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Original Research Article

NAFTA to USMCA Free Trade Agreements: A Comparative Study About Trade Deficit and Net Trade of HS6 Digit Commodities in the Agricultural Section

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This study examines the impact of NAFTA and USMCA free trade agreements on trade deficits and net agricultural trade between the United States, Canada, and Mexico, focusing on HS6-digit level agricultural commodities from 1994 to 2020. Using ARDL and gravity models, the results show that NAFTA led to increased trade volumes and improved net trade positions—particularly for Mexico, whose net agricultural trade surplus with the U.S. grew by approximately 24%. In contrast, the United States experienced a 15% increase in its agricultural trade deficit under USMCA, while Canada's balance remained relatively stable, with fluctuations within a ±5% range. The ARDL model results indicates that GDP ($\beta = 0.47$, $p < 0.01$), exchange rate ($\beta = 0.82$, $p < 0.05$), and government spending ($\beta = -0.39$, $p < 0.1$) significantly influenced bilateral trade deficits. In the gravity model, GDP per capita had the strongest positive effect on net agricultural trade ($\beta = 1.75$, $p < 0.01$), while agricultural value-added had a negative impact ($\beta = -0.61$, $p < 0.05$). These findings suggest that structural changes in trade agreements, combined with macroeconomic conditions, have measurable effects on national trade balances. For countries like Iran, the study highlights the importance of designing bilateral trade frameworks that promote agricultural competitiveness, maintain exchange rate stability, and protect vulnerable producers. Evidence-based trade policy can help Iran achieve greater trade resilience and improve its position in regional agricultural markets.

Keywords: Trade Deficit, Net Agricultural Trade, Free Trade Agreements, ARDL Approach, GLS Method

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1 Introduction

Trade is a vital aspect for human society from the past when they have a barter trade that has deep and more effective of various agreements. This paper aims to analyze and compare the effects of two major North American free trade agreements (NAFTA and USMCA) on the trade deficit and net agricultural trade flows among the United States, Mexico, and Canada. The primary objective is to evaluate how these agreements have influenced bilateral agricultural trade, using detailed HS6-digit product-level data and robust econometric modeling. This research is significant in understanding the dynamics of regional trade policy and provides insights applicable to other developing economies, particularly Iran, which is evaluating regional trade partnerships. From the General Agreement on Tariffs and Trade (GATT) to World Trade Organization (WTO), all the main developed nations (like U.S., Germany, Japan, etc.) and developing countries are trying to decline the barriers to trading with various kinds of rules that lead to agreements (Nordgren, 2000). A trade agreement occurred between two or more countries based on the specific subjects of investment, commerce, exchanges and others like that. There are types of trade agreements, including Free Trade Agreements (FTA), Preferential Trade Agreements (PTA), Comprehensive Economic Partnership Agreement (CEPA), Comprehensive Economic Cooperation Agreement (CECA), Framework Agreements (FA), and Regional Trade Agreement (RTA). These various kinds are a function of countries' trade rules, political relationships, and the size of economies to provide concessions to partner countries. Through the agreements, partner countries can promote liberalization, consider the desired rate of tariff, tremendous acceleration in catching a higher rate of innovation and technology associated with more production by deviation from the less effective products to a highly effective producer, induce states to reform the structure of policies based on the agreements and create steady-state economic growth rate by widening market in a variety of regional (Levy, 1997). " The main reason (for establishing) treaties between two or more countries is to reduce tariffs that are put on the import commodities for supporting internal industries, and based on each country is turned agreed to reduce or eliminate a lot of tradable goods. There are a lot of examples of removing duties between countries; for instance, Canada imports tobacco for cigars with up to 8% duty, but under terms of the Canada-EU FTA (CEFT), Canada removed duty for EU tobacco importing (Cameron & Loukine, 2001). Trade of honey is without any duty between EU country members; however, the EU imposes about 17%

for honey imported from the US. Also, there is an agreement between Japan and the EU to remove tariffs on to border for cars imported from Japan to the EU (García, 2018). Some of the trade agreements are bilateral, like the examples above, and also there are others that are plurilateral, like NAFTA between the US, Canada, and Mexico, and MERCOSUR that, 's concluded between Argentina, Brazil, Paraguay, Uruguay, and Venezuela. These two kinds of free trade agreements have distinct regional specifications.

Based on the report of the United States International Trade Commission, trade agreements, especially FTAs, have had a positive long-run effect on an economic index like GDP, Income, employment, and other factors. All the effects estimates are based on the two models, including the Economy-wide model and the stand-alone model. When we want to quantify all effects of agreements on the economic indexes like GDP, employment or unemployment, exchange rate, welfare, government expenditure and etc., this kind of model can be the appropriate choice (United States International Trade Commission, and United States. Office of the US Trade Representative. (1992) and United States International Trade Commission. (1999)). On the other hand, the stand-alone model can be used to analyze the effects of agreement provisions on specific sectors like intellectual property rights (IPRs) and cross-border trade (Campi & Dueñas, 2019). Evidence shows that impede decreasing is a consequence of trade agreements; for instance, FTAs trade agreements between U.S-Israel and NAFTA cause a reduction in cross-border barriers by 16 and 8 percent, respectively (Rosen, 2004). Trade agreements also make foreign direct investment less costly and can encourage foreign companies to trade by reducing or eliminating tariffs (Thangavelu & Findlay, 2011). On the other hand, there are lots of critics who believe that reduction in tariffs and tariff liberalizations acts as destroying national production by foreign cheapest goods. The effects of these various trade agreements on economic factors are diverse and challenging subjects. Based on the literature, these agreements have a direct impact on trade flows, GDP, wages, employment, and other macroeconomic factors (Urata and Sasuya, 2007). Also, local and multinational trade contracts can be affected by economies of scale, reduction risks, structural policy reform, and even competitiveness in the host country. Trade agreements can examine both cause and consequences; the consequences take into the macroeconomic impacts caused by forcing trade agreements. Most trade agreements' consequences have both short-term and long-term effects, so to have an appropriate conclusion, it should be run by a simulation for both situations.

This study addresses the following key question: (To what extent has the transition from NAFTA to USMCA, along with related macroeconomic factors, influenced agricultural trade balances among the United States, Mexico, and Canada?

The paper is structured as follows: Section 2 reviews the existing literature on trade agreements and agricultural trade. Section 3 outlines the methodological framework, including the ARDL and gravity models. Section 4 presents the data sources, empirical analysis, and results. Section 5 concludes with a discussion of the findings and policy implications, including considerations for countries with similar economic profiles.

2 Literature Review

2.1 Theoretical Background

International trade theory has long emphasized how agreements between countries can shape the direction and volume of trade flows. Free Trade Agreements (FTAs) and Preferential Trade Agreements (PTAs) are among the most widely used tools for trade liberalization, reducing tariffs and non-tariff barriers to promote cross-border exchange. These agreements are often influenced by economic size, geopolitical relationships, policy alignment, and industrial complementarities. Additionally, macroeconomic factors such as GDP, exchange rates, and government spending can influence the outcomes of such agreements, particularly in key sectors like agriculture and energy. To analyze these relationships, researchers have applied models such as Autoregressive Distributed Lag (ARDL), Gravity Models, and Feasible Generalized Least Squares (FGLS), each capturing different dimensions of trade performance over time.

2.2 Review of Previous Empirical Studies

Several empirical studies have examined how PTAs and FTAs affect trade volumes, investment, and sectoral outcomes across countries and commodities.

Cheong and Tang (2015) investigated the influence of economic similarity and distance on the gains countries derive from PTAs. Their approach included stratification techniques, interaction terms, and correlation analyze to show that trade benefits increase when member countries are similar in income levels, geography, or market structures. The study concluded that such similarities amplify trade effects after PTA implementation.

In the context of the energy sector, Galkin et al. (2018) focused on China's PTAs and their role in shaping energy import flows. Their model, based on an import demand function and estimated using a panel dataset with seemingly unrelated regression (SUR) methods, revealed that tariffs had a stronger effect on the import of coal, crude oil, and oil products than policy coordination or long-term investment strategies. This underscores the importance of tariff structures as opposed to qualitative factors in determining trade flows.

Zhang et al. (2021) explored the link between trade openness and renewable energy consumption (REC) through a panel smooth transition regression model. By testing three thresholds—imports, exports, and total trade relative to GDP—they showed a nonlinear relationship: for instance, imports increased REC up to a 40.95% GDP threshold, but beyond that point, they had a diminishing effect. Both exports and total trade were consistently found to support REC, indicating that trade liberalization can positively influence environmental outcomes under certain conditions.

Gil-Pareja et al. (2014) studied the effects of non-reciprocal trade agreements, such as AGOA, GSP, and ACP-EU, on export volumes from developing to developed nations. Using gravity modeling techniques, they analyzed variables like bilateral GDP, distance, and trade policy dummies. Their findings confirmed that such arrangements significantly boost exports from low-income countries when they are given favorable access to wealthier markets.

Zahid et al. (2021) investigated the impact of PTAs on foreign direct investment (FDI) inflows. Their model incorporated key variables such as market size, inflation, trade openness, and national income growth. After testing for heteroskedasticity and autocorrelation using Breusch-Pagan and Wooldridge methods, they applied a Feasible Generalized Least Squares (FGLS) approach. Their results indicated that a larger common market size positively affects FDI, primarily by increasing export potential and improving access to broader regional demand.

2.3 U.S. Trade Policy and Regional Integration

Since World War II, the United States has shaped its trade policy to lower barriers and establish trade rules aligned with multilateral institutions like the WTO. The country has also used FTAs to promote strategic interests, avoid monopolistic behavior, and provide domestic support mechanisms for industries facing global competition (Schott (2004) and Cooper (2014)). These agreements are subject to congressional oversight, and recent discussions have focused on enforcement and implementation, especially under new arrangements such as the USMCA.

