How Do The Trump Tariffs Affect Carbon Emissions?

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1 Introduction

How do the Trump tariffs affect carbon emissions? This paper answers this question by quantifying and identifying the mechanisms through which recent United States tariff policy influences carbon emissions. Given the urgency of climate change mitigation, understanding how major policy interventions shape emissions is of critical importance. While many studies have examined the effects of the tariffs on economic outcomes like GDP, employment, and welfare, their environmental consequences have received far less attention.

The Trump tariffs represent one of the most significant trade policy shifts in recent history, with real and measurable impacts on global production patterns. At first glance, tariffs might be expected to reduce emissions simply by lowering trade volumes and slowing economic activity. Indeed, our findings show that overall emissions decline. However, the mechanisms through which these reductions occur are not straightforward. On the other hand, trade barriers can also impede the international supply chains for environmental goods and services (EGS)—many of which are predominantly produced in China—thereby raising costs and potentially slowing the global transition to cleaner production.

This paper decomposes the tariff-induced changes in emissions into scale, composition, and technique effects. The scale effect captures the simple reduction in output that occurs when tariffs dampen trade and economic activity, thereby lowering emissions. The composition effect reflects changes in the relative weight of industries in total output—for example, when cleaner U.S. production replaces more carbon-intensive production abroad, or when energy-intensive sectors shrink in relative size. Finally, the technique effect measures shifts in the way goods are produced, such as greater reliance on renewables or improvements in energy efficiency. This relates to how tariffs indirectly reinforce existing green policies by raising the renewable share of power generation and encouraging substitution away from fossil fuels. Our results show that these technique effects dominate, while scale effects are present but negligible, and composition effects are comparatively small.

These findings highlight the importance of sustained commitment to green policies, as trade interventions can interact with and, in some cases, amplify their effectiveness. The decomposition framework plays a central role in clarifying this result: by distinguishing between scale, composition, and technique effects, it identifies the precise channels through which tariffs influence emissions. This methodology allows the paper to move beyond documenting a decline in aggregate emissions to explaining the mechanisms behind it, thereby answering the central question of how trade policy reshapes global environmental outcomes. Regardless of the original economic rationale, the evidence suggests that the Trump tariffs ultimately contributed to a cleaner global production mix.

2 Background: Trump Tariffs

President Trump has used tariffs as a cornerstone of his trade policy, once remarking that "tariff is the most beautiful word in the dictionary." On April 2, 2025—known as Liberation Day—the administration enacted the largest United States tariff increase since the Smoot-Hawley Act of 1930 (Evenett and Fritz, 2025). The tariffs were justified on the grounds that persistent and large United States trade deficits posed a national security risk. The executive order implemented a 10 percent ad valorem baseline tariff on all foreign-origin imports, with exceptions for certain goods under the United States–Mexico–Canada Agreement (USMCA). In addition, higher reciprocal tariffs were imposed on targeted countries to address bilateral trade imbalances, while specific industries—aluminum, autos, and steel—faced a 25 percent tariff.[1] The reciprocal tariff was defined as the tariff rate required to balance bilateral trade between the United States and a trading partner, calculated as

$$\Delta\tau_i = \frac{x_i - m_i}{\epsilon * \phi * m_i} \tag{1}$$

where ϵ is the elasticity of imports with respect to import prices, ϕ is the tariff pass-through rate to import prices, m_i is total imports from country i, and x_i is total exports (Office of the United States Trade Representative, 2025).

In response to United States tariffs, some trading partners sought exemptions or negotiated new trade deals, while others threatened retaliation. South Korea and Japan reached agreements setting tariff rates at 15 percent. The European Union initially threatened to target selected United States exports but ultimately negotiated a trade deal that also reduced tariffs to 15 percent. China, by contrast, responded with retaliatory tariffs that escalated rapidly, reaching rates as high as 150 percent in certain sectors by April 11. The escalation subsided on May 12, when both sides agreed to a 90-day pause that lowered the general tariff rate and was subsequently extended for another 90 days, until November 10 (Bown, 2025).

Following the initial announcement on April 2, the administration delayed the implementation of the reciprocal tariffs twice—pausing them on April 9 for 90 days and again on July 7—pushing implementation to August 1. While acknowledging that the tariff schedule may still be revised, this paper focuses on the version in effect as of August 1. The full schedule of United States tariffs is reported in Table 1 below.

[1] Later increased to 50 percent

Table 1: Tariff Rates on Exports to US by Region

Sector	chn	as5	sel	ind	xsa	cca	dea	ocn	xna	lac	eur	meo	mna	afr	rus	row
Crops	34	19	20	50	20	18	17	11	5	11	15	10	15	15	10	14
Livestock	34	19	21	50	16	10	17	10	2	12	14	10	14	15	10	14
Extraction	29	21	21	21	21	21	21	21	2	21	20	21	21	21	21	21
Chemicals	34	17	20	50	20	22	17	10	4	11	18	10	15	24	10	15
Light_mfg	34	18	20	50	20	11	17	10	15	11	15	10	14	16	10	16
En_int_mfg	33	29	33	37	28	44	32	36	19	32	28	31	32	34	39	44
Electrical	34	15	20	50	19	12	17	10	8	12	17	10	15	22	10	15
Machinery	32	16	20	50	19	10	16	10	7	12	16	10	15	25	10	16
Trans_eq	38	22	22	29	24	24	24	15	17	15	16	18	20	25	10	23
TnD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dwellings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oth_tp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wat_tp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air_tp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coal	34	19	20	50	15	16	19	10	0	10	15	10	15	19	10	15
Oil	34	19	21	50	10	13	15	13	0	12	14	19	29	15	10	12
Gas	10	17	40	50	10	13	18	10	0	15	14	10	26	15	10	15
Oil_Pcts	34	16	20	50	18	23	16	10	0	12	14	13	29	19	10	11
NuclearE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CoalE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GasE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WindE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HydroE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OilE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OthE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SolarE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note:
Author's calculations.

The tariff schedule highlights important regional and sectoral asymmetries. China and India face relatively higher tariffs than most other regions, with India subject to the highest rate at 50 percent because of its purchases of Russian oil and weapons.ua By contrast, Canada and Mexico (grouped under North America, nec) experience comparatively favorable treatment due to preferential access under USMCA. At the sectoral level, tariffs are concentrated in energy-intensive manufacturing such as steel and aluminum production, as well as transportation equipment which includes automobiles. Electricity generation sectors are largely non-tradable across borders and therefore not subject to tariffs, while other sectors—such as services, construction, dwellings, and many transport subsectors—are similarly exempt. To keep the analysis tractable, the discussion that follows presents detailed results for the world, the United States, and India, which together provide representative cases for the broader set of regions.

3 Literature Review

- Adding to the literature of effects of trade on the environment but applying its decomposition of effects on recent tariffs imposed by President Trump

- Many papers have examined the impact of the tariff on markets, inflation, and the economy but few have looked at the impact on the environment
- Impact may be small but it is significant
- This paper does not take into account the changes in environmental policy

4 Methodology/Model

Global Trade-Environment Model

The Global Trade-Environment Model is a dynamic, recursive computable general equilibrium (CGE) model extended with environmental modules, including energy use and emissions accounting. This model is particularly well suited to analyze the effects of tariffs on emissions because it models the economy in its entirety, representing the interactions between households, firms, and governments within global markets. This framework enables the study of cross-border trade flows and emissions linkages between regions. The model consists of a system of equations derived from economic theory that are summarized schematically in Figure 1. The arrows represent specific types of equations. For example, the arrows entering the production block denote commodity market demand, defined as the sum of intermediate demand, investment, consumption, and government use. These must equal and total output of a good including exports, shown by the arrows leaving the production block. The equilibrium solution ensures that all markets clear simultaneously, with prices adjust so that supply equals demand across the entire economy. International trade links production with final demand by making imported and exported goods available alongside domestic goods. Tariffs and other trade measures enter as ad valorem wedges between domestic and imported prices, altering relative costs and trade flows.

