Understanding the Impact of U.S. Trade Policy Shocks on Direct and Indirectly Affected Economies: A Bayesian Hierarchical Panel Vector Auto Regression - Exogenous Approach

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Abstract

This paper investigates the effects of US trade tariff, in particular the effects of the Section 201, 232 and 301 trade acts, on directly and indirectly affected economies. This paper utilizes a Bayesian Panel Var-X model with hierarchical priors to allow for fixed effect and heterogeneous slope and coefficients capturing the effects on each countries. Traditional trade model includes Computable General Equilibrium Model (CGE) and Eaton-Kortum (EK) Trade Model frameworks, which are heavily dependent on theoretical equilibrium assumptions. On the contrary, the selected Bayesian model is data driven, capturing dynamic heterogeneous responses across countries. The model allow for the isolation of both direct and indirect spillover effects of the tariff shocks. A binary and continuous severity shocks was constructed to account for the enactment and intensity of each tariff, capturing more nuanced analysis of each policy. U.S. protectionist tariffs were imposed to protect domestic industries, but the actual impact varies. China consistently emerge as the main casualty, especially under Section 201a and 232, while the seven other countries in the estimation shown statistically insignificant responses. Scenario-based forecast illustrate the prolonged adverse effects on China's real exports. This study contributes to the literature with regard to U.S.- China Trade war, providing an empirical approach to understand the impact of tariffs.

1 Introduction

1.1 Motivation

The inauguration of President Trump in January 2017 initiated a period of significant uncertainty for US foreign counterparts. Controversial trade protectionist policies were set in motion, justified by the administration efforts to shield the country form unfair foreign trade practices and dumping. The pretext for these protectionist polices were that these measures would reduce foreign competition within the domestic industry, enabling American firms to capture a greater share of the market, contending that income generated would benefit Americans.

The majority of the protectionist policies were focused disproportionately on China, resulting in widespread uncertainty in the global trade system. The high degrees of interconnectedness in international trade flow make it vulnerable to indirect spillover effects. It is crucial to understand how these trade policies propagate through the global economy, and how they affect both directly targeted and indirectly affected economies. This paper aims to understand the impact of U.S. trade policy shocks on export-dependent economies.

1.2 Tariffs

According to the World Trade Organization (WTO), tariffs are characterized as custom duties imposed on merchandise imports. They are usually implemented to provide domestic producers with a price advantage, simultaneously raising revenue for the government. The accumulated revenue may serve as redistribution to support industries negatively impacted by globalization and free trade. Nonetheless, such redistribution often harbor vested interests, benefiting exclusive groups, creating greater distortion within the economy (Furceri et al., 2018).

Most economist would argue that tariffs lead to inefficiencies. Furceri et al (2018) found that increases in tariff are associated with statistically significant declines in domestic produce and productivity. To build on this, tariffs are often met with retaliatory actions from foreign trade counterparts. William et al. (2019) find that retaliatory taxes potentially result in additional government expenditure to offset income losses, worsening the overall economic impact.

1.3 Trump's First Inauguration (2017)

Peter Navarro (2018) and Wilbur Ross (2024) made separate articles that emphasized the urgency to reduce the U.S. trade deficit, alleging that they were harmful to the economy. In 2017, Trump echoed this view, predominantly criticizing the considerable trade deficit with China. During his campaign, he threatened to impose tariffs of up to 45% on Chinese imports, holding China accountable for the job losses in the U.S. He alleged that U.S. manufacturing firms were either importing raw materials (such as Steel and Aluminum) or relocating factories to developing economies with cost advantages to reduce production costs, hurting domestic employment.

Coinciding with this, he pledged to break existing trade ties, threatening Mexico with higher export taxes and the construction of a border wall. This marked a drastic change the U.S.'s traditional role as the leader in global trade liberalization (Sheng, Zhao, and Zhao, 2019).

This was immediately followed by Trump withdrawing the U.S. from the Trans-Pacific Partnership (TPP), a trade agreement involving 11 other countries.

Section 201

In January 2018, the U.S. implemented tariffs under Section 201 on solar panels and washing machines. This include a 30% tariff levied on solar panels that reduce annually by 5% and a 25%

tariff placed on washing machines.

Section 232

This was followed by the initiation of an investigation under Section 232. Section 232 permits the U.S. to identify imports that pose as a threat to national security. The process involves the Secretary of Commerce consulting with the Secretary of Defense, and submitting a report to the President within 270 days, after which, the President has 90 days to decide on any actions to be taken. In this case, the investigation concluded that steel and aluminum were critical to U.S.'s national infrastructure. Consequently, a 25% tariff on steel and a 10% tariff on aluminum were introduced on March 2018 (U.S. Department of Commerce, n.d.), to a greater extend on China.

Section 301

To further challenge alleged unfair trade practices, tariffs under Section 301 were introduced. This was levied directly on China's imports, affecting approximately $50 - 60 billion USD worth of Chinese imports.

However, the rationale driving these tariffs have been challenged. Hanada (2019) pointed out that the U.S. military utilizes less than 4% of total U.S. steel consumption, lending credibility to the claim that the administration overstates the importance of domestic production of steel for military consumption. Vazquez (2018) argues that U.S. aluminum production have been in decline long before China became a major global supplier. These observations point to the likelihood that the domestic industry's struggles were largely internal.

