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Projected Effects of the Clean Competition Act of 2025

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Executive Summary

The Clean Competition Act (CCA) of 2025, updated and introduced to the 119th Congress by Senator Sheldon Whitehouse (D-RI), would establish a domestic performance standard and a symmetric **carbon border adjustment mechanism** (CBAM) for certain energy-intensive, trade-exposed goods. US manufacturers of goods covered by the legislation would pay a fee for carbon emissions above a benchmark specified for those goods. Imported, covered goods would face an analogous tariff based on how much more carbon-intensive that good was compared to the benchmark. The benchmark for each good would initially be set at the average level of emissions for its manufacture in the United States, becoming more stringent over time. The carbon emissions fee and tariff rates would also increase over time, providing an ongoing set of symmetric incentives to reduce the emissions intensity of both US manufacturing and imported goods.

Here, we use the Global Economic Model (GEM) to assess the effects of a CBAM stylized after the CCA.

We find that the CCA would have the following effects:

- **Shift US imports toward countries with less carbon-intensive manufacturing**: Imports for covered products are reduced from countries facing the carbon tariffs (e.g., China, Mexico, and India) and increased from countries exempt from the tariffs (e.g., the European Union, United Kingdom, and Japan) due to their lower carbon intensity of manufacturing for those products.
- **Reduce emissions globally, led by the United States**: Emissions are projected to decrease globally by 81 million metric tonnes (MMt) in the first year of the policy, with US emissions reductions of 63 MMt leading all other countries. The increasing fee and tightening standards lead to greater reductions over time, with 140 MMT of global and 119 MMt of US emission reductions in the tenth year after enactment. US emissions reductions result from decreased energy and emissions intensity of manufacturing driven by the CCA's domestic performance standard, as well as reductions in overall demand for energy intensive goods.
- **Raise revenue**: Annual revenues from the policy are projected to be $7.2 billion (in 2024 US$) for the covered refining and manufacturing sectors in the first year and total $101 billion over the first ten years of the policy. Roughly 75 percent of the revenues derive from the domestic performance standard.
- **Reduce US outputs in covered sectors and downstream industries**: The tariffs have a protective effect for US manufacturers, whilst the performance standard increases costs for higher-intensity producers. The balance of effects is slightly negative for US production of covered products: cement (–0.02 percent), aluminum (–1.9 percent), iron and steel (–0.6 percent), and pulp and paper (–0.3 percent). Output in industries such as construction and transportation equipment manufacturing falls slightly (0.04–0.5 percent) in response to higher prices for covered inputs.

Contents

1. Introduction

Carbon border adjustment mechanism (CBAM) policies, in general, impose tariffs on a set of covered goods intended to mirror the effects of domestic policies to reduce emissions from the production of those goods. By establishing a set of symmetric incentives under which domestic and foreign manufacturers are subject to equivalent policies, CBAMs are intended to deter the unintended "leakage" of manufacturing from the country initiating the carbon policy to foreign countries with less stringent environmental standards. The EU CBAM initiated in 2023 is an example of such a policy. For certain energy-intensive goods (e.g., steel and cement), EU importers are required to surrender carbon certificates under obligations that mirror those imposed on EU producers by the EU Emissions Trading System (EU ETS). A parallel system is followed by the United Kingdom.

The imposition of the EU CBAM, among other factors, has led to a renewed interest in CBAM policies globally, with proposals under active consideration in Japan and Australia. US policymakers have also demonstrated interest, driven in part by the current "carbon advantage" that the United States holds by manufacturing many energy-intensive, heavily traded goods with fewer carbon emissions than competing countries like China, Mexico, and India (David et al. 2025; Rorke et al. 2025; DeFilippo and Wise 2025). For example, Senator Cassidy (R-LA) introduced the **Foreign Pollution Fee Act of 2025**, which would impose an ad-valorem tariff on goods, including steel, aluminum, and cement, based on the carbon intensity of production in the foreign countries relative to a US benchmark. The **bipartisan PROVE IT Act** introduced by Senators Cramer (R-ND) and Coons (D-DE) would initiate data collection to support a future border measure based on carbon intensity. The CCA introduced by Senator Whitehouse would enact a full US CBAM, imposing a set of tariffs based on carbon intensity that mirror a domestic industrial performance standard for the covered goods.

In this report, we assess the effects of the CCA using the Global Economic Model (GEM) described in Cao et al. (2024). The model simulates how the tariffs and the domestic carbon intensity charges change all prices in the economy, not just changes to covered products, and how producers change their input mix to respond to the overall changes in costs. It accomplishes this by employing a top-down modeling approach that captures inter-industry "general equilibrium" effects, such as how changes in the prices and quantities of steel affect other sectors such as motor vehicles, aircraft, and construction, as well as the effect on aggregate GDP and growth over time. GEM is built on the Global Trade Analysis Project (GTAP) database covering 160 countries and 65 industries. To reduce complexity, GEM represents each of the G20 countries individually; the remaining countries are grouped into nine regions (Table A2)[1]. GEM also distinguishes between 30 economic sectors (Table A3).

By assessing general equilibrium effects, GEM differs from other approaches used to assess border measures. For example, partial equilibrium approaches, such as the

1 Citations which include the letter "A" refer to figures and tables in the appendix.

approach employed by David et al. (2025), leverage detailed, product-level information to assess price and trade effects for each product. Partial equilibrium approaches can offer greater sectoral detail, but do not account for interactions between specific sectors and may not capture the full substitution among suppliers from different countries facing varying tariff rates.

The imposition of a symmetric system of US tariffs and domestic fees based upon carbon intensity would have many potential effects. Here we use GEM to assess the extent of these effects using the following metrics for a policy stylized after the CCA: 1) Patterns of US imports, 2) US and foreign output for each sector, 3) US government revenue, 4) Overall economic output, and 5) Country- and global-level emissions.

2. Legislative Overview

The CCA, originally introduced into the 117th Congress by Senator Whitehouse, was updated and reintroduced into the 119th Congress in December of 2025. We provided detailed information about the previous version of the legislation in the following reports: **Comparing the European Union Carbon Border Adjustment Mechanism, the Clean Competition Act, and the Foreign Pollution Fee Act**; and **Carbon Border Adjustments: Design Elements, Options, and Policy Decisions**. In brief, for a set of covered goods, the legislation would impose fees on domestic production and tariffs on imports based on the carbon emissions of production above a baseline carbon intensity for that good, hereafter referred to as the "benchmark."

The domestic carbon intensity charges and tariffs are set on a dollar-per-ton-of-carbon-dioxide basis and apply only to production emissions above the benchmark. Analogous charges would be calculated by the US Department of the Treasury for each imported good based on the carbon intensity of production in the country of origin, likely through conversion to an *ad valorem* rate. The benchmark is initially established at the average carbon intensity of US production for each covered good for the year of enactment, and it becomes more stringent by 2.5 percent per year starting in 2027, and by 5 percent per year starting in 2031, until reaching a 0 percent intensity in 2048. The fee is initially set at $60 and escalates by 6 percent per year above inflation to reach $101 in year 10 of the policy[2] (Figure A1).

The legislation identifies a set of covered goods using the North American Industry Classification System (NAICS, Table A4). Covered goods include petroleum extraction and refining, natural gas extraction, coal mining, pulp and paper, manufacturing of asphalt, iron and steel, petrochemicals, adipic acid, ethyl alcohol, fertilizer, and lime and gypsum, as well as the production of hydrogen, glass, cement, and aluminum. Greenhouse gas emissions included in the carbon intensity calculations include direct emissions from manufacturing (often referred to as Scope 1 emissions) as well as indirect emissions from consumed electricity, steam, heating, or cooling (Scope 2). Large, finished goods that are imported to the United States and contain substantial amounts of the primary CCA-covered goods (e.g., cars and refrigerators with high steel content) are phased in over time as additional covered goods subject to tariffs.

2 See Section A4 for details.

The carbon intensities for imported goods are assessed in one of three ways depending on the availability and quality of data in the country of origin and other circumstances: 1) Based upon the economywide carbon intensity of production across all industries, 2) based upon the distribution of carbon intensities for the industrial sector in that country, or 3) at the firm level upon successful petition (which is available under specific circumstances). Carbon intensity calculations are carried out at the manufacturing facility level for domestic manufacturers. Carbon dioxide sequestered via direct air capture may be used to offset domestic charges.

Revenues raised by the policy are recycled directly back into the industrial sector to support decarbonization efforts through a combination of grants, rebates, loans, and a contract for differences program, with 75 percent of the funds earmarked for domestic programs and 25 percent to support emissions reductions from foreign firms. $100 billion of such revenues are pre-appropriated for rapid disbursal upon enactment of the legislation. The president is authorized to negotiate “carbon clubs” with other countries to align the CBAM and similar policies to accelerate greenhouse gas emissions reductions. US manufacturers are refunded fees paid under the domestic performance standard for exports of covered goods.

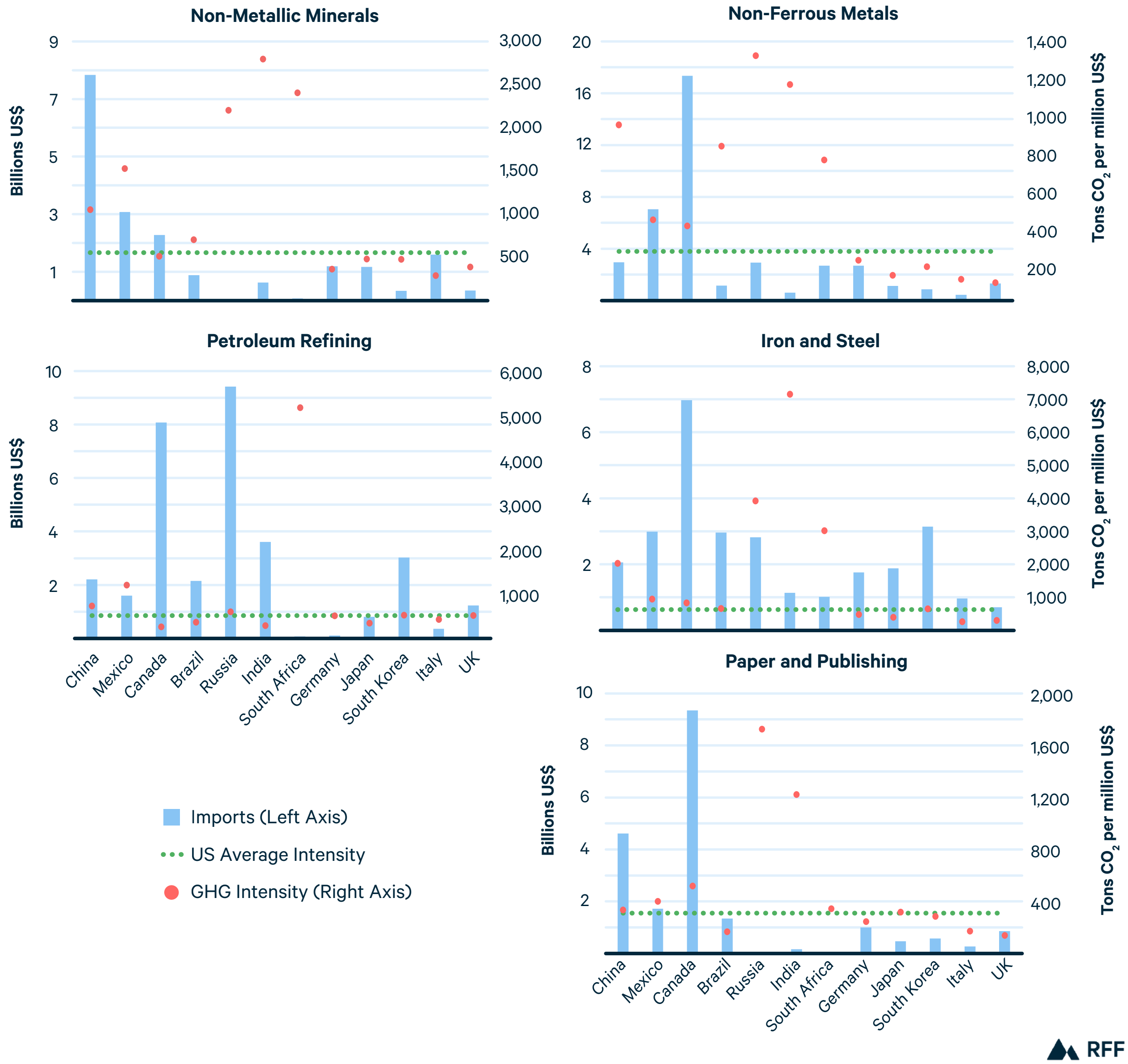
3. Model Results

3.1. Calculated Foreign Carbon Intensities and *Ad Valorem* Rates

When modeling the CCA, we used the GTAP dataset to estimate country- and sector-specific average carbon intensities of imports based on Scope 1 and Scope 2 emissions in the country of origin. The sector-specific estimates for the United States calculated in this manner are used to set the benchmark for purposes of calculating the tariffs and domestic fees.

