Effect of USMCA on U.S. Dairy Exports to Canada: A Causal Impact Analysis

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Effect of USMCA on U.S. Dairy Exports to Canada: A Causal Impact Analysis

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Abstract: Canadian tariff quotas and over-quota tariffs have restricted US dairy exports for a long time. Even under NAFTA, agricultural trade was liberalized with the exception of the Canadian dairy industry. The US-Mexico-Canada Agreement (USMCA) addressed these obstacles as Canada committed to increase the tariff quotas for US dairy products and removing the Canadian milk price system for Class 6 and 7. We analyzed the impact of the USMCA by applying a Bayesian structural time series based causal impact model and found that US dairy exports to Canda increases by USD 519 million (34%) on an average but it fell below the 43% increase forecast by the USITC, which assumed full Canadian compliance. We identified that Canda is partially complying the agreement and refraining US to reach to its maximum potential. This finding underlines the need for continuous monitoring and surveillance that each countries are complying with the USMCA agreement properly.

KEYWORDS: USMCA, US dairy exports, Canadian dairy imports, causal impact

JEL Codes: F13, F14, Q17

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1| INTRODUCTION

The U.S. dairy sector plays a crucial role in the nation's agricultural economy, contributing significantly to rural employment, revenue, and overall economic growth. In 2021, the U.S. dairy industry accounted for 3.5% of the country's GDP, supported 3.3 million jobs, generated $41.6 billion in wages, and produced $67.1 billion in taxes across federal, state, and local levels (IDFA, 2021). Exports are a key factor in sustaining U.S. dairy farmers' profitability, as approximately one-sixth of U.S. milk is sold internationally in various dairy products and ingredients (NMPF, 2024). In 2022, U.S. dairy exports reached a record $9.6 billion, with Canada becoming the second-largest market after Mexico (USDA-FAS, 2024). However, Canada's restrictive tariff rate quotas (TRQs), with over-quota tariffs as high as 315.5%, have historically limited U.S. dairy exports to Canada, preventing the U.S. from reaching its full export potential (Chow & Sheldon, 2024a; USITC, 2019; CRS, 2019). The frictions in U.S.-Canada dairy trade primarily stem from Canada’s protectionist supply management system, which includes production quotas, elevated milk prices, and stringent import restrictions. This system, while maintaining stable domestic prices, reduces the competitiveness of US dairy products on the Canadian dairy market (USDA-ERS, 2016). The Canadian Dairy Commission plays a central role in the system, setting market-sharing quotas (MSQs) and regulating the total milk production in order to meet the projected demand. These quotas are then distributed to the provinces and further allocated to individual producers, who are granted fixed farmgate prices for their milk. This system tightens control over prices, production and imports, and ensures stability on the domestic market (Van Tassel, 2021). Conversely, the more market driven US dairy market makes Canadian dairy markets vulnerable to lower priced US dairy imports, which ultimately led Canada to impose tariff quotas to limit US dairy flows to Canada (USDA-ERS, 2021; Van Tassel, 2021).

Even under the North American Free Trade Agreement (NAFTA), most of the agricultural trade between the US, Canada and Mexico has been liberalised, with the exception of the Canadian dairy sector (Ciuriak et al., 2017). Canadian milk duties, ranging from 241 percent for liquid milk to 298 percent for butter, have been at the heart of Canada's strategy for milk price and supply regulation (IATP, 2022). However, in 2018, the renegotiation of NAFTA into the US-Mexico-Canada Agreement (USMCA) was launched, with the aim of modernizing trade relations between the three countries with the promise of freer markets, fairer trade, and stronger growth (USMCA, 2018a). Under the new agreement, Canada has agreed to new tariff quotas for US dairy products, including 50,000 metric tons of milk solids, 12,500 metric tons of cheese, 10,500 metric tons of other dairy products, with a 1% increase in each quota over a period of 13 years. Furthermore, Canada has agreed to drop its controversial milk price classes 6 and 7, align prices for skimmed milk solids with those of the USA, impose export restrictions and surcharges for certain dairy products, and conduct regular reviews to ensure compliance with the US-Mexico-Canada Agreement (USMCA, 2018b). The removal of the controversial Canadian milk price system, which made Canadian skimmed-milk powder and milk protein concentrates cheaper and more competitive at the global level, was a major win for US producers. This pricing system had a significant impact on US exports of ultra-filtered (UF) milk to Canada, which decreased from USD 107 million in 2015 to USD 32 million in 2018 following the introduction of Class 7 (CRS, 2019).