A substantial body of research take the position that the tariffs were never really about U.S. national security. Hanada (2019) suggested that the U.S. uses national security as pretext to coerce and mislead other countries into trade negotiations. William et al. (2019) reinforced this position, stating that the "national security" justification served more as a smokescreen.

Hanada (2019) further affirmed the above argument by asserting that no rational state would trade its own national security for negotiated trade leverage. Negotiation with many affected countries indeed did not prioritize renegotiation of steel and aluminum tariffs. This supports the idea that the real aim of the tariffs was to bring countries to the negotiation table—not to defend national security.

Former U.S. Treasury Secretary Steve Munchin (2025) admitted that the main goal of these tariffs were to negotiate better trade deals. Douglas A Irwin (2019) categorized the use of these fake trade tariffs to pursue three objects: raising government revenue, restricting imports to protect domestic industries, and leveraging trade deals for reciprocity. This use of tariffs as a strategic tool rather than a genuine national security measure sets the stage for understanding the evolution of U.S. trade policy under Trump's second administration in 2025.

1.4 Trump's Second Inauguration (2025)

With Trump taking office for a second term, the widely anticipated new series of import taxes on imports from various countries were imposed once again. He continues to use the same argument to justify the intention of these tariffs.

The development of tariffs and retaliation tariffs were globally covered and reported. In this paper, we present the timeline reported on BBC by Clarke (2025). On 12 March, Trump doubled the import tax rates on steel and aluminum to 50% under Section 232. This iteration of tariffs diverged from earlier ones by not only aiming at China, but also affecting several other countries. To further amplify the tariffs, he introduced a baseline import tariff of 10% on all important into the U.S., with higher rates applied selectively to certain nations.

European Union (EU):

An initial exorbitant rate of 20% tariff were imposted on all EU goods. This was later reduce to 10% to allow room for negotiation. However, as there were little progress in trade talks, Trump indicated plans to increase it to 50% as of 1st June.

Canada and Mexico:

Imports from both neighboring countries were subjected to an even greater elevated tariff of 25% in February 2025. In retaliation, Canada imposed a 25% tariff on certain vehicles imported from th U.S. on 9th April.

United Kingdom (UK):

UK was the few countries that manage to reach a peaceful settlement with the U.S. Both side granted mutual tariff exceptions and negotiated a series fo favorable bilateral trade deals.

China:

An initial 10% tariff was levied on all Chinese imports, introduced on 4 February. Soon, it doubled. On 4th April, an absurdly disproportionate tariff of 145% were introduced on a broader set of Chinese imports. In retaliation, Beijing imposed a 125% tariff on selected U.S. goods. Several negotiations took place but to no avail. Talks held in Geneva failed to end the dispute, prompting for further negotiations in London on 6 June 2025 (CNA, 2025).

It is evident that with each term that Trump holds in office, there is significant market distortion and heightened uncertainty surrounding the arbitrary and unfounded tariff hikes. These measured appears to be reused and abused as bargaining tools, leveraging unrelated imports to strong-arm other countries into accepting favorable trade terms that primarily benefit the U.S. The eminent threat of high tariffs serves not only as a protective mechanism but also a strategic tool to extract concessions in broader trade negotiations.

This study provides an empirical analysis of how the U.S. trade tariffs would affect the macroeconomic dynamics of both targeted and non-targeted countries. The Bayesian estimation estimates the heterogeneous impulse responses across countries with respect to real exports, real exchange rates, real GDP, nominal interest rates and consumer price index. By quantifying these effects, the study offers a first step towards a more granular understanding of how trade tariffs transmit across borders through macroeconomic channels. Understanding these dynamics offer valuable insights into policy implications for external governments seeking to mitigate external trade risks and formulate a calculated response to these politically motivated trade disruptions.

Before proceeding to model estimation, we first present the timeline of key events and review the relevant literature.

1.5 Timeline of Events

This paper follows a chronological timeline of key trade policy events spanning from 2017 to 2022. The period captures major developments beginning with the inauguration of President Trump and the initiation of aggressive trade protectionist measures. The sequence includes the implementation of Section 201 safeguard tariffs, Section 232 national security tariffs, and Section 301 retaliatory tariffs targeting China. Each of these milestones played a pivotal role in shaping the global trade landscape during this period and serves as the foundation for the empirical analysis presented in the following sections.

Table 1: Timeline of Sections 201, 232, and 301 Tariff Actions (2017–2022)

Section	**Date**	**Description**
—	20-Jan-17	Donald Trump inaugurated as President of the United States.
232	19-Apr-17	Investigation into steel and aluminum imports initiated under Section 232.

Section	Date	Description
201	7-Feb-18	30% tariff on solar panels; 20% on washing machines. Affects China, Mexico, Germany, India, South Korea, Japan.
232	8-Mar-18	25% on steel and 10% on aluminum; exemptions announced for Canada, Mexico, EU, and South Korea.
232	1-Jun-18	Tariffs extended to EU, Canada, and Mexico as exemptions expire.
301	6-Jul-18	$34 billion in tariffs on Chinese goods (List 1).
301	23-Aug-18	$16 billion in tariffs on Chinese goods (List 2).
301	24-Sep-18	$200 billion in tariffs on Chinese goods (List 3).
201	7-Feb-19	Solar tariffs fall to 25% per scheduled phase-down; washing machine tariffs remain unchanged.
232	19-May-19	Canada and Mexico exemptions reinstated following new trade agreement (USMCA).
301	1-Sep-19	$300 billion in tariffs on Chinese goods (List 4).
232	24-Jan-20	Section 232 extended to derivative steel and aluminum products.
201	7-Feb-20	Solar tariffs drop to 20%; washing machine tariffs unchanged.
—	20-Jan-21	Joe Biden inaugurated as President of the United States.
201	7-Feb-21	Solar tariffs drop to 15%; washing machine tariffs remain unchanged.