Model Structure

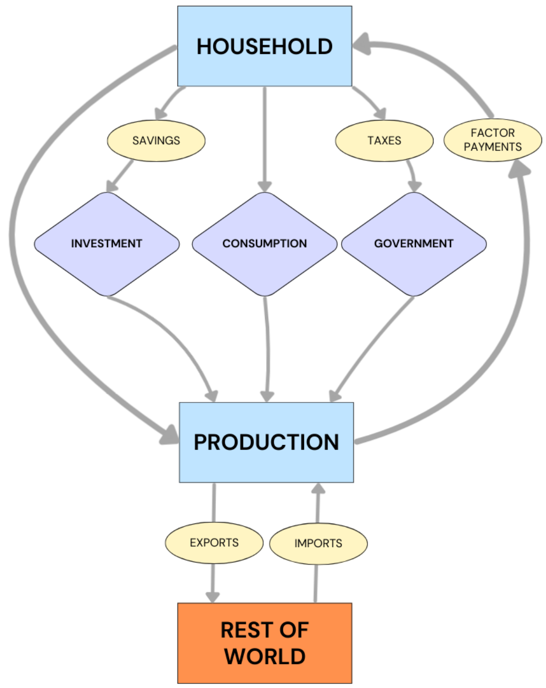

Figure 1: Circular flow of income and expenditure in the CGE model

Households

Households receive income from factor payments (wages, returns to capital, and land rents) and allocate it across private consumption, investment in the form of savings, and government spending through taxes (Figure 1). This allocation is governed by a Cobb–Douglas utility function, meaning that a constant share of income is directed to each type of final demand. Within private consumption, households allocate expenditures across goods using a non-homothetic Constant Difference Elasticity (CDE) utility function (Aguiar et al., 2019), allowing for varying income elasticities across goods. This structure captures important demand-side dynamics such as the tendency for wealthier households to shift toward cleaner or higher-quality consumption bundles.

Firms

Firms supply goods and services to meet household, government, and investment demand. Firms are assumed to be perfectly competitive, producing homogeneous commodities by combining value-added factors (labor, capital-energy, land, and natural resources) with intermediate inputs. Employment of primary factors depends on the endowments available to each region, which are fixed in each period but evolve over time along exogenously specified paths based on projections from the IMF and other sources. Firms maximize efficiency by minimizing costs given their production technologies. Intermediate inputs are separated into domestic and imported varieties, combined through CES functions under the Armington assumption. This structure ensures that firms can substitute between sources of supply while recognizing that domestic and foreign goods are imperfect substitutes. Domestic production functions are modeled using nested CES structures, which allow substitution between primary factors (land, labor, and capital-energy) and domestic and foreign intermediate inputs (Figure 2).

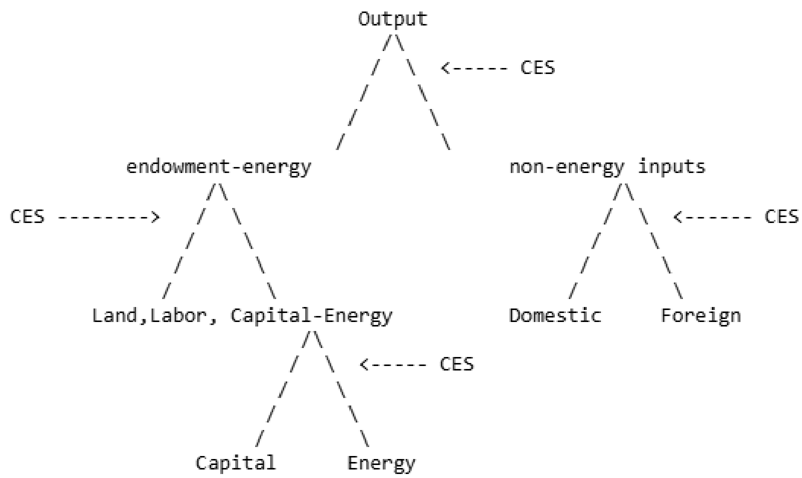

Figure 2: Production Nest

The capital–energy composite is modeled as a CES aggregate, allowing substitution between capital and various forms of energy in response to relative price changes. The energy component is further disaggregated to provide a detailed representation of energy demand, capturing substitution between fossil fuels and renewable sources and their implications for emissions (Figure 3).

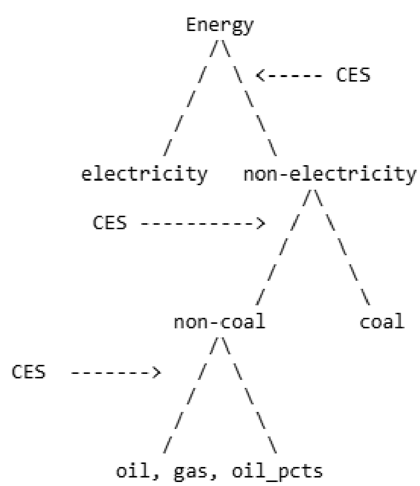

Figure 3: Energy Production Nest

Total energy demand is represented as a CES aggregate of electricity and non-electric energy. The non-electric bundle is further decomposed into coal and non-coal fuels, with the latter split among oil, gas, and refined oil products. CO_2 emissions are calculated directly from the combustion of fossil fuels—coal, oil, gas, and refined oil products in both production and consumption activities. The model also incorporates renewables such as wind, solar, and hydro. These enter the energy bundle alongside fossil fuels, with substitution possibilities governed by CES functions and calibrated elasticities. Electricity, in particular, is modeled as a mix of fossil-based and renewable sources (Figure 4).

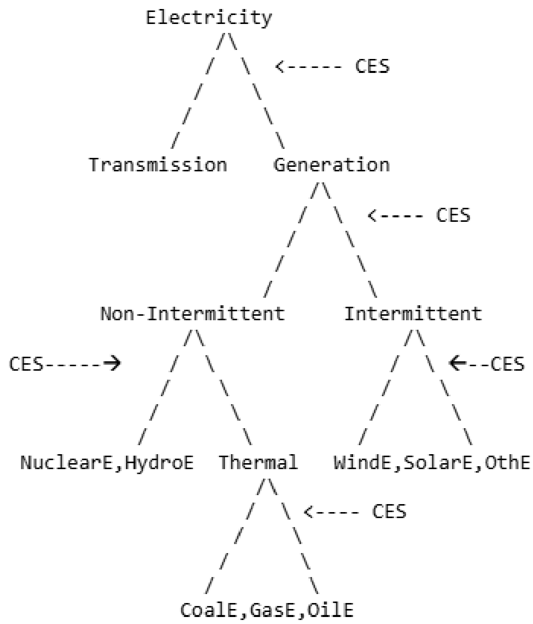

Figure 4: Electricity Production Nest

Policies such as tariffs, carbon taxes, and renewable energy subsidies influence relative prices within the nested structure. When the relative price of renewables falls—through technological improvements or subsidies-firms substitue away from fossil fuels toward cleaner sources. Likewise, tariffs on imported coal or oil raise their relative prices, encouraging a shift toward domestic energy and renewables. This is the channel through which trade, technology, and policy shocks affect energy demand and emissions outcomes. More details on the theoretical foundations and applications of this model can be found in Aguiar et al. (2019); Petri et al. (2024).

Scenarios and Model Closure

The analysis compares two scenarios. The baseline scenario is the IEA's Stated Policies Scenario (STEPS), which incorporates environmental policies that governments have already enacted but excludes future commitments that have not yet been implemented. The STEPS is not constructed to achieve a particular outcome such as net zero emissions, but rather to trace the environmental implications of prevailing policies and measures as they stand. The policies assessed span a broad spectrum, including Nationally Determined Contributions (NDCs) under the Paris Agreement as well as a wide range of energy-related measures such as pricing regimes, efficiency standards, electrification programs, and infrastructure projects. In the model these policies are implemented as gradual improvements in energy efficiency and electrification, as well as taxes and subsidies that encourage the expansion of wind and solar power while reducing reliance on coal. Further details of the STEPS scenario are available in IEA (2024); Petri et al. (2024).

The policy scenario introduces the Trump tariffs, implemented on August 1, as a shock following the tariff schedule reported in Table 1. All other assumptions remain the same as in the STEPS baseline, with the only change being in the model closure. The closure specifies which variables are fixed or exogenously determined outside the model and which are solved endogenously within the system of equations to achieve equilibrium. Under the tariff scenario, rather than fixing the quantities of wind and solar energy use as in the STEPS baseline, the model determines them endogenously, allowing the economy to adjust in response to relative price changes. Subsidies for renewable energy and carbon taxes are instead treated as exogenous and maintained at their STEPS baseline values. Likewise, emissions are determined endogenously, reflecting the combined effects of tariffs, technological change, and policy interactions on energy use and carbon emissions, while carbon taxes are held fixed at their STEPS baseline levels.