The USMCA entered into force on July 1, 2020 (CBP, 2024), and these changes were expected to increase US dairy exports to Canada by $227 million per year once fully implemented (USITC, 2019). Meanwhile, according to UN Comtrade data, between 2020 and 2023, US dairy exports to

Canada will increase from $508 million to $799 million. But the question remains: did this increase occur solely because of the US-MCA? Because there could be a number of factors that could have affected the US dairy exports to Canada. These factors may include the level of US milk production, demographic and income growth in Canada, exchange rate fluctuations, supply disruptions by competing exporters such as New Zealand, Italy and France, and wider economic conditions such as inflation and consumption trends (Cessna et al., 2016). Another critical question therefore arises: what is the specific impact of the USMCA on US dairy exports to Canada? While there are some reports on the impact of the USMCA on US dairy exports (USITC, 2019; CRS, 2019), these reports are mainly focused on the forecast of the impact of the USMCA on US dairy exports to Canada. In addition to these reports, Chepeliev et al. (2018) also analyzed the potential impact of the USMCA on US dairy exports to Canada with an estimated quantification. However, no such study has yet been conducted to empirically estimate the causal impact of the USMCA on US dairy exports to Canada. The purpose of this study is therefore to determine the causal impact of the USMCA on US dairy exports to Canada by using the causal impact model of the Bayesian structural time series.

The causal impact model developed by Brodersen et el. (2015) has been applied to a broad range of areas ranging from impact evaluation of taxes on soft drinks sales (Kurz and König, 2021), analyzing the impact of international conflicts on financial markets and exchange rates (Xu et al., 2023; Köseoğlu et al., 2023), and the impact evaluation of different environmental regulations and policies on emissions (Kim and Chung, 2022; González and Hosoda, 2016). But we have not found any significant application of this novel causal impact model for evaluating the impact of any trade agreements on export. Therefore, this study will also contribute to this literature gap by making an application of the causal model on evaluating the impact of trade agreement on export performance.

2| METHODOLOGY

This study examines the impact of the US-Mexico-Canada Agreement (USMCA) on US dairy exports to Canada using a Bayesian structural time series model. Traditional methods such as difference in difference (DID), gravity models and partial equilibrium models are widely used in business studies, but they have limitations, particularly when dealing with time series data. For example, the data-driven approach assumes that data points are independent of one another, which may lead to errors if the data are actually serially correlated (Solon, 1984; Bertrand et al., 2004). This ignores the time-based relationships that often appear in these data (Hansen, 2007; Hansen, 2006) and does not take into account how policy effects such as the USMCA evolve over time (Feng & Li, 2022). The BSTS model, on the other hand, proposed by Brodersen et al. (2015), provides a more sophisticated solution by using spatial models which can capture trends, seasonality and temporal relationships in data. BSTS creates a synthetic control using non-distorted time series data to estimate what would happen without the USMC.

The BSTS framework is developed as a state space model, consisting of an observation equation that links the observed data to the explanatory variables and a state transition equation that captures the underlying dynamic process that governs the development of unobserved state variables. This representation of the state of the space allows the model to distinguish between long-term trends and short-term fluctuations, which is particularly useful for the analysis of interventions where effects may develop gradually rather than be marked by sudden changes. An observation equation is a relationship between an observed dependent variable and its underlying determinants. It is given as:

$$y_t = Z_t' \alpha_t + \epsilon_t \tag{1}$$

where y_t denotes the observed response variable at time t, such as U.S. dairy exports to Canada. The term Z_t is a $d-$dimensional output vector that maps the latent state variables to the observed data, while αt is a latent state vector of dimension d that captures unobservable factors influencing y_t. The noise term ϵ_t is an idiosyncratic shock, assumed to be normally distributed with mean zero and variance σ_ϵ^2, accounting for randomness that is not explained by the systematic model structure. The state-transition equation, which describes how the unobserved latent state evolves over time expressed as:

