphasizing the potential constraints imposed by tariffs and exchange rate fluctuations.

Second, consistent with expectations and many other studies, trade between partners with economic disparities is overly sensitive to economic risks. The findings indicate that trade agreements and tariff measures, including ERV, have stronger negative effects when income disparities are high, revealing that trade flows between economies with large income gaps are extremely sensitive to both liberalization measures and financial instability triggered through the ERV. While the induced-tariff measures produced significant effects on exports rather than on total trade flows, the induced-trade agreement and ERV consistently reduce exports and total trade, highlighting how macroeconomic uncertainty disproportionately harms trade between unequal economies, with instability manifesting as a bigger barrier to trade than protectionist policies for trading partners with significant GDPpc differences. These findings highlight a key fragility in globalization as trade integration is significantly disrupted by trade diversion and financial uncertainty for partners with income disparities.

The findings underscore the significant role of globalization mechanisms in shaping provincial trade performance (hypothesis 1). Economic openness, trade agreements, and metropolitan influence all contribute to increased exports and total trade, while higher tariffs and ERV present challenges to trade. The results highlight the benefits of RTAs and economic

integration, reinforcing the importance of policies that enhance market access and trade facilitation. Robustness checks confirm the reliability of these conclusions, emphasizing the need for strategic trade policies to maximize globalization's benefits.

4.2.5 Gravity of Canada-U.S. trade – the border effect estimates

The results of gravity regressions for all forms of trade between Canadian provinces and the U.S. states are shown in [Table 4.8-4.10]. An empirical analysis was performed on exports, imports, and total trade. Discussions of the results are provided simultaneously since the models and resulting specifications are similar for all trade directions. As already mentioned, the estimates of the border effect between Canada and the United States were analyzed using 2002-2020 data.

Estimates of the standard gravity variables

Turning to the estimates, the result indicates that raising the GDP associated with Canadian provinces by 1% increases bilateral trade with the U.S. states by 0.91%. A 1% increase in the GDP of U.S. states is associated with about a 0.88% increase in bilateral trade with the Canadian provinces. Distance has a strong dampening effect on trade: a 1% increase in distance between two regions lowers the trade between them by approximately -0.81%.

Table 4.7 The gravity analysis of the border effects on Canada-U.S. total trade

SPECIFICATIONS / VARIABLES	(**T1**) Aggregate border effects	(**T2**) Border effects with the controls for borderland location	(**T3**) Border effects with the controls for borderland location and GDP per capita difference	(**T4**) Border effects with the controls for borderland location, GDP per capita difference, and tariffs	(**T5**) Border effects with the controls for borderland location, GDP per capita difference, tariffs, and exchange rate	(**T6**) Border effects with the controls for borderland location, GDP per capita difference, tariffs, exchange rate, and economic freedom
lnGDP_pr	0.909***	0.938***	0.936***	0.937***	0.937***	0.896***
	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.015)
lnGDP_us	0.875***	0.885***	0.886***	0.886***	0.888***	0.893***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)
lnDistance	-0.807***	-0.583***	-0.582***	-0.582***	-0.583***	-0.649***
	(0.044)	(0.034)	(0.034)	(0.034)	(0.034)	(0.036)
Border	-1.964***	-2.194***	-2.197***	-2.159***	-2.101***	-2.130***
	(0.029)	(0.023)	(0.024)	(0.040)	(0.049)	(0.047)
Cross_border		1.063***	1.064***	1.064***	1.065***	0.987***
		(0.057)	(0.056)	(0.056)	(0.056)	(0.053)
lnGDPpc_diff			-0.018	-0.017	-0.015	-0.033**
			(0.014)	(0.014)	(0.014)	(0.015)
Tariff_diff				-0.246	-0.051	-0.120
				(0.205)	(0.221)	(0.211)
Exch_rate					-0.442**	-0.631***
					(0.192)	(0.179)
Ec_fredom_pr						0.974***
						(0.119)
Ec_fredom_us						0.519***
						(0.086)
lnRM_HD_x	-0.052**	-0.043**	-0.043**	-0.043**	-0.042**	-0.040**
	(0.021)	(0.018)	(0.018)	(0.018)	(0.017)	(0.017)
lnRM_HD_m	-0.014	-0.010	-0.008	-0.009	-0.009	-0.009
	(0.027)	(0.022)	(0.022)	(0.022)	(0.022)	(0.021)
Constant	0.306	-1.902***	-1.745***	-1.760***	-1.360***	-11.905***
	(0.349)	(0.351)	(0.383)	(0.384)	(0.416)	(0.999)
Observations	11,400	11,400	11,400	11,400	11,400	11,210
R^2	0.8215	0.8538	0.8539	0.8542	0.8542	0.862
Border Effects	**7.1**	**8.9**	**9.0**	**8.7**	**8.2**	**8.4**

Source: Own calculations. Explanatory variables are as defined in Table 3.2; the key explanatory variable of focus is the border effect dummy (Border). All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed effects (PPML-HDFE) method, using the robust covariance matrix. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1% estimated using STATA/MP Version 17. **T** is the acronym for Total Trade. The border effects are calculated as an exponential function [exp (*)] of the estimated coefficients

Estimates of the border effect

After controlling for the size of an economy and the distance between the capitals of cities, bilateral trade between Canadian provinces is, on average, 7.1 times larger than trade between Canadian provinces and U.S. states. This represents a decline of 21.1 per cent from comparable estimates in Suvankulov's (2015) study that used panel data from 2001-2010. This amount of border effects indicates some levels of home bias in trade, meaning that Canadian provinces trade disproportionately more with each other than with U.S. states, despite shared

economic ties and trade agreements. Specifically on the directions of trade, the result indicates that. In contrast, Canadian provinces export to each other six times more than they export to U.S. states, and the provinces import about 8.7 times more from other provinces than from U.S. states after controlling for standard trade determinants (economic size and distance). This suggests that import barriers are stronger than export barriers. The asymmetry suggests that while Canadian firms do export to the U.S., they are even more reliant on domestic sources for imports, reflecting higher trade barriers for inbound goods.

Compared to other previous studies, these findings reflect declining trade frictions at the border. The estimated border effects of 6.0 for exports, 8.7 for imports, and 7.1 for total Canada-U.S. bilateral trade are lower than estimates from the existing literature from the 1980s and 1990s, once again indicating a decline in the home bias for trade by Canadian provinces. The result is even more encouraging because this specification integrates trade flows from all 50 U.S. states plus the District of Columbia (DC) as a separate state instead of only the 30 largest or adjacent U.S. states or 50 states considered in the existing literature. The parameter estimates for the Canada-U.S. border effect for the exports, imports, and total trade are significantly smaller than the results by Query (2014) and Suvankulov (2015), two of the few existing studies that feature a full set of 50 U.S. states. Clearly, some of the reduction in the border effects is driven by the realization of the full consequences of NAFTA/USMCA. 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/USMCA and that the economies were already well integrated before the agreement was ratified. The estimates of the remoteness indexes are negative and small across specifications, confirming that, all else equal, Canadian provinces are open to both interprovincial and international trade.

Table 4.8 The gravity analysis of the border effects on the Canadian exports to the U.S.

SPECIFICATIONS/ VARIABLES	(**E1**) Aggregate border effects	(**E2**) Border effects with the controls for the borderland location	(**E3**) Border effects with the controls for borderland location and GDP per capita difference	(**E4**) Border effects with the controls for borderland location, GDP per capita difference, and tariffs	(**E5**) Border effects with the controls for borderland location, GDP per capita difference, tariffs, and exchange rate	(**E6**) Border effects with the controls for borderland location, GDP per capita difference, tariffs, exchange rate, and economic freedom
lnGDP_pr	0.836***	0.868***	0.871***	0.872***	0.872***	0.807***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.020)
lnGDP_us	0.885***	0.899***	0.898***	0.899***	0.901***	0.913***
	(0.017)	(0.018)	(0.018)	(0.018)	(0.018)	(0.017)
lnDistance	-0.757***	-0.470***	-0.472***	-0.472***	-0.473***	-0.556***
	(0.058)	(0.046)	(0.047)	(0.047)	(0.046)	(0.049)
Border	-1.794***	-2.078***	-2.072***	-2.022***	-1.950***	-1.964***
	(0.035)	(0.030)	(0.031)	(0.054)	(0.066)	(0.067)
Cross_border		1.283***	1.278***	1.278***	1.278***	1.183***
		(0.068)	(0.069)	(0.069)	(0.070)	(0.068)
lnGDPpc_diff			0.035*	0.036*	0.038*	0.008
			(0.020)	(0.020)	(0.021)	(0.020)
Tariff_diff				-0.320	-0.074	-0.112
				(0.283)	(0.303)	(0.298)
Exch_rate					-0.552**	-0.659***
					(0.254)	(0.244)
Ec_fredom_pr						1.348***
						(0.161)
Ec_fredom_us						0.318***
						(0.112)
lnRM_HD_x	-0.068**	-0.058**	-0.058**	-0.057**	-0.056**	-0.054**
	(0.027)	(0.024)	(0.024)	(0.024)	(0.024)	(0.023)
lnRM_HD_m	-0.004	-0.001	-0.004	-0.005	-0.005	-0.004
	(0.035)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
Constant	0.140	-2.635***	-2.939***	-2.958***	-2.455***	-14.016***
	(0.494)	(0.481)	(0.526)	(0.528)	(0.559)	(1.283)
Observations	11,400	11,400	11,400	11,400	11,400	11,210
R^2	0.729	0.776	0.777	0.777	0.777	0.788
Border Effect	**6.0**	**7.9**	**7.9**	**7.6**	**7.0**	**7.1**

Source: Own calculations. Explanatory variables are as defined in Table 3.2; the key explanatory variable of focus is the border effect dummy (Border). All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed Effects (PPML-HDFE) method, using the robust covariance matrix. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%, estimated using STATA/MP Version 17. **E** is the acronym for Exports. The border effects are calculated as an exponential function [exp (*)] of the estimated coefficients

Table 4.9 The gravity analysis of the border effects on the Canadian imports from the U.S.

SPECIFICATIONS/ VARIABLES	(**M1**) Aggregate border effects	(**M2**) Border effects with the controls for borderland location	(**M3**) Border effects with the controls for borderland location and GDP per capita difference	(**M4**) Border effects with the controls for borderland location, GDP per capita difference, and tariffs	(**M5**) Border effects with the controls for borderland location, GDP per capita difference, tariffs, and exchange rate	(**M6**) Border effects with the controls for borderland location, GDP per capita difference, tariffs, exchange rate, and economic freedom
lnGDP_pr	1.011***	1.034***	1.027***	1.027***	1.027***	1.013***
	(0.014)	(0.013)	(0.013)	(0.013)	(0.013)	(0.015)
lnGDP_us	0.862***	0.868***	0.872***	0.872***	0.873***	0.870***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
lnDistance	-0.875***	-0.723***	-0.718***	-0.718***	-0.718***	-0.774***
	(0.037)	(0.031)	(0.031)	(0.031)	(0.031)	(0.034)
Border	-2.169***	-2.332***	-2.349***	-2.327***	-2.283***	-2.340***
	(0.034)	(0.029)	(0.030)	(0.044)	(0.050)	(0.047)
Cross_border		0.780***	0.777***	0.777***	0.779***	0.718***
		(0.058)	(0.055)	(0.055)	(0.056)	(0.054)
lnGDPpc_diff			-0.082***	-0.081***	-0.080***	-0.086***
			(0.012)	(0.012)	(0.013)	(0.014)
Tariff_diff				-0.140	0.006	-0.113
				(0.215)	(0.230)	(0.223)
Exch_rate					-0.333*	-0.629***
					(0.190)	(0.178)
Ec_fredom_pr						0.488***
						(0.097)
Ec_fredom_us						0.829***
						(0.094)
lnRM_HD_x	-0.030	-0.023	-0.025	-0.025	-0.024	-0.021
	(0.019)	(0.016)	(0.016)	(0.016)	(0.016)	(0.015)
lnRM_HD_m	-0.025	-0.021	-0.016	-0.017	-0.017	-0.018
	(0.025)	(0.020)	(0.019)	(0.019)	(0.019)	(0.019)
Constant	-1.147***	-2.693***	-1.980***	-1.988***	-1.690***	-11.132***
	(0.280)	(0.309)	(0.339)	(0.339)	(0.379)	(0.957)
Observations	11,400	11,400	11,400	11,400		11,210
R^2	0.8477	0.8628	0.8654	0.8655	0.8655	0.8715
Border Effect	**8.7**	**10.3**	**12.1**	**10.2**	**9.8**	**10.4**

Source: Own calculations. Explanatory variables are as defined in Table 3.2; the key explanatory variable of focus is the border effect dummy (Border). All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed Effects (PPML-HDFE) method, using the robust covariance matrix. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%, estimated using STATA/MP Version 17. **M** is the acronym for Imports. The border effects are calculated as an exponential function [exp (*)] of the estimated coefficients

While the estimated 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, 2002-2022, indicates that the border effect has decreased from 9.4 in 2002 to 8.3 in 2020. This represents some level of easing from the post–9/11 spike in the border effect between the United States and Canada. 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. Regarding the direction of trade, the border effect for exports declined from 7.7 in 2002 to 7.3 in 2020, while the border effect for imports decreased from 12.1 in 2002 to 9.7 in 2020, indicating a gradual reduction in trade

barriers over time. The observed increase in the border effect from 7.1 to 8.3 in total trade, 6.2 to 7.3 in exports, and 8.4 to 9.7 in imports from 2019 to 2020 can be attributed to a combination of factors associated with the transition from NAFTA to USMCA and the disruptive impact of the Covid-19 pandemic. First, the modernization and revision of NAFTA into USMCA introduced new trade rules, regulatory adjustments, and updated tariff quotas, particularly affecting key sectors such as automotive, agriculture, and industrial goods. The transition period increased trade frictions at the border as firms adjusted to the new regulatory environment, contributing to a higher sensitivity of trade flows to the border. Secondly, the pandemic disrupted global supply chains, logistics, and labor markets, leading to increased uncertainties and higher transaction costs for cross-border trade. As businesses and governments adopted more localized strategies to mitigate supply chain risks during the pandemic, there was a shift toward domestic sourcing and a reduction in cross-border transactions, further amplifying the border effect.

Overall, the trend across the years indicates that the border effects on imports are higher than the border effects on exports and total trade.

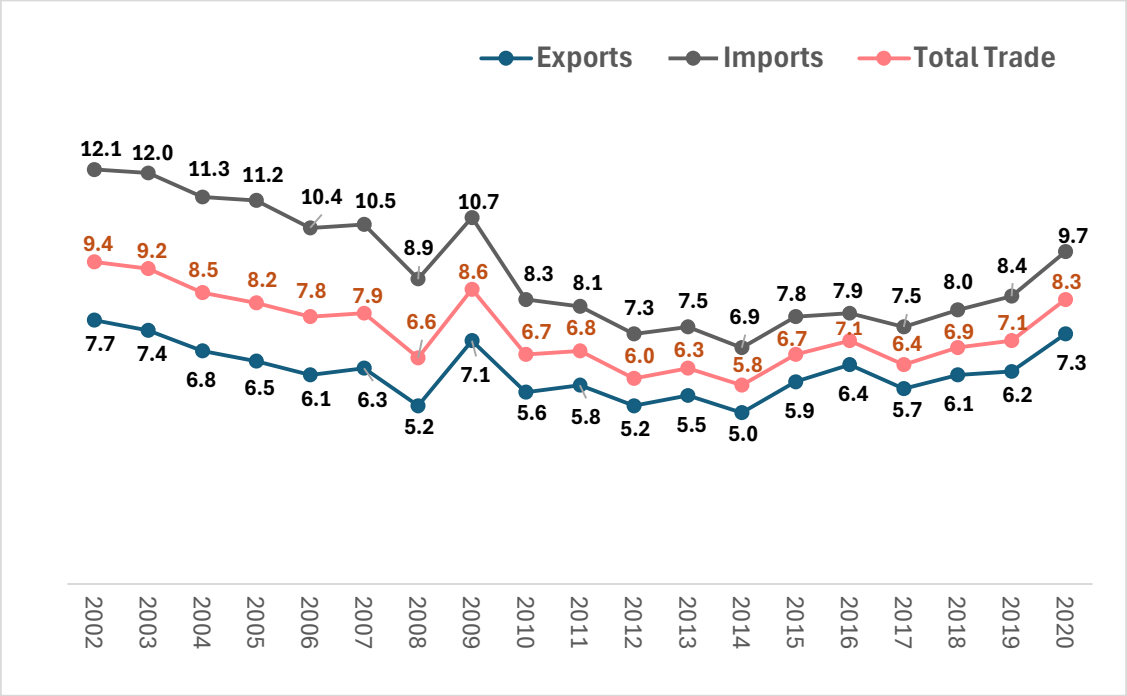


Figure 4.5 Evolution of border effects in Canadian trade with the U.S. (2002-2020)
Source: Own elaboration. See the estimation result in **Appendix 3A**

There is significant variation in provincial border effects (Figure 4.6 – 4.8). The smallest bias for domestic trade is found in New Brunswick and Saskatchewan, followed by Newfoundland and Alberta, with the relatively lower border effect being more pronounced for exports than imports. This indicates that these provinces are more outward-oriented in their export activities, likely due to their strong trade ties with U.S. markets. This suggests that these provinces are more outward-oriented in their export activities, likely due to their reliance on external trade partners for key industries such as energy and natural resources. In line with the existing literature, Manitoba and Ontario border effects for the trade with the U.S. are among the smallest among all provinces, while British Columbia's home bias is the most elevated, followed by Nova Scotia. Quebec and Prince Edward Island are also estimated to have smaller border effects compared to most existing literature. In terms of imports, Manitoba and Ontario exhibit the smallest border effect, followed by Saskatchewan and New Brunswick. On the other hand, Prince Edward Island and Nova Scotia have the highest border effect, indicating a strong home bias for domestic imports, followed by Newfoundland and British Columbia. This suggests that Manitoba and Ontario are more open to imports from the U.S. states, while Prince Edward Island and Nova Scotia rely more heavily on interprovincial imports.

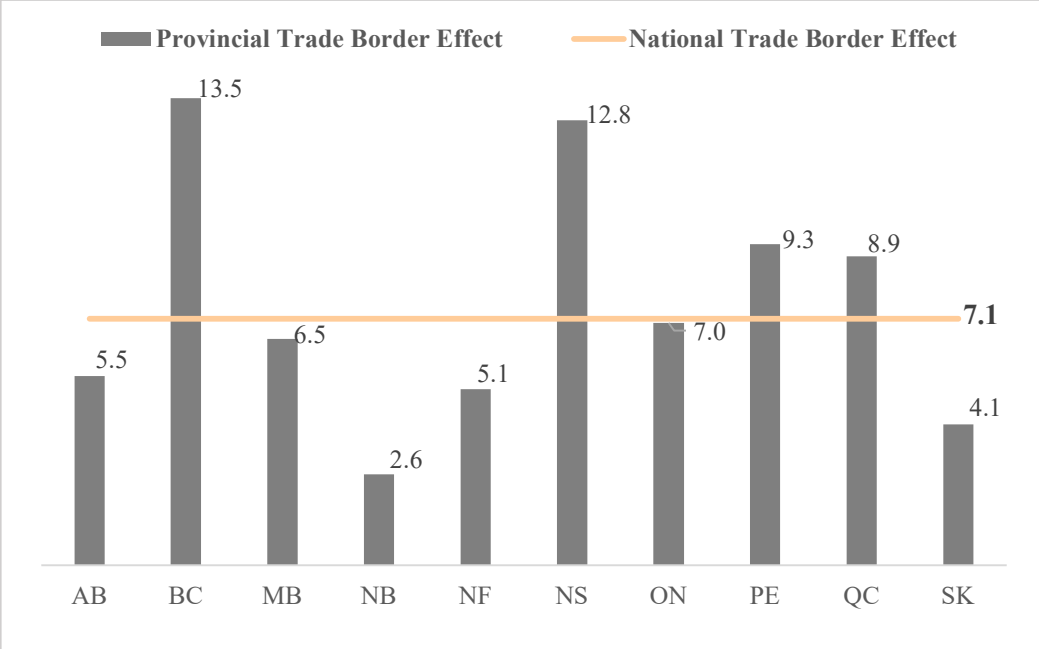


Figure 4.6 Border effect on total trade by province and national average
Source: Own elaboration (See estimated results in **Appendix 3B**)

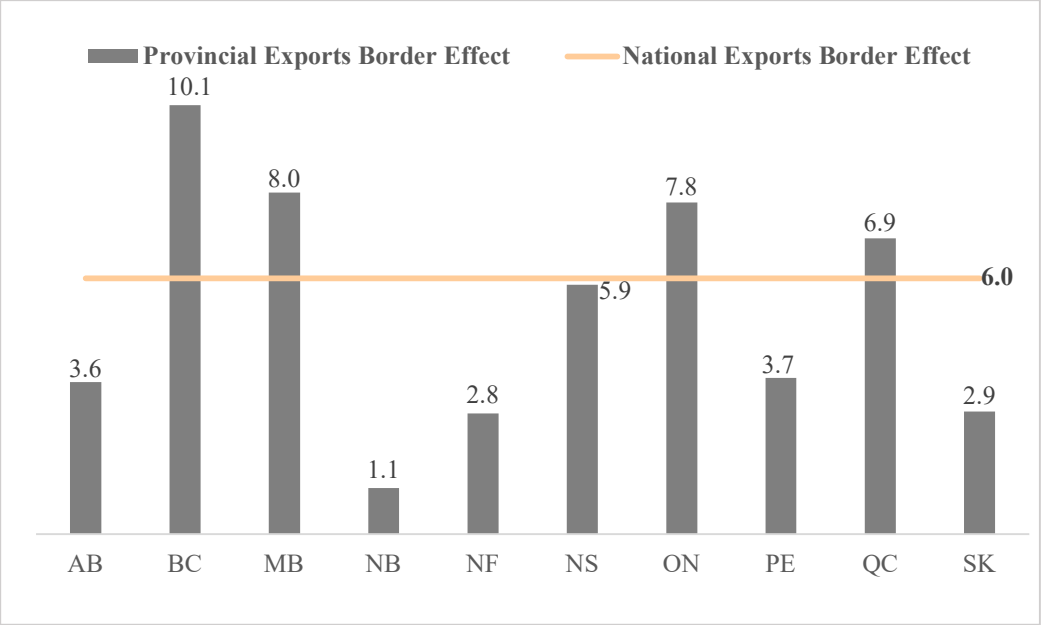


Figure 4.7 Border effect on exports by province and national average
Source: Own elaboration (See estimated results in **Appendix 3B**)