A recent report by the U.S. Congressional Research Service titled "U.S. Trade Policy: Background and Current Issues" highlights the ongoing importance of FTAs and underscores that enforcement mechanisms are a key challenge in contemporary trade policymaking. Villarreal and Fergusson (2020) specifically examined the implications of the USMCA agreement, focusing on welfare, trade creation, trade diversion, and sectoral trade deficits. Their study also points to the need for further empirical analyze, particularly with regard to enforcement outcomes and sector-specific impacts.

2.4 Contribution of the Present Study

Building on this body of literature, the present research applies ARDL and gravity model frameworks to assess the impact of NAFTA and USMCA on trade deficits and net trade in the agricultural sector using HS6-digit data. Unlike broader studies focusing on GDP or aggregate trade indicators, this paper offers a disaggregated view of trade flows across three economies. Given Iran's interest in expanding regional trade and the growing importance of agricultural exports, these findings can provide policy-relevant insights for similar economies seeking structured, data-informed trade engagement.

The findings of this study are largely consistent with previous empirical literature. For example, the ARDL model results confirm the positive effect of GDP on trade flows, aligning with Cheong and Tang (2015) and Zhang et al. (2021). Moreover, the observed trade surplus of Mexico under NAFTA and the temporary stagnation under USMCA resonate with the simulation outcomes of Burfisher et al. (2019), who predicted limited macroeconomic gains but sectoral rebalancing under the new agreement. Similarly, Rechenberg (2025) discusses the adverse effects of free trade agreements on U.S. agricultural trade performance. The importance of exchange rate effects, as revealed in this study, supports conclusions drawn by Zahid et al. (2021), who also emphasized the macroeconomic environment's influence on trade.

However, this study contributes uniquely by offering a disaggregated, HS6-digit agricultural sector analysis, which remains relatively underexplored in recent USMCA research.

3 Methodology Framework

The Congressional Research Service (CRS) reports on U.S. trade policy covering the background and current issues in the trade agreements area. This report includes diverse sections like the economic impacts of trade rules, components of U.S. trade policy, and trade relations with other partners. Also, there are some potential issues with studying this field. In this study, we investigate the topics in **prospects** and the need for various FTAs of the U.S. and other parties, such as NAFTA and USMCA (United States–Mexico–Canada Agreement). Firstly, we introduce both of these FTAs agreements and introduced them in a brief of its history manner and then, based on the problems to enforcement of this FTAs, use an ARDL model for investigation of the changing in trade deficit based on the some of macroeconomics index after running this agreement. After that, we will apportion our analyze into three main scenarios for three partners, including investigating the net trade agriculture when exposed to diverse indexes like GDP per capita, exchange rates, population, agriculture lands and value added in agriculture section, trying to measure the change in net trade agriculture, and studies. The main question of this paper is whether decreasing in obstacles by NAFTA and USMCA FTAs will change economic factors in the United States-Mexico-Canada partnership. Is these FTAs will be caused by to increase in trade between partners and affected their net trade flows and trade deficit streams of partners?

Besides theoretical issues, we want to mention some data about trade between the three countries, US-Mexico-Canada. Before establishing USMCA FTAs in 2018 and implementing in 2020, there was primarily a trade agreement between them named NAFTA that was signed and had been forcing in 1994. Regarding the volume of export and import, firstly, we will be applying some data about the United States and Mexico first and then spreading it to the United States and Canada. The NAFTA and USMCA FTAs are clearly important for both pairs, including Mexico vs. the United States and Canada vs. the United States: The United States was the destination for 79.24% of total Mexico’s export (total amount exports were US $416,982 million) in 2020, considering the first market for exporting products by Mexico. On the other side, the USA exported US$ 212,672 million to Mexico in 2020; Mexico is considered the second partner for exporting goods and services (next to Canada) with a 14.87% export partner share. Regarding trade between Canada and the United States, statistics show that in 2020, the USA was the first partner in both total Canada’s export and import. Canada exported about US$ 284,478 million to the USA (with a 73.25% export partner share) and also imported US$ 197,728 million from the USA (with a 48.84% import partner share). Some critical statistics are shown in Table 1. In this study, we investigate the trend of trade between three partners from 1994 (the time for the establishment of NAFTA) until 2020 (the time for implementation force USMCA FTA) to have clearly resulted in trade between three partner countries. Based on former information about the volume of trade between the three partnerships, it resulted that about 33% of export and 25% of imports of total USA trade volume is related to Mexico and Canada, so this agreement can effectively change the market equilibrium in the USA (Burfisher et al., 2019; Manole, 2005).

Table 1

Export and import statistics data between three partnerships of USMCA FTAs

Country	**Trade Statistics**			
USA				
Trade Volume*				
	overall import (M $)		overall export (M $)	
	1994	2020	1994	2020
	689,030	2,405,382	512,337	1,430,254
Product categories**				
	(Export (M $))-(product share (%))		(Import (M $))-(product share (%))	
	1994	2020	1994	2020
Raw materials	(48,545)-(9.48)	(190,295)-(13.31)	(68,702)-(9.97)	171,995)-(7.15)
Intermediate goods	(101,424)-(19.80)	(284,864)-(20.06)	(109,667)-(15.92)	(397,330)-(16.52)
Consumer goods	(104,059)-(20.31)	(369,730)-(25.85)	(240,854)-(34.96)	(903,423)-(37.56)
Capital goods	(237,598)-(46.38)	(468,653)-(32.77)	(237,334)-(34.44)	(829,728)-(34.49)
Partners				
	(Market (M $))-(share (%))		(Exporter (M $))-(share (%))	
	2020		2020	
	Canada	(255,022)-(17.83)	China	(457,164)-(19.01)
	Mexico	(212,672)-(14.87)	Mexico	(328,862)-(13.67)
	China	(124,649)-(8.72)	Canada	(276,196)-(11.48)
	Japan	(64,091)-(4.48)	Japan	(122,484)-(4.88)

Source: Research Findings calculations based on the World Bank, United Nations and International trade center open trade and competitiveness data.
All export and import data values are classified based on the Harmonized system 1988/92, SITC revision 2
List of trading products are based on HS6 digit level
Trade statistics for Mexico and Canada add in Annex
*Data source: UNSD Comtrade
** Products are categorized at the HS 6-digit level and classified under the HS 1988/92 system

It can be inferred from Table 1 the three partners have a significant increase in trade volume across all product categories. Shape 1 also shows the trend of trade between these three countries with some statistics, including import and export (in two scenarios: 1) all trade volume, 2) in the agriculture section), trade volume, and trade deficit. The total trade in the North American region shows that there is a significant volume of trade between the USA, Canada, and Mexico. The total number of North American imports from Canada was 279,187 million $, while exported 255,022 US$ to North America. About the USA, the import from and export to North America are 198,360 and 284,496 million US$, respectively. For Mexico, the North American region exported 217,261 million US$ to Mexico and imported 351,201 million US$ from Mexico (Rozanski et al., 2001). Also, other statistics data for other partners including Mexico and Canada are shown in Appendix Table S7 and S8, respectively.

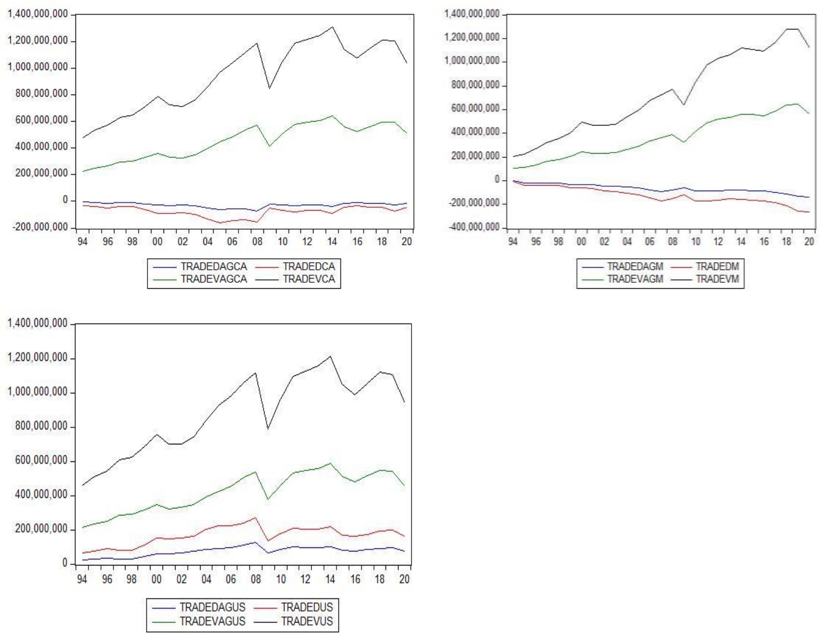


Figure 1. The trade statistics between three partners USA-Canada-Mexico
Source: Research Findings based on the World Bank, WITS-UNSD Comtrade.
All export and import data values are classified based on the Harmonized system 1988/92, SITC revision 2

To investigate the orientation and trend of trade volume and trade deficit between NAFTA and USMCA trade agreements, we calculate the trade volume (TRADEV(total trade volume) and TRADEVAG (trade volume in agricultural section)-country name) and trade deficit (TRADED (total trade deficit) and TRADEDAG (trade deficit for agricultural section)-country name) in two sections including all the trade volume and for three agricultural commodities (Animal, food products and vegetables). As shown in Fig1, the trade volume for both all products and agricultural categories in three partners increased from 1994-2018 (NAFTA FTA) but decreased between 2018-2020 (USMCA FTA). The 2008 world economic crisis had a direct effect on trade volume, but Mexico's economy was less affected. Regarding trade deficit (difference between import and export), it can be concluded that the two partners, including Mexico and Canada, have pure net profit in both whole and agricultural categories. As can be seen in Fig1, the trade volume hasn't been the stable duration of time; it includes some factors affecting it and should be investigated when exposed to other macroeconomic factors. So, we considered a gravity model to explain the measure and orientation of some economic factors on trade volume. Although some may argue that ARDL is not ideal for all trade contexts, it is especially appropriate in this study due to the mixed integration orders (I(0) and I(1)) of the variables and the limited time series observations per partner. Moreover, ARDL offers both short- and long-term elasticity estimates, which are essential to distinguish immediate policy impacts from structural trends in trade balances.

