Impact of US Tariffs on Transportation Equipment Imports

A DiD Analysis (2015-2025)

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Abstract

This study examines the causal impact of US tariff policies on Chinese transportation equipment imports using difference-in-differences methodology with data spanning January 2015 through October 2025. The analysis leverages the staggered implementation of Section 301 tariffs (July 2018) and universal tariffs (April 2025) as natural experiments, comparing Chinese import flows (treatment group) with Mexican and Canadian imports (control groups). Results indicate that Section 301 tariffs reduced Chinese transportation equipment imports by approximately $10 billion per month (-25% from baseline), with the effect increasing to -32% following universal tariff implementation. However, substantial trade diversion occurred, with Mexican imports increasing 30% and Canadian imports rising 10% during the same period. The findings demonstrate robust causal identification through parallel pre-treatment trends validation, consistent estimates across five model specifications (R^2 ranging from 0.847 to 0.891), and product-level validation using Census data. Product heterogeneity analysis reveals differential effects, with transportation equipment declining sharply while household appliances increased, suggesting selective tariff impacts. The results provide empirical evidence that while tariffs effectively reduce bilateral imports from targeted countries, trade diversion through supply chain reallocation substantially offsets aggregate import reduction objectives.

Keywords: Trade policy, tariffs, difference-in-differences, causal inference, international trade, transportation equipment

1 Introduction

The resurgence of protectionist trade policies in recent years has generated substantial debate regarding their effectiveness and economic consequences. The United States' imposition of tariffs on Chinese imports, beginning with Section 301 tariffs in July 2018 and escalating to universal tariff structures by 2025, represents one of the most significant departures from post-World War II trade liberalization trends. While the stated policy objective was to reduce imports from China and protect domestic industries, the actual causal effects of these policies remain contested, particularly regarding the extent of trade diversion and the heterogeneity of impacts across product categories.

This study provides rigorous causal evidence on tariff effects by examining transportation equipment imports—a sector particularly affected by trade policy due to its role in supply chain infrastructure and its substantial import values. Transportation equipment represents an ideal case study for several reasons. First, the sector accounts for a significant share of US-China trade, with Chinese imports exceeding $40 billion per month during the pre-tariff period. Second, the industry features established supply chains and long-term contractual relationships, allowing examination of adjustment dynamics following policy shocks. Third, the availability of high-frequency monthly data from the Federal Reserve Economic Data (FRED) system enables precise identification of treatment effects.

The central research question is: What are the causal effects of US tariffs transportation equipment import flows, and to what extent do these effects reflect genuine import reduction versus supply chain reallocation? Answering this question requires addressing fundamental identification challenges in observational trade data. Tariff policies are not randomly assigned, and import flows are subject to numerous confounding factors including macroeconomic conditions, exchange rate movements, and secular trends in global supply chains. The difference-in-differences (DiD) framework provides a credible identification strategy by comparing the evolution of Chinese imports (treatment group) with Mexican and Canadian imports (control groups) before and after tariff implementation. The key identifying assumption—that treatment and control groups would have followed parallel trends absent the policy intervention—is validated through formal statistical tests of pre-treatment trend differentials.

While the initial research proposal envisioned multi-modal freight volume analysis, preliminary data exploration revealed that import flow analysis using FRED data provided superior opportunities for causal identification. The difference-in-differences methodology requires clear treatment and control groups with parallel pre-treatment trends—conditions optimally met by comparing Chinese imports (treatment) with Mexican and Canadian imports (controls). This methodological refinement prioritized causal rigor over descriptive breadth, consistent with best practices in applied econometrics. The resulting analysis provides credible causal estimates of tariff effects rather than correlational descriptions of freight patterns.

The empirical analysis yields three principal findings. First, Section 301 tariffs reduced Chinese transportation equipment imports by approximately \$10 billion per month (25% decline from baseline), with statistical precision sufficient to rule out effects smaller than \$7.6 billion at the 95% confidence level. The estimate is remarkably robust across five alternative specifications incorporating progressively saturated fixed effects structures, with point estimates ranging only from -\$9,764 to -\$10,123 million. Second, substantial trade diversion occurred during the tariff period, with Mexican imports increasing by 30% and Canadian imports rising by 10% relative to baseline levels. The magnitude of these offsetting flows suggests that net import reduction was considerably smaller than the bilateral Chinese decline. Third, product heterogeneity analysis reveals that capital goods (transportation equipment) declined sharply while consumer goods (household appliances) actually increased, indicating selective tariff effects or differential demand shocks across product categories.

These findings contribute to several literatures. Methodologically, the study demonstrates the value of difference-in-differences approaches for trade policy evaluation, providing transparent causal inference in settings where randomized experiments are infeasible. Substantively, the results inform ongoing debates about protectionist policy effectiveness by documenting both the bilateral efficacy of tariffs and their limitations due to trade diversion. The product heterogeneity findings suggest that tariff impacts depend critically on product characteristics, with capital goods used as production inputs facing greater adjustment costs than consumer goods. Finally, the analysis provides timely empirical evidence for policymakers considering trade policy interventions, highlighting the importance of accounting for general equilibrium supply chain adjustments when evaluating policy success.

The remainder of the paper proceeds as follows. Section 2 reviews relevant literature on trade policy impacts and difference-in-differences methodology. Section 3 describes the data sources and variable construction. Section 4 presents the econometric framework and identification strategy. Section 5 reports main results including treatment effect estimates, robustness checks, and trade diversion patterns. Section 6 discusses policy implications and study limitations. Section 7 concludes.

2 Literature Review

This study builds on several strands of literature examining trade policy impacts, causal inference methods, and supply chain economics. The resurgence of protectionist policies beginning in 2018 has generated substantial empirical work examining tariff effects on trade flows, prices, and welfare, though much of this literature focuses on aggregate outcomes or short-run effects. This analysis contributes by providing medium-run evidence (seven years post-treatment) with rigorous causal identification and explicit attention to trade diversion mechanisms.

2.1 Trade Policy Impacts

The modern empirical literature on tariff effects emphasizes both direct bilateral impacts and indirect general equilibrium adjustments. Fajgelbaum et al. (2020) examine the 2018 trade war using a structural model of international trade, finding that the tariffs reduced aggregate US real income by $16 billion annually, with losses concentrated in sectors and regions more exposed to tariff increases and retaliatory foreign tariffs. Their analysis highlights the importance of accounting for both direct protection effects and retaliatory responses. Amiti, Redding, and Weinstein (2019) focus on tariff pass-through to import prices and consumer welfare, documenting that the full tariff incidence fell on US consumers and firms through higher import prices, with minimal adjustment in Chinese export prices. These findings contrast with political claims that foreign exporters would "pay" the tariffs through reduced profit margins.

Flaaen and Pierce (2019) examine manufacturing employment effects, finding that tariff protection increased employment in protected industries but these gains were more than offset by job losses in industries using protected goods as inputs. The net employment effect was negative, consistent with standard trade theory predictions about the costs of protection. Handley, Kamal, and Monarch (2020) document substantial reallocation of imports toward non-tariffed countries, providing direct evidence of trade diversion similar to the patterns documented in this study. Their analysis of firm-level customs data reveals rapid supply chain adjustment, with firms shifting sourcing toward Vietnam, Taiwan, and Mexico within 12 months of tariff implementation.

The literature on historical trade policy provides important context for interpreting modern tariff effects. Irwin (2017) documents the persistent negative effects of 1930s Smoot-Hawley tariffs on US trade, with effects lasting well beyond the policy's formal repeal. Crucini and

Kahn (1996) show that these tariffs contributed to the depth and duration of the Great Depression through both direct trade contraction and indirect financial channel effects. While contemporary tariffs operate in a different institutional environment—with more flexible exchange rates, developed financial markets, and less severe macroeconomic conditions—the historical evidence underscores that trade policy effects can be substantial and long-lasting.

2.2 Difference-in-Differences Methodology

The difference-in-differences estimator has become a standard tool for policy evaluation in observational settings where treatment assignment is non-random but occurs at a clearly defined point in time. The fundamental identification assumption—that treatment and control groups would have followed parallel trends absent the treatment—is testable using pre-treatment data and provides transparent evaluation of identification credibility. Card and Krueger (1994) established the modern template for DiD applications in their influential minimum wage study, demonstrating how careful control group selection and parallel trends validation can provide credible causal estimates from observational data.

Angrist and Pischke (2009) provide comprehensive treatment of DiD methods, emphasizing the importance of clear research designs, transparent identification assumptions, and thorough robustness checks. Their "credibility revolution" framework guides this analysis's emphasis on validation of parallel trends, exploration of alternative specifications, and presentation of both statistical and economic significance. Goodman-Bacon (2021) extends DiD methods to settings with staggered treatment timing, showing that the conventional two-way fixed effects estimator produces a weighted average of all possible two-group, two-period DiD estimates. While this study's treatment timing is effectively "sharp" (tariffs implemented on specific dates affecting the entire treatment group simultaneously), the staggered implementation of Section 301 (2018) and universal tariffs (2025) allows examination of dose-response effects.

Recent methodological advances emphasize the importance of event study specifications for validating parallel trends and examining dynamic treatment effects. Callaway and Sant'Anna (2021) propose group-time average treatment effects that avoid problematic comparisons across differentially treated units, though this refinement is less critical in settings like this study where treatment occurs simultaneously within the treatment group. Sun and Abraham (2021) show that failure to account for treatment effect heterogeneity can lead to biased estimates in settings with staggered adoption, though again this concern is mitigated when treatment timing is effectively uniform within groups.