To enable this calculation, covered products are first mapped into the corresponding nine GTAP sectors encompassing those products (e.g., cement and glass products are mapped to the non-metallic mineral products sector, Table A3). These sectors can be considered in two groups: 1) three sectors corresponding to the fossil fuel extraction and commodities themselves (coal mining, oil extraction, and natural gas extraction) and 2) six sectors related to further refining of such products and industrial manufacturing. For each of the GTAP sectors corresponding to refining and manufacturing, we calculate the percentage of US imports of covered products as a percentage of total imports from that GTAP sector. This includes the following sectors: Iron and Steel (90 percent); Nonmetallic Mineral Products (36 percent); Nonferrous Metals (21 percent); Chemicals (5 percent); Petroleum Refining (100 percent); and Pulp and Paper (41 percent) (Table A5). Fertilizer, adipic acid, and ethyl alcohol manufacturing comprise a very small share of the GTAP chemicals sector, so we omit this sector from the modeling to avoid overestimating the effects the policy’s application to those products.

Figure 1. Carbon Intensity by Country for Covered Sectors and Trade Volume (Billion US$) with the United States, 2017



Note: Figure 1 displays the value of US imports (left axis) and the associated carbon intensity of production (right axis) for major trading partners across the four modeled covered sectors. Carbon intensities are benchmarked against the US average (dotted line) for that sector. Countries with both high import values and higher carbon intensities than the United States have greater exposure to the CCA tariffs. These calculations are based on GTAP data for 2017.

For each covered sector, a relatively small set of countries provides most of the imports to the United States (e.g., Canada, Mexico, and China) (Figure 1). Since the data is from 2017 and the GTAP sectors encompassing the list of covered products[3] are highly aggregate in nature, the estimated carbon intensities are averages which will deviate from more detailed analyses of specific covered products using more recent data.

3 For example, the GTAP sector 'non-ferrous metals' used to represent aluminum also includes additional metals such as copper and nickel.

For the fossil-producing sectors (coal mining, oil mining, and gas), current trade flows depart from the 2017 data sufficiently that we report on and discuss their effects under the CCA in the appendix but omit them from our calculations of revenues discussed in Section 3.

The estimated carbon intensities for each country and sector are used to calculate country- and sector-specific *ad valorem* rates for each year of the policy simulation by multiplying the carbon intensity charge rate for the specific year (in US$ per tonne of carbon dioxide) by the difference between the carbon intensity in the country of origin and the carbon intensity benchmark for that year (both in tonnes of carbon dioxide per million US$ of product value, as shown in equations A1 and A2).[4] Figure 2 shows the relation between tariff rates and carbon intensity for the five sectors. As carbon dioxide intensities differ from sector to sector, so will the equivalent *ad valorem* rates of the per-tonne fee, even if there is the same percentage difference in carbon intensity between the domestic benchmark and the average in the country of origin. A given per-tonne fee leads to a higher *ad valorem* rate for sectors that are more carbon intensive and lower in value of sector output per ton of embodied carbon dioxide, and vice versa. Many European countries, as well as South Korea and Japan, are estimated to have zero or near-zero tariffs across all covered sectors in our model (Table 1).[5] *Ad valorem* rates for other countries vary: China at 0.2–7.7 percent, Mexico at 0.5–5.4 percent, Russia at 0.5–18.1 percent, India at 0.0–35.9 percent, and South Africa at 2.7–25.6 percent.[6]

3.2. Calculated Carbon Intensities and Fees for Domestic Facilities

Under the CCA, US manufacturers for the covered sectors would be assessed carbon intensity charges at the level of the manufacturing facility, based upon the carbon intensities of each facility relative to the benchmark for that year. Facilities producing above the benchmark would be assessed fees corresponding to how much higher their carbon intensity is than the benchmark, while facilities producing with carbon intensities lower than the benchmark would not be assessed fees. Estimating the fee amounts and their effects on the US covered sectors therefore requires knowledge of the distribution of carbon intensities at the facility level for each covered sector.

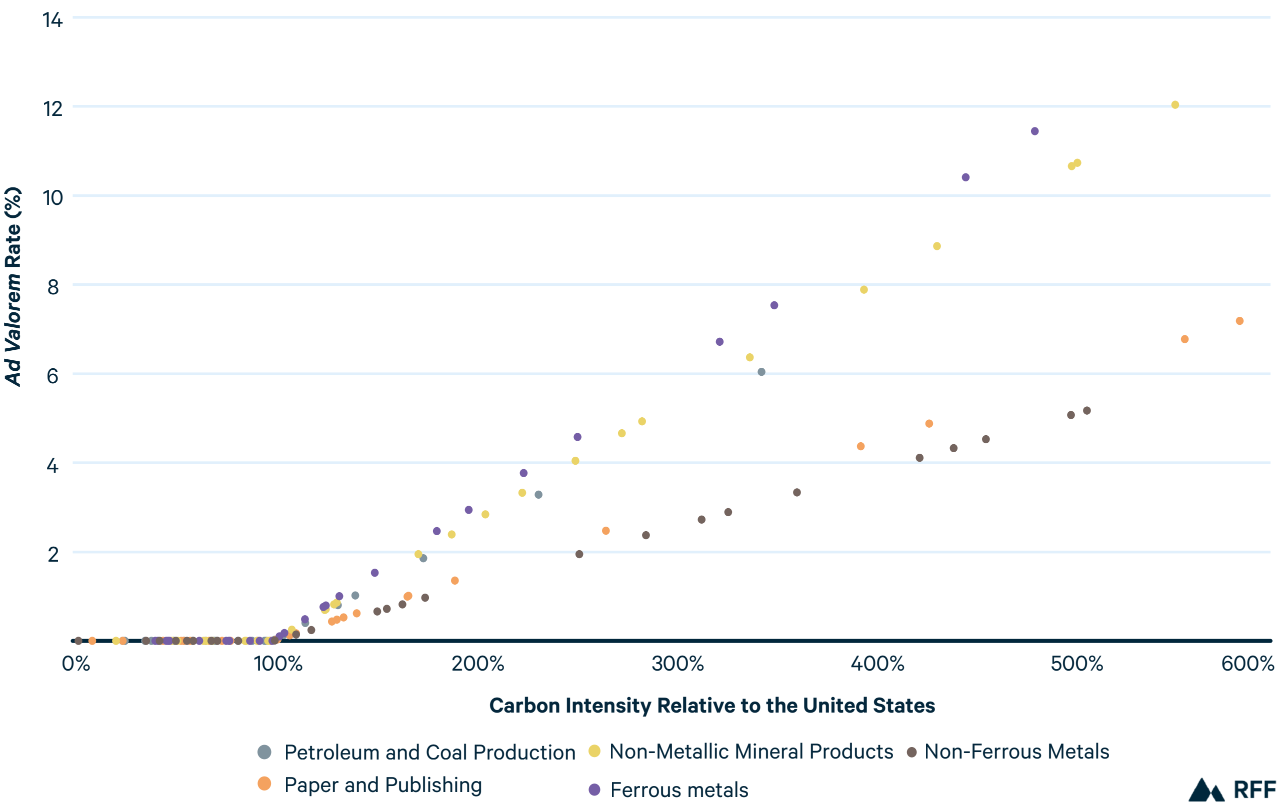
The data collection required by the CCA to support calculating facility-level carbon intensities—tonnes of carbon dioxide per unit of physical output—would leverage existing reporting requirements for emissions, electricity usage, and production volumes. Under current regulations, US greenhouse gas emissions data is publicly available at the facility level by the US Environmental Protection Agency, but facility-level production volumes are largely unavailable, held in confidence by the US Census Bureau.

4 The CCA is applied on a volumetric basis (US$ per tonne of carbon per ton of covered good), but for modeling purposes we must represent this relationship in value terms (US$ per tonne of carbon per million dollars of imports).

5 More detailed analysis at the product level could result in non-zero tariffs for specific products (e.g., a specific steel product).

6 Information for all countries is provided in Tables A6 and A7.

Figure 2. Ad Valorem Tariff Rates versus Carbon Intensities by Covered Sector, Year 1 of the Policy Simulation



Note: Figure 2 shows calculated ad valorem tariff rates for each covered sector and the carbon intensities relative to the US benchmark using the GTAP data for the base year 2017. Points for each sector (distinguished by color) represent different countries, each with its distinct intensity. The CCA determines the tariff rate according to the absolute amount of carbon emitted in the production of goods, which allows for goods with the same relative carbon intensity (e.g., each 10 percent higher than their corresponding US benchmark) to have different *ad valorem* rates.

To model the CCA's domestic performance standard in GEM, we draw on distributions of carbon intensities from Gray et al. 2024 (e.g., Figure A2), which provides distributions of facility-level emissions rates, along with their mean and standard deviation, for six industries based on confidential US Census Bureau data. To respect confidentiality, the distributions are truncated at both very low and very high levels.

GEM represents output at the industry level, but not the facility level, so we use the distributions for each covered sector to estimate the emissions per unit of average output that is liable for the fee and the share of industry output that is liable. In the base year, the CCA-liable shares for domestic output are: Pulp and Paper (29 percent) Chemicals (18 percent), Non-metallic Mineral Products (34 percent), Iron and Steel (79 percent), and Non-ferrous Metals (8 percent). The liable shares for the corresponding imports are 41 percent, 5 percent, 36 percent, 90 percent, and 21 percent (details in Table A5). The intensity distributions for each sector are assumed to remain constant over time, but we adjust the share of output liable for the fee based both on the

Table 1. Ad Valorem Carbon Tariff Rates During Year 1 of the Policy Simulation

	Ad Valorem Rate (%)											
	China	**Mexico**	**Canada**	**Brazil**	**Russia**	**India**	**South Africa**	**Germany**	**Japan**	**South Korea**	**Italy**	**UK**
Non-metallic Mineral Products	2	5	0	1	8	11	9	0	0	0	0	0
Iron and Steel	7	2	1	0.2	16	31	12	0	0	0	0	0
Non-ferrous Metals	3	1	1	3	5	4	2	0	0	0	0	0
Petroleum Refining	1	3	0	0	0.4	0	22	0	0	0	0	0
Pulp and Paper	0.1	0.4	1	0	7	4	0.2	0	0	0	0	0

Note: *Ad valorem* rates under the modeled policy are calculated using GTAP data based on the carbon intensity of production relative to US levels. Based on these calculations, European countries, South Korea, and Japan would not face tariffs due to their comparatively low carbon intensities. In contrast, higher-emitting countries such as China, Russia, South Africa, and India, would face *ad valorem* tariffs ranging between 0 and 22 percent.

tightening standard as well as a baseline projection of improvement of the carbon intensity for the sector. The carbon intensity charge is represented in GEM as a carbon fee on electricity and fossil inputs of coal, oil, and gas used in the production of covered goods. For each of the covered sectors, the carbon fee is scaled by the corresponding share of industry output liable for the fee to represent the heterogeneity of output for that sector.

Our representation of the domestic performance standard reflects the average effect of the fees on each sector in aggregate. Incentives for individual facilities would differ substantially by facility, however, with some facilities facing no fees at all while higher-emitting facilities would face penalties higher than the average. Our results for the aggregate sectors should be interpreted accordingly.[7]

3.3. Simulated Effects

3.3.1. Trade and US Production

The CCA tariffs and domestic performance standard would create relative price differentials between imports and US production, driving changes in import volumes, production, and trade patterns. Overall, import volumes are projected to remain fairly steady across all sectors, increasing slightly for Petroleum Refining ($160 million) and decreasing for the Pulp and Paper (–$36 million), Non-metallic Mineral Products (–$674 million), Iron and Steel (–$934 million), and Non-ferrous Metals (–$966 million) sectors. These changes are small shares of imports (both dollar and share changes are given in Figure 3a). US production is projected to decrease between 0.02 and 1.9 percent in each of the covered sectors, with the greatest absolute decrease in Petroleum Refining (–$4.6 billion). Net changes in imports and US production are negative, indicating a decrease in projected US consumption for each of the covered sectors.

GEM represents each of the domestic sectors in aggregate, so US production results should be interpreted as the net effects on the sector in total. The model structure does not reflect the relative incentives for facilities producing with lower carbon intensities that would face no carbon prices, and thus be able to increase their output and take market share from both domestic and foreign manufacturers subject to the charges.

Increased imports from lower carbon-intensity countries largely compensate for decreased imports from those with higher carbon intensities (Figure 3b), leading to the relatively small net effect on overall import volumes. US imports increase from Germany, Japan, South Korea, Italy, and the United Kingdom for all covered sectors, and for all but one sector for Canada and Brazil. Imports decrease across all or nearly all covered sectors from China, Mexico, Russia, India, and South Africa. The Iron and

7 Some other details in the CCA are not modeled due to their complexity or how the aggregated nature of the model is unable to address them. We do not account for the rebates allowed for exporters, the use of CCA revenues to support decarbonization (revenues are recycled by cutting existing taxes), and the possibility that some foreign firms may successfully petition for lower assessed intensities.

Steel sector is affected most by the tariffs in absolute dollar terms, including decreased imports from Russia (–$1.4 billion), India (–$877 million), China (–$461 million), and South Africa (–$406 million).[8] Downstream US sectors using inputs from covered sectors reduce output slightly, due to increased input prices driven by the policy (Figure 3c).