In this study, we first investigate an ARDL procedure to have a know-how of the basic universe situation, then investigate a Gravity model for studying the agricultural section. The models are estimated based on a comparison between NAFTA (1994-2018) and the new USMCA (2018-recently). The ARDL model is suitable for analyzing the relationship between trade balance and macroeconomic variables, especially in developing economies. Hanif et al. (2023) utilized this model to study Pakistan's trade deficit, while Ramos-Herrera (2024) applied both ARDL and NARDL approaches to assess economic growth and exchange rate deviations.

3.1 The ARDL Procedure

The trade deficit is also known as the ratio of nominal import to nominal export. For evaluating the trade deficit model, we write it as a model with some exogenous variables as we rendered below;

$$lnTD_{us,m} = \delta_0 + \delta_1 lnGDP_{us,m} + \delta_2 lnGDP_{m,m} + \delta_4 lnER_{us,m} + \delta_7 lnGS_{us,m} + \delta_8 lnGS_{m,m} + u_t \quad (1)$$

$$lnTD_{ca,m} = \delta_0 + \delta_1 lnGDP_{ca,m} + \delta_2 lnGDP_{m,m} + \delta_4 lnER_{ca,m} + \delta_7 lnGS_{ca,m} + \delta_8 lnGS_{m,m} + u_t \quad (2)$$

Where TD is stand for Trade Deficit, GDP_{us} = the USA GDP, GDP_m = the Mexico GDP, GDP_{ca} = the Canada GDP, ER is short of Exchange Rate and GS shows the Government Spending. Also, subscripts indicate the country to which each variable belongs. For example, the subscript "us" refers to the United States, "m" to Mexico, and "ca" to Canada.

Equations (1) and (2) show that trade deficit is introduced as differences between the nominal import and nominal export of Mexico from the USA and Canada as trade partners in the USMCA free trade agreement. We will be introducing Mexico's trade deficit as a sample, and other countries have the same equations like that. GDP for both partners of a trade agreement can be affected by the trade deficit in positive and negative forms. As in economic literature show (Halicioglu (2008)), coinciding with an increase in economic growth, wages for people in country Mexico will be increased, and they can buy more commodities from overseas countries, which means that imports will increase because of more spending for importing goods that cause to increase in the trade deficit. So, the positive and negative effects depend on the dominance degree of supply-side factors over demand or vice versa. But, if the increase in national income leads to an increase in substitute goods for imported goods, it causes to decrease in importing, and then the trade deficit gets low. Regarding the exchange rate (ER), it will expect that in the short term, it will have a negative effect on the trade deficit (J curve procedure). The coefficient of trade deficit should be investigated in both the short and long term because, for instance, the coefficient has a negative effect in the short term and a positive effect in the long term. While nominal exchange rate may exhibit endogeneity in trade models, we treat it as weakly exogenous due to its policy-determined nature in many countries. Lagged variables are also used to mitigate endogeneity bias. To investigate the existence of cointegration between variables, we investigate an Autoregressive Distributed Lag (ARDL) procedure. This model has some advantages. The problem of endogeneity and the inability to test the hypothesis about un-estimated long-run coefficients does not arise in the Engle-Granger (1987) method. Also, the long-run and short-run parameters will be investigated simultaneously, and knowledge about the cointegration degree between variables and the unit root test isn't necessary (Harris and Sollis (2003)). There is a lag between a politician's strategy decision and the effects of that on a macroeconomic variable. In our study, we want to have a short-term and long-term study in forcing both NAFTA and USMCA trade agreements' effects on the trade deficit of Mexico's economics. We suppose three categories of ARDL equations of bilateral trade for three partners as three scenarios that are shown in Equation (3).

$$\begin{cases} Scenario1.\,Mexico \begin{cases} Mexico - US \\ Mexico - Canada \end{cases} \\ \therefore \\ Scenario2.\,USA \begin{cases} US - Canada \\ US - Mexico \end{cases} \\ \therefore \\ Scenraio3.\,Canada \begin{cases} Canada - US \\ Canada - Mexico \end{cases} \end{cases} \quad (3)$$

3.1.1 Scenario 1. Mexico Trade Deficit

The ARDL form of the equation for Mexico's trade deficit can be rewritten as Equation (4) and (5) form (for other Scenarios all of the equations are as same as (4) and (5) equations);

$$\Delta \ln TD_{m,us} = \varepsilon_0 + \sum_{i=0}^{b} \varepsilon_{i1} \Delta lnTD_{us,m-i} + \sum_{i=0}^{b} \varepsilon_{i2} \Delta lnGDP_{m,m-i} + \sum_{i=0}^{b} \varepsilon_{i3} \Delta lnGDP_{us,m-i} + \sum_{i=0}^{b} \varepsilon_{i4} \Delta lnER_{us,m-i} + \sum_{i=0}^{b} \varepsilon_{i5} \Delta lnGS_{us,m-i} + \sum_{i=0}^{b} \varepsilon_{i6} \Delta lnGS_{m,m-i} + \varepsilon_7 lnTD_{us,m-1} + \varepsilon_8 lnGDP_{m,m-1} + \varepsilon_9 lnGDP_{us,m-1} + \varepsilon_{10} lnER_{us,m-1} + \varepsilon_{11} lnGS_{us,m-1} + \varepsilon_{12} lnGS_{m,m-1} + \mu_t \quad (4)$$

$$\Delta lnTD_{m,ca} = \varepsilon_0 + \sum_{i=0}^{b} \varepsilon_{i1} \Delta lnTD_{ca,m-i} + \sum_{i=0}^{b} \varepsilon_{i2} \Delta lnGDP_{m,m-i} + \sum_{i=0}^{b} \varepsilon_{i3} \Delta lnGDP_{ca,m-i} + \sum_{i=0}^{b} \varepsilon_{i4} \Delta lnER_{ca,m-i} + \sum_{i=0}^{b} \varepsilon_{i5} \Delta lnGS_{ca,m-i} + \sum_{i=0}^{b} \varepsilon_{i6} \Delta lnGS_{m,m-i} + \varepsilon_7 lnTD_{ca,m-1} + \varepsilon_8 lnGDP_{m,m-1} + \varepsilon_9 lnGDP_{ca,m-1} + \varepsilon_{10} lnER_{ca,m-1} + \varepsilon_{11} lnGS_{ca,m-1} + \varepsilon_{12} lnGS_{m,m-1} + \mu_t \quad (5)$$

In Equations (4), (5), b parameter shows the length of the break, the depreciation of the national currency is showing by the amount and significance of ε_9 coefficient that is normalized by ε_6 coefficient. Other parameters will be investigate in diverse length of break including I(0), I(1) and I(2). Pesaran et al. (2001) method investigated the constraint test is based on the F statistics. Based on the null hypothesis, lack of co-accumulation ($H_0: \varepsilon_6 = \varepsilon_7 = \varepsilon_8 = \varepsilon_9 = \varepsilon_{10} = 0$), will be tested against surrogate hypothesis ($H_1: \varepsilon_6 \neq \varepsilon_7 \neq \varepsilon_8 \neq \varepsilon_9 \neq \varepsilon_{10} \neq 0$). The F-statistics hasn't following a normal random distribution. So, we will investigates the null hypothesis based on a boundary test in that one of these hypothesis considered all variables in I(0) and another considered is I(1). For investigating the results, if F-statistics be greater than the upper limit of critical values, the null hypothesis (lack of co-accumulation) rejected, also, if the F-statistic be less than the lower limit of critical values, there is no co-accumulation relationship between the variables. But, if the F-statistics be between the upper and lower critical values, the test can't be solved.

Before estimating the models, we investigate the stationary time series procedures. In other words, is there a constant mean, variance, and autocorrelation across the time series dataset? In this study, we use an augmented Dickey-Fuller test (ADF) and Phillips-Perron (PP) tests for studying the stationary of all model variables. For Equations (4) and (5), the results show that all variables have stationary during study time. Some specific results shown in Appendix Table S1.

The results show that in the two-part Mexico scenario, all the variables are stationary, and the prerequisite for estimating ARDL for equations (4) and (5) is possible. After studying stationary results, we will run the ARDL model to investigate the relationship between independent and dependent variables of Mexico's trade deficit. We considered the 1994-2020 years to have a transparent result about trade between the three partners of NAFTA and USMCA free trade agreements. The procedure estimate is based on the two-sided logarithm and investigates the appropriate degree of interval based on the Akaike-Schwarz criterion to catch the best lags for ARDL estimation. The estimation ARDL results for Mexico's trade deficit (Scenario 1) is as follows as;