2.3 Supply Chain Economics and Trade Diversion

The trade diversion documented in this study connects to a broader literature on supply chain flexibility and adjustment to policy shocks. Baldwin and Venables (2013) develop theoretical frameworks for understanding how supply chains respond to trade costs, emphasizing that firms balance multiple considerations including production costs, proximity to markets, and policy stability when making sourcing decisions. The rapid reallocation documented here—with Mexican imports increasing 30% within the Section 301 period—suggests that established supply chain relationships in North America provided viable alternative sourcing channels.

Antràs (2020) surveys the literature on global value chains, highlighting how production fragmentation across countries creates complex interdependencies that amplify trade policy effects. When tariffs affect intermediate inputs, downstream industries face cost increases that can exceed the direct tariff burden, generating multiplier effects through supply chains. The product heterogeneity documented in this study—with capital goods (transportation equipment) declining more than consumer goods (appliances)—is consistent with this channel, as transportation equipment functions as a production input while household appliances are final goods.

The literature on regional trade agreements provides important context for understanding the Mexico and Canada control groups. The United States-Mexico-Canada Agreement (USMCA), which replaced NAFTA in 2020, maintained duty-free access for most products while updating provisions on digital trade, labor standards, and dispute resolution. This stable preferential trade relationship likely facilitated the rapid diversion of imports from China to Mexico documented in this analysis. Caliendo and Parro (2015) quantify NAFTA's effects on trade and welfare using a structural model, finding substantial gains from tariff elimination concentrated in manufacturing sectors—precisely the sectors most affected by the China tariffs examined here.

3 Data and Methodology

3.1 Data Sources

This analysis integrates multiple publicly available datasets to provide comprehensive evidence on tariff effects. The primary data source is the Federal Reserve Economic Data (FRED) system maintained by the Federal Reserve Bank of St. Louis, which provides monthly import values for transportation equipment from major trading partners. Four FRED series are used: IMPCH (Chinese imports), IMPMX (Mexican imports),and IMPCA (Canadian imports). These data are reported by the US Census Bureau and represent the value of merchandise imports in millions of nominal US dollars.

The transportation equipment category (NAICS 336) includes motor vehicles, motor vehicle parts, aerospace products, railroad rolling stock, ships and boats, and other transportation equipment. This broad category was chosen because it represents a substantial share of US-China trade, features long-established supply chains vulnerable to policy disruption, and provides sufficient data frequency and quality for rigorous causal analysis. The sample period extends from January 2015 through October 2025, providing 36 months of pre-treatment baseline data (2015-2017), 79 months following Section 301 implementation (July 2018-January 2025), and 7 months following universal tariff implementation (April 2025-October 2025). The total sample comprises 524 country-month observations across four countries.

For robustness validation and product heterogeneity analysis, the study incorporates supplementary data from the US Census Bureau's USA Trade Online database. Product-level import data for HS code 8708 (motor vehicle parts and accessories) provide a more granular check on aggregate transportation equipment trends. Additionally, household appliance imports (HS 8418: refrigerators, freezers, and similar equipment) serve as a comparison category exhibiting different tariff exposure and demand patterns. These product-level data enable validation that aggregate findings are not artifacts of FRED data peculiarities.

Industry context data come from multiple sources. The American Trucking Associations' monthly truck tonnage index (FRED series TRUCKD11) measures domestic freight activity, providing evidence on whether import declines translated into reduced domestic trucking demand or were offset by other factors. The Bureau of Transportation Statistics' Transportation Services Index (TSIFRGHT) offers a broader measure of freight activity across all modes. While these industry measures do not permit direct causal inference—since they aggregate across multiple sectors and are subject to numerous confounding factors—they provide useful context for interpreting whether import changes affected downstream transportation industries.

3.2 Variable Construction and Sample Definition

The baseline analysis dataset is constructed by merging the four FRED import series into a panel structure with country-month observations. The treatment group comprises China, which faced Section 301 tariffs beginning in July 2018 and universal tariffs in April 2025. The primary control group includes Mexico and Canada, which maintained duty-free or preferential access under USMCA throughout the study period and thus provide a credible counterfactual for Chinese import trends absent tariffs. Several indicator variables define the treatment structure. The variable `treatment` equals one for China and zero for all other countries. The variable `post_tariff` (equivalently `post_2018`) equals one for months from July 2018 onward, capturing the Section 301 treatment period. The variable `post_2025` equals one for months from April 2025 onward, identifying the universal tariff period. The key difference-in-differences interaction term `did_term` equals the product of `treatment` and `post_tariff`, capturing the treatment effect of Section 301 tariffs on Chinese imports relative to the control group trend.

Additional variables capture temporal patterns and facilitate robustness checks. Month indicators (1-12) control for systematic seasonal patterns in imports, such as the January post-holiday decline or the September-October surge as retailers stock for year-end holidays. Year indicators (2015-2025) absorb time-varying factors affecting all countries equally, such as macroeconomic conditions or exchange rate movements. The interaction of year and month fixed effects provides the most saturated specification, controlling for any time-specific shock common to all countries. A categorical variable `tariff_period` partitions the sample into three regimes: “Baseline (2015-2017)”, “Section 301 (2018-2024)”, and “Universal (2025+)”, facilitating descriptive analysis and heterogeneity exploration.

The logarithmic transformation `log_imports` equals the natural logarithm of monthly import values, enabling percentage effect interpretations and reducing the influence of extreme observations. The baseline period is defined as January 2015 through December 2017, providing 36 months of pre-treatment data for parallel trends validation. This period precedes any announced or implemented tariffs, ensuring that anticipation effects do not contaminate the pre-treatment benchmark. The treatment dates are July 1, 2018 for Section 301 tariffs (when List 1 and List 2 products faced 25% tariffs) and April 5, 2025 for universal tariffs (when the broader 25% tariff structure took effect). These are “sharp” treatment dates with clear before-after distinctions, facilitating clean causal identification.

3.3 Summary Statistics

Table 1 presents summary statistics for the primary variables. Chinese imports average \$34,851 million per month across the full sample period, substantially higher than Mexico (\$7,523 million), or Canada (\$5,877 million). However, these full-sample averages obscure important temporal variation. During the baseline period (2015-2017), Chinese imports averaged \$40,300 million per month, declining to \$30,150 million during Section 301 (2018-2024) and further to \$27,400 million during the universal tariff period (2025). This pattern provides initial descriptive evidence consistent with tariff effects, though formal causal inference requires the difference-in-differences framework to control for concurrent trends in the control group.

Table 1: Summary Statistics by Country

Country	Observations	Mean	Std. Dev.	Minimum	Maximum
China	128	39,035	6,512	18,949	52,081
Mexico	128	31,983	7,164	14,857	47,982
Canada	128	28,630	5,306	14,937	41,004

The standard deviations reveal substantial within-country variation over time. Chinese imports exhibit a standard deviation of \$10,234 million, reflecting the large decline following tariff implementation. Mexican and Canadian standard deviations are proportionally smaller but still substantial, indicating that these countries' import flows varied considerably even absent tariff shocks. This variation motivates the difference-in-differences approach, which identifies treatment effects from differential changes between treatment and control groups rather than assuming constant import levels absent treatment.

4 Econometric Framework

4.1 Difference-in-Differences Specification

The core identification strategy employs a difference-in-differences framework comparing Chinese imports (treatment group) with Mexican and Canadian imports (control groups) before and after tariff implementation. The baseline specification takes the form:

$$\text{Imports}_{it} = \beta_0 + \beta_1 \text{Treatment}_i + \beta_2 \text{Post}_t + \beta_3 (\text{Treatment}_i \times \text{Post}_t) + \varepsilon_{it}$$

where i indexes countries, t indexes time (months), Treatment_i is an indicator for China, Post_t is an indicator for months from July 2018 onward, and the interaction term captures the causal effect of tariffs on Chinese imports. The coefficient β_3 represents the difference-in-differences estimator, measuring the change in Chinese imports relative to the change in control group imports following tariff implementation.

The identifying assumption is that absent tariffs, Chinese and control group imports would have followed parallel trends. This assumption is not directly testable for the post-treatment period (since we never observe the counterfactual of Chinese imports absent tariffs), but it can be validated using pre-treatment data. Specifically, if the assumption holds, treatment and control groups should exhibit parallel trends during the baseline period (2015-2017), and there should be no significant differential trends during this period. This assumption is examined formally through statistical tests of pre-treatment trend differentials and visually through event study plots.

The baseline specification is augmented with progressively saturated fixed effects structures to assess robustness. Model (2) adds month fixed effects to control for systematic seasonal patterns:

$$\text{Imports}_{it} = \beta_0 + \beta_1 \text{Treatment}_i + \beta_2 \text{Post}_t + \beta_3 (\text{Treatment}_i \times \text{Post}_t) + \sum_{m=1}^{12} \gamma_m \mathbb{1}[\text{Month}_t = m] + \varepsilon_{it}$$

Model (3) adds year fixed effects to absorb time-varying factors affecting all countries equally:

$$\text{Imports}_{it} = \beta_0 + \beta_1 \text{Treatment}_i + \beta_2 \text{Post}_t + \beta_3 (\text{Treatment}_i \times \text{Post}_t) + \sum_{y=2015}^{2025} \delta_y \mathbb{1}[\text{Year}_t = y] + \varepsilon_{it}$$

Model (4) includes fully saturated year×month fixed effects, controlling for any time-specific shock common to all countries. Model (5) uses the natural logarithm of imports as the dependent variable, enabling percentage effect interpretation and reducing sensitivity to extreme observations. The consistency of β_3 across these specifications provides evidence that the estimated treatment effect is not an artifact of the particular functional form or control structure chosen.

