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Evolution of Global Soybean Trade Flows and Share Reconfiguration Amid Tariff Policy Fluctuations

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Abstract. In response to the United States' proposed “reciprocal tariff” policy scheduled for implementation in 2025, this study aims to quantitatively assess its far-reaching impact on the global soybean trade landscape. Based on monthly high-frequency data from 2000 to 2025, an integrated assessment framework combining an extended gravity model with demand price elasticity is constructed to estimate long-term structural parameters and short-term market responses. Simulation results reveal that tariff barriers trigger significant trade diversion effects, causing U.S. soybean exports to China to plummet by approximately 25% and market share to shrink. Meanwhile, Argentina leverages its low-cost advantage to surge exports by over threefold, emerging as the primary beneficiary of market restructuring, while Brazil maintains its dominant position. This study innovatively integrates long-term and short-term factors, revealing the underlying logic by which unilateral tariff policies reshape the international agricultural competitive landscape through supply chain substitution mechanisms.

Keywords: Gravity Model; Trade Diversion; Price Elasticity.

1. Introduction

Within the global agricultural trade system, soybeans serve as a core commodity critical to food security and supply chain stability. As the world's largest importer, China relies heavily on the United States, Brazil, and Argentina for its supply structure. However, with the U.S. introducing its “reciprocal tariff” plan targeting multiple trading partners in 2025, the existing trade equilibrium faces severe challenges [1]. Scientifically forecasting market redistribution triggered by trade barriers has become an urgent issue. Previous studies have predominantly focused on extrapolating historical trends in single dimensions, often overlooking the differentiated impacts tariff policies exert on different suppliers through price transmission mechanisms [2-3]. This approach struggles to balance long-term structural factors with short-term market fluctuations within a unified framework. This section innovates by deeply integrating an extended gravity model with a calibrated demand price elasticity model. It not only accounts for the influence of economic size and geographic distance between countries but also dynamically depicts the demand switching logic of the Chinese market across three major supply sources by simulating tariff surge scenarios. The general research approach first employs long-series trade data from the USITC for parameter estimation. It then establishes a control variable system incorporating exchange rates and international soybean prices. Finally, through smooth extrapolation simulations covering the next 12 months, it quantitatively analyzes the market share trajectories of the US, Brazil, and Argentina under varying tariff intensities, providing data support for responding to trade policy fluctuations [4-5].

2. Tariff Impact Assessment Model for the Soybean Industry

2.1. Problem Analysis and Overall Approach

The date is from https://apmcm.org/. The United States, Brazil and Argentina are the world's three largest soybean exporters, with China being the largest importer. Reciprocal tariff policies have increased US tariffs on China, potentially altering the competitive landscape among these three

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nations in the Chinese market. We examine this from two perspectives: long-term structural factors and short-term demand responses:

(1) Employing an extended gravity model to characterise the long-term structure of exports to China from these three countries;

(2) Estimate price elasticities to translate tariff changes into price adjustments, thereby forecasting medium-to-short-term shifts in export volumes and values;

(3) Employ scenario simulations to compare market share redistribution before and after policy implementation. Soybean export volume comparison is shown in figure 1. Soybean Export Market Share to China is shown in figure 2.