$$\alpha_{t+1} = T_t \alpha_t + R_t \eta_t \tag{2}$$

where T_t is a $d \times d$ transition matrix that governs the evolution of latent state variables, and R_t is a $d \times q$ control matrix that incorporates external shocks or interventions. The term η_t represents the system noise, modeled as a normal distribution with covariance Q_t, capturing stochastic changes in the latent state over time. These equations collectively allow BSTS to model time-dependent structures, capturing both slow-moving trends and abrupt shocks in response to external changes. One of the most critical components of the BSTS framework is its ability to construct synthetic control groups, which serve as counterfactual baselines against which the effects of an intervention can be measured. Unlike traditional fixed-effects models, BSTS does not assume that control variables have a constant effect over time; instead, it explicitly accounts for time-varying relationships through a linear regression component that integrates information from untreated control series. This is formulated as:

$$Z_t = \beta' x_t, \alpha_t = 1 \quad (3)$$

where x_t represents a vector of external control variables, such as macroeconomic indicators, and β is a coefficient vector that captures their influence on the response variable. By introducing simultaneous variables with stable coefficients in a spatial form, BSTS ensures that the model accurately separates effects of treatment from underlying market trends and reduces the risk of biased inferences. To ensure reliable estimates, the BSTS model uses Bayesian inference techniques, which include the prior distributions of both the model parameter and the latent variables. Defining a full set of state parameters as $\beta = (\beta_1, \dots \dots \dots, \beta_m)$, Bayesian inference allows the model to assign prior beliefs on parameters through distributions such as $p(\vartheta)$ for model parameters and $p(\beta_0|\vartheta)$ for initial latent states. These pre-conditions help to control parameter variability, especially when the data set is small or noisy. The estimation process is performed by sampling the Markov chain of Monte Carlo (MCMC) and iteratively generating the posterior distributions of all parameters, which allow the model to quantify uncertainty probabilistically. Unlike classical regression models, which provide point estimates, BSTS produces confidence intervals (CIs) that reflect the range of probable outcomes and thus provide a more reliable interpretation of the causal relationship.

To quantify the impact of an intervention, the BSTS model computes the pointwise causal effect, which measures the immediate difference between the observed outcome and its counterfactual estimate. This is formulated as:

$$\theta_t^i = y_t - y_t^i \quad (4)$$

where y_t represents the actual observed value and y_t^i is the predicted counterfactual— i.e., what would have occurred had the intervention not taken place. While pointwise effects are useful for identifying short-term fluctuations, long term intervention effects require cumulative measures. The cumulative causal2 impact, which aggregates the total intervention effect over time, is computed as:

$$\sum_{t=n+1}^{m} \theta_t^i \tag{5}$$

where n represents the time of intervention (e.g., policy enactment year) and m is the final observation in the post-intervention period. This cumulative sum provides a comprehensive measure of the effectiveness of the intervention, distinguishing between temporary and structural changes that are the result of the treatment. To avoid overfitting and improve the interpretability of the model, BSTS includes spike and slab pre-probability, a Bayesian regularization technique that selectively removes irrelevant explanatory variables while preserving significant ones. The spike-and-slab prior is defined as:

$$\beta_t \sim \gamma_t N(0, \sigma_{slab}^2) + (1 - \gamma_t)\delta_0, \quad \gamma_t \in \{0,1\} \tag{6}$$

where $\gamma_t = 0$ forces the coefficient to be zero (spike), effectively removing it from the model, whereas $\gamma_t = 1$ follows a normal distribution with variance σ_{slab}^2. This formulation ensures that only the relevant predictors are retained, which improves the accuracy of the model as well as its interpretation. Finally, BSTS uses Bayesian posterior inference to quantify the uncertainty of estimated cause effects and relies on MCMC sampling to derive the probability distribution of the individual parameters. The variance of the latent trend is modeled using an inverse-gamma prior, expressed as:

$$\sigma_\lambda^2 \sim IG(a_\lambda, b_\lambda) \tag{7}$$

where a_λ and b_λ are hyperparameters encoding prior beliefs about the scale of the trend variance.

