Transatlantic Automotive Trade

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Executive Summary

This policy brief outlines the strategic architecture for the United States in upcoming automotive trade negotiations with the European Union. Anchored in a 2014 baseline of significant bilateral volume, the analysis highlights the asymmetry between large EU-to-US passenger-vehicle exports (HS 870323/870324) and the US defensive posture in light commercial vehicles (HS 870431). US offensive interest centers on expanding its smaller export base into the EU market, while tariff asymmetry (US 2.5% vs EU 10% on passenger cars) and NTMs suppress potential volumes.

Our modeling, utilizing a deterministic transformation of tradeflows, based on BACI and WIOD input-output data, evaluates four distinct negotiating positions. The 'Zero_Zero' scenario, representing full bilateral tariff elimination and NTM convergence, yields the highest aggregate trade expansion, with a projected gross bilateral trade volume change of $4,286 (FOB, USD million). Conversely, the 'compliance' scenario, limited to regulatory alignment without tariff liberalization, yields $572 million and is strategically useful only if it delivers legally meaningful marketability (recognition of tests / type-approvals) in target segments. A strategic middle ground, the 'chicken_tax' scenario, which liberalizes passenger vehicles while retaining the 25% Chicken Tax tariff peak on light trucks, captures the majority of trade gains ($3,344 million) while preserving domestic manufacturing margins in the critical light truck segment.

The analysis also includes a 'bound_lift' bilateral bound-equivalent stress test (EU–US only), simulating escalation of bilateral applied rates to bound-equivalent ceilings. The negative change (-$490 million) suggests limited exposure under a bilateral shock; MFN-wide escalation could differ due to third-country diversion. The negotiation team is advised to leverage EU export dependence in the 3000cc and above vehicle class (HS 870324) to secure concessions on US auto parts (HS 870899) and lithium-ion accumulators (HS 850760), essential for the emerging EV supply chain.

Key Findings

- The 'zero_zero' scenario delivers the largest gross bilateral trade volume change under this metric at $4,286.10 million.

- Retaining the 25% tariff on light trucks ('chicken_tax' scenario) foregoes roughly $942 million in gross bilateral trade volume under this metric but protects the 'Fortress' segment (HS 870431).
- Under the assumed NTM convergence factor, tariff reductions drive most of the modeled response; regulatory convergence complements but does not substitute for tariff cuts.
- HS 870323 (Passenger cars, 1500-3000cc) is a primary US offensive interest; bilateral trade is large, but the directional baseline table shows the US export base to the EU is smaller, implying upside from tariff removal.
- The bilateral bound-equivalent stress test ('bound_lift') results in a trade contraction of $490.72 million.
- Future-proofing the agreement requires specific provisions for HS 850760 (Lithium-ion) and HS 870380 (EVs), which show low 2014 baselines but critical strategic importance.

Scenario Results Summary

Scenario	Result Summary	Gross Bilateral Trade Volume Change (USD million, FOB)
Zero-Zero	Full bilateral liberalization of tariffs and NTMs, maximizing gross bilateral trade volume under this metric.	4286.10
Compliance	Regulatory convergence only; tariffs remain at baseline.	572.31
Chicken Tax	Liberalization of passenger cars but retention of 25% tariff on light trucks.	3344.27
Lift to Bound (Bilateral Bound-Equivalent)	Bilateral escalation to bound-equivalent rates (EU–US only; stress test).	-490.72

Metric definition: gross bilateral trade volume change (US imports from EU + EU imports from US, FOB). This is a bargaining-relevance proxy, not a welfare measure.

1. Strategic Context and Objectives

The US-EU automotive relationship is the anchor of the transatlantic trade corridor but suffers from structural tariff asymmetries. This section outlines the geopolitical imperatives and the necessity of leveling the playing field. The automotive sector represents the single largest component of US-EU bilateral trade. However, the current relationship is defined by a fundamental asymmetry: the European Union maintains a 10% tariff on US passenger vehicle exports, while the United States maintains a 2.5% tariff on EU passenger cars. EU commercial-vehicle tariffs vary by line; this brief focuses on HS 870323/870324 for cars and HS 870431 for light trucks. The objective of

this negotiation is to correct this imbalance, securing reciprocal market access while maintaining defensive leverage in the light truck segment.