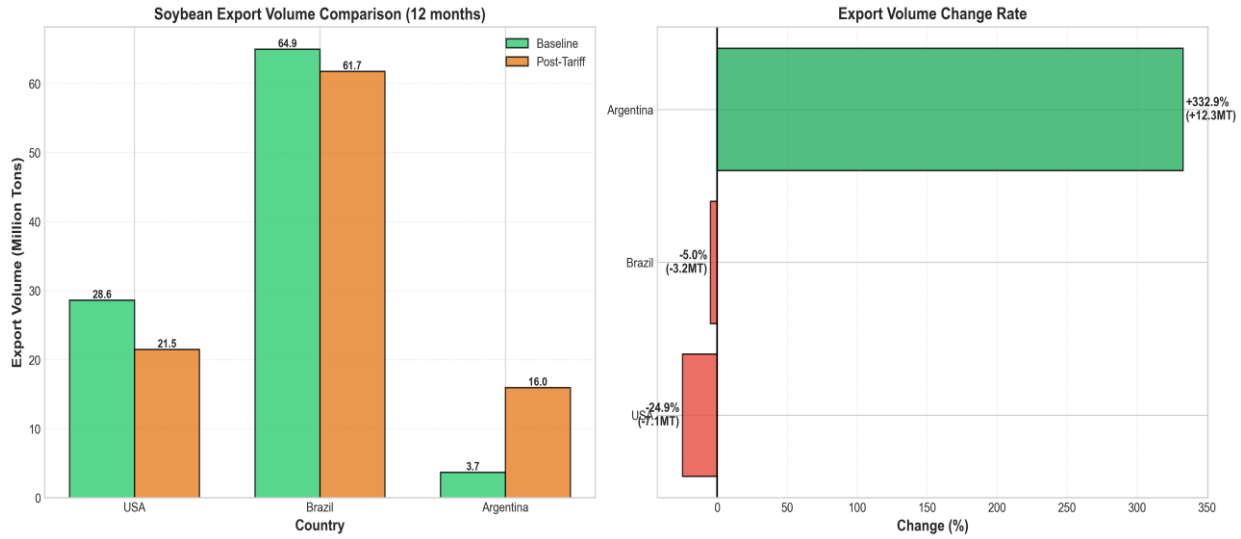

Figure 1. Soybean export volume comparison (12 months).

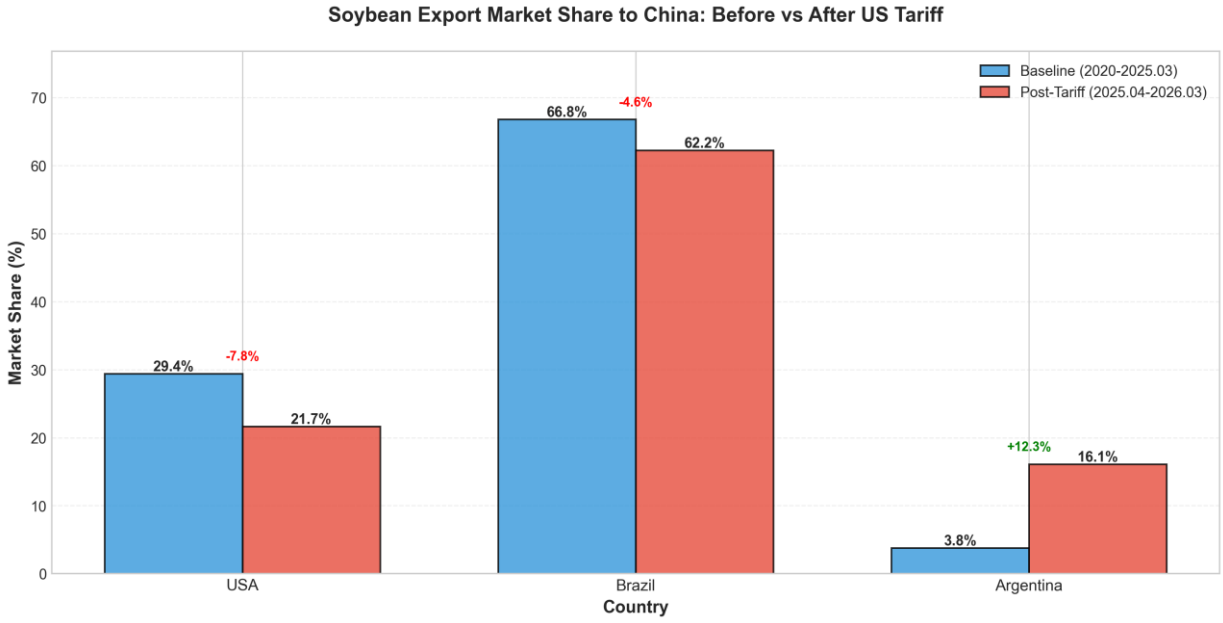

Figure 2. Soybean Export Market Share to China: Before vs After US Tariff.

2.2. Gravitational Models and Price Elasticity Models

2.2.1. Gravitational Model

Let $X_{i,t}$ denote the value of soybean exports from exporting country i (where $i \in \{USA, BRA, ARG\}$) to China during period t, employing the standard gravity model form:

$$\ln X_{i,t} = \alpha_i + \beta_1 \ln GDP_{CN,t} + \beta_2 \ln GDP_{i,t} - \beta_3 \ln Dist_i + \gamma \ln(1 + \tau_{i,t}) + \delta Z_t + \varepsilon_{i,t} \quad (1)$$

Where $Dist_i$ denotes geographical distance, $\tau_{i,t}$ represents the nominal tariff rate applied to China, and Z_t encompasses control variables such as exchange rates and international soybean prices [6-8].