3| DATA DESCRIPTION

The Causal Impact model relies on the full pre- and post-intervention time series of predictor variables to construct the counterfactual scenario. One critical assumption of this model is the availability of a set of control time series that were not affected by the intervention yet act as reliable predictors of the treated time series. However, if these control variables are impacted by the intervention, the model might underestimate or overestimate the true causal effect, or worse, conclude that an effect exists when in reality, there was none. One of the primary advantages of using a Bayesian Structural Time Series (BSTS) model in causal impact analysis is its integration of spike-and-slab priors. These priors are a Bayesian variable selection technique, often employed in regression models, to manage uncertainty about whether a specific covariate should be included in the model. They help prevent overfitting and encourage sparsity by forcing some regression coefficients to be exactly zero (indicating that a variable should be excluded) while allowing others to take non-zero values (indicating the inclusion of important variables). This selective process ensures that only the most relevant variables contribute to the estimation of the counterfactual, enhancing the model's accuracy. Given this, we considered a wide range of covariates that, based on intuition and empirical evidence, could influence the outcome variable but are likely not impacted by the intervention. The outcome variable in this study is U.S. dairy exports to Canada. We considered both internal and external factors that might affect U.S. dairy exports. Internal factors refer to variables related to the exporting country (U.S.) and the importing country (Canada), including milk production in both the U.S. and Canada, Canada’s population, and its

GDP per capita, which reflect domestic demand. Additionally, we included Canada's domestic milk consumption, to account for changes in local consumption patterns, as well as inflation rates in both the U.S. and Canada to control for macroeconomic shifts that could impact trade volumes. External factors include the global dairy price index, which captures fluctuations in international dairy prices, and dairy exports from New Zealand, Italy, France, and the Netherlands to Canada, as these countries, along with the U.S., are top exporters of dairy products to Canada. Including their export data provides a comparative performance benchmark, capturing external market dynamics and competition that might influence U.S. exports. This broad selection of covariates, detailed in Table 1, helps ensure a comprehensive analysis of factors influencing U.S. dairy exports, both domestically and globally, and mitigates the risk of omitted variable bias in the counterfactual construction.

Table 1. Data description

Variable (s)	**Description**	**Unit**	**Source**
USDPEC	US Dairy Product Exports to Canada[1]	Million USD	UN Comtrade (WITS)
MPUS	Milk Production in the US	1000 MT	PSD, USDA
MPC	Milk Production in Canada	1000 MT	PSD, USDA
CDCM	Canada's Domestic Consumption of Milk	1000 MT	PSD, USDA
POC	Population in Canada	Million	World Bank

[1] According to the USITC (2019), we defined dairy products as 0401 (milk and cream), 040210 (nonfat dry milk/skim milk powder), 040221 and 040229 (dry whole milk/whole milk powder), 0402.91 (evaporated milk), 0402.99 (sweetened condensed milk), 040310 (yogurt), 040390 (buttermilk), 040410 (whey and modified whey), 040490 (milk protein concentrates), 0405 (butter, dairy spreads, and butter fats and oils), 0406 (cheese), 170211 and 170219 (lactose), 190110 (infant formula), 210500 (ice cream), 350110 (casein), 350190 (caseinates), and 350220 (milk albumin). We derived the export values of dairy products from exporting countries (U.S., New Zealand, Italy, France, Netherlands, Switzerland) to the importing country (Canada) by using the same codes in Harmonized System 1996 (HS 1996) using the World Integrated Trade Solutions (WITS) platform because WITS provides the UN Comtrade data.

GDPPCC	GDP Per Capita of Canada	Current US$	World Bank
GPIDP	Global Price Index of the Dairy Products	Index Value (2014-2016= 100)	FAO Stat
USIRCP	US Inflation Rate (Consumer Price Index)	Percentage	World Bank
CAIRCP	Canada Inflation Rate (Consumer Price Index)	Percentage	World Bank

Table 1. Data description (continued)

Variable (s)	**Description**	**Unit**	**Source**
NZDPEC	New Zealand’s Dairy Product Exports to Canada	Million USD	UN Comtrade (WITS)
IDPEC	Italy’s Dairy Product Exports to Canada	Million USD	UN Comtrade (WITS)
FDPEC	France’s Dairy Product Exports to Canada	Million USD	UN Comtrade (WITS)
NDPEC	Netherlands’ Dairy Product Exports to Canada	Million USD	UN Comtrade (WITS)
SDPEC	Switzerland’s Dairy Product Exports to Canada	Million USD	UN Comtrade (WITS)