Geopolitical Imperatives

In an era of diversifying supply chains, reinforcing the transatlantic industrial base is a national security priority. Reducing friction in automotive trade allows for tighter integration of the defense industrial base and dual-use technologies found in modern mobility platforms.

- Need to offset non-market economy pressure.
- Strengthening NATO-adjacent industrial capacity.

Market Asymmetries

The EU's 10% tariff wall is a primary barrier. US negotiators must frame tariff reciprocity not as a concession, but as a correction of historical imbalances. The 'zero_zero' scenario is the optical baseline for 'fair trade', even if fallback positions are necessary.

- US applied rate: 2.5% (Cars), 25% (Trucks).
- EU applied rate: 10% (cars); commercial-vehicle tariffs vary by line (focus on HS 870431).

2. Baseline Diagnostics

Analysis of the 2014 baseline reveals the dominance of internal combustion engine vehicles in current flows. Top trade lines identify the high-value targets for immediate liberalization. The 2014 baseline data serves as the foundation for all scenario modeling. The trade relationship is heavily concentrated in a few high-volume lines. HS 870323 (Passenger cars, 1500-3000cc) and HS 870324 (3000cc and above) dominate bilateral value, but directional flows are asymmetric: EU to US exports are much larger than US to EU exports. The directional baseline table below clarifies this asymmetry and motivates the US offensive objective of expanding its smaller export base into the EU market.

HS6	US→EU (USD m)	EU→US (USD m)	Bilateral (USD m)
870323	748.25	19622.59	20370.84
870324	808.66	17645.47	18454.13
870431	27.24	581.97	609.21
870899	562.68	1725.10	2287.78
850760	313.28	58.80	372.09

Top Trade Lines

The concentration of value in specific HS codes dictates our offensive strategy. We must prioritize tariff elimination on lines with the highest 'trade value density'. By inspecting the magnitudes

HS6	Description (HS6)
870323	Passenger cars (< 10 persons), spark-ignition piston engine, 1,500–3,000 cm^3
870324	Passenger cars (< 10 persons), spark-ignition piston engine, > 3,000 cm^3
870431	Goods vehicles, spark-ignition engine, gross vehicle weight $\leq$ 5 t
870899	Parts and accessories for motor vehicles (headings 8701–8705), other
850760	Lithium-ion accumulators (excl. spent)

involved, we of course see that passenger cars (8703..) are what dominates in the intensive margin. That being said, some essential parts for supply chain continuity are included as well.

The Light Truck Anomaly

HS 870431 (Light trucks less than or equal to 5 tonnes) shows low baseline trade volume in the source data (potentially due to the prohibitive 25% tariff known as the Chicken Tax). This low volume is consistent with a tariff barrier and a 'Fortress' segment for US manufacturers, though other factors may also contribute.

3. Scenario Results and Analysis

We present a comparative analysis of four distinct negotiation outcomes ranging from full liberalization to varying degrees of protectionism. The results quantify the trade-offs between market access and domestic protection. We modeled four primary scenarios to guide decision-making. The 'zero_zero' scenario simulates the complete removal of all bilateral tariffs and a convergence of NTM costs, resulting in a gross bilateral trade volume change of $4.29 billion. This represents the largest change under this metric. The 'chicken_tax' scenario, which exempts the 25% light truck tariff from liberalization, retains 78% of the 'zero_zero' gains ($3.34 billion) while preserving the defensive posture on HS 870431. This implies roughly $942 million in foregone gross bilateral trade volume under this metric, a calculable cost for political stability.

Zero-Zero (Full Liberalization)

This scenario drives the largest gross bilateral trade volume change under the defined metric, particularly in the auto-parts supply chain (HS 870899). It is politically costly due to the removal of light truck protection.

- Total Import Change (bilateral gross imports, USD million FOB): +$4,286M
- Largest trade-flow gain under the defined metric.

Compliance (Regulatory Only)

Focusing solely on NTM reduction without tariff cuts yields limited results. The $572 million change indicates that NTM convergence complements tariff reduction but does not substitute for it. Compliance-only is only attractive if it delivers legally meaningful marketability (type-approval/testing recognition) in target segments.

- Total Import Change (bilateral gross imports, USD million FOB): +$572M
- Insufficient for a standalone agreement unless coupled with meaningful mutual recognition.