¡Add caveat¿

Data

The model uses the latest GTAP dataset (GTAP-11-POWER-E) aggregated into 17 regions and 28 sectors, of which 13 are energy-related (See Tables 9 and 10 in Appendix). This level of aggregation allows for a tractable yet detailed representation of international trade and energy use, while capturing the heterogeneity across regions and sectors. The data include input–output tables that describe inter-industry linkages and form the basis for modeling production, consumption, and trade. They also contain exogenous variables and parameters that govern how variables interact, such as elasticities that determine substitution between inputs and across regions. Energy data from the International Energy Agency (IEA) underpins the STEPS baseline, providing projections of energy use and associated emissions, including improvements in energy efficiency and electrification over time.

5 Simulation Results

Trade

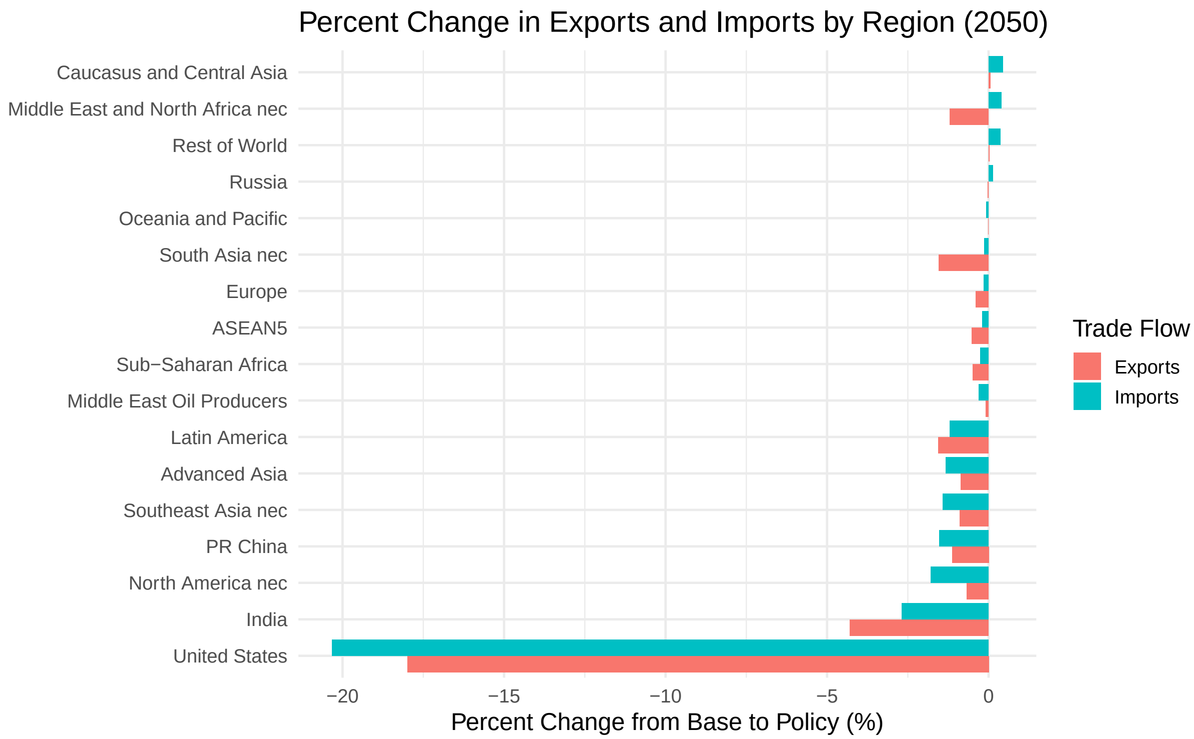

Figure 5: Percent change in exports and imports by region in 2050 under tariff scenario (relative to baseline).

Figure 5 shows the percent change in exports and imports across regions in 2050 under the tariff scenario relative to the baseline. The United States is by far the most negatively affected with imports declining more than 20 percent, reflecting the direct impact of tariffs on foreign goods, while United States exports fall by almost as much—around 17 percent—as global demand for United States goods contracts. Notably, no clear beneficiary emerges from the tariffs, suggesting that the costs of tariffs are spread across the global economy. While trade diversion allows some regions to expand exports to new destinations, in the aggregate most regions experience declines in both imports and exports as a result of the tariffs. India is the second most affected economy, facing the highest tariff rate of 50 percent; its imports fall by 3 percent and exports by 4 percent. Other regions also experience more moderate declines in the range of 1–3 percent. The tariffs exert a global drag on trade, imposing costs on all major economies, with the heaviest burden falling on the United States. This outcome reflects the general equilibrium nature of tariffs: although designed to protect domestic industries, they simultaneously distort both imports and exports, generating broad-based efficiency losses across the world economy.

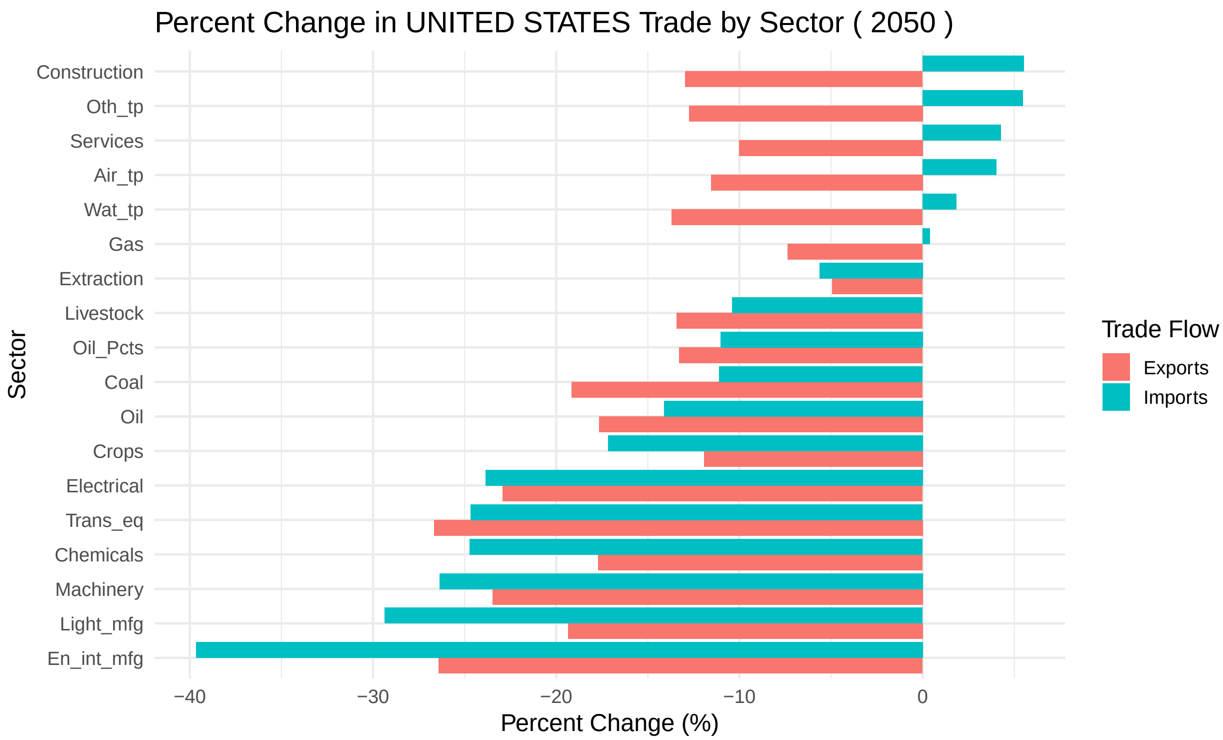

Figure 6: Percent change in United States exports and imports by sector in 2050 under tariff scenario (relative to baseline).

An examination of United States trade flows at the sectoral level reveals that the industries most directly targeted by tariffs experience the sharpest declines in both imports and exports (Figure 6). In contrast, sectors not directly affected by tariffs exhibit modest increases in imports, yet their exports continue to contract. The sharpest decline occurs in energy-intensive manufacturing, the sector subject to the highest tariffs, where imports contract by nearly 40 percent. Other heavily targeted industries—including light manufacturing, machinery, chemicals, transport equipment (includes automobiles), and electrical equipment—also experience substantial import reductions in the range of 25–30 percent. Notably, United States exports in many of these same sectors decline by a roughly proportional magnitude, underscoring the broader impact of tariffs on both sides of trade flows.