4| RESULT ANAD DISCUSSION

The causal impact analysis compares the actual outcomes of U.S. dairy exports to Canada with what would have happened without the USMCA agreement. The analysis shows that USMCA had a positive effect on exports after its implementation in 2020. Figure 1 displays the actual export data (solid line) and the estimated exports without USMCA (dashed line). The gap between these lines after 2020 shows the agreement's impact. The second panel (pointwise) shows the changes over time, and the third panel (cumulative) illustrates the overall effect.

According to Table 2, the actual cumulative export value post-USMCA agreement was $2112 million, compared to the predicted $1593 million if the agreement had not been in place. This means USMCA boosted exports by $519 million. The 95% confidence interval for this increase ranges from $256 million to $795 million, confirming a significant positive impact.

USMCA also led to a 34% increase in exports, with a confidence interval between 14% and 60%, meaning we are confident that the agreement played a big role in this growth. The p-value of 0.00033 shows there is a very low chance that these results occurred by luck.

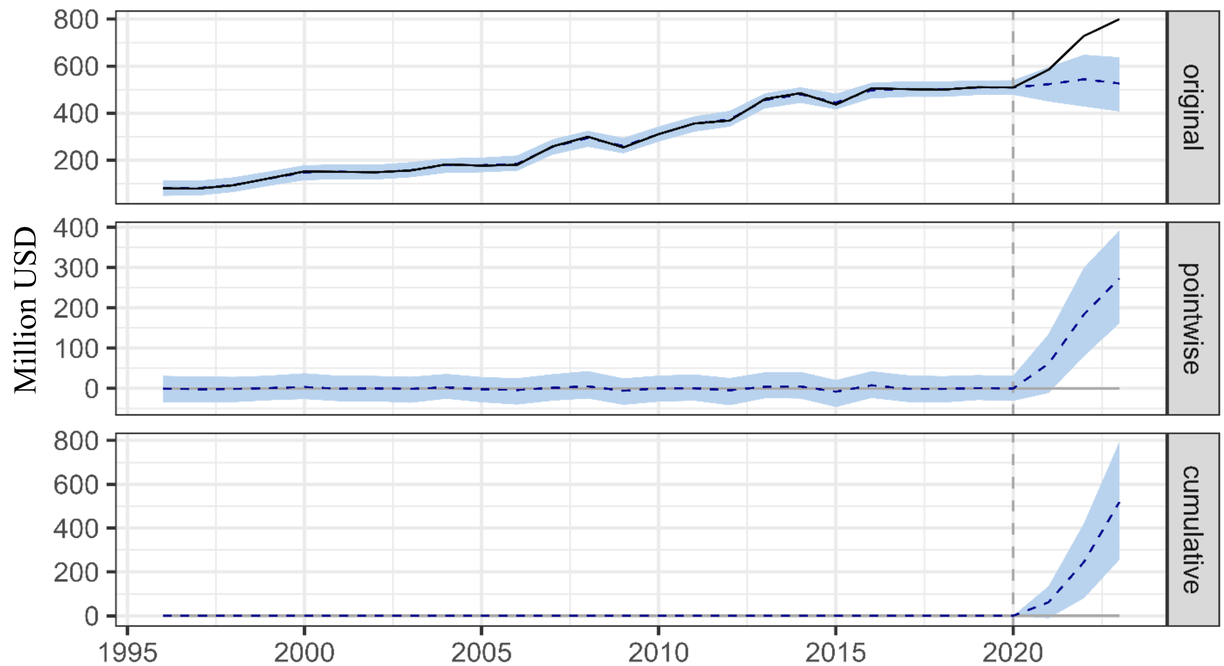

Figure1: Causal impact plot of the implementation of USMCA on U.S. Dairy Exports to Canada

Table 2. Causal impact output

Parameter	**Average**	**Cumulative**
Actual	704	2112
Prediction (s.d.)	531 (44)	1593 (133)
95% CI	[439, 619]	[1317, 1856]
Absolute effect (s.d.)	173 (44)	519 (133)
95% CI	[85, 265]	[256, 795]
Relative effect (s.d.)	34% (12%)	34% (12%)
95% CI	[14%, 60%]	[14%, 60%]
P-value	0.00033	
Posterior prob. of a causal effect	99.97%	

Note: The ‘Average’ column reflects the average values during the post-intervention period, while the ‘Cumulative’ column adds up the values from each individual time point. A total of 5000 MCMC samples were used for this analysis.