Section	Date	Description
201	4-Feb-22	Tariffs extended for 4 more years; bifacial solar panels exempt; tariff-free quota for solar cells increased.
232	1-Jan-22	Section 232 tariffs on EU replaced with tariff-rate quotas (TRQs).
232	1-Apr-22	TRQ agreement implemented with Japan; Section 232 tariffs eased.

2 Literature Review

There is extensive literature rigorously documenting the impact of Trump's tariffs on targeted countries and third parties. It is important to note that the motivations behind Trump's policies have been meticulously explored and reported. These studies reported varying aspects of the tariffs since Trump's first inauguration. Most of these paper deals with the impact of tariff on GDP and bilateral trade. Building on this, most models utilizes traditional computational methods such as Computable General Equilibrium (CGE) model developed by Johansen (1960). Several variations of the CGE model have been employed.

CGE Model Analysis

In the most recent wave of literature, Nilsson and Nolte (2023) adopt the CGE MIRAGE approach to investigate the economic impact of the measures taken during the negotiation period between the U.S., China, and third-party countries on GDP and total exports. In addition, the success of the tariff's ability to accomplished their objective of improving U.S. trade deficits was assessed. The analysis demonstrated that uncertainty and prolonged trade tensions stifle investment, inhibit growth and supress any short term potential gains for the U.S. The paper asserts that the trade war results in a lose-lose situation, reducing imports from each other at the expense of their GDP growth. Paradoxically, some third parties stand to gain from the U.S. - China trade war. The overall U.S. trade deficits after the tariffs were higher than before. Analogous framework was used by Tsutsumi (2018), drawing the same conclusion that there be a negative impact on both U.S. and China' GDP and income.

Enhanced CGE Model Analysis

Parallel work in the field utilizes a multi-regional CGE model of the world economy to analyze the implications of the U.S - China trade war (Hertel, 1999). This model is also identified as the Global Trade Analysis Project (GTAP) model. Improvements of this model allow for capturing the global linkages and provide a more holistic view of the trade war's impact. Dixon (2016) forecasted the effects of the threat of a 45% tariff imposed on China's exports by Trump. He reported three main conclusions. Firstly, the high tariff rates on China do not improve the growth of domestic manufacturing industry. Secondly, there is substantial redirection of trade flow to Australia's benefit. Lastly, retaliation by China was found to have potentially detrimental impact on China's economy.He drew the overall conclusion that the minimal welfare gain from the 45% tariff all far outside the range of what would be beneficial for the U.S. economy. In place of that, the tariff would create greater supply shortages that the domestic industry is unable to fill.

Recent work using of the same model by Rosyadi and Widodo (2018) reached similar conclusions, providing evidence that import tariffs lead to redirected imports from other countries, and the insignificant gains from tariffs do not resolve the underlying problems in the U.S. domestic manufacturing sector. Furthermore, the trade war distorts intial trade balance in the world economy, increasing export from Mexico, Vietnam, and Canada in to the U.S. It was also suggested that this incentivizes China to expand trade, increasing exports with other countries far beyond the trade loss with U.S., thus reducing its growth dependence on the U.S. and increasing its resilience to future trade disputes. Likewise, both models are agreement that the trade war leads to a declining GDP and adverse effects on both economies, aligning with previous studies.

Other Methods

Alongside the original computational methods, alternative approaches were explored. An IV approach was utilized by Kim and Yoon (2020), indicating that firms located in Trump-supporting states were 60–68% more likely to be granted exemptions. The results suggest that the administration was likely to biased towards less efficient firms in Trump states. This further reinforces the view that tariffs exert an adverse effect, creating greater distortions and inefficiencies in the domestic manufacturing sector.

An alternative approach, known as the EK approach (Eaton and Kortum, 2002) was utilized by

Guo et al. (2018) to model the sectoral linkages of exports and to forecast how exports, imports, and outputs would change under Trump's proposed 45% tariff. The study focuses on three different simulated scenario. The three scenarios are as follow: (1) Trump imposes a 45% tariff on Chinese imports, (2) China retaliates, and (3) trade balance remains unchanged despite the tariffs. The study concluded that in all possible three scenarios, U.S. would suffer a larger welfare loss compared to China, who could stand to gain if China responds strategically.

An event study approach was adopted by Tong, Lu-Andrew, and Kunkel (2024), which examines the announcement effects of Trump's tariff cancellations. It was found that these announcments were postively correlated with financial firms within China, experiencing a 5.6% cumulative abnormal growth. This is an indication that financial market in China embraced the tariff rollback as a constructive economic signal.

Research Contribution

This study contributes to existing literature on the economic impact and consequences of the U.S.-China trade war. The introduction of a Bayesian Panel VAR-X framework allows for the incorporation of a panel structure, dynamic responses and parameter heterogeneity. This model builds on prior research, quantifying both direct and spillover effect. This is the first study applying a Bayesian Panel VAR-X model to this context, offering new insights into ow trade policy shocks affect different countries over time.