3.3.2. US Government Revenues

Both the tariff and domestic performance standard components of the CCA are projected to raise revenue, with additional increases over time. The tariffs shift imports toward lower carbon-intensity producers, from which no tariff revenues are collected. However, substantial trade continues with higher-emitting countries over the full modeled period due to the relatively low level of the tariffs. For the first year of the policy, total projected tariff revenues for the covered manufacturing sectors are $1.5 billion (Table 2, all revenue estimates in 2024 US$) primarily from continued trade with Canada, China, and Mexico (Table A9). Revenues collected from domestic manufacturers total $5.7 billion in the first year of the policy, accounting for 78 percent of the overall revenues collected.[9] Tariff revenues and domestic fees increase each year as the benchmark standards tighten, the per-tonne fees increase, and the global economy grows. Total projected revenues are approximately $15 billion in year 10 of the policy, and cumulative projected revenues are approximately $100 billion for the 10-year period.

CCA revenues collected in the real world could deviate from our modeled projections for multiple reasons. For example, we do not model CCA's policy to recycle all revenue back into the industrial sector to support decarbonization of the covered sectors but expect that it would reduce both emissions and fees collected compared to our projections. Additionally, by construction, the model reaches a new trade equilibrium within the first year of the policy. Real world short-run adjustments would depend on existing spare capacity and availability of suitable workers for each product. If there is limited substitution toward imports from zero-tariff countries, then there is a strong incentive for US producers, particularly those producing with lower carbon intensity than the benchmark, to quickly expand capacity. If current trade patterns with higher carbon- intensity countries for covered sectors are slow to adjust and persist for a longer timeframe (due perhaps to large sunk costs), real-world revenue estimates would be higher than projected by the model.

8 Imports from each country do not fall to zero with the tariffs in this model since they are regarded as imperfect substitutes with imports from other countries and with domestic goods. If goods are perfectly substitutable then the exporting country would have to either completely absorb the tariff or export nothing.

9 Out of necessity, we apply the tariff to the full GTAP sector in which the covered products reside. One consequence of this simplification is that it overestimates the downstream effects from those aggregate sectors compared to the real-world effects, where only the specific Harmonized Tariff Schedule (HTS) codes would be affected and not the entire sector. For calculating revenues, we account in part for this by multiplying by the fraction of US imports for those HTS codes for the year 2017 taken from the US Census Trade Data (see Table A8). Model calculations are carried out using 2017 data in dollar values from that year for internal consistency. The revenues are reported in 2024 US$, whereas the other tables giving historical levels of imports are in model base year 2017 US$.

Figure 3. Change in Production and Imports in Year 1

Figure 3 presents the modeled effects of the policy across three panels. Panel 3a shows changes in US production and imports by covered sector (percent change reported in text above or below each bar). The policy is projected to increase domestic production and reduce imports across all covered sectors. Panel 3b shows import changes by country and sector, with increased imports from countries with lower carbon intensity than the United States and sharp declines from trading partners with high carbon intensities. Panel 3c shows the percent change in production across the covered sectors and selected upstream and downstream sectors. Domestic production from covered sectors and certain upstream sectors increases, while production in downstream sectors such as machinery and construction declines.

3.3.3. Greenhouse Gas Emissions

The tariffs on covered sectors as well as the US domestic performance standard are projected to affect emissions within each country and globally (Figure 4). Lower-emitting European countries, Japan, and the United Kingdom increase their trade with

Table 2. Revenues by Year Over 10-year Budget Window

	Billion US$ (2024 US$)		
Year	**Tariff Revenue**	**Domestic Revenue**	**Total Revenue**
1	1.5	5.7	7.2
2	1.6	5.8	7.5
3	1.8	6.2	8.0
4	1.9	6.5	8.4
5	2.0	7.0	9.0
6	2.2	7.6	9.9
7	2.5	8.4	10.8
8	2.8	9.2	12.0
9	3.1	10.2	13.3
10	3.4	11.3	14.7
10-year total	**22.8**	**78.0**	**100.8**

Note: Table 2 displays projected revenues from the policy over the first 10 years.

the United States as well as production in the covered sectors, leading to increased direct emissions from those countries. Higher-emitting countries, such as China, Russia, India, South Africa, decrease their trade with the United States for the covered sectors, compensating in part by increasing trade with non-US countries to avoid the tariffs. In general, these countries also reduce their output slightly, thereby reducing direct emissions. The effects for any given country are relatively small, as are the net changes in emissions from non-US countries due to changing trade patterns.

For the first year of the simulated policy, the United States reduces its emissions by 63 MMt, comprising over 75 percent of the 81 MMt of net reductions in global emissions. 70 percent of the changes in US emissions for that year are attributable to reductions in energy intensity of production, 22 percent to reductions in industry output, and 8 percent to reductions in energy usage by households facing higher fuel prices (Table A18). As the standards tighten and the per-tonne fee escalates, the CCA is projected to drive greater emissions reductions over time, leading to US reductions of 119 MMt and global reductions of 140 MMt in after ten years. Total global emissions also are reduced due to lower aggregate output (i.e., lower GDP) from the overall distortionary effects of the tariffs (Table A13).

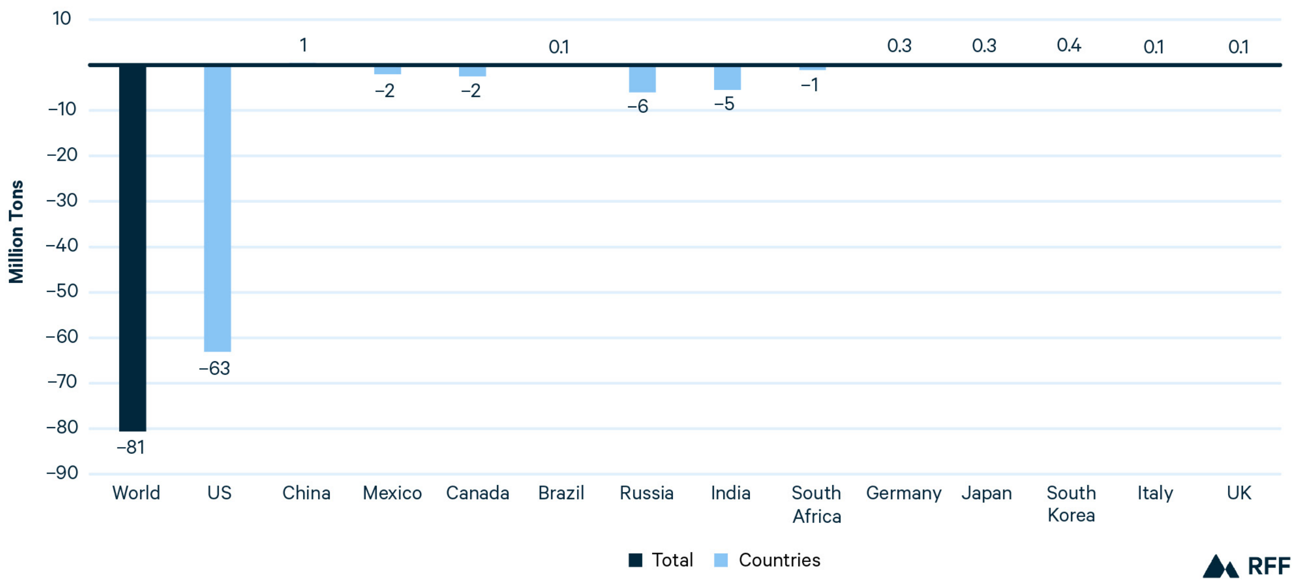
The CCA tariffs and domestic fees are, by design, symmetric, but the United States is projected to reduce its emissions far more than other countries. Minor effects on emissions in foreign countries are attributable, in part, to the relatively low level of the tariffs, and that they are applied by only one trading partner, offering the opportunity to shift trading patterns. We see greater reductions in the United States because a much greater proportion of US manufactured covered goods are destined for US consumption and are therefore subject to the carbon intensity charges.

4. Discussion

The proposed CCA would apply a domestic industrial performance standard with a symmetric border adjustment mechanism, both of which become more stringent over time. Our modeling finds that the CCA would incentivize a reorientation of trade to partners with lower carbon intensity, providing an ongoing and escalating set of incentives to reduce emissions over time (particularly in the United States), and would raise revenues to support policy goals of decarbonization of the industrial sector. Emissions reductions are driven by both decreased energy intensity from US production as well as slightly decreased US production and consumption of the covered and downstream goods.

The specification of sectors in GEM precludes its representation of key aspects of the CCA, including the heterogenous incentives the CCA would provide domestic facilities, and our results should be interpreted accordingly. Facilities manufacturing with lower emissions than the benchmark would see marginal benefits from the policy in two ways—from an improved competitive standing against other higher-emissions manufacturers (both domestic and foreign) and the higher pricing of their products. Higher-emissions manufacturers could be expected to see reduced profits from the fees but would also benefit from government investments to implement lower emission

Figure 4. Global and Country-level Emissions Changes for the First Year of the Policy



Note: Figure 4 displays the projected change in emissions across major trading partners, the United States, and the world (highlighted in black). Global emissions decline, driven primarily by emissions reductions in the United States. Emissions fall slightly in countries facing high carbon-based tariffs due to decreased production.

processes and equipment. Accounting for these effects within GEM would tend to improve the competitive standing of US manufacturing compared to the simplified representation in the simulation. The modeling also does not account for the potential for carbon clubs to reinforce the goals of the policy.

A natural point of comparison for the CCA is the Foreign Pollution Fee Act of 2025 (FPFA). The proposed FPFA would establish *ad valorem* tariffs for a set of energy-intensive sectors that partially overlap with the ones covered in the CCA but would not enact a domestic requirement. The FPFA establishes much higher ad valorem rates overall; for example, the FPFA's tariffs for the Iron and Steel sector are 200 percent for China and 34 percent for Canada, but 6.7 percent and 1 percent for those respective countries under the CCA. The FPFA's higher ad valorem rates, when viewed as an equivalent carbon price, would be much higher than the $60 per tonne carbon price of the CCA, though they would be applied solely to foreign manufacturers. Both policies reorient trade towards lower-carbon intensity countries, with a markedly stronger effect from the FPFA due to its higher rates. The CCA is projected to collect $22.8 billion over ten years from the tariff portion of the policy, roughly two-thirds of the tariff revenues from the FPFA, though it has far lower rates. This is because the CCA continues to collect tariff revenue on products from higher-emitting countries, whereas trade with those countries virtually stops under the FPFA in favor of trade with countries exempt from the tariffs .

The projected changes in US emissions reductions from the CCA are greater than those from the FPFA, with US emissions reductions of 63 MMT under the CCA for the first year compared to a direct emissions increase of 14 MMT for the FPFA. The CCA would reduce emissions increasingly over time (−119 MMT in the 10th year after enactment) due to the increasing stringency of the domestic performance standard over time, yielding higher fees and a benchmark to net zero in 2050 (outside of our modeling period). The FPFA emissions effects are projected to remain relatively constant over time. The FPFA would periodically adjust the sector-specific benchmarks to account for the evolution of US performance in each sector but does not provide additional incentives or requirements for US manufacturers to reduce carbon intensity beyond the greater prices resulting from the tariffs. Over the model period, changes in emissions from both bills are modest overall, accounting for less than two percent of US emissions and less than half a percent of global emissions (EPA 2024; Rivera et al. 2024). The greatest leverage for changing global emissions from such policy approaches could be if they led to the widespread adoption of economy-wide domestic policies by trading partners. Such "**policy spillovers**" have been attributed to the EU CBAM but are not accounted for in this analysis.

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Appendix

This appendix provides additional details covering the methods used and more detailed results of the effects of the carbon prices imposed by the CCA, proposed by Senator Whitehouse in December 2025. The effects of the policy on global trade flows, US output, revenues and carbon emissions are simulated using a global economic model. We begin here with a description of the model and how we implemented a stylized version of the CCA. We then provide detailed results for all regions and additional periods that were omitted for brevity from the summary of the results in the main report text.

A1. Features of the Global Economic Model (GEM)

The GEM used in this report is based on the one in Cao, Ho and Hu (2024), but using a different set of regions and industries. It is a dynamic multi-region, multi-sector economic model, in the class of computable general equilibrium (CGE) models. It is dynamic, in that we trace the growth of economies over time, tracking the impact of policies on investment and capital accumulation. The model has a "dynamic recursive" structure, that is, we have an exogenous investment rate assumption in contrast to foresighted models that determine investment as a function of expected returns. Details with all equations are available as an appendix to Cao et al. (2024); we summarize the main features in this appendix.

The model is built on the Global Trade Analysis Project (GTAP 11) database covering 160 countries and 65 industries. Each of the G20 countries are represented in the model and the others are grouped into 9 regions as shown in Table A2. The definition of the 30 sectors in the model is given in Table A3. The GTAP data does not identify products at the detailed level specified in the CCA, such as aluminum or cement, so these products are subsumed under one of the 30 sectors in this model.