Simulating bilateral escalation to bound-equivalent rates results in a contraction of trade (-$490M). This is a stylized upper-bound sensitivity check on tariff-water exposure under a bilateral shock; MFN-wide escalation could differ due to third-country diversion. It underscores the value of current applied rates and highlights tariff water (bound minus applied) as unused space that could be activated in a bilateral dispute.

- Total Import Change (bilateral gross imports, USD million FOB): -$491M
- Highlights risk of no deal/trade war.

4. Regulatory Landscape and NTMs

Non-Tariff Measures represent a significant barrier to trade, particularly on the extensive margin - hence, it's likely that the model underestimates the impact of harmonization. Harmonizing safety and emission standards is critical for mid-sized sedans and SUVs. Beyond tariffs, regulatory divergence imposes a significant cost on US exporters, effectively acting as a tax on production. The 'compliance' scenario results demonstrate that addressing these frictions is necessary but not sufficient. The primary friction points are in safety standards (FMVSS vs UNECE) and emissions testing. For HS 870323, regulatory convergence complements tariff elimination by making the product legally marketable in the EU.

Mutual Recognition Agreements (MRAs)

We propose an MRA framework focused on mutual recognition of test results and accredited conformity assessment bodies for defined safety standards. This reduces re-engineering costs for export models without asserting full regulatory equivalence.

- Focus on crashworthiness standards.
- Lighting and signaling harmonization.

5. Rules of Origin and Supply Chain Integration

Defining the 'origin' of a vehicle is central to preventing trans-shipment. We must ensure that benefits accrue to US and EU manufacturers, specifically integrating battery supply chains. Strict

Rules of Origin (RoO) are required to prevent third-party beneficiaries from exploiting the agreement. We advocate for a high regional value content (RVC) requirement, 55% or higher. However, flexibility is needed for critical components where transatlantic capacity is still ramping up, such as Lithium-ion accumulators (HS 850760). The 'zero_zero' scenario shows a massive increase in parts trade (HS 870899), indicating deep supply chain integration. We must ensure this integration supports 'Just-in-Time' manufacturing across the Atlantic.

Accumulation Provisions

Materials sourced from the EU should count toward US RVC requirements and vice versa. This bilateral accumulation encourages joint investment in supply chains.

- Encourages FDI.
- Strengthens joint supply security.

Critical Minerals and Batteries

HS 850760 is a strategic bucket. While 2014 trade values are modest ($45M base in scenarios), this line will be important with the advance of electrical vehicles. Reducing tariffs here lowers the cost of production for next-gen vehicles (HS 870380).

- Secure access to EU chemical processing.
- Lower input costs for US OEMs.

6. Negotiation Leverage and Architecture

The US holds the 'Chicken Tax' as a major bargaining chip against the EU's desire for light truck market access. The US negotiating position is strong. The EU industry is heavily dependent on the US export market for their high-margin luxury vehicles (HS 870324) and has a strong offensive interest in penetrating the US light truck market (HS 870431). Assuming a comprehensive mandate (goods + regulatory + selected services), the truck tariff can be used as cross-sector leverage. Our leverage lies in the 25% tariff. We can offer to reduce this tariff only in exchange for disproportionate concessions on EU agricultural or digital services, or we can retain it (as in the 'chicken_tax' scenario) to protect domestic labor. The analysis suggests that retaining the tax foregoes less than $1 billion in gross bilateral trade volume under this metric, which may be an acceptable price for leverage.

Offensive Interests

Elimination of the 10% EU tariff on HS 870323. This is the primary US objective; if it cannot be achieved, the fallback is a modular compliance-only accord focused on mutual recognition (not a full agreement).

- Leveling the playing field.

- Export expansion for US assembly plants.

Defensive Interests

Protection of the light truck segment (HS 870431) and careful monitoring of parts imports (HS 870899) to ensure they don't undermine domestic tier-1 suppliers.

- Maintain light-truck tariff leverage.
- Strict RoO enforcement.