Table 2

ARDL result test estimation, Scenario 1. Mexico trade deficit

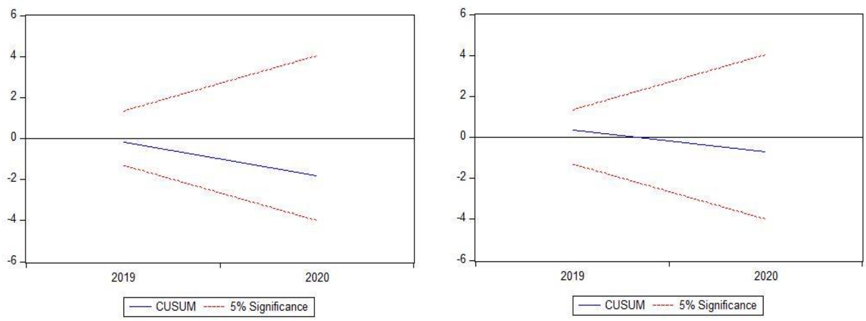
Mexico-US Procedure					Mexico-Canada Procedure				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*	*Variable*	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
LNTD(-1)	0.823572	0.047078	17.49371	0.0033	*LNTD(-1)*	-0.587374	0.207045	-2.836936	0.1050
LNGDPM	-10.85257	0.601049	-18.05605	0.0031	*LNTD(-2)*	-0.794045	0.180343	-4.402972	0.0479
LNGDPM(-1)	-7.682723	0.489109	-15.70760	0.0040	*LNGDPCA*	23.83964	5.192614	4.591068	0.0443
LNGDPM(-2)	2.875917	0.178283	16.13116	0.0038	*LNGDPCA(-1)*	23.15142	3.307264	7.000173	0.0198
LNGDPM(-3)	-1.551602	0.121345	-12.78665	0.0061	*LNGDPCA(-2)*	6.108663	2.098661	2.910743	0.1005
LNGDPUS	41.47953	2.141855	19.36617	0.0027	*LNGDPM*	-41.66462	7.867762	-5.295613	0.0339
LNGDPUS(-1)	-48.29468	2.446660	-19.73903	0.0026	*LNGDPM(-1)*	-31.39845	4.121573	-7.618075	0.0168
LNGDPUS(-2)	23.38432	1.277177	18.30939	0.0030	*LNGDPM(-2)*	35.06892	3.770260	9.301459	0.0114
LNGDPUS(-3)	3.486394	0.348493	10.00420	0.0098	*LNGDPM(-3)*	16.47467	4.582181	3.595378	0.0694
LNERM	8.976217	0.469540	19.11703	0.0027	*LNERM*	39.22871	7.533922	5.206944	0.0350
LNERM(-1)	7.775837	0.459376	16.92697	0.0035	*LNERM(-1)*	17.14284	2.413804	7.102001	0.0193
LNERM(-2)	-2.418939	0.191592	-12.62544	0.0062	*LNERM(-2)*	-30.96371	3.830594	-8.083268	0.0150
LNERM(-3)	2.981202	0.154674	19.27409	0.0027	*LNERM(-3)*	-20.68672	4.926847	-4.198775	0.0523
LNGSUS	-0.283692	0.052438	-5.410021	0.0325	*LNGSCA*	1.745087	1.620792	1.076688	0.3942
LNGSUS(-1)	2.948245	0.156966	18.78267	0.0028	*LNGSCA(-1)*	-2.559449	1.049460	-2.438825	0.1349
LNGSUS(-2)	2.541321	0.138523	18.34590	0.0030	*LNGSCA(-2)*	-10.93784	1.735869	-6.301076	0.0243
LNGSUS(-3)	0.976134	0.082722	11.80020	0.0071	*LNGSCA(-3)*	-23.21608	3.584174	-6.477386	0.0230
LNGSM	-0.008430	0.006483	-1.300309	0.3232	*LNGSM*	-0.332851	0.078226	-4.254974	0.0510
LNGSM(-1)	0.352180	0.027339	12.88182	0.0060	*LNGSM(-1)*	-0.084723	0.088205	-0.960521	0.4381
LNGSM(-2)	0.058894	0.018926	3.111832	0.0896	*LNGSM(-2)*	-0.852750	0.220974	-3.859055	0.0611
LNGSM(-3)	-1.093976	0.051919	-21.07071	0.0022	*LNGSM(-3)*	-2.329097	0.461540	-5.046357	0.0371
C	-355.7378	15.64588	-22.73684	0.0019	*C*	36.93251	6.684748	5.524891	0.0312

Source: Research Findings
Dynamic regressors (2 lags, automatic): LNGDPM LNGDPUS LNERM LNGSUS LNGSM
Selected Model: ARDL (1, 3, 3, 3, 3, 3) for Mexico-US and ARDL (2, 2, 3, 3, 3, 3) for Mexico-Canada

Table 2 supplied the estimation results using the ARDL model with critical values (Pesaran et al., 2001). The results of Table 3 show that, in short-term, Mexico's GDP with 0,1,2 and 3 lags, the US GDP with 0,1,2 and 3 lags, the exchange rate with 0,1,2 and 3 lags, good and service expenditure for US 0,1,2 and 3 lags, good and services expenditure for Mexico with 1 and 3 lags have a significant relationship with the trade deficit of Mexico in relating to the USA. As shown in Table 2, Mexico's GDP positively affected the trade deficit between the US and Mexico. It approved the basic theory of trade deficit because when internal production increases, the extra amount of this production will export, and it has a negative impact on the trade deficit. Regarding the GDP of the US, it acts in reverse mode, and the result of the estimation approved the theory of trade deficit because the increase in production in the US causes an increase in imports from Mexico, which leads to an increase in the trade deficit of Mexico. The actual effective exchange rate index of Mexico positively affected the trade deficit, which approves the theoretical assumptions for this paper that introduce a direct relation between the wealth of currency of a specific country and the increase in import of goods and services. The following variable, goods and services expenditure, can be accepted in both negative and positive coefficients because both theories are true about the increase or decrease of government expenses and its' effect on the trade between two countries. It is concluded that the GSUS has a negative impact on the Mexico trade deficit. An increase in middle material and even technological development in the US caused a rise in internal substitute production and a decrease in exporting to other partner countries. Finally, the goods and service expenditure by the Mexican government has a positive impact on the trade deficit because of an increase in internal production and an increase in export that cause an increase in the trade deficit. The results for the Mexico-Canada procedure can provide interpretation as the same as the Mexico-US procedure except for good and services expenditure of Mexico governments that has a negative effect on the trade deficit. It can be concluded that spending on goods and services leads to a response to internal demand.

To study the model fit and choose the best model, we investigate two tests for all the variables, the serial correlation, and the heteroscedasticity tests. Table 4 shows a summary of correlation and Variance heteroscedasticity. Besides these two tests, we investigate the structural change by a CUSUM test duration 1994-2020 for the Mexico procedure to study whether any events caused a structural change in the trend of Mexico's trade deficit. The presence of co-accumulation is not necessary for the stability of the estimated coefficient. So, the constancy test (Brown et al., 1975) will be implemented that is calculated based on the CUSUM test that is accountable based on the recursive regression. The statistics of the CUSUM test take new amounts and be drawn against the breakpoint of the model. Serial correlation and heteroskedasticity test results (Appendix Tables S2) show that the model residuals satisfy standard assumptions.

The amount of prob for F-statistic in the serial correlation test for the Mexico-US implies failure to reject the null hypothesis (lack of serial correlation). Also, the heteroscedasticity acts the same as the correlation test and shows there isn't residual heteroscedasticity between estimated model variables. In the Mexico-Canada procedure, the statistics imply not a failure to reject the null hypothesis. But the heteroscedasticity acts the same as the correlation test and shows there isn't residual heteroscedasticity between estimated model variables.



Mexico-US procedure Mexico-Canada procedure

Figure 2. CUSUM results for scenario 1. Mexico trade deficit

Source: Research Findings

The CUSUM test shows that the trend is put between two bounds, and it can be concluded that structural stability exists in the model.

After selecting the optimal model specification, we proceed to examine the long-run relationship between the dependent and independent variables. We use a long run and bounds test based on the (Pesaran et al., 2001) procedure to have a good result for this procedure. The results of long-term relationships are shown in Tables 3.

Table 3

Long run and bounds test for Mexico-US

Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
Mexico - USA				
F-Bounds test				
F-statistic	338.4296	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15
Mexico - Canada				
F-Bounds test				
F-statistic	39.07542	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Source: Research Findings

Null Hypothesis: No levels relationship

As shown in Tables 3, for both procedures, the amount of F-statistic is more significant than criterion amounts in both I(0) and I(1), so the null hypothesis is rejected, and there is a level relationship between the variables for the long-term.

After it is proved that there is a long-term relationship between variables, it is necessary to investigate the error correction that shows how much is corrected in each period of the model. The results are shown in Table 4.

Table 4

ARDL Error Correction Regression for Mexico-US

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Mexico - USA				
ECM regression				
CointEq(-1)*	-0.176428	0.001812	-97.34490	0.0001
Mexico – Canada				
ECM regression				
CointEq(-1)*	-2.381418	0.071995	-33.07736	0.0009

Source: Research Findings

The basic results of the Mexico-USA procedure, based on Table 6, show that in any period, the model will be corrected at about -0.18 and be converged to the future. Also, for Mexico-Canada show that in any period, the model will be corrected by about -2.38 and be connected to the future.

3.1.2 Scenario 2. USA Trade Deficit

The ARDL form of the equation for the USA trade deficit is like Mexico and can be rewritten as Equation (4) and (5) states; based on a sequence of previous estimating procedures, we will do stationary tests for the USA trade deficit under relation with Canada and Mexico in NAFTA and USMCA free trade agreements. The results of the Unit root test result for scenario 2. USA trade deficit are shown in the Appendix Tables S3. The results show that all the USA trade deficit scenario variables are stationary in I(0) and I(1), so the ARDL procedure should be running to estimate the relation between the trade deficit and other variables. The ARDL results for both USA-related partners (Canada and Mexico) are shown in Table (5). Like the Mexico scenario, we should choose the best form of ARDL based on the Akaike info criterion (AIC). Also, we do some tests to have comprehensive knowledge about the selected model, like Serial Correlation LM, Heteroscedasticity, and CUSUM tests.