3 Methodology

The paper employs a Bayesian Panel Vector Auto Regression Model with exogenous variables to estimate the impact of trade tariffs imposed by the U.S. This panel framework traces out the intertemporal dependencies across the macroeconomic variables.The model assumes that the seven countries exhibit heterogeneous responses to macroeconomic shocks. This heterogeneity in slope coefficients is enabled by the Bayesian framework, which models country-specific effects via hierarchical priors. This framework embeds trade tariffs as observable trade policy shocks, including both weighted shocks and binary shocks. The weight shocks represents the severity of the three tariffs imposed while the binary shocks capture the occurrence of the tariffs. The incorporation of both types of shocks allow us to capture the presence and strength of trade policies.

Priors

The estimation in this paper is carried out by a Bayesian framework with hierarchical priors. Hierarchical priors are imposed on the country-specific coefficients to allow for potential heterogeneity in how countries respond to macroeconomic shocks and policy shocks. The hierarchical priors allow for the partial pooling across the common distribution, improving the estimation precision in capturing cross-country variations. The model employs a weakly informative prior to represent modest beliefs about the likely magnitude and direction of each parameter. We assumed that most slope coefficients are likely to be of small magnitude, approximately zero. Drawing from the existing literature, most macroeconomic shocks have limited spillovers on each other, allowing for the use of normal priors centered at zero. Supported by the extensive literature, it is found that the trade war has little to no spillover effect on third-party countries (Furceri et al., 2019; Amiti et al., 2019; Fajgelbaum et al., 2020). Therefore, it is assumed that the coefficient of policy shocks are also normally centered at zero.

3.1 Data Collection

All macroeconomic data were obtained from the Federal Reserve Bank of St. Louis.[1] The source is highly reputable and recognized, therefore allowing for production of credible and reliable results. The timeline and severity of the selected three trade policies is obtained from official U.S government sources and institutions [2]. The dataset comprises of data from eight countries, analyzing both the direct and indirect effect of the U.S. tariffs. These countries are categorized based on whether they were direct targets of the trade measures:

- **United States**: Included to evaluate the domestic effects of U.S. policy measures.
- **Direct targets of Section 201**:
  - China
  - South Korea
- **Direct targets of Section 232**:
  - Canada
  - Mexico
  - Germany
- **Direct target of Section 301**:
  - China (also targeted under Section 201)
- **Non-targeted countries**:
  - **India**: Included to study the spillover effects on a large but less developed economy.
  - **Japan**: Included to study the spillover effects on a mid-sized but highly developed economy.

[1] Federal Reserve Economic Data (FRED). Available at: `https://fred.stlouisfed.org`

[2] Peterson Institute for International Economics `https://www.piie.com/research/piie-charts/2019/us-china-trade-war-tariffs-date-chart` and Office of the U.S. Trade Representative: `https://ustr.gov`

3.2 Panel Data Structure

The dataset comprises of monthly data that spans from January 2010 to December 2022. The panel comprises of eight countries in total. The panel includes five macroeconomic variables that potentially affect real exports of each country. For each country, macroeconomic data and severity and binary shocks are stacked vertically. Specifically:

- There are $N = 8$ countries in the panel.
- The time period contains monthly observations from 2010 to 2022
- For each country $i = 1, \ldots, N$ and time $t = 1, \ldots, T$, we observe:
  - A vector of endogenous macroeconomic variables $\mathbf{Y}_{it}$
  - A vector of exogenous policy shocks $\mathbf{X}_{it}$

Endogenous Macroeconomic Variables ($\mathbf{Y}_{it}$)

These macroeconomic variables are selected to account for internal macroeconomic conditions and external trade linkages. Note that most macroeconomic variables are expressed in natural logarithm to account for percentage changes and to stabilize variance across observations. The five macroeconomic variables are as follow:

- $\log(\text{Exports})$ – Real exports
- $\log(\text{REER})$ – Real effective exchange rate
- $\log(\text{GDP})$ – Real GDP
- $\log(\text{CPI})$ – Consumer Price Index
- Interest Rate – Nominal interest rate

Exogenous Policy Shocks ($\mathbf{X}_{it}$)

The model comprises of eight variables to model the direct and indirect policy shocks. The section 201 tariffs is split in to two portion, comprising of 201a tariffs on solar panels anf 201b tariffs on washers. The indirect effect of the tariffs are modeled as binary dummies. The direct effect of the tariffs is modeled as severity shocks, constructed by assigning weighted values to reflect the intensity of each policy shock.

- Trade policy shocks as defined by U.S. law:
  - Section 201(a) - Tariffs on Solar
  - Section 201(b) - Tariffs on Washer
  - Section 232
  - Section 301
- These variables are either:
  - Binary dummies (e.g., equal to 1 if a shock was implemented in a given period)
  - Continuous severity indices on a 0 – 1 scale, capturing the severity of the policy imposed

Each shock name correspond directly to U.S. specific regulatory sections to maintain clarity in interpretation.

3.3 Model Specifications and Notations

Basic Vector Autoregression (VAR) model assumes that all variables are treated as endogenous and independent. In the exogenous variable VAR model pioneered by Ramey and Shapiro (1998), a method was introduced to study how external shocks propagate through the model.

We extend the VAR-X framework by incorporating slope heterogeneity across countries and estimating the model within a Bayesian framework. Therefore, in this paper, we adopt a Bayesian Panel VAR-X(p) model.