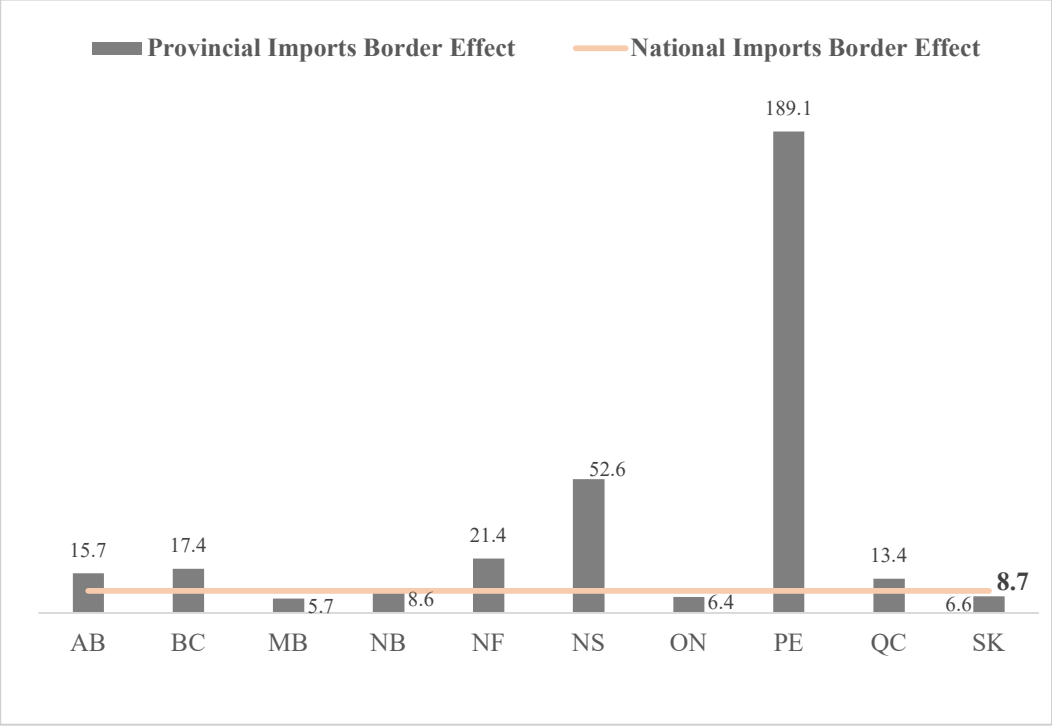


Figure 4.8 Figure 4.7 Border effect on imports by province and national average
Source: Own elaboration (See estimated results in **Appendix 3B**)

Estimates of other determinant variables

Column 2 of the three trade models indicates the result for the specification with controls for the border-land region (equation 5.4). The positive and statistically significant coefficients for the border-land region indicator suggest that land border regions have a trade-enhancing effect between Canada and the U.S. After controlling for the standard gravity variables, the result indicates that trade is more intense in the border-land region. Additionally, including this variable leads to a decline in the distance coefficient, indicating that land border crossings mitigate the negative impact of geographic distance on trade. The finding suggests that all else equal, the presence of a land border region is associated with a multiplicative increase in trade flows by approximately 2.89 times [exp (1.063)]. On the directions of trade, the larger border-land region coefficient for exports compared to imports suggests that geographic proximity to the U.S. border plays a more significant role in facilitating exports than imports. This directional difference indicates that Canadian provinces near the U.S. border engage in significantly higher exports to the U.S. than they receive in imports from U.S. states, even after controlling for economic factors like market size and distance. The result shows that, all else equal, provinces in border-land regions export approximately 3.61 times more [exp (1.283)] to the U.S. than non-border provinces. At the same time, provinces in border-land regions import approximately 2.18 times more [exp (0.780)] from the U.S. than non-border provinces. The estimated coefficient of distance also reduced more for exports than for imports. coefficient. This implies that border-land regions are more export-oriented than import-dependent in their trade with the U.S. Many industries located in border regions, such as automotive manufacturing (Ontario-Michigan), agriculture (Saskatchewan-North Dakota), and energy (Alberta-Montana), are highly export-driven. Border proximity lowers logistics costs and enhances supply chain integration, making it easier for firms in these regions to access the U.S. markets.

Column 3 of the three trade models provides the result for the specification with controls for income per capita difference (equation 5.5). The impact of similarity in the income per capita levels is negative for the total trade and import models but positive for the export model. The larger the gap in the level of development, the less intense the trade flows. The result indicates that the overall trade effect is slightly negative - the export gain does not fully compensate for the import decline. Exports increase but at a lower rate than imports decline, leading to an overall reduction in trade. This also results from weaker economic integration, as partners with large income differences are less integrated into bilateral trade networks.

Column 4 contains the results for the gravity specifications with controls for tariff-related barriers (equation 5.6). Estimated coefficients for the average applied tariff rate are in line with expectations and statistically insignificant for all the directions of trade and specifications. The insignificant role of tariff measures is the result of a tariff phase-out between the United States and Canada in the wake of the FTA, NAFTA, and USMCA. 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, and construction materials such as aluminum and steel.

Column 5 shows findings on the effect of the exchange rate between Canada and the U.S. (equation 5.7). The coefficients of the average yearly exchange rates in all three trade models are negative and statistically significant across all trade models and specifications, with the magnitude of the impact visibly higher in the case of exports [E5 and E6]. The findings show that exchange rate (currency depreciation) reduces total trade by the coefficient -0.442, exports by -0.552, and imports by -0.333. Currency depreciation (a rise in the exchange rate) reduces both exports and imports, leading to lower overall trade. Exports are more negatively affected than imports, suggesting that depreciation raises export costs more than it improves competitiveness. The negative effect on total trade reflects the fact that depreciation creates uncertainty and trade friction, leading to an overall decline in trade activity. The negative impact of depreciation on exports and imports challenges the traditional view that depreciation improves trade balances. However, all else equal, the results are in line with the conclusions, indicating some ambiguity in terms of the impact of the exchange rate on trade.

Column 6 tests for the effect of the economic freedom index (equation 5.8). The coefficient of the parameter estimates for the provinces and U.S. states is positive and statistically significant across all trade models and specifications, with the effect stronger for exports than imports. A positive coefficient indicates that higher economic freedom increases trade, measuring the percentage increase in trade for a one-unit increase in the economic freedom index. Free economies have lower tariffs, fewer non-tariff barriers, and more trade agreements, facilitating trade. Looking at the direction of trade, the result shows that partners with higher economic freedom attract more foreign demand for their exports due to better quality standards, production efficiency, and regulatory stability. Import growth is slower because even in free economies, domestic industries may still compete with foreign goods or benefit from some protectionist policies.

Estimate of the tariff-induced component of the border effect

To isolate the portion of the border effect attributable to tariff measures, an interaction term between the border dummy and tariff differentials is included in the gravity model. Although the interaction coefficients are statistically insignificant, they are consistently positive across specifications, suggesting a weak but directionally reinforcing influence of tariffs on border frictions. Using the average bilateral tariff rate of 0.129 (as calculated from descriptive statistics on Table 3.2), the total border effect is recalculated under a counterfactual scenario. The exponential transformation of this adjusted coefficient yields modest increases in the overall border effect: from 6.75 to 6.99 for total trade, 5.68 to 5.88 for exports, and 8.31 to 8.63 for imports. The marginal contribution of tariffs, quantified as the difference between the total and baseline border effects, is relatively small: 0.24 for total trade, 0.20 for exports, and 0.32 for imports. Expressed as a share of the total border effect, tariffs account for only 3.4% to 3.7%, depending on the trade flow examined. In contrast, the remaining 96% or more is attributed to non-tariff barriers (NTBs), institutional asymmetries, and other unobservable characteristics.

These findings support the broader hypothesis that the effects of globalization mechanisms reflect the extent to which international borders impede trade more than domestic (interprovincial) borders, not primarily due to tariffs, but as a result of deeper and more complex non-tariff regulatory frictions. This aligns with the evolving literature on border effects, which highlights the rising role of non-tariff measures (NTMs) in shaping modern trade patterns. As emphasized by Hufbauer and Hart (2008), Baldwin and Evenett (2009), and Watson and James (2013), the United States has significantly increased the use of NTMs directed at foreign product developments that are particularly relevant to Canadian exporters. While Canada has also reported a rise in NTM notifications, the magnitude and rate of change are substantially lower than those observed in the United States.

Table 4.10 Decomposition of tariff-induced border effect

Dependent Variable	Total Trade	Exports	Imports
Specifications	**[1]**	**[2]**	**[3]**
lnGDP_pr	0.909***	0.835***	1.011***
	(0.013)	(0.016)	(0.014)
lnGDP_us	0.876***	0.886***	0.862***
	(0.013)	(0.017)	(0.012)
lnDistance	-0.807***	-0.757***	-0.874***
	(0.044)	(0.058)	(0.037)
Border (A)	-1.909***	-1.737***	-2.117***
	(0.048)	(0.059)	(0.050)
Tariff_diff	-0.541	-0.548	-0.543
	(0.372)	(0.454)	(0.379)
Border*Tariff_diff (B)	0.268	0.261	0.297
	(0.286)	(0.354)	(0.295)
lnRM_HD_x	-0.052**	-0.069**	-0.031
	(0.022)	(0.027)	(0.020)
lnRM_HD_m	-0.014	-0.005	-0.025
	(0.027)	(0.035)	(0.025)
Constant	0.297	0.131	-1.155***
	(0.349)	(0.494)	(0.280)
Observations	11,400	11,400	11,400
R^2	0.822	0.729	0.848
Decomposition of Tariff-Induced Border Effect			
Baseline Border Effect [Exp (A)] (C)	*6.75*	*5.68*	*8.31*
Total Border Effect [Exp(A+B*0.129)] (D)	*6.99*	*5.88*	*8.63*
Tariff-induced portion [D-C] (E)	*0.24*	*0.20*	*0.32*
Border Effect Attributed to Tariff barrier: $\left(1-\frac{C}{D}\right)*100$	*3.4%*	*3.4%*	*3.7%*
Border Effect Attributed to NTMs and All Other Unobserved Characteristics	*96.6%*	*96.6%*	*96.3%*

Source: Own calculations. Explanatory variables are as defined in Table 3.2; the key explanatory variable of focus is the border effect dummy (Border) and the tariff/border effect interaction term (Border*Tariff_diff). All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed Effects (PPML-HDFE) method, using the robust covariance matrix. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%, estimated using STATA/MP Version 17. The border effects are calculated as an exponential function [Exp (*)] of the estimated coefficients.
Note: 0.129 is the average value of tariff differentials across Canada-U.S. trade pairs (see Descriptive Statistics)

The underlying causes of this increase in NTMs are multi-dimensional. While some NTMs reflect protectionist impulses, others are driven by legitimate concerns tied to consumer protection, environmental sustainability, and the management of complex global value chains. The proliferation of NTMs is, in part, a response to the fragmentation of production, whereby goods are manufactured across multiple jurisdictions, each with distinct regulatory and technical standards. Consumers have also become more discerning, placing greater emphasis on product attributes such as health, safety, ethical sourcing, and environmental impact. Consequently, many NTMs are not inherently trade-distorting but rather respond to the evolving nature of supply chains and market expectations. In this context, the intensification of NTMs may be

viewed not as a reversal of globalization but as a recalibration of trade governance to reflect the demands of a more interconnected global economy.

Consistent with Helliwell (2003) and Helliwell and Schembri (2005), these results reaffirm that border effects are not solely reflective of costly trade barriers such as tariffs. Instead, they largely embody differences in transaction costs, consumer preferences for domestic products, institutional norms, and structural features of the organization of production. While the tariff-induced share of the border effect is minimal, the persistent non-tariff component underscores the continued relevance of borders in economic life, not merely as lines on a map, but as loci of regulatory, institutional, and cultural differentiation. These findings suggest that future efforts at deepening trade integration, particularly in North America, must focus on addressing these non-tariff dimensions if meaningful reductions in cross-border trade frictions are to be achieved.

Summary of findings and corresponding hypothesis

The finding highlights that border effects in foreign trade between Canada and its southern neighbor (the United States) decreased in comparison to the previously reported estimates in the existing literature. An estimated border effect of 7.1 for total trade, 6.0 for exports, and 8.7 for imports 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/USMCA implementation. The findings are reassuring, given that our study integrated trade flows from all U.S. states (plus the District of Columbia), rather than only the 30 largest or adjacent U.S. states used in the existing literature. The result also indicates that the border effects for trade by Canadian provinces with the United States have gradually decreased from 9.4 in 2002 to 8.3 in 2020. For exports, it declined from 7.7 in 2002 to 7.3 in 2020, and for imports, it fell from 21.1 in 2002 to 9.7 in 2020. Between 2019 and 2020, the border effect in Canada-U.S. trade increased significantly, with total trade rising from 7.1 to 8.3, exports from 6.2 to 7.3, and imports from 8.4 to 9.7. This uptick can be linked to two main factors: the transition from NAFTA to USMCA and the disruptions caused by the Covid-19 pandemic. The USMCA transition introduced new regulatory frameworks and adjustments that temporarily increased trade frictions as firms adapted to updated rules. At the same time, the pandemic disrupted supply chains and logistics, prompting firms to rely more on domestic sourcing. Together, these factors heightened border

sensitivities and led to increased trade barriers in 2020. In line with existing studies, the result showed significant variation in provincial border effects. The border with the United States is quite thin for New Brunswick, Saskatchewan, Newfoundland & Labrador, and Alberta. It is much thicker, however, for British Columbia, Nova Scotia, and Prince Edward Island. Overall, the finding indicates that despite deep economic integration, the Canada-U.S. border remains a substantial barrier to trade, with Canadian provinces trading significantly more with each other than with U.S. states. The higher border effect for imports compared to exports suggests that Canadian firms are particularly reliant on domestic suppliers. In contrast, the total trade border effect highlights a general preference for intra-Canada trade over cross-border transactions. The effect of the border-land region highlights that geographic proximity to the U.S. border significantly enhances trade, independent of specific border crossings or infrastructure investments. This suggests that firms and industries located near the border benefit from natural trade advantages, such as lower transportation costs, integrated supply chains, and established cross-border business networks. While reducing tariffs and regulatory barriers remains important, proximity-driven trade advantages reinforce the idea that geography plays a critical role in shaping trade patterns. The analysis further found the degree of economic freedom to be a powerful driver of trade between Canada and the United States, particularly for exports. Overall, the observed increase in border effects supports **the hypothesis that globalization mechanisms tend to impede international trade more than domestic trade**. The heightened border effects evidenced by larger increases in export and import barriers across the Canada-U.S. border, relative to interprovincial trade flows, suggest that international borders continue to impose additional frictions due to regulatory divergence, logistical complexity, and the need to adapt to evolving trade frameworks such as the United States-Mexico-Canada Agreement (USMCA). Moreover, the disruptions triggered by the Covid-19 pandemic have further exacerbated these structural impediments, particularly by destabilizing global supply chains and underscoring the vulnerability of international trade to external shocks. While globalization through tariff liberalization has generally enhanced trade by reducing formal barriers, the decomposition analysis confirms that tariffs no longer constitute a substantial component of the border effect. Instead, the residual trade frictions are primarily driven by non-tariff measures, institutional constraints, and market-specific standards. In this light, the findings suggest that although globalization mechanisms have fostered greater trade integration, they have also intensified the complexities of cross-border transactions, impeding international trade to a greater extent than domestic trade.

4.2.6 IIT pattern and province-specific characteristics – empirical estimates

This section presents the empirical results of how IIT and its components are impacted by province-specific characteristics (hypothesis 2). The relationship is shown in Table 4.13, Table 4.14, and Table 4.15. The finding shows mixed results on the coefficients of the parameter estimates, which are mostly significant. First is the GDP variable. As expected, across the specifications, the GDP variable is positive and statistically significant for the IIT and its components. HIIT is far more sensitive to GDP growth than IIT and VIIT. These results underscore the centrality of economies of scale in facilitating IIT, particularly in horizontally differentiated products, where consumer demand for variety and firms mostly require specialization. The weaker relationship between GDP and VIIT suggests that trade patterns rooted in quality differentiation and factor endowment differences are less driven by absolute economic size and more by relative structural characteristics. Higher GDP indicates a larger economy with more diversified production and trade networks, facilitating IIT. Economies with high GDP often have well-developed industries that engage in reciprocal trade of similar goods. HIIT (trade in similar-quality differentiated goods) benefits from economic size, as larger economies can sustain competition in multiple product varieties. VIIT (trade in quality-differentiated goods) depends on economic development, but at a lower rate compared to IIT and HIIT. As GDP increases, economies move toward high-value-added exports and reduce reliance on lower-quality imports, which moderates VIIT growth. Larger economies have stronger IIT networks, with a preference for horizontally structured trade.

Geographic location, proxied by the log of distance from the equator, produced a consistently positive and significant effect across all IIT components. The positive and statistically significant coefficient of equatorial distance indicates that regions located farther from the equator tend to engage in higher levels of trade, including all forms of IIT. The similarity in impact across all the IIT components indicates that distance from the equator consistently encourages all forms of trade integration. The result suggests a robust direct relationship between proximity to the equator and the intensity of IIT. From the perspective of structural economics, distance from the equator serves as a geographic proxy for levels of economic development, institutional conditions, and historical patterns that influence trade. Regions located farther from the equator tend to exhibit more diversified industrial bases, more developed infrastructures, and stronger institutional frameworks, which are conducive to the formation of complex production networks and demand for differentiated goods. The gradient

of effects across IIT types (HIIT > IIT > VIIT) indicates that industrial maturity and similarity in production structures are central to enabling HIIT.

Table 4.11 Panel regression of IIT and province-specific factors

Dependent Variable	**IIT**	**IIT**	**IIT**	**IIT**	**IIT**	**IIT**	**IIT**	**IIT**	**IIT**	**IIT**
Specifications	**[1]**	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**	**[7]**	**[8]**	**[9]**	**[10]**
lnGDP	0.893***	1.468***				1.307***			2.063***	1.194***
	(0.184)	(0.131)				(0.060)			(0.065)	(0.183)
lnsr_low		0.577***								
		(0.147)								
lnsr_high	1.046***									
	(0.179)									
lnEquat_dist			6.451***		3.073***		1.644***	2.403***	0.765*	
			(1.191)		(0.678)		(0.497)	(0.382)	(0.452)	
lnGDPpc			3.798***							
			(1.254)							
inst_qlity				0.659**	1.010					
				(0.273)	(0.951)					
lnR&D				1.506***						
				(0.043)						
lnTx_prod						-0.839***			-0.362**	
						(0.071)			(0.180)	
lnTx_imp						1.288***				0.725***
						(0.077)				(0.120)
lnMNEs_va							0.537***	0.400**		
							(0.133)	(0.159)		
lnMNEs_job					0.338***			0.206**		
					(0.113)			(0.097)		
lnMNEs_cf							0.350***			0.055**
							(0.121)			(0.028)
Constant	-14.144***	-21.654***	-65.374***	-14.305***	-10.507	6.753***	3.068	-0.233	-34.875***	-9.664**
	(2.527)	(1.959)	(22.443)	(2.708)	(10.811)	(0.725)	(3.044)	(2.425)	(4.036)	(4.495)
Observation	230	230	220	220	120	160	80	130	160	80
Log-Pseudo Likelihood	-5.30E+11	-5.80E+11	-3.90E+12	-5.00E+11	-1.80E+12	-2.50E+11	-7.50E+11	-1.80E+12	-4.90E+11	-1.80E+11
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.953	0.949	0.632	0.952	0.706	0.969	0.842	0.738	0.940	0.962
Prob > chi2	0	0	0	0	0	0	0	0	0	0
Wald chi2	1244.04	1151.5	92.23	1357.37	136.5	4424.85	227.38	172.87	1314.13	778.8

Source: Own calculations. Explanatory variables are as defined in Table 3.3. All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed Effects (PPML-HDFE) method, using the robust covariance matrix. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1% estimated using STATA/MP Version 17

The estimated coefficient for the low and high skill-ratio variables demonstrates a strong and statistically significant positive relationship between labor endowments and IIT, including its components. Higher concentrations of high-skilled labor are strongly linked to greater IIT (1.05), HIIT (1.01), and especially VIIT (1.26) at 1% level, indicating the pivotal role of human capital in supporting trade in differentiated and higher-quality goods. Although smaller in magnitude, the coefficients on low-skilled labor are also positive and significant across all trade patterns, 0.58 for IIT, 0.48 for HIIT, and 1.14 for VIIT, suggesting that economies with abundant low-skilled labor also actively participate in IIT, particularly through vertically differentiated production structures. These findings are consistent with theoretical expectations from new trade theory and the literature on IIT. HIIT, which involves the exchange of similarly priced but differentiated goods, tends to be more prevalent in regions with a well-developed industrial base and a high concentration of skilled labor, consistent with models of product differentiation and scale economies (Falvey & Kierzkowski, 1987; Greenaway, Hine, and Milner, 1995). The strong relationship between high-skill labor and VIIT further supports the notion that technologically advanced regions are more likely to export higher-quality goods while importing lower-quality variants, an outcome aligned with quality-based trade models. Conversely, the large positive coefficient for low-skill labor on VIIT suggests that labor-abundant regions may specialize in cost-sensitive production stages, participating in vertical trade through the import of capital-intensive inputs and the export of labor-intensive goods (Fontagné, Freudenberg, and Ünal-Kesenci, 2006; Torstensson, 1996). Empirically, these results align with prior studies highlighting the dual role of skill composition in shaping trade structure. Brülhart (2009) and Blanes and Martín (2000) show that both low- and high-skill endowments are associated with different forms of IIT, with advanced economies leveraging skilled labor to compete in innovation-driven segments, while less developed or labor-rich regions integrate through vertically structured trade. Within the Canadian context, this suggests that high-skill provinces are better positioned to engage in differentiated, value-added production. In contrast, low-skill provinces can still benefit from participating in global value chains through labor-intensive activities. Together, the findings reinforce the view that skill endowments are central to determining not only the volume of trade but also the nature and quality of products exchanged, with important implications for industrial and labor policy at the subnational level.