Table 5

ARDL result test estimation, Scenario 1. USA trade deficit

US-Mexico Procedure					**US-Canada Procedure**				
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNTD(-1)	0.076072	0.059174	1.285561	0.2158	LNTD(-1)	0.560256	0.135664	4.129721	0.0026
LNGDPUS	1.042607	0.447776	2.328411	0.0325	LNGDPUS	9.437974	3.220176	2.930887	0.0167
LNGDPM	-0.202475	0.393890	-0.514039	0.6138	LNGDPUS(-1)	-8.113569	4.199220	-1.932161	0.0854
LNGDPM(-1)	0.421422	0.300581	1.402024	0.1789	LNGDPUS(-2)	-3.703670	2.033814	-1.821047	0.1019
LNERMUS	-2.262025	0.959658	-2.357117	0.0307	LNGDPCA	0.181610	1.502235	0.120893	0.9064
LNERMUS(-1)	3.223966	0.698714	4.614140	0.0002	LNGDPCA(-1)	2.745117	1.249321	2.197287	0.0546
LNGSM	0.072128	0.063476	1.136315	0.2716	LNERMUS	-5.437085	2.002757	-2.714800	0.0238
LNGSUS	0.301289	0.306626	0.982594	0.3396	LNERMUS(-1)	5.615353	1.992492	2.818256	0.0201
C	-34.30303	7.062584	-4.857009	0.0001	LNERMUS(-2)	6.700693	1.028002	6.518174	0.0001
					LNGSCA	-0.560246	0.781954	-0.716469	0.4919
					LNGSCA(-1)	-3.958286	0.674387	-5.869459	0.0002
					LNGSCA(-2)	2.630964	0.550794	4.776679	0.0010
					LNGSUS	-0.478379	0.253238	-1.889047	0.0915
					LNGSUS(-1)	0.757919	0.352779	2.148425	0.0602
					LNGSUS(-2)	1.522289	0.278376	5.468466	0.0004
					C	-37.00176	11.47823	-3.223645	0.0104

Source: Research Findings

Dynamic regressors (2 lags, automatic): LNGDPM LNGDPUS LNERM LNGSUS LNGSM

Selected Model: ARDL (1, 0, 1, 1, 0, 0) for UA-Mexico and ARDL (1, 2, 1, 2, 2, 2) for US-Canada

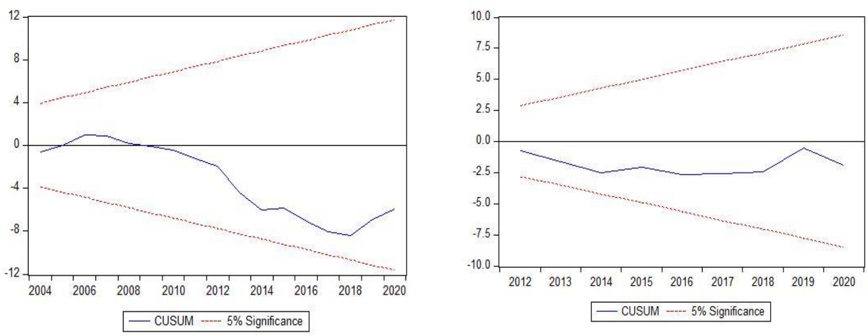
The results of Table 5 for the US-Mexico procedure show that in the short term, the exchange rate with 0 and 1 lags and the USA GDP with 0 lag have a significant relationship with the trade deficit of the USA about Mexico. About the US-Canada procedure, the US GDP with 0 lag, Canada's GDP with one lag, the exchange rate of the US with 0,1 and 2 lags, the goods, and services expenditure of Canada with 0,1 and 2 lags, and the goods and services of US expenditures with two lag, have a significant relationship with the trade deficit of the USA in relating to Canada.

The interpretation of the coefficients for the USA-Mexico procedure shows that the US GDP positively affects the US trade deficit with Mexico. It established that demand for goods is over the supply, so it can infer that during

1994-2020 the USA consumption increased rapidly. About the exchange rate index, it is concluded that the decrease in the US dollar hasn't signed in trade relations with Mexico. Because of the volume of the two economies, one is more extensive (US), and another cannot affect the trade deficit significantly. Regarding the US-Canada procedure, the US GDP positively affected the trade deficit; the Canadian GDP didn't significantly affect the trade deficit in 0 lag. Still, it has a positive impact after applying one lag. It approved the theoretical base assumption because the US import and trade deficit will increase with an increase in Canada's GDP.

After estimating the short-run coefficients, choosing the best model based on criteria including Serial Correlation LM, Heteroscedasticity, and CUSUM tests is necessary. The serial correlation, Heteroscedasticity, and CUSUM results are shown in Appendix Tables S4 and Fig 3, respectively.

The F-statistic prob in the USA-Mexico serial correlation test implies failure to reject the null hypothesis (lack of serial correlation). In contrast, it is rejected the null hypothesis for the USA-Canada. Also, the heteroscedasticity show there isn't residual heteroscedasticity between estimated variables of models in both US with Mexico and Canada.



USA-Mexico procedure USA-Canada procedure

Figure 3. CUSUM results for scenario 2. USA trade deficit

Source: Research Findings

The CUSUM test shows that the trend is put between two bounds for both procedures, and it can be concluded that there is structural stability in the estimated models.

The long-run estimation of scenario 2 for the USA trade deficit is as same as the Mexico trade deficit scenario, the long-term study of coefficients estimation of models established with the use of a long run and bounds test based on the (Pesaran et al., 2001) procedure. The results of long-term relationships are shown in Tables 6.

Table 6

Long run and bounds test for scenarion2.USA trade deficit

Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
USA - Mexico				
F-Bounds test				
F-statistic	85.37943	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15
USA - Canada				
F-Bounds test				
F-statistic	19.09206	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Source: Research Findings

Null Hypothesis: No levels relationship

Based on the Table 6 results, the F-statistic for both procedures is bigger than the coefficient of I(0) and I(1), so the null hypothesis is rejected, and there is a level relationship between the variables for the long-term. To explain how much the coefficients of two procedures about the USA trade deficit will require correction, we investigate the Error Correction regression for both scenarios. The ECM results are presented in Table 7.

Table 7
ARDL Error Correction Regression for scenarion2.USA trade deficit

Variable	Coefficient	Std. Error	t-Statistic	Prob.
USA - Mexico				
ECM regression				
CointEq(-1)*	-0.923928	0.032492	-28.43578	0.0000
USA - Canada				
ECM regression				
CointEq(-1)*	-0.439744	0.029465	-14.92450	0.0000

Source: Research Findings

The result of the USA-Mexico procedure, based on Table 7, shows that in any period, the model will be corrected at about -0.92 and be converged to the future. Also, for USA-Canada show that in any period, the model will be corrected by about -0.44 and be linked to the future.

3.1.3 Scenario 3. Canada Trade Deficit

The rewritten Equation (3) and (4) based on the ARDL model by (Pesaran et al., 2001) for scenario three about the Canadian trade deficit are similar to both previous models for the USA and Mexico scenarios. Stationary tests for Canada's trade deficit between USA and Mexico in NAFTA and USMCA free trade agreements tested by the ADF test. The results of the stationary test for scenario 3 are presented in Appendix Tables S5.

The results show that all the variables for the Canada trade deficit scenario are stationary in I(0) and I(1); the ARDL procedure is considered the proper method for estimating the relation between the trade deficit and other variables. The ARDL results for both Canada-related partners (USA and Mexico) are shown in Table (8). Like both previous scenarios, we should choose the best form of ARDL based on the Akaike Information Criterion (AIC). Also, we do Serial Correlation LM, Heteroscedasticity, and CUSUM tests.

Table 8

ARDL result test estimation, Scenario 3. Canada trade deficit

Canada-Mexico Procedure					Canada-USA Procedure				
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNTD(-1)	0.736795	0.171388	4.298977	0.0006	LNTD(-1)	0.524226	0.141567	3.703014	0.0027
LNGDPCA	0.361340	0.550116	0.656843	0.5212	LNTD(-2)	0.655380	0.178760	3.666258	0.0028
LNGDPCA(-1)	-1.165555	0.358668	-3.249681	0.0054	LNGDPCA	5.497365	0.770717	7.132789	0.0000
LNGDPCA(-2)	0.734442	0.189439	3.876932	0.0015	LNGDPCA(-1)	-1.970030	0.308224	-6.391543	0.0000
LNGDPM	0.695065	0.270278	2.571665	0.0213	LNGDPUS	-1.148739	1.378121	-0.833554	0.4196
LNGDPM(-1)	-0.705785	0.202590	-3.483808	0.0033	LNGDPUS(-1)	3.861295	2.275071	1.697219	0.1135
LNERMCA	-0.072698	0.423269	-0.171755	0.8659	LNGDPUS(-2)	-7.844385	1.891335	-4.147539	0.0011
LNGSM	0.213592	0.165703	1.289001	0.2169	LNERMCA	-7.730208	1.426902	-5.417475	0.0001
LNGSCA	0.272545	0.318004	0.857051	0.4049	LNGSUS	0.358541	0.187945	1.907690	0.0788
C	-4.206289	5.255861	-0.800305	0.4360	LNGSUS(-1)	0.377282	0.196907	1.916046	0.0776
					LNGSCA	1.138588	0.514744	2.211950	0.0455
					C	41.45109	8.326867	4.977993	0.0003

Source: Research Findings

Dynamic regressors (2 lags, automatic): LNGDPM LNGDPUS LNERM LNGSUS LNGSM

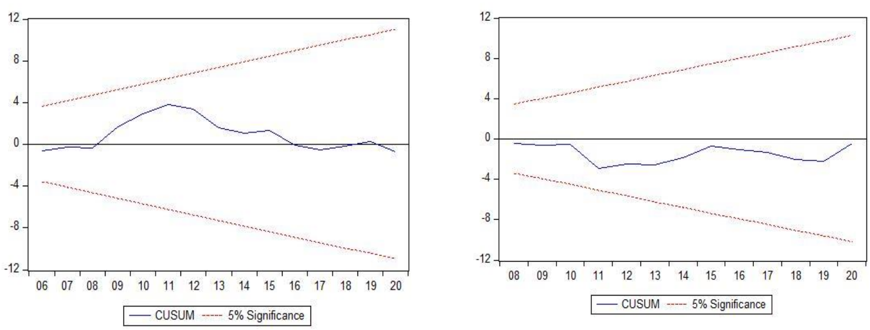
Selected Model: ARDL (1, 2, 1, 0, 0, 0) for Canada-Mexico and ARDL (2, 1, 2, 0, 1, 0) for Canada-USA

Table 8 for the Canada-Mexico procedure shows that in the short term, the Canadian GDP, with 1 and 2 lags, and the Mexico GDP, with 0 and 1 lags, have a significant relationship with the trade deficit of Canada about Mexico. About the Canada-USA procedure, Canada's GDP with 0 and 1 lags, the USA's GDP with two lags, the exchange rate of Canada with 0, and the goods and services expenditure for Canada with 0 lag have a significant relationship with the trade deficit of Canada to Mexico.