Several mechanisms account for this pattern. First, tariffs raise the cost of imported intermediate inputs, forcing firms to substitute toward more expensive domestic inputs. This increases production costs not only for goods consumed domestically but also for those produced for export, thereby reducing United States competitiveness abroad. Second, domestic inputs that might otherwise have been available for export are redirected to meet stronger domestic demand. Third, United States trading partners experience income losses as their own exports to the United States decline, diminishing their capacity to import United States products. Finally, global supply chains are disrupted, raising costs across production networks and further weakening United States exports. This is illustrated most clearly by the United States service sector. Although not directly targeted by tariffs, service exports—one of the largest and most competitive United States sectors—decline, underscoring how broad-based tariffs indirectly erode United States export competitiveness through higher costs, disrupted supply chains, and reduced foreign demand.

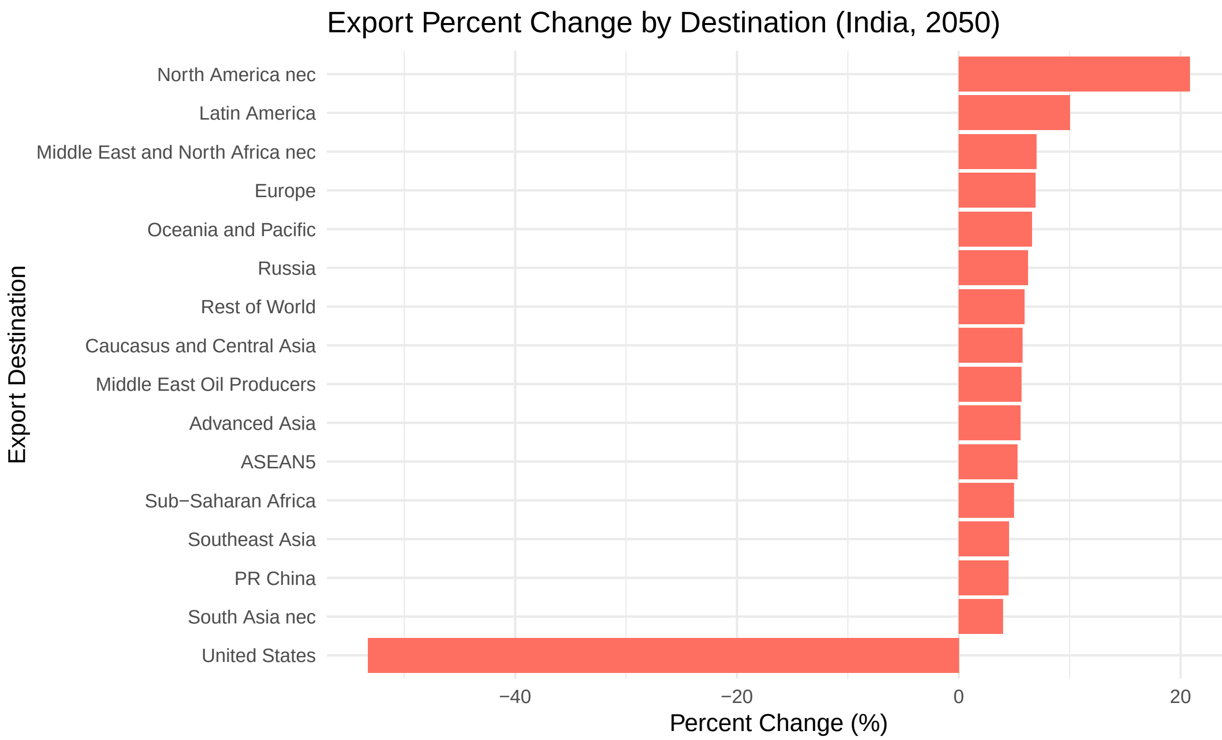

Figure 7: Percent change in India's exports by destination in 2050 under tariff scenario (relative to baseline).

Figure 7 shows that India's exports to the United States in 2050 decline by more than 45 percent. Some of these exports are diverted to North America nec, which benefits from favorable terms of trade with the United States relative to other regions. However, this diversion is modest and insufficient to offset the sharp reduction in exports to the United States, even when accounting for increased exports to other regions in the long run. This illustrates the efficiency loss associated with tariffs, where reductions in trade with a major partner are not fully offset elsewhere, resulting in a net decline in overall trade (i.e., a deadweight loss). This finding highlights that tariffs not only disrupt direct bilateral trade flows but also distort global trade patterns in ways that reduce efficiency and undermine potential gains from trade.

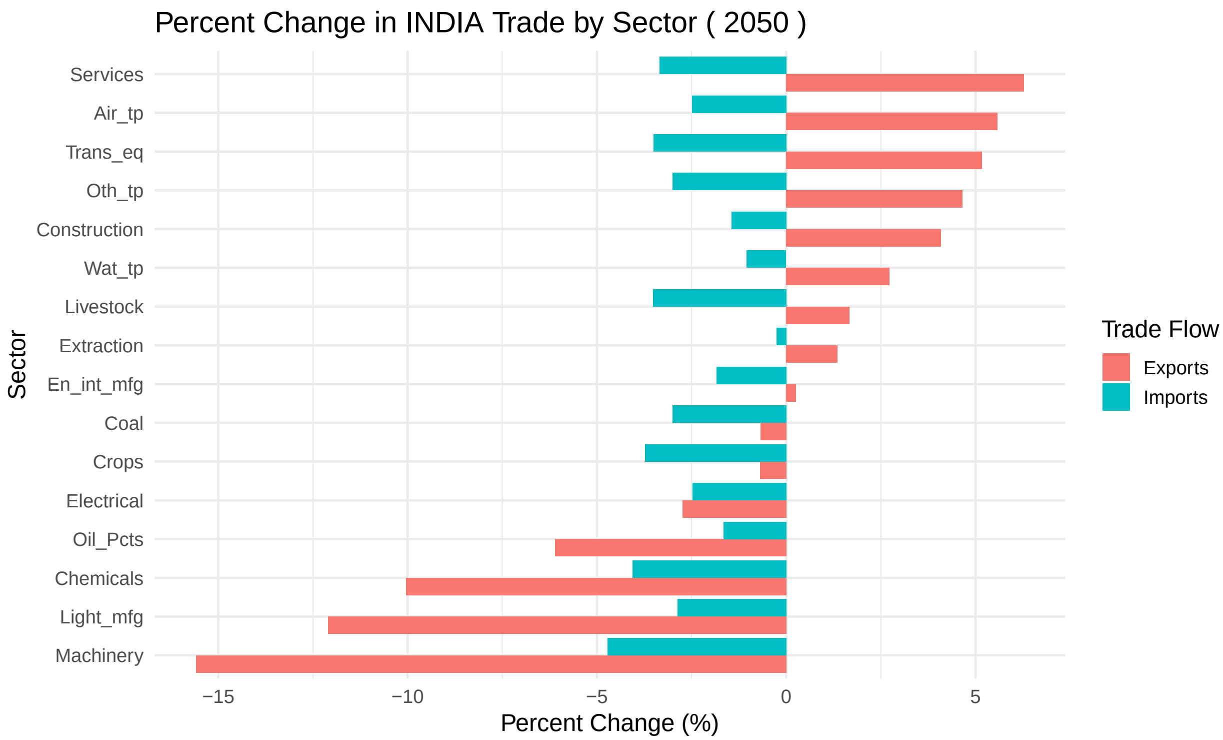

Figure 8: Percent change in India's exports and imports by sector in 2050 under tariff scenario (relative to baseline).

India's main export sectors to the United States—machinery, light manufacturing, chemicals, and oil products—experience sharp declines in exports, reflecting the direct impact of tariffs (Figure 8). Imports in these same sectors also fall, as reduced production lowers the demand for imported intermediate inputs. This pattern is consistent with the United States results, underscoring how global supply chains contract when key sectors are subject to tariffs. At the same time, India experiences increases in exports in sectors not directly targeted. In particular, services, which represent one of India's largest and most competitive export sectors, show relatively strong growth as resources are reallocated away from tariff-affected manufacturing industries. Imports into these sectors decline as well, reflecting the redirection of domestic resources toward service production. This reallocation mirrors the sectoral adjustments observed in other regions, such as China, where domestic resources shift into non-tariffed sectors as part of the broader global restructuring induced by tariffs.