The estimated coefficients on the GDPpc variable are positive and statistically significant for the IIT (3.79), HIIT (5.21) at 1% level, and insignificant for VIIT (0.11). The

large and significant coefficients on IIT and HIIT suggest that higher-income economies tend to engage more intensively in IIT, particularly in the exchange of horizontally differentiated goods. These findings align with the predictions of NTT and more recent extensions of IIT models, which postulate that higher-income economies tend to engage more intensively in horizontal IIT, owing to greater product differentiation, economies of scale, and diverse consumer preferences (Krugman, 1980; Melitz, 2003). GDPpc functions as an indicator of economic maturity, industrial diversity, and human capital accumulation, all of which contribute to a region's ability to both produce and demand a wide array of differentiated goods. The strong positive effect of HIIT supports this, suggesting that as economies become more affluent, they are more likely to trade differentiated goods within the same industry. This result is echoed in recent empirical work by Sano (2020), Dhingra (2013), and Kandogan (2006), who show that economic development independent of bilateral trade frictions drives specialization in product variety and quality. The lack of a statistically significant relationship between GDPpc and VIIT reinforces the notion that VIIT is less dependent on income levels and more influenced by differences in factor endowments, production costs, and specialization in value chains. VIIT often occurs between economies with different levels of development, where one exports higher-quality or capital-intensive goods and the other exports lower-quality or labor-intensive products. This is consistent with studies by Fontagné et al. (2006) and, more recently, by Cieślik and Michałek (2018), who show that VIIT patterns are driven more by technological asymmetries and production fragmentation than by income convergence. Thus, while economic growth enhances overall trade capacity, it disproportionately strengthens HIIT by supporting the diversification and sophistication of domestic production and consumption.

The R&D expenditure variable is positive and significant for all forms of IIT, with the magnitude of the effect higher in the case of HIIT. The result reveals coefficients of 1.51 for aggregate IIT, 1.57 for HIIT, and 1.19 for VIIT, indicating that increases in R&D investment are associated with disproportionately higher levels of IIT. The magnitude of the coefficients suggests that R&D serves as a structural driver of trade specialization, influencing the capacity of various economic units to export and import differentiated goods within the same industry simultaneously. This aligns with the theoretical frameworks of technology-driven trade, where innovation capacity, rather than geography or income disparities, shapes the extent and composition of trade relationships (Barba Navaretti, Venables, & Barry, 2020). The stronger relationship between R&D and HIIT, compared to VIIT, points to the predominance of variety-based mechanisms in explaining the observed trade patterns. In particular, HIIT is driven by

product differentiation that is horizontal in nature, offering similar-quality goods with varied characteristics, which R&D facilitates through process innovation, design diversification, and customization (Falk & Falk, 2022). These findings support the notion that innovation enables producers to meet heterogeneous consumer preferences across borders, thus expanding mutual trade within the same industry. The relatively smaller but still significant impact on VIIT implies that quality upgrading remains important, especially where R&D leads to the production of higher-tech or more sophisticated goods. However, the difference in elasticities suggests that the returns to R&D in promoting quality-based trade are somewhat more constrained, potentially due to asymmetries in absorptive capacities or complementarities with other forms of intangible capital (Castellani & Zanfei, 2019).

These results emphasize innovation as a key endogenous factor underpinning two-way trade flows. The finding is consistent with recent literature highlighting the centrality of innovation ecosystems in supporting trade diversification and intra-industry linkages (Gaulier, Taglioni, & Zignago, 2023). Maican, Orth, Roberts, and Vuong (2020) also find higher R&D investment to be associated with increased IIT, as it enhances firms' capabilities to produce differentiated products and improve productivity, thereby making them more competitive in both domestic and international markets. Together, these findings indicate that while income level alone may not drive IIT, investment in technology plays a critical role in fostering both the breadth and depth of trade integration.

Table 4.12 Panel regression of HIIT and province-specific factors

Dependent Variable	HIIT	HIIT	HIIT	HIIT	HIIT	HIIT	HIIT	HIIT	HIIT	HIIT
Specifications	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
lnGDP	1.026***	1.652***				1.359***			2.270***	1.222***
	(0.208)	(0.139)				(0.058)			(0.067)	(0.219)
lnsr_low		0.479***								
		(0.161)								
lnsr_high	1.010***									
	(0.205)									
lnEquat_dist			7.880***		3.499***		1.894***	2.662***	1.355***	
			(1.284)		(0.795)		(0.567)	(0.418)	(0.489)	
lnGDPpc			5.209***							
			(1.317)							
lnR&D				1.573***						
				(0.051)						
inst_qlity				0.776**	1.353					
				(0.307)	(1.072)					
lnTx_prod						-1.025***			-0.669***	
						(0.078)			(0.188)	
lnTx_imp						1.470***				0.813***
						(0.075)				(0.148)
lnMNEs_va							0.548***	0.425**		
							(0.148)	(0.170)		
lnMNEs_job					0.332***			0.198*		
					(0.120)			(0.101)		
lnMNEs_cf							0.384***			0.069**
							(0.140)			(0.030)
Constant	-17.3***	-25.5***	-91.7***	-16.9***	-16.52	5.89***	0.534	-2.54	-44.2***	-11.01**
	(2.840)	(2.098)	(23.823)	(3.116)	(12.551)	(0.724)	(3.568)	(2.704)	(4.437)	(5.355)
Observation	230	230	220	220	120	160	80	130	160	80
Log-Pseudo Likelihood	-5.40E+11	-5.90E+11	-3.30E+12	-5.20E+11	-1.70E+12	-2.30E+11	-6.70E+11	-1.70E+12	-4.40E+11	-1.80E+11
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.9466	0.9418	0.6509	0.9448	0.7018	0.9681	0.8438	0.7349	0.9394	0.9579
Prob > chi2	0	0	0	0	0	0	0	0	0	0
Wald chi2	1027.74	987.25	84.95	1075.73	125.89	5191.58	213.57	158.98	1542.01	704.51

Source: Own calculations. Explanatory variables are as defined in Table 3.3. All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed effects (PPML-HDFE) method, using the robust covariance matrix. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1% estimated using STATA/MP Version 17

The estimate for institutional quality suggests that the indicator exerts a positive and statistically significant influence on overall IIT, with a coefficient of 0.66 at the 5% level, and an even stronger effect on HIIT, with a coefficient of 0.78 at the 5% level. In contrast, the coefficient for VIIT is smaller and statistically insignificant at 0.12. These results indicate that improved institutional quality, such as stronger legal enforcement, regulatory transparency, and contract protection, is associated with greater engagement in IIT in similar goods, particularly when those goods are horizontally differentiated rather than vertically stratified. The observed difference in elasticities between HIIT and VIIT is consistent with theoretical expectations from institutional and transaction cost economics. In the context of HIIT, where firms engage in mutual trade of goods with similar quality but different attributes, high institutional quality reduces transaction costs, enhances trust in cross-border exchanges, and supports firms' willingness to engage in repeated trade interactions (North, 1990; Nunn, 2007). This is particularly crucial for trade in horizontally differentiated products, where brand credibility, intellectual property rights, and regulatory harmonization are essential. In contrast, VIIT often reflects trade between higher- and lower-quality variants, which may be less sensitive to institutional environments and more driven by cost differentials or technology gaps. The insignificant effect of institutional quality on VIIT could also suggest that for vertically stratified trade, firms may rely more on other structural variables such as R&D intensity, FDI linkages, or human capital endowment, than on institutional governance per se (Levchenko, 2007; Chor, 2010). Empirically, these findings align with recent studies emphasizing the role of institutions in shaping trade composition rather than just trade volumes. For instance, Francois and Manchin (2013) argue that high-quality institutions support deeper trade integration by lowering non-tariff barriers and encouraging investment in product quality and branding, both of which are key for sustained HIIT. Similarly, Chen, Dollar, and Tang (2022) find that institutional convergence between trading partners facilitates two-way trade in differentiated goods among emerging economies. These findings reinforce these arguments by showing that institutional quality is not merely a background condition, but a strategic determinant of provincial IIT. From a policy standpoint, this implies that trade-enhancing reforms should not only focus on infrastructure or tariffs, but also on institutional development, such as judicial independence, anti-corruption enforcement, and regulatory quality, to foster more competitive trade structures.

As expected, production tax shows a negative and statistically significant effect on IIT and HIIT, with estimated coefficients of approximately -0.84 and -1.03 at 1% level, respectively. Higher production taxes increase the cost of domestic production, making firms less competitive

in international markets. Firms engaged in HIIT rely on economies of scale and branding, making them more sensitive to cost increases due to input costs or value-added taxation. Interestingly, the coefficient for VIIT is positive and significant (0.15) at 5% level. The positive effect on VIIT implies that higher production taxes may induce firms to specialize in vertically differentiated trade, possibly by reallocating resources toward lower-end product segments or through increased reliance on foreign intermediate goods to circumvent domestic cost pressures.

Contrary to standard trade theory, import tax yields positive and statistically significant coefficients across all IIT components, with the estimated coefficient of approximately 1.29 for IIT, 1.47 for HIIT, and 0.46 for VIIT. This result tends to reflect the strategic use of tariffs in trade regimes that engage in tariff escalation or import-substitution industrialization, where protectionist measures are accompanied by domestic policies aimed at fostering industry competitiveness and product differentiation. In some contexts, moderate import taxes may stimulate local production capabilities, especially in horizontally differentiated sectors, and induce reciprocal trade patterns among economies at similar levels of development. Alternatively, these results may signal that economies with higher import taxes are also those with stronger domestic demand for differentiated goods, sustaining IIT despite tariff barriers.

Across specifications, the estimation provides strong evidence of significance and a positive link between trade and the activities of MNEs. In particular, value-added shows the strongest influence, with coefficients of 0.54 for IIT, 0.55 for HIIT, and 0.39 for VIIT, at 1% level. This suggests that as MNEs contribute more to domestic value creation, regions become more engaged in IIT, especially in horizontally differentiated products. Value-added reflects not only the scale of MNE operations but also the depth of their integration into domestic production, innovation, and supply chains. These findings are consistent with Keller and Yeaple (2003), who documented that FDI leads to significant productivity gains in domestic firms, accounting for about 14% of productivity growth in U.S. firms between 1987 and 1996. These productivity gains can enhance a country's ability to engage in IIT. MNEs' employment (Jobs) also has a positive and significant effect across all IIT components, with slightly smaller but consistent coefficients (approximately 0.33 across all the IIT components), indicating that MNEs' role in generating employment supports the labor capacity and organizational infrastructure necessary for sustained trade in differentiated goods. Similarly, fixed capital formation by MNEs, a proxy for long-term investment and productive capacity, has a significant positive impact, with coefficients of approximately 0.35 for IIT, 0.38 for HIIT, and 0.24 for VIIT, pointing to the importance of capital-intensive investments in enabling economies to

participate in sophisticated production and trade structures. This aligns with the study by Şentürk (2023), which found a causal relationship from FDI to IIT in Turkey's capital goods sector, indicating that foreign investments enhance IIT. Alfaro and Chen (2013) have also shown that regions with higher foreign affiliate activity experience deeper integration into global production networks and exhibit more complex trade patterns. The similar magnitudes across MNE employment and value-added suggest that both scale and productivity dimensions matter, while the positive impact of capital formation highlights the importance of reinvestment and fixed asset accumulation in sustaining trade capacity. Overall, the results highlight that MNEs are key facilitators of IIT through their contributions to value creation, job generation, and capital accumulation. Their presence enhances both the extensive margin (increasing the number of traded product varieties) and the intensive margin (raising the quality and technological sophistication of traded goods), thereby supporting both horizontal and vertical trade integration. These findings reinforce the argument that policies aimed at attracting and embedding MNE activity, particularly those that promote local linkages and innovation, can significantly deepen a country's participation in global value chains and international markets.

Summary of findings and corresponding hypotheses

The finding highlights the significant role of province-specific characteristics in shaping IIT and its components. The findings indicate that key economic, geographic, institutional, labor market factors, and activities of MNEs interact to determine the intensity and structure of trade within and across industries. Economic scale, innovation, labor market composition, and taxation policies emerge as key determinants influencing trade integration. A higher GDP fosters IIT, particularly HIIT, emphasizing the importance of economic size and industrial diversification in sustaining reciprocal trade. However, greater GDPpc is associated with a decline in IIT, as wealthier economies shift toward specialization in high-tech and innovation-driven exports rather than maintaining balanced two-way trade within industries (hypothesis 2_A). This suggests that factor endowment influences trade composition, requiring policies that support both specialization and IIT networks.

Table 4.13 Panel regression of VIIT and province-specific factors

Dependent Variable	VIIT	VIIT	VIIT	VIIT	VIIT	VIIT	VIIT	VIIT	VIIT	VIIT
Specifications	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
lnGDP	0.214**	0.494***				0.879***			1.104***	0.986***
	(0.108)	(0.087)				(0.079)			(0.056)	(0.130)
lnsr_low		1.141***								
		(0.088)								
lnsr_high	1.259***									
	(0.104)									
lnEquat_dist			2.871***		1.749***		0.980***	1.479***	-1.171***	
			(0.311)		(0.266)		(0.304)	(0.240)	(0.110)	
lnGDPpc			0.111							
			(0.464)							
lnR&D				1.185***						
				(0.025)						
inst_qlity				0.123	0.117					
				(0.140)	(0.462)					
lnTx_prod						0.147**			0.967***	
						(0.062)			(0.072)	
lnTx_imp						0.461***				0.394***
						(0.098)				(0.079)
lnMNEs_va							0.388***	0.218**		
							(0.087)	(0.111)		
lnMNEs_job					0.332***			0.253***		
					(0.070)			(0.070)		
lnMNEs_cf							0.239***			0.001
							(0.080)			(0.040)
Constant	-1.052	-4.909***	-0.107	-4.698***	4.618	9.975***	8.981***	6.241***	-0.401	-4.421
	(1.532)	(1.363)	(6.958)	(1.338)	(4.453)	(0.879)	(1.604)	(1.319)	(1.383)	(3.031)
Observation	230	230	220	220	120	160	80	130	160	80
Log-Pseudo Likelihood	-4.80E+10	-4.10E+10	-4.80E+11	-4.00E+10	-1.70E+11	-3.80E+10	-9.20E+10	-1.80E+11	-3.30E+10	-1.90E+10
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.9614	0.967	0.5865	0.9656	0.7207	0.9558	0.7948	0.7321	0.9624	0.9568
Prob > chi2	0	0	0	0	0	0	0	0	0	0
Wald chi2	1747.81	1971.67	199.33	2226.42	240	1192.09	243.28	259.52	1470.59	869.5

Source: Own calculations. Explanatory variables are as defined in Table 3.3. All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed Effects (PPML-HDFE) method, using the robust covariance matrix. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1% estimated using STATA/MP Version 17

Geographic factors, particularly distance from the equator, exert a persistent positive effect on IIT, suggesting that regions in higher latitudes (e.g., Canada, Northern Europe) and other temperate regions are more export-oriented, more globally integrated, and possibly better equipped with trade-enabling infrastructure or governance – this presents a deviation from the proposition in Hypothesis 2_B. This finding underscores the importance of trade facilitation policies aimed at offsetting geographic disadvantages. Investments in infrastructure, digital connectivity, and logistical efficiency can play a critical role in mitigating the trade-inhibiting effects of physical distance and fostering deeper trade integration. Tax and trade policies also

significantly influence trade patterns. Higher production taxes increase domestic production costs, thereby discouraging both HIIT and IIT, in line with Hypothesis 2_B. However, they may simultaneously promote VIIT by incentivizing firms to outsource lower-quality production segments. In contrast, higher import taxes tend to encourage all forms of IIT, as firms seek regional trade alternatives to substitute for more costly imports. These dynamics highlight the importance of designing a tax framework that supports trade expansion while ensuring economic efficiency. Furthermore, the positive effect of institutional quality on IIT provides additional support for equatorial distance, which highlights a deviation from Hypothesis 2_B. While stronger institutions typically enhance overall efficiency and specialization, they may play a lesser role where trade is driven more by cost or quality differentials. This suggests that institutional development is a key structural determinant of trade composition and should be prioritized alongside innovation and infrastructure in trade policy strategies necessary for sustaining IIT.

The study also reveals the critical role of R&D investment in driving IIT, with HIIT benefiting the most from innovation (Hypothesis 2_C). Increased R&D spending enhances the production of quality-differentiated goods, improving competitiveness in high-tech and sophisticated markets. This aligns with existing literature on the role of technological advancements in enhancing trade competitiveness. Policymakers should therefore prioritize research and development incentives to strengthen IIT and maintain a competitive advantage in knowledge-intensive industries. Labor market characteristics (physical capital) are also central to trade performance. While a highly skilled workforce significantly increases overall IIT, particularly in sectors characterized by technological sophistication and vertical differentiation, low-skilled labor also plays a vital role, especially in facilitating VIIT that relies on labor-intensive production processes (hypothesis 2_D). This dual significance of both skill levels reinforces the importance of education and workforce training programs in the integration of regions into the global trade networks.

Finally, the findings highlight the significant role of multinational enterprises (MNEs) in shaping IIT and its components. The positive and statistically significant coefficients for MNEs' value-added contributions, capital formation, and employment creation suggest that increased MNE activity enhances trade flows (consistent with hypothesis $2_{E)}$, albeit with varying magnitudes across different components of IIT. The robust effects of MNEs' value-added contributions on all the IIT components indicate that MNE-led productivity improvements, knowledge spillovers, and integration into global supply chains foster stronger trade linkages.

Notably, the stronger effect on HIIT suggests that MNE activities contribute more to trade in differentiated products with similar quality levels than to trade in vertically specialized goods. Similarly, the significant effect of MNE-driven capital formation highlights the role of FDI and capital-intensive production in facilitating trade integration, with a pronounced impact on HIIT. The relatively large coefficients associated with MNE-generated employment further affirm that labor market integration through MNEs plays a vital role in promoting IIT. While VIIT also benefits from these employment effects, the notable influence on HIIT reflects the contribution of MNEs to horizontally fragmented production networks.

Overall, these findings emphasize the interconnected nature of economic, institutional, and policy factors in shaping trade dynamics at the provincial level. A strategic approach that promotes economic diversification, enhances infrastructure, supports R&D, strengthens the workforce, and optimizes trade policies is essential for sustaining and expanding IIT. Within this broader framework, the results also highlight the important role of MNEs as key drivers of IIT, contributing to technological advancement, production efficiency, and labor market integration. The stronger effects observed on HIIT suggest that MNEs primarily support trade in similar-quality differentiated products, while their influence on VIIT indicates a significant role in global value chains and supply chain fragmentation. These insights reinforce the importance of targeted economic strategies that align with regional economic characteristics, including FDI-friendly policies, investment in high-value-added industries, and the strengthening of linkages between MNEs and domestic firms, to enhance international trade performance and regional competitiveness.

CHAPTER 5 CONCLUSION, POLICY RECOMMENDATIONS AND FURTHER RESEARCH OPPORTUNITIES

This chapter concludes the dissertation by synthesizing the core findings, drawing out their broader theoretical and empirical implications, and offering practical policy recommendations derived from the analysis. Building on the preceding chapters, which examined the multidimensional impact of globalization and institutional mechanisms on Canadian provincial trade performance, this chapter reflects on the study's contributions to the literature on subnational trade, globalization dynamics, and IIT. It also identifies actionable strategies for enhancing trade performance at the provincial level, emphasizing both external engagement and internal structural reforms. Finally, the chapter outlines potential avenues for future research that could extend and deepen the understanding of subnational trade integration in the context of a rapidly evolving global economic landscape.

5.1 Conclusion

This dissertation explored the impact of globalization on international trade at the subnational level, with a specific focus on Canada's ten provinces. It underscored how globalization has transformed trade through reduced transaction costs, technological advancements, and liberalization mechanisms. Historically, globalization has influenced openness to trade, with major shifts driven by technological progress, economic policies, and global crises. While most existing research focuses on national trade aggregates, this study fills a gap by examining regional trade dynamics, emphasizing the distinct economic roles of provinces within the global market. A key contribution of this dissertation is the development of a comprehensive regional narrative that contextualizes how globalization affects trade at the provincial level.

The research is structured around two main hypotheses, closely tied to both trade theory and empirical evidence. The first hypothesis posits that globalization affects provincial trade patterns differently, leading to variations in exports and imports based on resource endowments, industrial specialization, and economic flexibility. To test this, the study employed a gravity panel dataset covering exports and imports between ten Canadian provinces and 212 global trading partners from 1999 to 2022, totaling 49,220 province-country observations. The

gravity model incorporates key determinants of trade flows, such as economic size and geographic distance, while also integrating variables that capture globalization's influence, including the KOF Trade Globalization Index, the Economic Freedom Index, trade liberalization measures (RTAs and tariffs), ERV, metropolitan influence, and historical/cultural linkages.

The second hypothesis explores the role of province-specific characteristics, including activities of MNEs, in shaping IIT. MNEs' activity is evaluated using proxies such as GDP contribution, gross fixed capital formation, and employment levels, providing insights into their impact on IIT. Using a panel-data regression model, the study analyzed total provincial exports and imports at both the four-digit (industry level) and six-digit (product level) Harmonized System (HS) classifications. Trade data from 2000 to 2022, obtained from Industry Canada Trade Data Online, is assessed to determine how economic structure, innovation, labor composition, trade policies, and foreign investment influence IIT. A notable contribution from this section of the dissertation is the calculation of IIT using the Grubel-Lloyd (1975) index and the decomposition of its components (HIIT and VIIT) using Kandogan (2003).

A key methodological contribution of this research is the application of a Poisson Pseudo-Maximum Likelihood (PPML) estimation method with high-dimensional time fixed effects, ensuring empirical robustness. By employing this advanced econometric approach, the study provides a more comprehensive empirical analysis, which strengthens the reliability of its findings and contributes to the broader understanding of how globalization shapes provincial trade patterns. Ultimately, this dissertation provides valuable insights into regional trade dynamics, economic integration, and policy implications for enhancing Canada's competitiveness in the global market.

The preliminary stage of the dissertation provided an extensive analysis of Canada's provincial trade patterns, trade liberalization, and sectoral trade profiles. The analysis reveals that Canada's trade openness has evolved significantly, with interprovincial trade steadily declining while international trade has expanded, reaching over 80% of GDP before stabilizing at about 61% in 2020. Trade agreements such as CUSFTA, NAFTA, and presently USMCA have played a pivotal role in shaping Canada's trade structure, facilitating international trade growth, and altering provincial trade openness. Trade patterns indicate that Ontario, Quebec, Alberta, and British Columbia are the primary drivers of both interprovincial and international trade. Conversely, the Atlantic provinces remain more reliant on interprovincial trade, though agreements like CETA (2017) have boosted their international trade share. Across all provinces, international exports and imports have outpaced

interprovincial trade, reflecting an increasing dependence on foreign markets. Alberta and Saskatchewan lead in resource-based exports (e.g., crude oil, minerals, and wheat), while Ontario and Quebec dominate manufacturing and high-tech exports (e.g., motor vehicles, aerospace, and pharmaceuticals). The study also highlights Canada's revealed comparative advantage (RCA), showing strong reliance on the U.S. market while also expanding trade into European and Asian markets.