The interpretation of the coefficients for the Canada-Mexico procedure shows that the Canadian GDP positively affects its trade deficit with Mexico. It is established that demand for goods exceeded supply, and it can be inferred that during 1994-2020, Canada's consumption increased rapidly. Mexico's GDP has a significant positive effect on the Canadian trade deficit; it approved the theory about trade between two partners joining a trade agreement because of an increase in exports from Mexico to Canada. About the exchange rate index, it is concluded that the decrease in the Canadian dollar hasn't signed in trade relations with Mexico. Because of the volume of the two economies, one is more significant (Canada), and another cannot affect the trade deficit significantly. About the Canada-USA procedure, the Canadian GDP positively affected the trade deficit; it is an approved theoretical base assumption because the increase in Canada's GDP affects its trade deficit and shows that demand for goods is over the supply.

After estimating the short-run coefficients, choosing the best model is based on the criteria including Serial Correlation LM, Heteroscedasticity, and CUSUM tests. The tests' results are shown in Appendix Tables S6 and Fig 4, respectively.

The p-value of the F-statistic in the serial correlation test for the Canada–Mexico model implies failure to reject the null hypothesis, indicating no serial correlation. In contrast, it is rejected the null hypothesis for the Canada-USA. Also, the heteroscedasticity show there isn't residual heteroscedasticity between estimated variables of models in Canada, Mexico, and the USA.



Canada-Mexico procedure Canada-USA procedure

Figure 4. CUSUM results for scenario 3. Canada trade deficit
Source: Research Findings

The CUSUM test shows that the trend is put between two bounds for both procedures, and it can be concluded that there is structural stability in the estimated models.

The long-run estimation of scenario 3 for the Canada trade deficit is as exact as both the Mexico and USA trade deficit scenarios, the long-term coefficient analysis is conducted using the bounds testing approach proposed by Pesaran et al. (2001), and the results are presented in Table 9.

Table 9
Long run and bounds test for scenarion3.Canada trade deficit

Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
Canada - Mexico				
F-Bounds test				
F-statistic	2.294105	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15
Canada - USA				
F-Bounds test				
F-statistic	10.54139	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Source: Research Findings

Null Hypothesis: No levels relationship

Based on Table 9 results, the F-statistic for the Canada-Mexico procedure shows that only in 10% and for I(0) is a long-term relationship between independent and dependent variables. For the Canada-USA procedure, F-statistic is more significant than the coefficient of I(0) and I(1), so the null hypothesis is rejected, and there is a level relationship between the variables for the long term. To explain how much the coefficients of two procedures about the USA trade deficit will require correction, we investigate the Error Correction regression for both scenarios. The results are shown in Table 10;

Table 10

ARDL Error Correction Regression for scenarion3.Canada trade deficit

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Canada - Mexico				
ECM regression				
CointEq(-1)*	-0.263205	0.055510	-4.741543	0.0003
Canada - USA				
ECM regression				
CointEq(-1)*	0.179605	0.017295	10.38492	0.0000

Source: Research Findings

The result of the Canada-Mexico procedure based on Table 10 shows that in any period, the correcting rate for the model is about -0.26 and be converged to the future. Also, Canada-USA shows that in any period, the model will be corrected by about 0.17 and be connected to the future.

3.2 The Gravity procedure for HS6 digit commodities

The trade deficit model based on the ARDL procedure has been applied to comprehensively analyze trade among the three partners of the North American Free Trade Agreement (NAFTA). However, to gain clearer insights into the agricultural sector, the gravity model is proposed to explain bilateral trade between countries. This model is based on Newton's general law of gravitation. Newton's general law states that the gravity force between two materials depends on the weight of two materials, the distance between them, and a constant g. The basic form of the gravity model is as follows (Isard, 1954):

$$X_{ij} = g\frac{Y_i Y_j}{T_{ij}^{\theta}} \qquad (6)$$

Equation (6) states that the gravity force between two materials is directly related to their weights and indirectly to their distance. In trade relations, the gravity force can be replaced with a trade agreement between two countries, as we can suppose that X_{ij} shows trade between country i and country j, Y_i *and* Y_j indicate the size of economy of country i and country j that can be shown by factors like income, population and gross domestic production, and

T_{ij}^{θ} shows the trade expenses that can be including standard proxies like distance and common currency and language. Tinbergen (1979) executed a logarithm form of the gravity model to determine standard and regular patterns for international trade, even used for a no-discrimination situation. Anderson (1979) uses an economical approach to investigate the gravity model based on the features of the expenditure system model. By examining the gravity model, we can catch some valuable results about trade creation and diversion effects. We will be using a Panel data procedure to estimate the effect of some economics index on net agriculture trade between three partner countries (USA-Canada-Mexico) joining in NAFTA and USMCA free trade agreements. We can introduce the model based on the variables, including

$$lnNAT_{ijt} = \beta_0 + \beta_1 lnGDPPC_{it} + \beta_2 lnPOP_{it} + \beta_3 lnal_{it} + \beta_4 lnER_{it} + \beta_5 lnVA_{it} + \mu_t \quad (7)$$

Equation (7), include dependence variable net agriculture trade and 5 independence variables including GDP per capita (GDPPC)[1], population (POP)[2], agricultural land (al)[3], exchange rate (ER)[4] and agriculture part value added (VA)[5]. Panel data in economic research provide a rich environment of information for the development of estimation techniques and theoretical results. Researchers use this method for cases where issues cannot be examined in a time series or cross-sectional manner. The integration of time series and cross-sectional data increases the number of observations and the degrees of freedom, thereby improving estimation efficiency. Some studies used the cross-sectional statistics for evaluating the gravity model (Koo et al., 1994; Mátyás, 1998; Batra, 2006)), while in some articles we can see a panel

[1] GDP per capita is gross domestic product divided by midyear population calculates based on the current US$

[2] Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship

[3] Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures calculates based on the % of land area

[4] Official exchange rate refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market

[5] Agriculture, forestry, and fishing corresponds to ISIC divisions 1-3 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production calculates based on the current US $

data statistic for estimating (Westerlund & Wilhelmsson, 2011; Keum, 2010; Rahman, 2003).

The trend in the value of net agriculture trade includes the three net differences between the three countries' partnerships in free trade agreements. We considered the net agriculture trade as a difference between the import and export of agricultural commodities, including animals, food products, and vegetables, by three FTA partners of FTAs. Based on the trade between the North America region in addition to Mexico (except Bermuda), table 1, North America all product exports to Canada, the US, and Mexico in 2020 are equal to (255,021,732), (22,138,500) and (217,261,213) in US$ thousand, respectively, while the agriculture products have a share about 10% for Canada and US and 9 % for Mexico in commodities, they imported by 2020. When the parameters of a regression model are efficiently estimated using the least squares method, the dependence between the error sentences is not observed, and they will have the same variance. This assumption is required to prove the Gauss-Markov theorem and also in nonlinear regression models to prove their efficiency. In such a case, the variance-covariance matrix estimated by the ordinary least square method will not be valid. Therefore, in the presence of heterogeneity variance or sequential dependence of error sentences, we need an approach to estimate the regression model. The Generalized Least Squares method (GLS) is a technique for estimating the unknown parameters of linear regression when there is a certain degree of correlation between the residuals in a regression model. دارد In such cases, OLS and Weighted Least Squares (WLS) may be statistically inefficient or even yield misleading results(Trott et al., 2004).

Before estimating the model, to ensure the estimation results, it is necessary to check the reliability of the variables by the unit root test. Levin et al. (2002), showed that in panel data, the unit root test for combined data is more valid than the unit root test for each individual cross section. The Levin et al., (2002) unit root test is as follow as Equation (8)

$$\Delta y_{i,t} = \alpha_i + \rho y_{i,t-1} + \sum_{k=1}^{N} \varphi_k y_{i,t-k}, \delta_{it} + \theta_i + u_{it} \qquad (8)$$

In this model, fixed effects enter the model through αi and θi. The null hypothesis is proposed as ρ=1 in Levin and Lin's test. The hypothesis of this test is the independence of the variables at different stages.

3.2.1 Levin, Lin, and Chu (LLC) Unit Root Test

The estimated result of stationary for Equation (8) variables is presented in Table (11). All variables were tested using the Levin, Lin, and Chu unit root test, with probabilities computed under the assumption of asymptotic normality.

Table 11

The estimated results of Levin, Lin and Chu stationary test

Series	**Statistics**	**Prob**
LNNAT	-4.17367	0.000
LNGDPPC	-2.56330	0.005
LNPOP	-2.37360	0.008
LNAL	-2.92307	0.001
LNER	-2.78344	0.002
LNVA	-10.2106	0.000

Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 75
Cross-sections included: 3

As seen in Table (11), all the variables are stable; therefore, their use does not lead to the estimation of a false pattern.

3.2.2 F-Limer result test

The next step is recognizing the accuracy of the selected model as a panel procedure. The f-Limer test is presented to detect the panel pattern. The test's null hypothesis indicates that all widths of the origins are equal, and the opposite hypothesis expresses the difference of at least one of them. Therefore, rejecting the null hypothesis shows the need to use the panel data method, and not denying it shows the need to use the aggregated ordinary least squares method. The results shown in Table 12,

Table 12

The estimated results of Redundant Fixed Effects test (F-Limer)

Effects test	**Statistic**	**d.f.**	**prob**
Cross section F	7.08688	(2.73)	0.001

Source: Research Findings

The test result shows that the probability value of the F-Limer statistic in these patterns is less than five percent. The null hypothesis that the estimation method is a group (pooled least squares) is rejected, and the opposite hypothesis that the research method is panel data is confirmed.