Let Y_t be a $G \times 1$ vector of endogenous macroeconomic variables. Let X_t be a $R \times 1$ vector of exogenous variables, which include tariff shocks and tariff binary dummies. Let Y_t be a $G \times 1$ vector of endogenous variables, and let X_t be a $M \times 1$ vector of exogenous variables. The single-country VAR-X(p) model is specified as:

$$Y_t = \sum_{j=1}^{p} A_j Y_{t-j} + \Gamma X_t + \alpha + \varepsilon_t, \quad \varepsilon_t \sim \mathcal{N}(0, \Sigma)$$

Where:

- A_j: $G \times G$ coefficient matrix for the j-th lag of Y_t
- Γ: $G \times M$ coefficient matrix capturing the contemporaneous effect of exogenous variables X_t
- α: $G \times 1$ intercept vector
- ε_t: $G \times 1$ vector of residuals with $\varepsilon_t \sim \mathcal{N}(0, \Sigma)$, where Σ is a $G \times G$ covariance matrix

We then expand this single-country Bayesian VAR-X(p) model into a Panel Bayesian VAR-X(p) model. The Panel Bayesian VAR-X(p) model retains the same structure as the basic model and follows the same underlying assumptions. However, there is an added cross-sectional dimension to the representation, accounting for intertemporal dependencies across countries and allowing us to assess how shocks in one country affect and are propagated to another.

Let Y_{it} be a $G \times 1$ vector of endogenous macroeconomic variables for country i at time t. Let X_{it} be a $R \times 1$ vector of exogenous variables, which include tariff shocks and tariff binary dummies, for country i at time t.

In this model, we observe each country $i = 1, \ldots, N$ over each time period $t = 1, \ldots, T$. The Bayesian Panel VAR-X(p) model, with p lags of the endogenous variables, is specified as:

$$Y_{it} = \sum_{j=1}^{p} A_{i,j} Y_{i,t-j} + B_i X_{it} + c_i + u_{it}$$

Explanation of Terms:

- Y_{it} : $G \times 1$ Vector of endogenous macroeconomic variables for country i at time t
- $A_{i,j}$: $G \times G$ Country-specific coefficient matrix for the j-th lag
- X_{it} : $R \times 1$ Vector of exogenous trade policy shocks (e.g., Section 201/232/301)
- B_i : $G \times R$ Coefficient matrix for the exogenous variables, allowed to vary across countries
- c_i: Country-specific intercept
- $u_{it} \sim \mathcal{N}(0, \Sigma_i)$: Error term assumed to follow a multivariate normal distribution

3.4 VAR Lag Selection

Prior to implementing the Bayesian framework, the time series data within the model requires the underlying lag structure to be determined. The standard tests comprising the Akaike Information Criterion (AIC), Hannan-Quinn Criterion (HQ), Schwarz Criterion (SC), and Final Prediction Error (FPE)—was employed. Given that the model was complex, the results generated by AIC was prioritized. Accordingly, a lag order of two (p = 2) was selected. The dataset was subsequently restructured to accommodate this specification.

3.5 Severity Shock Modelling

3.5.1 Shock Construction: Binary and Severity-Based Approaches

To accurately reflect the tariff policies, two distinct measures of tariff shocks were constructed: a binary indicator and a severity-based index. These specifications allows the model to capture the presence to a policy intervention and its relative magnitude over time.

The binary shock variable is defined as an indicator that equals one in any month during which the specific tariff is in effect. This is regardless of whether the country is directly targeted. The variable is one as long as the tariff is effect on one of the eight countries within the panel. This variable is designed to capture the spillover of indirect effects from the policy shocks across international trade network.

The severity based variable is a continuous measure bounded between 0 and 1, accounting for intensity of the policy implementation during each period. The severity index is computed by computing the ratio of observed tariff in a given month to the maximum applicable tariff under the policy. This accounts for how strongly enforce is the policy over the study period. The ratio method of obtaining the severity is justified as by expressing the tariff as a proportion of the full imposed tariff, it reflects how binding the shock is at each point in time. This helps us captures the changes in tariff intensification over time and across countries. Furthermore, the binding between 0 and 1 allow the severity index to be easily interpreted. Thus, this method of modeling allow for a more granular analysis of the tariffs.

Policy-specific severity calibrations:

- **Section 201a (Solar Panel Safeguards):** Tariff severity was modeled to reflect the scheduled reduction as follows: 30% $\rightarrow$ 1.00; 25% $\rightarrow$ 0.83; 20% $\rightarrow$ 0.67; and 15% $\rightarrow$ 0.50.
- **Section 201b (Washing Machines):** Given the constancy of the policy rate, a severity of 1.00 was maintained throughout the entire implementation period.

- **Section 232 (Steel and Aluminum Tariffs):** The severity index was set to 0.9 starting from 8 March 2018, corresponding to the initial implementation of tariffs on steel and aluminum imports. This value was increased to 1.0 from 24 January 2020, reflecting the expansion in the scope of covered products. For countries that were temporarily exempted or subsequently removed from the tariff coverage, the severity was set to 0 during the respective exemption periods.

- **Section 301 (China-Specific Tariffs):** Severity values were assigned based on the cumulative escalation of tariffs: 6 July 2018 $\rightarrow$ 0.11; 23 August 2018 $\rightarrow$ 0.17; 24 September 2018 $\rightarrow$ 0.83; and 1 September 2019 $\rightarrow$ 1.00.