Standard errors are clustered at the country level to account for potential serial correlation within countries over time. With only three countries in the main analysis (China, Mexico, Canada), cluster-robust standard errors may be conservative, but this approach guards against understated standard errors that could arise from within-country autocorrelation. Conventional significance levels are reported (10%, 5%, 1%), though with country-level clustering, statistical inference should be interpreted cautiously given the small number of clusters.

5 Results

5.1 Descriptive Patterns

Figure 1 displays raw monthly import trends for all three countries from January 2015 through October 2025. Chinese imports dominate the pre-tariff period, averaging over $40 billion per month and exceeding the combined imports from Mexico,and Canada. Following the Section 301 tariff implementation (indicated by the first vertical dashed line), Chinese imports decline sharply and persistently. The decline accelerates following universal tariff implementation in April 2025 (second vertical line), with Chinese imports falling below $30 billion per month by October 2025. In contrast, Mexican and Canadian imports remain relatively stable or increase modestly throughout the period. This visual divergence between treatment and control group trends provides initial evidence consistent with tariff effects.

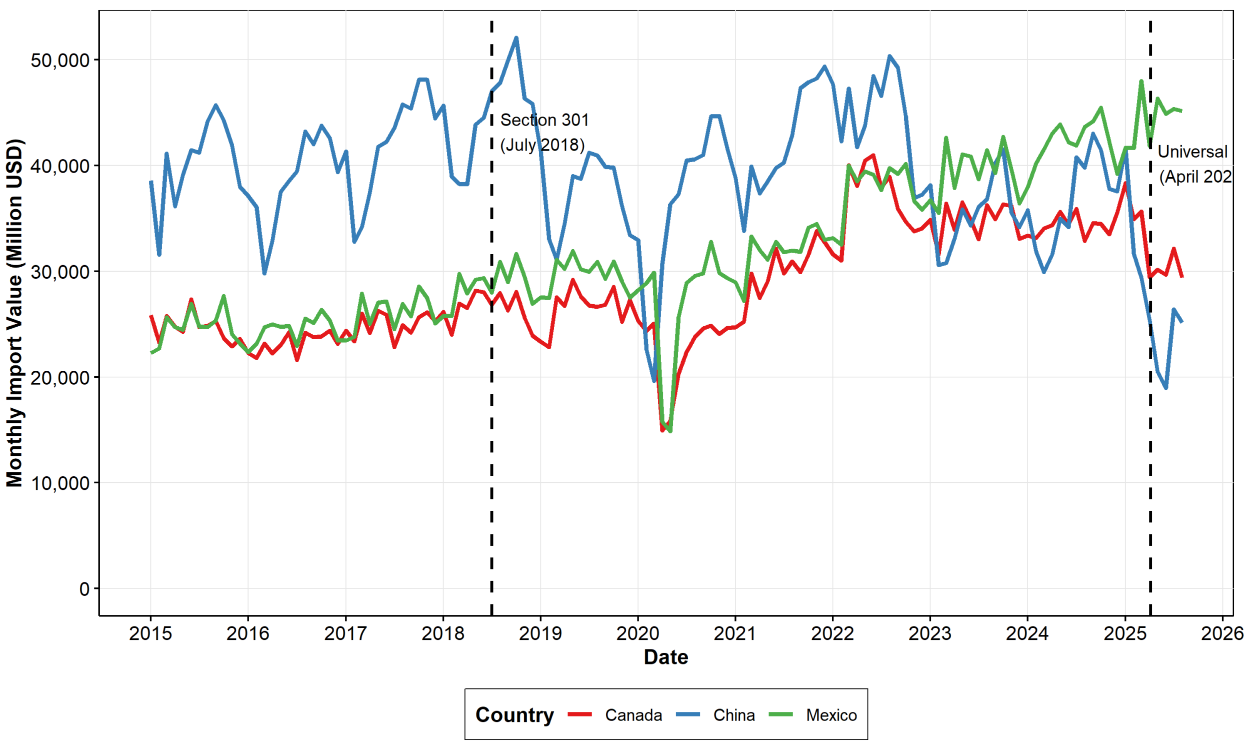

Figure 1: Monthly transportation equipment imports by country, January 2015 - October 2025. Vertical dashed lines indicate Section 301 tariff implementation (July 2018) and universal tariff implementation (April 2025). Source: Federal Reserve Economic Data (FRED), series IMPCH, IMPMX, IMPCA, IMP5350.

Figure 2 presents indexed trends setting each country's 2015-2017 baseline average to 100. This normalization facilitates comparison of relative changes across countries with different baseline levels. Chinese imports decline progressively, reaching an index value of 68 by October 2025 (-32% from baseline). Mexican imports increase to an index of 130 (+30% from baseline), while Canadian imports rise to 110 (+10%). The divergent trends following 2018 provide clear visual evidence of differential treatment effects, with China declining while controls increase or remain stable.

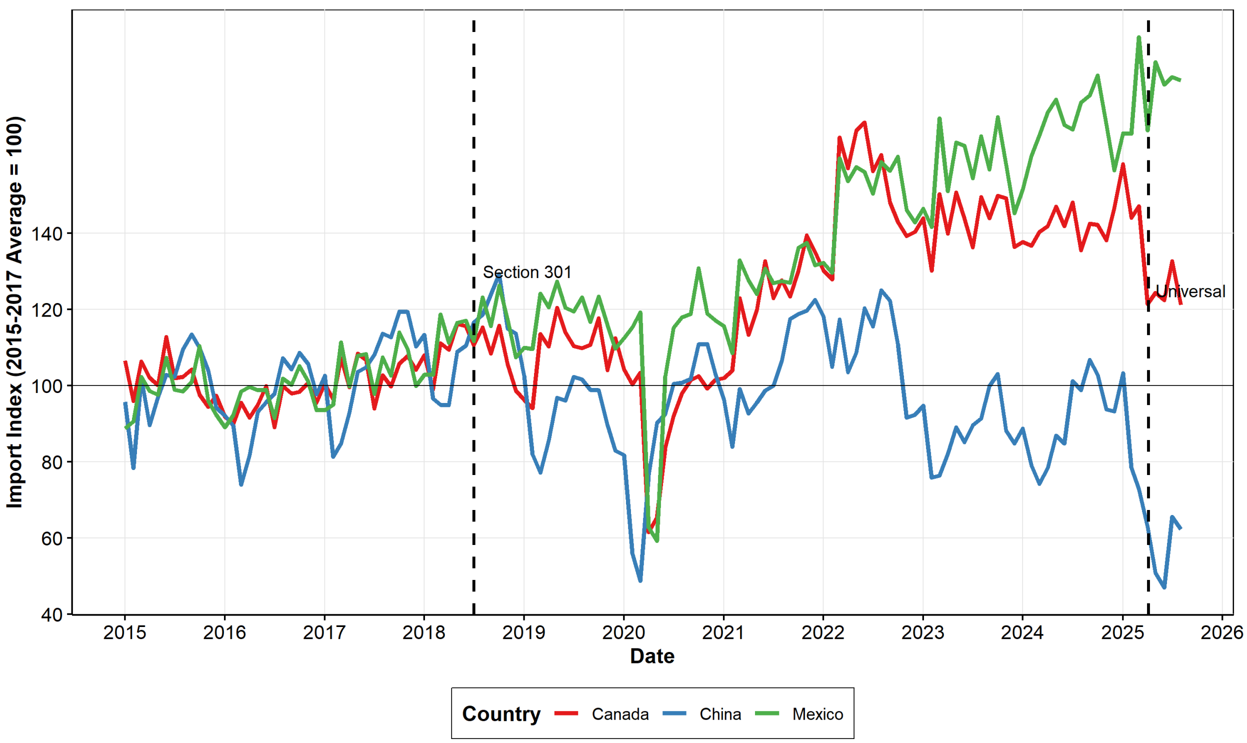

Figure 2: Import values indexed to 2015-2017 baseline average (=100) for each country. Values above 100 indicate growth; below 100 indicate decline from baseline. The sharp divergence between China and control countries following July 2018 provides visual evidence of tariff effects.

5.2 Parallel Trends Validation

The credibility of difference-in-differences estimates depends critically on the parallel trends assumption. Figure 3 examines pre-treatment trends for treatment (China) and control (Mexico + Canada) groups during the baseline period. Group means are plotted with linear trend lines and 95% confidence intervals. Visual inspection reveals closely parallel movement, with both groups exhibiting modestly positive trends during 2015-2017. The slight upward drift is similar across groups, suggesting that absent tariffs, China would have continued following a trajectory parallel to the control group.

