A Structural Quality Index of Economic Adjustment in CGE Models: The U.S.-ASEAN Case

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ABSTRACT

This paper introduces the *Structural Quality Index (SQI)*, an *ex post* diagnostic tool for comparing CGE simulation outcomes across scenarios, models, and closures. SQI maps high-dimensional bilateral and sectoral results into a unit-less, sign-consistent index without altering the underlying CGE structure. The index preserves bilateral transmission, standardizes heterogeneous outputs using global median/MAD normalization, and aggregates correlated adjustment channels through PCA-based weights to limit double counting. SQI is useful in standard, fully specified policy exercises and remains informative when policy detail is incomplete and shock design is uncertain. Using U.S.–ASEAN trade-policy counterfactuals, SQI helps policymakers assess which response strategy delivers the highest-quality structural adjustment for ASEAN beyond aggregate GDP and welfare effects.

KEYWORDS

Tariff HS6; GTAP; Recursive dynamic model; Trade policy; Reciprocal tariffs

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1 | INTRODUCTION

Tariffs have re-emerged as central instruments of trade policy, with recent U.S. actions in 2025 emphasizing partner- and product-specific measures. Evidence shows that narrowly targeted changes at the HS6 level can propagate through supply chains, reshape sourcing, and redirect trade in ways that aggregate summaries can understate (Ederington & Ruta, 2016; Amiti et al., 2019; Santeramo & Lamonaca, 2019, 2022; Boehm et al., 2019; Vasconcelos et al., 2021; Egger & Erhardt, 2024; Yotov, 2022). This shift increases the need to compare many counterfactual designs in a coherent and interpretable way.

Policy evaluation at tariff-line detail remains constrained by data frictions. Global repositories (UNCTAD TRAINS, WITS, UN Comtrade) are updated with lags and rely on aggregations that can mask tariff-line variation (Ederington & Ruta, 2016; Le Thi et al., 2022; Santeramo & Lamonaca, 2022). National schedules such as the HTSUS are timelier but are disseminated in legal and textual formats not designed for economic modeling (Kuenzel, 2020). These sources often lack bilateral structure, sector concordances, and trade-weighted aggregation (Aguiar, 2016).

To study general-equilibrium implications, we embed the resulting tariff dataset in the GTAP-Recursive Dynamic (GTAP-RD) framework (Corong et al., 2017; Aguiar et al., 2020). GTAP-RD captures adjustment margins central under sustained tariff changes, including capital accumulation, factor reallocation, and production restructuring (Nicita & Tresa, 2023; Egger & Erhardt, 2024). Combining HS6 detail with a global CGE model yields a consistent mapping from tariff-line shocks to sectoral and regional outcomes (Vasconcelos et al., 2021; Yotov, 2022). The same setting also produces high-dimensional results that are difficult to compare across scenarios using standard outputs alone.

CGE simulations report rich bilateral and sectoral outcomes, yet ranking alternative policy responses is not straightforward. Outputs mix units and co-moving mechanisms, so comparisons depend on indicator choice and can be distorted by correlated channels and extreme realizations. These issues matter in standard, fully specified exercises and become more binding when the analyst must compare many counterfactuals or communicate a clear policy ranking.

We therefore propose the *Structural Quality Index (SQI)* as a model-consistent, *ex post* diagnostic for scenario comparison. SQI consolidates CGE outcomes into a unit-less statistic while preserving bilateral transmission, enabling sign-consistent comparison and ranking across aggregation levels. It complements real GDP and welfare by emphasizing the quality and composition of adjustment rather than headline outcomes alone (Hertel, 1997; Corong et al., 2017; Aguiar et al., 2020). Operating on solved equilibria, SQI is model-agnostic and applies across CGE frameworks, closures, and extensions.

We illustrate SQI using U.S.–ASEAN tariff counterfactuals, where response design is economically consequential. ASEAN is a major and rapidly rising economic region in Asia, sufficiently large and integrated to exhibit meaningful adjustment under U.S. tariff shocks. It also faces multiple feasible responses, so structural outcomes can differ across designs even when aggregates appear similar. We examine three representative scenarios: (1) no retaliation, (2) reciprocal retaliation matching U.S. actions, and (3) preferential tariff reductions among non-U.S. economies, including ASEAN, to deepen intra-regional trade and reduce exposure to U.S. markets.

2 | LIMITATIONS OF AGGREGATED POLICY SHOCKS IN CGE ANALYSIS

Applied CGE models often rely on aggregated representations of trade policy shocks to balance tractability with data and computational constraints. Such approximations abstract from heterogeneity in policy design across commodities and trading partners that governs relative price dispersion, substitution patterns, and factor reallocation. This section examines how policy aggregation alters trade-policy transmission in CGE models and why these distortions are amplified in recursive–dynamic frameworks.

2.1 | Disaggregated Policy and Data Constraints

The effectiveness of policy analysis depends not only on its overall rate but also on how measures are distributed across products and trading partners. Modern tariff schedules specify duties at highly disaggregated levels, often at the HS6 classification, capturing sectoral sensitivities and strategic interests rather than uniform protection (Amiti et al., 2019; Yotov, 2022; Egger & Erhardt, 2024).[1] This detail shapes how protection is transmitted through supply chains, influencing firms' production and trade decisions as well as broader adjustments in global supply chains and economies.

Aggregating policy measures into regional or sectoral averages obscures within-industry variation and biases estimates of effective protection and welfare (Ederington & Ruta, 2016). Empirical evidence shows that even narrowly targeted tariff changes can propagate through production networks, altering costs, competitiveness, and trade composition across sectors (Amiti et al., 2019; Boehm et al., 2019; Vasconcelos et al., 2021). Accurately capturing these channels therefore requires policy data that preserve the legislative granularity and partner-specific structure at which measures are enacted.

Available tariff datasets from major institutions—MAcMap, UNCTAD, the World Bank, and UN Comtrade—are typically updated only on an annual cycle and, even at their most detailed level (HS6), omit country-specific provisions. These sources remain valuable for *ex-post* policy analysis but are less suitable for real-time monitoring or granular, country-level assessment. This limitation has become particularly evident in 2025,

[1]Non-tariff measures (NTMs), such as technical barriers, sanitary and phytosanitary standards, and licensing requirements, follow a similar product- and partner-specific structure (Webb et al., 2020).

as rapid U.S. tariff revisions have repeatedly disrupted global supply chains and partner economies.[2]

Imposing policy countries address this limitation by publishing real-time tariff schedules at very fine levels of detail—for example, the United States releases HS8-level schedules through the USITC (HTSUS). These documents, however, are designed for administrative enforcement, relying on hierarchical legal text. Frequent intra-year revisions further widen the gap between the pace of policy change and available empirical frameworks, rendering them unsuitable for economic modeling due to the absence of bilateral rates and standardized concordances.

2.2 | Modeling Trade Policy Shocks under Limited Information

Data limitations often compel policymakers to rely on stylized assumptions in modeling, particularly in real-time settings where policy decisions must be calibrated using incomplete or contemporaneous information. As a result, short-run policy analysis frequently relies on simplified representations of shocks rather than fully observed heterogeneity (Oatley, 2010; Francis et al., 2011).

In this context, uniform shocks are commonly used as practical proxies when bilateral or sectoral detail is unavailable.[3] Such implementations depend on assumed behavioral or equilibrium relationships rather than observed variation (Oatley, 2010; Jiang et al., 2017). In practice, policy interventions—such as tariffs and non-tariff measures—are often applied uniformly by partner, by commodity, or across all commodity–partner pairs:

$$\Delta t_{c,s,d} = \begin{cases} \bar{\Delta t}_d, & \text{uniform by partner,} \\ \bar{\Delta t}_c, & \text{uniform by commodity,} \\ \bar{\Delta t}, & \text{fully uniform.} \end{cases}$$

The analytical cost of these simplifications increases when policy changes affect multiple margins simultaneously, as aggregation suppresses interaction effects across sectors and partners and masks the joint response of prices, quantities, and substitution patterns. Evidence from incomplete-markets and policy-aggregation frameworks shows that overlooking such cross-dimensional variation distorts policy transmission and distributional outcomes, leading to systematic mismeasurement of welfare and sectoral adjustment (Oatley, 2010; Ditta et al., 2020; Zhu, 2024).

This issue is particularly pronounced under Armington demand, where substitution responses are driven by relative price dispersion across sources and between domestic and imported goods. When aggregation dampens these price differentials, the resulting CGE responses are governed primarily by imposed elasticities rather than by the realized cross-partner and cross-product structure of policy shocks.

[2]This context-specific example illustrates the broader need for mechanisms that deliver rapid and consistent tariff data updates.

[3]Uniform shocks may introduce bias but provide a systematic benchmark for comparison and are generally preferred to random or arbitrary changes that could obscure the direction of policy effects.

2.3 | Shock Aggregation Bias under the Armington Structure

The Armington assumption, as implemented in the GTAP model Corong et al. (2017), represents import demand through a two-level substitution structure (Armington, 1969; Hertel, 1997). At the upper level, agents substitute between domestic and imported composites with elasticity $\sigma^D_{c,d}$, while at the lower level they reallocate imports across source countries with elasticity $\sigma^M_{c,d}$. Both elasticities are predetermined for each commodity c and destination d, reflecting empirically estimated substitution patterns.[4]

The bilateral import-demand relationship in percentage-change form links proportional imports of commodity c from source s to destination d, denoted by $\hat{M}_{c,s,d}$, to aggregate import demand $\hat{Q}^M_{c,d}$ and relative prices. Supplier reallocation is governed by the relative price term $(\hat{P}_{c,s,d} - \hat{P}^M_{c,d})$, scaled by the Armington elasticity $\sigma^M_{c,d}$, making the response sensitive to the structure of tariff changes:

$$\hat{M}_{c,s,d} = \hat{Q}^M_{c,d} - \sigma^M_{c,d}\left(\hat{P}_{c,s,d} - \hat{P}^M_{c,d}\right). \tag{1}$$

Tariff interventions directly affect the relative import prices that underpin this Armington allocation mechanism. When tariff adjustments vary across source countries—$\Delta t_{c,s,d} \neq \Delta t_{c,s',d}$ for $s \neq s'$—they alter bilateral relative prices, activating the lower-level substitution elasticity $\sigma^M_{c,d}$ and inducing trade diversion across partners. Conversely, if the tariff change is uniform across all sources for a given commodity and destination, then $\hat{P}_{c,s,d} = \hat{P}^M_{c,d}$ for all s, and the lower-level substitution margin becomes inactive. In that case, the import response operates entirely through the upper-level elasticity:

$$\hat{Q}^M_{c,d} = -\,\sigma^D_{c,d}\,(\hat{P}^M_{c,d} - \hat{P}^D_{c,d}), \tag{2}$$

where $\hat{P}^D_{c,d}$ denotes the domestic price. Thus, uniform shocks remove the partner-reallocation margin and leave responses governed solely by domestic–import substitution.

The loss of variation under uniform shocks can be formalized through the dispersion of tariff changes. With heterogeneous shocks, $\mathrm{Var}(\Delta t_{c,s,d}) > 0$ generates differential impacts across bilateral flows, allowing the model to capture trade creation and diversion driven by elasticities and initial trade shares. When uniform aggregations collapse this heterogeneity, aggregate import adjustment can be approximated as:

$$\Delta\hat{M}_d \approx -\,\bar{\sigma}^D_d\,\bar{\Delta}t, \tag{3}$$

where $\bar{\sigma}^D_d$ is a trade-weighted average elasticity and $\bar{\Delta}t$ represents the uniform shock magnitude.

The deviation from the true heterogeneous response is defined in eq. (4) and is weighted by commodity and bilateral import shares, denoted by $s^{imp}_{c,d}$ and $s^{imp}_{c,s,d}$, respectively. The first term captures aggregation bias arising from replacing commodity-specific elasticities with a regional average, while the second reflects omitted lower-nest variation that would otherwise induce partner-specific reallocation, leaving responses driven by assumed substitution patterns rather than the empirical dispersion of tariff changes.[5]

$$\mathbb{E}[\Delta\hat{M}_d - \Delta M_d] = -\,\bar{\Delta}t\left(\bar{\sigma}^D_d - \sum_c s^{imp}_{c,d}\,\sigma^D_{c,d}\right) + \sum_{c,s} s^{imp}_{c,s,d}\,\sigma^M_{c,d}\,(\Delta t_{c,s,d} - \bar{\Delta}t), \tag{4}$$

[4] The two levels capture import penetration and trade diversion across foreign suppliers.

[5] The resulting aggregation bias increases with $\mathrm{Var}(\sigma^M_{c,d})$ and $\mathrm{Cov}(\sigma^M_{c,d}, \Delta t_{c,s,d})$, and is most pronounced when tariff changes are concentrated in highly substitutable sectors or among major trading partners.

2.4 | Structural Distortions in Recursive Adjustment

In addition to capital misallocation, uniform policy shocks introduce systematic biases into the structural evolution of the economy. These biases arise because the functional forms governing CGE models—specifically Constant Elasticity of Substitution (CES) and Leontief functions—are non-linear. Consequently, the response to an average shock differs from the aggregated response to heterogeneous shocks.

Let $\tau_{c,s,d,t}$ denote a generic policy instrument (e.g., tariff, tax, or non-tariff measure) applied to commodity c from source s imported by region d at time t. A uniform aggregation replaces the vector τ with a scalar mean $\bar{\tau}$. This simplification distorts three specific transmission channels in the recursive-dynamic framework.

2.4.1 Aggregation Bias via Jensen's Inequality

The first distortion applies to trade volume responses. Import demand in the Armington framework is convex with respect to prices and policy shocks. By Jensen's Inequality, for a convex function $f(\cdot)$ and a variable τ with non-zero variance, $f(\mathbb{E}[\tau]) < \mathbb{E}[f(\tau)]$.

In the context of trade reduction, the aggregate decrease in trade volume calculated under a uniform shock $(\bar{\tau})$ is systematically smaller than the cumulative reduction under true heterogeneous shocks. The bias in the trade flow response ΔM is defined as:

$$\text{Bias}_{d,t}^{\text{Trade}} = \Delta M_{d,t}(\bar{\tau}_{d,t}) - \sum_{c,s} \Delta M_{c,s,d,t}(\tau_{c,s,d,t}), \tag{5}$$

where $\text{Bias}_{d,t}^{\text{Trade}} > 0$ for standard elasticity values. Uniform shocks therefore underestimate the magnitude of trade destruction, projecting an artificially high degree of trade openness in future periods (Feenstra, 1994; Lloyd & MacLaren, 2010).

2.4.2 Input Cost Smoothing and Production Constraints

The second distortion affects the vertical production structure. Downstream firms in activity a optimize their input mix based on the composite price of intermediates. Under heterogeneous shocks, a high tariff on a specific critical input creates a spike in the marginal cost of production. Uniform shocks smooth this variance, diluting the cost spike across all inputs.

The distortion in the composite input price index $P_{a,d,t}^{Q}$ is expressed as:

$$P_{a,d,t}^{Q}(\bar{\tau}) \neq \left[\sum_{c} \theta_{c,a} \left(P_{c,s,d,t}(1 + \tau_{c,s,d,t}) \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \tag{6}$$

where $\theta_{c,a}$ represents the input cost share and σ is the elasticity of substitution. By underestimating the cost burden on import-intensive sectors, the uniform assumption allows these sectors to maintain higher output levels than would be feasible under the actual constraints, leading to an overestimation of sectoral GDP contribution (Boehm et al., 2019).

2.4.3 The Real Income–Savings Channel

The third mechanism operates through the macroeconomic closure linking welfare to capital formation. In dynamic CGE closures, the regional pool of savings $S_{d,t}$ is a function of real income. Targeted policy shocks affect Terms of Trade (ToT) and real income differently than uniform shocks, particularly when countries exert market power in specific commodities.

The bias in real income distorts the savings available for future investment:

$$S_{d,t+1} = \mathrm{mps}_d \cdot \left(Y_{d,t} + \mathrm{Bias}_{d,t}^{\mathrm{ToT}}\right), \tag{7}$$

where mps_d is the marginal propensity to save and $Y_{d,t}$ is regional income. This creates a recursive feedback loop: an initial miscalculation of welfare alters the trajectory of the total capital stock $K_{d,t+1}$ available for the next period, causing the simulated growth path to diverge from the true baseline (Aguiar et al., 2020).

3 | METHODOLOGY

The analysis proceeds in three steps. First, Monte Carlo experiments in the standard GTAP model compare heterogeneous and uniform-shock structures to quantify aggregation bias. Second, the GTAP-RD framework is used to evaluate the dynamic effects of recent U.S. tariff shocks, constructed by converting unstructured policy reports into applied ad valorem rates using Natural Language Processing (NLP). Third, we introduce the Structural Quality Index (SQI), a new framework that integrates macroeconomic and sectoral responses to interpret CGE results.

3.1 | GTAP Recursive–Dynamic Model

The dynamic assessment employs the GTAP recursive–dynamic (GTAP-RD) model, see Corong et al. (2017) and Aguiar et al. (2020), which links sequential equilibria through capital accumulation and endogenous labor responses. This structure allows the evolving tariff environment to influence U.S. trade and production decisions over time, capturing both immediate adjustments and the gradual reallocation of resources that characterize dynamic policy effects.

Tariff changes are implemented as bilateral wedges on import prices, Equation (8), ensuring that policy shocks in each period are introduced at the same level of disaggregation as the underlying tariff measures. The bilateral tariff $t_{c,s,\mathrm{US},t}$ applies to the world price $p^w_{c,s,\mathrm{US},t}$, generating source-specific tariff-inclusive import prices $p^m_{c,s,\mathrm{US},t}$. These price differentials are transmitted through the Armington structure, reallocating U.S. import composition and domestic demand (Hertel, 1997).

$$p^m_{c,s,US,t} = \left(1 + t_{c,s,US,t}\right) p^w_{c,s,US,t}, \tag{8}$$

where c indexes sectors, s indexes source regions, and t denotes time periods.

Total demand for composite good $Q_{c,\mathrm{US},t}$ is formed by aggregating domestic output $D_{c,\mathrm{US},t}$ and imported varieties $M_{c,\mathrm{US},t}$ through a CES Armington structure with elasticity

σ_A, as defined in eq. (9). Changes in relative prices induced by tariff-inclusive import prices affect the allocation between domestic and imported quantities within the composite good, leading to substitution across sources while preserving the overall demand aggregation implied by preferences.

$$Q_{c,\mathrm{US},t} = \left[\alpha_{D,c} D_{c,\mathrm{US},t}^{\rho_A} + \alpha_{M,c} M_{c,\mathrm{US},t}^{\rho_A}\right]^{1/\rho_A}, \qquad \sigma_A = \frac{1}{1-\rho_A}. \tag{9}$$

From the supply side, the tariff wedge raises the cost of imported intermediates embedded in composite inputs. Through Armington aggregation, higher import prices increase composite input costs, inducing firms to re-optimize their input mix and constraining output capacity. These cost pressures pass through vertical production linkages, compressing value added in import-intensive sectors and altering relative profitability across activities.