Economy

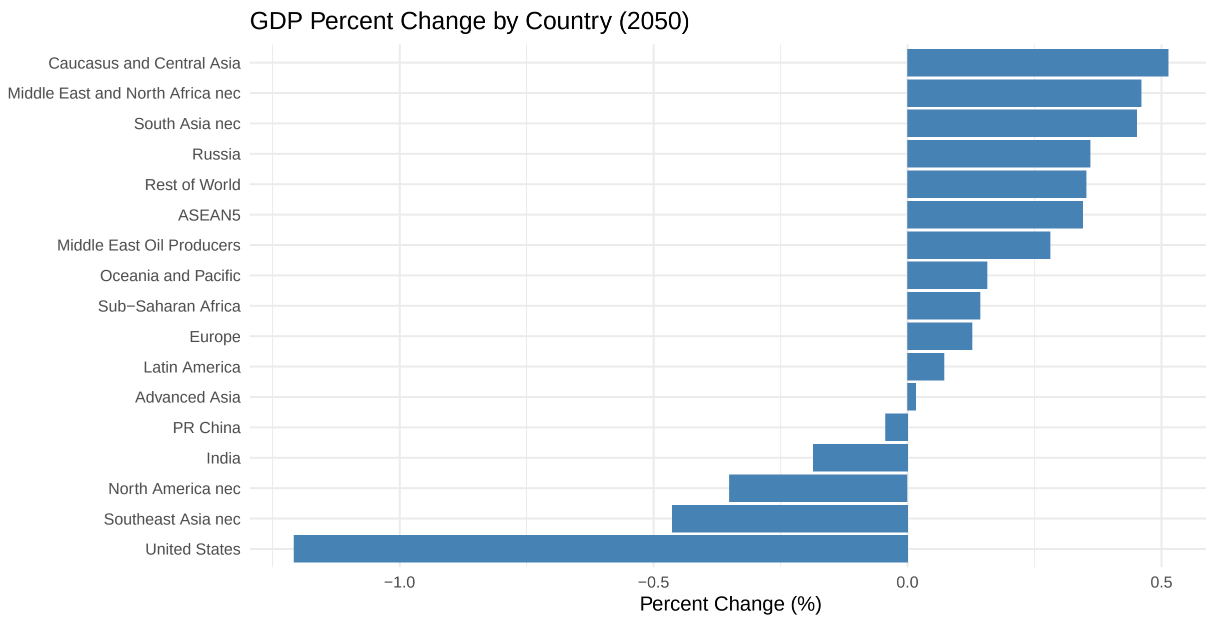

Figure 9: Percent change in GDP by country and region in 2050 under tariff scenario (relative to baseline).

Although the trade impacts of tariffs are substantial, the overall effects on GDP are comparatively modest. This reflects the fact that trade accounts for only a small share of GDP, so even large shifts in trade flows translate into relatively small changes in aggregate output. The United States records the largest GDP loss, at approximately 1.2 percent, consistent with its central role in the imposition of tariffs (Figure 9). Other economies also experience GDP declines, including China, India, North America nec, and Southeast Asia nec, reflecting both reduced exports and higher production costs. A few regions, however, register small gains. Europe, ASEAN5, and the Middle East and North Africa benefit slightly as production that was previously concentrated in the United States is diverted to these regions. This reallocation illustrates a general equilibrium outcome: while tariffs generate efficiency losses globally, some regions experience modest gains from the shifting patterns of production and trade.

Emissions

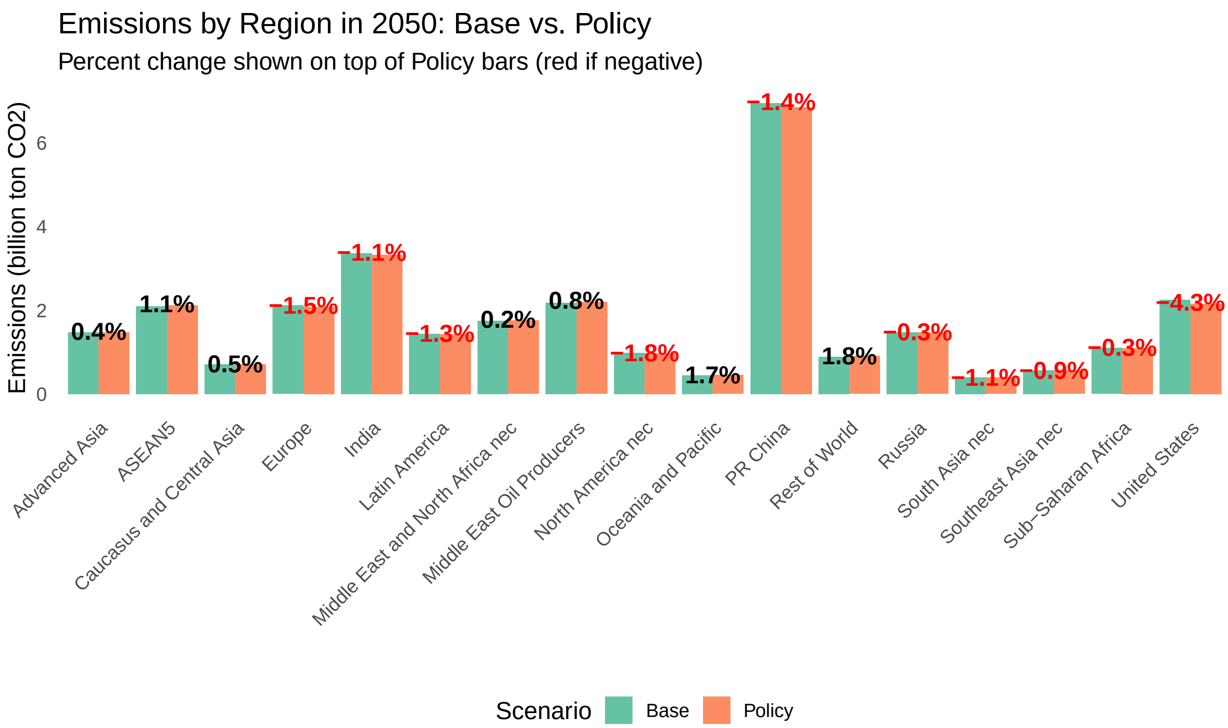

Figure 10: Percent change in emissions by country and region in 2050 under tariff scenario (relative to baseline).

Consistent with the GDP results, changes in emissions under the tariff scenario are small but not insignificant. Net global emissions decline, with the largest reduction occurring in the United States (Figure 10). In absolute terms, China remains the world's largest emitter, reflecting its scale of production and reliance on fossil fuels. Nevertheless, China records an emissions reduction of about 1.4 percent, while North America nec and Europe see declines of roughly 1.9 percent and 1.5 percent, respectively. Figure 11 plots the percent change in emissions against the percent change in GDP across regions in 2050 under the tariff scenario. The general pattern aligns with expectations: regions experiencing GDP growth also tend to register emissions increases, while those with GDP losses exhibit emissions reductions. This outcome reflects the scale effect, whereby higher levels of production are associated with greater energy use and emissions, and conversely, reduced economic activity leads to lower emissions.