7. Data Procedure and Decision Criteria

This section details the deterministic transformations used to generate scenario outputs. We utilized the BACI HS12 (V202601) dataset for high-resolution bilateral trade flows (HS6 level), mapped to US and EU reporters for the year 2014. These flows were scaled to align with macro-economic totals provided by the World Input-Output Database (WIOD 2016). Applied tariffs were sourced from MAcMap (2013), and bound rates from WTO CTS (HS12). The scenario modeling employs an elasticity-based intensive margin allocation and an auto-within-sector raking step (statistical balancing) to distribute sector-level shocks across HS6 auto lines. HS6 elasticities are import-demand price elasticities (negative by convention) whereas Armington/CES substitution elasticities remain positive and are not replaced by these HS-level parameters. All numeric results come from the data pipeline described below.

Data Provenance

Primary sources: BACI for trade flows, MAcMap for applied tariffs, WTO CTS for bound rates, and WIOD for sectoral scaling. This multi-source approach mitigates single-source bias.

- Trade Unit: USD Million (FOB).
- BACI values are provided in thousands of USD; converted to USD million for reporting.
- Reporters: USA; Partners: EU.

Transformation Methodology

The pipeline applies scaling factors derived from IO tables to HS6 flows and these CGE-aligned totals are what sets sector constraints. Scenarios are computed by applying import-demand elasticities to tariff changes and then re-raking so HS6 changes sum to the CGE-scaled sector totals. We solve a multiregion Armington CGE to generate by-sector totals and then HS6 raking gives us within-sector changes.

- Elasticity-based allocation.
- Sector-specific raking.

8. Risk Register

Identification of potential economic and political risks associated with the proposed liberalization scenarios. Every trade agreement carries risk. The 'zero_zero' scenario predicts a significant increase in parts imports ($1212M change). Politically, the relaxation of the Chicken Tax poses the highest risk of backlash from organized labor. Conversely, the 'bound_lift' scenario highlights the risk of bilateral escalation to bound ceilings: gross bilateral trade volume falls by roughly half a billion dollars under this stress test.

Economic Risks

Displacement of domestic parts suppliers; trans-shipment of non-originating goods.

- Import surge monitoring.
- RoO circumvention.

Political Risks

Opposition from UAW regarding light truck tariff reduction; EU resistance to agricultural concessions (assuming a comprehensive mandate).

- Labor union alignment.
- Electoral impact in manufacturing states.

9. Implementation Roadmap

A phased approach to tariff elimination and regulatory compliance to allow industry adjustment. Immediate elimination of tariffs (T-0) is recommended for 'Crown Jewel' exports (HS 870323) and critical supply chain inputs (HS 850760). For sensitive import lines, specifically if the Chicken Tax is touched, a phase-out period of 10-15 years is necessary. Regulatory convergence working groups should be established immediately with a mandate to deliver mutual recognition on safety standards within 24 months.

Phasing

Asymmetric phasing: US cuts tariffs on cars immediately, and EU cuts tariffs on cars immediately. US truck tariff cuts (if any) backloaded.

- T-0: Passenger Cars.
- T-10: Light Trucks (if applicable).

10. Communications Strategy

The agreement should be sold as 'opening foreign markets to American cars'. We must emphasize the 10% to 0% drop in EU tariffs as a win for US exporters. Defensive measures regarding trucks should be framed as 'preserving fair competition'. The 'zero_zero' gross bilateral trade volume change of $4.3 billion is the headline metric under this framework.

Key Messages

Focus on fairness, export growth, and lowering costs for consumers (via cheaper parts/batteries).

- Breaking down the EU tariff wall.
- Protecting American trucks.

Data Sources

- BACI HS12 (V202601) - Bilateral Trade Flows
- WIOD 2016 (Year 2014) - Sectoral Scaling and Input-Output
- MAcMap HS6 (2013) - Applied Tariffs
- WTO CTS (HS12) - Bound Tariffs
- CGE Outputs - Scaled Import Flows

Limitations

- Analysis is based on 2014 baseline data, but market structure (especially EV penetration) has evolved until 2017.
- Elasticity estimations are inputs to the model, not derived endogenously.
- Scenario results assume full utilization of preferences; actual utilization may be lower due to RoO compliance costs.
- The 'bound_lift' scenario assumes a static demand environment despite price shocks.

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Appendix A: Methodology and HS Concordance

Technical details regarding the mapping of HS codes to industrial sectors and the specific rake algorithms used. The model utilizes a cross-walk between HS 2012 nomenclature and WIOD sector classifications. Special attention was paid to the allocation method, which performs a two-stage rake: first allocating changes within the auto sector specifically, and then balancing to the broader manufacturing totals. This prevents auto-specific shocks from being diluted across unrelated manufacturing categories.