Employing both the binary and severity-based constructions enables the model to separately identify the direct and indirect effects of tariff shocks on each countries, enhancing the credibility and interpretability of the empirical findings.

3.6 Bayesian Framework

The Bayesian Framework is used to estimate and structure the above model. The posterior distributions is estimated via Bayes Rule, whereby:

$$\text{Posterior} \propto \text{Likelihood} \times \text{Prior}$$

This estimation prevents overfitting, which is essential in a high-dimensional dataset used in this model.

This Bayesian modelling approach allows us to introduce hierarchical priors on coefficients across countries. In this model, $A_{i,j}$ and B_i are assigned hierarchical priors. This allows the parameters to be heterogeneous and country-specific, but not independent.

Under the Bayesian framework, we impose the following hierarchical priors:

$$A_{i,j} \sim \mathcal{N}(0,I), \quad B_i \sim \mathcal{N}(0,I),$$

This structure allows the model to capture heterogeneous dynamic responses across countries while borrowing strength from global patterns.

3.7 Forecast

Scenario-Based Forecast

The coefficients obtained in the model would be further utilized to examine the future trajectory of China's exports under continued trade pressure. This approach is otherwise known as scenario-based forecast.This approach projects out-of-sample values based on a Bayesian model estimated from historical data, under assumed exogenous shocks.

To capture the new trade tariff threat in 2025, we simulate an intensification of both the Section 232 and Section 301 tariffs—specifically, Section 232 increasing from 25% to 50%, and Section 301 rising from approximately 10% to 30%. Due to the lack of post 2022 data, the model continues to assume that trade dynamics observed in 2022 remains stable through to the start of 2025. This assumption allows the simulation of counterfactual outcomes under an intensified tariff environment, conditional on pre-shock trends.

The scenario-based forecast is intended to illustrate the directional and dynamic impact of the policy shocks.Section 201a and 201b tariffs are excluded since there were no anticipated changes to these measures after 2022.

The effect of the tariffs is modeled to decay over time, capturing China's potential adjustment to the new tariff regime. It's worth noting that this decay is user-defined and not naturally generated by the model.

4 Results

The Bayesian Panel VAR-X Model was estimated in Rstudio. In the estimation, we obtained country-specific heterogeneous coefficient $A_{i,j}$ and B_i. The coefficient of interest in this model is B_i. The B_i is broken down into two components, comprising of fixed effect and random slope.

$$B_i = \text{Fixed Effect} + \text{Random Slope}$$

Fixed effect is obtained by pooling across countries, studying the overall average effect of each trade policy across all countries. Random slope captures how individual countries deviates from the global mean. The table below presents the full results derived from the model.

China

Table 2: Estimated Effect of Trade Shocks on China's Real Exports

Shock Variable	**Mean**	**2.5% CI**	**97.5% CI**
Severity_201a	**-0.1829**	**-0.3019**	**-0.0638**
Severity_201b	**0.2596**	**0.1024**	**0.4167**
Severity_232	**-0.1147**	**-0.2285**	**-0.0009**
Severity_301	0.0383	-0.0459	0.1224
Exposure_201a	0.0168	-0.0560	0.0896
Exposure_201b	-0.0146	-0.0870	0.0577
Exposure_232	0.0086	-0.0646	0.0818
Exposure_301	-0.0137	-0.0850	0.0576

Interpretation: From the above table, we can conclude that there are three shocks which have statistically significant effect with China's macroeconomic systems with effect likely to be largely affecting real exports. The three shocks are identified to be Severity_201a, Severity_201b and Severity_232. The negative coefficient obtained for Severity_201a suggests that a one-unit increase in the severity of Section 201a tariff is met with an average 18.29% average decline across China's dependent macroeconomic variable including real exports, ceteris paribus. The negative correlation suggest spillover effects on related macroeconomic outcomes within the system of equations. Severity_201b was found to show a positive effect of 25.96%, indicating there seem to exist a complex dynamics within the trade model. Lastly, Severity_232 found a statistically significant negative effect of 0.1147. All exposure variables are statistically insignificant, indicating that indirect channels may have been limited for China in this specification.

Canada, Germany, India, Japan, Mexico, South Korea, and USA

Table 3: Estimated Effect of Trade Shocks on Real Exports (Non-significant Countries)

Country	Shock Variable	Mean	2.5% CI	97.5% CI
Canada	Severity_201a	0.0409	-0.0485	0.1292
Germany	Severity_201a	0.0132	-0.0904	0.1168
India	Severity_201a	0.0113	-0.0907	0.1132
Japan	Severity_201a	-0.0059	-0.1069	0.0951
Mexico	Severity_201a	0.0488	-0.0389	0.1365
South Korea	Severity_201a	-0.0254	-0.1187	0.0679
USA	Severity_201a	-0.0029	-0.0974	0.0917
Canada	Severity_201b	0.0387	-0.0511	0.1285
Germany	Severity_201b	-0.0088	-0.0993	0.0816
India	Severity_201b	-0.0351	-0.1263	0.0560
Japan	Severity_201b	-0.0127	-0.1024	0.0770