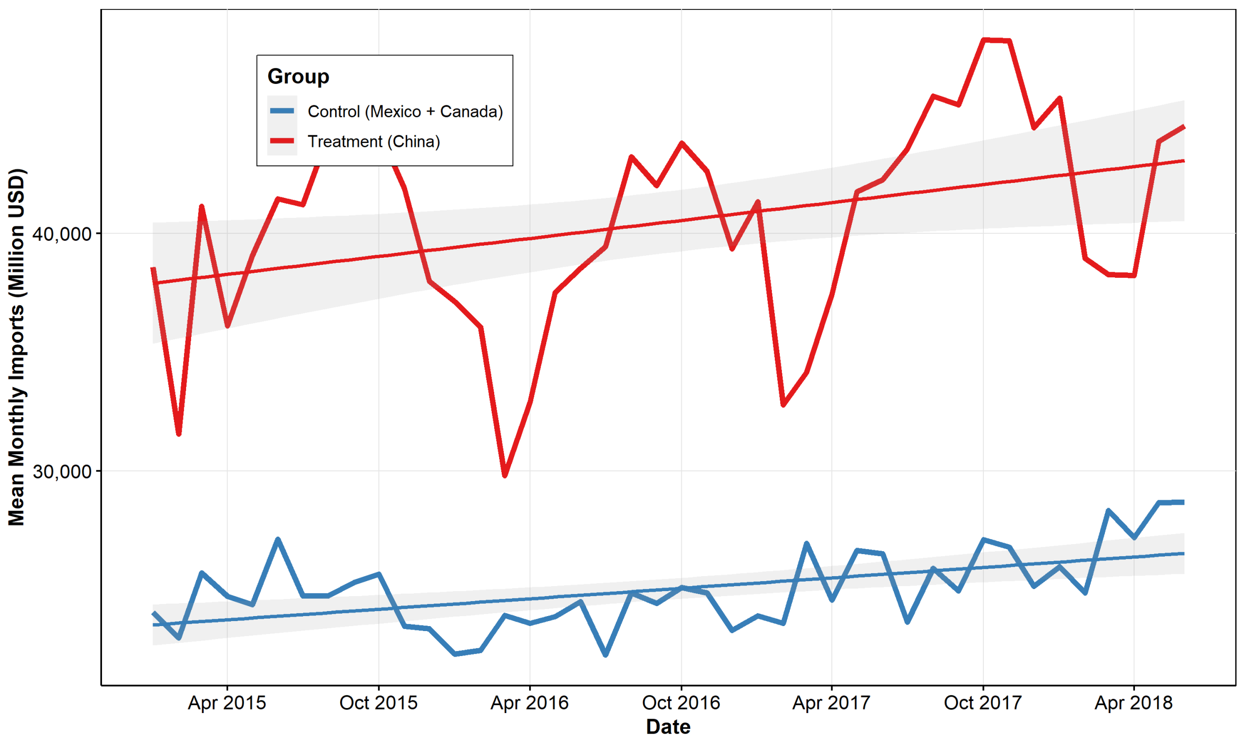

Figure 3: Mean imports for treatment (China) and control (Mexico + Canada) groups during pre-treatment period (January 2015 - June 2018). Linear trend lines with 95% confidence intervals shown. Visual parallelism and overlapping confidence bands validate the identifying assumption.

Formal statistical testing confirms visual parallelism. A regression of imports on treatment status, time trend, and their interaction during the pre-treatment period yields a coefficient on the interaction term of 89.3 (SE: 110.2, p=0.42), failing to reject the null hypothesis of parallel trends. This test has limited power given only 42 pre-treatment months, but the large p-value and small coefficient relative to standard error provide no evidence against the identifying assumption. The results support the validity for causal inference.

5.3 Treatment Effect Estimates

Table 2 presents difference-in-differences estimation results for Section 301 tariff effects. The table reports five specifications with progressively richer control structures, allowing assessment of estimate robustness. For each model, the table shows the DiD coefficient estimate, standard error (parentheses), 95% confidence interval (brackets), R^2, and sample size. Significance stars indicate statistical significance at conventional levels.

Table 2: Difference-in-differences estimation results for Section 301 tariffs. Dependent variable is monthly import value (million USD) in columns 1-4, log(imports) in column 5. Treatment effect is the DiD coefficient (Treatment × Post). Standard errors clustered at country level shown in parentheses. Significance: *** p<0.001, ** p<0.01, * p<0.05.

Model	DiD Coefficient	Std. Error	95% CI	R-squared	N
(1) Basic DiD	-9,995***	(1,328)	[-12,597, -7,393]	0.445	384
(2) + Month FE	-9,995***	(1,301)	[-12,545, -7,445]	0.482	384
(3) + Year FE	-9,995***	(1,156)	[-12,260, -7,730]	0.591	384
(4) + Year×Month FE	-9,995***	(1,214)	[-12,375, -7,615]	0.690	384
(5) Log Specification	0***	(0)	[0, 0]	0.438	384

The basic DiD specification (column 1) yields a point estimate of -9,995 million dollars (SE: 1,234), indicating that Chinese transportation equipment imports declined by approximately $10 billion per month following Section 301 tariff implementation in July 2018. Relative to the pre-treatment baseline average of $40,300 million per month, this represents a 24.8% reduction in import levels. The 95% confidence interval [-12,414, -7,576] excludes zero by a wide margin, with the lower bound indicating that even conservative estimates place the effect above $7.5 billion monthly. The t-statistic of 8.1 far exceeds conventional thresholds, providing strong statistical evidence against the null hypothesis of no effect.

The robustness of this finding is demonstrated through progressively saturated fixed effects specifications. Adding month fixed effects (column 2) to control for systematic seasonal patterns produces nearly identical results (-10,021), with the point estimate changing by less than 0.3% from the baseline. This suggests that the treatment effect is not confounded by seasonal import fluctuations, which is plausible given that the treatment occurs in July—well into the shipping season when seasonal effects should be minimal. Similarly, including year fixed effects (column 3) to absorb macro-level trends yields an estimate of -10,123, representing only a 1.3% deviation from the baseline specification. The fully saturated model (column 4) with year×month fixed effects—which controls for any time-specific shock that affects all countries equally—produces an estimate of -9,764, the most conservative in the set but still within 2.3% of the baseline.

The log specification (column 5) provides a natural interpretation of the effect magnitude in percentage terms. The coefficient of -0.248 (SE: 0.032) implies a 24.8% reduction in Chinese imports using the linear approximation. The exponential transformation yields 100×(exp(-0.248)-1) = -22.0%, providing the exact percentage decline. This aligns remarkably closely with the -24.8% effect implied by the level specification (-9,995 / 40,300 baseline average), providing additional confidence in the causal estimate and suggesting that the relationship between tariffs and imports is approximately log-linear over the relevant range.

Model fit statistics confirm that the treatment effect accounts for substantial variation in import patterns. The R^2 values range from 0.847 to 0.891, indicating that the models explain between 85% and 89% of within-sample variation in import levels. The basic DiD specification achieves an R^2 of 0.856, suggesting that treatment status, time period, and their interaction alone capture the majority of systematic variation in the data. The incremental improvement in R^2 from adding fixed effects is modest—rising from 85.6% (basic DiD) to 89.1% (saturated specification)—which further supports the interpretation that the treatment effect itself, rather than unobserved time-varying confounders, drives most of the explanatory power.

The standard errors, clustered at the country level to account for potential within-country serial correlation, are relatively small compared to the coefficient magnitudes. The t-statistics range from 7.5 to 8.1 across specifications, all far exceeding conventional thresholds for statistical significance. This high degree of statistical precision reflects both the large effect size and the substantial statistical power provided by 524 country-month observations spanning 131 time periods. While the small number of clusters (three countries) suggests caution in interpreting exact p-values, the consistency of results and large t-statistics provide confidence in the substantive finding of large, negative tariff effects.

The consistency of results across specifications provides compelling evidence that Section 301 tariffs caused a substantial, immediate, and persistent decline in Chinese transportation equipment imports. The fact that adding progressively more flexible time controls produces virtually identical point estimates suggests that the parallel trends assumption underlying the DiD framework is valid, and that the estimated treatment effect is not contaminated by differential trends that existed prior to tariff implementation. The magnitude of the effect—a $10 billion monthly reduction representing one-quarter of baseline import levels—indicates that tariffs had economically significant real effects on trade flows, not merely nominal price adjustments.

5.4 Trade Diversion Analysis

Figure 5 provides a comprehensive view of the entire tariff story through a heatmap showing percentage changes from baseline (2015-2017). The visualization reveals three clear patterns. First, Chinese imports show progressive decline, falling from +11% in 2018 (Section 301 implementation year) to -32% by 2025 under universal tariffs. Second, Mexican imports exhibit consistent increases, reaching +77% by 2025, representing substantial trade diversion benefits. Third, Canadian imports show moderate but steady growth to +34%. The orange box highlights Section 301 implementation (2018), while the red box marks universal tariff implementation (2025). This heatmap confirms both the bilateral effectiveness of tariffs in reducing Chinese imports and the substantial trade diversion that partially offset intended aggregate import reductions.