The model follows standard "neoclassical" competitive assumptions used in most economic simulation models—constant returns to scale and perfectly competitive markets. Production is represented by constant elasticity of substitution (CES) functions where an energy-value-added bundle substitutes against a non-energy intermediate bundle. Energy is an aggregate of coal, oil, gas mining, petroleum products, electricity, and gas utilities. Trade flows are modeled in a 2-stage system. In the first stage, total imports of a commodity in each region are an aggregate over the supply of imperfectly substitutable varieties from all other regions; and, in the second stage, aggregate import of the commodity is an imperfect substitute for the domestically produced one. The elasticities of substitution in the first stage are very high—Non-ferrous Metals (8.4), Iron and Steel (5.9), Non-metallic Mineral Products (5.8), and machinery (8.6) —while the elasticity between imports and domestic goods are slightly lower (but still comparatively high at around 3 to 4). This means that a 1 percent rise in the average price of imports (say, due to tariffs) will reduce imports by 3 to 4 percent.

Economic growth is driven by population growth, capital accumulation, and "total factor productivity" growth. Households receive wages, returns to capital, and government transfer payments. Income is allocated to consumption and savings according to the Extended Linear Expenditure System (ELES). The utility function includes leisure and generates an endogenous labor supply in the developed regions of the world. In other regions, we specify exogenous labor supply. Investment demand is driven by household savings and retained earnings. Government revenues are collected from tariffs, indirect taxes, and direct taxes on labor and capital income, and expenditures include purchases of products, subsidies, and transfer payments.

For each period, given an inherited stock of capital and resources, the general equilibrium model solves for a set of prices that clears all goods and factor markets. The closure rules for the macro balances are as follows:

1. Aggregate investment is set as a fixed proportion of GDP, and household savings adjust endogenously;
2. Government deficits and tax rates are exogenous, with endogenous government purchases in the base case. In the policy cases, the revenues from the new taxes and tariffs are recycled by cuts in factor income taxes such that government purchases remain at base case levels; and,
3. The exogenous current account balance is achieved through an endogenous exchange rate. One may regard rule (2) as implementing a revenue neutral version of a policy proposal that does not describe how new revenues raised by the policy are to be used. The CCA has clauses that describe how revenues are to be used to help companies decarbonize, but they are not easily represented in this model, and we ignore this aspect of the proposal.

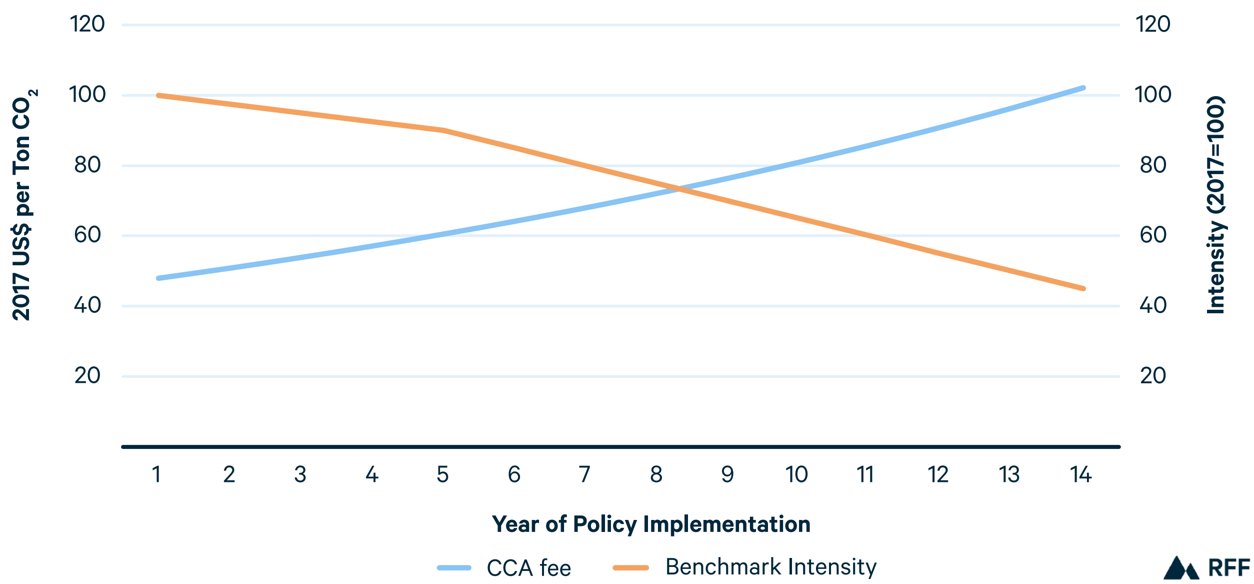
Carbon dioxide emissions come from the combustion of fossil fuels and some production processes. The energy used per unit output is projected to improve over time as the structure of the economy changes; that is, a greater share of workers is allocated to service industries and a smaller share to agriculture throughout the world over time in the base case. This projected change in gross emission intensity (CO_2 per US$ of GDP for each country) is calibrated to the projections reported in the Energy Modeling Forum 36 comparison exercises (Bohringer et al.). This calibration yields an autonomous 1.7 percent per year decline in gross emissions intensity for the United States over the simulation horizon.

A2. Implementing CCA Policy into GEM

A2.1. CCA Rules and the Calculation of Tariffs

The CCA covers the more energy-intensive industries and imposes: (i) carbon fees on US producers that exceed a pre-specified industry benchmark carbon intensity and (ii) carbon tariffs on imported goods that exceed the benchmark carbon intensity for that good. The benchmark intensity is the average intensity derived from total emissions from "eligible facilities" and their output (see Sec. 4691 (b) (1) (B) (i) of the CCA). To calculate the import tariff of each year, the carbon fee set for that year multiplied by the gap between the producer intensity and the benchmark set for the same year. The carbon price (Fee_t in the equations below) starts at $60 per ton CO_2[10] and rises at a real rate of 6 percent per year and the benchmark carbon intensity is tightened over time (i.e., lower benchmark rates), as shown in Figure A1.

Figure A1. CCA Carbon Prices and Benchmark Intensity Over Time



For good *i* from country *r* imported into the United States in year *t*, the tariff rate is:

$$\tau_{i,r,US,t} = \mathrm{Fee}_t \left(\theta_{irt} - \theta^{bench}_{i,US,t}\right) \qquad \text{(A1)}$$

$$\theta^{bench}_{i,US,t} = \lambda^{CCA}_t \theta^{bench}_{i,US,2017} \qquad \text{(A2)}$$

10 $60 in 2024 US$ is equivalent to $48 in the base year 2017.

where θ_{ir} is the carbon intensity in country r, and $\theta_{i,US,t}^{bench}$ is the US benchmark intensity. θ_{ir} is in terms of CO_2 per US$, and Fee is US$ per ton of CO_2. and thus τ_{ir} is US$ of carbon tariffs per US$ of imports; in other words, the *ad valorem* rate.

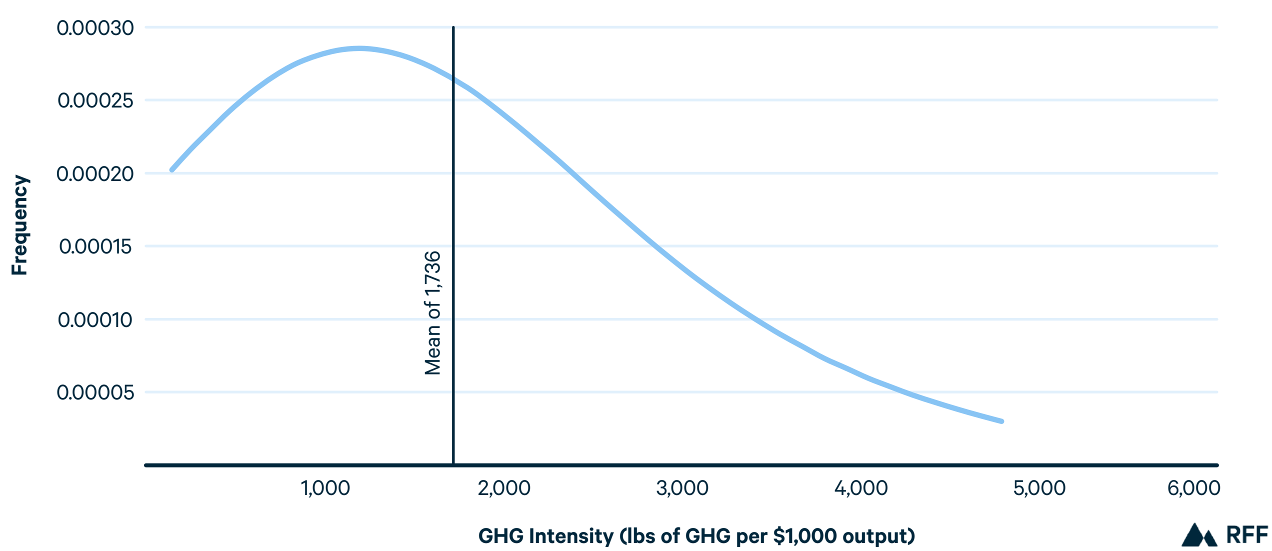
λ_t^{CCA} represents the factor that tightens the benchmark over time, starting at 100 percent of the first-year intensity, and falling to 45 percent in 13 years, as shown in Figure A1.

Since we are simulating using a model with a 2017 base year, we regard 2017 as the first year of the policy. The simulated impacts of the CCA reported below for 2017–2030 are typically reported in terms of percent change from the "no policy" case (e.g., reduction in imports of steel as a percentage of the base year imports). These results are thus best interpreted as impacts in year 1 through year 14 of CCA's implementation.

2.2. Estimating Benchmark Intensity and Taxable Production from US Firm Data

The CCA defines the benchmark performance standard as the mean GHG intensity of a covered product, averaged over all "eligible" facilities producing that item in the United States. To estimate how this benchmark rule in equation (A1) affects US production, we use the estimates provided by the study of emissions using plant-level data in Gray, Linn and Morgenstern (2024). That study uses confidential Census plant data and is therefore not allowed to provide detailed information; instead, it provided the graphical distribution of emission rates for each of the 6 industries together with the mean and standard deviation. These distributions are truncated at both ends (at very low or very high intensities) to maintain confidentiality. Figure A2 shows an example distribution for the Pulp and Paper industry from Gray et al. (2024).

Figure A2. Distribution of GHG Intensity Among Firms in the Pulp and Paper Industry in 2017



The GEM represents output at the industry level, not the plant level (as outlined in Section A1). The CCA requires each plant to pay the carbon price for emissions above the benchmark level. To accurately model the policy, we thus need to estimate the proportion of US output in each industry in GEM that would be liable for the carbon price. Consider a plant *p* in the Pulp and Paper industry with intensity, x_p, and output $q(x_p)$. Let the mean intensity in that industry be $\bar{\theta}$; the carbon fees payable by plant *p* is then:

$$\text{Fee}\left(x_p - \bar{\theta}\right) q\left(x_p\right) \tag{A3}$$

The carbon fees payable by the whole Pulp and Paper industry are only from those firms with intensities greater than the mean intensity. Since the distributions given in Gray et al. (2024) are smooth curves, we use the continuous form in our description here; that is, using an integral instead of discrete summation over individual *p*'s. Using *x* to denote the continuous index of intensity, the total fees payable by industry *j* is:

$$F_{j=\text{paper}} = \int_{\bar{\theta}}^{\infty} \text{Fee}\left(x - \bar{\theta}\right) q\left(x\right) dx \tag{A4}$$

Normalizing the output function so that $f(x) = q|Q_j$ is the share of total industry output (Q_j), we have:

$$1 = \int_{\bar{\theta}}^{\infty} f\left(x\right) dx \tag{A5}$$

and

$$\bar{\theta} = \int_{0}^{\infty} x f\left(x\right) dx \tag{A6}$$

This gives us a distribution *f(x)* that corresponds to Figure A2. To estimate the carbon fees payable by each industry, we take the distributions for the 6 industries given in Gray et al. (2024) and compute a numerical approximation to:

$$\phi_j = \int_{\bar{\theta}}^{\infty} \left(x - \bar{\theta}\right) f\left(x\right) dx \tag{A7}$$

To do this, we first extrapolated the right side of the tail of the distribution that has been truncated. This is done by fitting a Gaussian curve over the truncated lines. Expression (A7) is also the expected value of the intensity gap for firms that exceed the benchmark intensity, $E\left(x - \bar{\theta} | x > 0\right)$. We compute this expectation using the distributions for each of the 6 industries given in the paper. ϕ_j should be interpreted as the emissions per unit of average output of that industry that is liable for the carbon fee. The share of industry output that is liable for the fee may thus be obtained by dividing ϕ_j by the mean intensity (emissions per unit output):

$$\rho_{j,t=2017} = \frac{\phi_j}{\bar{\theta}_{j,2017}} \quad \text{(A8)}$$

These shares, calculated using the 2017 distributions, are given in Table A1 below.

Table A1. GHG Intensities of US Industries (2017) and Share of Output Above Benchmark Liable for CCA Fees

Sector	Intensity (Tons per million US$)	Estimated share of output liable for CCA fees from high intensity firms
Coal	223	0.5
Oil	103	0.5
Gas	788	0.5
Petroleum Refining	515	0.3118
Pulp and Paper	310	0.3275
Chemical (Excluding pharmaceuticals)	369	0.2956
Non-metallic Mineral Products	556	0.3241
Iron and Steel	626	0.4749
Non-ferrous Metals	265	0.5

Note: This is based on GTAP11. GHG intensity based on Scope 2 coverage (i.e., primary fuels and electricity.)