Continued on next page

Country	Shock Variable	Mean	2.5% CI	97.5% CI
Mexico	Severity_201b	0.0402	-0.0488	0.1292
South Korea	Severity_201b	0.0042	-0.0856	0.0941
USA	Severity_201b	0.0072	-0.0825	0.0968
Canada	Severity_232	0.0089	-0.0785	0.0962
Germany	Severity_232	-0.0077	-0.0952	0.0799
India	Severity_232	0.0387	-0.0489	0.1264
Japan	Severity_232	-0.0163	-0.1041	0.0714
Mexico	Severity_232	-0.0364	-0.1237	0.0509
South Korea	Severity_232	-0.0256	-0.1136	0.0624
USA	Severity_232	-0.0065	-0.0945	0.0815
Canada	Severity_301	0.0409	-0.0437	0.1256
Germany	Severity_301	0.0330	-0.0514	0.1173
India	Severity_301	0.0497	-0.0349	0.1342
Japan	Severity_301	0.0224	-0.0619	0.1066
Mexico	Severity_301	0.0269	-0.0571	0.1109
South Korea	Severity_301	0.0259	-0.0581	0.1100
USA	Severity_301	0.0007	-0.0834	0.0848

Interpretation: For Canada, Germany, India, Japan, Mexico, South Korea, and the United States, there was no statistically significant estimated coefficients across all four severity shocks and binary shocks. Since the effects are non-distinguishable from zero, it suggests that these policies may not have any direct or indirect effects on the macroeconomic variables of these economies.

Furthermore, other countries may have embarked on swift policy responses that mitigated the impact.

4.1 Forecast - Trump's Return and Tariff Implications

Trump officially returned to office on 20 January 2025 (BakerMckenzie, 2025). In the months that followed his inauguration, he began to shake up the worlds' economies by threatening several hikes in tariffs across many countries. From our model, it can be seen that most countries effects remains insignificant, being unable to decipher the direction of causation. The indirect effects of the tariffs were minimal, suggesting that global trade patterns are already highly saturated—making it difficult even for a major player like the U.S. to shift the balance significantly.

From our findings, it can be inferred that China is most adversely affected. It could be observed that each tariff consistently harms China more than any other countries. Since taking office, Trump has repeatedly threatened China with aggressive tariff actions to pressure them into negotiations favorable to the U.S. and to meet U.S. demands (CNA, 2025). This has culminated in increased severity of Section 232 and Section 301 tariffs as seen in the early months of 2025.

By implementing a scenario forecast method, we hope to shed light on how these newly intensified tariffs might affect China's real exports. The scenario-based forecast is narrowed to focus on China due to insignificant effects found on other countries. On the other hand, the IRF and FEVD would be found for all countries.

4.1.1 Scenario-Based Forecast Results

From the projected trajectory shown in Figure 1, it can be seen that Trump's new tariff hikes are likely to deal a significant blow to China's macroeconomic variables, primarily through real exports.

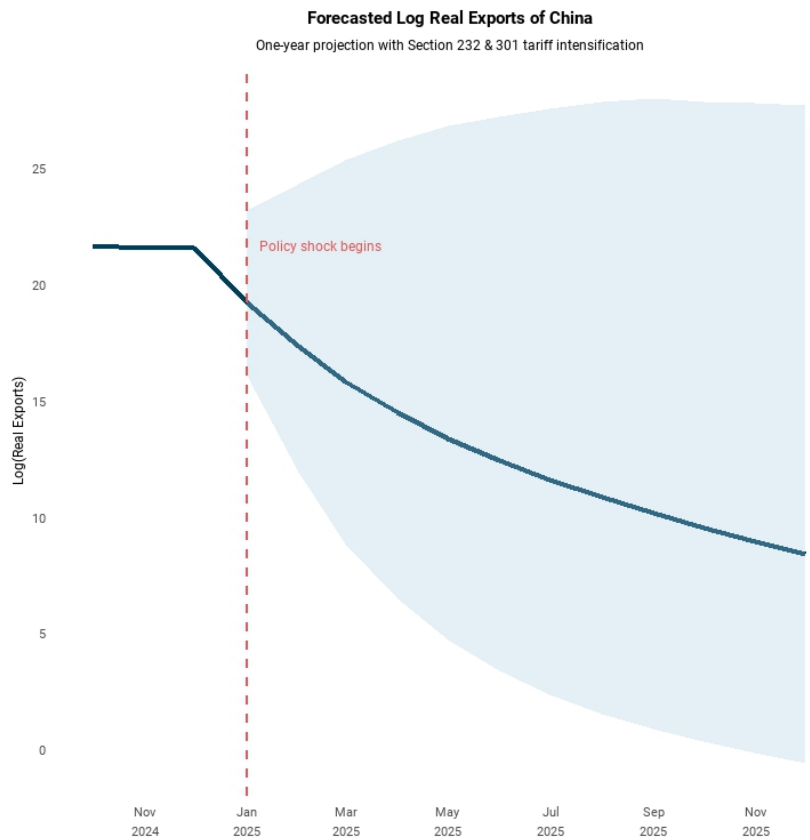

Figure 1: Scenario-Based Forecast: China's Real Exports

The long term projection of a continuous heightened shock suggests that the China's macro-economy would be severely impacted. This underscores the need for policy to mitigate the risk of these U.S. tariffs.

5 Discussions

5.1 Impact on China

While this study does not explicitly model retaliatory measures by China or other affected countries, the framework remains a valid proxy for assessing the direct and indirect effects of U.S. protectionist policies. Although excluding retaliation is a limitation, focusing solely on tariffs implemented by the U.S. allows for a clearer identification of unilateral policy impacts on China's real exports. From the results above, it is clear that China suffers significant loses at the expanse of such U.S. tariffs.