Appendix B: Scenario Definitions

Detailed parameters for each modeled scenario.

1. Zero_Zero: Applied rates set to 0.00 for all auto lines, and NTM ad valorem equivalents reduced.

2. Compliance: Applied rates remain unchanged, but NTM costs reduced by estimated convergence factor.

3. Chicken_Tax: Applied rates set to 0.00 for HS 8703xx, but HS 8704xx rates held at baseline (25% for US).

4. Bound_Lift: Applied rates set to max(Applied, Bound) on EU–US bilateral wedges only (bound-equivalent stress test).

Appendix A: Mathematical Model

Production and Cost Structure

$$Q_{r,s} = \min\left(\frac{VA_{r,s}}{\text{va_share}_{r,s}}, \frac{INT_{r,s}}{\text{int_share}_{r,s}}\right) \tag{1}$$

$$P_{r,s} = \text{va_share}_{r,s} \cdot P^{va}_{r,s} + \text{int_share}_{r,s} \cdot P^{int}_{r,s} \tag{2}$$

$$P^{int}_{r,s} = \frac{\sum_j IO_{r,j,s} \cdot PC_{r,j}}{\sum_j IO_{r,j,s}} \tag{3}$$

$$P^{va}_{r,s} = \begin{cases} PF_{r,L}^{\alpha_{r,s,L}} PF_{r,K}^{1-\alpha_{r,s,L}}, & \sigma_{va,s} = 1 \\ \left[\alpha_{r,s,L} PF_{r,L}^{1-\sigma_{va,s}} + (1-\alpha_{r,s,L}) PF_{r,K}^{1-\sigma_{va,s}}\right]^{1/(1-\sigma_{va,s})}, & \sigma_{va,s} \neq 1 \end{cases} \tag{4}$$

Trade Prices and Aggregation

$$PM_{r,ro,s} = P_{ro,s} \cdot \left(1 + \tau_{r,ro,s} + t^{imp}_r\right) \tag{5}$$

$$PMA_{r,s} = \begin{cases} \sum_{ro} \theta_{r,ro,s} PM_{r,ro,s}, & \sigma_{m,s} = 1 \\ \left[\sum_{ro} \theta_{r,ro,s} PM_{r,ro,s}^{1-\sigma_{m,s}}\right]^{1/(1-\sigma_{m,s})}, & \sigma_{m,s} \neq 1 \end{cases} \tag{6}$$

$$PC_{r,s} = \left[\delta_{r,s} P_{r,s}^{1-\sigma_{a,s}} + (1-\delta_{r,s}) PMA_{r,s}^{1-\sigma_{a,s}}\right]^{1/(1-\sigma_{a,s})} \cdot (1 + t_{r,s}^{prod} + m_{r,s}) \tag{7}$$

Demand System

$$QC_{r,s} = C_{r,s} + G_{r,s} + I_{r,s} + \sum_{j} IO_{r,s,j} \cdot Q_{r,j} \tag{8}$$

$$D_{r,s} = QC_{r,s} \cdot \delta_{r,s} \left(\frac{PC_{r,s}}{P_{r,s}}\right)^{\sigma_{a,s}} \tag{9}$$

$$MA_{r,s} = QC_{r,s} \cdot (1-\delta_{r,s}) \left(\frac{PC_{r,s}}{PMA_{r,s}}\right)^{\sigma_{a,s}} \tag{10}$$

$$MA_{r,s} = \sum_{ro \neq r} M_{r,ro,s} \tag{11}$$

Markets and Income

$$Q_{r,s} = D_{r,s} + \sum_{rd \neq r} M_{rd,r,s} + \text{inventory_change}_{r,s} \tag{12}$$

$$\sum_{s} \frac{\alpha_{r,s,f} \cdot \text{va_share}_{r,s} \cdot P_{r,s} Q_{r,s}}{PF_{r,f}} = \text{endowment}_{r,f} \tag{13}$$

$$Y_r = \sum_{f} PF_{r,f} \cdot \text{endowment}_{r,f} + \text{tax_prod}_r + \text{tax_import}_r \tag{14}$$