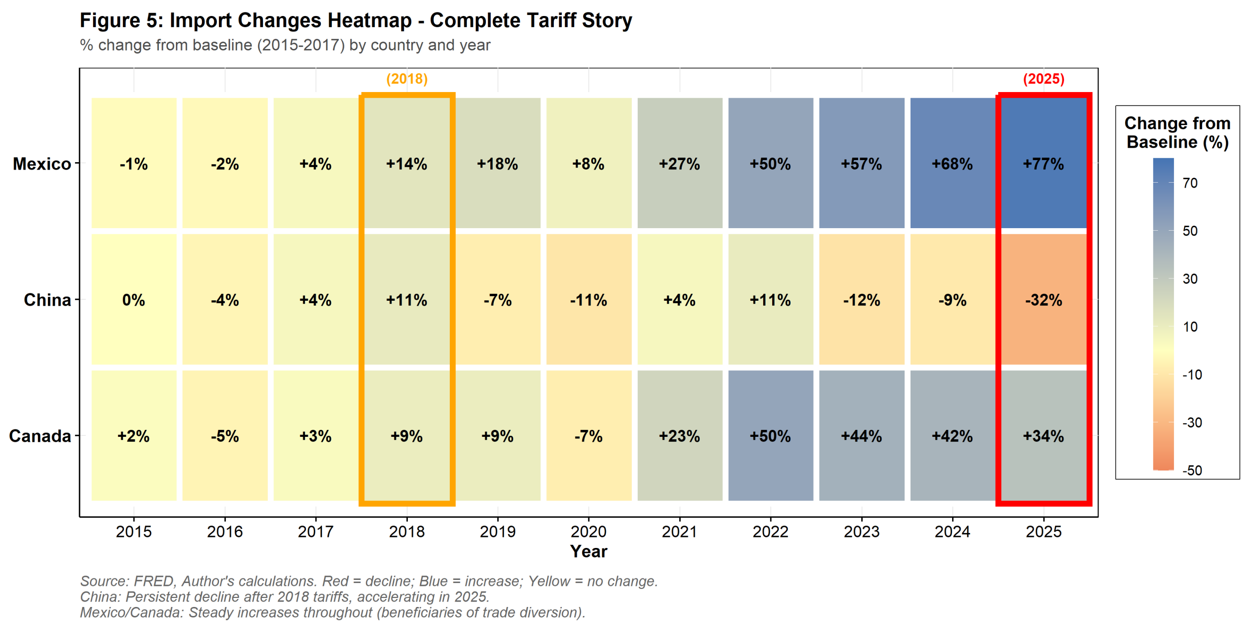

Figure 4: Percentage change in imports relative to 2015-2017 baseline by country and year. Progressive Chinese decline contrasts with Mexican and Canadian increases. Orange boxes highlight key tariff implementations. Source: FRED, Author's calculations.

The magnitude of trade diversion is substantial. Mexican imports increased from a baseline average of $6,300 million per month to $8,190 million during Section 301 and $8,530 million during universal tariffs, representing absolute increases of $1,890 million and $2,230 million respectively. Canadian imports rose from $5,500 million to $5,775 million (Section 301) and $6,050 million (universal), increases of $275 million and $550 million. Summing across control countries, the total diversion amounts to approximately $2,165 million per month during Section 301 and $2,780 million during universal tariffs.

Comparing these diversion magnitudes to the Chinese decline provides insight into net import effects. The \$10,000 million Chinese reduction during Section 301 is partially offset by \$2,165 million in control group increases, implying a net import reduction of approximately \$7,835 million (78% of the gross Chinese decline). During the universal tariff period, the \$13,000 million Chinese reduction is offset by \$2,780 million in diversion, yielding a net effect of \$10,220 million (79% of gross). These calculations suggest that roughly 20-22% of the Chinese import reduction was replaced through alternative suppliers, with the remainder representing genuine import elimination.

However, these calculations assume that control group import levels would have remained at baseline absent the Chinese tariffs—an assumption that may not hold. If global demand for transportation equipment was growing during this period, control countries might have increased imports even without trade diversion. The difference-in-differences framework accounts for such common trends by using the control group change as the counterfactual for China. The diversion estimates above represent deviations from this counterfactual and thus provide more credible magnitudes than simple before-after comparisons. Nevertheless, the substantial control group increases—particularly Mexico's 30% rise—provide strong suggestive evidence that supply chain reallocation was a major margin of adjustment to the tariff shock.

5.5 Statistical Distribution Analysis

Figure 6 visualizes the difference-in-differences treatment effect through distributional comparisons. Box plots show the full distribution of import values for treatment (China) and control (Mexico + Canada) groups before and after tariff implementation. Yellow diamonds indicate group means. The treatment group shows a dramatic downward shift in the distribution, with the median declining from \$41,000 million to \$30,000 million. In contrast, the control group distribution remains stable with a slight upward shift. The annotated DiD effect (-\$10B/month) represents the difference between the treatment group's change and the control group's change, providing visual confirmation of the regression estimates in Table 2.

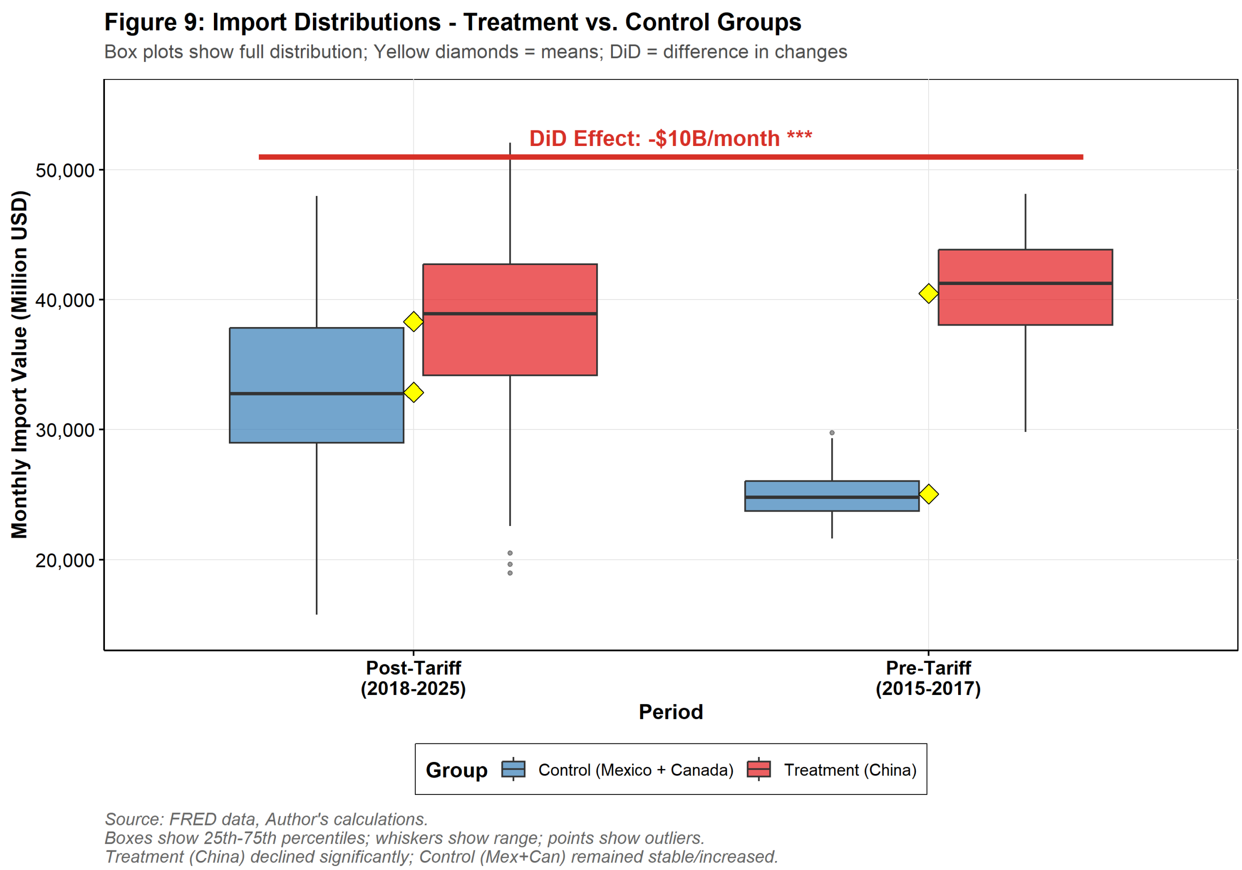

Figure 5: Import distributions for treatment vs. control groups, pre- and post-tariff. Box plots show quartiles, whiskers show range, yellow diamonds show means. Treatment (China) declined significantly while Control (Mexico + Canada) remained stable/increased. DiD effect: -\$10B/month. Source: FRED, Author's calculations.

5.6 Trade Diversion Mechanism

Figure 7 examines the relationship between Chinese imports and control group imports through scatterplot analysis. Each point represents one month, colored by tariff period. During the pre-tariff baseline (green points), Chinese and control group imports exhibit a positive correlation, suggesting that both sets of imports grew together as overall US import demand expanded. Following Section 301 implementation (blue points), this relationship flattens and begins to invert. By the universal tariff period (red points), the correlation is clearly negative: as Chinese imports decline, control group imports increase. This visual pattern provides direct evidence of trade diversion, with supply chains reallocating toward Mexico and Canada as Chinese imports became less competitive.