3.2.3 Hausman-Test Result

After making sure that the model used is a panel, it is necessary to find out with the help of the Hausman test whether the model is a model with fixed effects or random effects. The Hausman test is used to compare models with fixed and random effects in terms of the explanatory power of the dependent variable. The existence of a correlation between random effects and estimators is checked, so the null hypothesis shows the lack of correlation between random effects and estimators. Under this hypothesis, the OLS and GLS estimators are both consistent, but the OLS estimator is not efficient. While under the opposite hypothesis, the OLS estimate is efficient and consistent, and the GLS estimate is inconsistent. Therefore, under the null hypothesis, there is no systematic difference between the two estimation methods. The statistics of this test are as follows.

$$\begin{cases} H_0: b = \hat{\beta} \\ H_1: b \neq \hat{\beta} \end{cases}$$

$$H = \left(\beta^{FE} - \beta^{RE}\right)' \left[Var\left(\beta^{FE}\right) - Var\left(\beta^{RE}\right)\right]^{-1} \left(\beta^{FE} - \beta^{RE}\right) \sim X_K^2 \qquad (9)$$

If the value of the experimental statistic is greater than the critical value, the null hypothesis is rejected, and we should use the model with fixed effects. The results of the Hausman test are presented in Table 13.

Table 13

The estimated results of Correlated Random Effects test (Hausman-test)

Test summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross section random	1.335300	5	0.9313

Source: Research Findings

According to the Hausman test result, the statistical probability value equals 0.9313 (greater than 0.05), so our model is confirmed with random effects.

Our findings align with those of Masood and Martínez-Zarzoso (2024), who found that trade facilitation measures positively impact bilateral exports. Additionally, the survey by Leitão (2024) supports the robustness of the gravity model in analyzing international trade flows.

3.2.4 GLS model Results

The generalized Least Squares (GLS) method is a solution to estimate the parameters that a linear equation doesn't have a line with disruptive sentences. In other words, this method will be used as long as the disturbance term has autocorrelation or variance heterogeneity. The results of estimating Equation (9) can be seen in Table 14.

Table 14

The estimated results of Panel-EGLS model

Variable	Coefficient	Std.error	t-statistic	Prob.
C	7.815854	8.902228	0.877966	0.3829
LNER	0.815777	0.125765	6.486520	0.0000
LNGDPPC	1.752164	0.463364	3.781397	0.0003
LNAL	0.816964	0.840075	0.972489	0.3341
LNVA	-0.602246	0.300059	-2.007091	0.0485
LNPOP	0.196605	0.695172	0.282815	0.7781

Source: Research Findings

In our study, we will investigate the unit root test for all the variables of the model (9). The results of the GLS method based on Equation (9) show that the exchange rate, GDP per capita, and value-added in the agriculture section significantly affected the net agriculture trade between 1994 to 2020. First, it concluded that the exchange rate of the three partners positively affected the net agriculture trade. There is some evidence that the shock on the exchange rate significantly affects the trade balance (Wahyudi and Sari, (2020)). Based on table 20 and the significant positive relationship between the exchange rate and net agriculture trade confirms the theoretical assumption. The GDP per capita is shown as an increase in the production level of a country or region. It can lead to a rise in export levels and should positively affect net trade. The increased value added in a specific section of economics shows improvement in this section that the innovation can create in technology or growth in labor and capital productivities. So, it should have a significant positive relationship with the net trade. But, about the NAFTA and USMCA trade between the USA, Canada, and Mexico, it concluded that it rejected the fundamental theories about the significant relationship. There is a reverse relation between value added in the agriculture section and net agriculture trade of the free trade agreement.

4 Conclusion Remark

This study investigated the impact of the NAFTA and USMCA free trade agreements on both the trade deficit and net agricultural trade among the United States, Mexico, and Canada. A two-model approach was employed: an Autoregressive Distributed Lag (ARDL) model was used to assess macroeconomic influences on trade deficits (across three country-specific scenarios), and a Gravity model estimated using the Generalized Least Squares (GLS) method was applied to examine agricultural trade flows at the HS6-digit level.

The ARDL results demonstrate significant short- and long-term relationships between trade deficits and macroeconomic variables such as GDP, exchange rate, and government expenditure. In Scenario 1 (Mexico), Mexico’s GDP negatively influenced its trade deficit with both the U.S. and Canada, indicating that domestic production growth contributed to reducing trade imbalance. In contrast, the U.S. GDP had a positive effect on Mexico’s trade deficit, reflecting increased U.S. imports. Additionally, the Mexican exchange rate had a positive effect-suggesting that currency appreciation raised import volumes—while U.S. government expenditure had a negative effect. For the Mexico-Canada relationship, Canada’s GDP had a positive impact on Mexico’s trade deficit, while Mexican government spending showed a negative effect, indicating stronger internal demand absorption.

In Scenario 2 (USA), the U.S. trade deficit with both Mexico and Canada was positively affected by its own GDP, while the exchange rate had a negative effect-implying that currency depreciation reduced imports and helped ease the deficit. These results suggest that U.S. economic growth has consistently driven higher import demand, contributing to widening deficits under both FTAs.

In Scenario 3 (Canada), Canada's trade deficit with Mexico was positively influenced by Mexican GDP, while the Canada-U.S. trade deficit was affected by Canada’s GDP (positive), the Canadian exchange rate (negative), and its government expenditure (positive). These relationships imply that Canada's trade performance is more responsive to foreign GDP and fiscal trends, with more stable patterns compared to Mexico and the U.S.

The Gravity model, estimated using GLS, focused on three major agricultural product groups, food products, vegetables, and animal products—classified under the HS 1988/92 system. The results revealed that both exchange rate and GDP per capita had a statistically significant and positive impact on net agricultural trade. However, the effect of GDP per capita was more substantial, indicating its stronger role in determining trade capacity and competitiveness. Agricultural value-added, on the other hand, showed a negative relationship with net trade, suggesting that increases in domestic agricultural output may be used to meet internal demand rather than boosting exports. Variables such as population and agricultural land area were not statistically significant.

Overall, the findings confirm that macroeconomic variables significantly influence trade outcomes under both NAFTA and USMCA, but the direction and intensity of these effects vary across countries and sectors. The transition from NAFTA to USMCA did not produce immediate uniform gains; rather, Mexico showed the most consistent net trade improvements, particularly in agriculture, while the U.S. experienced a growing trade deficit, and Canada remained relatively stable.

These results have policy implications beyond North America. For countries like Iran, the findings suggest that trade agreements alone are insufficient to secure long-term benefits. Instead, success requires strategic alignment of trade policy with macroeconomic management, including exchange rate stability, support for high-value agricultural production, and effective government expenditure targeting. Trade liberalization efforts should be accompanied by institutional and structural reforms to ensure resilience and competitiveness in key export sectors.

5 Policy Recommendations

The results of this study provide important insights not only for the three NAFTA/USMCA countries but also for other economies considering trade liberalization in agriculture, particularly Iran. Based on the empirical findings from both the ARDL and gravity models, several policy recommendations emerge:

5.1 Macroeconomic Alignment with Trade Goals

The study finds that GDP growth, exchange rates, and government expenditure have strong effects on trade balances. For Iran, this suggests that macro-stability is a prerequisite for successful trade agreements. Iranian policymakers should:

- Maintain a stable and competitive exchange rate to avoid import surges that could widen the trade deficit.
- Design fiscal policy to support productive sectors, particularly agriculture and export-oriented manufacturing, rather than merely subsidizing consumption.
- Monitor income-driven import demand, as higher domestic GDP may raise imports unless matched by export competitiveness.

5.2 Sectoral Focus on High-Value Agriculture

The gravity model results show that GDP per capita positively impacts net agricultural trade, while value-added in agriculture has a negative effect, likely due to inward-oriented use of agricultural output. For Iran, this implies the need to:

- Invest in export-grade agricultural production (e.g., saffron, pistachios, dates, medicinal herbs) with clear demand in regional and global markets.
- Develop agri-processing value chains that increase the market value of exports beyond raw commodities.
- Ensure that rising agricultural productivity translates into trade surpluses, not just domestic consumption.

5.3 Institutional Preparation for Regional Agreements

The transition from NAFTA to USMCA underscores the importance of implementation and enforcement mechanisms. If Iran pursues regional FTAs (e.g., with ECO countries or under trade agreements with Eurasia), it should:

- Establish clear legal and dispute resolution frameworks to support private sector engagement.
- Strengthen customs, standards, and compliance institutions to meet partner expectations.
- Negotiate trade terms that protect sensitive sectors while promoting mutual tariff concessions in strategic industries.

5.4 Data-Driven Trade Policy Design

The use of HS6-digit level trade data in this study shows the importance of disaggregated trade monitoring. For Iran:

- Trade policy should be grounded in commodity-specific data analysis to avoid generalizations that may overlook product-level competitiveness.
- The government should develop early warning systems for trade deficits in vulnerable sectors using macroeconomic indicators and bilateral trade data.

5.5 Leverage Comparative Advantages in Regional Markets

Given Iran's resource base and geographic location, the country can benefit by targeting regional markets for agricultural exports. The results of this study suggest that well-structured agreements, with partner-specific macroeconomic coordination, can enhance trade resilience. Iran should:

- Focus on bilateral or trilateral FTAs where macroeconomic complementarities exist (e.g., food-deficit countries in the Persian Gulf or Central Asia).
- Align trade strategy with regional logistics development such as railway corridors, port access, and border market zones.

6 Declaration of Competing Interest

The authors are willing to announce that they have no competing financial interests, both from public or private organizations, that could have become visible and affected the work results reported in this paper.

7 Conflict of Interest

None.