In the recursive–dynamic framework, resource reallocation is accommodated through an endogenous labor supply response. Changes in labor demand are absorbed along an upward-sloping supply curve, partitioning adjustment between employment and real wages and mitigating the binding capacity constraints implied by fixed-factor closures:

$$L_{l,\mathrm{US},t} = \overline{L}_{l,\mathrm{US}} \left(\frac{W_{l,\mathrm{US},t}}{P_{\mathrm{US},t}^{\mathrm{cpi}}}\right)^{\varepsilon_l}, \qquad \varepsilon_l > 0. \tag{10}$$

Here, $L_{l,\mathrm{US},t}$ denotes labor supply of type l, $\overline{L}_{l,\mathrm{US}}$ is the baseline endowment, $P_{\mathrm{US},t}^{\mathrm{cpi}}$ defines the real wage, and ε_l governs the elasticity of labor supply.

Investment and capital accumulation provide the intertemporal channel through which tariff shocks affect future production capacity. Building on **??**, the evolution of the U.S. capital stock by activity a following the tariff increase is given by:

$$K_{a,\mathrm{US},t+1} = (1-\delta)\, K_{a,\mathrm{US},t} + I_{a,\mathrm{US},t}\big(r_{a,\mathrm{US},t}(t_{c,s,\mathrm{US},t})\big), \tag{11}$$

where investment $I_{a,\mathrm{US},t}$ depends on the expected sectoral rate of return $r_{a,\mathrm{US},t}$, which reflects tariff-induced changes in profitability.

Through this mechanism, tariff-induced cost distortions affect labor allocation within each period while simultaneously reshaping the capital stock across periods, allowing successive tariff shocks to accumulate into persistent changes in production structure. Variations in $t_{c,s,\mathrm{US},t}$ reallocate investment across activities, translating short-run distortions into medium-run adjustments in capital, resource allocation, and output.

3.2 | Structural Quality Index for Macro-micro Insights

CGE models generate extensive post-simulation results on prices, quantities, and welfare across multiple dimensions as economies adjust to a new equilibrium relative to the baseline. Adjustments occur simultaneously across margins such as trade flows, production costs, and domestic conditions, with heterogeneous directions and magnitudes (Hertel, 1997; Corong et al., 2017). This complexity obscures whether observed outcomes reflect structurally grounded growth or short-term, shock-driven adjustment.

To address this challenge, we introduce the Structural Quality Index (SQI), a data-driven macro–micro measure that aggregates CGE outputs while preserving theoretical consistency and avoiding double counting. The SQI focuses on directional responses across external exposure and internal adjustment channels, linking bilateral shocks to sectoral and country-level outcomes (Figure 1).

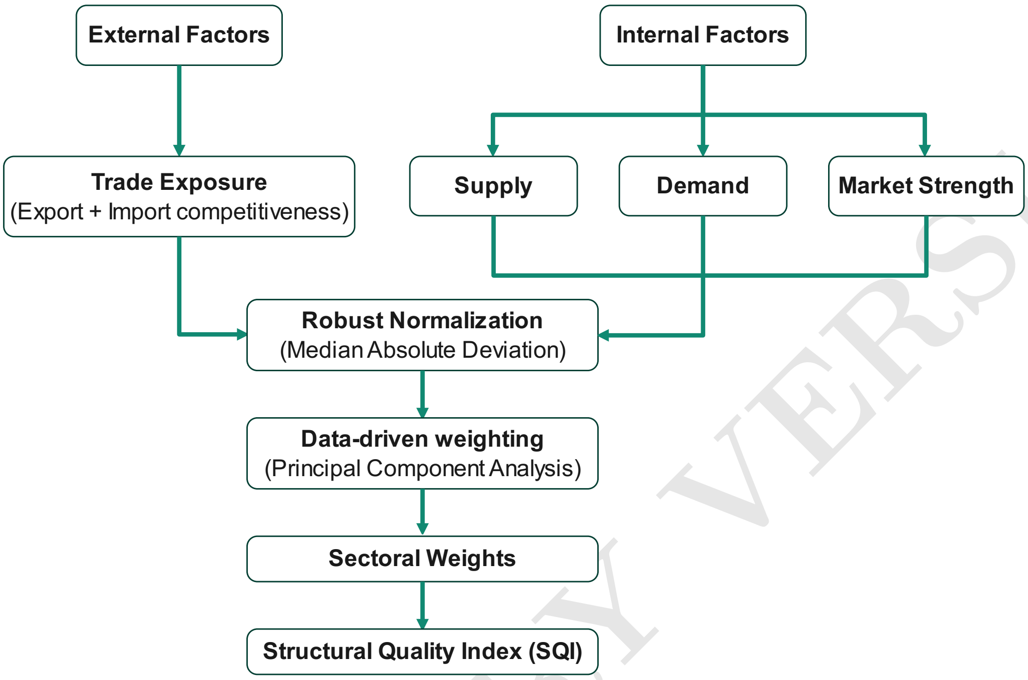


Figure 1: Structural Quality Index (SQI): macro–micro post-simulation framework

Note: Conceptual framework for synthesizing CGE simulation outcomes into the Structural Quality Index (SQI) through robust normalization and data-driven sectoral weighting.
Source: Author's construction.

3.2.1 Bilateral Transmission and Exposure Indices

To quantify sectoral trade pressure, we construct the sectoral exposure index $s^{\text{eps}}_{c,r}$, which aggregates import- and export-side competitive pressures arising from joint quantity and price adjustments in bilateral trade. Import exposure increases with higher import quantities and lower prices, while export exposure increases with higher export quantities and prices. Total exposure is defined as:

$$s^{\text{eps}}_{c,r} = s^{\text{imp}}_{c,r} + s^{\text{exp}}_{c,r}, \tag{12}$$

where

$$s^{\text{imp}}_{c,r} = \sum_{s \neq r} w^{m}_{c,s,r} \left(q^{m}_{c,s,r} - p^{m}_{c,s,r}\right), \qquad s^{\text{exp}}_{c,r} = \sum_{d \neq r} w^{x}_{c,r,d} \left(q^{x}_{c,r,d} + p^{x}_{c,r,d}\right). \tag{13}$$

The weights $w^{m}_{c,s,r}$ and $w^{x}_{c,r,d}$ are baseline trade-share weights constructed from pre-shock bilateral trade values $V^{m}_{c,s,r}$ and $V^{x}_{c,r,d}$, respectively:

$$w^{m}_{c,s,r} = \frac{|V^{m}_{c,s,r}|}{\sum_{s' \neq r} |V^{m}_{c,s',r}|}, \qquad w^{x}_{c,r,d} = \frac{|V^{x}_{c,r,d}|}{\sum_{d' \neq r} |V^{x}_{c,r,d'}|}.$$

Building on Viner (1950)'s framework of trade creation and diversion, we classify bilateral adjustments for each sectoral trade flow by comparing bilateral price and quantity changes to weighted global benchmarks. To distinguish efficiency-driven responses from distortionary movements, we construct trade-value-weighted world-price benchmarks:

$$\bar{P}^m_{c,d} = \frac{\sum_s V^m_{c,s,d} \cdot p^m_{c,s,d}}{\sum_s V^m_{c,s,d}}, \qquad \bar{P}^x_{c,s} = \frac{\sum_d V^x_{c,s,d} \cdot p^x_{c,s,d}}{\sum_d V^x_{c,s,d}}. \tag{14}$$

Table 1 reports the resulting regimes based on quantity changes and price movements relative to world-price benchmarks, summarizing ex-post bilateral trade statuses, with import and export cases treated separately.

Table 1: Classification of Bilateral Trade Adjustments

Quantity	Relative Price	Import Side	Export Side	Exposure
> 0	$p \leq \bar{P}$	*Trade Creation*: Expansion at favorable prices.	*Competitiveness Gain*: Market capture via pricing.	$+$
> 0	$p > \bar{P}$	*Trade Diversion*: Expansion despite higher costs.	*Market Surge*: Demand- or quality-driven expansion.	$\pm$
≤ 0	$p \leq \bar{P}$	*Imp. Compression*: Internal-demand contraction.	*Exp. Compression*: External-demand contraction.	$\pm$
≤ 0	$p > \bar{P}$	*Imp. Destruction*: Cost-driven contraction.	*Exp. Destruction*: Loss of competitiveness.	$-$

Note: $\bar{P}$ is the world-price benchmark, defined separately for imports (tariff-inclusive) and exports (export-tax-inclusive); Exposure denotes the sign of $(q^m - p^m)$ and $(q^x + p^x)$, aggregated as in eq. (12).

3.2.2 Sectoral Structural Indicators

The sectoral adjustment framework captures internal responses not reflected in external trade pressure, s^{eps} in eq. (12). We construct five indicators of internal adjustment—consumer prices (s^{cpi}), domestic sales performance (s^{dom}), cost efficiency (s^{eff}), supply-chain resilience (s^{res}), and structural depth (s^{dep}). These indicators are theory-consistent but not unique and can be adapted to the policy context.

Sectoral consumer prices reflect the burden or relief experienced by private households. The change in aggregate purchase prices is measured by combining domestic and imported varieties for each sector and region:

$$s^{\text{cpi}}_{c,r} = (1 - \omega^M_{c,r})\, \Delta p^{\text{dom}}_{c,r} + \omega^M_{c,r}\, \Delta p^{\text{imp}}_{c,r}, \tag{15}$$

where $\omega^M_{c,r}$ denotes the import expenditure share for sector c in region r. Negative values imply welfare gains through lower consumption costs, consistent with standard price-index and trade-cost interpretations (Feenstra, 2010).

Domestic market performance assesses the structural vitality of domestic sectors by separating volume expansion from price effects. This indicator is defined as the difference between changes in domestic sales quantity $\Delta q^{\text{dom}}_{c,r}$, which reflect realized market outcomes, and domestic supply prices $\Delta ps^{\text{dom}}_{c,r}$, which capture producer-side cost conditions, as defined in eq. (16). Positive values indicate volume growth exceeding price increases, while negative values reflect supply constraints or contracting demand relative to prices (Pavcnik, 2002).

$$s^{\text{dom}}_{c,r} = \Delta q^{\text{dom}}_{c,r} - \Delta ps^{\text{dom}}_{c,r}. \tag{16}$$

Cost efficiency, denoted by s^{eff}, is measured as the ratio of changes in total production costs—including expenditures on domestic and imported intermediate inputs, primary factors, and production taxes ($\Delta TPC_{c,r}$)—to changes in output value at supplier prices ($\Delta VOS_{c,r}$), relative to the baseline equilibrium. Higher values of eq. (17) indicate greater cost intensity and lower productive efficiency (Syverson, 2011; Restuccia & Rogerson, 2017).

$$s^{\text{eff}}_{c,r} = \frac{\Delta TPC_{c,r}}{\Delta VOS_{c,r}} \times 100. \tag{17}$$

Supply chain resilience measures allocative efficiency as the net welfare effect of reallocating intermediate sourcing between domestic and imported inputs. Let $\mathcal{W}^{\text{dom}}_{c,a,r}$ and $\mathcal{W}^{\text{imp}}_{c,a,r}$ denote the corresponding welfare contributions for input c used by activity a in region r; the resilience indicator s^{res}, defined in eq. (18), takes positive values when sourcing shifts welfare-improvingly toward domestic inputs, consistent with allocative efficiency and global value-chain adjustment (Antràs & Chor, 2013; Miroudot, 2020).

$$s^{\text{res}}_{c,r} = \sum_a \mathcal{W}^{\text{dom}}_{c,a,r} - \sum_a \mathcal{W}^{\text{imp}}_{c,a,r}. \tag{18}$$

Structural depth, s^{dep} defined in eq. (19), measures the relative shift of sectoral production toward value-added activities versus intermediate input use, based on joint price and quantity adjustments. It is computed as the difference between changes in value-added prices and quantities, $\Delta p^{\text{va}}_{c,r}$ and $\Delta q^{\text{va}}_{c,r}$, and the corresponding changes for composite intermediate inputs, $\Delta p^{\text{int}}_{c,r}$ and $\Delta q^{\text{int}}_{c,r}$. Positive values indicate a shift toward higher value-added production and deeper domestic embedding (Antràs & Chor, 2013; Koopman et al., 2014).

$$s^{\text{dep}}_{c,r} = \left(\Delta p^{\text{va}}_{c,r} + \Delta q^{\text{va}}_{c,r}\right) - \left(\Delta p^{\text{int}}_{c,r} + \Delta q^{\text{int}}_{c,r}\right). \tag{19}$$

3.2.3 Construction of the Structural Quality Index

Aggregating heterogeneous CGE outputs raises two methodological challenges. First, mixed-unit variables must be mapped onto a common, unit-free scale (Huber, 1981, ch. 5). Second, composite indicators must avoid overlapping-effects bias arising from multicollinearity among jointly determined equilibrium variables, which can otherwise induce implicit double counting (Hertel, 1997; Corong et al., 2017). In recursive-dynamic CGE models, such redundancies may cumulate over time, distorting cross-simulation and intertemporal comparisons.

We address unit comparability using global robust standardization based on the median absolute deviation (MAD), a canonical high-breakdown estimator in robust statistics (Hampel, 1974; Rousseeuw & Croux, 1993). Normalization is performed over the pooled distribution of all sectors c, regions r, and simulations σ:

$$\tilde{s}^{i}_{c,r,\sigma} = \frac{s^{i}_{c,r,\sigma} - \text{median}(s^i)}{1.4826\ \text{MAD}^i} \quad \forall\, i \in \{\text{eps}, \text{cpi}, \text{dom}, \text{eff}, \text{res}, \text{dep}\}, \tag{20}$$

where $\text{MAD}^i = \text{median}(|s^i - \text{median}(s^i)|)$. The scaling constant 1.4826 ensures consistency with the standard deviation under normality, since $\text{median}(|Z|) = \Phi^{-1}(0.75)$ for $Z \sim \mathcal{N}(0,1)$ (Huber, 1981; Rousseeuw & Croux, 1993).

The resulting unit-free scores, $\tilde{s}$, are mapped onto the bounded interval $[-1, 1]$ to ensure a consistent and interpretable scale, as defined in eq. (21). This monotone transformation preserves ordinal rankings while attenuating the influence of extreme realizations, thereby placing heterogeneous components on a common scale and enabling comparisons of relative sectoral positions within each country–simulation–period.

$$\hat{s}^i_{c,r,\sigma} = \frac{\tilde{s}^i_{c,r,\sigma}}{1 + |\tilde{s}^i_{c,r,\sigma}|}. \tag{21}$$

To address multicollinearity among the structural scores and to avoid overlapping-effects bias when aggregating CGE outcomes, we derive data-driven weights using Principal Component Analysis (PCA). PCA exploits the empirical covariance structure of the standardized indicators to construct an orthogonal weighting scheme that concentrates the shared equilibrium response into a single dominant component (Hotelling, 1933; Jolliffe, 2002; Abdi & Williams, 2010).

The objective is to find the projection vector $\mathbf{v}$ that captures the maximum joint variation in the standardized structural indicators $\hat{s}^i$. Let $\boldsymbol{\Sigma}$ denote their covariance matrix, so that $\mathbf{v}^\top \boldsymbol{\Sigma} \mathbf{v}$ equals the variance of the linear combination $\mathbf{v}^\top \hat{\mathbf{s}}$. The optimization problem is:

$$\max_{\mathbf{v}} \ \mathbf{v}^\top \boldsymbol{\Sigma} \mathbf{v} \quad \text{s.t.} \quad \mathbf{v}^\top \mathbf{v} = 1, \tag{22}$$

where the unit-norm constraint ensures identification. To ensure all indicators contribute non-negative weights, the aggregation weights w^i are defined as normalized absolute elements of $\mathbf{v}$:

$$w^i = \frac{|v_i|}{\sum_j |v_j|}. \tag{23}$$

The SQI is constructed at three aggregation levels. At the bilateral–sector level, structural trade exposure is captured by eq. (12). At the country–sector level, defined in eq. (24), multiple structural dimensions are aggregated using PCA-derived weights. Finally, the country-level SQI is obtained as the output-weighted average of sectoral scores in eq. (25), providing a consistent macro–micro linkage for policy analysis.

$$SQI_{c,r,\sigma} = \sum_i w^i \hat{s}^i_{c,r,\sigma}. \tag{24}$$

$$SQI_{r,\sigma} = \sum_c \omega_{c,r,\sigma} SQI_{c,r,\sigma}, \quad \omega_{c,r,\sigma} = \frac{VOS_{c,r,\sigma}}{\sum_{c'} VOS_{c',r,\sigma}}. \tag{25}$$

In addition to the country-level aggregation in eq. (25), the SQI can be summarized across regions for a given sector to obtain $SQI_{c,\sigma}$, enabling interpretation of global sectoral adjustment. Its unit-free construction and robust normalization allow consistent cross-region and cross-sector comparisons across policy scenarios while remaining insensitive to scale and outliers (Hampel, 1974; Rousseeuw & Croux, 1993; Jolliffe, 2002).

3.2.4 Economic Interpretation and Classification of the SQI

We introduce an economic interpretation that translates the unit-free SQI into economically meaningful regimes reflecting relative structural positions. Building on the bilateral–sector classifications in Table 1, the analysis focuses on country–sector adjustment patterns and their aggregation to the country level. The country–sector SQI defined in eq. (24) is classified along three dimensions: trade position, growth driver, and structural source, grounded in relevant economic theory.