$$PC_{r,s} \cdot C_{r,s} = \beta_{r,s} \cdot C_r^{tot} \tag{15}$$

$$PC_{r,s} \cdot G_{r,s} = \gamma_{r,s} \cdot G_r^{tot} \tag{16}$$

$$PC_{r,s} \cdot I_{r,s} = \text{inv_share}_{r,s} \cdot I_r^{tot} \tag{17}$$

$$\sum_{r} SAV_r = P_{SAVE} \sum_{r} I_r^{tot} \tag{18}$$

Symbol↔Code Table

Symbol	Description	Code Reference
$Q_{r,s}$	Output quantity	model_spec_multiregion.py: Q
$P_{r,s}$	Output price	model_spec_multiregion.py: P
$VA_{r,s}$	Value-added quantity	model_spec_multiregion.py: VA
$D_{r,s}$	Domestic demand	model_spec_multiregion.py: D
$M_{r,ro,s}$	Bilateral import quantity	model_spec_multiregion.py: M
$MA_{r,s}$	Import aggregate quantity	model_spec_multiregion.py: MA
$QC_{r,s}$	Composite quantity	model_spec_multiregion.py: QC

Symbol	Description	Code Reference
$PC_{r,s}$	Composite price	model_spec_multiregion.py: PC
$PM_{r,ro,s}$	Import price (bilateral)	model_spec_multiregion.py: PM
$PMA_{r,s}$	Import aggregate price	model_spec_multiregion.py: PMA
$PF_{r,f}$	Factor price	model_spec_multiregion.py: PF
$\sigma_{va,s}$	VA CES elasticity	model_spec_multiregion.py: sigma_va
$\sigma_{a,s}$	Armington elasticity	model_spec_multiregion.py: sigma_a
$\sigma_{m,s}$	Import substitution elasticity	model_spec_multiregion.py: sigma_m
$\delta_{r,s}$	Domestic share parameter	model_spec_multiregion.py: delta
$\theta_{r,ro,s}$	Import share weights	model_spec_multiregion.py: theta_m
$\alpha_{r,s,f}$	Factor share parameter	model_spec_multiregion.py: alpha
$\text{va_share}_{r,s}$	Value-added share	model_spec_multiregion.py: va_share
$\text{int_share}_{r,s}$	Intermediate input share	model_spec_multiregion.py: int_share
$IO_{r,j,s}$	Intermediate input coefficient	model_spec_multiregion.py: IO
$\tau_{r,ro,s}$	Tariff wedge	run_gtap_pipeline.py: policy_wedges -¿ tariff
$t^{prod}_{r,s}$	Production tax rate	model_spec_multiregion.py: tax_prod_rate
t^{imp}_{r}	Import tax rate	model_spec_multiregion.py: tax_import
$m_{r,s}$	Margin rate	model_spec_multiregion.py: margin_rate
Y_r	Household income	model_spec_multiregion.py: Y
$C_{r,s}$	Private consumption	model_spec_multiregion.py: C_priv
$G_{r,s}$	Government consumption	model_spec_multiregion.py: G_cons
$I_{r,s}$	Investment demand	model_spec_multiregion.py: INV
SAV_r	Savings	model_spec_multiregion.py: SAV

Appendix B: Data Flow and Transformation

- **Trade Baseline (HS6):** BACI HS12 trade cube filtered to 2014 EU/USA/ROW flows; converted to HS4 target revision; stored in `trade_hs6_2014_usa_eu_row.parquet`.
- **Tariffs (Applied):** MAcMap HS6 applied rates for 2013, normalized to ad-valorem; schedule audits built per scenario.
- **Bound Rates:** WTO CTS bound schedules ingested to form the BoundLift stress test (applied-to-bound overhang).
- **Mapping:** HS→ISIC and ISIC→WIOD concordances align micro HS6 to macro WIOD sectors.
- **Elasticities:** HS6 import-demand price elasticities (ϵ) loaded from IMIP dataset; clipped to [-10, -1.01] to bound extreme demand responses in the HS allocation layer.
- **CGE Calibration:** WIOD tables produce SAM; Armington and factor shares derived; CGE substitution parameters (σ) are standard positive elasticities, while HS6 elasticities (ϵ) are used only as responsiveness weights in the HS allocation/raking stage.
- **Scenario Wedges:** Bilateral wedges (EU↔US only) applied to the tariff wedge matrix for each scenario.
- **Value-Flow Exports:** CGE exports import values (PM × M) to the HS allocation pipeline.
- **Scaling:** CGE import flows scaled to WIOD bilateral totals before HS allocation.
- **HS Allocation:** Elasticity-based raking aligns HS changes with sector totals; raking factors are clipped and residuals reported.