In confirmation of hypothesis 1, this study provides strong empirical evidence on how the traditional indicators of the gravity equation and globalization mechanisms shape provincial trade performance. The results confirm that economic size, liberalization, and integration into global markets significantly enhance trade, while geographical distance and institutional factors create persistent barriers. These findings align with several seminal works in trade literature, including Anderson and van Wincoop (2003), who emphasize the role of economic size and trade costs in shaping trade flows, and Baier and Bergstrand (2007), who demonstrate the substantial trade-enhancing effects of RTAs.

The study also reveals key asymmetries in globalization's effects on trade, particularly when considering income disparities between trading partners. Similar to the findings of Fajgelbaum and Khandelwal (2016), this study shows that lower-income economies face greater export constraints under protectionist policies, whereas higher-income economies trade more by maintaining import demand despite tariffs. The results further support the work of Baier et al. (2019), which highlights how trade liberalization disproportionately benefits developed economies, while low-income partners struggle to expand market access.

Moreover, the findings on ERV and income disparities are consistent with those of Bacchetta and van Wincoop (2000), who demonstrate that exchange rate fluctuations create significant trade frictions, especially for developing economies with weaker financial systems. This study confirms that as income disparities increase, ERV becomes a greater deterrent to trade, reinforcing the structural disadvantages faced by lower-income trading partners, as observed in studies by Gopinath et al. (2020).

Overall, the results suggest that globalization fosters trade integration but in an uneven manner. While liberalization mechanisms encourage exports and total trade, disparities in economic development influence how RTAs and trade barriers, such as tariffs and exchange rate fluctuations, impact trade flows. Lower-income partners face greater export constraints and trade volatility.

Recognizing the significant role of the United States in Canada's foreign trade, the dissertation included a dedicated analysis of the Canada-U.S. border effect. Using gravity model estimations on recent data from 2002 to 2020, it examined trade integration and potential barriers under NAFTA and USMCA to provide an updated assessment. By incorporating interprovincial trade into the analysis, the study refines the measurement of trade integration between Canadian provinces and U.S. states. Findings suggest that provincial economies have benefited from increased trade openness, which has supported job creation, capital investment, and deeper integration into global value chains. New Brunswick, Saskatchewan, Prince Edward Island, and Alberta exhibit the highest levels of trade openness, while Ontario and Quebec continue to be central to national GDP growth.

The findings highlight the evolving nature of cross-border trade, the persistence of trade frictions, and the asymmetrical impact of globalization mechanisms. The empirical results confirm that while trade between Canadian provinces and U.S. states has grown over time, there remains a significant home bias in trade, with interprovincial trade being 7.1 times larger than cross-border trade. The observed decline in border effects from earlier studies, including Suvankulov (2015) and Query (2014), suggests a gradual easing of trade frictions, likely due to deeper economic integration under NAFTA. However, the persistence of trade barriers, especially in imports, indicates that domestic sourcing remains a strong preference for Canadian firms. **The empirical results provide compelling evidence in support of the hypothesis that globalization mechanisms reflect the extent to which international borders impede trade more than domestic boundaries.** The significant increase in border effects, particularly in exports and imports, indicates that international borders impose additional frictions not observed in domestic trade flows. The persistence of substantial border effects underscores the growing importance of NTBs and institutional differences in shaping trade flows. Addressing these deeper frictions is essential for advancing meaningful trade integration in the post-globalization era. These frictions are further exacerbated by the regulatory adjustments associated with the transition from NAFTA to USMCA and the disruptions introduced by the Covid-19 pandemic. Overall, the findings confirm that while globalization mechanisms generally promote trade integration, they also magnify cross-border challenges, thereby impeding international trade to a greater extent than domestic trade.

The study further reveals that border effects are not uniform across provinces. Regions with strong trade linkages to the U.S., such as Ontario and Manitoba, exhibit lower home bias in trade, while provinces like British Columbia and Nova Scotia continue to rely more on

interprovincial markets. This variation aligns with previous literature, including McCallum (1995) and Anderson & van Wincoop (2003), which emphasize the role of regional economic structures and geographic proximity in trade integration. The results demonstrate that Canadian provinces import 8.7 times more from each other than from U.S. states, compared to exporting 6.0 times more. This asymmetry suggests that while Canadian firms actively engage in cross-border exports, they continue to source the majority of their imports domestically, reflecting stronger barriers to inbound trade. Similar patterns have been documented by Chen (2004) and Helliwell (1998), who argue that regulatory differences, supply chain structures, and tariff measures contribute to higher import frictions. Another key finding is that provinces with major export-driven industries, such as Alberta (energy), Ontario (automotive), and Saskatchewan (agriculture), are more outward-oriented, whereas regions with smaller economies and less trade diversification experience have higher home bias. This further supports the gravity literature that highlights sectoral specialization as a driver of trade openness (Bergstrand, 1985).

The study also confirms that land-border proximity significantly enhances trade. Provinces with direct land connections to U.S. states experience higher trade intensities, with borderland regions increasing trade flows by approximately 2.89 times. This finding is coherent with existing literature, e.g., Downs and Sawchuk (2007). Industries located in these regions, such as automotive manufacturing (Ontario-Michigan), agriculture (Saskatchewan-North Dakota), and energy (Alberta-Montana), rely heavily on U.S. markets. This effect is stronger for exports than imports, reflecting the cost advantages and supply chain efficiencies associated with cross-border production networks. These findings are consistent with the literature on regional trade integration, including Feenstra (2004) and Anderson & Yotov (2016), who argue that border proximity reduces transaction costs and facilitates smoother trade flows.

In terms of macroeconomic determinants of Canada-U.S. trade, first, the results confirmed a strong positive impact of provinces and U.S. states' economic size on trade by 0.91% and 0.88%, respectively. These estimates align with traditional gravity model expectations (Tinbergen, 1962) and reaffirm the importance of economic scale in trade integration (Suvankulov, 2015; Brodzicki and Umiński, 2017; Friedman, 2020). Further findings indicate that tariff-related barriers are statistically insignificant, suggesting that the tariff phase-out has had a minimal direct impact on trade volumes. However, residual trade restrictions in sectors such as dairy, steel, and construction materials continue to influence trade patterns.

It was also found that currency fluctuations significantly impact trade flows, with the depreciation of the Canadian dollar reducing total trade by 35.7%, exports by 42.4%, and imports by 28.4%. This suggests that exchange rate instability increases transaction costs and trade frictions, discouraging both exports and imports. These results are in line with findings from Bacchetta & van Wincoop (2000), Gopinath et al. (2020), and Brodzicki and Umiński (2017) who emphasize the destabilizing effects of exchange rate uncertainty on trade relationships.

Higher economic freedom is positively correlated with greater trade intensity, particularly in exports. Economies with fewer trade restrictions and stronger institutional frameworks attract higher foreign demand, leading to expanded trade activities. This finding is consistent with studies by de Jong and Ripoll (2006), who demonstrate that regulatory quality and market openness enhance trade performance. The study finds that as income disparities between Canada and U.S. states increase, trade integration weakens. While provinces with similar income levels exhibit stronger trade ties, regions with larger income differences trade at lower intensities, particularly in imports. This suggests that economic convergence plays a crucial role in facilitating bilateral trade, a conclusion supported by Baier et al. (2019).

Overall, the study provides new insights into the evolving Canada-U.S. trade relationship, showing that while border effects have declined over time, significant trade frictions persist. Home bias in trade remains evident, particularly in imports, but deeper economic integration and globalization have contributed to a gradual easing of trade barriers. The study's findings align with existing literature and highlight the importance of economic size, geographic proximity, regulatory harmonization, and financial stability in shaping trade outcomes.

To test hypothesis 2, this study highlights the significant role of province-specific characteristics in shaping IIT and its components. The findings highlight the complex interplay between economic scale, institutional quality, workforce composition, taxation, and trade structures, shaping how provinces engage in international and interprovincial trade. While the results show some expected relationships, they also reveal unexpected trends, particularly regarding the impact of import and production taxes on different trade structures.

The results confirm the fundamental role of GDP size in driving IIT, particularly HIIT. Larger economies exhibit stronger IIT due to their ability to sustain multiple product varieties and diversified production networks. As provinces grow economically, they engage more in trade of similar-quality differentiated goods, benefiting from economies of scale and market

size. VIIT, while also responsive to GDP growth, is less sensitive than IIT and HIIT, suggesting that economic expansion encourages trade in horizontally structured goods rather than vertically specialized products. This aligns with Proença and Faustino (2015), who found that economic size enhances reciprocal trade in differentiated goods.

The findings also highlight the importance of both geographic positioning and institutional quality in shaping IIT patterns at the provincial level in Canada. Provinces located farther from the equator and thereby more likely to benefit from temperate climates, historical industrial development, and effective institutions tend to engage more intensively in IIT, particularly HIIT, which tends to reflect the convergence in demand structures and production capabilities across high-latitude regions and their major trade partners (Helpman and Krugman, 1985). These results support the broader literature linking geography and institutions to trade specialization and reinforce the policy relevance of strengthening institutional capacity and infrastructure to deepen regional trade integration. The moderate elasticities for the VIIT suggest that while geographic and institutional endowments facilitate inter-stage production trade, the role of factor endowment differentials (e.g., labor cost variation) may remain relevant in explaining VIIT flows. The joint significance of institutional quality and distance from the equator supports the hypothesis that structural factors associated with geography and governance jointly influence trade specialization patterns (Gallup et al., 1999; Dollar and Kraay, 2003; Rodrik et al., 2004). The results imply that as governance quality improves, economies focus more on high-tech, innovation-driven exports and maintaining diversified IIT structures.

The results further underscore the central role of economic development, as proxied by GDPpc, in shaping the structure of IIT and especially HIIT, suggesting that as income levels rise, economies tend to develop more diversified and sophisticated production structures, enabling greater engagement in two-way trade within industries. This trend supports previous findings (Dhingra, 2013; Sano, 2020), which link rising incomes to increased consumer preference for variety, firm-level innovation, and product quality upgrading. The insignificant impact on VIIT suggests that vertical trade flows are driven more by structural production differences than by income levels alone, a conclusion also supported by recent studies focusing on global value chains and North–South trade asymmetries (Lopez-Gonzalez, 2016). Collectively, the findings affirm that GDPpc is a key determinant of HIIT, while VIIT responds more to cross-country or cross-regional differences in specialization and factor costs.

The positive effect of R&D investment on all forms of IIT underscores the role of technological innovation in enhancing trade competitiveness. The results indicate that

economies investing in R&D are more likely to engage in quality-differentiated trade (VIIT) while also boosting HIIT and overall IIT. This suggests that innovation fosters both high-end product differentiation and competition in similar-quality goods, consistent with the findings of Doruk (2015) and Gilroy & Broll (1988). The ability to develop advanced technologies and improve product quality makes firms more competitive in both domestic and international markets, increasing IIT intensity.

The results highlight the dual significant importance of labor skill composition on trade structures. While low-skilled labor facilitates cost-effective production, high-skilled labor enhances product differentiation, innovation, and value-added trade. The stronger association with vertical IIT underscores the central role of human capital in enabling functional upgrading and integration into higher-value segments of global value chains (Feenstra & Hanson, 1996; Grossman & Rossi-Hansberg, 2008). These results underscore the policy relevance of investing in skill development and education to enhance a region's trade competitiveness in an increasingly knowledge-driven global economy (Krugman, 1980; OECD, 2023).

The findings on taxation present a nuanced picture of how fiscal policies shape trade structures. Higher production taxes negatively affect IIT and HIIT by increasing production costs and reducing firms' ability to compete in differentiated product markets. This suggests that tax burdens on firms discourage IIT, particularly in horizontally structured trade, where branding and economies of scale are critical. However, VIIT benefits from higher production taxes, indicating that firms respond by shifting lower-quality production to foreign suppliers, increasing VIIT. On the other hand, higher import taxes encourage IIT and HIIT by making domestic alternatives more competitive, leading to a substitution effect. This reinforces the notion that protectionist measures, while generally trade-restrictive, may stimulate IIT by incentivizing firms to produce domestically rather than relying on imports. However, while VIIT also increases under higher import taxes, the magnitude is lower, suggesting that import restrictions primarily encourage trade within similar-product industries rather than vertically structured supply chains.

The findings also provided strong empirical evidence that MNEs significantly influence trade performance, particularly in the expansion of IIT and its components. The results indicate that various MNE activities, including value-added contributions, capital formation, and employment generation, play a crucial role in shaping trade flows.

The positive and significant relationship between MNEs' value-added contributions and all IIT components suggests that MNEs enhance trade in differentiated products through all

forms of production networks, technology transfer, and economies of scale. This is in line with Keller and Yeaple (2003), who found that FDI contributes significantly to domestic firms' productivity, leading to greater IIT participation. Similarly, Blonigen et al. (2003) established that FDI strengthens IIT, particularly in industries with high capital intensity and knowledge spillovers.

Furthermore, the positive impact of MNEs' capital investments on all forms of IIT (with the strongest effect on HIIT) highlights the role of fixed capital formation in fostering trade within industries. This suggests that capital accumulation enables firms in the host country to engage in high-value manufacturing and trade, aligning with Markusen and Venables (2000), who demonstrated that MNE investments lead to productivity spillovers and increased IIT. Additionally, Helpman, Melitz, and Yeaple (2004) argue that MNEs prefer investing in skill-intensive industries, reinforcing their role in HIIT expansion. The results also align with Şentürk (2023), who found a causal relationship between FDI and IIT in Turkey's capital goods sector, highlighting that foreign investments promote IIT growth.

The employment-generating activities of MNEs are shown to have the strongest impact on IIT, particularly HIIT, reinforcing the idea that MNEs facilitate labor market integration into global supply chains. This result corroborates earlier findings, e.g. Javorcik (2004), who demonstrated that MNE employment creation enhances domestic firms' integration into global production networks. Additionally, Görg and Greenaway (2004) provide empirical evidence that MNEs' employment generation plays a crucial role in increasing trade flows, particularly in high-skilled industries. The substantial effect of MNEs' employment on VIIT also suggests that MNEs help integrate domestic suppliers into vertically structured trade networks, consistent with Baldwin and Lopez-Gonzalez (2015), who emphasized MNEs' role in expanding global value chains.

Overall, the findings confirm that MNEs play a crucial role in enhancing trade performance through intra-industry linkages. Their contributions to capital investments, employment generation, and value-added activities significantly bolster all forms of IIT. These results align with existing literature that highlights the role of FDI, production networks, and labor market integration in driving trade flows. Thus, policymakers seeking to enhance trade performance should focus on fostering an environment that attracts MNE investments, encourages technology transfer, and facilitates workforce integration into global production systems.

5.2 Policy recommendations

This section synthesizes the empirical findings of the dissertation and outlines key policy recommendations derived from the analysis. The study has investigated the structural, institutional, and macroeconomic determinants of international and IIT at the provincial level in Canada using an augmented gravity model estimated via PPML. Results underscore the strong importance of economic size, geographic proximity, institutional compatibility, and globalization mechanisms, particularly liberalization factors and exchange rate dynamics in shaping trade outcomes. Moreover, the impact of these mechanisms is shown to be conditional on structural asymmetries, including disparities in income and institutional development among trading partners, including observed border effects, which were found to be more attributable to institutional asymmetries and unobservable non-tariff frictions rather than tariffs. The findings further reveal that differentiated trade flows are strongly influenced by provincial capacities in innovation, human capital, and the presence of multinational enterprises (MNEs). These insights provide the basis for a more differentiated, structure-aware, and regionally adaptive trade policy approach.

1. Deepening institutionally aligned trade agreements

Trade agreements that are limited to tariff reductions offer only partial solutions when substantial institutional or income gaps exist between trading partners. The analysis indicates that Canadian trade policy should be expanded to include regulatory convergence, mutual recognition of standards, and frameworks for technical cooperation. Such agreements should integrate institutional support mechanisms, including trade facilitation, SME development initiatives, and capacity-building programs for less developed partners (cf. Baldwin, 2016; Rodrik, 2018). These comprehensive frameworks are more likely to foster durable and mutually beneficial trade flows, particularly in complex and differentiated goods sectors.

2. Contextualizing tariff liberalization

The study finds that the adverse effects of tariffs are magnified in asymmetric trade relationships. Accordingly, tariff liberalization should be prioritized in trade engagements with partners that exhibit structural and institutional similarities. In contexts where asymmetries are unavoidable, complementary support measures are required, such as investment in border infrastructure, modernization of customs administration, and technical assistance (Anderson &

van Wincoop, 2003). This contextualized approach will enhance the efficacy of tariff policies and mitigate unintended distributional consequences.

3. Managing ERV through risk mitigation instruments

ERV emerged as a significant constraint, especially for trade involving institutionally or economically dissimilar partners. SMEs are particularly vulnerable in such environments due to their limited access to financial risk instruments. Trade resilience can be enhanced through expanded access to currency hedging mechanisms, credit guarantees, and financial literacy programs. Strengthening national and provincial trade finance infrastructure is also recommended to better support firms against external shocks (Gopinath et al., 2020).

4. Enhancing domestic trade capacity through structural investments

Infrastructure and institutional quality are critical to enabling effective trade participation. Targeted investments in logistics, transport, and digital infrastructure, especially in lagging regions, are essential to overcoming spatial inequalities. Simultaneously, provinces with established infrastructure should be utilized as strategic export hubs. Institutional reforms to enhance regulatory transparency, streamline bureaucracy, and improve market access are also recommended (World Bank, 2020). These investments will support a more balanced and inclusive national trade architecture.

5. Advancing regulatory integration and supply chain resilience

Based on the findings that over 96% of the border effect is attributable to NTBs and institutional frictions, policymakers should prioritize regulatory harmonization and the negotiation of Mutual Recognition Agreements (MRAs), particularly in sectors heavily affected by technical and sanitary standards. Enhanced regulatory alignment under the USMCA framework would reduce transaction costs and streamline cross-border compliance. Additionally, to address the heightened vulnerability of international trade to systemic shocks, as evidenced during the Covid-19 pandemic, Canada and the United States should strengthen institutional mechanisms for supply chain resilience and crisis coordination, including shared emergency protocols and interoperable digital trade systems, to minimize future disruptions and reinforce trade integration.

6. Promoting innovation and human capital development

Differentiated trade, both horizontal and vertical, is strongly associated with provincial capacities in innovation and human capital. Policymakers should prioritize the expansion of advanced education, particularly in STEM fields, and vocational training linked to high-tech industries. Public support for R&D, as well as incentives for university-industry collaboration, is also essential to fostering a knowledge-intensive export base (Krugman, 1991; Grossman & Helpman, 1991). These investments will enable provinces to participate more fully in global value chains and sustain long-term competitiveness.

7. Strategically embedding multinational enterprises

MNEs serve as key conduits for trade integration, technology transfer, and capital investment. Trade policy should promote high-value FDI while facilitating strong linkages between MNEs and domestic suppliers. Policies encouraging knowledge spillovers such as innovation clusters, training partnerships, and supplier development programs can amplify the developmental impact of MNEs. Special emphasis should be placed on attracting MNEs to underdeveloped regions to promote regional economic convergence (Narula & Dunning, 2010).

8. Tailoring trade policy to partner and flow characteristics

The analysis affirms the need for trade policy differentiation based on partner profiles and the direction of trade flows. Export promotion should target institutionally and economically similar partners to increase the likelihood of success. Conversely, import policy should incorporate risk management strategies to address volatility and structural mismatch. Trade negotiations should be informed by ex-ante structural diagnostics, enabling policymakers to identify and mitigate frictions early in the policy cycle (Helpman, Melitz & Rubinstein, 2008).

5.2.1 Province-specific recommendations

The heterogeneity observed across provinces in the export and total trade models indicates that globalization mechanisms, institutional quality, and structural factors do not affect all regions equally. Consequently, policy interventions aimed at enhancing provincial trade performance need to be tailored to each province's economic profile, sectoral composition, and exposure to global markets. Drawing on the model results, the following recommendations

outline practical measures for provinces to strengthen their trade competitiveness and mitigate vulnerabilities identified in the estimates.

Central provinces (Ontario and Quebec)

Given their large gains from RTAs and strong metropolitan effects, Ontario and Quebec should focus on policies that deepen their integration into global value chains and protect preferential market access. This includes reinforcing trade facilitation with the United States and the European Union, supporting advanced manufacturing clusters (automotive, aerospace, high-tech), and expanding provincial export-credit guarantees to sustain SMEs' participation in cross-border supply chains. Continued investment in urban infrastructure and innovation ecosystems would further enhance the agglomeration advantages already driving trade performance.

Western provinces (Alberta, British Columbia, Manitoba, and Saskatchewan)

These provinces benefit strongly from partner globalization but display greater sensitivity to commodity prices and ERV. Policy should concentrate on diversifying export markets beyond traditional partners, developing commodity-hedging tools for producers, and enhancing transportation and port infrastructure to reduce distance-related costs. Alberta and British Columbia could also strengthen climate-resilient logistics and certification systems to maintain competitiveness in energy and agri-food exports, while Saskatchewan should expand value-added processing to reduce vulnerability to raw commodity price swings. With weaker RTA effects and stronger tariff sensitivity, Manitoba would benefit from targeted support to expand its export base within preferential agreements and reduce tariff exposure. Developing export-readiness programs for SMEs, especially in agri-food and light manufacturing, could increase integration into global value chains. Enhancing digital trade infrastructure would also reduce distance penalties for smaller firms.

Atlantic provinces (New Brunswick, Nova Scotia, Newfoundland & Labrador, Prince Edward Island)

The Atlantic provinces show the highest vulnerability to tariffs and exchange rate volatility, reflecting narrow export bases and heavy reliance on imported inputs. Policy should focus on diversification into higher-value sectors (such as ocean technology and renewable

energy), improving port efficiency and customs procedures, and providing hedging and trade-finance support to SMEs. Prince Edward Island, in particular, would benefit from programs aimed at scaling up small exporters to withstand currency and tariff shocks.

The recommendations are further decomposed into short and medium-term policy pursuits by individual provinces.