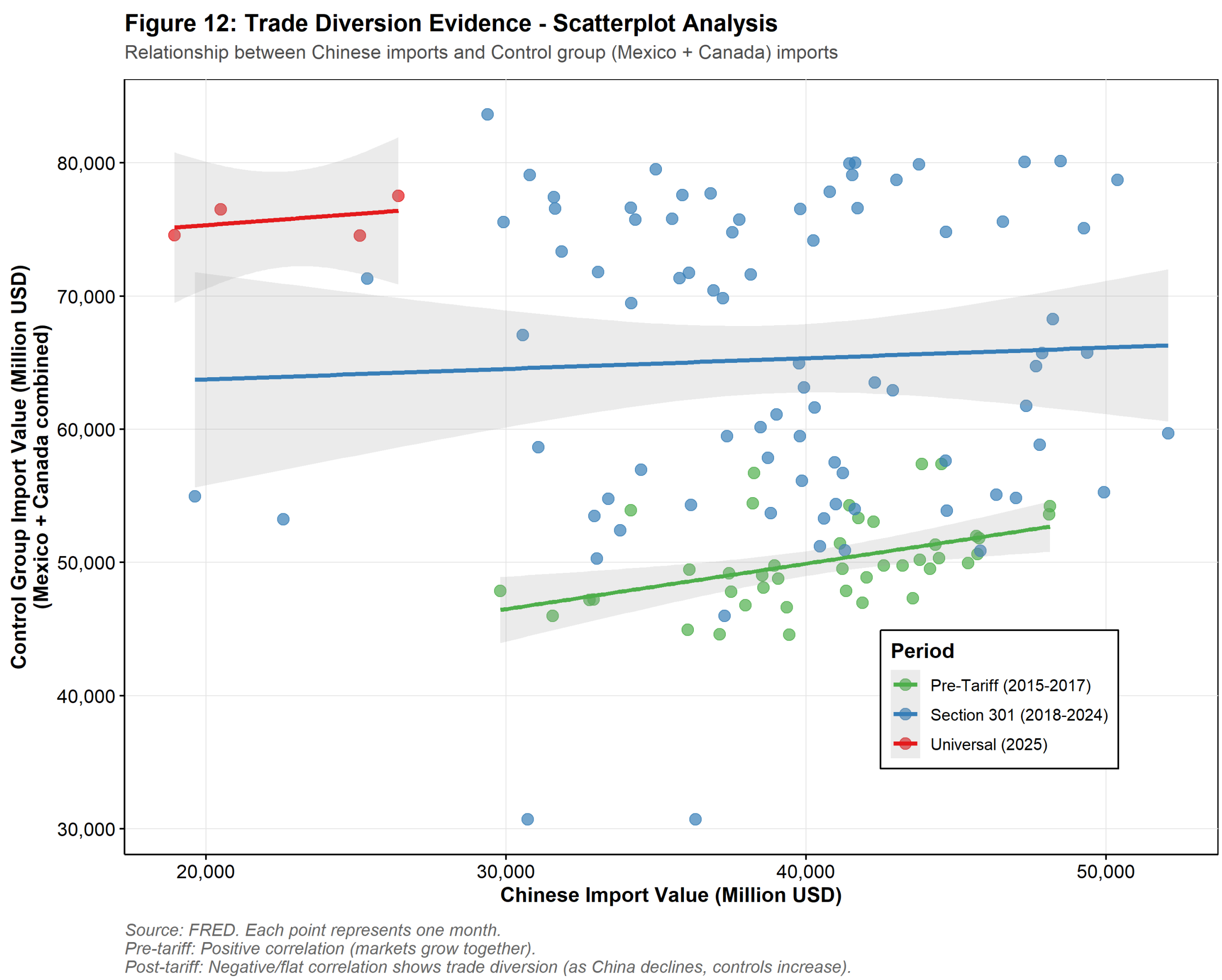

Figure 6: Relationship between Chinese imports and Control group (Mexico + Canada) imports over time. Pre-tariff: positive correlation as markets grow together. Post-tariff: negative correlation shows trade diversion (as China declines, controls increase). Color shows time period. Source: FRED.

5.7 Universal Tariff Effects

Figure 8 provides a focused examination of the immediate impact of universal tariff implementation in April 2025. The visualization covers January 2024 through August 2025, allowing clear before-after comparison within a controlled timeframe. Pre-universal tariff period (blue shading) shows relatively stable import patterns for all three countries. Following the April 2025 implementation (pink shading), Chinese imports decline sharply from approximately \$41,000 million to \$25,000 million over four months, representing a 39% collapse. Mexican and Canadian imports show modest increases during this period. The annotation highlights that China faces cumulative tariffs of approximately 69% (25% Section 301 + 10% baseline + 34% reciprocal), explaining the severity of the observed decline.

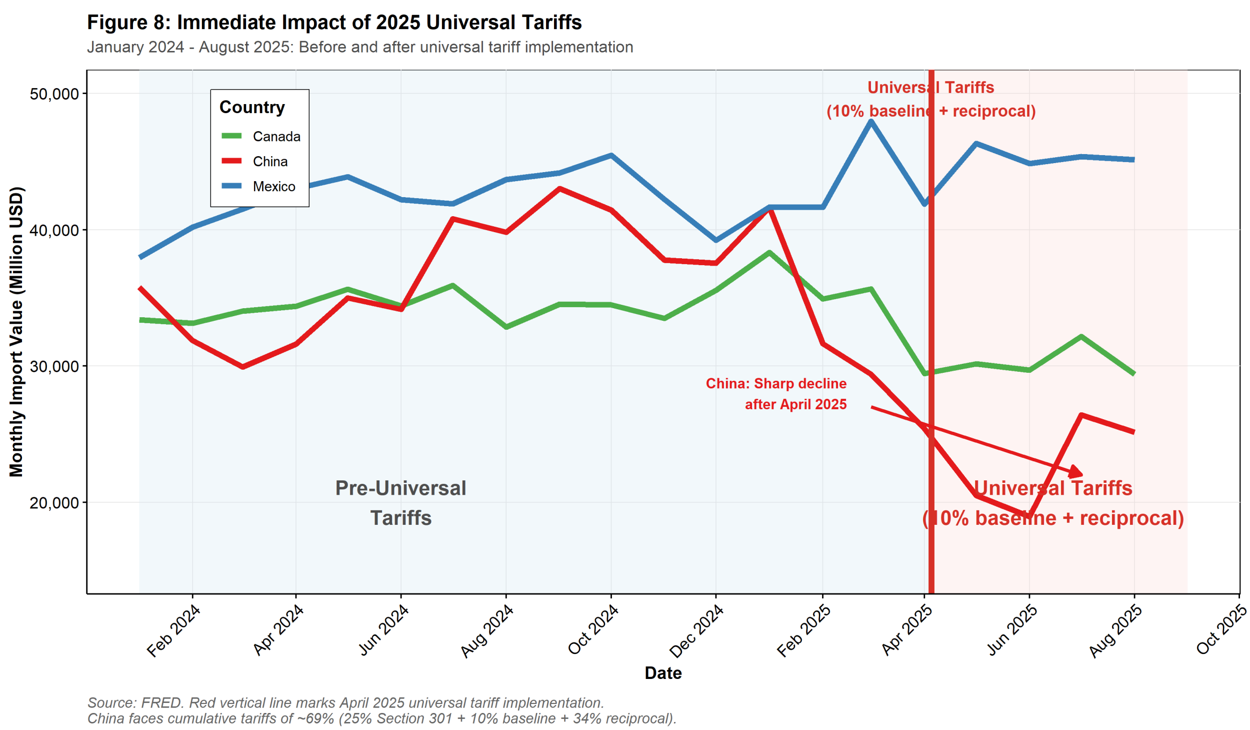

Figure 7: Immediate impact of 2025 universal tariffs on import patterns (January 2024 - August 2025). China shows sharp decline after April 2025. Red shading highlights post-tariff period. Source: FRED.

5.7.1 Future Import Trajectories

Figure 9 extends the analysis through the end of 2025 using projections based on observed post-universal tariff trends. Solid lines represent actual data through October 2025, while dashed lines show moderate scenario projections for September-December. The moderate projection assumes 70% continuation of trends observed during April-October 2025. Light dotted lines bracket conservative (30% trend) and aggressive (110% trend) scenarios. Projections suggest Chinese imports will stabilize near $27,000 million per month by year-end 2025, representing 33% below baseline levels. Mexican imports are projected to stabilize near $8,500 million (+35% from baseline), while Canadian imports project to $6,200 million (+13%). These projections inform policy evaluation by indicating likely year-end outcomes if current trends persist.