Sectoral comparability within each country is achieved by rescaling the SQI by its country-level dispersion, producing a normalized index that measures deviations from the national benchmark and defines the quartile-based classification in Table 2. Let $S\bar{Q}I_{r,\sigma}$ denote the output-weighted country-level SQI as defined in eq. (25). The normalized SQI is defined as:

$$\widetilde{SQI}_{c,r,\sigma} = \frac{SQI_{c,r,\sigma} - S\bar{Q}I_{r,\sigma}}{\sqrt{\sum_c \omega_{c,r,\sigma} \left(SQI_{c,r,\sigma} - S\bar{Q}I_{r,\sigma}\right)^2}}, \tag{26}$$

Table 2: Country–Sector Structural Classification

Classification	**Conditions**	**Economic Interpretation**
Trade Position		
Dual-Advantaged	$\hat{s}^{\text{exp}}_{c,r} > 0 \ \wedge \ \hat{s}^{\text{imp}}_{c,r} > 0$	Comparative advantage and competitiveness are inferred from relative export and import performance under joint price–quantity adjustment (Ricardo, 1817; Viner, 1950; P. R. Krugman, 1980; Melitz, 2003)
Dual-Constrained	$\hat{s}^{\text{exp}}_{c,r} < 0 \ \wedge \ \hat{s}^{\text{imp}}_{c,r} < 0$	
Export-Advantaged	$\hat{s}^{\text{exp}}_{c,r} > 0 \ \wedge \ \hat{s}^{\text{exp}}_{c,r} > \lvert\hat{s}^{\text{imp}}_{c,r}\rvert$	
Export-Constrained	$\hat{s}^{\text{exp}}_{c,r} > 0 \ \wedge \ \lvert\hat{s}^{\text{imp}}_{c,r}\rvert > \hat{s}^{\text{exp}}_{c,r}$	
Import-Advantaged	$\hat{s}^{\text{imp}}_{c,r} > 0 \ \wedge \ \hat{s}^{\text{exp}}_{c,r} \leq 0$	
Import-Constrained	$\hat{s}^{\text{imp}}_{c,r} < 0 \ \wedge \ \hat{s}^{\text{exp}}_{c,r} \leq 0$	
Neutral	Otherwise	
Growth Driver		
Domestic Driven	$\lvert\hat{s}^{\text{dom}}_{c,r}\rvert > \lvert\hat{s}^{\text{eps}}_{c,r}\rvert \ \wedge \ \hat{s}^{\text{dom}}_{c,r} > 0$	Demand-led versus external-led growth frameworks identify the dominant growth engine by the relative strength of domestic absorption and external demand (Thirlwall, 1979; Hertel, 1997; Rodrik, 2013)
Domestic Shock	$\lvert\hat{s}^{\text{dom}}_{c,r}\rvert > \lvert\hat{s}^{\text{eps}}_{c,r}\rvert \ \wedge \ \hat{s}^{\text{dom}}_{c,r} < 0$	
Trade Driven	$\lvert\hat{s}^{\text{eps}}_{c,r}\rvert > \lvert\hat{s}^{\text{dom}}_{c,r}\rvert \ \wedge \ \hat{s}^{\text{eps}}_{c,r} > 0$	
Trade Shock	$\lvert\hat{s}^{\text{eps}}_{c,r}\rvert > \lvert\hat{s}^{\text{dom}}_{c,r}\rvert \ \wedge \ \hat{s}^{\text{eps}}_{c,r} < 0$	
Balanced	Otherwise	
Structural Source		
Efficient-Local	$\hat{s}^{\text{eff}}_{c,r} > 0 \ \wedge \ \hat{s}^{\text{res}}_{c,r} > 0$	Distinguishes allocative efficiency from the domestic versus foreign origins of sectoral competitiveness (Antràs & Chor, 2013; Koopman et al., 2014).
Efficient-Imported	$\hat{s}^{\text{eff}}_{c,r} > 0 \ \wedge \ \hat{s}^{\text{res}}_{c,r} \leq 0$	
Inefficient-Local	$\hat{s}^{\text{eff}}_{c,r} \leq 0 \ \wedge \ \hat{s}^{\text{res}}_{c,r} > 0$	
Inefficient-Imported	$\hat{s}^{\text{eff}}_{c,r} \leq 0 \ \wedge \ \hat{s}^{\text{res}}_{c,r} \leq 0$	
Structural Performance		
Favorable Position	$\widetilde{SQI}_{c,r} \in Q_4$	Structural transformation and sectoral upgrading are evaluated using relative performance rankings (Hausmann et al., 2007; McMillan & Rodrik, 2014)
Moderately Favorable	$\widetilde{SQI}_{c,r} \in Q_3$	
Moderately Unfavorable	$\widetilde{SQI}_{c,r} \in Q_2$	
Unfavorable Position	$\widetilde{SQI}_{c,r} \in Q_1$	

Note: Each $\hat{s}^i$, for $i \in \{\text{exp}, \text{imp}, \text{cpi}, \text{dom}, \text{eff}, \text{res}, \text{dep}\}$, is a bounded indicator in $[-1, 1]$ defined in eq. (21). $\widetilde{SQI}$ denotes the normalized Structural Quality Index defined in eq. (26). Interpretations depend on the indicator set and CGE model specification.

We extend the analysis to the aggregate country level by relating structural quality to the direction of economic activity, $DOC_{r,\sigma}$, as defined in eq. (27). The measure is computed as the output-weighted average percentage change in sectoral output, $qo_{c,r,\sigma}$, obtained from the CGE simulations, where $\omega_{c,r,\sigma}$ denotes the corresponding sectoral value-added share, defined consistently with eq. (25). Table 3 summarizes the joint interpretation of $SQI_{r,\sigma}$ and $DOC_{r,\sigma}$.

$$DOC_{r,\sigma} = \sum_{c} \omega_{c,r,\sigma}\, qo_{c,r,\sigma}, \tag{27}$$

Table 3: Country-Level Structural Quality Regimes

Regime	Condition	Economic Interpretation
Structural Growth	$DOC > 0 \wedge SQI > 0$	Output expansion with improving structural efficiency, consistent with productivity-led and welfare-enhancing structural change (Solow, 1957; Rodrik, 2013).
Distorted Expansion	$DOC > 0 \wedge SQI \leq 0$	Output growth occurs alongside declining structural quality, indicating distortion-led expansion rather than efficiency gains (Harberger, 1964; Restuccia & Rogerson, 2008).
Structural Consolidation	$DOC \leq 0 \wedge SQI > 0$	Aggregate output contracts while structural quality improves, reflecting efficiency-enhancing reallocation and exit of low-productivity activities (Schumpeter, 1942; Melitz, 2003).
Shock-Driven Loss	$DOC \leq 0 \wedge SQI \leq 0$	Output and structural quality decline jointly, reflecting distortion-amplified policy shocks and misallocation (Blanchard & Quah, 1989; Gopinath et al., 2020).

Note: DOC denotes the value-weighted percentage change in aggregate output, as defined in eq. (27), and SQI is reported at the country level as computed in eq. (25).

4 | DATA AND POLICY SIMULATION

This study employs the GTAP Version 11c database as the core computable general equilibrium dataset. The data are aggregated to 10 sectors and 34 regions; see Tables A1 and A2, respectively. The baseline projections are aligned with the Shared Socioeconomic Pathways (SSPs) and the Organisation for Economic Co-operation and Development (OECD) outlooks, which provide consistent forecasts of key macroeconomic indicators such as GDP, population, and factor endowments. Baseline bilateral tariff levels are based on estimates from the Market Access Map (MAcMap) database.

In addition, we incorporate U.S. tariff data reported by the United States International Trade Commission (USITC). For this paper, we use Revision 30 to capture the implementation of tariffs at the disaggregated HTS8 level, preserving both product heterogeneity and country-specific tariffs, as documented in Appendix B. These text-based schedules are converted into bilateral applied rates using Natural Language Processing (NLP), as detailed in Appendix C.

4.1 | Calibration and Policy Shocks

We employ a recursive–dynamic simulation spanning 2017–2035 with five policy shocks, summarized in Figure 2. GTAP tariff data are calibrated to match 2017 USITC estimates using the *GTAP-AlterTax* mechanism, with resulting differences shown in Figure 3.[6] Pre-

[6]The *AlterTax* procedure adjusts tax wedges while holding quantities fixed, allowing GTAP to incorporate updated USITC tariff data with minimal distortion; see Malcolm (2000).

shocks in 2019 and 2023 are introduced to account for administrative policy changes and to maintain alignment with USITC tariff data along the dynamic path.

The reciprocal tariff policy is implemented in two stages, with product-specific rates introduced in 2025 and country-specific rates in 2026, reflecting their distinct aggregation structures. Product-level tariffs correspond to the *UNI_ PART* case and country-specific tariffs to *UNI_ COMM*, allowing the dynamic simulation to preserve their respective transmission mechanisms (Hertel, 1997; Corong et al., 2017). A final shock in 2030 reverses tariffs to their 2025 levels by eliminating the country-specific rates, allowing observation of whether the economy recovers toward its dynamic growth path.

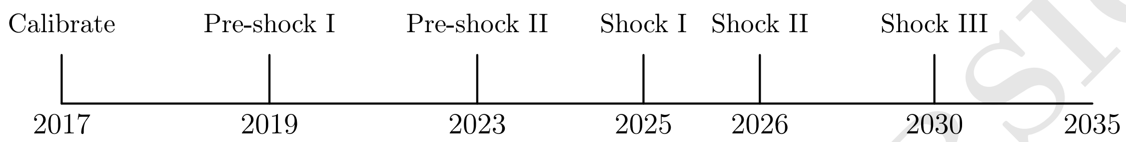


Figure 2: Calibration and tariff shock implementation timeline, 2017–2035

Note: The 2017 baseline employs *AlterTax* for tariff calibration. *Pre-shock I* and *Pre-shock II* update the dynamic path prior to the reciprocal tariff intervention. *Shock I* applies product-specific tariffs from HTS Rev. 30, *Shock II* adds the corresponding country-specific rates extracted from the same revision, and *Shock III* reverts tariffs to their 2025 levels.

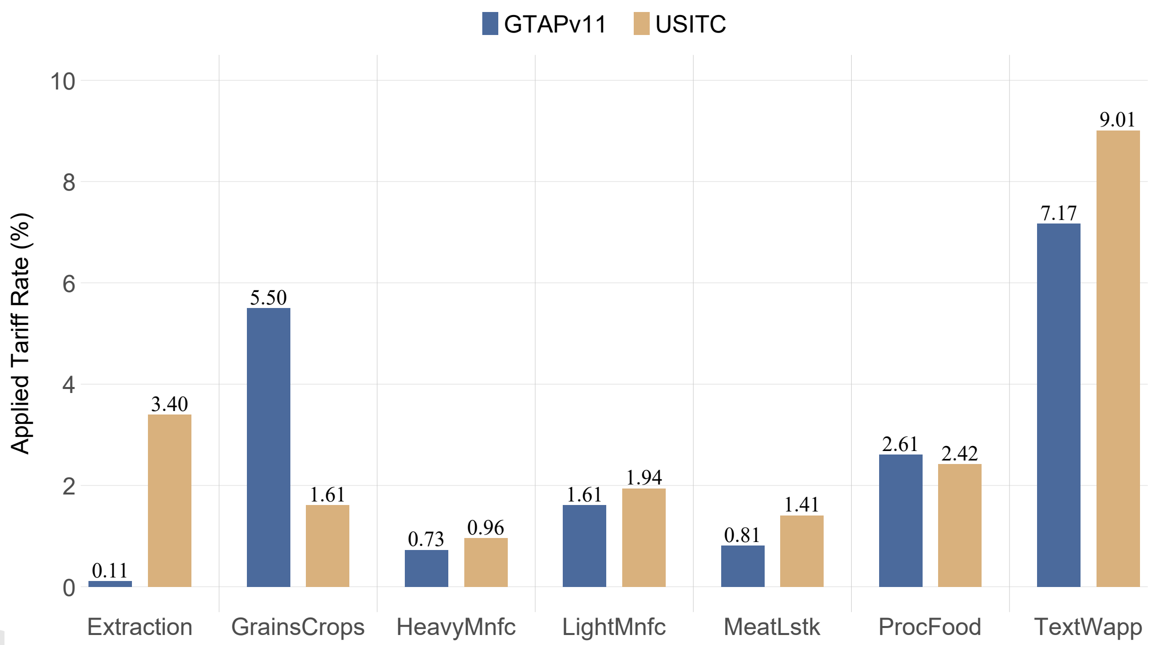


Figure 3: Comparison of U.S. tariffs in 2017 between GTAP v11 and USITC data

Source: GTAPv11 tariffs are derived from the GTAP database, while USITC tariffs are collected from the U.S. International Trade Commission and aggregated to the sectoral level by the authors.

4.2 | Scenario Design

The policy experiments compare three alternative global responses to the U.S. reciprocal tariff measures. The *NoRetal* refers to a scenario in which other regions keep their tariffs unchanged. The *TarRetal* simulates a trade war, with trading partners imposing retaliatory tariffs against the U.S. equal to 50% of the U.S. tariff increase in the affected sectors. The *ReduceTar* is a trade-liberalization alternative, with non-U.S. regions mutually reducing bilateral tariffs by 50% following a U.S. tariff increase.

Table 4 summarizes the construction of the policy shocks. Let $\mathcal{C}$ denote the set of 10 sectors and $\mathcal{R}$ the set of 34 regions, with $row \equiv \mathcal{R} \setminus \{\text{USA}\}$ denoting U.S. trading partners. The variable $\Delta t_{c,row,row'}$ denotes tariff shocks measured as level changes applied to imports of sector $c \in \mathcal{C}$ from region row and imposed by region row'. The term $t_{c,row,row'}$ denotes the applied tariff rate expressed in percentage terms.

Table 4: Trading Partner Responses to the U.S. Reciprocal Tariff Policy

Scenario	Shock Structure	Description
NoRetal	$\Delta t_{c,USA,row} = 0$	Trading partners keep tariffs on U.S. imports unchanged.
TarRetal	$\Delta t_{c,USA,row} = 0.5\,\Delta t_{c,row,USA}$	Trading partners retaliate at 50% of the U.S. tariff increase.
ReduceTar	$\Delta t_{c,row,row} = -0.5\,t_{c,row,row}$	Non-U.S. regions mutually reduce applied tariff rates by 50% in sectors targeted by U.S. tariff increases.

Note: c denotes tariff-targeted sectors; $\mathcal{R}$ denotes regions, with $row = \mathcal{R} \setminus \{USA\}$. $\Delta t_{c,row,row'}$ denotes tariff level changes, while $t_{c,row,row'}$ denotes the applied tariff rate.

5 | RESULTS

The results are organized into two sections. The first examines policy implications and global adjustment responses from GTAP-RD simulations of the U.S. reciprocal tariff policy. The second section incorporates the Structural Quality Index (SQI) as an additional diagnostic indicator to bridge macro–micro insights from the GTAP-RD results.[7]

5.1 | Recursive Dynamic Policy Simulation Results

GTAP-RD simulations applying our NLP text–based U.S. tariff conversion address the aggregation bias identified in the Monte Carlo exercises. Results are reported for the United States and the Rest of the World (ROW), with ROW aggregating the remaining 33 regions. Individual country-level outcomes are reported in Appendix D. Figure 4 summarizes post-simulation U.S. tariff rates averaged across trading partners.

The 2019 and 2023 shocks generate mild changes across sectors. In 2025, a sharp divergence appears when the product-specific reciprocal tariff targeting major U.S. deficit sectors substantially increases rates in manufacturing-intensive sectors—rising by roughly 770–1100%. Agriculture- and food-related sectors, including grains and crops, processed food, and meat, increase by about 450–870%. Extraction records the smallest change,

[7] All results are generated using the `GTAPViz` R package (Puangchit, 2025).

reflecting the U.S. dependence on imported rare-earth inputs. The country-specific tariff in 2026 intensifies these patterns, doubling most sectoral increases.

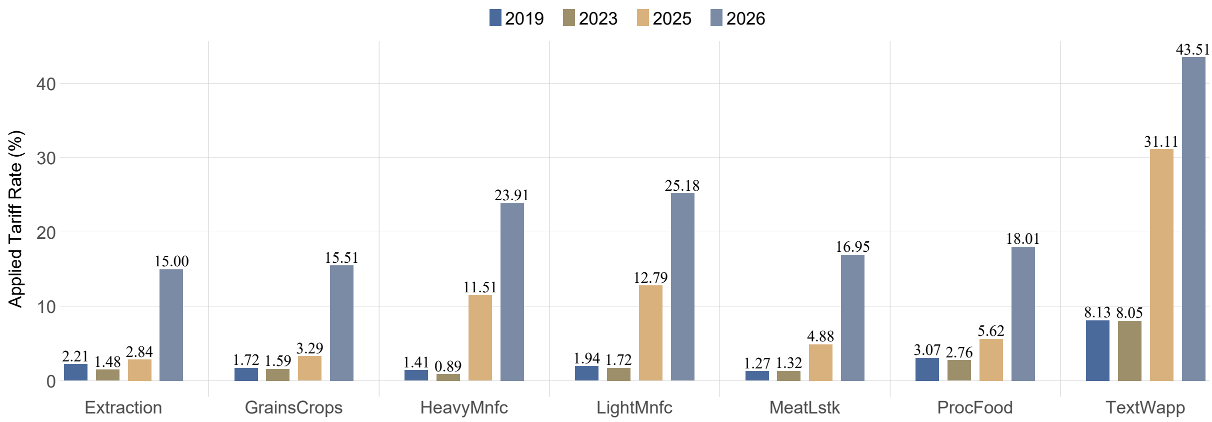


Figure 4: Post-shock U.S. applied tariffs, 2019–2026

Note: Values report post-shock U.S. average applied tariffs across all trading partners by sector.

5.1.1 Real GDP Decomposition

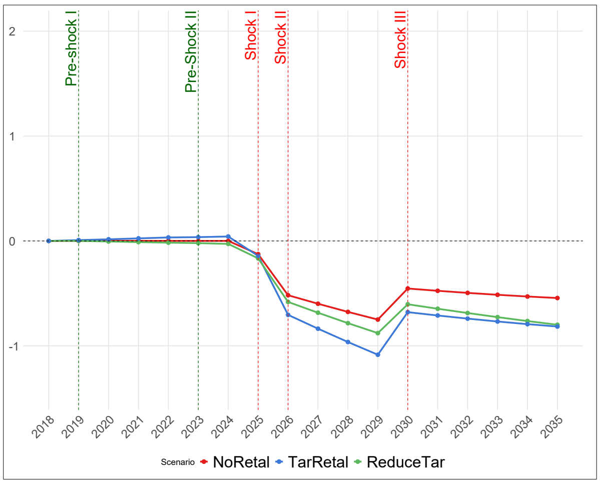
U.S. real GDP declines across all scenarios once reciprocal tariffs are imposed (Figure 5a). Losses are largest under *TarRetal*, where partner counter-tariffs worsen the U.S. terms of trade and restrict market access (Bagwell & Staiger, 1999). The 2030 rollback offers only partial relief before the downward trend resumes, indicating persistent long-run scarring driven by gradual capital adjustment and reallocation frictions (Aguiar et al., 2020).

Rest-of-World outcomes differ sharply across policy responses (Figure 5b). GDP falls in both *NoRetal* and *TarRetal*, with the latter showing deeper short-run losses due to trade-war costs (P. R. Krugman et al., 2018). *TarRetal* partially recovers in the mid-run as firms reallocate toward alternative markets and signals better long-run performance than *NoRetal* (Melitz, 2003). By contrast, *ReduceTar* drives economic growth, signaling trade creation and diversion as lower intra-ROW barriers redirect supply chains toward more efficient partners, offsetting lost U.S. market access (Viner, 1950).

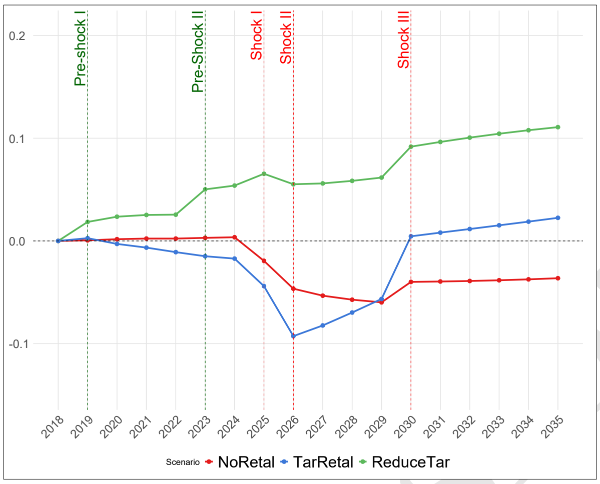
Figure 6 decomposes the negative U.S. GDP components, which are primarily driven by declines in exports and investment (Figure 6a).[8] Losses peak under *TarRetal* as household consumption sharply declines, consistent with non-cooperative tariff settings where retaliation eliminates terms-of-trade gains and magnifies efficiency losses through higher domestic prices (Johnson, 1953). While *NoRetal* and *ReduceTar* generally return a similar structure in the U.S. GDP decomposition,

Persistent investment weakness across all scenarios highlights the domestic cost of protectionism (Ianchovichina & Walmsley, 2012). Although tariffs raise nominal revenue, their real incidence acts as a tax on domestic agents (Harberger, 1962; Hertel, 1997). Despite a positive government contribution across setups, the decline in overall activity reduces the fiscal base faster than tariff receipts expand it, leaving the public sector to absorb part of the adjustment cost (Amiti et al., 2019; Fajgelbaum et al., 2020; Cavallo et al., 2021; Barattieri & Cacciatore, 2021).