Appendix C: Data Quality and Stability Diagnostics

- HS elasticities clipped to [-10.0, -1.01] to prevent corner solutions.
- Clipped low-count: 1919; clipped high-count: 17.
- Raking factors constrained to [0.1, 10.0] with $\epsilon = 1e-06$.
- Rake residual sum: 3106750.12; absolute sum: 3114436.88; max absolute residual: 169681.56.
- Raking factor distribution (auto mean: 0.67, non-auto mean: 2.60).

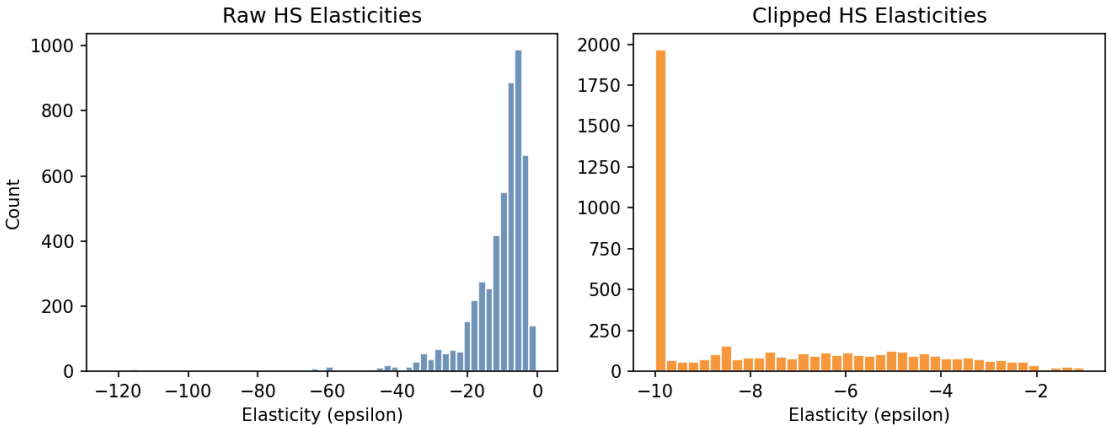

Figure 1: Raw vs. clipped HS elasticity distribution.

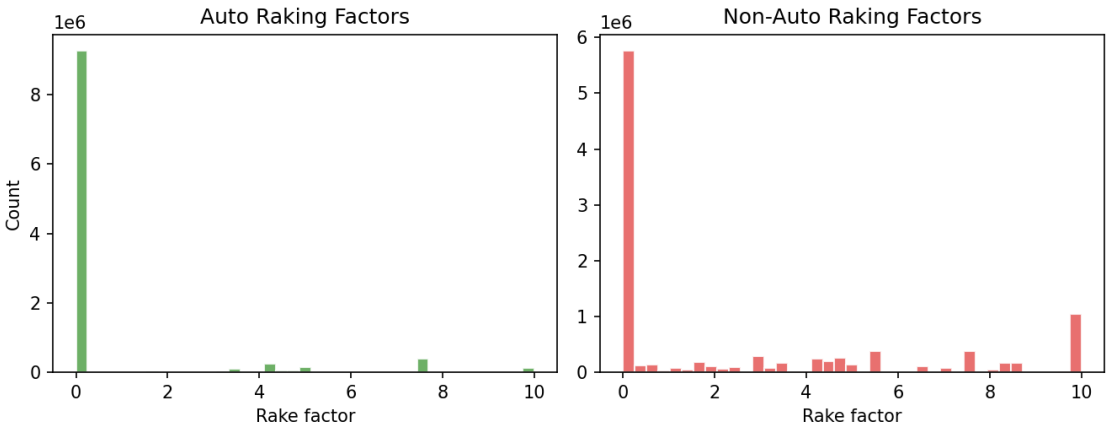

Figure 2: Raking factor distribution by auto vs non-auto lines.