Table 5.1 Province-specific policy measures for enhancing trade performance

Province	Short-Term Measures (1–3 Years)	Medium-Term Structural Measures (3–7 Years)
Ontario	▪ Expand export-credit guarantees for SMEs in U.S. and EU markets. ▪ Streamline customs and border procedures with federal agencies. ▪ Provide quick-access R&D vouchers for automotive and aerospace firms.	▪ Invest in next-generation transport/logistics hubs and digital customs systems. ▪ Strengthen innovation ecosystems and workforce training to sustain metropolitan agglomeration effects. ▪ Deepen cross-border regulatory cooperation in key sectors (automotive, med-tech).
Quebec	▪ Increase support for aerospace and high-tech exporters in certification and market entry. ▪ Expand bilingual trade facilitation services to diversify markets. ▪ Provide bridging finance to SMEs integrating into GVCs.	▪ Upgrade port and airport infrastructure to support intercontinental exports. ▪ Develop specialized innovation clusters in aerospace, AI, and clean tech. ▪ Strengthen institutional ties with emerging markets to reduce U.S. dependence.
Alberta	▪ Introduce commodity-price hedging support and risk-management training for energy/agri-food SMEs. ▪ Launch targeted export-market intelligence and diversification programs toward Asia/EU. ▪ Pilot climate-resilient logistics certification.	▪ Develop large-scale infrastructure (pipelines, rail, ports) to reduce distance costs. ▪ Expand value-added processing in energy and agriculture to reduce raw-commodity vulnerability. ▪ Establish provincial innovation funds for clean energy and agri-tech supply chains.
British Columbia	▪ Expand port efficiency and customs streamlining at Vancouver and Prince Rupert. ▪ Provide SME training on Asian standards and logistics. ▪ Support hedging tools for forestry and agri-food exporters.	▪ Invest in green shipping and port modernization to enhance Pacific gateway competitiveness. ▪ Foster high-tech and film/creative export clusters. ▪ Strengthen provincial trade offices in Asia to secure long-term market presence.
Saskatchewan	▪ Offer value-added export readiness training for agricultural producers. ▪ Support risk-management and currency hedging for grain and potash exporters. ▪ Provide incentives for SME participation in overseas trade fairs.	▪ Expand agri-food processing infrastructure to shift from raw to processed exports. ▪ Develop transport corridors linking northern resources to global markets. ▪ Strengthen R&D partnerships in agri-tech and clean fertilizers.
Manitoba	▪ Launch SME export-readiness programs in agri-food and light manufacturing. ▪ Provide tariff-mitigation advisory services for firms in sensitive sectors. ▪ Enhance digital platforms for trade finance and customs clearance.	▪ Invest in intermodal logistics hubs to reduce distance penalties. ▪ Diversify export base beyond U.S. markets via provincial trade missions. ▪ Build long-term innovation capacity in food processing and transport equipment.

New Brunswick	▪ Improve port efficiency at Saint John to lower transaction costs. ▪ Provide hedging and trade-finance support to SMEs. ▪ Create quick-access export diversification grants for ocean-tech firms.	▪ Develop renewable energy and ocean-tech clusters to diversify exports. ▪ Modernize transport infrastructure connecting rural producers to ports. ▪ Strengthen institutional ties with the EU and Atlantic markets post-CETA.
Nova Scotia	▪ Expand customs streamlining and SME export-credit support. ▪ Provide training on currency risk management for small exporters. ▪ Facilitate joint marketing of seafood and ocean-tech products abroad.	▪ Upgrade port and cold-chain infrastructure for perishable exports. ▪ Foster higher-value ocean-tech and education services exports. ▪ Establish long-term innovation funds for marine sciences and shipbuilding.
Newfoundland & Labrador	▪ Support risk-management for oil, gas, and fisheries exporters. ▪ Provide SME export grants for diversification beyond U.S. markets. Improve logistics coordination for remote communities.	▪ Develop large-scale renewable energy and hydrogen export infrastructure. ▪ Invest in R&D for sustainable fisheries and offshore technologies. ▪ Strengthen training programs to build a skilled workforce for emerging industries.
Prince Edward Island	▪ Scale up small exporters through mentoring and hedging facilities. ▪ Provide tariff-exposure diagnostics for agri-food SMEs. ▪ Offer micro-grants for product certification to access new markets.	▪ Diversify export base into high-value agri-food niches and tourism services. ▪ Build collaborative marketing platforms for small producers. ▪ Develop logistics hubs to lower shipping costs and reduce vulnerability to volatility.

Source: Own elaboration

Conclusion

The empirical findings presented in this dissertation demonstrate that Canadian provincial trade dynamics are shaped by a multifaceted interplay of structural, institutional, and macroeconomic factors. Globalization mechanisms such as RTAs, tariff liberalization, and exchange rate stabilization cannot be uniformly effective without accounting for income disparities, institutional compatibility, and regional development capacities. A structure-sensitive and regionally differentiated approach to trade policy is therefore essential.

To move beyond one-size-fits-all liberalization, Canadian policymakers must embed structural diagnostics into the formulation and implementation of trade strategies. Moreover, building inclusive innovation ecosystems, modernizing institutions, and supporting human capital development are vital to enabling provincial economies to engage more effectively in global trade networks. By adopting these recommendations, Canada can enhance provincial competitiveness, foster more equitable trade outcomes, and construct a resilient and future-ready national trade system.

5.3 Further research opportunities

While this doctoral dissertation offers a comprehensive analysis of the provincial trade dynamics, several areas remain open for further exploration. First, while this study utilizes annual disaggregated provincial-level trade data, future research could extend the analysis to a more granular level by examining industry- or firm-specific trade patterns. This dissertation could not undertake this level of analysis due to the unavailability of suitable data. A firm-level approach could offer deeper insights into trade participation, supply chain integration, and the role of multinational enterprises in provincial trade. Second, this dissertation investigates three sources of non-linearity in the relationship between provincial trade and globalization mechanisms. However, additional research could explore other potential non-linearities, such as the interaction effects between RTAs, tariffs, exchange rates, and GDP, as well as the role of institutional quality in moderating these relationships. Given the dynamic nature of global trade policies, future studies could also assess whether economic structure heterogeneity across provinces influences the extent to which globalization affects trade performance. Furthermore, since the analyzed sample concludes in 2022, it would be valuable to re-examine provincial trade performance in light of evolving global trade dynamics, including the impact of rising protectionism, supply chain reconfigurations, and geopolitical trade tensions. Future studies could explore how shifts in U.S. trade policy, such as potential tariff escalations under the new Trump administration, affect Canadian provincial trade. Beyond these considerations, additional research could investigate the implications of digital trade, e-commerce, and automation on provincial trade structures. The growing influence of sustainability policies, carbon border adjustment mechanisms, and climate-related trade regulations presents another avenue for exploration.

Lastly, incorporating firm productivity measures and labor market adjustments into trade models could provide a more comprehensive understanding of how globalization shapes regional economic development and competitiveness.

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APPENDIX

Appendix 1: Baseline Gravity Model

Appendix 1A: Gravity of provincial trade and globalization mechanisms – estimates of the import model

The main gravity variables

The result from the import model is also robust. The base specifications of the gravity model are given in columns M-1A and then further extended with augmented variables across the specifications. The impact of the size of the provincial economies and that of the trading partners is positive and statistically significant. Models containing a log of the population of trading partners as a proxy for the size of the economy have also been tested. The results are robust and consistent. As expected, the coefficients on the log of real GDP of both provinces and trading partners are statistically significant and are either approximately or more than 1. Across specifications, the provinces' economic size has a greater effect on the import models. This implies a strong sensitivity of trade flows to the economic size of the provinces, supporting the theoretical gravity model and consistent with findings in Anderson and van Wincoop (2003), Chen (2004), Head and Mayer (2014). As expected, the coefficient on the log of distance is negative and statistically significant across specifications. The magnitude of this effect is more pronounced in specification M-2B. (e.g., -1.79 and -1.85, respectively). The implication of the results is that distance puts downward pressure on imports and trade by extension, regardless of the other partners' characteristics. The differences in the effects of size and distance across specifications are due to the number of controlled variables in each specification.

The estimates for the remoteness indexes are small and highly insignificant across specifications, confirming that, all else equal, Canadian provinces and trading partners are open to international trade, given the small coefficients of the multilateral trade resistance or remoteness terms. Partners that are far from global suppliers face high import costs due to transportation and logistics constraints. Importers are less affected by the exporter's remoteness, as they can find suppliers willing to adjust prices or alternative markets with less cost of imports.

Globalization/institutional mechanisms

The estimated results further indicate a robust and statistically significant negative relationship between provinces' index of economic freedom and import volumes, with the PPML estimate yielding a coefficient of -0.59 at 1% level. This suggests that greater economic freedom at the provincial level may foster domestic competitiveness or reduce reliance on foreign imports. Alternative estimations using the HT and GPML methods yield similar results, respectively, supporting the robustness of the main PPML results. Regarding trading partners' economic freedom, the PPML and GPML estimates also reveal a negative and statistically significant effect on imports, indicating that provinces tend to import less from more economically free partners, possibly due to overlapping competitiveness. The HT estimate, however, presents a positive and significant coefficient, highlighting some model sensitivity but ultimately reinforcing the value of PPML as a more consistent estimator in capturing the trade implications of economic freedom.

The estimated results for the impact of RTAs on provincial imports demonstrate a consistently positive and statistically significant effect across all estimation methods. This suggests that the presence of a trade agreement significantly enhances import flows, likely by reducing trade barriers, increasing market access, and fostering regulatory alignment. The consistent direction and statistical significance across models underscore the strong facilitative role of trade agreements in promoting international import activity at the provincial level. The estimated results for the effect of tariff measures on provincial imports reveal a predominantly negative and statistically significant relationship. This finding suggests that higher tariff levels substantially reduce import volumes, reflecting the classical trade-deterring effect of increased trade costs. The consistency of the negative and significant estimates in both PPML and GPML models supports the conclusion that tariff measures act as a significant impediment to provincial import flows.

The estimated results from the import model indicate that ERV exerts a strong and consistently negative effect on provincial imports, suggesting that greater uncertainty in exchange rates significantly deters trade activity. This result is corroborated by the GPML estimate, while the HT estimate, though smaller in magnitude, remains statistically significant, reinforcing the robustness of the finding. The GDPpc difference between provinces and trading partners shows a positive and significant association with imports across all estimators, implying that income differentials may create complementary trade patterns driven by demand and

specialization. Conversely, the presence of a metropolis is associated with a significant reduction in import volumes, possibly reflecting self-sufficiency or localized economic clustering. The GPML estimator yields similar results.

Panel gravity regression – baseline estimates of the import model

Estimation Method	**PPML**	**PPML**	**PPML**	**PPML**	**PPML**	**HT**	**HT**	**HT**	**GPML**	**GPML**
Variable/Specification	**M-1A**	**M-2A**	**M-3A**	**M-4**	**M-5**	**M-1B**	**M-2B**	**M-3B**	**M-1C**	**M-2C**
lnGDP_pr	1.173***	1.195***	1.149***	1.190***	1.376***	0.809***	1.421***	0.594***	1.420***	1.178***
	(0.029)	(0.028)	(0.027)	(0.030)	(0.038)	(0.197)	(0.107)	(0.182)	(0.043)	(0.027)
lnGDP_tp	0.989***	1.007***	1.002***	0.981***	1.020***	0.859***	0.717***	0.794***	0.994***	1.014***
	(0.017)	(0.018)	(0.016)	(0.019)	(0.015)	(0.038)	(0.050)	(0.039)	(0.019)	(0.017)
lnDistance	-0.629***	-0.676***	-0.690***	-0.601***	-0.643***	-1.661***	-2.040***	-1.535***	-0.529***	-0.691***
	(0.028)	(0.023)	(0.050)	(0.026)	(0.025)	(0.145)	(0.164)	(0.144)	(0.028)	(0.053)
lnRM_HD_pr			-0.015			0.003				-0.021
			(0.022)			(0.008)				(0.023)
lnRM_HD_tp			-0.018			0.007				-0.025
			(0.032)			(0.012)				(0.034)
Ec_fredom_pr		-0.585***					-0.398			-0.543***
		(0.166)					(0.425)			(0.166)
Ec_fredom_tp		-0.170***					0.223***			-0.111***
		(0.026)					(0.062)			(0.030)
lnGlo_dj_tp		-0.001						-0.008		0.009
		(0.025)						(0.014)		(0.026)
Lib_RTA				0.470***		0.291***		0.314***	0.544***	
				(0.072)		(0.064)		(0.063)	(0.070)	
Lib_Tarif_df				-0.507***		0.332***			-0.496***	
				(0.123)		(0.058)			(0.115)	
ERV				-1.570***		-0.127***	-0.116**		-1.391***	
				(0.218)		(0.047)	(0.048)		(0.206)	
lnGDPpc_diff					0.113***			0.069***		0.057*
					(0.024)			(0.025)		(0.030)
Metrop_node					-1.005***	1.878***		2.097***	-1.038***	
					(0.114)	(0.427)		(0.399)	(0.124)	
Com_Lang			0.168**				-0.432			0.226***
			(0.068)				(0.393)			(0.079)
Col_Link			-0.520***				0.150			-0.444***
			(0.068)				(0.392)			(0.076)
Constant	-2.385***	3.397***	-1.228*	-2.360***	-5.519***	1.219	2.638	1.707	-5.742***	2.257*
	(0.702)	(1.285)	(0.643)	(0.674)	(0.714)	(2.248)	(3.081)	(2.234)	(0.791)	(1.312)
Observation	46,340	29,280	46,340	30,820	46,340	30,820	30,800	41,960	30,820	29,280
Log-Pseudo Likelihood	-3.70E+12	-3.10E+12	-3.70E+12	-2.80E+12	-3.60E+12				-2.70E+12	-3.00E+12
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.915	0.916	0.917	0.924	0.919					
Prob > chi^2	0	0	0	0	0	0	0	0		
Wald chi^2	36295	35428	42346	36258	48817	8783.68	9161	7291		
AIC									1.76E+08	2.07E+08

Source: Own elaboration using STATA/MP Version 17. Explanatory variables are as defined in Table 3.1. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%. M - is the imports model, estimated using PPML (as the primary estimator); HT and GPML are alternative estimators

Appendix 1B: Estimates of the alternative size (population) variable in the baseline gravity model

Across all three trade dimensions (exports, total trade, and imports), both GDP and population variables produce positive and highly significant coefficients for both provincial and partner size. This confirms the fundamental gravity-model expectation that larger provinces and larger partner markets trade more. In all specifications, the signs and levels of statistical significance remain robust, with pseudo-R^2 values above 0.85, suggesting that substituting population for GDP does not erode explanatory power. The similarity in the estimated effects indicates that the model is capturing a genuine size effect, whether measured by economic scale (GDP) or demographic scale (population), which is consistent with classical gravity findings (Tinbergen, 1962; Anderson & van Wincoop, 2003). Moreover, the sign and statistical significance of the core coefficients (distance, RTAs, partner globalization index, ERV) remain broadly consistent across both sets of estimates, the GDP-based specifications yield systematically larger and more stable size elasticities, especially for exports and total trade, and produce higher pseudo-R^2 values than the population-based specifications. These results confirm that GDP better captures the combined effects of market scale and purchasing power underlying provincial trade flows, whereas population alone understates income-driven capacity and shifts more variation onto distance and institutional variables.

In the export models, provincial GDP coefficients in the baseline average between 0.65 and 0.88, while the alternative population-based coefficients range from 0.43 to 0.73 (PPML). Partner GDP coefficients are slightly higher than partner population coefficients (about 1.15–1.30 for GDP vs. approximately 0.95–1.20 for population). This suggests that while both measures capture market size, GDP better explains the intensity of exports because it reflects purchasing power and production capacity rather than just headcount. The larger partner-GDP coefficients underscore the role of economic scale and income in driving export demand. However, the close alignment of population coefficients across models suggests that demographic scale is still a meaningful predictor of export flows, especially for consumer goods and mass-market products.

For total trade, the difference between GDP-based and population-based size variables is narrower. Provincial coefficients cluster around 0.95–1.02 for GDP and 0.75–0.90 for population; partner coefficients around 1.05–1.11 for GDP and 0.94–1.12 for population. This reflects that when imports are included, demographic scale begins to approximate market size

more closely, perhaps because imports often track consumer demand directly. The similarity between GDP and population coefficients in the total trade model suggests that both economic and demographic scale shape two-way flows in a broadly proportional manner.

In the import models, population-based provincial coefficients are consistently higher (about 1.03–1.19) than GDP-based ones (approximately 1.15–1.37 but sometimes lower under alternative estimators), indicating that provincial population is a stronger predictor of import flows than GDP. Partner coefficients remain similar under both measures, though slightly lower for population than GDP. This pattern suggests that import demand may be more directly linked to demographic factors (consumer base size) than to GDP, which may also include non-consumption elements such as investment or government spending.

The similarity of results between the GDP and population specifications confirms the robustness of the size effect in the gravity models. It also highlights that population-based models are more informative for imports (consumer-driven flows), while GDP-based models are more informative for exports (production-driven flows). This supports the theoretical expectation that export capacity is tied to production scale and productivity, whereas import demand correlates with the size of the consuming population.

Overall, the findings show that replacing GDP with population as the size variable yields broadly consistent results across all three trade models, underscoring the robustness of the gravity specification. In each case, larger provinces and larger partner markets are associated with higher trade flows, regardless of whether size is measured by economic scale or demographic scale. However, the coefficients reveal a subtle but important divergence: GDP better predicts export intensity, reflecting its link to production capacity and purchasing power, whereas population is relatively stronger for import flows, which are more directly tied to consumer base size. For total trade, the gap between GDP and population coefficients narrows, suggesting that both economic and demographic scale jointly shape two-way flows. These similarities and differences are consistent with gravity-model theory and prior empirical work (e.g., Anderson & van Wincoop, 2003; Head & Mayer, 2014), reinforcing the credibility of the dissertation's estimation strategy.

Baseline panel gravity regression – alternative size estimates of the export model

Estimation Method	**PPML**	**PPML**	**PPML**	**PPML**	**PPML**	**HT**	**HT**	**HT**	**GPML**	**GPML**
Variable/Specification	**E-1A**	**E-2A**	**E-3A**	**E-4**	**E-5**	**E-1B**	**E-2B**	**E-3B**	**E-1C**	**E-2C**
lnpop_pr	0.527***	0.609***	0.563***	0.729***	0.428***	1.017**	1.554***	1.366***	0.573***	0.618***
	(0.018)	(0.021)	(0.018)	(0.021)	(0.040)	(0.430)	(0.110)	(0.391)	(0.035)	(0.021)
lnpop_tp	1.007***	1.202***	0.949***	1.118***	1.016***	0.956***	1.085***	0.988***	1.103***	1.184***
	(0.017)	(0.019)	(0.014)	(0.038)	(0.022)	(0.030)	(0.042)	(0.027)	(0.035)	(0.018)
lnDistance	-1.699***	-0.727***	-1.444***	-0.733***	-1.251***	-2.911***	-2.261***	-2.920***	-0.792***	-0.669***
	(0.025)	(0.029)	(0.130)	(0.087)	(0.046)	(0.148)	(0.154)	(0.138)	(0.081)	(0.055)
lnRM_HD_pr			0.008			-0.003				-0.012
			(0.086)			(0.009)				(0.034)
lnRM_HD_tp			-0.041			0.024*				-0.024
			(0.078)			(0.013)				(0.029)
Ec_fredom_pr		3.210***					0.819**			3.161***
		(0.201)					(0.373)			(0.198)
Ec_fredom_tp		1.702***					0.775***			1.600***
		(0.042)					(0.059)			(0.043)
lnGlo_dj_tp		0.195***						0.015		0.185***
		(0.031)						(0.014)		(0.030)
Lib_RTA				2.111***		-0.078		-0.028	2.031***	
				(0.180)		(0.065)		(0.060)	(0.167)	
Lib_Tarif_df				1.873***		0.123**			1.832***	
				(0.364)		(0.058)			(0.345)	
ERV				0.141***		-0.301***	-0.176***		0.133***	
				(0.022)		(0.039)	(0.040)		(0.021)	
lnGDPpc_diff					-0.736***			-0.103***		-0.113***
					(0.049)			(0.023)		(0.028)
Metrop_node					0.923***	1.286		0.544	0.723***	
					(0.128)	(0.832)		(0.750)	(0.107)	
Com_Lang			2.459***				1.973***			0.396**
			(0.083)				(0.345)			(0.183)
Col_Link			-1.388***				-1.975***			-0.376**
			(0.056)				(0.342)			(0.180)
Constant	8.37***	-43.79***	6.43***	-7.24***	12.53***	1.099	-24.72***	-1.691	-5.01***	-39.88***
	(0.446)	(1.951)	(0.687)	(1.752)	(0.626)	(5.519)	(2.659)	(4.991)	(1.640)	(1.809)
Observation	47,840	29,360	46,110	30,880	46,110	30,820	30,920	41,960	30,880	29,280
Log-Pseudo Likelihood	-6.90E+12	-1.90E+12	-6.30E+12	-4.00E+12	-5.30E+12				-3.90E+12	-1.90E+12
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.86	0.95	0.87	0.90	0.89					
Prob > chi^2	0	0	0	0	0	0	0	0		
Wald chi^2	26027	43973	29904	20354	16814	16541	18560	16599		
AIC									2.52E+08	1.28E+08

Source: Own elaboration using STATA/MP Version 17. Explanatory variables are as defined in Table 3.1. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%. E represents the exports model, estimated using PPML (as the primary estimator); HT and GPML are alternative estimators.