[8]The positive contribution of imports reflects lower import volumes, which mechanically raise real GDP through the national accounts identity where imports enter with a negative sign.



(a) United States



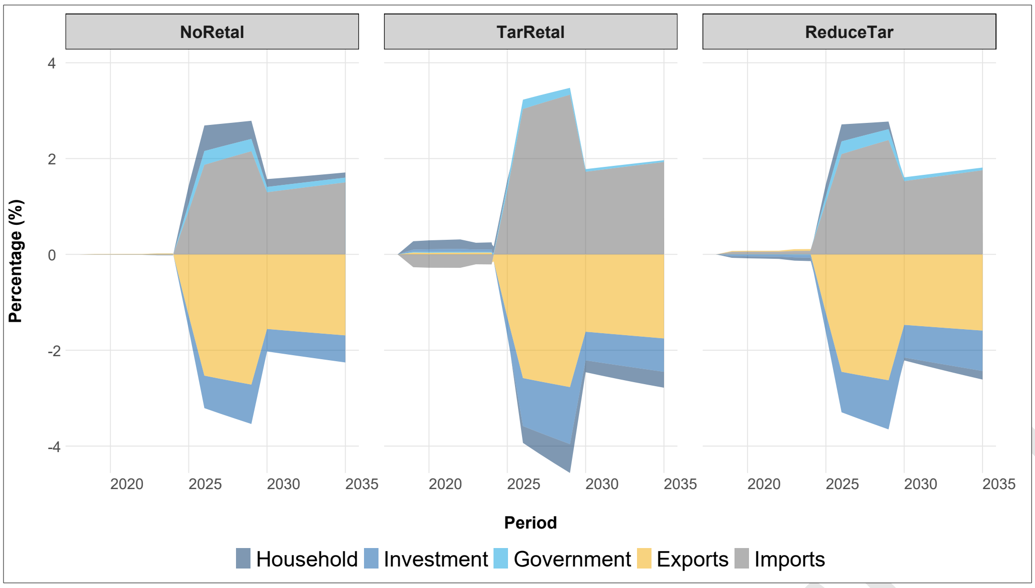
(b) Rest of World

Figure 5: Real GDP responses across policy scenarios

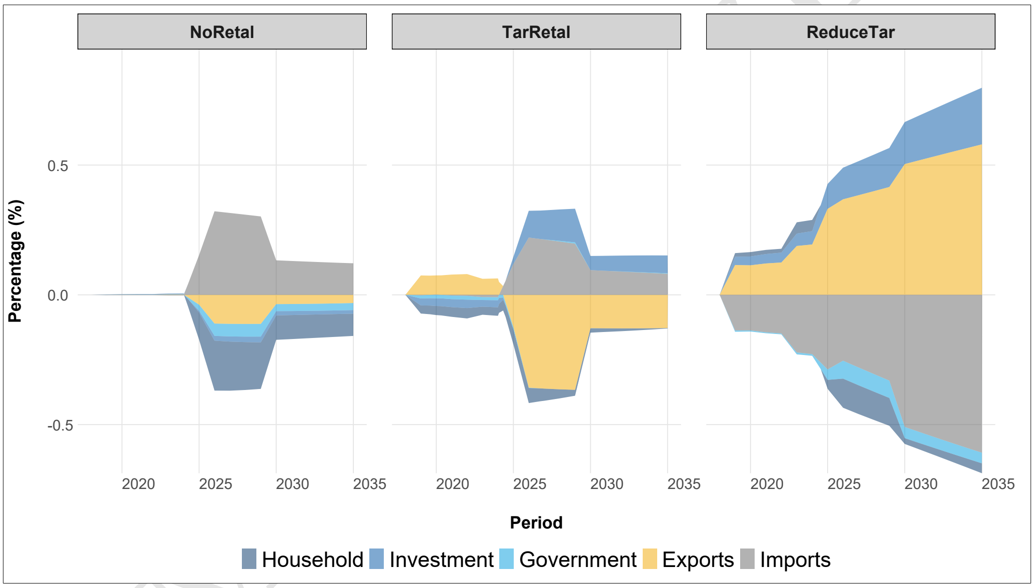
Note: Changes are reported in percentage points relative to the pre-policy baseline.

The decomposition of ROW's GDP (Figure 6b) shows a consistent decline in household consumption across all scenarios, with the largest drop under *ReduceTar*. This pattern reflects the stronger shift toward investment under intra-ROW liberalization, supported by the sharp rise in investment under *ReduceTar*, which reallocates resources away from current consumption. As demand shifts away from the United States and liberalization boosts profitability in expanding ROW export sectors, these dynamics draw capital into ROW, raising investment even as consumption remains compressed.

Trade responses show a clear divergence between the U.S. and ROW (Figures 6a and 6b). U.S. exports fall consistently across all scenarios, underscoring its central role in global supply chains and the low sensitivity of foreign demand to U.S. price shifts. ROW trade adjusts asymmetrically across scenarios: both exports and imports contract under *NoRetal* and *TarRetal*, with the latter more pronounced due to the broader tariff escalation. Under *ReduceTar*, ROW trade expands substantially in both imports and exports as trade costs fall.



(a) United States



(b) Rest of World

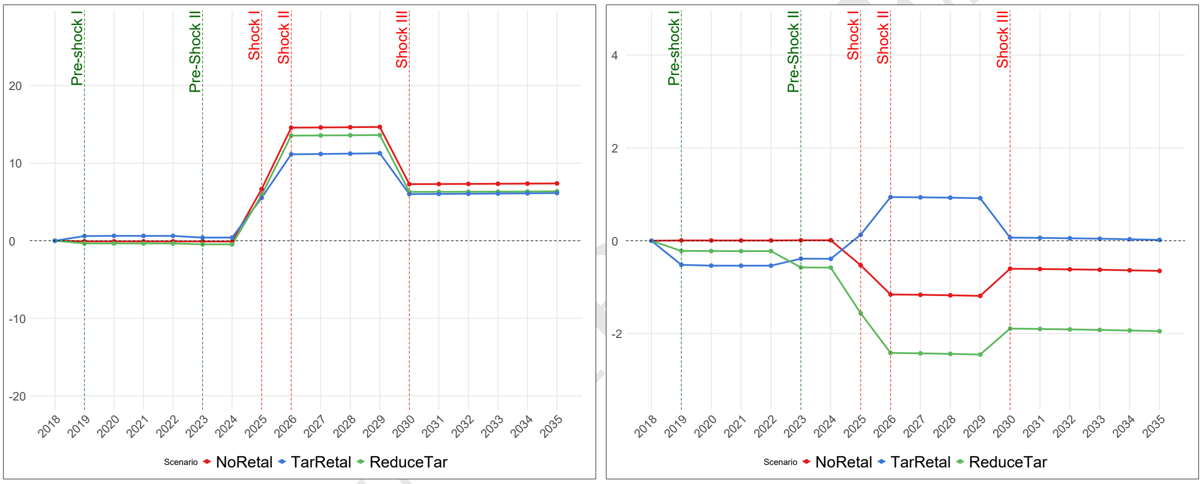
Figure 6: GDP component contributions to real GDP across policy scenarios
Note: The figure presents a stacked trend plot in which segment size reflects the magnitude of each component's contribution to GDP. Values denote percentage-point contributions, with positive segments raising GDP and negative segments lowering it.

5.1.2 Tariff Pass-Through and Price Effects

We examine the Consumer Price Index (CPI) to identify the price-side transmission of the tariff shocks and how these changes translate into household purchasing power. In contrast to the GDP decomposition, which reflects the income and quantity adjustments driving consumption, the CPI isolates movements in traded-input costs and tariff pass-through that shape the real cost of absorption. Considering the CPI alongside the consumption response therefore clarifies whether differences across scenarios arise primarily from price effects, income shifts, or the interaction of the two (Figure 7).

The U.S. exhibits the clearest price pass-through, with CPI rising nearly 15% as higher import costs feed directly into domestic absorption (Amiti et al., 2019; Cavallo et al., 2021). Under *NoRetal*, this price increase coincides with higher consumption (Figure 6a), reflecting temporary fiscal gains that offset the tariff-induced rise in consumer prices. *TarRetal* produces the smallest CPI increase yet the largest drop in consumption, consistent with income losses dominating the weaker price response. *ReduceTar* generates a moderate CPI rise and a slight consumption increase, as lower world prices offer only limited relief while U.S. tariff effects remain unchanged.

For the Rest of World in Figure 7b, CPI movements primarily reflect changes in traded-input costs rather than household spending. Under *NoRetal*, CPI declines as weaker U.S. import demand lowers world prices, even though ROW consumption also falls. *TarRetal* reverses this pattern: CPI increases despite a similar consumption drop because bilateral tariff escalation raises the import prices of U.S. goods. Under *ReduceTar*, CPI falls sharply as intra-ROW liberalization reduces production costs, while the persistent loss of U.S. market access keeps consumption depressed.



(a) United States **(b)** Rest of World

Figure 7: Consumer price index (CPI) responses across policy scenarios

Note: Changes are reported in percentage points relative to the pre-policy baseline.

5.1.3 Welfare Decomposition

The welfare decomposition in Table 5, reported in billion USD, presents cumulative changes for 2018–2029, excluding the assumed 2030 termination shock.[9] The findings indicate that U.S. advantages across all scenarios are mainly driven by the terms-of-trade component rather than by efficiency gains. This outcome aligns with the classic *optimal tariff* mechanism, see Johnson (1953), as a large importer can depress foreign export prices and shift part of the tariff incidence onto its trading partners, evidenced by the ROW's terms-of-trade losses across all scenarios (Broda & Weinstein, 2006).

Within this structure, the United States gains in both *NoRetal* and *ReduceTar*, with the largest increase occurring in *NoRetal* at $225.69 billion. While the terms-of-trade component largely benefits the United States, allocative efficiency and endowment effects

[9]GTAP reports welfare using equivalent variation (Corong et al., 2017).

are negative across all setups. The resulting welfare outcome reflects a *beggar-thy-neighbor* outcome, whereby the U.S. raises real income through an improved terms of trade that shifts the associated cost onto trading partners (Bagwell & Staiger, 1999).

In *TarRetal*, foreign partners raise their tariffs on U.S. exports, undoing much of the price advantage the United States obtains under unilateral protection. With export market access deteriorating, the remaining terms-of-trade gain ($30.26 billion) is insufficient to offset the efficiency loss (-$124.05 billion), yielding a net welfare deficit. This reflects the reduced ability to shift tariff incidence abroad once retaliation neutralizes the initial price effect, making domestic efficiency costs the dominant component (Kennan, 1988).

For the Rest of World, the welfare decomposition reveals a mirror pattern: as the U.S. gains through improved terms of trade, the ROW incurs corresponding losses. In *NoRetal*, where U.S. welfare peaks, the ROW faces its largest decline (-$440.50 billion), driven almost entirely by the sharp deterioration in export prices. These losses underscore that the adjustment is zero-sum rather than value-creating, as the transfer mechanism identified in the U.S. results operates in reverse for the ROW, with domestic efficiency components in both regions reinforcing the contraction rather than offsetting it.

The *TarRetal* welfare advantage arises entirely from strategic terms-of-trade gains, which shield the ROW but do so at the cost of global efficiency (Johnson, 1953; Bagwell & Staiger, 1999). This protection preserves pre-existing distortions rather than correcting them. By contrast, *ReduceTar* lowers import barriers and thereby strengthens allocative efficiency. Although this internal liberalization alleviates efficiency losses, it cannot fully counteract the adverse price shock transmitted through the U.S. tariff increase.

Factor-level decomposition reinforces this distinction (Hertel, 1997). Only *ReduceTar* generates a positive endowment effect ($6.12 billion), indicating that improved real returns stimulate factor supply. The technology component, however, is most negative under *ReduceTar* ($15.67 billion), implying that the structural adjustments needed to realize efficiency gains impose higher short-run costs than the distortion-preserving protectionism in *TarRetal*.

Table 5: Welfare Decomposition across Policy Scenarios

	NoRetal		TarRetal		ReduceTar	
Component	USA	ROW	USA	ROW	USA	ROW
Alloc. Eff.	-62.59	-57.05	-124.05	-53.27	-74.10	-35.87
Endow. Eff.	-28.51	-63.30	-71.35	-3.10	-61.74	6.12
Tech. Change	9.21	-30.67	-1.22	-4.93	6.48	-15.67
Pop. Effect	29.84	-2.97	11.36	3.75	20.97	-27.81
Terms of Trade	227.90	-235.29	30.26	-32.09	192.61	-198.98
Inv.–Sav. Effect	49.84	-51.22	18.25	-18.26	44.47	-45.74
Total	**225.69**	**-440.50**	**-136.75**	**-107.90**	**128.69**	**-317.95**

Note: Values report cumulative welfare changes for 2018–2029 (billion USD), excluding 2030–2035 to omit the termination shock. Alloc. Eff.=allocative efficiency; Endow. Eff.=endowment efficiency; Tech. Change=technological change; Pop. Effect=demographic scale effects; Terms of Trade=terms-of-trade contribution; Inv.–Sav. Effect=investment–savings price component (see Corong et al. (2017)).

5.1.4 Strategic Equilibria

We analyze the strategic interaction in Figure 8 by presenting a *policy–outcome matrix* summarizing changes in cumulative Real GDP and Welfare from 2018–2029. Real GDP reflects production scale and factor utilization, while welfare captures allocative efficiency, scale and endowment adjustments, and terms-of-trade effects (Burfisher et al., 2017). These outcomes do not necessarily align; policies that expand domestic output may simultaneously reduce welfare through adverse terms-of-trade shifts (P. Krugman, 1979). This divergence complicates the identification of a unique equilibrium.

For the United States, we identify *NoRetal* as the strictly dominant strategy (highlighted in green), yielding the optimal outcome across both dimensions. This scenario generates the highest welfare gain ($225.69 billion) consistent with optimal tariff theory (Johnson, 1953), while simultaneously resulting in the smallest contraction in Real GDP ($-25.10 billion) compared to the deeper recessions in alternative scenarios. Thus, the U.S. has a clear incentive to maintain the tariff shock in a static non-cooperative setting where the ROW accepts the status quo.

We find a divergent incentive structure for the ROW (light blue). When the objective is economic expansion, *ReduceTar* is superior, generating substantial Real GDP growth ($267.83 billion) through trade expansion. When limiting welfare losses is the priority, *TarRetal* performs better ($-107.90 billion) due to terms-of-trade defense (Ossa, 2011). *NoRetal* is strictly dominated by the alternative responses on both GDP and welfare, creating a strong incentive for the ROW to move away from passive acceptance.

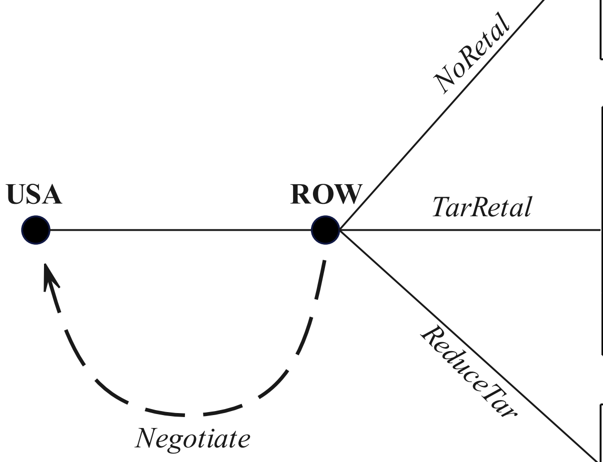
From a global perspective (orange), we identify *ReduceTar* as the Pareto-preferred outcome. It is the only scenario that produces a net expansion in World Real GDP ($167.26 billion), whereas *NoRetal* and *TarRetal* both generate global economic contraction. This scenario also minimizes global deadweight losses ($-189.24 billion). Taken together, these results indicate that unilateral liberalization by the ROW supports global economic activity more effectively than retaliatory protectionism, despite localized welfare costs (Bagwell & Staiger, 1999).

Furthermore, we interpret the dashed *Negotiate* path as the operative policy mechanism implied by these payoffs. Any deviation by the ROW—whether toward the growth-oriented *ReduceTar* or the defensive *TarRetal*—reduces U.S. welfare and GDP relative to *NoRetal*, thereby granting the ROW strategic leverage. This credible threat to shift the outcome encourages the U.S. to enter bargaining, potentially yielding a cooperative solution such as moderated tariffs in exchange for reciprocal market access.

5.1.5 Trade Dynamics: Import Volume and Price Adjustments

The strategic equilibria identify the dominant strategy in terms of GDP and welfare outcomes, while the underlying mechanisms appear in the associated shifts in trade volumes and prices. Figure 9 plots cumulative changes in aggregate import prices (pmw) and quantities (qmw) for 2018–2029 against the standard quadrants of trade adjustment.[10] This price–quantity mapping distinguishes demand-driven movements from efficiency-driven trade adjustments.[11]

[10] pmw is price at average world level, so it cannot accurately capture trade diversion.
[11] Disaggregated countries may exhibit larger adjustments; see Tables D5 to D7.



NoRetal

	GDP	Welfare	SQI
USA	-25.10	+225.69	-0.196
ROW	-766.47	-440.50	-0.021
Total	-236.43	-214.81	-0.026

TarRetal

	GDP	Welfare	SQI
USA	-191.10	-136.76	-0.265
ROW	-360.73	-107.90	-0.118
Total	-551.83	-244.66	-0.122

ReduceTar

	GDP	Welfare	SQI
USA	-100.57	+128.70	-0.217
ROW	267.83	-317.94	0.074
Total	167.26	-189.24	0.066

Figure 8: Strategic equilibria of U.S. and ROW responses across tariff scenarios
Note: Values are reported in billion USD, cumulative over 2018–2029 for both real GDP and welfare. Green, blue, and orange cells indicate the best outcome for the United States, the Rest of the World (ROW), and the global total, respectively.

In *NoRetal*, U.S. imports decline in both quantity (-15.6%) and price (-0.602%), placing this outcome in the Demand-Led Contraction quadrant. This co-movement suggests that broader income effects, rather than the tariff barrier alone, shift the import demand curve inward and pull prices lower (P. R. Krugman et al., 2018). The Rest of the World (ROW) exhibits a similar pattern (-0.804% quantity, -0.247% price), reflecting a modest, indirect response to weaker U.S. demand rather than a structural supply adjustment.

Tariff retaliation in *TarRetal* shifts this demand-led pattern into a Trade Contraction outcome. U.S. import quantities fall further (-22.3%), while prices rise ($+1.18\%$), indicating a supply-side cost shock as partner tariffs raise the composite cost of sourcing goods. This reflects a movement along the import demand curve rather than a change in underlying demand conditions. The ROW shows a similar contraction (-0.711% quantity, $+0.960\%$ price), reflecting reciprocal barriers that sever trade links and elevate global trading costs (Bagwell & Staiger, 1999).