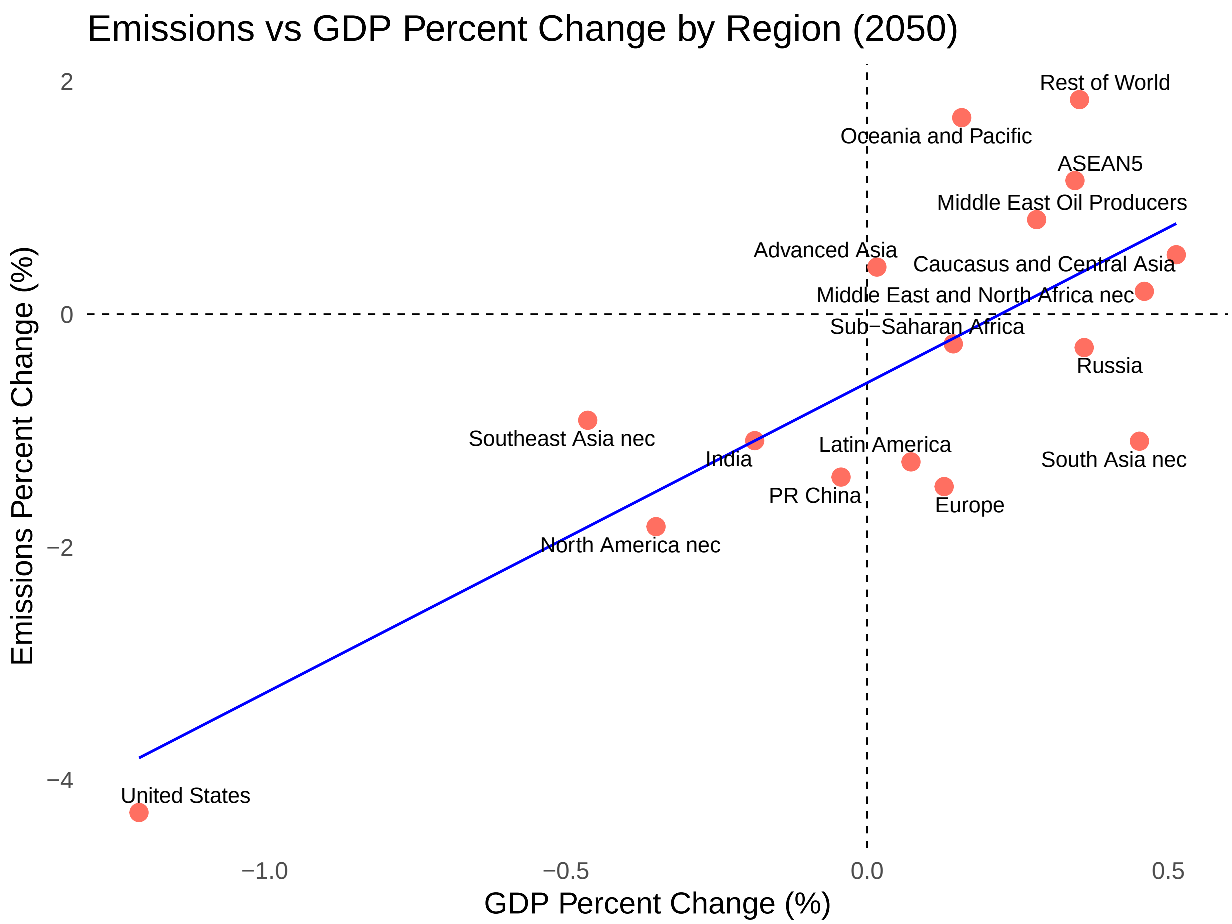

Figure 11: Relationship between GDP and emissions changes by region in 2050 under tariff scenario (relative to baseline).

While the scale effect accounts for much of the observed variation, it does not capture the entire picture. Several regions diverge from the one-to-one relationship between GDP and emissions, indicating that additional forces are at work. Therefore, it is necessary to decompose emission changes into scale, composition, and technique effects. This decomposition helps isolate the extent to which tariff-induced emission changes are driven purely by output changes versus sectoral shifts in production and improvements in efficiency.

6 Decomposition of Results

$$Q = \sum_i \sum_j q_{ij} = \sum_i \sum_j e_{ij} s_{ij} r_j G \tag{2}$$

Q = Global emissions
q_{ij} = Emissions of sector i, region j
y_{ij} = Output of sector i, region j
$e_{ij} = \frac{q_{ij}}{y_{ij}}$ = Emissions coefficient of sector i, region j
$s_{ij} = \frac{y_{ij}}{g_j}$ = Sector shares (of value added) of region j where $g_j = \sum_i y_{ij}$ (GDP of region j)

$r_j = \frac{g_j}{G}$ = Region shares of World GDP
G = Global GDP

Global emissions are the sum of emissions across all sectors and regions (Equation 2). Emissions from a sector in a given region can be expressed as the product of that sector's emissions intensity, its share of regional output, and the region's share of world GDP. This decomposition provides the basis for decomposing tariff-induced changes in emissions into scale, composition, and technique effects.

$$\Delta Q = \sum_i \sum_j \left[\underbrace{\frac{\Delta e_{ij}}{e_{ij}}}_{technique} + \underbrace{\frac{\Delta s_{ij}}{s_{ij}}}_{composition} + \underbrace{\frac{\Delta r_j}{r_j} + \frac{\Delta G}{G}}_{scale} \right] q_{ij} + \delta \tag{3}$$

Equation 3 expresses the change in global emissions as the sum of changes in each of the three components—technique, composition, and scale—weighted by the emissions of sector i in region j. The scale effect ($\frac{\Delta r_j}{r_j} + \frac{\Delta G}{G}$) measures the impact on emissions due to changes in the overall size of the world economy as well as shifts in the regional shares of global GDP. Increased global economic activity raises global emissions. In addition, growth in a region's GDP relative to other regions increases its contribution to global emissions. For example, if China's share of world GDP expands, it will contribute more to global emissions. The composition effect ($\frac{\Delta s_{ij}}{s_{ij}}$) captures how changes in sectors within regions affect emissions: a shift toward carbon-intensive sectors, such as energy-intensive manufacturing, raises emissions, while a shift toward cleaner sectors, such as electrical equipment, lowers them. Finally, the technique effect ($\frac{\Delta e_{ij}}{e_{ij}}$) reflects changes in emissions intensity, the volume of emissions per unit of output. For example, when firms substitute renewable energy in place of fossil fuels, emissions fall even if output remains unchanged.

Main Result

Table 2: Decomposition of Emissions Changes by Region (2050)

Region	Technique	Composition	Scale	Total
ASEAN5	15.75	1.00	7.24	24.00
Advanced Asia	5.71	0.01	0.24	5.96
Caucasus and Central Asia	-0.06	0.05	3.63	3.61
Europe	-32.74	-1.20	2.71	-31.23
India	-34.70	4.52	-6.28	-36.45
Latin America	-16.20	-3.15	1.05	-18.30
Middle East Oil Producers	10.78	0.76	6.15	17.69
Middle East and North Africa nec	-4.65	0.06	8.07	3.48
North America nec	-14.78	0.07	-3.46	-18.17
Oceania and Pacific	6.32	0.49	0.70	7.51
PR China	-98.91	4.86	-2.99	-97.04
Rest of World	12.97	0.22	3.14	16.33
Russia	-7.21	-2.27	5.31	-4.18
South Asia nec	-6.04	-0.03	1.79	-4.27
Southeast Asia nec	-3.59	1.07	-2.61	-5.13
Sub-Saharan Africa	-4.98	0.63	1.57	-2.78
United States	-56.43	-13.84	-27.26	-97.53
Total	-228.77	-6.73	-0.99	-236.49

Note:
Emission changes are in million tons of CO_2

The decomposition analysis reveals that global emissions decline by 236 million tons of CO_2 under the tariff scenario, representing less than 0.1 percent of projected total emissions in 2050 (30,149 million tons of CO_2). While modest in relative terms, this reduction is still environmentally significant, as it is comparable to the annual emissions of a mid-sized economy. A key finding is that the technique effect emerges as the primary driver in the decomposition. Reductions in emissions intensity—driven primarily by the adoption of cleaner production technologies and increased reliance on renewable energy—account for nearly the entire decrease in emissions. The sectoral composition effect is negative but relatively small, indicating that the relative shares of "dirty" versus "clean" sectors change marginally under the tariff scenario. Finally, the reduction in emissions generated by the scale effect is negligible. The reduction in emissions from lower output in regions that contract under the tariff—such as the United States, India, and China—is almost entirely offset by increases in emissions from regions that expand.