A2.3. Adjusting the Benchmark Over Time

We noted in equation (A2) above that the CCA tightens the benchmark over time. At the firm level, this would change the proportion of liable firms over time even if the intensity distribution remains unchanged. The distribution itself would change as firms exit and new firms enter, and as existing firms change production methods. The projection of changes in these intensity distributions would require industry experts, and thus are not considered in this study. We do adjust for the change in the estimate of the share ρ_{jt} as the benchmark tightens, assuming the 2017 distribution holds for the entire simulation period.

Before we make any adjustments, we first note that section A1 of this appendix describes how the base case projection is calibrated to meet the carbon dioxide emissions projected in the Energy Modeling Forum (EMF) 36 for each region. That is, we adjust the energy input requirements per unit output for each industry and region and change the consumption[11] and investment patterns in each country, to hit the EMF projections of national carbon dioxide emissions. is calibration exercise gives us a path of carbon intensities for each industry and region in the no-policy base case. For the United States, this results in carbon intensities that are 6 to 35 percent lower in 2030 compared to 2017, depending on the industry. If the benchmark is fixed, then this fall in mean intensities would mean that lower shares of output would be subject to the fee.

Since there is a tightening of standards, we make a simple adjustment to the share (ρ_{jt}) of US output liable for the CCA fees that accounts for both lower exemption benchmarks and falling projected intensity. We use the 2030 projected intensities for the United States in 2030 ($\theta_{i,US,t=2030}^{basecase}$) to calculate a smooth geometric path of decline:

$$\theta_{jt}^{US} = g^{t-2017}\theta_{j2017}^{US} \quad \text{(A9)}$$

and

$$\ln g = \ln \frac{1}{2030 - 2017} \frac{\theta_{j2017}^{US}}{\theta_{j2030}^{US}} \quad \text{(A10)}$$

This change in intensities is then combined with the targeted tightening of the benchmark from $\lambda_{j,2017} = 1$ in 2017 to $\lambda_{j,2030}$ in 2030 to give a simple adjustment to the taxable share of output:

$$\rho_{jt} = \rho_{j2017}^{actual} + \left(\frac{\theta_{jt}^{US}/\theta_{jt2017}^{US}}{\lambda_{jt}} - 1 \right) \rho_{j2017}^{actual} \quad \text{(A11)}$$

where *t*=2018, ..., 2030.

11 The consumption basket is projected according to estimated income elasticities for demand of different consumption goods.

A2.4. Implementing CCA Carbon Fees on US Producers in GEM

The CCA rules impose a carbon charge given by equation (A3) on any firm with GHG intensity higher than the industry benchmark for the covered products. We describe this in our report as the 9 sectors in the GEM that are covered by the CCA from Coal mining to Non-ferrous Metals industries. US producers would view this as a fee on direct emissions and those embodied in electricity purchased. In other words, it is essentially a tax on fossil fuel and electricity use. A producer may avoid the tax by sequestering its emissions or by generating its own electricity; but, within the time horizon we consider in this report, these are non-economic options for almost all producers. The GEM model does not represent these options explicitly; however, it does allow producers to reduce the payable fees by substituting other inputs (e.g., capital and labor) for energy inputs and substituting low-carbon energy for high-carbon ones.

The shadow carbon price (i.e., tax rate) on energy input *i* is the carbon fee (US$ per ton CO_2) times its emission coefficient, θ_i^F (tons of CO_2 per unit energy *i* purchased):

$$\mathrm{t_{it}^{CO_2}} = \mathrm{Fee_t} \theta_\mathrm{i}^\mathrm{F} \tag{A12}$$

where *i*=coal, oil, gas, electricity.

The shadow price of using energy input *i* by a liable party is thus the market price (*PX*) of *i* plus this carbon price:

$$\mathrm{PB_{ijt}} = \mathrm{PX_{it}} \left(1 + \mathrm{t_{it}^{CO_2}}\right) \tag{A13}$$

The market price of input *i* is common to all buyers and includes existing taxes. Since the model works at the industry level and not at the firm level, the carbon price payable by the industry average must be adjusted by the share calculated in equation (A11), and the input price becomes:

$$\mathrm{PB_{ijt}} = \mathrm{PX_{it}} \left(1 + \mathrm{t_{it}^{CO_2}} \rho_\mathrm{jt}\right) \tag{A14}$$

where *i*=coal, oil, gas, electricity.

A2.5. Implementation Notes

A2.5.1. Revenue recycling

The carbon tariffs and fees on domestic producers will generate new revenues for the US government. The net welfare effect of the policy depends crucially on how these new revenues are used. The CCA does not specify precisely how they are to be allocated, and we follow a standard policy simulation procedure to recycle them completely by cutting some other tax rate. Here we chose to cut taxes on factor incomes. Such a procedure allows a clean comparison with the no-policy base case since the unchanged total revenue allows total government purchases to be the same as base-case levels. Maintaining the same level of government purchases allows a welfare comparison to be based simply on household consumption, instead of having to consider the welfare effects of different levels of public goods in the policy case.

A2.5.2. Incentives and modeling of production in the rest-of-the-world

It is unclear how foreign producers might respond to US carbon tariffs, specifically whether they would use lower carbon intensity methods of production to avoid or reduce the tariffs. We note that the US market, while large, does not dominate most countries' exports. Furthermore, the carbon intensities are calculated as country averages and there is limited allowance for facility-level intensity evidence. Thus, for simplicity, in our simulations we assume that foreign governments do not respond by imposing their own policies to reduce the emissions intensity of production for the covered sectors, through carbon prices or any other actions. The EU CBAM allows for facility evidence and may be a major complication in determining future production behavior in major exporters, such as China. We ignore these complications in this report. The simulation results should be interpreted with these assumptions in mind.

A2.6. Regions and Sectors Represented in GEM and Mapping to CCA Categories

Regions and Sectors Represented in GEM

To reduce complexity in analyzing the simulation results and reduce the computational cost of GEM, the 160 countries represented in the GTAP dataset are mapped to individual countries for the G20, with all other countries aggregated into one of nine regions, for a total of 29 regions. The region definitions are given in Table A2.

Table A2. Mapping of GTAP Countries and Regions into Countries and Regions modeled in GEM

GTAP Country/Regions	GEM Country/Region
Argentina	Argentina
Australia	Australia
Brazil	Brazil
Canada	Canada
China; Hong Kong	China
France	France
Germany	Germany
India	India
Indonesia	Indonesia
Italy	Italy
Japan	Japan
Mexico	Mexico
Russian Federation	Russia
Saudi Arabia	Saudi Arabia
South Africa	South Africa
Korea	South Korea
Turkey	Turkey
United Kingdom	United Kingdom
United States of America	United States of America
Austria; Belgium; Denmark; Finland; Greece; Ireland; Luxembourg; Netherlands; Portugal; Spain; Sweden	Rest of western European Union

Bulgaria; Croatia; Cyprus; Czech Republic; Estonia; Hungary; Latvia; Lithuania; Malta; Poland; Romania; Slovakia; Slovenia	Rest of European Union
Switzerland; Norway; Rest of European Free Trade Association	Northern Europe
Rest of North America; Bolivia; Chile; Colombia; Ecuador; Paraguay; Peru; Uruguay; Venezuela; Rest of South America; Costa Rica; Guatemala; Honduras; Nicaragua; Panama; El Salvador; Rest of Central America; Dominican Republic; Haiti; Jamaica; Puerto Rico; Trinidad and Tobago; Caribbean	Latin and Central America
Iran; Iraq; Kuwait; Oman; Qatar; United Arab Emirates; Nigeria; Angola; Kazakhstan; Algeria	Other oil exporters
Bahrain; Israel; Jordan; Lebanon; State of Palestine; Syria; Rest of Western Asia; Egypt; Morocco; Tunisia; Rest of North Africa	Middle East; North Africa
Benin; Burkina Faso; Cameroon; Cote d'Ivoire; Ghana; Guinea; Mali; Niger; Senegal; Togo; Rest of Western Africa; Central African Republic; Chad; Congo; Congo the Democratic Republic; Equatorial Guinea; Gabon; Rest of South and Central Afri; Comoros; Ethiopia; Kenya; Madagascar; Malawi; Mauritius; Mozambique; Rwanda; Sudan; Tanzania; Uganda; Zambia; Zimbabwe; Rest of Eastern Africa; Botswana; Eswatini; Namibia; Rest of South African Customs	Sub-Saharan Africa
Afghanistan; Bangladesh; Nepal; Pakistan; Sri Lanka; Rest of South Asia	Southern Asia
Mongolia; Taiwan; Rest of East Asia; Brunei Darussalam; Cambodia; Laos; Malaysia; Philippines; Singapore; Thailand; Viet Nam; Rest of Southeast Asia; New Zealand; Rest of Oceania; Rest of the World	Eastern Asia; Rest of World
Albania; Serbia; Belarus; Ukraine; Rest of Eastern Europe; Rest of Europe; Kyrgyztan; Tajikistan; Uzbekistan; Rest of Former Soviet Union; Armenia; Azerbaijan; Georgia; Kyrgyztan; Tajikistan; Uzbekistan; Rest of Former Soviet Union; Armenia; Azerbaijan; Georgia	Former Soviet Union

The assignment of the 65 industries in GTAP to the 30 sectors of GEM is given in Table A3. We aggregated many of the services to create a smaller, more tractable model, but kept most of the details available for manufacturing industries.

Table A3. Mapping of GTAP industries into sectors modeled in GEM

GTAP Sector	GEM Model sector
Paddy rice; Wheat; Cereal grains nec; Vegetables, Fruits, and Nuts; Oil seeds; Sugar cane and Sugar beet; Plant-based fibers; Crops nec; Bovine cattle, Sheep and Goats; Animal products nec; Raw milk; Wool and Silk-worm cocoons	Agriculture
Forestry	Forestry
Fishing	Fishing
Coal	Coal
Oil	Oil
Gas; Gas manufacture and distribution	Gas
Petroleum and Coal products	Oil products
Electricity	Electricity
Non-metallic Mineral Products	Other Mining
Bovine meat products; Meat products nec; Vegetable oils and fats; Dairy products; Processed rice; Sugar; Food products nec; Beverages and tobacco products	Food, Tobacco
Textiles; Wearing apparel; Leather products	Textiles and Apparel
Wood products; Manufactures nec	Wood and other manufactoring
Paper products and publishing	Paper products
Chemical products	Chemicals
Basic pharmaceutical products	Basic pharmaceutical products
Rubber and plastic products	Rubber and plastic
Mineral products nec	Mineral Products
Ferrous metals	Iron and steel

Metals nec	Non-ferrous Metals
Metal products	Metal products
Motor vehicles and parts; Transport equipment nec	Vehicles and transport equipment
Computer, electronic and optic; Electrical equipment; Machinery and equipment nec	Machinery and equipment
Construction	Construction
Transport nec	Other Transport
Water transport	Water Transport
Air transport.	Air Transport
Trade	Trade
Water; Accommodation, Food and service; Warehousing and support activities; Communication; Financial services nec; Insurance; Business services nec; Recreational and other services	Market Services
Public administration and defense; Education; Human health and social work	Public Services
Real estate activities; Dwellings	Housing

Note: nec = not elsewhere classified.

Model Sectors and CCA Covered Products

The CCA specifies covered products according to the North American Industry Classification System (NAICS) codes. For modeling in GEM, each specified NAICS product code is mapped into the corresponding GTAP sector, as shown in Table A4.

Table A4. Mapping of CCA-Covered Products by NAICS Codes into Aggregate Sectors Modeled in GEM

CCA NAICS Code	Description	Model Sector
211120	Petroleum extraction	Oil mining
211130	Natural gas extraction	Gas mining and gas distribution

212114	Coal mining	Coal mining
212115	Coal mining	Coal mining
322110	Pulp mills	Pulp and paper
322120	Pulp mills	Pulp and paper
322130	Paperboard mills	Pulp and paper
324110	Petroleum refineries	Petroleum refining
324121	Asphalt paving mixture and block manufacturing	Petroleum refining
324122	Asphalt shingle and coating materials manufacturing	Petroleum refining
324199	All other petroleum and coal products manufacturing	Petroleum refining
325110	Petrochemical manufacturing	Chemicals
325120	Industrial gas manufacturing (only hydrogen)	Chemicals
325193	Ethyl alcohol manufacturing	Chemicals
325199	Other basic organic chemical manufacturing (only adipic acid)	Chemicals
325311	Nitrogenous fertilizer manufacturing	Chemicals
327211	Glass	Non-metallic Mineral products
327212	Glass	Non-metallic Mineral products
327213	Glass	Non-metallic Mineral products
327215	Glass	Non-metallic Mineral products
327310	Cement	Non-metallic Mineral products

327410	Lime and gypsum product manufacturing	Non-metallic Mineral products
327420	Lime and gypsum product manufacturing	Non-metallic Mineral products
331110	Iron and steel	Iron and steel
331313	Aluminum	Non-ferrous Metals
331314	Aluminum	Non-ferrous Metals

The model sectors that represent CCA-covered products include other products that are not subject to the CCA tariffs. For example, the Non-ferrous Metals industry includes copper and zinc, which are exempt. Table A5 gives the volume of imports covered by the CCA as assigned to each model sector as well as the total imports of that sector in 2017. It shows that the proposal covers 90 percent of Iron and Steel imports but only 21 percent of Non-ferrous Metals. The petrochemicals and fertilizer components of Chemicals constitute 5 percent while liable coal is 100 percent of that sector. Since the Chemicals share is so small, we excluded it from the policy in the simulations.