2.2.2. Price Elasticity of Demand

The full conversion of tariffs into an increase in the cost of goods delivered at destination is approximately:

$$\frac{\Delta Q_i}{Q_i} = \eta_i \cdot \frac{\Delta P_i}{P_i} \approx \eta_i \cdot \Delta \tau_i \quad (2)$$

Where η_i denotes the price elasticity of demand for soybean exports to the United States, Brazil, and Argentina. Based on the Q1 text results, elasticities were calibrated for each of the three export destinations, and export volume changes were simulated under the tariff increase scenario [9]. Price elasticity of demand for soybean exports from major countries is shown in figure 3.

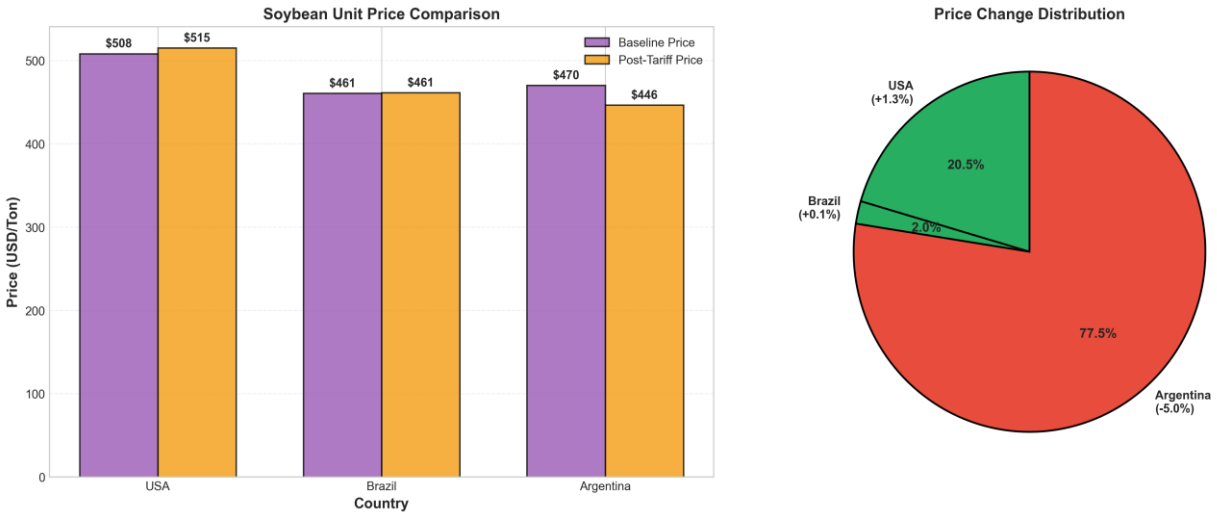

Figure 3. Price elasticity of demand for soybean exports from major countries.

2.3. Parameter Estimation and Scenario Setting

Data Coverage: 169 rows of monthly bilateral trade data between China and the United States, spanning 2020–2025; 307 records each for soybean data across four countries, covering 2000–2025.

Scenario Assumption: It is assumed that from 2025 onwards, US tariffs on soybeans imported from China will increase from zero to a significantly higher level, while tariffs from Brazil and Argentina remain unchanged [10].

Forecast Period: The total demand from China is projected for the next 12 months using a smooth extrapolation method, followed by reallocation among the three countries based on simulated prices and elasticities. Historical soybean export volume, value to China, historical soybean unit price and market share evolution are shown in figure 4.