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Appendix

Table S1

Unit root test result-ADF and PP results test statistics data for scenario 1. Mexico trade deficit

Scenario	ADF Statistics			PP Statistics		
Scenario 1. Mexico						
Mexico-USA						
	Variable*	**t-Statistic**	**Prob.****	**Variable***	**ADJ. t-Statistic**	**Prob.****
	lnTD	-3.816404	0.0078	lnTD	-3.816404	0.0078
	lnGDPm	-6.160619	0.0000	lnGDPm	-6.160619	0.0000
	lnGDPusa	-4.055208	0.0048	lnGDPusa	-3.687629	0.0112
	lnERm	-7.298381	0.0000	lnERm	-6.878616	0.0000
	lnGSusa	-4.778693	0.0008	lnGSusa	-4.777629	0.0008
	lnGSm	-7.640481	0.0000	lnGSm	-14.04882	0.0000
Mexico-Canada						
	Variable***	**t-Statistic**	**Prob.**	**Variable***	**ADJ. t-Statistic**	**Prob.****
	lnTD	-7.213837	0.0000	lnTD	-4.010803	0.0049
	lnGDPm	-6.160619	0.0000	lnGDPm	-6.160619	0.0000
	lnGDPca	-3.484925	0.0172	lnGDPca	-3.441348	0.0189
	lnERm	-7.298381	0.0000	lnERm	-6.878616	0.0000
	lnGSca	-3.800530	0.0084	lnGSca	-3.800530	0.0084
	lnGSm	-7.640481	0.0000	lnGSm	-14.04882	0.0000

Source: Research Findings

Lag Length: 0 (Automatic - based on SIC, maxlag=6)

*, *** based upon the significance level of .05 and the P-Value of ADF stationary test, the null hypothesis cannot be rejected.

** MacKinnon (1996) one-sided p-values.

Table S2

Serial Correlation LM and Heteroscedasticity tests for Mexico-US

Statistic			**Prob.**	
Mexico - USA				
Serial Correlation test				
	F-statistic	6.870715	Prob. F(1,1)	0.2320
	Obs*R-squared	20.95072	Prob. Chi-Square(1)	0.0000
Heteroscedasticity test				
	F-statistic	0.109769	Prob. F(1,21)	0.7437
	Obs*R-squared	0.119598	Prob. Chi-Square(1)	0.7295
Mexico - Canada				
Serial Correlation test				
	F-statistic	805.3173	Prob. F(1,1)	0.0224
	Obs*R-squared	23.97024	Prob. Chi-Square(1)	0.0000
Heteroscedasticity test				
	F-statistic	1.891770	Prob. F(1,21)	0.1835
	Obs*R-squared	1.900714	Prob. Chi-Square(1)	0.1680

Source: Research Findings

Table S3

Unit root test result-ADF result test statistics data for scenario 2. USA trade deficit

Scenario	**ADF Statistics**			**PP Statistics**		
USA-Mexico						
	Variable*	**t-Statistic**	**Prob.****	**Variable***	**Adj t-Statistic**	**Prob.****
	lnTD	-8.523662	0.0000	lnTD	-6.926812	0.0000
	lnGDPm	-6.160619	0.0000	lnGDPm	-6.160619	0.0000
	lnGDPus	-4.055208	0.0008	lnGDPus	-3.687629	0.0112
	lnERus	-3.555306	0.0147	lnERus	-3.582967	0.0138
	lnGSus	-4.778693	0.0008	lnGSus	-4.777629	0.0008
	lnGSm	-7.640481	0.0000	lnGSm	-14.04882	0.0000
USA-Canada						
	Variable***	**t-Statistic**	**Prob.**	**Variable***	**Adj t-Statistic**	**Prob.****
	lnTD	-5.361847	0.0002	lnTD	-5.525635	0.0001
	lnGDPus	-4.055208	0.0048	lnGDPus	-3.687629	0.0112
	lnGDPca	-3.484925	0.0172	lnGDPca	-3.441348	0.0189
	lnERus	-3.555306	0.0147	lnERus	-3.582967	0.0138
	lnGSca	-3.800530	0.0084	lnGSus	-4.777629	0.0008
	lnGSus	-4.778693	0.0008	lnGSca	-3.800530	0.0084

Source: Research Findings

Lag Length: 0 (Automatic - based on SIC, maxlag=6)

*, *** based upon the significance level of .05 and the P-Value of ADF stationary test, the null hypothesis cannot be rejected.

** MacKinnon (1996) one-sided p-values.

Table S4

Serial Correlation LM and Heteroscedasticity tests for Scenario 2

Statistic		**Prob.**		
USA - Mexico				
Serial Correlation test				
	F-statistic	1.393726	Prob. F(1,16)	0.2550
	Obs*R-squared	2.083330	Prob. Chi-Square(1)	0.1489
Heteroscedasticity test				
	F-statistic	0.011648	Prob. F(1,23)	0.9150
	Obs*R-squared	0.012654	Prob. Chi-Square(1)	0.9104
USA - Canada				
Serial Correlation test				
	F-statistic	12.82571	Prob. F(2,7)	0.0046
	Obs*R-squared	19.64036	Prob. Chi-Square(1)	0.0001
Heteroscedasticity test				
	F-statistic	0.354544	Prob. F(1,22)	0.5576
	Obs*R-squared	0.380641	Prob. Chi-Square(1)	0.5373

Source: Research Findings

Table S5

Unit root test result-ADF result test statistics data for scenario 3. Canada trade deficit

Scenario	ADF Statistics			PP Statistics		
Canada-Mexico						
	Variable*	**t-Statistic**	**Prob.****	**Variable***	**Adj t-Statistic**	**Prob.****
	lnTD	-4.185646	0.0034	lnTD	-4.093788	0.0042
	lnGDPm	-6.160619	0.0000	lnGDPm	-6.160619	0.0000
	lnGDPca	-3.484925	0.0172	lnGDPca	-3.441348	0.0189
	lnERca	-3.177132	0.0336	lnERca	-3.165504	0.0344
	lnGSca	-3.800530	0.0084	lnGSca	-3.800530	0.0084
	lnGSm	-6.350676	0.0000	lnGSm	-6.212816	0.0000
USA-Canada						
	Variable***	**t-Statistic**	**Prob.**	**Variable***	**Adj t-Statistic**	**Prob.****
	lnTD	-5.163868	0.0003	lnTD	-5.256346	0.0003
	lnGDPus	-4.055208	0.0048	lnGDPusa	-3.687629	0.0112
	lnGDPca	-3.484925	0.0172	lnGDPca	-3.441348	0.0189
	lnERca	-3.177132	0.0336	lnERca	-3.165504	0.0344
	lnGSca	-3.800530	0.0084	lnGSca	-3.800530	0.0084
	lnGSus	-4.778693	0.0008	lnGSusa	-4.777629	0.0008

Source: Research Findings

Lag Length: 0 (Automatic - based on SIC, maxlag=6)

*, *** based upon the significance level of .05 and the P-Value of ADF stationary test, the null hypothesis cannot be rejected.

** MacKinnon (1996) one-sided p-values.

Table S6

Serial Correlation LM and Heteroscedasticity tests for Scenario 3

Statistic		**Prob.**		
Canada - Mexico				
Serial Correlation test				
	F-statistic	0.511913	Prob. F(2,13)	0.6109
	Obs*R-squared	1.825153	Prob. Chi-Square(2)	0.4015
Heteroscedasticity test				
	F-statistic	1.673646	Prob. F(1,22)	0.2092
	Obs*R-squared	1.696719	Prob. Chi-Square(1)	0.1927
Canada - USA				
Serial Correlation test				
	F-statistic	4.259615	Prob. F(2,11)	0.0427
	Obs*R-squared	10.91133	Prob. Chi-Square(2)	0.0043
Heteroscedasticity test				
	F-statistic	1.857059	Prob. F(1,22)	0.1868
	Obs*R-squared	1.868186	Prob. Chi-Square(1)	0.1717

Source: Research Findings

Table S7

Export and import statistics data between three partnerships of NAFTA-USMCA FTAs

Country	**Trade Statistics**			
Mexico				
Trade Volume*				
	overall import (M $)		overall export (M $)	
	1994	2020	1994	2020
	79,335	382,980	60,619	416,982
Product categories**				
	(Export (M $))-(product share (%))		(Import (M $))-(product share (%))	
	1994	2020	1994	2020
Raw materials	(10,405)-(17.16)	(42,612)-(10.22)	(4,854)-(6.12)	(17,560)-(4.59)
Intermediate goods	(6,894)-(11.37)	(26,209)-(6.29)	(15,993)-(20.16)	(64,975)-(16.97)
Consumer goods	(22,839)-(37.68)	(119,529)-(28.67)	(21,844)-(27.53)	(94,959)-(24.79)
Capital goods	(200,422)-(33.06)	(195,613)-(46.91)	(27,564)-(34.74)	(173,999)-(45.43)
Partners				
	(Market (M $))-(share (%))		(Exporter (M $))-(share (%))	
	2020		2020	
	United States	(330,434)-(79.24)	United States	(168,197)-(43.92)
	Canada	(11,139)-(2.67)	China	(73,506)-(19.19)
	China	(7,788)-(1.87)	Korea, Rep.	(14,706)-(3.84)
	Germany	(6,585)-(1.58)	Japan	(13,893)-(3.63)

Source: Research Findings

Table S8

Export and import statistics data between three partnerships of NAFTA-USMCA FTAs

Country	**Trade Statistics**			
Canada				
Trade Volume*				
	overall import (M $)		overall export (M $)	
	1994	2020	1994	2020
	148,185	404,863	166,255	388,377
Product categories**				
	(Export (M $))-(product share (%))		(Import (M $))-(product share (%))	
	1994	2020	1994	2020
Raw materials	(19,567)-(11.77)	(98,985)-(25.49)	(11,040)-(7.45)	(32,487)-(8.02)
Intermediate goods	(48,511)-(29.18)	(100,831)-(25.96)	(24,244)-(16.36)	(78,827)-(19.47)
Consumer goods	(46,301)-(27.85)	(102,463)-(26.38)	(43,412)-(29.30)	(144,073)-(35.59)
Capital goods	(42,803)-(25.75)	(66,065)-(17.01)	(64,743)-(43.69)	(140,121)-(34.61)
Partners				
	(Market (M $))-(share (%))		(Exporter (M $))-(share (%))	
	2020		2020	
	United States	(284,478)-(73.25)	United States	(197,728)-(48.84)
	China	(18,861)-(4.86)	China	(57,055)-(14.09)
	United Kingdom	(14,855)-(3.83)	Mexico	(22,333)-(5.52)
	Japan	(9,244)-(2.38)	Germany	(12,882)-(3.18)

Source: Research Findings