The three columns on the right-hand side of Table A5 give the CCA-covered share of total US output for those 9 sectors. These shares are not very different from the shares for imports, except for Non-ferrous Metals where the domestic share is only 8 percent compared to the 21 percent imported share. We note that there are two distinct adjustments to model sector output for what US producers pay under the CCA rules. The first is Table A5's adjustment for the products made in the sector that are not liable for the CCA fee. The other adjustment is that the fees are payable only by firms with intensities above the benchmark as described by equation (A8).

A3. Carbon Intensities, Tariffs, and Fees on US Producers

Carbon intensities for CCA-covered sectors are calculated based on the GTAP dataset covering scope 1 and 2 emissions as required by the policy. Scope 2 emissions refer to those embodied in purchased electricity. The mix of electric power generation sources differs by locality in each country, that is: different areas have a different carbon intensity per kWh of electricity used. Such data is not available in GTAP and we assume that all sectors buy electricity at the national average carbon intensity in each country.[12]

12 This GTAP figure is slightly different from the data given in Table A3 taken from the US Census Bureau to calculate the CCA coverage shares.

Table A5. Share of CCA-covered Imports by NAICS Codes in Total Imports by Model Sector

	Imports			US domestic output		
	CCA-covered component (Billion US$)	Total sector (Billion US$)	CCA liable share (%)	CCA-covered component (Billion US$)	Total sector (Billion US$)	CCA liable share (%)
Coal	0.7	0.7	100	186	186	100
Oil	146.6	146.6	100	83	83	100
Gas	11.0	11.0	100	543	543	100
Petroleum Refining	51.5	51.4	100	736	736	100
Pulp and Paper	26.7	10.9	41	77	211	29
Chemicals	108.9	5.8	5	94	525	18
Non-metallic Mineral Products	25.0	9.1	36	42	126	34
Iron and Steel	38.9	35.2	90	88	222	79
Non-ferrous Metals	55.8	11.6	21	9	88	8

Note: CCA liable output as share of total US output in the sector represented in the GEM.

Figure 1 in the report shows the carbon intensities for 5 covered sectors for selected countries; whereas Table A6 provides the carbon intensities for each of the 29 GEM regions for all 8 of the covered sectors modeled. The intensity for the US in 2017 is used to represent $\theta^{\mathrm{bench}}_{\mathrm{i,US,t=2017}}$ in equations (A1, A2, A11). We note that the intensities are measured in tons of CO_2 per million US$ of gross output of each sector, covering many heterogenous products. The CCA only covers a portion of these products, as shown in Table A5.

There are some features of these intensities derived from GTAP data that are worth noting. The carbon intensity for natural gas extraction in Canada is much higher than in the United States, resulting in a high tariff. The intensity for petroleum products in the United States is higher than many countries that export refined products to the United States including Brazil, Canada, and Latin America.

Table A6. Calculated Carbon Intensities by GEM Country and Region by CCA-covered Sector

Sector	GEM Countries (Ton per Million US$)																	
	Argentina	Australia	Brazil	Canada	China	France	Germany	India	Indonesia	Italy	Japan	Mexico	Russia	Saudi Arabia	South Africa	South Korea	Turkey	UK
Coal	1,211	260	376	101	882	17,373	44	12	3	463	22	21	460	1,130	228	199	401	550
Oil	33	200	80	316	566	140	125	1	9	76	28	33	175	22	189	266	232	66
Gas	1,240	263	661	2,748	6,437	2,457	582	149	939	2,141	193	2,803	587	280	166	3,615	5,186	1,172
Petroleum Refining	363	1,775	367	260	728	462	509	287	548	426	343	1,201	599	372	5,175	520	903	517
Pulp and Paper	212	593	168	519	336	77	245	1,222	410	172	318	402	1,725	1,810	346	286	315	140
Chemical	358	410	159	330	566	96	288	551	1,089	144	323	583	1,999	865	952	273	474	160
Non-metallic Mineral Products	962	701	705	513	1,055	275	364	2,797	3,070	291	482	1,529	2,203	735	2,407	479	1,400	388
Iron and Steel	1,582	555	663	836	2,028	293	481	7,152	2,199	258	396	946	3,921	727	3,016	648	785	303
Non-ferrous Metals	467	1,211	834	404	960	151	219	1,168	1,713	115	137	437	1,324	1,345	760	184	316	97

Sector	GEM Regions (Ton per Million US$)									
	Rest of Western European Union	Rest of European Union	Northern Europe	Latin and Central America	Other oil exporters	Middle East, North Africa	Sub-Saharan Africa	Southern Asia	Eastern Asia; Rest of World	Former Soviet Union
Coal	372	1,040	585	7	933	3,179	57	6	43	695
Oil	133	180	14	129	74	39	13	0	7	105
Gas	392	862	500	1,269	244	1,173	15	44	917	633
Petroleum Refining	402	683	129	499	494	203	186	134	308	543
Pulp and Paper	182	346	30	307	1,329	420	231	440	521	827
Chemical	190	482	82	255	1,697	556	457	492	341	1,430
Non-metallic Mineral Products	371	727	120	544	1,251	1,149	609	2,781	1,585	1,885
Iron and Steel	298	793	266	1,142	1,241	1,413	585	490	626	2,799
Non-ferrous Metals	192	416	7	160	672	1,123	268	2,643	296	869

Note: Based on GTAP11; GHG intensity based on Scope 2 coverage (i.e., primary fuels and electricity).

For manufactured goods among main trading partners, Canada has lower intensities for Non-metallic Mineral Products, Brazil for Pulp and Paper and Chemicals, as well as many European countries for all covered manufactured sectors; whereas Japan and Korea have lower intensities for almost all manufactured sectors except for one.

A3.1. Tariff Rates

Carbon tariffs are estimated for the CCA according to equation (A1) and illustrated in Figure 2 and Table 1 in the report for the main regions in 2017. We show the tariffs for all modeled countries and/or regions for the covered sectors in Table A7. Some countries have low intensities and have negligible tariff rates—Germany, Japan, UK, Rest of Western EU, Northern Europe and Sub-Saharan Africa. There are high tariff rates on imports from France, but they are on trivial energy imports. Tariff rates for non-energy goods from South Korea are also very low.

Total imports of the CCA-covered sectors (excluding Chemicals) into the United States are $370 billion in 2017 (in 2017 US$) according to the GTAP database. These are the imports of the entire model sector, including items that are not covered by the CCA (Table A10). Canada is a major source of imports of these covered products ($105 billion in 2017) but are subject to low tariff rates of about 1 percent from the CCA, except for gas imports. The estimated intensity for gas mining from the GTAP data shows a substantial difference between Canada and the United States, which may be partly due to the structure of within-industry transactions; that is, in the input-output table, the industry buys significant inputs from itself. More detailed estimates of gas mining intensities would be valuable in removing this source of uncertainty in the simulated effects of CCA tariffs. It is important to note that the imports of gas from Canada in the recent years is small in comparison to levels in 2017, reported in Table A10.

The next major source of covered imports after Canada and Europe is China ($20 billion). China is subject to tariff rates in the 1–8 percent range for manufactured goods (ignoring trivial energy imports). Mexico is an important source of oil for the United States, but less so for manufactured goods compared to China (who bears a total of $20 billion). Mexico is subject to tariffs in the 0–5 percent range for manufactured goods. Brazil and other Latin American countries are next as suppliers of the CCA manufactured products and face tariff rates up to 5 percent. Imports from Russia was $16 billion and subject to tariff rates of 0–16 percent. India is subject to high tariffs (31 percent for Iron and Steel), but their total imports only accounted for $6 billion.

Table A7. Calculated Carbon Tariffs by GEM Country and/or Region and Covered Sector

	Percent Rate in 2017 for GEM Countries																		
Sector	US equivalent Tax on Output	Argentina	Australia	Brazil	Canada	China	France	Germany	India	Indonesia	Italy	Japan	Mexico	Russia	Saudi Arabia	South Africa	South Korea	Turkey	UK
Coal	0.18	4.73	0.18	0.73	0.00	3.16	82.16	0.00	0.00	0.00	1.15	0.00	0.00	1.14	4.47	0.02	0.00	0.85	1.56
Oil	0.07	0.00	0.46	0.00	1.02	2.22	0.18	0.10	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.41	0.78	0.62	0.00
Gas	1.53	2.16	0.00	0.00	9.39	27.06	7.99	0.00	0.00	0.72	6.48	0.00	9.65	0.00	0.00	0.00	13.54	21.07	1.84
Petroleum Refining	0.63	0.00	6.04	0.00	0.00	1.02	0.00	0.00	0.00	0.16	0.00	0.00	3.29	0.40	0.00	22.32	0.03	1.86	0.01
Pulp and Paper	0.16	0.00	1.36	0.00	1.00	0.13	0.00	0.00	4.37	0.48	0.00	0.04	0.44	6.78	7.19	0.17	0.00	0.03	0.00
Non-metallic Mineral Products	0.61	4.58	0.00	0.18	1.01	6.72	0.00	0.00	31.26	7.54	0.00	0.00	1.53	15.79	0.49	11.45	0.11	0.76	0.00
Iron and Steel	0.75	0.97	4.53	2.73	0.67	3.33	0.00	0.00	4.33	6.94	0.00	0.00	0.83	5.07	5.18	2.37	0.00	0.25	0.00
Non-ferrous Metals	0.13	467	1,211	834	404	960	151	219	1,168	1,713	115	137	437	1,324	1,345	760	184	316	97

Sector	Percent Rate in 2025 for GEM Countries																		
	US equivalent Tax on Output	Argentina	Australia	Brazil	Canada	China	France	Germany	India	Indonesia	Italy	Japan	Mexico	Russia	Saudi Arabia	South Africa	South Korea	Turkey	UK
Coal	0.24	6.82	0.52	1.27	0.00	3.94	117.50	0.00	0.00	0.00	1.94	0.00	0.00	2.00	7.65	0.27	0.24	1.43	2.17
Oil	0.10	0.00	0.64	0.00	1.68	2.62	0.24	0.17	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.62	1.37	0.92	0.00
Gas	2.12	5.24	0.00	0.77	16.60	33.89	13.92	0.00	0.00	2.95	12.04	0.00	17.13	0.04	0.00	0.00	23.39	35.00	4.74
Petroleum Refining	1.25	0.00	10.07	0.02	0.00	1.85	0.73	0.88	0.00	1.38	0.16	0.00	6.31	1.50	0.00	35.32	1.07	4.05	1.06
Pulp and Paper	0.24	0.00	1.83	0.00	1.54	0.02	0.00	0.00	5.42	1.13	0.00	0.27	0.94	9.52	10.42	0.58	0.00	0.33	0.00
Non-metallic Mineral Products	0.89	2.97	1.48	1.94	0.48	3.42	0.00	0.00	14.97	18.40	0.00	0.18	7.17	12.02	2.04	13.56	0.07	6.47	0.00
Iron and Steel	1.06	6.46	0.08	1.32	2.29	8.58	0.00	0.00	31.94	11.01	0.00	0.00	2.97	22.10	1.12	14.83	0.58	1.65	0.00
Non-ferrous Metals	0.17	0.94	5.81	4.05	0.96	2.99	0.00	0.00	5.08	9.77	0.00	0.00	1.36	7.19	7.20	3.46	0.00	0.59	0.00

	Percent Rate in 2030 for GEM Countries																		
Sector	**US equivalent Tax on Output**	**Argentina**	**Australia**	**Brazil**	**Canada**	**China**	**France**	**Germany**	**India**	**Indonesia**	**Italy**	**Japan**	**Mexico**	**Russia**	**Saudi Arabia**	**South Africa**	**South Korea**	**Turkey**	**UK**
Coal	0.30	9.12	1.12	2.04	0.00	5.23	148.18	0.00	0.00	0.00	2.89	0.00	0.00	3.07	11.17	0.79	0.81	2.21	2.98
Oil	0.12	0.00	0.98	0.25	2.47	3.42	0.44	0.39	0.00	0.00	0.06	0.00	0.00	1.04	0.00	1.02	2.08	1.39	0.15
Gas	2.59	9.03	0.00	2.98	24.08	43.22	20.23	1.64	0.00	5.97	18.13	0.00	24.93	1.90	0.00	0.00	33.37	48.62	8.33
Petroleum Refining	2.27	1.31	14.58	1.35	0.22	3.47	2.29	2.38	0.45	3.19	1.37	0.85	9.80	3.18	0.87	48.24	2.68	6.74	2.66
Pulp and Paper	0.34	0.00	2.65	0.00	2.36	0.40	0.00	0.16	6.73	2.04	0.00	0.83	1.72	12.24	13.63	1.30	0.40	0.94	0.00
Non-metallic Mineral Products	1.30	4.88	2.84	3.60	1.68	4.89	0.00	0.14	18.91	24.20	0.00	1.27	9.85	16.22	3.65	18.20	1.03	9.06	0.42
Iron and Steel	1.54	9.36	1.20	3.00	4.06	10.90	0.00	0.71	37.82	14.70	0.00	0.22	4.87	28.27	2.52	18.95	1.66	3.11	0.00
Non-ferrous Metals	0.19	1.58	7.33	5.49	1.54	3.44	0.00	0.20	6.11	12.46	0.00	0.00	2.11	9.32	9.36	4.74	0.00	1.19	0.00

Note: The price under the CCA is $60 per ton of CO_2 in 2024US$ for year 1, rising at overall rate of 6 percent per year.