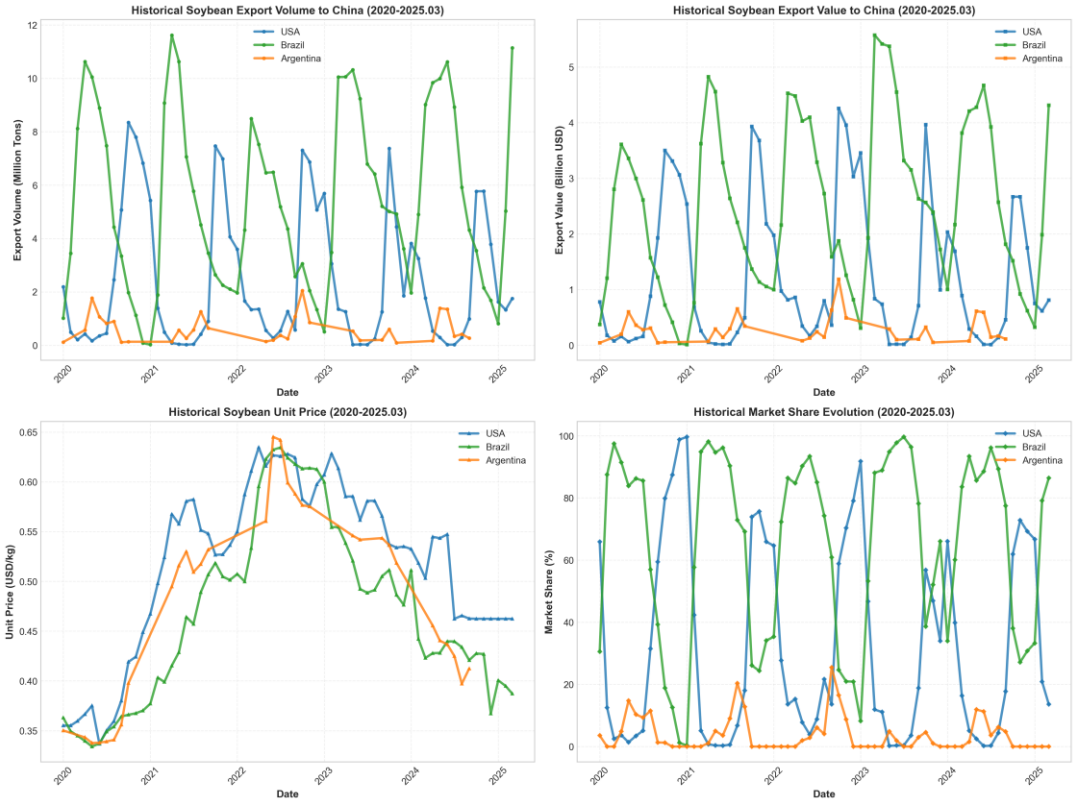

Figure 4. Historical soybean export volume to China (2020-2025.03).

2.4. Analysis of Results

Based on the Q1 tariff impact summary table, the principal conclusions are as follows:

(1) Export volume changes: US exports decreased by approximately 25%, with its market share in China falling from around 29% to approximately 22%; Brazilian exports declined slightly by about 5%, with a modest drop in market share; Argentine exports increased more than threefold, resulting in a significant rise in market share.

(2) Export value changes: US export value decreased by approximately 24%; Brazilian export value fell by around 5%; Argentine export value increased by more than threefold.

(3) Price changes: Average soybean prices in the US and Brazil rose slightly, while Argentine prices declined marginally, aiding its market share expansion. Cost comparison and Market attractiveness comparison is shown in figure 5. Tariff impact summary for soybean trade is shown in figure 6.

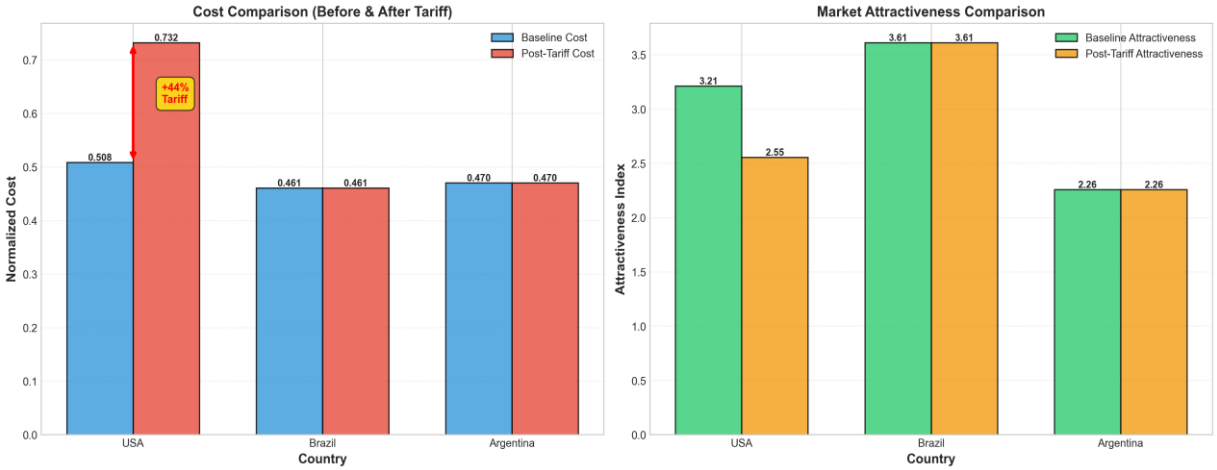

Figure 5. Market attractiveness comparison.