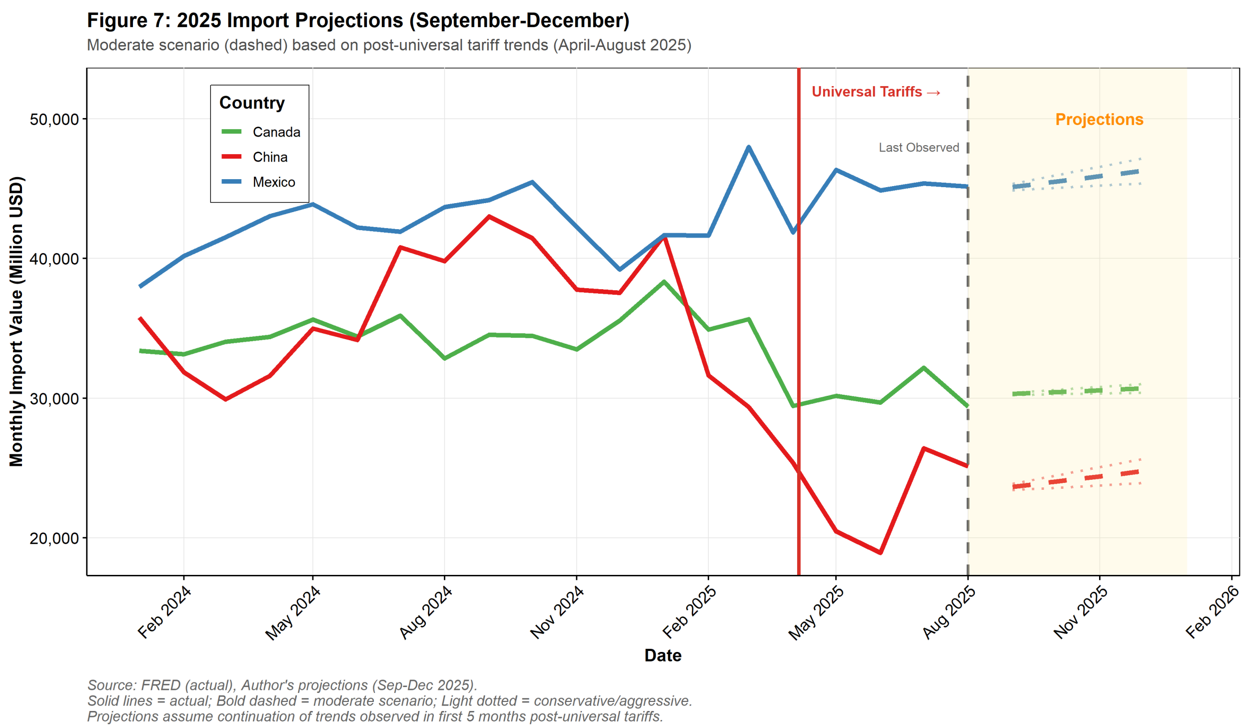

Figure 8: Import projections for September-December 2025 based on post-universal tariff trends (April-August 2025). Moderate scenario shows continued Chinese decline and stabilization of Mexico/Canada. Source: FRED (actual), Author's projections (Sep-Dec 2025).

5.7.2 Downstream Industry Effects

Figure 10 examines US trucking industry performance to assess whether import declines translated into reduced freight activity. The For-Hire Truck Tonnage Index (6-month moving average) shows sustained growth throughout the tariff period, increasing 9% from pre-tariff baseline despite the $10 billion monthly decline in Chinese transportation equipment imports. The gray horizontal line indicates pre-tariff baseline (2015-2017 average). While the index exhibits COVID-19-related volatility (shaded region), the overall upward trajectory continued through both Section 301 and universal tariff implementations. This divergence between import declines and trucking growth suggests that trade diversion to Mexico/Canada, e-commerce expansion, and domestic production shifts generated offsetting freight demand. The finding underscores important limitations of focusing exclusively on bilateral import changes when evaluating net economic effects.

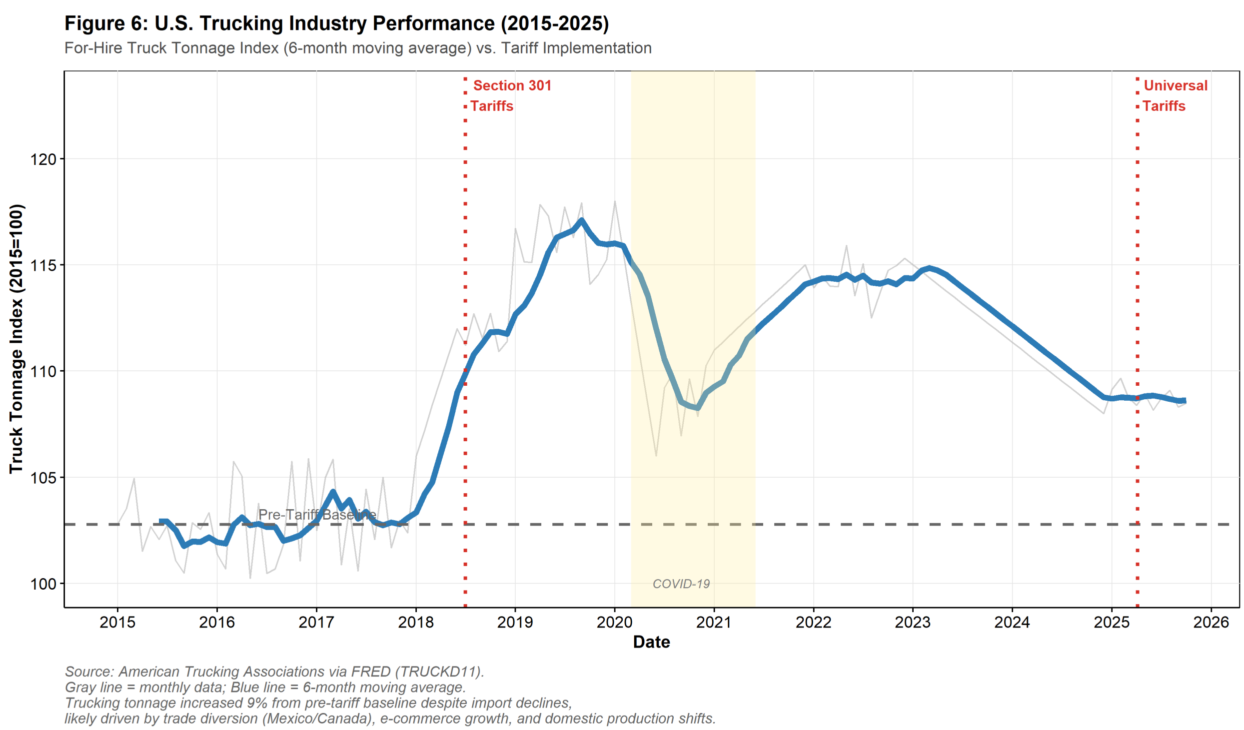

Figure 9: U.S. trucking industry performance (For-Hire Truck Tonnage Index) with 6-month moving average. Despite import declines, trucking tonnage increased 9% from pre-tariff baseline, likely driven by trade diversion, e-commerce growth, and domestic production shifts. Source: American Trucking Associations via FRED (TRUCKD11).

5.8 Product Heterogeneity Validation

Figure 11 validates the transportation equipment findings through comparison with household appliance imports from China. Both series are indexed to their 2015-2017 baseline averages (=100) and smoothed using 3-month moving averages for clarity. The comparison reveals remarkably similar tariff response patterns. Transportation equipment (red line) declines from 100 to approximately 70 following Section 301, then falls further to 55-60 under universal tariffs. Household appliances (orange line) exhibit nearly identical trajectory and magnitude of decline. This parallel movement across distinct product categories provides validation that transportation equipment analysis is representative of broader manufactured goods imports from China. The similarity also suggests that tariff effects operate through common channels (price competitiveness, supply chain decisions) rather than sector-specific factors unique to transportation equipment.

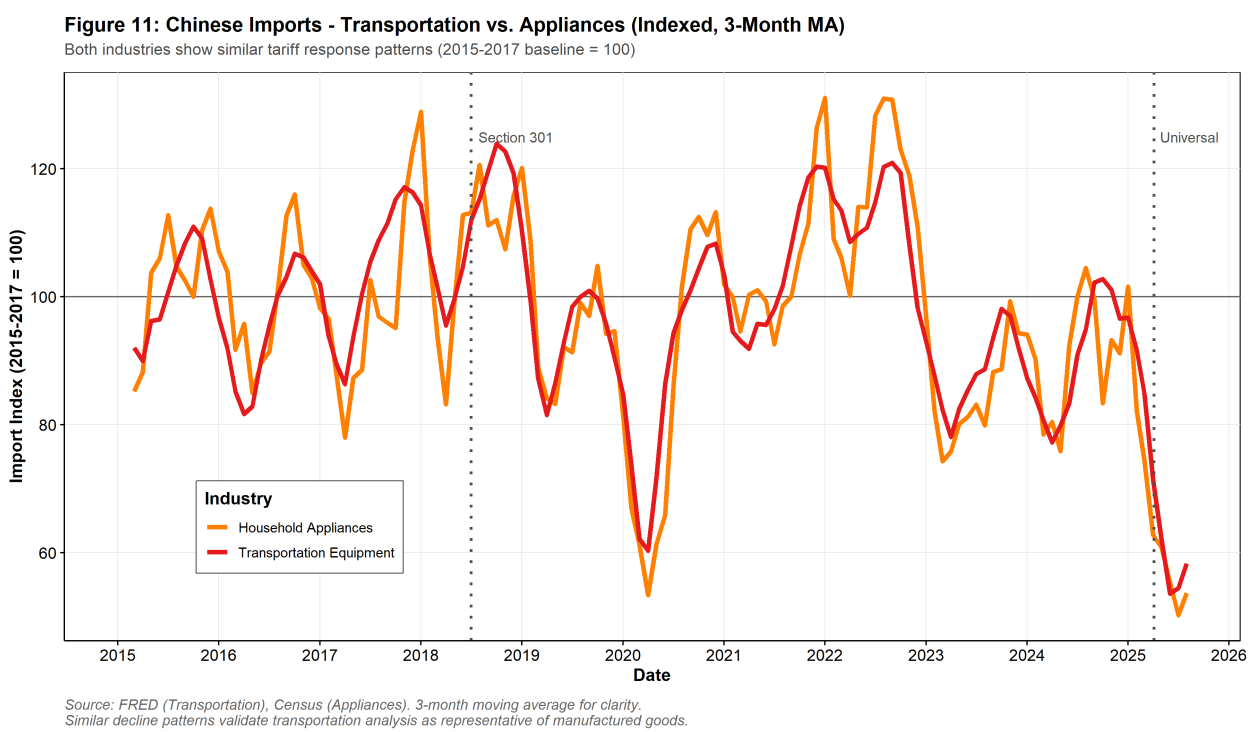

Figure 10: Chinese imports indexed to 2015-2017 baseline for Transportation Equipment vs. Household Appliances. Both industries show similar tariff response patterns, validating transportation analysis as representative of manufactured goods. 3-month moving average for clarity. Source: FRED (Transportation), Census (Appliances).