		Percent Rate in 2017 for GEM Regions									
Sector	**US equivalent Tax on Output**	**Rest of Western European Union**	**Rest of European Union**	**Northern Europe**	**Latin and Central America**	**Other oil exporters**	**Middle East, North Africa**	**Sub-Saharan Africa**	**Southern Asia**	**Eastern Asia; Rest of World**	**Former Soviet Union**
Coal	0.18	0.71	3.91	1.73	0.00	3.40	14.16	0.00	0.00	0.00	2.26
Oil	0.07	0.14	0.37	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.01
Gas	1.53	0.00	0.35	0.00	2.30	0.00	1.84	0.00	0.00	0.62	0.00
Petroleum Refining	0.63	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Pulp and Paper	0.16	0.00	0.17	0.00	0.00	4.88	0.53	0.00	0.62	1.01	2.48
Non-metallic Mineral Products	0.61	0.00	0.82	0.00	0.00	3.33	2.84	0.26	10.66	4.93	6.37
Iron and Steel	0.75	0.00	0.80	0.00	2.47	2.94	3.77	0.00	0.00	0.00	10.41
Non-ferrous Metals	0.13	0.00	0.72	0.00	0.00	1.95	4.11	0.01	11.39	0.15	2.90

Sector	Percent Rate in 2025 for GEM Regions										
	US equivalent Tax on Output	Rest of Western European Union	Rest of European Union	Northern Europe	Latin and Central America	Other oil exporters	Middle East, North Africa	Sub-Saharan Africa	Southern Asia	Eastern Asia; Rest of World	Former Soviet Union
Coal	0.24	0.87	4.85	3.07	0.00	4.75	18.72	0.00	0.00	0.00	3.76
Oil	0.10	0.22	0.45	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.18
Gas	2.12	0.00	1.74	0.00	5.43	0.00	4.74	0.00	0.00	2.77	0.59
Petroleum Refining	1.25	0.21	2.04	0.00	1.02	0.89	0.00	0.00	0.00	0.00	1.20
Pulp and Paper	0.24	0.00	0.28	0.00	0.35	6.11	1.05	0.00	0.80	2.10	4.24
Non-metallic Mineral Products	0.89	0.00	1.46	0.00	0.79	4.91	4.88	1.14	14.64	8.77	10.83
Iron and Steel	1.06	0.00	1.49	0.00	4.07	3.95	6.02	0.29	0.00	1.14	16.58
Non-ferrous Metals	0.17	0.00	0.85	0.00	0.00	2.35	5.54	0.13	11.79	0.68	4.74

	Percent Rate in 2030 for GEM Regions										
Sector	**US equivalent Tax on Output**	**Rest of Western European Union**	**Rest of European Union**	**Northern Europe**	**Latin and Central America**	**Other oil exporters**	**Middle East, North Africa**	**Sub-Saharan Africa**	**Southern Asia**	**Eastern Asia; Rest of World**	**Former Soviet Union**
Coal	0.30	1.31	6.11	4.50	0.00	6.47	24.46	0.00	0.00	0.00	5.40
Oil	0.12	0.44	0.72	0.00	0.74	0.18	0.00	0.00	0.00	0.00	0.48
Gas	2.59	0.06	3.98	1.46	9.24	0.00	8.35	0.00	0.00	5.71	2.78
Petroleum Refining	2.27	1.56	3.85	0.00	2.68	2.50	0.00	0.00	0.00	0.72	2.84
Pulp and Paper	0.34	0.00	0.74	0.00	1.05	7.82	1.90	0.33	1.34	3.40	6.15
Non-metallic Mineral Products	1.30	0.30	2.63	0.00	2.16	7.03	7.25	2.50	18.37	12.67	15.37
Iron and Steel	1.54	0.00	2.77	0.00	6.27	5.76	8.73	1.47	0.29	2.85	22.61
Non-ferrous Metals	0.19	0.03	1.30	0.00	0.00	3.18	7.19	0.59	13.14	1.44	6.66

Note: The price under the CCA is $60 per ton of CO_2 in 2024US$ for year 1, rising at overall rate of 6 percent per year.

A3.2. CCA Fees on US Producers

The payments that US producers are liable for under the CCA are calculated using the shadow carbon price in equation (A14). The total payments for each sector in year 1 are given below in Table A8 and A9. To allow comparison of import tariff rates, we compute the equivalent CCA tax on US output for each sector by dividing the total CCA payments by the value of industry gross output. We report these equivalent rates in the first column of Table A7. We find that these resulted in low rates for domestically manufactured goods, from 0.16 percent for Pulp and Paper to 0.75 percent for Iron and Steel. This is comparable to the 1–30 percent tariff rates noted in section A3.1.

Table A8. Total US Revenues from Carbon Tariffs in 2017 (Million 2017 US$)

Sector	Total Carbon Tariff Revenues, Entire Sector	Total Carbon Tariff Revenues, Only CCA-covered Products in Each Sector
Coal	0.06	0.06
Oil	484.17	484.17
Gas	1,020.43	1,020.43
Petroleum Refining	134.79	134.79
Pulp and Paper	127.86	52.26
Non-metallic Mineral Products	484.44	175.12
Iron and Steel	782.63	708.17
Non-ferrous Metals	615.38	127.29
Total (Excluding energy mining)	**2,145.11**	**1,197.63**
Total	**3,649.77**	**2,702.29**

Table A9. US Revenues from Carbon Tariffs in 2017

	GEM Countries Carbon Tariff Revenues from the Entire Sector (Million 2017 US$)																	
Sector	**Argentina**	**Australia**	**Brazil**	**Canada**	**China**	**France**	**Germany**	**India**	**Indonesia**	**Italy**	**Japan**	**Mexico**	**Russia**	**Saudi Arabia**	**South Africa**	**South Korea**	**Turkey**	**UK**
Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Oil	0.00	0.07	0.00	457.66	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.52	0.00	0.00	0.00	0.00	0.00
Gas	0.00	0.00	0.00	1,002.80	0.00	0.01	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11
Petroleum Refining	0.00	0.09	0.00	0.00	26.82	0.00	0.00	0.00	0.09	0.00	0.00	47.22	39.52	0.00	7.01	0.89	3.25	0.19
Pulp and Paper	0.00	2.41	0.00	93.88	6.57	0.00	0.00	6.36	1.27	0.00	0.20	7.67	1.14	0.05	0.07	0.00	0.01	0.00
Non-metallic Mineral Products	0.17	0.11	7.68	0.00	203.69	0.00	0.00	53.37	7.24	0.00	0.00	123.15	0.80	0.05	4.52	0.00	27.94	0.00
Iron and Steel	9.94	0.00	6.50	77.18	1,17.51	0.00	0.00	85.40	5.42	0.00	0.00	48.50	224.47	0.61	74.58	3.99	11.79	0.00
Non-ferrous Metals	6.54	26.02	28.59	1,18.71	88.18	0.00	0.00	21.73	17.49	0.00	0.00	58.74	110.67	8.75	57.76	0.00	0.22	0.00
Total (Excluding energy mining)	**16.65**	**28.63**	**42.76**	**289.77**	**442.77**	**0.00**	**0.00**	**166.86**	**31.50**	**0.00**	**0.20**	**285.29**	**376.60**	**9.46**	**1,43.94**	**4.88**	**43.20**	**0.19**
Total	**16.65**	**28.70**	**42.76**	**1,750.23**	**443.40**	**0.01**	**0.00**	**166.86**	**31.59**	**0.00**	**0.20**	**285.29**	**380.15**	**9.46**	**1,43.94**	**4.88**	**43.20**	**0.30**

GEM Countries Carbon Tariff Revenues, Only from CCA-covered Products in Each Sector (Million 2017 US$)																		
Sector	**Argentina**	**Australia**	**Brazil**	**Canada**	**China**	**France**	**Germany**	**India**	**Indonesia**	**Italy**	**Japan**	**Mexico**	**Russia**	**Saudi Arabia**	**South Africa**	**South Korea**	**Turkey**	**UK**
Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Oil	0.00	0.07	0.00	457.66	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.52	0.00	0.00	0.00	0.00	0.00
Gas	0.00	0.00	0.00	1,002.80	0.00	0.01	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11
Petroleum Refining	0.00	0.09	0.00	0.00	26.82	0.00	0.00	0.00	0.09	0.00	0.00	47.22	39.52	0.00	7.01	0.89	3.25	0.19
Pulp and Paper	0.00	0.99	0.00	38.37	2.68	0.00	0.00	2.60	0.52	0.00	0.08	3.14	0.47	0.02	0.03	0.00	0.00	0.00
Non-metallic Mineral Products	0.06	0.04	2.77	0.00	73.63	0.00	0.00	19.29	2.62	0.00	0.00	44.52	0.29	0.02	1.63	0.00	10.10	0.00
Iron and Steel	8.99	0.00	5.88	69.84	106.33	0.00	0.00	77.27	4.90	0.00	0.00	43.89	203.11	0.55	67.48	3.61	10.67	0.00
Non-ferrous Metals	1.35	5.38	5.91	24.55	18.24	0.00	0.00	4.49	3.62	0.00	0.00	12.15	22.89	1.81	11.95	0.00	0.04	0.00
Total (Excluding energy mining)	**10.41**	**6.50**	**14.57**	**132.76**	**2,27.71**	**0.00**	**0.00**	**103.66**	**11.74**	**0.00**	**0.08**	**150.92**	**266.28**	**2.40**	**88.10**	**4.51**	**24.07**	**0.19**
Total	**10.41**	**6.57**	**14.57**	**1,593.22**	**2,28.34**	**0.01**	**0.00**	**103.66**	**11.83**	**0.00**	**0.08**	**150.92**	**269.83**	**2.40**	**88.11**	**4.51**	**24.07**	**0.30**

Sector	GEM Regions Carbon Tariff Revenues from the Entire Sector (Million 2017 US$)									
	Rest of Western European Union	**Rest of European Union**	**Northern Europe**	**Latin and Central America**	**Other oil exporters**	**Middle East, North Africa**	**Sub-Saharan Africa**	**Southern Asia**	**Eastern Asia; Rest of World**	**Former Soviet Union**
Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Oil	0.10	0.00	0.00	22.17	0.00	0.00	0.00	0.00	0.00	0.01
Gas	0.00	0.01	0.00	16.75	0.00	0.42	0.00	0.00	0.24	0.00
Petroleum Refining	0.00	9.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38
Pulp and Paper	0.00	0.23	0.00	0.00	0.63	0.92	0.00	0.05	5.80	0.59
Non-metallic Mineral Products	0.00	3.94	0.00	0.00	1.57	6.44	0.03	1.69	40.47	1.60
Iron and Steel	0.00	4.59	0.00	27.09	14.95	11.50	0.00	0.00	0.00	58.62
Non-ferrous Metals	0.00	2.07	0.00	0.00	39.28	25.14	0.03	0.57	1.43	3.46
Total (Excluding energy mining)	**0.00**	**20.15**	**0.00**	**27.09**	**56.42**	**44.00**	**0.06**	**2.31**	**47.69**	**64.66**
Total	**0.10**	**20.16**	**0.00**	**66.01**	**56.42**	**44.42**	**0.06**	**2.31**	**47.93**	**64.70**

	GEM Regions Carbon Tariff Revenues, Only from CCA-covered Products in Each Sector (Million 2017 US$)									
Sector	Rest of Western European Union	Rest of European Union	Northern Europe	Latin and Central America	Other oil exporters	Middle East, North Africa	Sub-Saharan Africa	Southern Asia	Eastern Asia; Rest of World	Former Soviet Union
Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Oil	0.10	0.00	0.00	22.17	0.00	0.00	0.00	0.00	0.00	0.01
Gas	0.00	0.01	0.00	16.75	0.00	0.42	0.00	0.00	0.24	0.00
Petroleum Refining	0.00	9.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38
Pulp and Paper	0.00	0.10	0.00	0.00	0.26	0.38	0.00	0.02	2.37	0.24
Non-metallic Mineral Products	0.00	1.42	0.00	0.00	0.57	2.33	0.01	0.61	14.63	0.58
Iron and Steel	0.00	4.15	0.00	24.52	13.53	10.41	0.00	0.00	0.00	53.04
Non-ferrous Metals	0.00	0.43	0.00	0.00	8.13	5.20	0.01	0.12	0.30	0.72
Total (Excluding energy mining)	**0.00**	**15.42**	**0.00**	**24.52**	**22.47**	**18.31**	**0.02**	**0.75**	**17.29**	**54.96**
Total	**0.10**	**15.43**	**0.00**	**63.43**	**22.47**	**18.73**	**0.02**	**0.75**	**17.53**	**55.00**

A4. Simulated Effects of the CCA

Our report summarizes the estimated effects of CCA tariffs on trade flows, US manufacturing output, revenues, and emissions in Figure 3 and Table 2. This section provides more detail on the effects over the 14-year simulation horizon (during the years 2017–2030). We started the simulation in 2017 since that is the base year data underlying the economic model. It is most useful to think of 2017 as "year 1" and 2030 as "year 14."