A distinct decoupling emerges in *ReduceTar*, where U.S. imports remain in Demand-Led Contraction, but the ROW shifts to Trade Creation. Multilateral tariff cuts reduce ROW import prices by -0.454% and raise volumes by $+1.08\%$, generating the inverse price–quantity pattern associated with efficiency-driven trade creation. These gains reflect substitution toward cheaper partner markets that offsets the U.S. demand shock (Baldwin & Evenett, 2009).

Across all policy scenarios, a clear divide emerges. U.S. imports contract in every case, with the sharpest decline under *TarRetal* as retaliation amplifies domestic adjustment pressures (Amiti et al., 2019; Fajgelbaum et al., 2020). *TarRetal* also imposes the greatest strain on global trade, consistent with trade-war models in which noncooperative tariff setting leaves all regions worse off (Ossa, 2011). The Rest of the World improves only under *ReduceTar*, where mutual tariff reductions preserve market access and sustain higher trade activity despite weaker U.S. demand (Viner, 1950).

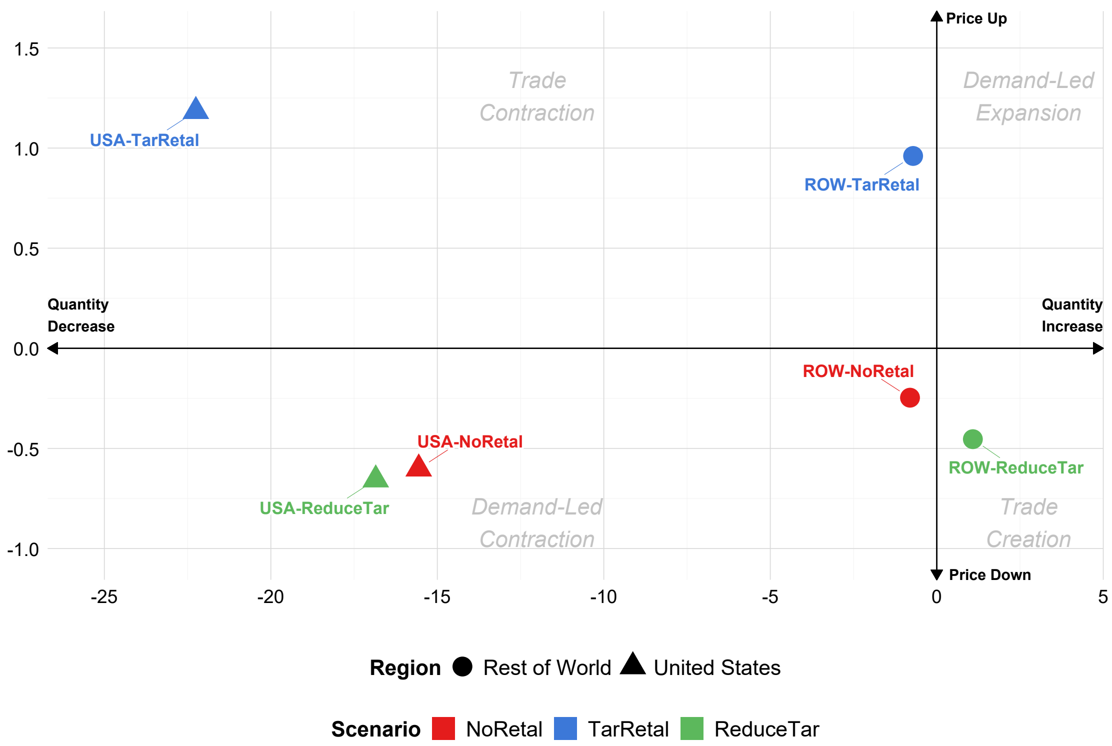


Figure 9: Import price–quantity changes across policy scenarios

Note: The figure plots the percentage change in import prices (pmw) and quantities (qmw) for the United States and the Rest of the World under the three policy scenarios. Values report cumulative effects over 2018–2029. The quadrants identify the dominant source of the trade adjustment.

5.1.6 U.S. Sectoral Adjustments

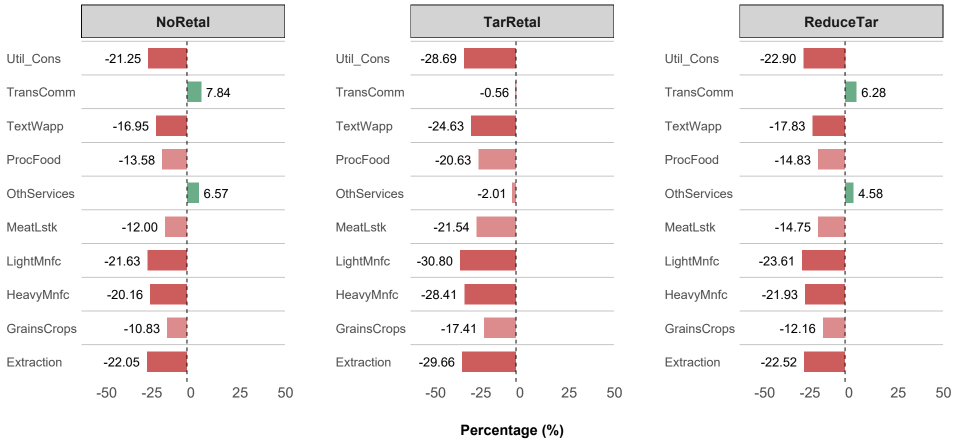
The aggregate trade decoupling documented above reflects sectoral reallocations that aggregate data obscure. To isolate these mechanisms, we examine cumulative deviations in import volumes (qms) and output (qo) over 2018–2029. The analysis first considers the United States, the first mover as the policy-implementing economy, and then turns to the potential responses of trading partners.

The U.S. import response in Figure 10a displays a broad contraction across industrial sectors. Manufacturing and extraction register the largest declines (22–24%), reflecting their intensive use of imported intermediates and direct exposure to the tariff shock. The similarity of these reductions across *NoRetal*, *TarRetal*, and *ReduceTar* indicates that, on the import side, the dominant adjustment is driven by the U.S. tariff itself rather than by partners' responses (Caliendo & Parro, 2015).

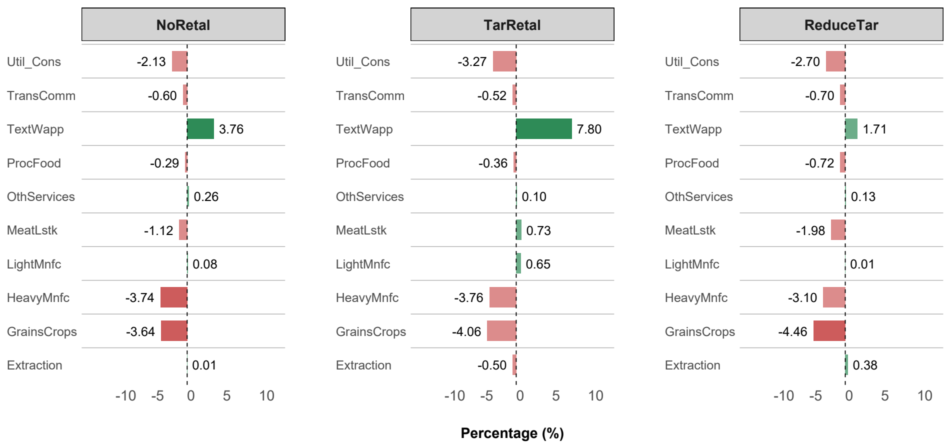
Output responses in Figure 10b show a more pronounced asymmetry. Grain–crop producers and heavy manufacturing record the steepest declines (around -4%), while light manufacturing remains near zero and textiles expand. These differences reflect variation in dependence on imported intermediates: upstream and heavy industries absorb the full tariff-induced cost shock, whereas sectors with more flexible sourcing or stronger downstream demand adjust more smoothly (Hertel, 1997; Amiti et al., 2019).

Manufacturing illustrates this mechanism clearly. Tariffs reduce import volumes in heavy and light manufacturing by roughly 25% across all scenarios, yet domestic output remains stagnant or contracts. Limited substitution away from disrupted global value-chain inputs raises intermediate costs and dampens real income, offsetting the protective wedge and yielding a contractionary outcome rather than the expansion implied by standard import-substitution logic (Hertel, 1997).

Partner responses nonetheless influence the magnitude of these effects. Retaliation preserves the deepest contractions in upstream and heavy industries by maintaining elevated input costs, whereas mutual liberalization among partners partially lowers these pressures and moderates the decline. In a production structure organized around global value chains, the reciprocal tariff therefore reshapes sectoral outcomes without delivering broad-based manufacturing revival.



(a) Import volumes



(b) Output

Figure 10: Sectoral adjustment of U.S. imports and output across policy scenarios

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APPENDIX

A | Region and Sector Aggregation

This analysis aggregates the GTAP version 11c database from 160 regions and 65 sectors into 34 regions and 10 sectors to improve computational efficiency while retaining the countries of interest and key economic sectors, as shown in Table A1 and Table A2, respectively.

Table A1: Region aggregation based on GTAP version 11c

Region	Description	GTAP ISO
AUS	Australia	aus
NZL	New Zealand	nzl
OWR	Other World Regions	xoc xna ven xef alb srb blr ukr xee kaz kgz tjk uzb xsu arm aze geo zaf xtw
CHN	China	chn
HKG	Hong Kong	hkg
JPN	Japan	jpn
KOR	Republic of Korea	kor
MNG	Mongolia	mng
TWN	Taiwan	twn
XAS	Rest of Asia	xea xse afg bgd npl pak lka xsa xws
BRN	Brunei Darussalam	brn
KHM	Cambodia	khm
IDN	Indonesia	idn
LAO	Lao PDR	lao
MYS	Malaysia	mys
PHL	Philippines	phl
SGP	Singapore	sgp
THA	Thailand	tha
VNM	Viet Nam	vnm
IND	India	ind
CAN	Canada	can
USA	United States of America	usa
MEX	Mexico	mex
ARG	Argentina	arg
XLC	Rest of South America	bol chl col ecu pry per ury xsm cri gtm hnd nic pan slv xca dom hti jam pri tto xcb
BRA	Brazil	bra
EUR	European Union	aut bel bgr hrv cyp cze dnk est fin fra deu grc hun irl ita lva ltu lux mlt nld pol prt rou svk svn esp swe
GBR	United Kingdom	gbr
XER	Rest of Europe	che nor xer
RUS	Russian Federation	rus
MENA	Middle East and North Africa	bhr irn irq isr jor kwt lbn omn pse qat sau syr are dza egy mar tun
TUR	Türkiye	tur

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Table A1 – Continued from previous page

Aggregation	Regional Description	GTAP ISO
XNF	Rest of North Africa	xnf
XSS	Sub-Saharan Africa	ben bfa cmr civ gha gin mli ner nga sen tgo xwf caf tcd cog cod gnq gab xac com eth ken mdg mwi mus moz rwa sdn tza uga zmb zwe xec bwa swz nam xsc

Source: The mapping is based on GTAP version 11c database (Aguiar, 2016; Corong & Aguiar, 2019).

Table A2: Sector Aggregation based on GTAP version 11c

Aggregation	Description	GTAP Sector
GrainsCrops	Cereal grains, oilseeds, sugar and fiber crops, fruits, and vegetables	pdr wht gro v_f osd c_b pfb ocr pcr
MeatLstk	Livestock, dairy, poultry, wool, and meat products	ctl oap rmk wol cmt omt
Extraction	Forestry, fishing, coal, oil, gas, and mineral extraction	frs fsh coa oil gas oxt
ProcFood	Food processing, beverages, dairy, sugar, and edible oils	vol mil sgr ofd b_t
TextWapp	Textiles, clothing, and apparel manufacturing	tex wap
LightMnfc	Leather, wood, paper, fabricated metals, vehicles, and misc. goods	lea lum ppp fmp mvh otn omf
HeavyMnfc	Petroleum, chemicals, metals, machinery, and equipment	p_c chm bph rpp nmm i_s nfm ele eeq ome
Util_Cons	Electricity, gas, water, and construction services	ely gdt wtr cns
TransComm	Trade, transport, warehousing, and communication	trd afs otp wtp atp whs cmn
OthServices	Finance, real estate, education, health, and public services	ofi ins rsa obs ros osg edu hht dwe

Note: The mapping is based on the GTAP version 11c database (Aguiar, 2016; Corong & Aguiar, 2019).

B | Country-Specific U.S. Reciprocal Tariff Rates

Table B1 documents the evolution of U.S. country-specific reciprocal tariffs across the April, June, and September 2025 announcements. The April round introduces the initial "Liberation Day" shock, June temporarily reverts most rates to the 10% baseline, and September reinstates and adjusts country-specific tariffs, underscoring the policy's rapid and irregular evolution and motivating the use of the latest available schedule.[12]

Table B1: U.S. Reciprocal Tariff Country-Specific Rates

Country	ISO	Apr-25	Jun-25	Sep-25	Rev.30
Afghanistan	AFG	10	10	15	0
Albania	ALB	10	10	10	0

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[12]See https://www.pattawee-pp.com/blog/2025/us-reciprocal-tariff-measures/ for an archived summary.

Table B1 – Continued from previous page

Country	ISO	Apr-25	Jun-25	Sep-25	Rev.30
Algeria	DZA	30	10	30	30
Andorra	AND	10	10	10	0
Angola	AGO	32	10	15	32
Anguilla	AIA	10	10	10	0
Antigua and Barbuda	ATG	10	10	10	0
Argentina	ARG	10	10	10	0
Armenia	ARM	10	10	10	0
Aruba	ABW	10	10	10	0
Australia	AUS	10	10	10	0
Austria	AUT	20	10	15	20
Azerbaijan	AZE	10	10	10	0
Bahamas	BHS	10	10	10	0
Bahrain	BHR	10	10	10	0
Bangladesh	BGD	37	10	20	37
Barbados	BRB	10	10	10	0
Belarus	BLR	10	10	10	0
Belgium	BEL	20	10	15	20
Belize	BLZ	10	10	10	0
Benin	BEN	10	10	10	0
Bermuda	BMU	10	10	10	0
Bhutan	BTN	10	10	10	0
Bolivia	BOL	10	10	15	0
Bosnia and Herzegovina	BIH	35	10	30	35
Botswana	BWA	37	10	15	37
Brazil	BRA	10	10	10	0
British Indian Ocean Territory	IOT	10	10	10	0
British Virgin Islands	VGB	10	10	10	0
Brunei	BRN	24	10	25	24
Bulgaria	BGR	20	10	15	20
Burkina Faso	BFA	10	10	10	0
Burundi	BDI	10	10	10	0
Cabo Verde	CPV	10	10	10	0
Cambodia	KHM	49	10	19	49
Cameroon	CMR	11	10	15	11
Canada	CAN	10	10	10	0
Cayman Islands	CYM	10	10	10	0
Central African Republic	CAF	10	10	10	0
Chad	TCD	13	10	15	13
Chile	CHL	10	10	10	0
China	CHN	34	145	34	34
China, Hong Kong SAR	HKG	10	10	10	34
China, Macao SAR	MAC	10	10	10	34
Christmas Island	CXR	10	10	10	0
Cocos (Keeling) Islands	CCK	10	10	10	0
Colombia	COL	10	10	10	0
Comoros	COM	10	10	10	0
Congo	COG	10	10	10	11
Cook Islands	COK	10	10	10	0
Costa Rica	CRI	10	10	15	0
Côte d'Ivoire	CIV	21	10	15	21
Croatia	HRV	20	10	15	20
Cuba	CUB	10	10	10	0
Curaçao	CUW	10	10	10	0
Cyprus	CYP	20	10	15	20
Czechia	CZE	20	10	15	20

Continued on next page

Table B1 – Continued from previous page

Country	ISO	Apr-25	Jun-25	Sep-25	Rev.30
DPR Korea	PRK	10	10	10	0
DR Congo	COD	11	10	15	0
Denmark	DNK	20	10	15	20
Djibouti	DJI	10	10	10	0
Dominica	DMA	10	10	10	0
Dominican Republic	DOM	10	10	25	0
Ecuador	ECU	10	10	10	0
Egypt	EGY	10	10	10	0
El Salvador	SLV	10	10	10	0
Equatorial Guinea	GNQ	13	10	15	13
Eritrea	ERI	10	10	10	0
Estonia	EST	20	10	15	20
Eswatini	SWZ	10	10	10	0
Ethiopia	ETH	10	10	10	0
Falkland Islands	FLK	41	10	10	41
Faroe Islands	FRO	10	10	10	0
Fiji	FJI	32	10	10	32
Finland	FIN	20	10	15	20
France	FRA	20	10	15	20
French Polynesia	PYF	10	10	10	0
French Southern Territories	ATF	10	10	10	0
Gabon	GAB	10	10	10	0
Gambia	GMB	10	10	10	0
Georgia	GEO	10	10	10	0
Germany	DEU	20	10	15	20
Ghana	GHA	10	10	15	0
Gibraltar	GIB	10	10	10	0
Greece	GRC	20	10	15	20
Greenland	GRL	10	10	10	0
Grenada	GRD	10	10	10	0
Guatemala	GTM	10	10	10	0
Guinea	GIN	10	10	10	0
Guinea-Bissau	GNB	10	10	10	0
Guyana	GUY	38	10	15	38
Haiti	HTI	10	10	10	0
Heard/McDonald Islands	HMD	10	10	10	0
Holy See	VAT	10	10	10	0
Honduras	HND	10	10	10	0
Hungary	HUN	20	10	15	20
Iceland	ISL	10	10	15	0
India	IND	26	10	25	26
Indonesia	IDN	32	10	19	32
Iran	IRN	10	10	10	0
Iraq	IRQ	39	10	35	39
Ireland	IRL	20	10	15	20
Israel	ISR	17	10	15	17
Italy	ITA	20	10	15	20
Jamaica	JAM	10	10	10	0
Japan	JPN	24	10	15	24
Jordan	JOR	20	10	15	20
Kazakhstan	KAZ	27	10	25	27
Kenya	KEN	10	10	10	0
Kiribati	KIR	10	10	10	0
Kuwait	KWT	10	10	10	0
Kyrgyzstan	KGZ	10	10	10	0

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Table B1 – Continued from previous page

Country	ISO	Apr-25	Jun-25	Sep-25	Rev.30
Laos	LAO	48	10	40	48
Latvia	LVA	20	10	15	20
Lebanon	LBN	10	10	10	0
Lesotho	LSO	50	10	15	50
Liberia	LBR	10	10	10	0
Libya	LBY	31	10	30	31
Liechtenstein	LIE	37	10	15	37
Lithuania	LTU	20	10	15	20
Luxembourg	LUX	20	10	15	20
Madagascar	MDG	47	10	15	47
Malawi	MWI	17	10	15	17
Malaysia	MYS	24	10	19	24
Maldives	MDV	10	10	10	0
Mali	MLI	10	10	10	0
Malta	MLT	20	10	15	20
Marshall Islands	MHL	10	10	10	0
Mauritania	MRT	10	10	10	0
Mauritius	MUS	40	10	15	40
Mexico	MEX	10	10	10	0
Micronesia	FSM	10	10	10	0
Moldova	MDA	31	10	25	31
Mongolia	MNG	10	10	10	0
Montenegro	MNE	10	10	10	0
Montserrat	MSR	10	10	10	0
Morocco	MAR	10	10	10	0
Mozambique	MOZ	16	10	15	16
Myanmar	MMR	44	10	40	44
Namibia	NAM	21	10	15	21
Nauru	NRU	30	10	15	30
Nepal	NPL	10	10	10	0
Netherlands	NLD	20	10	15	20
New Caledonia	NCL	10	10	10	0
New Zealand	NZL	10	10	10	0
Nicaragua	NIC	18	10	18	18
Niger	NER	10	10	10	0
Nigeria	NGA	14	10	15	14
Niue	NIU	10	10	10	0
Norfolk Island	NFK	10	10	10	0
North Macedonia	MKD	33	10	15	33
Norway	NOR	15	10	15	15
Oman	OMN	10	10	10	0
Pakistan	PAK	29	10	19	29
Palau	PLW	10	10	10	0
Panama	PAN	10	10	10	0
Papua New Guinea	PNG	10	10	10	0
Paraguay	PRY	10	10	10	0
Peru	PER	10	10	10	0
Philippines	PHL	17	10	19	17
Pitcairn	PCN	10	10	10	0
Poland	POL	20	10	15	20
Portugal	PRT	20	10	15	20
Qatar	QAT	10	10	10	0
Romania	ROU	20	10	15	20
Russian Federation	RUS	10	10	10	0
Rwanda	RWA	10	10	10	0