Baseline panel gravity regression – alternative size estimates of the import model

ESTIMATION METHOD	PPML	PPML	PPML	PPML	PPML	HT	HT	HT	GPML	GPML
SPECIFICATION	M-1A	M-2A	M-3A	M-4	M-5	M-1B	M-2B	M-3B	M-1C	M-2C
lnpop_pr	1.033***	1.157***	1.027***	1.139***	1.197***	3.073***	2.152***	3.491***	1.274***	1.143***
	(0.030)	(0.032)	(0.029)	(0.030)	(0.045)	(0.404)	(0.136)	(0.384)	(0.044)	(0.029)
lnpop_tp	0.927***	1.005***	0.936***	0.925***	0.917***	0.861***	0.808***	0.813***	0.930***	1.071***
	(0.016)	(0.022)	(0.016)	(0.020)	(0.017)	(0.056)	(0.069)	(0.051)	(0.020)	(0.022)
lnDistance	-1.387***	-0.759***	-1.448***	-0.872***	-1.110***	-2.682***	-2.853***	-2.754***	-0.840***	-0.776***
	(0.023)	(0.029)	(0.056)	(0.048)	(0.032)	(0.176)	(0.176)	(0.176)	(0.050)	(0.059)
lnRM_HD_pr			0.003			0.002				-0.026
			(0.027)			(0.008)				(0.024)
lnRM_HD_tp			-0.009			0.006				-0.027
			(0.037)			(0.012)				(0.037)
Ec_fredom_pr		0.732***					0.575			0.728***
		(0.176)					(0.383)			(0.171)
Ec_fredom_tp		0.884***					0.478***			0.930***
		(0.034)					(0.077)			(0.040)
lnGlo_dj_tp		-0.024						-0.001		-0.018
		(0.030)						(0.014)		(0.028)
Lib_RTA				0.960***		0.204***		0.254***	0.999***	
				(0.076)		(0.065)		(0.063)	(0.075)	
Lib_Tarif_df				1.293***		0.368***			1.311***	
				(0.212)		(0.057)			(0.215)	
ERV				-0.137***		-0.115***	-0.076**		-0.124***	
				(0.032)		(0.030)	(0.035)		(0.030)	
lnGDPpc_diff					-0.357***			-0.037		-0.127***
					(0.042)			(0.025)		(0.034)
Metrop_node					-0.554***	-2.198***		-3.201***	-0.622***	
					(0.131)	(0.782)		(0.742)	(0.132)	
Com_Lang			1.930***				0.574*			1.558***
			(0.070)				(0.297)			(0.128)
Col_Link			-2.234***				-1.142***			-2.338***
			(0.077)				(0.288)			(0.138)
Constant	-0.420	-21.173***	0.245	-7.572***	-0.949	-27.379***	-20.215***	-30.568***	-9.766***	-19.695***
	(0.788)	(1.554)	(0.712)	(1.048)	(0.978)	(5.253)	(3.309)	(5.040)	(1.169)	(1.687)
Observation	47,840	29,360	46,110	30,880	46,110	30,820	30,920	41,960	30,880	29,280
Log-Pseudo Likelihood	-5.80E+12	-3.70E+12	-5.60E+12	-4.10E+12	-5.30E+12				-4.00E+12	-3.40E+12
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.8687	0.8991	0.8714	0.8918	0.8783					
Prob > chi2	0	0	0	0	0	0	0	0		
Wald chi2	35857.91	55865.06	36011.73	24285.28	18994.6	6980.31	8778.5	5945.46		
AIC									2.60E+08	2.31E+08

Source: Own elaboration using STATA/MP Version 17. Explanatory variables are as defined in Table 3.1. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%. M represents the imports model, estimated using PPML (as the primary estimator); HT and GPML are alternative estimators

Baseline panel gravity regression – alternative size estimates of the total trade model

Estimation Method	**PPML**	**PPML**	**PPML**	**PPML**	**PPML**	**HT**	**HT**	**HT**	**GPML**	**GPML**
Variable/Specification	**T-1A**	**T-2A**	**T-3A**	**T-4**	**T-5**	**T-1B**	**T-2B**	**T-3B**	**T-1C**	**T-2C**
lnpop_pr	0.756***	0.867***	0.768***	0.899***	0.752***	1.305***	1.674***	1.782***	0.857***	0.868***
	(0.021)	(0.021)	(0.020)	(0.018)	(0.039)	(0.395)	(0.105)	(0.381)	(0.033)	(0.020)
lnpop_tp	0.961***	1.093***	0.940***	0.998***	0.952***	0.976***	1.069***	1.016***	0.996***	1.126***
	(0.013)	(0.019)	(0.012)	(0.021)	(0.014)	(0.034)	(0.044)	(0.030)	(0.020)	(0.019)
lnDistance	-1.536***	-0.729***	-1.439***	-0.812***	-1.180***	-2.982***	-2.478***	-3.057***	-0.825***	-0.681***
	(0.018)	(0.023)	(0.082)	(0.059)	(0.033)	(0.147)	(0.153)	(0.140)	(0.057)	(0.051)
lnRM_HD_pr			0.008			0.001				-0.022
			(0.050)			(0.008)				(0.027)
lnRM_HD_tp			-0.026			0.027**				-0.030
			(0.050)			(0.012)				(0.029)
Ec_fredom_pr		1.982***					0.859**			1.961***
		(0.184)					(0.350)			(0.185)
Ec_fredom_tp		1.222***					0.671***			1.212***
		(0.034)					(0.061)			(0.037)
lnGlo_dj_tp		0.065**						-0.004		0.073***
		(0.025)						(0.013)		(0.026)
Lib_RTA				1.466***		0.065		0.106*	1.450***	
				(0.103)		(0.058)		(0.055)	(0.097)	
Lib_Tarif_df				1.543***		0.218***			1.535***	
				(0.251)		(0.056)			(0.248)	
ERV				0.029		-0.192***	-0.088**		0.027	
				(0.018)		(0.039)	(0.041)		(0.017)	
lnGDPpc_diff					-0.518***			-0.072***		-0.134***
					(0.041)			(0.020)		(0.027)
Metrop_node					0.327***	1.066		0.055	0.200*	
					(0.119)	(0.766)		(0.735)	(0.106)	
Com_Lang			2.169***				1.545***			1.425***
			(0.068)				(0.321)			(0.133)
Col_Link			-1.864***				-1.807***			-1.823***
			(0.062)				(0.318)			(0.136)
Constant	5.14***	-30.79***	4.54***	-5.53***	7.35***	-1.81	-22.91***	-6.12	-5.19***	-28.57***
	(0.464)	(1.728)	(0.560)	(1.055)	(0.695)	(5.045)	(2.575)	(4.841)	(1.053)	(1.757)
Observation	47,840	29,360	46,110	30,880	46,110	30,820	30,920	41,960	30,880	29,280
Log-Pseudo Likelihood	-1.10E+13	-4.60E+12	-1.00E+13	-6.60E+12	-9.10E+12				-6.60E+12	-4.40E+12
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.88	0.94	0.88	0.91	0.90					
Prob > chi^2	0	0	0	0	0	0	0	0		
Wald chi^2	36281	83468	37921	29990	21496	20294	22856	19191		
AIC									4.30E+08	3.02E+08

Source: Own elaboration using STATA/MP Version 17. Explanatory variables are as defined in Table 3.1. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%. T represents the total trade model, estimated using PPML (as the primary estimator); HT and GPML are alternative estimators.

Appendix 1C: Gravity of provincial trade and non-linear determinants – estimates of the import model

This section of the appendix presents an analysis of key interaction terms incorporated into the import model to capture the conditional effects of economic distance proxied by GDPpc differences on the relationship between provincial imports and three central trade-related variables: RTA, tariff measures, and ERV. These interaction terms are included to test whether and how the influence of institutional and macroeconomic factors on trade flows varies depending on the level of economic asymmetry between trading partners. The variables of interest reflect both formal trade institutions (i.e., RTAs), trade policy instruments (i.e., tariff measures), and market-related uncertainties (i.e., ERV), thereby allowing for a more nuanced assessment of how these mechanisms interact with structural income differentials to shape provincial import dynamics.

The interaction effects estimated in the import model underscore the complex and nonlinear role of economic distance, as captured by GDPpc differences, in moderating the impact of key trade-related variables. The negative and statistically significant coefficient on the interaction between GDPpc difference and RTAs (-0.11) suggests that the trade-enhancing effect of income differentials is weakened in the presence of formal trade agreements. This finding may reflect a convergence mechanism, whereby institutional integration through RTAs reduces the relative influence of economic asymmetries on trade flows, potentially by harmonizing standards, reducing transaction costs, or fostering more symmetric trade relations across diverse income levels.

In contrast, the interaction between GDPpc difference and tariff measures yields a large and statistically significant positive coefficient (0.78), indicating that income asymmetries amplify the trade-restrictive effects of tariffs. This suggests that when income disparities are large, tariffs may impose disproportionately higher costs on trade relationships, particularly those involving lower-income partners. Furthermore, the interaction term between GDPpc difference and ERV is strongly negative and significant (-1.57), highlighting that income differentials intensify the negative effects of exchange rate uncertainty on imports. This could be due to increased risk sensitivity or limited hedging capacity in asymmetrical trade relations, where volatility in currency markets introduces substantial unpredictability in transaction costs.

The gravity estimate of the non-linearities in the import model

Variable/ Estimation Method	Import [1]	Import [2]	Import [3]
lnGDP_pr	1.140***	1.174***	1.135***
	(0.027)	(0.027)	(0.025)
lnGDP_tp	1.005***	1.007***	1.002***
	(0.018)	(0.017)	(0.015)
lnDistance	-0.785***	-0.628***	-0.779***
	(0.028)	(0.024)	(0.026)
lnGDPpc_diff	-0.701***	0.179***	0.313***
	(0.271)	(0.038)	(0.041)
Lib_RTA		1.522***	
		(0.460)	
lnIneq_RTA		-0.105**	
		(0.045)	
Lib_Tarif_df	-1.725***		
	(0.521)		
lnIneq_tarif_dif	0.778***		
	(0.266)		
ERV			15.468***
			(2.556)
lnIneq_ERV			-1.566***
			(0.241)
Com_Lang	0.090	0.157**	0.211***
	(0.089)	(0.069)	(0.067)
Col_Link	-0.291***	-0.509***	-0.504***
	(0.089)	(0.068)	(0.067)
Constant	0.006	-4.540***	-3.871***
	(0.880)	(0.862)	(0.772)
Observation	30,820	46,340	45,970
Log-Pseudo Likelihood	-2.90E+12	-3.60E+12	-3.50E+12
Time FE	Yes	Yes	Yes
Pseudo R^2	0.9228	0.919	0.9197
Prob > chi^2	0	0	0
Wald chi^2	44489.55	39949.26	51397.51

Source: Own elaboration. Explanatory variables are as defined in Table 3.1. The main explanatory variables of focus include the log interaction between GDPpc difference and RTAs (lnIneq_RTA), log interaction between GDPpc difference and tariff difference (lnIneq_tarif_dif) and log interaction between GDPpc difference and ERV (lnIneq_ERV). All models are estimated using the PPML. Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%

In conclusion, the interaction effects highlight that the impact of trade policies and macroeconomic conditions on imports is significantly shaped by income asymmetries between provinces and their trading partners. While RTAs tend to moderate the influence of GDPpc differences, tariffs and ERV exhibit amplifying or compounding effects. These results underscore the necessity of incorporating non-linear dynamics into trade models to better understand the heterogeneous responses of subnational trade flows to global economic forces.

Appendix 1D: Heterogeneous effect across provinces – baseline gravity model

Across exports and total trade models, the coefficients on province and partners GDP are positive and highly significant for all provinces. This confirms the gravity-model expectation that larger provincial economies and larger destination markets generate more trade flows. Similarly, distance is consistently negative and highly significant, highlighting the importance of trade costs. The negative coefficients on GDP per capita differences indicate that greater income asymmetries reduce bilateral trade intensity, consistent with Hypothesis 1E.

Economic-freedom variables (both province and partners) are uniformly positive, signalling that provinces benefit when their own institutions and those of their partners are more market-oriented (Hypothesis 1A). The partners' globalization index also shows a large positive effect everywhere, reinforcing the view that provinces trade more with globally integrated partners.

Ontario, Quebec, and Alberta display the largest and most significant coefficients on RTAs, confirming that preferential access disproportionately benefits provinces with deep automotive, aerospace, and resource-based global value-chain linkages. Ontario's and Alberta's positive and significant coefficients on tariff measures imply that tariff reductions under NAFTA /CUSFTA/USMCA translate directly into higher provincial exports and total trade. These provinces also show robust positive effects of metropolis nodes, common language, and colonial links as indicators of established business networks. For policy, this suggests that maintaining and expanding preferential access and reducing non-tariff barriers are prominently critical for these provinces.

Manitoba, New Brunswick, Newfoundland & Labrador, Nova Scotia, and particularly Prince Edward Island show large negative coefficients on ERV, in some cases extremely large (e.g., –42.9 for PEI in exports, –68.4 for total trade). This indicates that smaller, less diversified provinces are far more sensitive to currency instability, likely due to their heavy reliance on imported intermediate goods and limited hedging capacity. Their weaker or insignificant metropolis node coefficients also suggest fewer agglomeration benefits. Policy levers for these provinces could include hedging facilities, provincial export insurance, and supply-chain diversification to reduce ERV exposure.

Saskatchewan and Manitoba display strong positive effects from economic-freedom variables and the globalization index, but more moderate RTA coefficients. Their tariff

differential coefficients are negative, indicating that tariff barriers still impede their trade flows. Saskatchewan shows a positive metropolis-node effect in total trade but not exports, reflecting its concentration in primary commodities. These patterns suggest that investment in value-added processing and transport infrastructure could yield stronger gains from trade agreements.

All Atlantic provinces show weaker RTAs gains and stronger negative ERV effects. Nova Scotia and Newfoundland also exhibit the largest negative coefficients on distance, indicating acute transport cost sensitivity. Metropolis effects are mostly absent due to collinearity, underlining the lack of large urban hubs. Tariff measures remain a constraint, and common language/colonial links are mostly insignificant. This profile suggests the need for policies targeting port infrastructure, logistical efficiency, and export-market diversification, along with fiscal incentives to attract MNE investment.

Globalization mechanisms (RTAs, tariff liberalization, partners' openness) have heterogeneous effects across provinces, with larger, diversified economies capturing the largest gains. Taken together, the estimates show that trade-policy benefits are not uniform. Provinces with large, diversified economies gain most from RTAs and institutional quality, while smaller provinces remain vulnerable to ERV and trade costs. This underscores the importance of tailoring trade-support measures to provincial characteristics rather than relying on a “one size fits all” approach.

Provincial trade profiles: areas of strengths and vulnerabilities in exports

Variables /Province	lnGDP_pr	lnGDP_tp	lnDistance	lnGDPpc_ diff	Ec_fredom_pr	Ec_fredo m_tp	lnGlo_dj_tp	Lib_RTA	Lib_Tari f_df	ERV	Metrop_nod e	Com_Lan g	Col_Link	lnRM_HD _pr	lnRM_HD _tp
AB	0.66***	1.69***	-3.04***	-0.72***	1.89***	2.13***	6.53**	4.84***	0.83***	0.09	2.31***	2.75***	2.64***	-0.76***	-1.68***
BC	0.60***	1.63***	-3.11***	-0.81***	1.82***	2.01***	6.32**	3.59***	-0.32	-0.38	1.42***	1.49	1.38	-0.82***	-1.76***
MB	0.57***	1.56***	-3.34***	-0.92***	1.72***	1.88***	6.08**	2.72***	-1.50***	-4.96***		0.63	0.52	-0.92***	-1.91***
NB	0.60***	1.56***	-3.61***	-0.93***	1.73***	1.88***	6.07**	2.83***	-1.44***	-4.11***		0.76	0.65	-0.94***	-1.98***
NL	0.59***	1.55***	-3.57***	-0.95***	1.72***	1.86***	6.02**	2.44***	-1.72***	-6.36***		0.36	0.25	-0.96***	-1.98***
NS	0.51***	1.51***	-3.86***	-1.02***	1.63***	1.78***	5.89**	1.92**	-2.46***	-12.50***	-0.50***	-0.15	-0.26	-1.02***	-2.06***
ON	0.67***	1.73***	-3.32***	-0.65***	2.04***	2.22***	6.70**	5.57***	1.67***	0.17**	3.05***	3.51***	3.40***	-0.72***	-1.69***
PE	0.43*	1.40***	-4.15***	-1.24***	1.43***	1.57***	5.49*	0.28	-4.92***	-42.89***		-1.77*	-1.88**	-1.17***	-2.24***
QC	0.63***	1.67***	-3.29***	-0.74***	1.97***	2.10***	6.49**	4.58***	0.62***	0.06	2.14***	2.51***	2.40**	-0.79***	-1.76***
SK	0.63***	1.60***	-3.22***	-0.85***	1.80***	1.96***	6.23**	3.24***	-0.77***	-1.38***	1.02***	1.20	1.08	-0.86***	-1.83***
Constant	11.59***	-3.39**	27.31***	46.85***	4.41	4.06	-7.72	17.40***	23.29***	19.35***	17.49***	17.77***	17.82***	29.59***	36.73***
Observation	49,220	46,340	46,340	49,220	47,080	30,750	42,650	49,220	30,750	47,610	49,220	49,220	49,220	49,220	46,340

Source: Own calculations. Explanatory variables are as defined in Table 3.1. All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed Effects (PPML-HDFE) method, using the robust covariance matrix. For reporting convenience, robust standard errors have been excluded; *Significant at 10%; **significant at 5%; ***significant at 1% estimated using STATA/MP Version 17. Note: The metropolis indicator (Metrop_node) is omitted for MB, NB, NL, and PE due to collinearity.

Provincial trade profiles: areas of strengths and vulnerabilities in total trade

Variables Province	lnGDP_pr	lnGDP_tp	lnDistance	lnGDPpc_diff	Ec_fredom_pr	Ec_fredom_tp	lnGlo_dj_tp	Lib_RTA	Lib_Tarif_df	ERV	Metrop_node	Com_Lang	Col_Link	lnRM_HD_pr	lnRM_HD _tp
AB	0.73***	1.42***	-2.57***	-0.74***	1.43***	1.61**	4.29	3.90***	0.25	0.01	1.92***	1.66	1.55	-0.76***	-1.55***
BC	0.72***	1.40***	-2.58***	-0.77***	1.42***	1.56**	4.21	3.12***	-0.33	-0.67	1.60***	0.86	0.75	-0.78***	-1.57***
MB	0.71***	1.33***	-2.78***	-0.88***	1.32***	1.44**	3.98	2.49***	-1.38***	-3.96**		0.25	0.13	-0.87***	-1.71***
NB	0.73***	1.31***	-2.98***	-0.91***	1.30***	1.40**	3.91	2.06**	-1.81***	-6.44***		-0.15	-0.27	-0.91***	-1.79***
NL	0.69***	1.28***	-3.00***	-0.96***	1.24***	1.33**	3.79	1.47*	-2.52***	-11.58***		-0.77	-0.88	-0.95***	-1.83***
NS	0.66**	1.28***	-3.13***	-0.96***	1.23***	1.33**	3.78	1.23*	-2.47***	-12.41***	-0.22	-1.01	-1.12	-0.96***	-1.84***
ON	0.79***	1.51***	-2.61***	-0.60***	1.65***	1.79***	4.62*	5.24***	1.82***	0.18**	3.35***	2.97***	2.86***	-0.66***	-1.46***
PE	0.52*	1.12***	-3.53***	-1.30***	0.91***	1.02	3.20	-0.83	-6.68***	-68.40***		-3.01***	-3.13***	-1.19***	-2.11***
QC	0.74***	1.44***	-2.69***	-0.71***	1.54***	1.64**	4.35	3.88***	0.47***	0.03	2.20***	1.72**	1.61*	-0.75***	-1.57***
SK	0.72***	1.34***	-2.73***	-0.86***	1.33***	1.45**	4.00	2.49***	-1.28***	-3.50**	0.70***	0.28	0.17	-0.86***	-1.69***
Constant	10.91***	1.05	42.96***	27.73***	8.41***	8.49*	2.23	18.54***	23.59***	20.10***	18.10***	19.05***	19.10***	29.80***	35.71***
Observation	49,220	46,340	49,220	46,340	47,080	31,140	42,650	49,220	30,880	47,610	49,220	49,220	49,220	49,220	46,340

Source: Own calculations. Explanatory variables are as defined in Table 3.1. All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed Effects (PPML-HDFE) method, using the robust covariance matrix. For reporting convenience, robust standard errors have been excluded; *Significant at 10%; **significant at 5%; ***significant at 1% estimated using STATA/MP Version 17. Note: The metropolis indicator (Metrop_node) is omitted for MB, NB, NL, and PE due to collinearity.

Appendix 3: Canada-U.S. trade – the border effect estimates

Appendix 3A: Panel gravity estimates for the evolution of the border effect (2002-2020)

The yearly estimates of border effects from 2002 to 2020 for total trade, exports, and imports reveal notable fluctuations that align with key economic and policy events. In the early 2000s, border effects were relatively high across all trade models, particularly in 2002, when total trade recorded a coefficient of 9.4, exports at 7.7, and imports at 12.1, indicating substantial home bias in Canadian interprovincial trade. This trend steadily declined through the mid-2000s, reflecting gradual trade liberalization and deeper North American integration under NAFTA. However, a sharp increase is observed in 2009 across all models, total trade (8.6), exports (7.1), and imports (10.7), corresponding with the global financial crisis. The spike suggests a retrenchment in cross-border trade during a period of heightened economic uncertainty and a temporary resurgence of national trade boundaries, even among closely integrated economies.

Following 2009, the border effects generally resumed a downward trend, indicating a return to trade normalization and policy efforts aimed at reinforcing international trade. This gradual decline persisted until the mid-2010s, with total trade reaching a low of 5.8 in 2014 and exports and imports similarly trending downward. Yet, beginning around 2015, there is a mild resurgence in border effects, with values for all trade models trending upward through to 2019. This increase may reflect growing policy uncertainties and protectionist sentiments globally, especially surrounding the renegotiation of NAFTA, which introduced significant uncertainty to North American trade relationships. In 2020, border effects rose sharply again - total trade (8.3), exports (7.3), and imports (9.7), coinciding with the implementation of the USMCA and the disruptive trade and mobility constraints imposed during the Covid-19 pandemic.