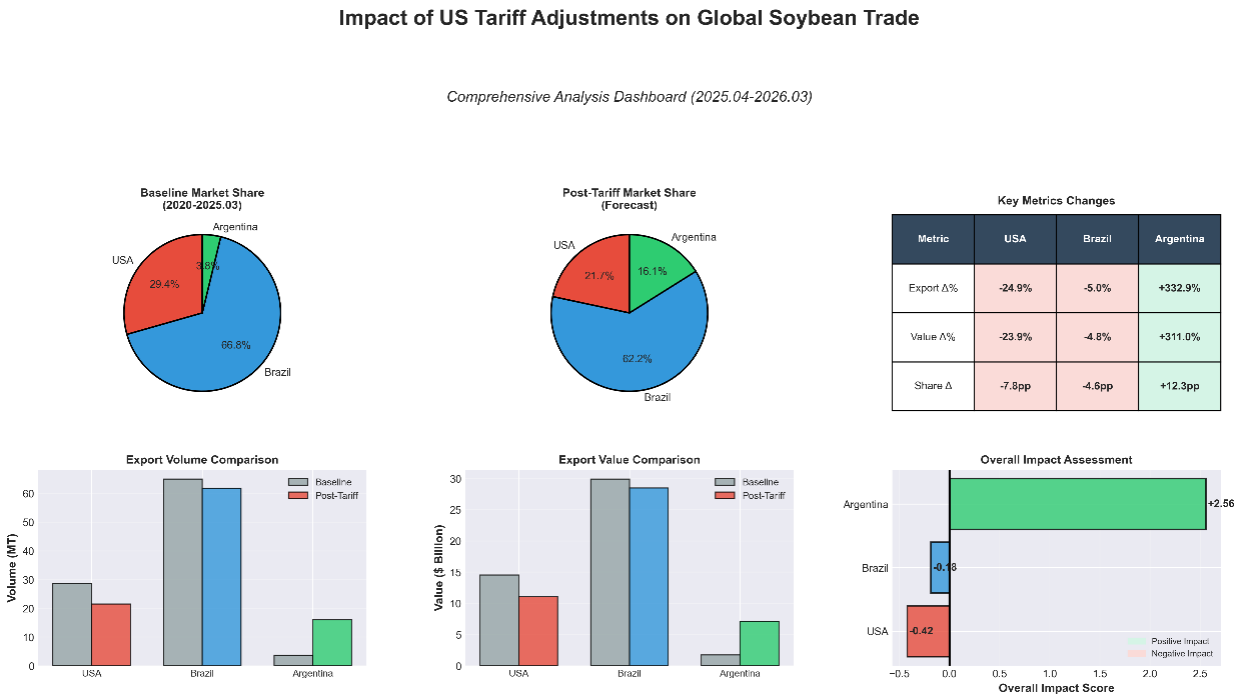

Figure 6. Tariff impact summary for soybean trade.

3. Conclusions

By establishing a quantitative analysis framework coupling gravity models with price elasticities, this study comprehensively evaluates the impact of U.S. tariff policy adjustments on international soybean trade. Findings indicate that tariff impositions would significantly erode U.S. soybeans' market competitiveness, inducing a structural shift in China's import composition. Argentina would leverage its cost advantages to fill most of the market gap, while Brazil demonstrates strong market resilience. This indicates that trade barriers not only alter the relative positions of exporting countries but also accelerate the diversification of the global soybean supply axis.

Despite the study's high rigor in data coverage and model logic, certain limitations exist. The model assumes a relatively stable macroeconomic environment and does not fully account for potential non-tariff barriers, extreme weather disruptions to South American production, or dynamic countermeasures countries may adopt in response to tariff policies. Future research should focus on incorporating multi-country game theory models or more complex Computable General Equilibrium (CGE) frameworks to explore adaptive adjustment mechanisms across supply chain segments in response to policy shifts. Integrating higher-frequency shipping data will enhance the model's real-time predictive accuracy and robustness within complex geopolitical landscapes.

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