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Table B1 – Continued from previous page

Country	ISO	Apr-25	Jun-25	Sep-25	Rev.30
Saint Helena	SHN	10	10	10	0
Saint Kitts and Nevis	KNA	10	10	10	0
Saint Lucia	LCA	10	10	10	0
Saint Pierre and Miquelon	SPM	10	10	10	0
Saint Vincent/Grenadines	VCT	10	10	10	0
Samoa	WSM	10	10	10	0
San Marino	SMR	10	10	10	0
Sao Tome/Principe	STP	10	10	10	0
Saudi Arabia	SAU	10	10	10	0
Senegal	SEN	10	10	10	0
Serbia	SRB	37	10	35	37
Seychelles	SYC	10	10	10	0
Sierra Leone	SLE	10	10	10	0
Singapore	SGP	10	10	10	0
Sint Maarten	SXM	10	10	10	0
Slovakia	SVK	20	10	15	20
Slovenia	SVN	20	10	15	20
Solomon Islands	SLB	10	10	10	0
Somalia	SOM	10	10	10	0
South Africa	ZAF	30	10	30	30
South Korea	KOR	25	10	15	25
South Sudan	SSD	10	10	10	0
Spain	ESP	20	10	15	20
Sri Lanka	LKA	44	10	20	44
State of Palestine	PSE	10	10	10	0
Sudan	SDN	10	10	10	0
Suriname	SUR	10	10	10	0
Sweden	SWE	20	10	15	20
Switzerland	CHE	31	10	39	31
Syria	SYR	41	10	41	41
Taiwan	TWN	32	10	20	32
Tajikistan	TJK	10	10	10	0
Thailand	THA	36	10	19	36
Timor-Leste	TLS	10	10	10	0
Togo	TGO	10	10	10	0
Tokelau	TKL	10	10	10	0
Tonga	TON	10	10	10	0
Trinidad and Tobago	TTO	10	10	15	0
Tunisia	TUN	28	10	25	28
Turkey	TUR	10	10	15	0
Turkmenistan	TKM	10	10	10	0
Turks and Caicos	TCA	10	10	10	0
Tuvalu	TUV	10	10	10	0
Uganda	UGA	10	10	15	0
Ukraine	UKR	10	10	10	0
United Arab Emirates	ARE	10	10	10	0
United Kingdom	GBR	10	10	10	0
Tanzania	TZA	10	10	10	0
Uruguay	URY	10	10	10	0
Uzbekistan	UZB	10	10	10	0
Vanuatu	VUT	22	10	15	22
Venezuela	VEN	15	10	15	15
Vietnam	VNM	46	10	20	46
Wallis and Futuna	WLF	10	10	10	0
Yemen	YEM	10	10	10	0

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Table B1 – Continued from previous page

Country	ISO	Apr-25	Jun-25	Sep-25	Rev.30
Zambia	ZMB	17	10	15	17
Zimbabwe	ZWE	18	10	15	18

Note: April 2, 2025 marks the initial "Liberation Day" announcement, which introduced partner-specific rates alongside a uniform 10% flat rate applied to all remaining countries. Under the "Rev.30" update, this flat rate is removed; countries without documented revisions therefore appear as zeros. All rates shown here are in addition to the product-specific rates, which are not presented in this table.

Source: Initial White House tariff announcement (April 2, 2025): https://www.whitehouse.gov/wp-content/uploads/2025/04/Annex-I.pdf. Subsequent updates summarized in the author's blog: https://www.pattawee-pp.com/blog/2025/us-reciprocal-tariff-measures/.

C | Construction of Applied Tariff Data

C.1 Natural Language Processing and Automated Textual Analysis

We develop a specialized Natural Language Processing (NLP) module that directly parses regulatory PDF documents using rule-based extraction to integrate dynamic tariff modifications embedded in unstructured regulatory text. A hierarchical Regular Expression (Regex) engine identifies temporary tariff provisions and delineates their product scope in the absence of structured bilateral tariff tables.

Partner attribution is first established through a dictionary-based Named Entity Recognition (NER) procedure. We construct a mapping dictionary D_{country} that links ISO 3166-1 alpha-2 codes to common semantic variants observed in trade policy texts, allowing flexible matching; for example,

$$CN \in \{\text{China}, \text{PRC}, \text{Chinese}, \text{CHN}, \text{China, Mainland}, \ldots\}.$$

To capture finer detail, token-level matching within the `tariff_description` field is used to recover country- and product-specific inclusions or exclusions not encoded in standard schedules.

The parsed textual and semantic information is used to reconstruct applied tariff rates in four sequential steps: (i) MFN rate extraction as the baseline, (ii) adjustment for trade agreements and special programs, (iii) incorporation of country-specific rate provisions, and (iv) application of product-specific rates. Each step is triggered by distinct linguistic cues, with the keyword set flexibly extended as new regulatory formulations arise.

(i) *Most-favored Nation (MFN).* For each product, the parser identifies all parenthetical segments and links them to the preceding rate expression, recovering all associated rates to form the initial MFN rate for all country pairs. The algorithm extracts all reported components—ad valorem MFN rates, unit rates, and specific duties—and retains them for conversion to applied rates.

(ii) *Trade agreements and special programs.* Preferential arrangements provide alternative rates recorded in the "Special" field (e.g., Free *(A+, AU, BH)*), where identifiers correspond to ISO codes or program symbols.[13] For NLP processing, each program symbol g is expanded to its member set S_g, with exclusions applied where asterisks appear.

[13] See https://dataweb.usitc.gov/tariff/programs.

The preferential candidate set for each product is defined as the union of all expanded identifiers after exclusions:

$$\mathcal{G} = \{(g, S_g)\}, \qquad g \in \mathcal{G},\ S_g = \text{set of ISO member countries in program } g.$$

U.S. territories—Puerto Rico, Guam, the U.S. Virgin Islands, American Samoa, and the Northern Mariana Islands—are treated separately and assigned zero rates under statutory exemptions.

(iii) *Country-specific rates.* Additional country-specific duties are signaled by keywords such as "See," "Refer to," or "Product of" (e.g., Section 301 tariffs). The parser resolves these provisions by linking Chapter 99 codes to the relevant partner countries using proximate semantic cues within the same textual block and incorporates the resulting duties into the MFN rate.

(iv) *Product-specific rates.* Product-level trigger phrases such as "apply to all" identify duties that apply uniformly across trading partners rather than bilaterally. Depending on the matched token in `tariff_description`, the associated duty is either added to or replaces the corresponding ad valorem rate.

Robustness is assessed using a sensitivity framework that evaluates the precision–recall trade-off inherent in deterministic keyword matching. Fuzzy string similarity based on Levenshtein distance is used for stress testing (see Levenshtein (1966) and Navarro (2001)) and is defined as:

$$\operatorname{lev}(a,b) = \begin{cases} |a| & \text{if } |b| = 0, \\ |b| & \text{if } |a| = 0, \\ \operatorname{lev}(\operatorname{tail}(a), \operatorname{tail}(b)) & \text{if } a_0 = b_0, \\ 1 + \min\{\operatorname{lev}(\operatorname{tail}(a), b), \operatorname{lev}(a, \operatorname{tail}(b)), \operatorname{lev}(\operatorname{tail}(a), \operatorname{tail}(b))\} & \text{otherwise.} \end{cases}$$

The baseline implementation prioritizes exact string matching to maximize legal precision, with extracted rates cross-validated against MAcMap and TRAINS.

The main contribution of this NLP routine lies in its portability, as it can be applied with minimal setup to text-based tariff reports from other countries that characterize real-time policy releases. Although designed for tariffs, the framework provides a scalable foundation for extension to other trade policy instruments expressed in unstructured text.

C.2 Derivation of Applied Tariff Rates

All monetary and quantity units are standardized to a common valuation base so that specific and mixed duties—originally reported per physical unit—can be expressed in ad valorem form. From the NLP output, we retain the tariff line for each product–source pair (i, s) with the following components:

$$\mathit{MFN}_{i,s}, \quad \mathit{URATE}_{i,s}, \quad \mathit{SPECIAL}_{i,s}, \quad \mathit{PREF}_{i,s},$$

where $\mathit{MFN}_{i,s}$ is the most-favoured-nation rate, $\mathit{URATE}_{i,s}$ the unit-based duty, $\mathit{SPECIAL}_{i,s}$ any conditional or program-specific rate, and $\mathit{PREF}_{i,s}$ the preferential or free-trade rate.

The applied tariff for each product–source pair (i, s) is obtained by sequentially converting legal tariff components into ad valorem form—unit rate conversion, special rate adjustment, applied rate computation, country-specific assignment, and aggregation. Tariff schedules and trade records are sourced consistently from the USITC, and trade weights are based on customs and dutiable values rather than total imports, which include non-dutiable transactions and misstate the effective tariff base.[14]

(i) *Unit rate conversion.* Let $UP_{i,s}$ denote the implied unit price, defined as the ratio of the average customs value to the corresponding dutiable value:

$$UP_{i,s} = \frac{\overline{V}_{i,s}}{\overline{D}_{i,s}},$$

where $\overline{V}_{i,s}$ and $\overline{D}_{i,s}$ represent the multi-year averages of customs and dutiable values for product i from source s. The ad valorem equivalent of a specific duty is then given by

$$UNIT_{i,s} = \frac{URATE_{i,s}}{UP_{i,s}}.$$

(ii) *Special rate adjustment.* Product- and country-specific provisions are incorporated through $SPECIAL_{i,s}$ and $PREF_{i,s}$. The $SPECIAL_{i,s}$ component represents an additive surcharge to the base MFN rate, while $PREF_{i,s}$ denotes a preferential or free trade rate that supersedes all other applicable rates when specified in the schedule.

(iii) *Applied rate computation.* The total applied product-level tariff is determined by combining the relevant components as follows:

$$\tau_{i,s}^{\text{prod}} = \begin{cases} PREF_{i,s}, & \text{if a preferential rate applies,} \\ MFN_{i,s} + URATE_{i,s} + SPECIAL_{i,s}, & \text{otherwise.} \end{cases}$$

This formulation ensures that preferential rates take precedence over statutory and special duties, while maintaining additivity among the latter components.

(iv) *Country-specific assignment.* Exporter-specific adjustments are applied to incorporate partner-based tariff differentials, yielding the final bilateral rate:

$$\tau_{i,s}^{\text{cs}} = \tau_{i,s}^{\text{prod}} + c_s,$$

where c_s represents the uniform country-specific additive adjustment reflecting reciprocity or partner-based policy treatment.

(v) *Aggregation.* Tariff-line data are first mapped from HS8 products i to GTAP commodities c using the concordance between HS8 and GTAP sector classifications (Aguiar, 2016). Product-level rates are aggregated to the commodity level using trade-weighted means based on the country-specific rates:

$$\tau_c^{\text{base}} = \frac{\sum_{i \in c} \tau_i^{\text{cs}} \overline{V}_i}{\sum_{i \in c} \overline{V}_i},$$

or, when trade data are unavailable,

$$\tau_c^{\text{base}} = \frac{\sum_{i \in c} \tau_i^{\text{cs}}}{\sum_{i \in c} 1},$$

[14] Customs and dutiable values correspond to the statutory assessment base in U.S. import administration.

where the denominator represents the number of HS8 tariff lines aggregated within commodity c.

The sector-level rates are then mapped to GTAP regions r by aggregating over all exporting countries s within each region using bilateral trade weights:

$$\tau_{r,c}^{\text{base}} = \frac{\sum_{s\in r} \tau_{s,c}^{\text{base}} W_{s,c}}{\sum_{s\in r} W_{s,c}},$$

where $W_{s,c} = \sum_{i\in c} \overline{V}_{i,s}$ denotes the total trade value of commodity c imported from exporter s belonging to region r.

Additionally, we verify data accuracy by comparing and, where possible, calibrating against sectoral estimates $\tilde{\tau}_{s,c}$ from external sources such as WITS or MAcMap. When available, these estimates are incorporated through deterministic blending:

$$\tau_{s,c}^{\text{alt}} = \begin{cases} \frac{1}{2}\left(\tau_{s,c}^{\text{base}} + \tilde{\tau}_{s,c}\right), & \text{if both exist,} \\ \tilde{\tau}_{s,c}, & \text{if only } \tilde{\tau}_{s,c} \text{ exists,} \\ \tau_{s,c}^{\text{base}}, & \text{otherwise.} \end{cases}$$

However, this blended average is not employed in our GTAP-RD simulations, as it lacks theoretical robustness and may compromise consistency across data sources. Nevertheless, it can improve data completeness for supplementary structural analyses.

D | Regional Trade Flow Responses

Tables D1, D3, D4, D6 and D7 report regional macroeconomic and trade responses under each scenario, summarizing percentage-point changes in real GDP, welfare, terms of trade, private consumption prices, price index of imports, and aggregate exports and imports relative to the pre-policy baseline. Results span 2024–2030 for all regions across the three policy experiments—*NoRetal* (S1), *TarRetal* (S2), and *ReduceTar* (S3)—providing a compact overview of how tariff shocks propagate through the global system, capturing both immediate U.S. trade contractions and heterogeneous welfare adjustments across partners.

Table D1: Change in Real GDP Index by Region

Region	2024			2025			2026			2030			2035		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
ARG	-0.000	-0.001	0.018	0.092	0.115	0.064	0.098	0.108	0.203	0.179	-0.048	-0.020	0.024	0.191	0.255
AUS	0.000	-0.006	-0.011	0.058	0.070	0.015	0.021	0.024	0.102	0.119	-0.023	-0.021	-0.015	0.142	0.179
BRA	-0.002	-0.029	-0.024	-0.002	-0.006	0.113	0.153	0.185	0.284	0.297	-0.010	-0.006	0.034	0.126	0.147
BRN	0.001	-0.007	-0.009	0.160	0.199	-0.024	-0.047	-0.074	-0.017	-0.104	-0.035	-0.056	-0.076	0.235	0.318
CAN	-0.000	-0.103	-0.189	-0.300	-0.349	0.013	-0.077	-0.166	-0.245	-0.288	-0.062	-0.158	-0.305	-0.386	-0.457
CHN	0.006	-0.039	-0.132	-0.172	-0.198	0.109	0.135	0.108	0.209	0.374	0.014	-0.037	-0.177	-0.117	-0.137
EUR	-0.000	-0.013	-0.005	0.045	0.054	0.017	0.016	0.024	0.068	0.050	-0.028	-0.050	-0.053	0.089	0.116
GBR	-0.000	-0.018	0.007	0.037	0.026	0.005	-0.002	0.019	0.039	-0.002	-0.020	-0.054	-0.047	0.031	0.020
HKG	-0.001	-0.001	0.014	0.186	0.239	-0.027	-0.035	-0.033	0.074	0.051	-0.015	-0.052	-0.077	0.097	0.127
IDN	0.001	-0.009	0.002	0.124	0.186	0.005	-0.001	0.009	0.113	0.146	-0.024	-0.035	-0.025	0.203	0.299
IND	0.003	-0.004	-0.019	0.051	0.087	0.069	0.098	0.118	0.328	0.536	-0.003	0.004	-0.019	0.107	0.160
JPN	-0.001	-0.018	-0.029	0.011	-0.012	0.107	0.132	0.149	0.264	0.315	-0.022	-0.056	-0.083	0.059	0.049
KHM	0.014	0.012	0.010	0.443	0.654	0.155	0.185	0.223	0.837	1.303	0.180	0.256	0.267	0.628	0.932
KOR	0.002	0.028	0.049	0.107	0.153	-0.008	0.040	0.084	0.242	0.389	-0.033	-0.007	-0.001	0.162	0.235
LAO	-0.002	-0.010	-0.015	0.115	0.145	0.138	0.164	0.197	0.445	0.633	-0.016	-0.017	-0.007	0.231	0.300
MENA	0.000	-0.023	-0.021	0.066	0.102	0.116	0.173	0.218	0.414	0.534	-0.020	-0.047	-0.065	0.154	0.227
MEX	-0.004	-0.029	-0.057	-0.259	-0.414	0.032	0.013	-0.039	-0.196	-0.365	-0.097	-0.142	-0.284	-0.512	-0.777
MNG	-0.002	-0.019	-0.011	0.131	0.167	0.211	0.351	0.481	0.953	1.299	-0.007	-0.003	0.037	0.285	0.367
MYS	-0.001	-0.008	-0.024	-0.016	-0.053	0.061	0.074	0.068	0.109	0.101	-0.018	-0.045	-0.142	-0.020	-0.061
NZL	-0.002	-0.021	-0.020	0.063	0.078	0.011	-0.000	0.004	0.085	0.087	-0.036	-0.065	-0.066	0.084	0.107
OWR	-0.000	-0.021	-0.020	0.075	0.103	0.062	0.066	0.070	0.209	0.247	-0.007	-0.010	0.003	0.166	0.226
PHL	-0.003	-0.014	-0.013	0.091	0.133	-0.030	-0.034	-0.041	0.029	0.020	-0.017	-0.026	-0.062	0.165	0.255
RUS	-0.000	-0.010	-0.011	0.142	0.196	0.031	0.038	0.045	0.235	0.314	-0.020	-0.030	-0.021	0.239	0.337
SGP	0.003	-0.040	-0.105	-0.241	-0.355	-0.095	-0.142	-0.213	-0.384	-0.532	-0.092	-0.130	-0.213	-0.098	-0.170
THA	-0.002	-0.024	-0.059	0.056	0.096	0.264	0.361	0.427	0.838	1.206	0.022	0.031	-0.011	0.176	0.265
TUR	-0.001	0.006	0.025	0.144	0.195	0.219	0.327	0.406	0.682	0.912	-0.050	-0.042	-0.015	0.229	0.325
TWN	-0.000	-0.002	-0.014	-0.074	-0.111	0.102	0.128	0.145	0.245	0.373	-0.036	-0.090	-0.236	-0.150	-0.205
USA	0.000	-0.126	-0.518	-0.454	-0.544	-0.028	-0.166	-0.582	-0.604	-0.799	0.042	-0.142	-0.705	-0.679	-0.816
VNM	-0.017	-0.128	-0.221	-0.361	-0.653	0.083	0.043	0.024	0.238	0.423	-0.003	-0.141	-0.359	-0.500	-0.841
XAS	-0.005	-0.006	0.019	0.149	0.166	0.091	0.139	0.186	0.463	0.598	-0.026	-0.020	0.012	0.216	0.265
XER	0.000	-0.012	-0.038	-0.065	-0.060	0.080	0.131	0.139	0.124	0.147	-0.045	-0.067	-0.143	-0.045	-0.025
XLC	-0.001	-0.025	-0.038	0.009	0.015	0.041	0.027	0.005	0.098	0.109	-0.024	-0.040	-0.074	0.081	0.123
XNF	-0.000	-0.010	-0.020	0.123	0.188	-0.013	-0.018	-0.038	0.025	-0.005	-0.028	-0.049	-0.062	0.215	0.326
XSS	-0.001	-0.009	0.011	0.109	0.150	0.123	0.216	0.274	0.489	0.622	-0.019	-0.009	0.035	0.229	0.316

Note: Changes are reported in percentage points relative to the pre-policy baseline. S1 = NoRetal, S2 = TarRetal, S3 = ReduceTar.