This findings suggest several important implications. Firstly, the impulse response function (IRF) indicates that the negative trade shock is likely to persist over several months. When combined with the scenario-based forecast, a consistent and prolonged decline in real exports is observed—assuming China takes no mitigating action. Such a decline may contribute to slower GDP growth, reinforcing the need for Chinese government intervention.

Policy Options for China

Retaliatory Tariffs

There are contradictory evidences regarding the imposition of retaliatory tariffs. A study by Bollen& Rojas-Fomagosa (2018), caution that such measures may intensify the level of harm caused on the economy in both countries. On the other hand, Scitovsky (1942) asserted that retaliatory tariff can be employed to reclaim welfare loss through import tariffs.

Diversification of Trade Partners.

China could attempt to diversify exports to non-tariff-imposing countries as another viable strategy. A redirection of exports during the first trade war was observed by Bown and Crowley (2007). Furthermore, Rosyadi and Widodo (2018) found rising Chinese exports to Vietnam, Mexico, and

Canada. This diversification is supported by Dong and Whalley (2012), which emphasized the long-term benefit of reduced dependency on U.S. markets. Dixon (2017) further supports non-retaliation, citing substantial gains from China's expanding trade with Australia. These studies suggest that diversification of trade partners could result in China's independence from trade with U.S., reducing any detrimental tariff shocks.

Diplomatic and Mulitlateral Engagement

Riley (2018) argue that the tariffs are merely a strategic pretext for unrelated negotiations. Jamrisko and Woods (2016) drew similar conclusion suggest that threats to impose higher tariffs were largely bluffs that were targeted at strengthening the United States' bargaining position. In such cases, pursuing resolution through the WTO and reinforcing diplomatic ties with other similarly affected countries may offer a more constructive and sustainable path forward (Hanada, 2019). Furthermore, the rich body of literature available, provides substantial evidences and opportunities to challenge the actions of the U.S.

Tariff Avoidance.

An alternative approach to be explored is tariff evasion via rerouting trade through third countries. The low gains from such rerouting is argued to lower incentives of firms to engaged in such methods. However, evidence from Ito (2024) suggests that a minor yet significant amount of exports to the U.S. from Vietnam originated from China through such rerouting channels. The evidence suggest that this alternative could be further expanded, allowing for economies of scales, improving gains.

Other Countries

Due to the limitation of the results obtained, there is inconclusiveness on the direction to which other countries should embarked on. The overall consensus would be diversification of exports to mitigate specific export tariffs.

6 Limitations and Possible Expansions

The current findings of the model offers insightful results into how U.S. trade policies may affects China's real exports. While insignificant results were obtain for other countries, it also offer a proxy as to how U.S. trade policies may affect the other six countries. While the overall current framework provide a nuanced understanding, there are several limitations that are worth noting.

Fixed Model Coefficients B_i:

Firstly, the estimated parameter explaining the impact of the tariff shocks are held constant over time. However, in practice, policy responses would shift overtime as firms and governments adapt. This was not capture within our model. This is also partially due to the inability of estimating such a complex model without the use of high-performance computing resources.

No Direct Retaliation Behavior Included:

Secondly, when engaging in the scenario-based forecast, shocks were allowed to decay to simulate adjustment, but the model did not explicitly model China's retaliatory actions. Furthermore, the entire model did not account for any retaliatory actions from the seven countries. However, this model still serves as a good proxy, accounting for essential transmission of tariff policy shock.

No Within-Country Variation:

Thirdly, every country in the model is modeled as one entity. However, in reality, different provinces or states may react differently to the shocks. Nonetheless, the broad directional effect at the country level was captured and accounted for.

Shock Construction Involves Assumptions:

Lastly, the severity and binary shock constructed relied on some subjective judgment when defining the maximum intensity and timing. This might resulted in missing some nuances.

Future expansions Future expansions of this study could include modeling relation behaviors by other countries. Furthermore, each countries could be further broken into varying states to model within provinces trade behavior. Accounting for a time varying B_i would allow model to closely represent trade behavior in reality. An impulse response function and forecast error variance decomposition could also be conducted to allow the identification of the policies' shock paths.

7 Conclusion

This study sets out to evaluate the dynamic relationship of U.S. tariffs, in particular Sections 201, 232, and 301 on both directly targeted and indirectly affected countries, utilizing a Bayesian Panel VAR-X framework with hierarchical priors. We then model the severity variable to account for intensity of tariffs. The model captures heterogeneous, country-specific responses in a system of macroeconomic variables including real exports, GDP, CPI, interest rates, and exchange rates.

The paper's finding found that China was the most adversely affected economy with statistically significant responses to Section 201a, 201b, and 232 severity shocks. These results in a negative impact on China's macroecnomic system. The scenario-based forecast indicates that continued tariff threats by the U.S. would result in prolonged deterioration in China's export performance and broader macroeconomic stability.

At the same time, the model found no statistically significant effect for Canada, Germany, India, Japan, Mexico, South Korea, or the United States. These results are consistent with existing literature that there are limited spillover effects of U.S. tariff to third-party countries.

While this framework offers empirical insights, it also has notable limitations. However, this research is still a foundation step in utilizing an econometric data-driven model to access trade policies.

The paper concludes by stating that the results supports the view that U.S. policies have disproportionately large effects on China. For policymakers within China should engage in strategies to mitigate such external risks.

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