Technique

Story 1: Tariffs accentuate the effects of green energy policies

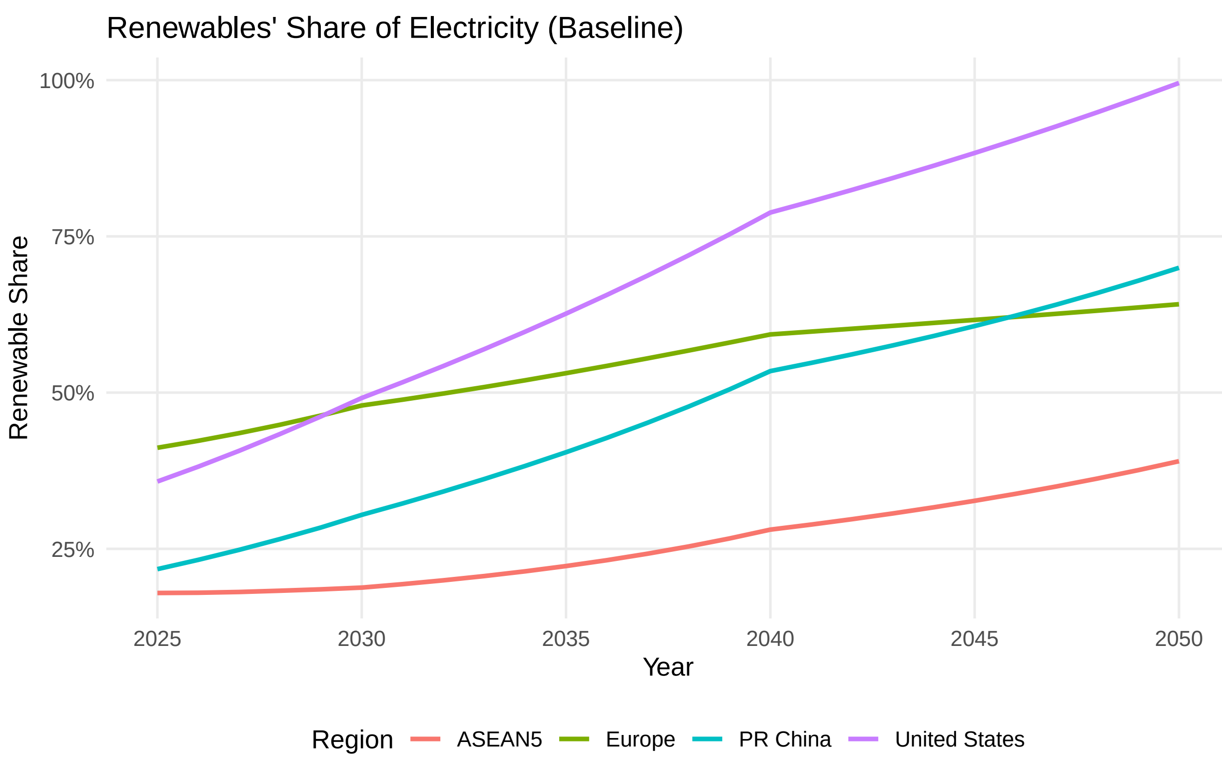

Figure 12: Share of renewable energy in electricity generation under the baseline scenario

Figure 12 illustrates the evolution of the renewable energy (wind, hydro, and solar) share in electricity generation over time under different green energy policies under the STEPS scenario. The green energy policy in the United States is particularly aggressive, with the share of renewables rising rapidly and approaching full decarbonization by 2050. China follows closely behind, surpassing Europe around 2045 in terms of renewable adoption. Other regions, such as ASEAN5, also experience increases in renewable energy shares, though at a much slower pace. These gains for the ASEAN5 are even more modest under the tariff scenario, where growth in its economy and sectors dampens the expansion of clean energy. However, for regions that contract under the tariff scenario, such as the United States, Europe, and China, the impact of their green energy policies is magnified. Reduced output lowers energy demand while renewable subsidies remain fixed, resulting in a higher share of renewables in electricity generation.

Table 3: Renewable Energy Share of Electric Power in 2050

Region	Renewable Share (Baseline)	% Change (Baseline vs Policy)
ASEAN5	0.39	-0.73
Advanced Asia	0.49	-0.34
Caucasus and Central Asia	0.21	0.19
Europe	0.64	0.65
India	0.67	0.59
Latin America	0.58	0.63
Middle East Oil Producers	0.29	-0.97
Middle East and North Africa nec	0.40	0.51
North America nec	0.51	2.07
Oceania and Pacific	0.31	-1.78
PR China	0.70	0.68
Rest of World	0.33	-0.84
Russia	0.29	0.52
South Asia nec	0.43	1.78
Southeast Asia nec	0.61	0.08
Sub-Saharan Africa	0.63	0.10
United States	1.00	-0.20

The largest negative technique effects occur in the United States, China, Europe, and India (Table 2). For China, Europe, and India, the magnitude of the effect is particularly large because they are the world's three largest emitters; thus, when their production becomes cleaner, the impact on global emissions is correspondingly greater. In all three regions, the share of renewable energy in total electricity generation is higher under the tariff scenario than in the baseline (Table 3). This is because tariffs reduce overall electricity demand through lower production, while subsidies and policy incentives for renewables remain fixed. With lower total demand, the unchanged subsidy regime increases the renewable share of the energy mix, leading to greener production. The same applies to consumption, though not shown in this table, where renewable shares also rise under the tariff scenario. By contrast, regions with positive technique effects experience rising emissions, as higher levels of production increase reliance on more carbon-intensive, or "brown," energy sources. In these cases, additional output is sustained through an expansion of fossil fuel use, which raises emissions intensity and results in dirtier production. For the United States, the technique effect is also negative (Table 2), but the decline in the renewable share of electricity generation in Table 3 does not reflect a meaningful shift in energy use, as the share is already close to one in the baseline. Another mechanism, explored in the following section, helps explain the large technique effect observed in the United States.

Story 2: Other endowments are substituted for energy, making production relatively "greener"

Table 4: Percent Change in Factor/Energy Price Ratios by Sector (United States, 2050)

Activity	UnSkLab	SkLab	Capital
Air_tp	-3.41	-3.49	-1.84
Chemicals	-3.09	-3.16	-1.51
Construction	-2.94	-3.01	-1.36
En_int_mfg	-1.43	-1.51	0.17
Extraction	-1.69	-1.76	-0.09
Light_mfg	-1.32	-1.40	0.28
Oth_tp	-3.27	-3.35	-1.70
Services	-1.29	-1.37	0.32
Wat_tp	-3.43	-3.51	-1.86

Table 4 reports the percent changes in factor-to-energy price ratios under the tariff scenario relative to the baseline. A negative entry indicates that a given factor has become cheaper relative to energy. The results show a consistent pattern across all sectors: both skilled and unskilled labor become cheaper relative to energy. This implies that tariffs create excess labor supply in these sectors, as the demand for labor falls more sharply than the demand for energy. One reason is that labor is far more mobile across sectors than energy inputs and can therefore be reallocated more easily. Producers, therefore, substitute away from energy and toward labor, making production less energy-intensive. As production becomes less energy-intensive overall, emissions decline.

While labor prices fall relative to energy across the board, the adjustment is less uniform for capital. In most sectors, capital also becomes cheaper relative to energy. However, exceptions emerge in energy-intensive manufacturing, light manufacturing, and services, where capital rents remain relatively high compared to energy prices. This reflects the fact that these sectors are relatively capital-intensive, so the demand for capital is more resilient than in other sectors. Nevertheless, in the United States, most sectors substitute labor and, to some extent, capital for energy, and through this mechanism production becomes "greener."

Composition

Table 5: Top 5 Sectors by Sector Composition Contribution (United States, 2050)

Sector	Emissions	Sector % Chg	Emission Chg
Air_tp	319.28	-2.43	-7.77
Consumption	893.08	-0.38	-3.37
Oil_Pcts	70.30	-3.86	-2.71
Wat_tp	56.08	-2.14	-1.20
Services	132.70	-0.63	-0.84

Note:
Emissions is in million tons of CO_2.

Table 6: Top 5 Sectors by Sector Composition Contribution (United States, 2050)

Sector	Emissions	Sector % Chg	Emission Chg
En_int_mfg	12.19	8.92	1.09
Light_mfg	7.72	5.95	0.46
Chemicals	16.60	2.66	0.44
Oth_tp	654.92	0.04	0.25
Extraction	6.99	2.64	0.18

Note:
Emissions is in million tons of CO_2.

In the United States, the sectoral composition effect results in lower overall emissions, even though energy-intensive manufacturing and light manufacturing expand significantly under the tariff scenario, by 9 percent and 6 percent respectively (Table 5). The key reason is that by 2050 manufacturing sectors in the United States are already relatively clean due to their high usage of renewable energy sources (Figure 12). Thus, contractions in high-emission sectors such as transport, consumption, and oil products, though smaller in percentage terms, generate reductions in emissions large enough to offset the increases from expanding sectors.

Table 7: Top 5 Sectors by Sector Composition Contribution (PR China, 2050)

Sector	Emissions	Sector % Chg	Emission Chg
Oil_Pcts	401.99	-0.29	-1.15
Consumption	1966.95	-0.06	-1.13
Light_mfg	112.73	-0.59	-0.66
CoalE	21.41	-1.39	-0.30
Coal	41.38	-0.62	-0.26

Note:
Emissions is in million tons of CO_2.

Table 8: Top 5 Sectors by Sector Composition Contribution (PR China, 2050)

Sector	Emissions	Sector % Chg	Emission Chg
En_int_mfg	1178.95	0.22	2.61
Air_tp	223.40	1.04	2.33
Chemicals	406.76	0.25	1.03
Services	779.56	0.13	1.00
Construction	192.98	0.29	0.55

Note:
Emissions is in million tons of CO_2.