Table D2: Change in Equivalent Variation (Welfare) by Region

Region	2024			2025			2026			2030			2035		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
ARG	0.000	-0.086	-0.084	-0.010	0.012	0.025	-0.174	-0.270	-0.165	-0.172	-0.187	-0.064	0.156	0.115	0.171
AUS	0.000	-0.110	-0.209	-0.077	-0.067	0.096	-0.031	-0.149	-0.017	-0.019	-0.071	0.025	0.173	0.141	0.181
BRA	-0.007	-0.182	-0.224	-0.162	-0.152	0.196	0.078	0.060	0.165	0.164	-0.112	-0.076	0.121	0.010	0.040
BRN	0.015	-0.003	0.007	0.110	0.143	-0.077	-0.320	-0.452	-0.437	-0.503	-0.008	0.180	0.379	0.420	0.507
CAN	-0.010	-0.825	-1.756	-1.010	-1.081	0.099	-0.587	-1.464	-0.691	-0.759	-0.254	-0.366	-0.537	-0.610	-0.699
CHN	0.020	-0.377	-1.043	-0.457	-0.488	0.192	-0.052	-0.590	0.079	0.213	-0.025	-0.295	-0.805	-0.337	-0.374
EUR	0.000	-0.184	-0.247	-0.135	-0.125	0.047	-0.058	-0.085	0.036	0.039	-0.050	-0.105	-0.026	0.009	0.035
GBR	-0.002	-0.211	-0.080	-0.184	-0.179	-0.004	-0.154	-0.005	-0.101	-0.121	-0.029	-0.166	0.020	-0.115	-0.103
HKG	-0.006	0.148	0.501	0.210	0.266	-0.090	0.046	0.374	0.097	0.115	0.048	0.041	0.080	0.121	0.183
IDN	0.005	-0.043	-0.107	0.065	0.113	0.009	-0.082	-0.175	-0.035	-0.025	-0.059	0.003	0.072	0.213	0.298
IND	0.019	-0.076	-0.304	-0.027	-0.002	-0.049	-0.132	-0.346	0.012	0.166	-0.076	-0.053	-0.144	0.038	0.060
JPN	0.005	-0.302	-0.381	-0.279	-0.291	0.413	0.283	0.291	0.462	0.514	-0.055	-0.222	-0.126	-0.138	-0.142
KHM	0.114	0.739	1.034	0.961	1.098	-1.258	-1.848	-2.420	-2.828	-3.379	0.093	0.605	0.699	0.784	0.895
KOR	0.009	0.010	-0.208	0.061	0.091	-0.269	0.015	-0.027	0.327	0.464	-0.104	0.157	0.254	0.279	0.323
LAO	-0.008	0.016	0.039	0.078	0.091	0.301	0.273	0.295	0.424	0.514	-0.053	0.104	0.304	0.250	0.297
MENA	0.001	-0.218	-0.409	-0.154	-0.125	0.089	-0.093	-0.263	0.077	0.186	-0.043	-0.068	-0.044	0.106	0.178
MEX	-0.034	-0.779	-1.426	-1.034	-1.165	0.013	-0.649	-1.290	-0.854	-0.992	-0.270	-0.247	-0.124	-0.605	-0.787
MNG	-0.008	-0.141	-0.191	-0.052	-0.018	0.213	0.900	1.287	1.687	1.976	0.001	0.080	0.337	0.310	0.404
MYS	-0.015	-0.446	-0.629	-0.428	-0.426	0.009	-0.595	-0.880	-0.662	-0.642	-0.109	-0.263	-0.190	-0.184	-0.170
NZL	-0.025	-0.203	-0.223	-0.135	-0.116	0.141	-0.043	-0.069	0.013	0.018	-0.142	-0.213	-0.087	-0.084	-0.049
OWR	-0.001	-0.143	-0.207	-0.078	-0.056	0.047	-0.139	-0.232	-0.049	0.013	-0.054	-0.052	0.042	0.090	0.145
PHL	-0.008	-0.085	-0.184	0.002	0.042	-0.214	-0.494	-0.733	-0.640	-0.741	-0.138	0.007	0.112	0.185	0.259
RUS	-0.001	-0.019	-0.010	0.108	0.151	0.059	0.065	0.088	0.246	0.324	-0.035	0.040	0.150	0.281	0.370
SGP	0.010	-0.755	-1.527	-0.911	-1.066	-0.226	-0.807	-1.473	-0.850	-0.952	-0.273	-0.130	0.120	-0.165	-0.254
THA	-0.013	-0.115	-0.370	-0.050	-0.015	0.488	0.545	0.407	0.889	1.118	-0.168	-0.102	-0.170	0.019	0.078
TUR	-0.002	-0.050	-0.069	0.066	0.110	0.175	0.199	0.190	0.416	0.558	-0.099	-0.018	0.136	0.212	0.293
TWN	-0.001	-0.477	-0.965	-0.525	-0.543	0.282	0.010	-0.349	0.232	0.381	-0.106	-0.266	-0.457	-0.290	-0.320
USA	-0.006	0.565	0.803	0.253	0.167	-0.100	0.382	0.555	-0.060	-0.239	0.203	0.142	-0.483	-0.329	-0.454
VNM	-0.074	-1.457	-1.894	-1.729	-1.877	-0.509	-2.436	-3.218	-3.169	-3.640	-0.043	-1.436	-1.984	-1.670	-1.790
XAS	-0.017	-0.105	0.092	0.021	0.042	-0.372	-0.816	-0.830	-0.864	-0.875	-0.063	-0.092	0.159	0.116	0.166
XER	0.004	-0.248	-0.791	-0.271	-0.273	0.200	0.028	-0.470	0.069	0.109	-0.086	-0.095	-0.390	-0.060	-0.045
XLC	-0.002	-0.278	-0.529	-0.277	-0.274	0.038	-0.276	-0.561	-0.266	-0.252	-0.127	-0.081	0.047	-0.005	0.031
XNF	-0.002	0.041	-0.190	0.141	0.194	0.024	0.050	-0.194	0.069	0.049	-0.033	0.086	-0.060	0.313	0.413
XSS	-0.003	-0.089	-0.072	-0.005	0.025	-0.143	-0.363	-0.432	-0.280	-0.194	-0.070	-0.003	0.197	0.184	0.255

Note: Changes are reported in percentage points relative to the pre-policy baseline. S1 = NoRetal, S2 = TarRetal, S3 = ReduceTar.

Table D3: Change in Terms of Trade by Region

Region	2024			2025			2026			2030			2035		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
ARG	0.002	-0.445	-0.429	-0.499	-0.480	-0.320	-1.672	-2.168	-2.155	-2.057	-1.009	-0.399	0.769	-0.452	-0.449
AUS	-0.002	-0.256	-0.447	-0.330	-0.323	0.289	-0.142	-0.489	-0.425	-0.550	-0.193	0.245	0.880	0.224	0.288
BRA	-0.044	-1.115	-1.407	-1.153	-1.083	0.554	-0.643	-0.970	-1.006	-1.227	-0.885	-0.612	0.698	-0.711	-0.647
BRN	0.025	0.172	0.381	0.110	0.123	-0.142	-0.461	-0.524	-0.788	-0.814	0.102	0.578	1.082	0.579	0.650
CAN	-0.026	-1.870	-4.053	-1.982	-2.095	0.213	-1.335	-3.375	-1.300	-1.398	-0.566	-0.564	-0.577	-0.747	-0.840
CHN	0.056	-1.090	-3.147	-1.016	-1.053	0.327	-0.582	-2.391	-0.306	-0.177	-0.079	-0.884	-2.329	-0.839	-0.915
EUR	-0.001	-0.280	-0.353	-0.286	-0.276	0.040	-0.127	-0.138	-0.038	0.003	-0.038	-0.074	0.122	-0.088	-0.076
GBR	-0.004	-0.486	-0.174	-0.525	-0.488	-0.041	-0.404	-0.037	-0.342	-0.299	-0.030	-0.293	0.195	-0.321	-0.261
HKG	-0.008	0.217	0.704	0.067	0.081	-0.094	0.114	0.579	0.044	0.097	0.097	0.130	0.223	0.063	0.127
IDN	0.019	0.137	0.100	0.094	0.085	-0.058	-0.234	-0.457	-0.523	-0.647	-0.122	0.320	0.684	0.337	0.377
IND	0.063	-0.108	-0.766	-0.137	-0.140	-0.497	-0.730	-1.381	-0.597	-0.276	-0.272	-0.150	-0.371	-0.129	-0.151
JPN	0.021	-1.155	-1.314	-1.157	-1.119	1.462	0.844	0.923	1.089	1.108	-0.159	-0.694	-0.055	-0.705	-0.657
KHM	0.087	0.629	0.874	0.412	0.329	-1.127	-1.506	-1.862	-2.229	-2.357	-0.027	0.337	0.383	0.174	0.067
KOR	0.016	0.124	-0.273	0.074	0.056	-0.695	0.006	-0.046	0.294	0.307	-0.149	0.473	0.739	0.417	0.386
LAO	-0.014	0.131	0.280	0.048	0.029	0.328	0.295	0.364	0.130	0.017	-0.059	0.274	0.671	0.173	0.173
MENA	0.000	-0.378	-0.743	-0.422	-0.427	-0.134	-0.673	-1.118	-0.857	-0.893	-0.054	0.002	0.160	0.008	0.043
MEX	-0.071	-1.640	-2.949	-1.712	-1.656	-0.076	-1.491	-2.730	-1.487	-1.392	-0.428	-0.225	0.443	-0.238	-0.091
MNG	-0.013	-0.063	-0.009	-0.154	-0.149	-0.262	0.639	1.149	0.947	0.878	0.008	0.244	0.724	0.185	0.226
MYS	-0.018	-0.448	-0.570	-0.426	-0.384	-0.097	-0.802	-1.081	-0.934	-0.898	-0.101	-0.196	0.058	-0.126	-0.061
NZL	-0.086	-0.513	-0.425	-0.533	-0.499	0.425	-0.106	-0.092	-0.215	-0.236	-0.382	-0.462	0.056	-0.446	-0.372
OWR	-0.003	-0.226	-0.289	-0.275	-0.277	-0.090	-0.555	-0.735	-0.689	-0.637	-0.122	-0.064	0.198	-0.093	-0.079
PHL	-0.013	-0.089	-0.234	-0.143	-0.146	-0.415	-0.914	-1.311	-1.229	-1.272	-0.260	0.075	0.367	0.060	0.051
RUS	-0.008	0.212	0.547	0.160	0.145	-0.006	0.048	0.276	-0.149	-0.241	-0.042	0.454	1.034	0.439	0.463
SGP	0.006	-0.623	-1.226	-0.566	-0.568	-0.131	-0.603	-1.117	-0.414	-0.360	-0.163	-0.027	0.254	-0.046	-0.035
THA	-0.019	-0.049	-0.288	-0.071	-0.071	0.274	0.239	-0.006	0.073	-0.076	-0.293	-0.157	-0.146	-0.167	-0.189
TUR	-0.005	-0.049	-0.038	-0.075	-0.075	-0.169	-0.352	-0.469	-0.499	-0.512	-0.121	0.113	0.481	0.082	0.083
TWN	-0.003	-0.708	-1.402	-0.686	-0.654	0.308	-0.134	-0.676	0.041	0.090	-0.098	-0.235	-0.259	-0.175	-0.123
USA	-0.042	4.641	9.525	4.836	4.953	-0.494	3.626	8.157	3.529	3.605	1.052	1.915	1.709	2.053	2.210
VNM	-0.039	-0.815	-0.985	-0.746	-0.600	-0.387	-1.504	-1.872	-1.656	-1.597	-0.015	-0.793	-0.966	-0.635	-0.459
XAS	-0.045	-0.280	0.424	-0.317	-0.286	-1.625	-3.025	-2.996	-3.710	-3.746	-0.123	-0.241	0.549	-0.227	-0.175
XER	0.004	-0.336	-1.155	-0.300	-0.305	0.181	-0.168	-0.990	-0.121	-0.092	-0.065	-0.010	-0.351	0.026	0.033
XLC	-0.004	-0.775	-1.492	-0.885	-0.901	-0.027	-0.957	-1.747	-1.154	-1.145	-0.348	-0.130	0.444	-0.203	-0.196
XNF	-0.011	0.373	-0.309	0.301	0.266	0.155	0.386	-0.361	0.292	0.320	0.013	0.673	0.266	0.621	0.613
XSS	-0.009	-0.190	-0.085	-0.246	-0.252	-0.948	-1.825	-2.092	-2.283	-2.299	-0.163	0.043	0.618	0.027	0.050

Note: Changes are reported in percentage points relative to the pre-policy baseline. S1 = NoRetal, S2 = TarRetal, S3 = ReduceTar.

Table D4: Change in Price Index for Private Household Consumption by Region

Region	2024			2025			2026			2030			2035		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
ARG	-0.013	-0.116	0.142	-0.225	-0.264	-0.909	-2.585	-3.334	-3.831	-4.269	-1.356	0.050	1.989	-0.013	-0.021
AUS	0.005	-0.292	-0.740	-0.408	-0.485	-0.068	-0.761	-1.381	-1.083	-1.119	-0.319	0.486	1.510	0.398	0.327
BRA	-0.047	-0.466	-0.334	-0.571	-0.580	-0.179	-1.446	-1.848	-2.338	-2.841	-1.074	0.041	1.996	-0.062	-0.036
BRN	0.021	-0.559	-1.367	-0.657	-0.737	-0.087	-0.805	-1.631	-0.964	-0.981	-0.166	0.355	1.093	0.255	0.156
CAN	-0.046	1.721	3.284	1.688	1.621	-0.589	0.678	1.944	0.340	0.226	-0.163	2.128	4.727	2.191	2.144
CHN	0.051	-1.160	-3.185	-1.175	-1.255	0.084	-1.085	-2.961	-0.999	-0.911	-0.336	-0.455	-0.836	-0.506	-0.615
EUR	0.000	-0.541	-0.805	-0.633	-0.675	-0.363	-1.017	-1.342	-1.190	-1.280	-0.194	0.285	1.313	0.204	0.154
GBR	0.000	-0.462	-0.585	-0.561	-0.605	-0.569	-1.345	-1.643	-1.644	-1.742	-0.138	0.381	1.420	0.297	0.243
HKG	0.016	-0.397	-1.051	-0.528	-0.611	0.014	-0.351	-0.919	-0.420	-0.433	-0.106	0.476	0.918	0.360	0.254
IDN	0.033	-0.379	-1.114	-0.455	-0.496	-0.165	-0.887	-1.754	-1.146	-1.181	-0.414	0.349	1.196	0.308	0.293
IND	0.070	-0.390	-1.464	-0.441	-0.495	-1.067	-1.954	-3.214	-2.072	-1.838	-0.658	-0.075	0.302	-0.105	-0.173
JPN	0.021	-0.935	-1.399	-1.008	-1.048	0.386	-0.642	-1.180	-0.826	-0.874	-0.722	-0.525	0.583	-0.612	-0.668
KHM	0.082	-0.047	-0.625	-0.153	-0.211	-1.547	-3.116	-4.554	-4.117	-4.265	-0.655	0.059	0.720	-0.010	-0.063
KOR	0.020	-0.152	-0.816	-0.257	-0.337	-1.173	-1.338	-1.949	-1.401	-1.440	-0.421	0.433	1.348	0.338	0.243
LAO	-0.008	-0.576	-1.447	-0.683	-0.749	0.343	-0.514	-1.403	-0.616	-0.587	-0.657	-0.054	0.733	-0.113	-0.174
MENA	0.006	-0.430	-0.942	-0.528	-0.585	-1.376	-2.921	-4.055	-3.694	-3.832	-0.319	0.314	1.277	0.233	0.174
MEX	-0.096	1.074	2.339	1.012	1.016	-0.606	0.237	1.260	-0.069	-0.159	0.015	1.665	3.486	1.669	1.720
MNG	0.012	-0.600	-1.364	-0.742	-0.817	-1.424	-2.300	-3.168	-2.633	-2.747	-0.305	0.192	0.952	0.059	-0.018
MYS	0.002	-0.750	-1.547	-0.818	-0.870	-0.540	-1.762	-2.763	-2.087	-2.103	-0.405	-0.004	0.709	-0.059	-0.120
NZL	-0.043	-0.497	-0.776	-0.596	-0.646	0.111	-0.646	-1.047	-0.909	-0.941	-0.403	0.242	1.296	0.173	0.129
OWR	0.004	-0.461	-0.889	-0.574	-0.632	-0.918	-2.237	-3.112	-2.843	-2.960	-0.398	0.153	1.055	0.057	0.002
PHL	0.005	-0.433	-1.186	-0.494	-0.522	-0.593	-1.605	-2.667	-2.136	-2.338	-0.679	0.140	1.004	0.101	0.050
RUS	0.004	-0.415	-0.776	-0.548	-0.620	-0.670	-1.783	-2.479	-2.281	-2.365	-0.292	0.393	1.452	0.283	0.217
SGP	-0.000	0.117	0.126	0.023	-0.070	-0.154	-0.099	-0.079	-0.236	-0.303	-0.116	1.064	2.473	1.004	0.903
THA	-0.002	-0.525	-1.337	-0.612	-0.674	-0.442	-1.480	-2.518	-1.885	-1.939	-0.990	-0.445	0.260	-0.527	-0.606
TUR	-0.001	-0.395	-0.691	-0.496	-0.543	-1.464	-2.870	-3.787	-3.657	-3.858	-0.414	0.274	1.435	0.181	0.127
TWN	0.002	-0.503	-1.106	-0.557	-0.605	-0.624	-1.669	-2.547	-2.025	-2.072	-0.486	0.239	1.364	0.211	0.145
USA	-0.094	6.664	14.580	7.301	7.392	-0.466	5.896	13.556	6.301	6.374	0.408	5.537	11.146	6.017	6.153
VNM	-0.013	-1.135	-2.094	-1.193	-1.200	-0.865	-2.560	-3.770	-2.869	-2.803	-0.350	-0.510	-0.087	-0.528	-0.535
XAS	-0.019	-0.784	-1.045	-0.855	-0.882	-1.961	-4.112	-5.108	-4.918	-4.971	-0.401	-0.180	0.887	-0.201	-0.216
XER	-0.001	-0.391	-0.805	-0.466	-0.514	-1.003	-2.178	-3.065	-2.746	-2.805	-0.172	0.438	1.400	0.372	0.315
XLC	-0.019	0.307	0.499	0.185	0.122	-0.610	-1.000	-1.214	-1.541	-1.677	-0.402	0.739	2.299	0.661	0.610
XNF	-0.006	-0.160	-0.933	-0.277	-0.348	-0.193	-0.576	-1.458	-0.821	-0.886	-0.293	0.614	1.244	0.482	0.428
XSS	0.005	-0.513	-0.958	-0.604	-0.636	-2.070	-4.059	-5.308	-5.026	-5.162	-0.482	0.112	1.170	0.075	0.065

Note: Changes are reported in percentage points relative to the pre-policy baseline. S1 = NoRetal, S2 = TarRetal, S3 = ReduceTar.