Evolution of the border effect estimates for the total trade model

TRADE	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
lnGDP_pr	0.985***	0.970***	0.951***	0.953***	0.943***	0.918***	0.892***	0.892***	0.885***	0.863***	0.858***	0.877***	0.880***	0.907***	0.937***	0.894***	0.900***	0.901***	0.890***
lnGDP_us	0.926***	0.907***	0.905***	0.895***	0.899***	0.916***	0.880***	0.868***	0.867***	0.851***	0.866***	0.869***	0.867***	0.886***	0.881***	0.856***	0.866***	0.862***	0.869***
lnDistance	-1.035***	-0.936***	-1.040***	-0.775***	-0.817***	-0.500***	-0.947***	-0.979***	-0.682***	-0.802***	-0.925***	-0.694***	-0.810***	-0.785***	-0.859***	-0.560***	-0.754***	-0.692***	-0.975***
Border	-2.236***	-2.221***	-2.137***	-2.105***	-2.052***	-2.067***	-1.888***	-2.146***	-1.908***	-1.915***	-1.800***	-1.844***	-1.761***	-1.907***	-1.964***	-1.858***	-1.930***	-1.972***	-2.122***
lnRM_HD_x	-0.142	0.111	-0.002	-0.191***	0.038	-0.237***	0.018	-0.023	-0.035	-0.183*	-0.081	-0.104	-0.088	0.041	0.001	-0.064	-0.070	0.001	0.063
lnRM_HD_m	0.159	-0.102	0.117	0.046	-0.159	-0.140	0.062	0.141**	-0.136	0.088	0.116	-0.041	0.081	-0.107	-0.017	-0.203	-0.015	-0.133*	0.116
Constant	0.321	-0.330	-0.129	0.577	0.333	0.732	0.235	0.343	0.714	1.673	1.012	0.676	0.176	-0.334	-0.540	0.344	0.030	-0.130	-0.818
Observation	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
R2	0.87	0.86	0.85	0.85	0.85	0.86	0.81	0.84	0.82	0.81	0.80	0.80	0.79	0.82	0.83	0.82	0.80	0.80	0.83
Border Effect	**9.4**	**9.2**	**8.5**	**8.2**	**7.8**	**7.9**	**6.6**	**8.6**	**6.7**	**6.8**	**6.0**	**6.3**	**5.8**	**6.7**	**7.1**	**6.4**	**6.9**	**7.1**	**8.3**

Source: Own calculations. Explanatory variables are as defined in Table 3.2. All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed effects (PPML-HDFE) method, using the robust covariance matrix. For reporting convenience, robust standard errors have been excluded; *Significant at 10%; **significant at 5%; ***significant at 1% estimated using STATA/MP Version 17

Evolution of the border effect estimates for the export model

EXPORTS	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
lnGDP_pr	0.915***	0.909***	0.877***	0.879***	0.861***	0.839***	0.807***	0.808***	0.805***	0.785***	0.787***	0.818***	0.820***	0.838***	0.865***	0.815***	0.825***	0.819***	0.817***
lnGDP_us	0.912***	0.894***	0.898***	0.884***	0.896***	0.915***	0.868***	0.859***	0.877***	0.851***	0.904***	0.885***	0.881***	0.902***	0.929***	0.896***	0.896***	0.879***	0.887***
lnDistance	-1.077***	-0.949***	-1.060***	-0.777***	-0.733***	-0.390***	-0.875***	-0.877***	-0.606***	-0.764***	-0.935***	-0.713***	-0.800***	-0.766**	-0.736***	-0.401**	-0.711***	-0.566*	-0.919***
Border	-2.046***	-2.004***	-1.912***	-1.876***	-1.814***	-1.842***	-1.652***	-1.958***	-1.731***	-1.754***	-1.651***	-1.697***	-1.616***	-1.774***	-1.860***	-1.738***	-1.809***	-1.830***	-1.992***
lnRM_HD_x	-0.131	0.129	-0.001	-0.237***	0.014	-0.227***	0.006	-0.021	-0.044	-0.222*	-0.134	-0.123	-0.103	0.084	-0.032	-0.108	-0.086	-0.043	0.074
lnRM_HD_m	0.193	-0.091	0.154	0.126	-0.187	-0.209	0.055	0.102	-0.154	0.141	0.222**	0.042	0.146	-0.113	-0.060	-0.253	0.019	-0.172*	0.105
Constant	0.562	-0.322	-0.006	0.730	0.552	0.714	0.424	0.373	0.587	1.623	0.442	0.156	-0.421	-0.894	-1.108	-0.134	-0.529	-0.100	-1.230
Observation	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
R2	0.81	0.79	0.78	0.78	0.77	0.77	0.69	0.74	0.72	0.70	0.69	0.69	0.68	0.73	0.75	0.73	0.71	0.70	0.75
Border Effect	**7.7**	**7.4**	**6.8**	**6.5**	**6.1**	**6.3**	**5.2**	**7.1**	**5.6**	**5.8**	**5.2**	**5.5**	**5.0**	**5.9**	**6.4**	**5.7**	**6.1**	**6.2**	**7.3**

Source: Own calculations. Explanatory variables are as defined in Table 3.2. All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed effects (PPML-HDFE) method, using the robust covariance matrix. For reporting convenience, robust standard errors have been excluded; *Significant at 10%; **significant at 5%; ***significant at 1% estimated using STATA/MP Version 17

Evolution of the border effect estimates for the import model

IMPORTS	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
lnGDP_pr	1.083***	1.059***	1.057***	1.073***	1.060***	1.035***	1.019***	1.003***	0.992***	0.968***	0.959***	0.957***	0.967***	0.993***	1.028***	1.003***	1.002***	1.014***	0.990***
lnGDP_us	0.949***	0.928***	0.917***	0.912***	0.902***	0.916***	0.901***	0.876***	0.853***	0.852***	0.819***	0.850***	0.853***	0.861***	0.824***	0.808***	0.832***	0.837***	0.846***
lnDistance	-0.991***	-0.915***	-1.016***	-0.757***	-0.940***	-0.645***	-1.060***	-1.112***	-0.792***	-0.867***	-0.931***	-0.692***	-0.803***	-0.798***	-1.024***	-0.778***	-0.802***	-0.849***	-1.056***
Border	-2.496***	-2.487***	-2.425***	-2.420***	-2.347***	-2.355***	-2.195***	-2.374***	-2.121***	-2.095***	-1.984***	-2.018***	-1.940***	-2.064***	-2.075***	-2.017***	-2.083***	-2.124***	-2.271***
lnRM_HD_x	-0.155**	0.085	-0.007	-0.133*	0.069	-0.253***	0.028	-0.033	-0.021	-0.121	-0.005	-0.078	-0.066	-0.018	0.041	-0.002	-0.046	0.059	0.054
lnRM_HD_m	0.115	-0.111	0.058	-0.080	-0.118	-0.055	0.083	0.194***	-0.113	0.028	-0.012	-0.123	-0.013	-0.107	0.041	-0.136	-0.055	-0.086	0.132*
Constant	-1.648	-2.166*	-1.871	-1.411	-1.644	-0.932	-1.770	-1.227	-0.676	-0.042	0.014	-0.371	-0.918	-1.099	-1.422	-0.773	-1.103	-1.830	-1.973*
Observation	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
R2	0.8844	0.8775	0.8755	0.8753	0.8745	0.8831	0.8633	0.8782	0.8589	0.8581	0.8445	0.8415	0.8239	0.833	0.8335	0.8293	0.8234	0.8205	0.836
Border Effect	**12.1**	**12.0**	**11.3**	**11.2**	**10.4**	**10.5**	**8.9**	**10.7**	**8.3**	**8.1**	**7.3**	**7.5**	**6.9**	**7.8**	**7.9**	**7.5**	**8.0**	**8.4**	**9.7**

Source: Own calculations. Explanatory variables are as defined in Table 3.2. All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed effects (PPML-HDFE) method, using the robust covariance matrix. For reporting convenience, robust standard errors have been excluded; *Significant at 10%; **significant at 5%; ***significant at 1% estimated using STATA/MP Version 17

In conclusion, the observed border effects across total trade, exports, and imports reflect a complex interplay between macroeconomic shocks and trade policy developments. The spikes in 2009 and 2020 are particularly telling, highlighting the vulnerability of cross-border trade to both global crises and policy shifts. The resilience of interprovincial trade during these periods underscores the continued significance of internal economic integration in Canada, even amidst fluctuating international trade dynamics. These findings offer important empirical context for understanding how external shocks and institutional changes influence subnational trade behavior over time.

Appendix 3B: Panel gravity estimates of the border effect by provinces

Total trade model

The border effect estimates for total trade indicate substantial provincial variation in the degree to which provinces trade more intensively within Canada than internationally. At the national level, the average border effect is 7.1, suggesting that total interprovincial trade is approximately seven times larger than international trade, all else equal. Provinces such as British Columbia (13.46), Nova Scotia (12.82), and Prince Edward Island (9.26) report particularly high border effects, pointing to stronger reliance on domestic markets. Conversely, New Brunswick (2.62) and Saskatchewan (4.06) exhibit the lowest total trade border effects, suggesting greater international trade integration. Central provinces such as Ontario (6.98) and Quebec (8.91) fall closer to the national average, reflecting balanced engagement in both domestic and international trade. These patterns illustrate how geographic, economic, and infrastructural factors influence the relative strength of domestic trade linkages across Canadian provinces.

Border effect estimates for the total trade model, by province

TRADE	**AB**	**BC**	**MB**	**NB**	**NF**	**NS**	**ON**	**PE**	**QC**	**SK**
lnGDP_pr	-	-	-	-	-	-	-	-	-	-
lnGDP_us	0.961***	0.972***	0.938***	0.393***	0.868***	0.636***	1.003***	0.649***	0.859***	0.878***
lnDistance	-1.205***	-0.940***	-1.694***	-1.354***	-1.991***	-0.901***	-0.755***	-1.200***	-0.712***	-1.895***
Border	-1.697***	-2.600***	-1.876***	-0.962***	-1.624***	-2.551***	-1.943***	-2.226***	-2.187***	-1.400***
lnRM_HD_x	-0.090*	0.002	-0.006	0.052	0.010	0.029	-0.076*	0.070	-0.007	-0.014
lnRM_HD_m	0.096*	0.014	-0.061***	-0.003	-0.142*	-0.005	-0.032	-0.047	-0.016	-0.005
Constant	13.286***	10.474***	15.962***	17.884***	19.386***	12.367***	10.912***	12.301***	10.835***	17.692***
Observation	1,140	1,140	1,140	1,140	1,140	1,140	1,140	1,140	1,140	1,140
R^2	0.6547	0.9618	0.8905	0.6028	0.623	0.8323	0.7492	0.8647	0.9029	0.7956
Border Effect	**5.46**	**13.46**	**6.53**	**2.62**	**5.07**	**12.82**	**6.98**	**9.26**	**8.91**	**4.06**

Source: Own calculations. Explanatory variables are as defined in Table 3.2. All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed effects (PPML-HDFE) method, using the robust covariance matrix. For reporting convenience, robust standard errors have been excluded; *Significant at 10%; **significant at 5%; ***significant at 1% estimated using STATA/MP Version 17. **Note**: The provincial Log of GDP (lnGDP_pr) is omitted because of collinearity

Export model

In the export model, the national border effect is slightly lower at 6.0, indicating that, while interprovincial export flows remain dominant, international export activity plays a relatively larger role compared to total trade. Provinces such as British Columbia (10.06) and Manitoba (8.01) show strong preferences for domestic export destinations. Meanwhile, New Brunswick (1.08), Newfoundland and Labrador (2.83), and Saskatchewan (2.87) register the lowest border effects, reflecting a high degree of outward export orientation, potentially due to port access or the prominence of resource-based exports. Ontario (7.78) and Quebec (6.94) maintain moderate export border effects, consistent with their diversified trade portfolios. The relatively smaller national border effect in exports compared to total trade indicates that Canadian provinces are more externally oriented when it comes to export activities than overall trade.

Border effect estimates for the export model, by province

EXPORTS	**AB**	**BC**	**MB**	**NB**	**NF**	**NS**	**ON**	**PE**	**QC**	**SK**
lnGDP_pr	-	-	-	-	-	-	-	-	-	-
lnGDP_us	0.961***	0.925***	0.988***	0.400***	0.909***	0.625***	1.136***	0.749***	0.858***	0.856***
lnDistance	-1.311***	-0.906***	-1.708***	-2.023***	-2.558***	-0.947***	-0.736***	-1.288***	-0.782***	-1.938***
Border.	-1.273***	-2.309***	-2.081***	-0.075	-1.042***	-1.766***	-2.052***	-1.298***	-1.937***	-1.054***
lnRM_HD_x	-0.107*	0.000	-0.006	0.109	0.017	0.014	-0.111*	0.057	-0.002	-0.058
lnRM_HD_m	0.113	-0.025	-0.062*	-0.022	-0.180*	-0.035	-0.046	-0.045	0.012	-0.042
Constant	13.521***	10.248***	14.686***	20.788***	22.823***	12.342***	8.830***	10.820***	10.440***	18.334***
Observation	1,140	1,140	1,140	1,140	1,140	1,140	1,140	1,140	1,140	1,140
R^2	0.5509	0.9458	0.867	0.6264	0.59	0.70	0.69	0.77	0.88	0.69
Border Effect	**3.57**	**10.06**	**8.01**	**1.08**	**2.83**	**5.85**	**7.78**	**3.66**	**6.94**	**2.87**

Source: Own calculations. Explanatory variables are as defined in Table 3.2. All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed effects (PPML-HDFE) method, using the robust covariance matrix. For reporting convenience, robust standard errors have been excluded, *Significant at 10%; **significant at 5%; ***significant at 1% estimated using STATA/MP Version 17. **Note**: The provincial Log of GDP (lnGDP_pr) is omitted because of collinearity

Import model

Among the three trade models, the import model displays the largest border effects, with a national average of 8.7, suggesting that provinces are most inwardly biased when sourcing goods. The most extreme values appear in Prince Edward Island (189.05), Nova Scotia (52.56), and Newfoundland and Labrador (21.35), signaling very strong preferences for domestic sources. Such inflated values may be explained by logistical constraints, limited port infrastructure, or small market sizes that reduce international import penetration. British Columbia (17.39), Alberta (15.65), and Quebec (13.44) also exhibit high import border effects, indicating entrenched domestic supply networks. By contrast, provinces such as Manitoba (5.65), Ontario (6.39), and Saskatchewan (6.64) report more moderate border effects, suggesting relatively greater import openness. These findings highlight that, relative to exports and total trade, imports are most significantly shaped by internal market preferences and domestic trade frictions.

Border effect estimates for the import model, by province

IMPORTS	**AB**	**BC**	**MB**	**NB**	**NF**	**NS**	**ON**	**PE**	**QC**	**SK**
lnGDP_pr	-	-	-	-	-	-	-	-	-	-
lnGDP_us	0.954***	1.012***	0.901***	0.449***	0.789***	0.644***	0.897***	0.516***	0.861***	0.934***
lnDistance	-0.964***	-0.976***	-1.680***	-0.585***	-1.036***	-0.873***	-0.777***	-1.085***	-0.584***	-1.892***
Border	-2.751***	-2.856***	-1.732***	-2.153***	-3.061***	-3.962***	-1.854***	-5.242***	-2.598***	-1.893***
lnRM_HD_x	-0.041	0.002	-0.007	-0.049	-0.002	0.061*	-0.043	0.097	-0.019	0.063*
lnRM_HD_m	0.029	0.053**	-0.057**	0.003	-0.001	0.024	-0.020	-0.051	-0.071**	0.045
Constant	10.839***	9.384***	15.671***	12.533***	11.181***	10.999***	11.307***	12.446***	9.690***	15.061***
Observation	1,140	1,140	1,140	1,140	1,140	1,140	1,140	1,140	1,140	1,140
R^2	0.8676	0.949	0.8349	0.6014	0.6442	0.875	0.7523	0.9223	0.8606	0.8212
Border Effect	**15.65**	**17.39**	**5.65**	**8.61**	**21.35**	**52.56**	**6.39**	**189.05**	**13.44**	**6.64**

Source: Own calculations. Explanatory variables are as defined in Table 3.2. All models are estimated using the Poisson pseudo-maximum likelihood with the High-Dimensional Fixed Effects (PPML-HDFE) method, using the robust covariance matrix. For reporting convenience, robust standard errors have been excluded; *Significant at 10%; **significant at 5%; ***significant at 1% estimated using STATA/MP Version 17. **Note:** The provincial Log of GDP (lnGDP_pr) is omitted because of collinearity

Conclusion

The analysis of border effects across trade models and provinces reveals that imports are the most sensitive to internal-external trade boundaries, followed by total trade and exports. This ranking, where import is greater than total trade, greater than exports, suggests that while Canadian provinces engage in both domestic and international trade, they remain especially dependent on internal sources for imports. The high border effects across most provinces also signal the persistent relevance of subnational trade barriers or structural economic preferences that continue to favor interprovincial trade despite Canada's broader trade liberalization efforts. These results reinforce the importance of accounting for internal economic geography when evaluating the spatial distribution of trade flows and suggest that further integration within Canada could help reduce inefficiencies and enhance competitiveness in both domestic and international markets.

Appendix 4: Alternative Estimates of IIT, HIIT and VIIT

IIT model estimates

The GPML estimates for IIT indicate a theoretically consistent and empirically robust influence of economic structure, geography, human capital, institutional quality, and firm-level dynamics. The coefficient for provincial GDP in all specifications affirms that larger economic size significantly enhances engagement in IIT, consistent with new trade theory, which underscores the role of economies of scale and consumer preference for differentiated products (Krugman, 1980). Equatorial distance is positively associated with IIT (6.45), suggesting that provinces farther from the equator, potentially reflecting greater institutional development or economic centrality, are more integrated in differentiated trade, reflecting insights from Hall and Jones (1999). Human capital composition also exhibits marked effects: a positive and significant coefficient on the low skill-ratio (0.58) and the high skill-ratio (1.05), highlighting the pivotal role of skilled labor in supporting complex trade structures. The coefficient for per capita income (3.798***) is robust and supports the traditional Linder hypothesis by suggesting that wealthier provinces may engage more in IIT, possibly due to greater demand for product variety or production capabilities. Among structural and policy variables, R&D expenditure (1.51) is positively and significantly related to IIT, emphasizing the importance of innovation capacity in supporting product differentiation (Grossman & Helpman, 1991). Fiscal policy variables yield differentiated impacts: production tax has a negative effect (-0.84), suggesting cost-related disincentives to specialization, while import tax is positively associated with IIT (1.29), potentially reflecting protective measures that sustain vertically integrated production systems. Although institutional quality exhibits a positive association (0.66) its significance is marginal at the 5% level, warranting further exploration. Lastly, indicators of multinational enterprise (MNE) activities including value-added (0.54), employment (0.34), and capital formation (0.35) are all positively associated with IIT, reinforcing the role of MNEs in embedding provinces within global value chains and enhancing trade in differentiated goods.

A generalized pseudo maximum likelihood (GPML) estimate of the IIT

Dependent Variable	**IIT**	**IIT**	**IIT**	**IIT**	**IIT**	**IIT**	**IIT**	**IIT**	**IIT**	**IIT**
Specifications	**[1]**	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**	**[7]**	**[8]**	**[9]**	**[10]**
lnGDP	0.893***	1.468***				1.307***			2.063***	1.194***
	(0.184)	(0.131)				(0.060)			(0.065)	(0.183)
lnsr_low		0.577***								
		(0.147)								
lnsr_high	1.046***									
	(0.179)									
lnEquat_dist			6.451***		3.073***		1.644***	2.403***	0.765*	
			(1.191)		(0.678)		(0.497)	(0.382)	(0.452)	
lnGDPpc			3.798***							
			(1.254)							
inst_qlity				0.659**	1.010					
				(0.273)	(0.951)					
lnR&D				1.506***						
				(0.043)						
lnTx_prod						-0.839***			-0.362**	
						(0.071)			(0.180)	
lnTx_imp						1.288***				0.725***
						(0.077)				(0.120)
lnMNEs_va							0.537***	0.400**		
							(0.133)	(0.159)		
lnMNEs_job					0.338***			0.206**		
					(0.113)			(0.097)		
lnMNEs_cf							0.350***			0.055**
							(0.121)			(0.028)
Constant	-14.385***	-21.727***	-66.211***	-14.542***	-10.461	6.614***	2.799	-0.369	-35.177***	-9.695**
	(2.560)	(2.025)	(22.786)	(2.666)	(10.714)	(0.742)	(3.051)	(2.401)	(4.056)	(4.528)
Observation	230	230	220	220	120	160	80	130	160	80
Log-Pseudo Likelihood	-5.30E+11	-5.80E+11	-3.90E+12	-5.00E+11	-1.80E+12	-2.50E+11	-7.50E+11	-1.80E+12	-4.90E+11	-1.80E+11
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AIC	4.60E+09	5.04E+09	3.51E+10	4.57E+09	3.00E+10	3.13E+09	1.87E+10	2.76E+10	6.09E+09	4.54E+09

Source: Own elaboration using STATA/MP Version 17. Explanatory variables are as defined in Table 3.3. All models are estimated using the Generalized Pseudo Maximum Likelihood (GPML). Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%

HIIT model estimates

The GPML results for HIIT substantiate key theoretical expectations while extending the insights derived from the general IIT model. Across specifications, provincial GDP remains a strong and highly significant predictor of HIIT intensity, consistent with Krugman's (1980) proposition that horizontally structured trade thrives in larger markets due to the coexistence of scale economies and consumer preference for variety. The positive and significant coefficient for equatorial distance (7.88) suggests that provinces situated further from Canada's economic core

may be more integrated into horizontally structured trade networks, potentially reflecting institutional or infrastructural endowments rather than geographic disadvantage (Hall & Jones, 1999). Labor skill composition exerts a particularly notable influence: the low-skill labor ratio has a positive but comparatively modest effect (0.48), while the high-skill ratio exerts a stronger and statistically significant positive influence (1.01), underscoring the importance of a skilled workforce in facilitating the production of quality-differentiated goods characteristic of horizontal trade. Furthermore, GDPpc (5.21) is positively and significantly associated with HIIT, deviating from traditional Linder-type predictions and instead suggesting that wealthier provinces may engage more intensively in trade of horizontally differentiated products due to greater demand for variety and product sophistication. Innovation capacity, proxied by R&D expenditure (1.57), is positively and strongly associated with HIIT, affirming the role of technological advancement in supporting horizontal differentiation (Grossman & Helpman, 1991). In terms of fiscal instruments, production taxes exhibit a negative and statistically significant association (-1.03), indicating that higher input costs may deter participation in such trade, while import taxes unexpectedly show a positive effect (1.47), likely reflecting the role of strategic protection or regional import-substitution dynamics that facilitate domestic diversification. Institutional quality presents a positive but only moderately significant effect (0.78), suggesting a supportive role for governance in enabling horizontally structured trade. Lastly, all three MNE indicators including value-added (0.55), employment (0.33), and capital formation (0.38) are positively and significantly associated with HIIT, reinforcing the hypothesis that MNEs serve as vital conduits for embedding local economies within global value chains and promoting the exchange of differentiated products through skill, investment, and technological spillovers.