The opposite pattern is observed in China, where expansion in emission-intensive sectors outweighs the reductions from contracting sectors. Under the tariff scenario, energy-intensive manufacturing expands, but unlike in the United States, this sector in China remains highly emissions-intensive. Moreover, although China experiences contractions in emission-intensive sectors such as oil products and consumption, the extent of expansion in other sectors is larger, resulting in a net increase in emissions from the reallocation of sectoral production. Although production in the United States is more costly, it is considerably cleaner than in many trading partners. As a result, relocating energy-intensive industries, light manufacturing, and chemicals to the United States is environmentally beneficial. This cleaner production structure generates a net reduction of 9.6 million tons of CO_2 through the sectoral composition effect.

Scale

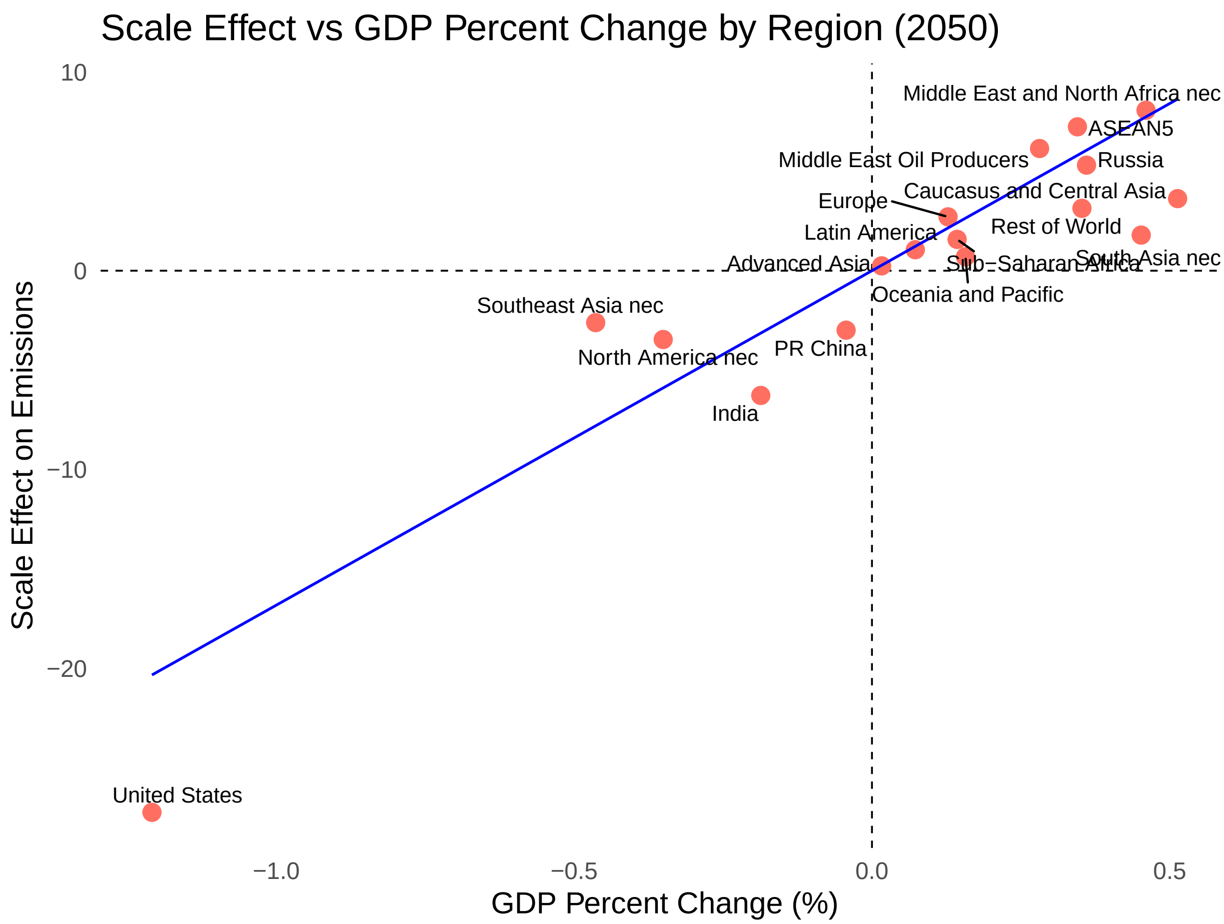

Figure 13: Relationship between GDP and emissions changes (scale effect, including regional composition) by region in 2050 under tariff scenario.

Figure 13 plots changes in GDP and emissions only from the scale effect. The results show that a decline in GDP leads to lower emissions, though the strength of this relationship varies across regions, reflecting differences in emissions intensities and production structures. For example, China, North America (nec), and Southeast Asia (nec) display reductions in emissions of similar magnitude, yet China achieves this outcome with a comparatively smaller contraction in GDP. This reflects the fact that Chinese production remains relatively emissions-intensive, so even modest output declines translate into substantial emission reductions. By contrast, regions with cleaner production technologies require larger GDP reductions to generate comparable declines in emissions. The strongest scale effect is observed in the United States, which experiences by far the largest contraction in GDP and, correspondingly, the largest reduction in emissions. This underscores the extent to which tariffs impose economic costs on the United States and its associated emission reductions from lower economic activity.

7 Conclusion

The decomposition of emissions changes shows that the technique effect is by far the dominant channel. Two distinct mechanisms drive this result. In many regions—most notably China, Europe, and India—production becomes cleaner as the renewable share of electricity generation increases. Tariffs indirectly reinforce existing green energy policies: by lowering overall electricity demand through reduced production, while subsidies for renewables remain fixed, they raise the renewable share of the power mix and thereby reduce emissions intensity. A second mechanism operates through factor substitution. As tariffs reduce demand for imported intermediates and capital-intensive inputs, labor and capital become relatively cheaper than energy. This relative price shift encourages producers to substitute away from energy and toward other endowments, further lowering emissions.

The composition effect is also negative, though small in magnitude. A key driver is the United States, where energy-intensive manufacturing processes are reshored. Because production in these sectors is considerably cleaner in the United States than in other regions, this relocation reduces global emissions, particularly as other high-emitting U.S. sectors shrink in size. This effect outweighs the opposite tendency in other regions, where expansion is concentrated in more carbon-intensive sectors. By contrast, the scale effect contributes little to overall emissions changes. Although lower GDP in some regions reduces emissions, these reductions are almost entirely offset by positive scale effects elsewhere. Consequently, the global impact of the scale channel is negligible compared with the composition effect and especially the technique effect.

Appendix

Table 9: Region Code Mapping

#	Code	Region Name
1	chn	PR China
2	as5	ASEAN5
3	sel	Southeast Asia nec
4	ind	India
5	xsa	South Asia nec
6	cca	Caucasus and Central Asia
7	dea	Advanced Asia
8	ocn	Oceania and Pacific
9	usa	United States
10	xna	North America nec
11	lac	Latin America and Caribbean
12	eur	Europe
13	meo	Middle East Oil Producers
14	mna	Middle East and North Africa nec
15	afr	Sub-Saharan Africa
16	rus	Russia
17	row	Rest of World

Table 10: Sector List with Descriptions

#	**Sector Code**	**Description**
1	Crops	Agricultural crops
2	Livestock	Animal husbandry and meat production
3	Extraction	Mining and raw resource extraction
4	Chemicals	Chemical and petrochemical products
5	Light_mfg	Light manufacturing (e.g., textiles, apparel)
6	En_int_mfg	Energy-intensive manufacturing (e.g., metals, cement)
7	Electrical	Electrical equipment manufacturing
8	Machinery	Industrial and general-purpose machinery
9	Trans_eq	Transport equipment (e.g., vehicles, aircraft)
10	TnD	Transmission and distribution (electricity grid)
11	Construction	Construction services
12	Dwellings	Residential housing services
13	Services	Other commercial and public services
14	Oth_tp	Other transport (unspecified)
15	Wat_tp	Water transport
16	Air_tp	Air transport
17	Coal	Coal mining and processing
18	Oil	Crude oil extraction
19	Gas	Natural gas extraction
20	Oil_Pcts	Refined petroleum products
21	NuclearE	Nuclear power generation
22	CoalE	Coal-based electricity generation
23	GasE	Gas-based electricity generation
24	WindE	Wind power generation
25	HydroE	Hydroelectric generation
26	OilE	Oil-based electricity generation
27	OthE	Other renewable or miscellaneous energy sources
28	SolarE	Solar power generation

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