Table D5: Change in Price Index of Imports by Region

Region	2024			2025			2026			2030			2035		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
ARG	-0.015	0.279	0.567	0.205	0.148	-0.176	-0.183	-0.180	-0.706	-1.183	-0.246	0.463	1.300	0.432	0.423
AUS	0.004	-0.126	-0.409	-0.215	-0.295	-0.028	-0.151	-0.367	-0.182	-0.162	-0.132	0.225	0.673	0.137	0.046
BRA	-0.007	0.515	0.924	0.435	0.361	-0.233	0.038	0.222	-0.245	-0.517	-0.048	0.625	1.276	0.593	0.568
BRN	0.011	-0.592	-1.324	-0.678	-0.746	-0.041	-0.658	-1.355	-0.749	-0.774	-0.260	0.007	0.481	-0.095	-0.184
CAN	-0.036	2.504	5.033	2.539	2.495	-0.376	1.831	4.165	1.662	1.564	0.391	1.571	2.437	1.586	1.542
CHN	-0.002	-0.163	-0.285	-0.241	-0.287	-0.070	-0.271	-0.407	-0.383	-0.451	-0.193	0.351	1.182	0.286	0.248
EUR	-0.001	-0.335	-0.485	-0.423	-0.469	-0.135	-0.463	-0.611	-0.579	-0.676	-0.155	0.248	1.073	0.173	0.121
GBR	-0.002	-0.126	-0.155	-0.207	-0.257	-0.138	-0.278	-0.314	-0.401	-0.502	-0.109	0.300	1.003	0.232	0.170
HKG	0.021	-0.526	-1.412	-0.600	-0.686	0.071	-0.397	-1.175	-0.424	-0.452	-0.190	-0.037	0.114	-0.138	-0.265
IDN	0.014	-0.509	-1.234	-0.595	-0.669	0.028	-0.475	-1.138	-0.535	-0.546	-0.234	0.065	0.493	-0.028	-0.111
IND	0.005	-0.274	-0.691	-0.364	-0.432	-0.163	-0.577	-1.056	-0.764	-0.876	-0.179	0.251	0.811	0.170	0.125
JPN	0.006	-0.094	-0.443	-0.174	-0.244	-0.127	-0.298	-0.646	-0.430	-0.498	-0.136	0.243	0.618	0.145	0.053
KHM	0.015	-0.755	-1.864	-0.800	-0.865	0.034	-0.720	-1.738	-0.706	-0.665	-0.303	-0.174	-0.007	-0.215	-0.262
KOR	0.008	-0.239	-0.629	-0.325	-0.402	0.054	-0.228	-0.610	-0.321	-0.374	-0.134	0.189	0.640	0.102	0.022
LAO	0.009	-0.711	-1.768	-0.794	-0.866	0.171	-0.520	-1.487	-0.591	-0.609	-0.401	-0.186	0.088	-0.270	-0.353
MENA	0.005	-0.218	-0.502	-0.311	-0.378	-0.197	-0.536	-0.898	-0.739	-0.879	-0.173	0.247	0.865	0.152	0.076
MEX	-0.031	2.532	4.953	2.541	2.465	-0.345	1.896	4.104	1.669	1.467	0.365	1.640	2.536	1.602	1.496
MNG	0.018	-0.533	-1.299	-0.630	-0.714	0.053	-0.442	-1.135	-0.507	-0.558	-0.203	0.045	0.392	-0.046	-0.138
MYS	0.014	-0.397	-1.064	-0.486	-0.569	0.018	-0.376	-0.979	-0.447	-0.477	-0.212	0.145	0.577	0.029	-0.081
NZL	0.004	-0.155	-0.419	-0.248	-0.318	0.019	-0.183	-0.428	-0.288	-0.313	-0.171	0.286	0.896	0.199	0.116
OWR	0.005	-0.268	-0.574	-0.364	-0.429	-0.147	-0.493	-0.848	-0.709	-0.877	-0.176	0.245	0.875	0.169	0.112
PHL	0.016	-0.400	-1.091	-0.481	-0.558	0.073	-0.311	-0.933	-0.371	-0.408	-0.192	0.092	0.416	-0.005	-0.089
RUS	0.009	-0.557	-1.129	-0.649	-0.712	-0.054	-0.595	-1.119	-0.640	-0.662	-0.220	0.085	0.693	-0.004	-0.074
SGP	0.000	0.170	0.235	0.074	-0.002	-0.088	0.017	0.084	-0.132	-0.194	-0.062	0.396	0.933	0.312	0.227
THA	0.013	-0.506	-1.147	-0.592	-0.659	0.070	-0.453	-1.040	-0.486	-0.454	-0.225	0.077	0.580	-0.004	-0.058
TUR	0.004	-0.368	-0.705	-0.462	-0.519	-0.140	-0.558	-0.910	-0.665	-0.729	-0.191	0.253	1.012	0.171	0.112
TWN	0.009	-0.154	-0.484	-0.235	-0.315	0.059	-0.094	-0.389	-0.190	-0.268	-0.136	0.244	0.739	0.128	0.010
USA	-0.015	-0.389	-0.722	-0.244	-0.250	-0.074	-0.442	-0.762	-0.327	-0.332	-0.246	0.264	1.062	0.420	0.411
VNM	0.024	-0.553	-1.547	-0.625	-0.712	-0.032	-0.489	-1.354	-0.478	-0.494	-0.260	0.062	0.354	-0.038	-0.148
XAS	0.022	-0.556	-1.448	-0.633	-0.701	-0.074	-0.726	-1.618	-0.838	-0.874	-0.250	0.009	0.300	-0.070	-0.140
XER	-0.004	-0.145	-0.076	-0.230	-0.272	-0.156	-0.306	-0.231	-0.404	-0.465	-0.117	0.320	1.163	0.246	0.197
XLC	-0.016	0.839	1.563	0.764	0.686	-0.214	0.395	0.952	0.153	-0.013	-0.014	0.754	1.462	0.691	0.628
XNF	0.004	-0.435	-0.810	-0.527	-0.579	-0.218	-0.717	-1.113	-0.863	-0.936	-0.214	0.183	0.924	0.100	0.044
XSS	0.012	-0.371	-0.899	-0.462	-0.529	-0.216	-0.736	-1.352	-0.943	-1.076	-0.207	0.128	0.593	0.060	0.011

Note: Changes are reported in percentage points relative to the pre-policy baseline. S1 = NoRetal, S2 = TarRetal, S3 = ReduceTar.

Table D6: Change in Imports by Region

Region	2024			2025			2026			2030			2035		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
ARG	0.002	-0.191	0.060	-0.139	-0.089	1.358	2.400	3.580	3.658	4.221	0.585	0.174	0.633	0.305	0.367
AUS	-0.005	-0.039	0.048	-0.027	0.002	0.334	0.490	0.637	0.524	0.424	-0.086	0.050	0.415	0.168	0.266
BRA	-0.039	-0.786	-0.754	-0.772	-0.697	2.398	3.681	5.006	4.905	5.154	0.886	-0.159	0.199	-0.153	-0.081
BRN	0.004	0.090	0.245	0.143	0.170	-0.059	-0.101	-0.030	-0.180	-0.226	-0.034	0.152	0.440	0.289	0.368
CAN	-0.039	-0.638	-2.004	-0.783	-0.812	0.263	0.031	-1.102	0.119	0.164	-0.263	-1.097	-3.028	-1.257	-1.251
CHN	0.061	-1.260	-3.577	-1.296	-1.349	1.630	1.871	0.515	2.785	2.938	0.440	-1.242	-3.717	-1.226	-1.302
EUR	-0.000	-0.228	-0.281	-0.181	-0.169	0.198	0.188	0.266	0.392	0.451	-0.062	-0.233	-0.124	-0.114	-0.073
GBR	-0.003	-0.347	-0.113	-0.324	-0.311	0.165	0.095	0.497	0.327	0.393	-0.068	-0.446	-0.151	-0.372	-0.326
HKG	-0.004	0.096	0.352	0.136	0.183	-0.093	-0.012	0.223	0.013	0.026	-0.016	-0.104	-0.031	-0.005	0.091
IDN	0.026	0.200	0.182	0.287	0.344	0.493	0.940	1.043	1.113	1.086	0.020	0.179	0.221	0.373	0.481
IND	0.078	0.009	-0.575	0.082	0.128	1.413	3.061	3.449	4.240	4.573	0.403	0.166	-0.593	0.307	0.344
JPN	0.017	-0.938	-0.923	-0.896	-0.860	1.693	1.621	2.092	2.154	2.197	0.082	-0.943	-0.734	-0.783	-0.665
KHM	0.088	0.505	0.651	0.807	0.976	0.457	1.221	1.500	1.649	1.630	0.540	0.764	0.646	1.028	1.193
KOR	0.011	0.108	-0.180	0.138	0.173	0.201	1.346	1.642	1.970	2.075	-0.027	0.160	-0.072	0.298	0.374
LAO	-0.010	0.147	0.277	0.254	0.279	0.498	0.800	1.027	1.100	1.187	-0.018	0.282	0.627	0.504	0.574
MENA	-0.002	-0.191	-0.368	-0.144	-0.108	1.181	2.003	2.428	2.766	2.999	0.008	-0.098	-0.154	0.067	0.162
MEX	-0.061	-0.856	-1.440	-1.046	-1.112	0.192	-0.104	-0.303	0.104	0.246	-0.334	-1.978	-3.456	-2.195	-2.251
MNG	-0.007	0.042	0.147	0.096	0.120	0.839	1.797	2.401	2.539	2.752	0.050	0.132	0.350	0.287	0.352
MYS	-0.018	-0.423	-0.540	-0.399	-0.396	0.380	0.116	0.074	0.224	0.232	0.014	-0.470	-0.427	-0.341	-0.287
NZL	-0.067	-0.312	-0.095	-0.250	-0.200	0.455	0.396	0.686	0.504	0.467	-0.224	-0.593	-0.251	-0.451	-0.341
OWR	-0.004	-0.051	0.013	0.008	0.041	0.737	1.355	1.825	1.947	2.170	0.111	0.041	0.149	0.175	0.237
PHL	-0.014	-0.041	-0.160	0.047	0.104	-0.025	0.059	0.000	0.173	0.191	0.205	0.105	0.009	0.336	0.464
RUS	-0.009	0.284	0.762	0.354	0.391	1.057	2.444	3.478	3.083	3.092	-0.037	0.414	1.040	0.587	0.683
SGP	0.007	-0.249	-0.594	-0.366	-0.445	-0.374	-0.585	-0.898	-0.694	-0.773	-0.208	-0.204	-0.140	-0.132	-0.140
THA	-0.020	0.014	-0.244	0.083	0.120	1.214	1.961	2.129	2.539	2.662	0.431	0.359	0.064	0.497	0.551
TUR	-0.005	0.023	0.068	0.142	0.192	1.065	1.972	2.546	2.686	2.870	0.008	0.153	0.346	0.398	0.500
TWN	-0.000	-0.550	-1.157	-0.588	-0.594	1.083	1.295	1.148	1.809	1.986	-0.210	-0.813	-1.264	-0.736	-0.666
USA	0.098	-6.874	-14.792	-7.174	-7.498	-0.392	-7.837	-16.024	-8.454	-8.908	1.202	-9.152	-21.402	-8.485	-8.787
VNM	-0.038	-0.406	-0.454	-0.529	-0.695	0.438	0.522	0.706	0.803	0.850	0.022	-0.441	-0.537	-0.560	-0.711
XAS	-0.045	-0.224	0.470	-0.094	-0.039	1.276	2.222	3.491	3.081	3.207	0.042	-0.210	0.400	0.017	0.114
XER	0.004	-0.194	-0.839	-0.209	-0.206	0.393	0.439	-0.029	0.627	0.678	-0.140	-0.236	-0.700	-0.186	-0.156
XLC	-0.008	-0.464	-0.870	-0.473	-0.439	0.713	0.928	0.953	1.365	1.551	0.062	-0.209	-0.586	-0.126	-0.036
XNF	-0.012	0.418	0.102	0.444	0.462	0.052	0.279	-0.144	0.168	0.157	-0.033	0.547	0.346	0.673	0.751
XSS	-0.008	0.023	0.280	0.092	0.139	1.466	2.889	3.966	4.010	4.400	0.183	0.296	0.666	0.476	0.561

Note: Changes are reported in percentage points relative to the pre-policy baseline. S1 = NoRetal, S2 = TarRetal, S3 = ReduceTar.

Table D7: Change in Exports by Region

Region	2024			2025			2026			2030			2035		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
ARG	0.004	-0.360	-0.711	-0.293	-0.301	1.736	3.230	4.132	4.701	5.168	1.046	-0.199	-1.056	-0.015	-0.031
AUS	0.002	-0.179	-0.455	-0.111	-0.115	0.361	0.421	0.295	0.671	0.712	-0.040	-0.383	-0.755	-0.168	-0.160
BRA	0.008	-0.235	-0.672	-0.163	-0.247	1.314	2.571	3.151	4.231	5.223	1.050	-0.393	-1.810	-0.025	-0.117
BRN	0.006	-0.103	-0.323	0.025	0.033	-0.004	-0.103	-0.314	-0.034	-0.063	-0.014	-0.184	-0.457	0.066	0.086
CAN	-0.033	1.552	2.224	1.379	1.419	0.129	1.869	2.666	1.892	2.050	0.142	0.191	-0.956	0.063	0.111
CHN	0.021	-0.734	-1.695	-0.877	-0.761	1.147	1.438	1.002	1.581	1.330	0.429	-1.041	-2.772	-1.027	-0.798
EUR	0.002	-0.319	-0.600	-0.286	-0.303	0.181	0.052	-0.111	0.228	0.252	-0.061	-0.314	-0.399	-0.179	-0.179
GBR	0.004	-0.704	-0.994	-0.675	-0.736	0.233	-0.097	-0.149	0.230	0.260	-0.118	-0.646	-0.514	-0.527	-0.579
HKG	0.004	-0.112	-0.211	-0.099	-0.100	-0.106	-0.220	-0.291	-0.186	-0.167	-0.071	-0.025	0.143	0.013	0.010
IDN	0.020	-0.332	-0.922	-0.285	-0.272	0.546	0.695	0.390	1.101	1.235	0.116	-0.624	-1.615	-0.496	-0.512
IND	0.088	-0.693	-2.267	-1.023	-1.089	2.285	3.954	3.792	5.096	5.032	0.624	-0.477	-2.349	-0.590	-0.565
JPN	0.002	-0.429	-0.965	-0.384	-0.432	0.649	0.667	0.421	1.141	1.276	0.183	-0.809	-1.829	-0.567	-0.591
KHM	0.044	-0.116	-0.502	0.332	0.588	1.161	1.906	2.009	2.534	2.384	0.488	0.395	0.106	0.796	1.079
KOR	0.005	-0.124	-0.437	-0.075	-0.040	0.384	0.811	0.801	1.187	1.261	0.023	-0.306	-0.909	-0.142	-0.081
LAO	-0.001	-0.167	-0.570	-0.103	-0.103	0.401	0.302	-0.012	0.545	0.699	-0.101	-0.192	-0.410	0.040	0.068
MENA	0.002	-0.218	-0.543	-0.179	-0.167	0.990	1.617	1.786	2.281	2.484	-0.001	-0.307	-0.677	-0.128	-0.087
MEX	-0.016	0.510	0.991	0.396	0.294	0.274	1.203	2.004	1.463	1.552	0.013	-1.519	-3.307	-1.708	-1.917
MNG	-0.002	-0.061	-0.113	0.085	0.114	0.418	0.694	0.873	1.390	1.708	-0.018	-0.004	0.075	0.299	0.371
MYS	-0.006	-0.303	-0.556	-0.341	-0.395	0.373	0.286	0.156	0.380	0.354	0.021	-0.426	-0.655	-0.368	-0.399
NZL	-0.048	-0.566	-0.876	-0.548	-0.573	0.486	0.212	0.052	0.419	0.450	-0.215	-0.786	-0.918	-0.683	-0.705
OWR	0.006	-0.308	-0.723	-0.261	-0.263	0.623	0.851	0.758	1.277	1.374	0.003	-0.140	-0.231	0.019	0.033
PHL	0.003	-0.440	-1.253	-0.534	-0.575	0.429	0.635	0.244	1.032	1.160	0.444	-0.311	-1.253	-0.169	-0.123
RUS	0.001	-0.146	-0.328	-0.027	0.001	0.701	1.233	1.417	1.759	1.871	0.005	-0.252	-0.554	-0.036	0.005
SGP	0.006	0.064	-0.127	-0.009	0.004	-0.592	-0.566	-0.753	-0.706	-0.730	-0.219	-0.025	0.014	0.073	0.078
THA	-0.009	-0.166	-0.643	-0.130	-0.115	1.086	1.540	1.466	2.213	2.525	0.357	0.161	-0.280	0.284	0.327
TUR	0.002	-0.207	-0.588	-0.125	-0.109	1.254	2.104	2.406	2.972	3.181	0.108	-0.276	-0.868	-0.034	0.019
TWN	0.004	-0.374	-0.876	-0.459	-0.490	0.974	1.228	1.117	1.636	1.774	-0.184	-0.844	-1.470	-0.838	-0.836
USA	0.110	-8.752	-18.086	-8.620	-9.069	-0.089	-8.986	-18.203	-8.983	-9.433	1.105	-10.211	-22.603	-9.995	-10.588
VNM	-0.004	0.213	0.147	-0.000	-0.319	0.713	1.664	1.984	1.922	1.771	0.020	0.186	0.158	-0.076	-0.387
XAS	-0.021	-0.841	-1.384	-0.914	-1.041	3.608	5.890	7.060	7.922	8.297	0.165	-0.823	-1.440	-0.785	-0.889
XER	0.005	-0.250	-0.954	-0.346	-0.360	0.336	0.319	-0.208	0.432	0.485	-0.151	-0.326	-0.847	-0.315	-0.311
XLC	-0.009	-0.006	-0.223	0.044	0.061	0.701	1.327	1.494	1.813	1.982	0.142	-0.154	-0.845	0.030	0.077
XNF	0.001	-0.134	-0.320	-0.012	0.039	0.004	-0.128	-0.328	-0.086	-0.094	-0.015	-0.232	-0.486	0.025	0.107
XSS	0.006	-0.279	-0.702	-0.231	-0.226	2.060	3.752	4.455	5.031	5.250	0.262	-0.155	-0.688	0.017	0.026

Note: Changes are reported in percentage points relative to the pre-policy baseline. S1 = NoRetal, S2 = TarRetal, S3 = ReduceTar.