The posterior probability of 99.967% means we can be almost certain that USMCA caused the rise in exports. Overall , the results show that USMCA significantly increased U.S. dairy exports to Canada, with strong statistical support backing these findings.

The U.S. International Trade Commission projected that U.S. dairy exports to Canada will be increased by 43.8% ($227 million) after the full implementation of USMCA. Meanwhile, Chepeliev et al. (2018) also projected a $280 million dairy export increase of the U.S. However, our causal impact analysis shows that U.S. dairy exports have increased by 34% ($173 million) compared to what was expected without the agreement. One reason for this difference is the use of different baseline data. The USITC used 2017 data when exports were valued at $442 million, but we found the dairy export data valued at $501 million in 2017. This incident also highlights the difficulty of deriving the same trade data from different data sources, and USDA also recognized the fact that trade data often changes due to updates and adjustments in tariff codes (USDA-ERS, 2024). However, another import point to note that USITC’s prediction assumed full implementation of 14 expanded TRQs and elimination of class 7 pricing system while projecting the U.S. dairy exports growth. But in reality, Canada kept its commitment partially, not fully. This could be one of the main reasons that we got a slightly lower percentage increase compared to USITC’s prediction. Mainly, Canada increased tariff-rate quotas (TRQs) for U.S. dairy products, but Canada’s allocation of these quotas mostly favors its own processors over U.S. exporters targeting the retail market. In 2021, 85% of TRQs for milk and cream were given to bulk shipments for food processing, limiting U.S. access to higher-value retail markets (CRS, 2019). Even with expanded TRQs, any U.S. exports that exceed these limits are hit with hefty tariffs of up to 315% (CSR, 2019). For example, the quota for U.S. cheese exports is capped at 7,113 metric tons by Year 19, with any extra exports facing steep tariffs, making it tough for U.S. cheese producers to grow their market share (USITC, 2019). These high tariffs effectively cap exports of key products like cheese and butter, keeping them less competitive in the Canadian market. Additionally, Canada's quota allocation process lacks transparency, making it hard for U.S. exporters to plan effectively and get timely information on quota distribution, which makes market access unpredictable (CRS, 2019). Furthermore, despite promising to eliminate class 7 pricing system for skim milk powder (SMP) and milk protein concentrates (MPC) under USMCA, Canada's new pricing formulas still allow Canadian products to undercut U.S. prices (USTR, 2021; USTR, 2022; Turland et al., 2023).

In December 2020, the U.S. filed a complaint alleging that Canada's TRQ allocation favored domestic processors and restricted U.S. products in the retail market. A dispute panel in December 2021 ruled in favor of the U.S., finding that Canada's TRQ system violated the agreement. Although Canada agreed to modify its allocation, concerns about compliance persist (USTR, 2021; USTR, 2022; Turland et al., 2023).

5| CONCLUSION AND RECOMMENDATION

While USMCA aimed to improve U.S. dairy exports to Canada, these gains have been limited by Canada's partial fulfillment of its commitments. Although dispute rulings have favored the U.S., Canada's compliance remains incomplete, keeping significant barriers in place. Specifically, Canada's restrictive TRQ allocations, high over-quota tariffs, and ongoing issues with pricing systems are still acting as the barriers of U.S. dairy exports to Canada. But it is also evident that U.S. dairy exports to Canada have increased significantly after 2020 because of Canada’s partial fulfillment of the commitments under USMCA. To maximize USMCA’s benefits, Canada must fully comply with the rulings and ensure that TRQ and pricing systems are transparent and fair. The U.S. should continue to monitor compliance and use dispute mechanisms to address emerging barriers promptly.

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