A generalized pseudo maximum likelihood (GPML) estimate for the HIIT model

Dependent Variable	**HIIT**	**HIIT**	**HIIT**	**HIIT**	**HIIT**	**HIIT**	**HIIT**	**HIIT**	**HIIT**	**HIIT**
Specifications	**[1]**	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**	**[7]**	**[8]**	**[9]**	**[10]**
lnGDP	1.026***	1.652***				1.359***			2.270***	1.222***
	(0.208)	(0.139)				(0.058)			(0.067)	(0.219)
lnsr_low		0.479***								
		(0.161)								
lnsr_high	1.010***									
	(0.205)									
lnEquat_dist			7.880***		3.499***		1.894***	2.662***	1.355***	
			(1.285)		(0.795)		(0.567)	(0.418)	(0.489)	
lnGDPpc			5.209***							
			(1.317)							
inst_qlity				0.776**	1.353					
				(0.307)	(1.072)					
lnR&D				1.573***						
				(0.051)						
lnTx_prod						-1.025***			-0.669***	
						(0.078)			(0.188)	
lnTx_imp						1.470***				0.813***
						(0.075)				(0.148)
lnMNEs_va							0.548***	0.425**		
							(0.148)	(0.170)		
lnMNEs_job					0.332***			0.198*		
					(0.120)			(0.101)		
lnMNEs_cf							0.384***			0.069**
							(0.140)			(0.030)
Constant	-17.657***	-25.661***	-92.953***	-17.180***	-16.440	5.689***	0.208	-2.733	-44.594***	-11.092**
	(2.873)	(2.159)	(24.171)	(3.069)	(12.434)	(0.739)	(3.578)	(2.680)	(4.462)	(5.388)
Observation	230	230	220	220	120	160	80	130	160	80
Log-Pseudo Likelihood	-5.40E+11	-5.90E+11	-3.30E+12	-5.20E+11	-1.70E+12	-2.30E+11	-6.70E+11	-1.70E+12	-4.40E+11	-1.80E+11
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AIC	4.68E+09	5.11E+09	2.99E+10	4.72E+09	2.77E+10	2.92E+09	1.68E+10	2.54E+10	5.55E+09	4.53E+09

Source: Own elaboration using STATA/MP Version 17. Explanatory variables are as defined in Table 3.3. All models are estimated using the Generalized Pseudo Maximum Likelihood (GPML). Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%

VIIT model estimates

The GPML estimates for VIIT exhibit a distinct empirical pattern that aligns closely with theoretical expectations regarding trade in quality-differentiated goods, particularly those grounded in productivity differentials and factor endowments (Falvey & Kierzkowski, 1987). While GDP retains a positive and statistically significant influence in all specifications, its comparatively smaller magnitude relative to IIT and HIIT suggests that market size plays a more modest role in explaining vertically structured trade flows. This indicates that VIIT is more sensitive to structural asymmetries than to aggregate demand conditions. The coefficient on equatorial distance is positive and significant (2.87), implying that provinces situated further from Canada's geographic core may actually be more embedded in vertically fragmented production networks, potentially due to factor-cost advantages or specialization in specific segments of global value chains. In contrast to the HIIT model, the skill composition of labor yields a reversed structure: low-skill labor is strongly and positively associated with VIIT (1.14), while high-skill labor also shows a positive, albeit slightly higher, effect (1.26). This dual significance suggests that provinces with varied labor endowments may integrate into different tiers of vertically differentiated production, spanning both low- and high-value-added segments (Feenstra & Hanson, 1996). GDPpc is statistically insignificant (0.11), indicating that income convergence is not a necessary condition for vertical trade, unlike the Linder hypothesis typically applied to HIIT. By contrast, R&D expenditure plays a critical role in enhancing VIIT performance (1.19), reinforcing the argument that technological upgrading is essential for climbing the value chain. Among fiscal variables, production taxes show a positive and significant effect (0.15), potentially reflecting the fact that in vertically integrated sectors, firms may absorb higher domestic costs if compensated by gains in specialization or export-oriented productivity. Import taxes (0.46) remain positively associated with VIIT, suggesting that imported intermediates are integral to fragmented production systems. Institutional quality, however, is statistically insignificant (0.12), pointing to a reduced role for broad governance frameworks in vertical trade, possibly due to the predominance of firm-level or network-based coordination mechanisms. Finally, the influence of multinational enterprises is consistently positive across all three indicators: MNE value-added (0.39), employment (0.33), and capital formation (0.24) each contribute significantly to VIIT intensity. These results underscore the centrality of MNEs in placing provincial economies within complex global production systems, facilitating access to external markets, technology, and knowledge spillovers.

A generalized pseudo maximum likelihood (GPML) estimate for the VIIT

Dependent Variable	**VIIT**	**VIIT**	**VIIT**	**VIIT**	**VIIT**	**VIIT**	**VIIT**	**VIIT**	**VIIT**	**VIIT**
Specifications	**[1]**	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**	**[7]**	**[8]**	**[9]**	**[10]**
lnGDP	0.214**	0.494***				0.879***			1.104***	0.986***
	(0.108)	(0.087)				(0.079)			(0.056)	(0.130)
lnsr_low		1.141***								
		(0.088)								
lnsr_high	1.259***									
	(0.104)									
lnEquat_dist			2.871***		1.749***		0.980***	1.479***	-1.171***	
			(0.311)		(0.266)		(0.304)	(0.240)	(0.110)	
lnGDPpc			0.111							
			(0.464)							
inst_qlity				0.123	0.117					
				(0.140)	(0.462)					
lnR&D				1.185***						
				(0.025)						
lnTx_prod						0.147**			0.967***	
						(0.062)			(0.072)	
lnTx_imp						0.461***				0.394***
						(0.098)				(0.079)
lnMNEs_va							0.388***	0.218**		
							(0.087)	(0.111)		
lnMNEs_job					0.332***			0.253***		
					(0.070)			(0.070)		
lnMNEs_cf							0.239***			0.001
							(0.080)			(0.040)
Constant	-0.953	-4.325***	0.144	-4.848***	4.700	10.139***	8.997***	6.401***	-0.260	-4.238
	(1.552)	(1.429)	(7.110)	(1.320)	(4.429)	(0.906)	(1.619)	(1.317)	(1.401)	(3.051)
Observation	230	230	220	220	120	160	80	130	160	80
Log-Pseudo Likelihood	-4.80E+10	-4.10E+10	-4.80E+11	-4.00E+10	-1.70E+11	-3.80E+10	-9.20E+10	-1.80E+11	-3.30E+10	-1.90E+10
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AIC	4.17E+08	3.57E+08	4.34E+09	3.61E+08	2.77E+09	4.79E+08	2.31E+09	2.81E+09	4.08E+08	4.85E+08

Source: Own elaboration using STATA/MP Version 17. Explanatory variables are as defined in Table 3.3. All models are estimated using the Generalized Pseudo Maximum Likelihood (GPML). Robust standard errors are in parentheses, *Significant at 10%; **significant at 5%; ***significant at 1%

Conclusion

Taken together, the GPML estimation results mirror those from PPML, highlight the nuanced and heterogeneous nature of IIT at the subnational level. The results across the IIT, HIIT, and VIIT models reveal a consistent and theoretically grounded relationship between key economic, structural, and institutional variables and the intensity of IIT at the provincial level. Economic size, measured by GDP, consistently exhibits a positive and statistically significant influence across all trade types, reaffirming the central insight from new trade theory that larger economies foster greater specialization and engagement in differentiated trade. Equatorial distance, as a proxy for geographic centrality and institutional maturity, also demonstrates a positive association across all models, suggesting that spatial positioning within national economic geography significantly shapes trade integration patterns. The positive effects of GDPpc in the IIT and HIIT models support the view that wealthier provinces, through higher consumer demand and greater productive capabilities, are better positioned to engage in horizontally differentiated trade, although this relationship does not hold in the context of vertically integrated trade. Labor skill composition exhibits a differentiated but complementary effect across the trade models. Both low-skill and high-skill ratios are positively associated with IIT and HIIT, indicating that skill diversity enhances participation in the production and exchange of similar goods. In the case of VIIT, the dual significance of both low- and high-skilled labor underscores the structural complexity of vertical trade, where provinces may participate in varying tiers of global production networks. The positive and significant role of R&D expenditure across all models highlights the critical function of innovation capacity in enabling product differentiation, technological upgrading, and value-chain integration. This is particularly notable in the VIIT model, where technological capability appears to compensate for income or geographic disadvantages. Fiscal and institutional variables also present important implications. Production taxes tend to deter IIT and HIIT participation, while their positive association in the VIIT model may reflect sectoral dynamics where cost absorption is feasible within export-oriented structures. The consistently positive effect of import taxes across all trade types suggests that protective fiscal instruments may inadvertently support domestic capabilities or encourage backward linkages within vertically structured systems. Institutional quality exhibits a mixed influence, positive but marginal in IIT and HIIT, and statistically insignificant in VIIT, indicating that governance structures may matter more in horizontally organized trade, while vertical trade may rely more heavily on firm-level mechanisms and MNE-

led coordination. The consistent positive contributions of MNE indicators across all models reinforce the argument that multinational enterprises play a vital role in aiding provincial economies within global production networks, thus facilitating IIT through investment, employment, and knowledge diffusion. These findings underscore the multifaceted nature of trade specialization and the importance of disaggregated analyses in understanding subnational trade dynamics in the context of globalization.

Appendix 5: Correlation coefficient analysis (test for multicollinearity)

In quantitative trade research, the presence of multicollinearity among explanatory variables poses a significant econometric challenge, particularly when models incorporate multiple dimensions of economic, institutional, and spatial determinants. This is especially relevant in subnational and bilateral trade analyses, where variables such as income, economic openness, globalization indices, and border characteristics often exhibit conceptual and empirical overlap. To ensure the robustness and interpretability of regression estimates across the three core analytical frameworks of this study - the baseline gravity model incorporating globalization mechanisms, the Canada-U.S. trade determinants model capturing the border effect, and the IIT model based on province-specific factors- a systematic assessment of multicollinearity was undertaken through the use of correlation matrices. These matrices serve as a preliminary diagnostic tool to detect potentially redundant relationships among regressors and guide appropriate model specification strategies, including the application of nested models and parsimonious variable selection. According to Hailer et al. (2006) correlation coefficient below 0.9 may not cause a serious multicollinearity problem.

Correlation matrix of globalization mechanisms – the baseline gravity model

The correlation matrix of globalization-related variables in the baseline gravity model reveals insignificant levels of multicollinearity, with most pairwise correlations well below the conventional thresholds (i.e., $\rho < 0.8$). The main globalization indicators, economic freedom, tariff liberalization, regional integration, and de jure globalization demonstrate low correlations, suggesting that they capture distinct conceptual dimensions. To address any residual multicollinearity concerns and enhance model parsimony, a nested specification strategy is adopted. This approach introduces theoretically related variables sequentially across model specifications to test robustness and ensure that the estimated effects of globalization mechanisms on trade are both stable and interpretable.

Explanatory Variables	lnGDP_pr	lnGDP_tp	lnDistance	lnGDPpc_diff	Ec_fredom_pr	Ec_fredom_tp	lnGlo_dj_tp	Lib_RTA	Lib_Tariff_dif	ERV	Metrop_node	Com_Lang	Col_Link	lnRM_HD_pr	lnRM_HD_tp
lnGDP_pr	1.00														
lnGDP_tp	0.02	1.00													
lnDistance	0.14	-0.15	1.00												
lnGDPpc_diff	0.03	-0.38	0.24	1.00											
Ec_fredom_pr	0.51	-0.02	0.15	-0.04	1.00										
Ec_fredom_tp	0.01	0.38	-0.28	-0.47	0.01	1.00									
lnGlo_dj_tp	0.01	0.17	-0.11	-0.09	0.00	0.25	1.00								
Lib_RTA	0.04	0.25	-0.27	-0.18	-0.10	0.29	0.10	1.00							
Lib_Tarif_df	0.02	0.29	-0.21	-0.28	-0.03	0.51	0.18	0.26	1.00						
ERV	0.01	0.02	-0.04	0.02	-0.01	-0.09	0.03	-0.03	0.06	1.00					
Metrop_node	0.72	0.00	0.12	0.00	0.46	0.00	0.00	0.00	0.00	0.00	1.00				
Com_Lang	0.00	-0.19	0.15	0.00	0.00	-0.12	-0.13	-0.11	-0.18	-0.06	0.00	1.00			
Col_Link	0.00	-0.20	0.15	0.00	0.00	-0.15	-0.15	-0.11	-0.19	-0.06	0.00	0.09	1.00		
lnRM_HD_pr	0.05	-0.05	0.39	0.09	0.06	-0.11	-0.03	-0.11	-0.08	-0.01	0.05	0.06	0.05	1.00	
lnRM_HD_tp	0.07	-0.08	0.51	0.12	0.08	-0.14	-0.05	-0.14	-0.11	-0.02	0.06	0.08	0.08	0.20	1.00

Source: Own elaboration using STATA/MP Version 17. Explanatory variables are as defined in Table 3.1

Correlation matrix of the Canada-U.S. trade determinants – the border effect model

The correlation matrix for the Canada-U.S. trade determinants model provides a preliminary diagnostic of potential multicollinearity among explanatory variables included in the border effect model. The findings indicate that multicollinearity is not a dominant issue in the model. A parsimonious modelling strategy is also adopted. Specifically, variables are introduced in nested models to test robustness, grouping related mechanisms (e.g., macroeconomic, institutional, or geographic variables), and monitoring coefficient stability. This strategy ensures that the explanatory power of closely related variables is tested incrementally, allowing for clearer attribution of effects and avoiding overfitting. Overall, while the matrix indicates some moderate inter-variable correlation, it does not provide evidence of severe multicollinearity. The findings are complemented with formal diagnostics through the Variance Inflation Factor (VIF) in the regression estimation phase.

Explanatory Variables	lnGDP_pr	lnGDP_us	lnDistance	Border	Cross_border	lnGDPpc_diff	Exch_rate	Tariff_diff	Ec_fredom_pr	Ec_fredom_us	lnRM_HD_x	lnRM_HD_m
lnGDP_pr	1.00											
lnGDP_us	0.00	1.00										
lnDistance	-0.10	0.09	1.00									
Border	0.00	0.31	0.12	1.00								
Cross_border	0.00	-0.12	-0.42	0.13	1.00							
lnGDPpc_diff	-0.02	0.07	0.05	-0.03	0.07	1.00						
Exch_rate	-0.03	0.22	0.06	0.46	0.06	0.09	1.00					
Tariff_diff	0.02	0.20	0.05	0.41	0.05	0.05	0.51	1.00				
Ec_fredom_pr	0.53	-0.05	0.03	0.00	0.04	0.06	0.03	-0.11	1.00			
Ec_fredom_us	-0.08	0.18	0.10	0.47	0.06	-0.05	0.49	0.25	0.21	1.00		
lnRM_HD_x	-0.06	0.04	0.59	0.06	-0.25	0.02	0.02	0.02	0.02	0.05	1.00	
lnRM_HD_m	-0.07	0.08	0.69	0.12	-0.30	0.05	0.05	0.05	0.03	0.08	0.41	1.00

Source: Own elaboration using STATA/MP Version 17. Explanatory variables are as defined in Table 3.2

Correlation matrix of province-specific factors – the IIT model

The correlation matrix for the IIT model reveals a number of multicollinearities among some regressors. Notably, variables such as lnGDP, lnsr_high, lnsr_low, lnR&D, and the tax indicators (lnTx_pro and lnTx_imp) demonstrate pairwise correlation coefficients frequently in the neighborhood of approximately 0.90. These strong associations indicate that the included variables may not be providing entirely distinct information, thereby inflating standard errors and reducing the reliability of coefficient estimates. Institutional quality (inst_qlity) and GDPpc, by contrast, show more moderate correlations and contribute unique explanatory variation to the model. To ensure empirical rigor, this study addresses multicollinearity through a parsimonious modeling strategy. Specifically, variables are grouped and introduced in nested model specifications, allowing for systematic robustness checks and isolating the marginal contribution of each group. This approach strengthens the reliability of the results and enhances interpretability, while maintaining theoretical consistency in assessing the determinants of IIT at the provincial level.

Explanatory Variables	lnGDP	lnsr_high	lnsr_low	lnEquat_dist	lnGDPpc	inst_qlity	lnR&D	lnMNEs_va	lnMNEs_job	lnMNEs_cf	lnTx_pro	lnTx_imp
lnGDP	1.000											
lnsr_high	0.991	1.000										
lnsr_low	0.982	0.990	1.000									
lnEquat_dist	0.813	0.779	0.765	1.000								
lnGDPpc	0.458	0.344	0.320	0.587	1.000							
inst_qlity	0.454	0.412	0.470	0.375	0.386	1.000						
lnR&D	0.988	0.994	0.979	0.826	0.372	0.381	1.000					
lnMNEs_va	0.808	0.791	0.769	0.713	0.425	0.212	0.802	1.000				
lnMNEs_job	0.636	0.649	0.652	0.417	0.161	0.164	0.637	0.516	1.000			
lnMNEs_cf	0.732	0.716	0.698	0.604	0.430	0.393	0.714	0.545	0.465	1.000		
lnTx_prod	0.948	0.943	0.954	0.741	0.397	0.460	0.932	0.748	0.622	0.661	1.000	
lnTx_imp	0.971	0.984	0.980	0.794	0.286	0.373	0.982	0.802	0.623	0.671	0.948	1.000

Source: Own elaboration using STATA/MP Version 17. Explanatory variables are as defined in Table 3.3

Appendix 6: Summary table of results based on primary estimation

THE BASELINE GRAVITY MODEL - TESTING HYPOTHESES (1)	**Export Model**	**Total Trade Model**	**Import Model**	**Status**
Traditional Gravity Varibles:	---	---	---	---
▪ Province GDP (lnGDP_pr)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
▪ Partners GDP (lnGDP_tp)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
▪ Distance (lnDistance)	– (1%, ***)	– (1%, ***)	– (1%, ***)	Confirmed
Historical Facts:	---	---	---	---
▪ Common Language (Com_Lang)	+ (1%, ***)	+ (1%, ***)	– (5%, **)	Confirmed
▪ Colonial Linkage (Col_Link)	+ (1%, ***)	– (not sig.)	– (1%, ***)	Mixed
Remoteness Terms:	---	---	---	---
▪ Outward Multilateral Resistance Term (lnRM_HD_pr)	+ (not sig.)	– (not sig.)	– (not sig.)	Confirmed
▪ Inward Multilateral Resistance Term (lnRM_HD_tp)	– (not sig.)	– (not sig.)	– (not sig.)	Confirmed
H (1_A): Economic Openness	----	---	---	---
▪ Province Economic Freedom (Ec_fredom_pr)	+ (1%, ***)	+ (1%, ***)	– (1%, ***)	Confirmed
▪ Partners Economic Freedom Ec_fredom_tp	+ (1%, ***)	+ (not Sig.)	– (1%, ***)	Confirmed
▪ Partners' KOF De Jure Globalization Index (lnGlo_dj_tp)	+ (1%, ***)	+ (1%, ***)	– (not sig.)	Confirmed
H (1_B): Libralization Mechanisms	---	---	---	---
▪ Rgional Trade Agreements (Lib_RTAs)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
▪ Tariff Measures (Lib_Tariff_Differentials)	– (not sig.)	– (1%, ***)	– (1%, ***)	Confirmed
H (1_C): Exchange Rate Volatility (ERV)	+ (1%, ***)	– (10%, *)	– (1%, ***)	Ambiguos
H (1_D): Metropolis (Metrop_Node)	+ (1%, ***)	+ (1%, ***)	– (1%, ***)	Confirmed
H (1_E): Income Inequality	---	---	---	---
▪ GDPpc Difference (lnGDPpc_diff)	– (1%, ***)	+ (not Sig.)	+ (1%, ***)	Confirmed
▪ Non-linearities:	---	---	---	---
o GDPpc Difference*RTAs (lnIneq_RTA)	– (1%, ***)	– (1%, ***)	– (5%, **)	Confirmed
o GDPpc Difference*Tariff_df (lnIneq_tarif_dif)	– (1%, ***)	– (not sig.)	+ (1%, ***)	Confirmed
o GDPpc Difference*ERV (lnIneq_ERV)	– (1%, ***)	– (1%, ***)	– (1%, ***)	Confirmed
Canada-US Trade Analysis – Border Effect Model (Complement to H1)	---	---	---	---
▪ Border	– (1%, ***)	– (1%, ***)	– (1%, ***)	Confirmed
▪ Borderland Regions (Cross_border)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
▪ Tariff Measures (Tariff_diff)	– (not sig.)	– (not sig.)	– (not sig.)	Confirmed
▪ Non-Tariff Measures	---	---	---	---
o Exchange Rate (Exch_rate)	– (5%, **)	– (5%, **)	– (10%, *)	Confirmed
o GDPpc Difference_Ca_us (lnGDPpc_diff)	+ (10%, *)	– (not sig.)	– (1%, ***)	Confirmed
o Provincial Economic Freedom (Ec_fredom_pr)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
o Partners' Economic Freedom (Ec_fredom_us)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
o Outward Multilateral Resistance Term (lnRM_HD_x)	– (5%, **)	– (5%, **)	– (not sig.)	Confirmed
o Inward Multilateral Resistance Term (lnRM_HD_m)	– (not sig.)	– (not sig.)	– (not sig.)	Confirmed
THE IIT MODEL - TESTING HYPOTHESIS (2)	**IIT Model**	**HIIT Model**	**VIIT Model**	
H (2_A): Factor Endowments	---	---	---	---
▪ GDP (lnGDP)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
▪ GDPpc (lnGDPpc)	+ (1%, ***)	+ (1%, ***)	+ (not Sig.)	Confirmed
H (2_B): Trade Frictions	---	---	---	---
▪ Equatorial Distance (lnEquat_dist)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
▪ Institutional Quality (inst_qlity)	+ (5%, **)	+ (5%, **)	+ (not Sig.)	Confirmed
▪ Production Tax (lnTx_prod)	- (1%, ***)	- (1%, ***)	+ (5%, **)	Confirmed
▪ Import Tax (lnTx_imp)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
H (2_C): Technological capabilities/innovations (lnR&D)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
H (2_D): Human capital quality	---	---	---	---
▪ High Skill Ratio (lnsr_high)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
▪ Low Skill Ratio (lnsr_low)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
H (2_E): Role of MNEs	---	---	---	---
▪ Value-Added (lnMNEs_va)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
▪ Employment (lnMNEs_job)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
▪ Capital Formation (lnMNEs_cf)	+ (1%, ***)	+ (1%, ***)	+ (1%, ***)	Confirmed
Source: Own elaboration based on coefficient estimates of various models				