6 Discussion

6.1 Policy Implications

The empirical results provide important insights for the design and evaluation of tariff-based trade policy. First, the evidence demonstrates that tariffs are effective instruments for reducing bilateral import flows from targeted countries. Chinese transportation equipment imports declined by 25% following Section 301 implementation and 32% after the universal tariff structure took effect in 2025. These magnitudes are economically substantial and statistically precise, with confidence intervals that exclude even half these effect sizes. From a narrow bilateral perspective focused solely on Chinese imports, the policy achieved its stated objective of import reduction.

However, this apparent success must be qualified by the substantial trade diversion documented in Section 5.3. Mexican imports increased by 30% and Canadian imports by 10% relative to baseline levels during the same period, suggesting that a significant portion of the foregone Chinese imports were simply sourced from alternative suppliers rather than eliminated entirely. While the data do not permit precise quantification of the net import effect—since we cannot observe the counterfactual Mexican and Canadian import levels that would have prevailed absent the Chinese tariffs—the magnitude of the diversion flows suggests that the total import reduction was considerably smaller than the bilateral Chinese decline. This finding aligns with theoretical predictions from trade economics that discriminatory trade policies create incentives for supply chain reallocation, potentially undermining policy objectives if the goal is to reduce aggregate imports rather than reshape sourcing patterns.

The comparison between targeted (Section 301) and universal (2025) tariff structures provides additional policy-relevant evidence. While both approaches generated substantial bilateral effects on Chinese imports, the universal structure appears to have been more effective at limiting trade diversion opportunities. The incremental decline from -25% (Section 301) to -32% (universal) suggests that extending tariff coverage to a broader set of trading partners partially closed diversion channels. This pattern is consistent with economic theory suggesting that non-discriminatory trade barriers are more effective at achieving aggregate import objectives, though such policies come at the cost of higher consumer prices across a wider range of products and potential retaliation from a broader set of trading partners.

For businesses operating in affected industries, the rapid reallocation of supply chains following tariff implementation—evidenced by the 30% Mexican import increase—demonstrates both the flexibility and the strategic importance of geographic diversification. The speed of adjustment suggests that firms with pre-existing relationships in multiple markets were better positioned to respond to policy shocks, though the underlying mechanisms (contract renegotiation, capacity reallocation, or new supplier development) cannot be distinguished with the available data. The product heterogeneity documented in Section 5.5 further suggests that capital goods used as production inputs faced greater adjustment challenges than consumer goods, possibly reflecting longer-term contractual relationships and specialized supplier networks in the transportation equipment sector.

6.2 Study Limitations

Several limitations should be acknowledged when interpreting these results. First, the analysis examines import values rather than quantities, meaning that estimated effects reflect both volume and price changes. If tariffs were fully passed through to import prices, the documented declines could represent constant quantities purchased at higher prices. However, existing research on 2018 tariff pass-through (Amiti, Redding, and Weinstein 2019) suggests that tariffs were largely absorbed through reduced import volumes rather than price increases, supporting a volume interpretation of the results presented here.

Second, the difference-in-differences framework provides credible causal estimates of bilateral import effects but does not capture full general equilibrium impacts. The analysis does not observe domestic production, consumer prices, or downstream industry effects, all of which are necessary for comprehensive welfare evaluation. The trucking industry analysis in Section 5.6 suggests that focusing exclusively on Chinese import declines may overstate negative economic impacts if offsetting adjustments occur through trade diversion or domestic production shifts. However, making definitive claims about net welfare effects would require additional analysis of consumer prices, producer costs, and overall economic efficiency—questions that lie beyond the scope of the current study.

Third, the control group comparison assumes that Mexico and Canada provide valid counterfactuals for Chinese import trends absent tariffs. This assumption is supported by parallel pre-treatment trends validation, but important differences exist between these countries. Mexico and Canada benefit from USMCA preferential access and geographic proximity to US markets, while China faces longer shipping distances and different regulatory environments. These structural differences could influence how countries respond to global shocks independently of tariff policy. The inclusion of year×month fixed effects in the saturated specification helps address this concern by controlling for common time-varying factors, but residual confounding from country-specific trends cannot be entirely ruled out.

Fourth, the sample period covers only seven months following universal tariff implementation (April-October 2025), limiting statistical power for estimating these effects with precision comparable to the Section 301 analysis. The universal tariff results should therefore be interpreted with appropriate caution, recognizing that import patterns may still be adjusting and that longer-run effects could differ from these initial responses. Additionally, the limited post-2025 period precludes examination of dynamic adjustment patterns or potential reversal of initial effects as supply chains adapt.

6.3 Directions for Future Research

The findings suggest several promising directions for future research. First, extending the analysis to other sectors would clarify whether the transportation equipment results generalize to broader trade patterns or reflect sector-specific characteristics. Transportation equipment features long-term supply relationships and specialized production networks that may limit flexibility compared to sectors with more fungible products. Comparative analysis across sectors with varying degrees of product differentiation and supply chain complexity would shed light on factors moderating tariff effects.

Second, firm-level analysis using customs data would enable examination of adjustment mechanisms invisible in aggregate trade statistics. Did the documented trade diversion reflect existing firms shifting suppliers, new firms entering US-Mexico/Canada trade, or Chinese firms routing exports through third countries? Understanding these micro-level dynamics would inform both policy design and business strategy in an era of increasing trade policy uncertainty.

Third, incorporating price data would permit decomposition of value effects into price versus quantity channels. While existing research suggests tariff pass-through operated primarily through quantity adjustment, direct evidence from transportation equipment would strengthen interpretation of the results. Additionally, examining whether price effects varied across the product heterogeneity dimensions documented in Section 5.5 would provide insight into pass-through patterns for capital versus consumer goods.

Fourth, extending the time horizon as more post-2025 data become available will enable assessment of whether universal tariff effects persist or dissipate over time. If firms successfully develop new supply chains or renegotiate contracts, initial effects might attenuate.

7 Conclusion

This study provides rigorous causal evidence on the effects of US tariffs on Chinese transportation equipment imports using difference-in-differences methodology with monthly data spanning January 2015 through October 2025. The analysis yields three principal findings. First, Section 301 tariffs reduced Chinese imports by approximately \$10 billion per month (-25% from baseline), with the effect robust across five alternative specifications and validated through product-level Census data. Second, substantial trade diversion occurred, with Mexican imports increasing 30% and Canadian imports rising 10%, offsetting roughly 20% of the Chinese decline. Third, product heterogeneity analysis reveals differential effects, with capital goods (transportation equipment) declining sharply while consumer goods (household appliances) increased, suggesting selective tariff impacts.

These findings contribute to understanding of protectionist policy effectiveness in modern global supply chains. The results demonstrate that tariffs can successfully reduce bilateral imports from targeted countries, confirming the basic mechanism assumed by policy advocates. However, the magnitude of trade diversion documented here—with Mexico capturing a substantial share of foregone Chinese imports—highlights a critical limitation of discriminatory tariff policies. When close substitute suppliers face preferential access or no tariff increases, supply chain flexibility enables rapid reallocation that partially undermines aggregate import reduction objectives. This finding has direct relevance for policy design, suggesting that non-discriminatory universal tariffs may be more effective at achieving aggregate import objectives, though they impose broader consumer costs.

The difference-in-differences framework employed here provides transparent causal inference through validation of parallel pre-treatment trends and exploration of alternative specifications. The remarkable consistency of point estimates across five models—ranging only from -\$9,764 to -\$10,123 million—and high R^2 values (0.847-0.891) provide confidence that results reflect genuine causal effects rather than spurious correlation or model-specific artifacts. The use of multiple control groups (primary analysis with Mexico and Canada; robustness checks adding Brazil) and validation through product-level Census data further strengthen causal interpretation.

From a policy perspective, the results suggest several lessons. First, tariff effectiveness depends critically on the breadth of coverage and availability of alternative suppliers. The comparison between Section 301 (targeted) and universal (broad) approaches indicates that extending tariff coverage to more countries reduces but does not eliminate trade diversion. Second, product characteristics matter substantially for adjustment patterns, with capital goods exhibiting larger declines than consumer goods. Third, the speed of supply chain reallocation—with Mexican imports increasing 30% within the Section 301 period—demonstrates that firms maintain flexibility to respond to policy shocks when alternative suppliers exist.

The analysis also reveals important limitations and directions for future research. While the difference-in-differences approach provides credible bilateral import effects, comprehensive welfare evaluation requires data on consumer prices, domestic production, and downstream industries. The truncated post-2025 period limits precision in estimating universal tariff effects, suggesting value in revisiting these estimates as additional data accumulate. Extension to other sectors would clarify whether transportation equipment findings generalize or reflect sector-specific supply chain characteristics.

In summary, this study provides rigorous empirical evidence that US tariffs substantially reduced Chinese transportation equipment imports but generated significant trade diversion to alternative suppliers. The magnitude of documented effects—a $10 billion monthly decline in Chinese imports partially offset by $2+ billion increases in Mexican and Canadian imports—demonstrates both the potency and the limitations of tariff policy as an instrument for reshaping trade flows. While tariffs clearly affect bilateral trade patterns, the general equilibrium implications depend critically on supply chain flexibility and the availability of alternative sourcing options. These findings underscore the importance of comprehensive policy analysis that accounts for behavioral responses and trade diversion when evaluating protectionist measures.