A4.1. Changes in Imports Due to the CCA

Figures 3a and 3b outline the changes in US imports of the 8 covered sectors from the main countries due to CCA tariffs and domestic fees. We note the unusually high estimate of the intensity of gas production in Canada leading to a very high 11 percent tariff rate. This has also led to a large, 28 percent reduction in total US imports of gas (last column of Table A10).[13] For the other sectors, the reduction in aggregate imports ranges from 0.1 percent for Paper to 2 percent for Non-metallic Mineral Products. This small fall in total imports of each manufacturing sector in year 1 is due the shift in imports from countries with high intensities to those with low intensities and zero (or very low) tariffs, such as Europe and Japan. Here we describe the year 1 change in imports in greater detail, with Table A10 showing the percentage change in imports into the United States from each of the 28 regions and Table A11 showing the change in absolute US dollars. The total imports in the base year are also given in Table A10.

13 It should be noted that imports of gas in more recent years is much lower than in 2017, the model base year.

Table A10. US Revenues from Fees on Domestic Producers of CCA-covered Products in 2017

	Domestic Fees on Entire Sector (Million US$)													
Sector	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Coal	185	190	195	200	205	211	216	222	228	235	241	248	255	263
Oil	291	277	284	290	302	315	329	344	360	377	395	414	435	456
Gas	1,808	1,879	1,978	2,075	2,188	2,303	2,424	2,551	2,683	2,821	2,965	3,112	3,267	3,426
Petroleum Refining	2,615	2,577	2,726	2,876	3,082	3,401	3,771	4,203	4,702	5,286	5,973	6,781	7,756	8,935
Pulp and Paper	1,004	1,057	1,110	1,166	1,229	1,328	1,439	1,564	1,706	1,865	2,050	2,262	2,513	2,811
Non-metallic Mineral Products	830	905	959	1,015	1,072	1,160	1,257	1,367	1,491	1,630	1,789	1,971	2,184	2,434
Iron and Steel	1,657	1,800	1,909	2,020	2,137	2,317	2,518	2,746	3,000	3,288	3,619	3,997	4,443	4,965
Non-ferrous Metals	656	716	758	800	842	886	932	981	1,033	1,087	1,146	1,208	1,275	1,346
Total (Excluding energy mining)	**6,761**	**7,055**	**7,462**	**7,877**	**8,362**	**9,092**	**9,917**	**10,861**	**11,931**	**13,155**	**14,578**	**16,220**	**18,171**	**20,492**
Total	**9,045**	**9,401**	**9,919**	**10,442**	**11,057**	**11,921**	**12,886**	**13,979**	**15,203**	**16,588**	**18,179**	**19,994**	**22,128**	**24,637**

	Domestic Fees on CCA-covered Products Only in Each Sector (Million US$)													
Sector	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Coal	185	190	195	200	205	211	216	222	228	235	241	248	255	263
Oil	291	277	284	290	302	315	329	344	360	377	395	414	435	456
Gas	1,808	1,879	1,978	2,075	2,188	2,303	2,424	2,551	2,683	2,821	2,965	3,112	3,267	3,426
Petroleum Refining	2,615	2,577	2,726	2,876	3,082	3,401	3,771	4,203	4,702	5,286	5,973	6,781	7,756	8,935
Pulp and Paper	289	304	319	336	354	382	414	450	491	537	590	651	723	809
Non-metallic Mineral Products	278	304	322	341	360	389	422	459	500	547	600	661	733	817
Iron and Steel	1,315	1,428	1,515	1,603	1,696	1,839	1,999	2,179	2,381	2,609	2,873	3,173	3,526	3,941
Non-ferrous Metals	51	56	59	62	65	69	72	76	80	84	89	94	99	105
Total (Excluding energy mining)	**4,548**	**4,669**	**4,941**	**5,218**	**5,557**	**6,080**	**6,678**	**7,367**	**8,154**	**9,063**	**10,125**	**11,360**	**12,837**	**14,606**
Total	**6,832**	**7,015**	**7,398**	**7,782**	**8,252**	**8,909**	**9,647**	**10,484**	**11,426**	**12,495**	**13,726**	**15,135**	**16,794**	**18,751**

Table A11. Effects of Carbon Tariffs on CCA-covered Imports into the United States, Percent Change in 2017, 2025, and 2030

	Percent Change in 2017 for GEM Countries																	
Sector	Argentina	Australia	Brazil	Canada	China	France	Germany	India	Indonesia	Italy	Japan	Mexico	Russia	Saudi Arabia	South Africa	South Korea	Turkey	UK
Coal	0.00	−1.81	0.00	−0.70	0.00	0.00	0.00	0.00	−0.65	0.00	0.00	0.00	−7.22	0.00	−0.37	0.00	0.00	0.00
Oil	−2.08	−5.58	−1.26	−1.77	−21.09	−2.93	0.00	−0.66	−0.88	0.00	0.00	−0.11	−4.13	−0.76	−4.25	0.00	0.00	−0.98
Gas	0.00	164.10	0.00	−34.84	−99.92	−79.95	172.59	0.00	106.70	0.00	0.00	0.00	173.61	177.79	0.00	0.00	0.00	47.11
Petroleum Refining	0.58	−21.15	0.77	3.52	−3.15	1.04	1.06	1.09	0.37	1.07	1.02	−12.49	−0.52	0.98	−56.61	0.94	−6.45	0.96
Pulp and Paper	2.39	−5.25	2.27	−2.30	1.71	2.44	2.39	−20.17	−0.33	2.37	2.11	−0.33	−30.08	−31.95	1.80	2.31	2.31	2.47
Non-metallic Mineral Products	−1.99	4.59	4.43	10.01	−4.36	8.93	8.87	−39.02	−42.64	8.86	8.87	−16.57	−28.70	3.89	−33.15	8.82	−12.96	8.97
Iron and Steel	−13.36	12.99	11.64	6.88	−22.43	13.01	12.97	−77.16	−26.25	12.95	12.93	2.69	−52.10	9.95	−40.08	12.18	8.02	13.03
Non-ferrous Metals	−0.59	−25.79	−14.28	2.08	−17.39	7.68	7.59	−24.16	−38.29	7.60	7.64	0.44	−27.85	−28.76	−10.79	7.48	5.58	7.31

	Percent Change in 2025 for GEM Countries																	
Sector	**Argentina**	**Australia**	**Brazil**	**Canada**	**China**	**France**	**Germany**	**India**	**Indonesia**	**Italy**	**Japan**	**Mexico**	**Russia**	**Saudi Arabia**	**South Africa**	**South Korea**	**Turkey**	**UK**
Coal	0.00	0.00	−1.08	0.00	0.00	0.00	−12.21	0.00	−2.34	0.00	0.00	0.00	−7.22	0.00	−0.37	0.00	0.00	0.00
Oil	0.00	−1.63	−1.74	0.00	0.00	−0.62	−7.49	−1.55	−7.15	0.00	0.00	−1.77	−4.13	−0.76	−4.25	0.00	0.00	−0.98
Gas	487.49	0.00	108.86	0.00	0.00	0.00	481.56	493.28	0.00	0.00	0.00	22.09	173.61	177.79	0.00	0.00	0.00	47.11
Petroleum Refining	−0.50	3.26	−2.51	2.46	3.04	−21.43	−2.85	3.03	−71.06	−1.41	−12.65	−1.32	−0.52	0.98	−56.61	0.94	−6.45	0.96
Pulp and Paper	3.67	−23.68	−2.79	3.62	2.00	−2.03	−38.88	−42.16	0.55	3.54	1.86	3.80	−30.08	−31.95	1.80	2.31	2.31	2.47
Non-metallic Mineral Products	15.13	−47.85	−55.58	15.10	13.94	−23.09	−38.84	2.95	−44.69	14.59	−19.22	15.31	−28.70	3.89	−33.15	8.82	−12.96	8.97
Iron and Steel	22.51	−75.92	−33.61	22.50	22.43	2.27	−61.88	15.17	−45.53	18.23	11.27	22.64	−52.10	9.95	−40.08	12.18	8.02	13.03
Non-ferrous Metals	10.31	−26.59	−49.05	10.35	10.34	−1.11	−36.99	−37.43	−16.30	10.11	5.28	9.88	−27.85	−28.76	−10.79	7.48	5.58	7.31

Sector	Percent Change in 2030 for GEM Countries																	
	Argentina	Australia	Brazil	Canada	China	France	Germany	India	Indonesia	Italy	Japan	Mexico	Russia	Saudi Arabia	South Africa	South Korea	Turkey	UK
Coal	0.00	−8.38	0.00	−1.54	0.00	0.00	0.00	0.00	−1.78	0.00	0.00	0.00	−18.09	0.00	−6.11	0.00	0.00	0.00
Oil	−6.33	−12.56	−6.00	−4.85	−31.66	−7.81	0.00	−2.98	−3.06	0.00	0.00	−1.66	−12.48	−2.74	−12.06	0.00	0.00	−4.47
Gas	0.00	1,050.11	0.00	−81.20	−99.99	−97.71	594.97	0.00	59.20	0.00	0.00	0.00	540.19	1,123.83	0.00	0.00	0.00	−20.27
Petroleum Refining	0.53	−39.64	0.89	12.23	−6.94	−2.33	−2.52	5.49	−5.59	1.49	3.47	−29.13	−5.53	3.36	−79.49	−3.99	−18.32	−3.82
Pulp and Paper	6.35	−8.71	6.23	−5.35	3.93	6.38	5.27	−27.20	−5.45	6.19	1.14	−4.10	−45.71	−49.92	−1.27	3.68	0.88	6.47
Non-metallic Mineral Products	−4.52	4.99	1.03	14.35	−4.87	23.79	22.64	−53.78	−63.61	23.59	15.12	−28.44	−46.56	1.22	−52.92	16.41	−24.27	21.05
Iron and Steel	−20.53	25.46	13.14	6.90	−25.93	34.93	29.32	−79.48	−39.74	34.81	33.01	0.69	−68.57	16.89	−51.33	22.12	12.60	35.03
Non-ferrous Metals	0.23	−37.41	−27.39	0.62	−13.42	13.94	11.87	−30.22	−57.05	13.79	13.75	−3.64	−44.62	−45.21	−22.16	13.44	3.40	13.18

	Percent Change in 2017 for GEM Regions									
Sector	**Rest of Western European Union**	**Rest of European Union**	**Northern Europe**	**Latin and Central America**	**Other oil exporters**	**Middle East, North Africa**	**Sub-Saharan Africa**	**Southern Asia**	**Eastern Asia; Rest of World**	**Former Soviet Union**
Coal	0.00	0.00	0.00	−0.82	0.00	0.00	−0.57	0.00	0.00	−13.17
Oil	−2.45	0.00	−0.86	−1.40	−0.82	−0.83	−0.75	0.00	−0.94	−0.83
Gas	168.24	144.58	167.59	23.56	165.63	43.48	160.28	0.00	115.71	170.45
Petroleum Refining	1.03	−2.22	0.90	0.79	0.80	1.05	0.94	1.04	1.02	0.51
Pulp and Paper	2.43	1.40	2.47	2.21	−22.80	−0.59	2.44	−1.15	−3.48	−11.23
Non-metallic Mineral Products	8.92	4.11	8.99	8.67	−9.65	−7.26	7.37	−37.96	−17.08	−22.74
Iron and Steel	13.00	7.86	13.01	−2.42	−4.83	−9.13	13.05	13.04	12.96	−36.88
Non-ferrous Metals	7.71	1.52	7.29	7.42	−8.30	−23.08	7.69	−56.44	6.37	−14.56

Sector	Percent Change in 2025 for GEM Regions									
	Rest of Western European Union	Rest of European Union	Northern Europe	Latin and Central America	Other oil exporters	Middle East, North Africa	Sub-Saharan Africa	Southern Asia	Eastern Asia; Rest of World	Former Soviet Union
Coal	0.00	0.00	0.00	−1.25	0.00	0.00	−1.07	0.00	0.00	−20.73
Oil	−4.21	0.00	−1.67	−3.76	−1.60	−1.60	−1.53	0.00	−1.83	−3.26
Gas	470.85	231.16	469.49	2.24	460.43	17.30	441.22	0.00	124.66	376.22
Petroleum Refining	2.16	−5.08	2.87	−1.51	−0.94	3.16	2.96	3.12	3.07	−1.79
Pulp and Paper	3.71	2.06	3.78	1.38	−27.01	−2.31	3.75	−0.73	−8.23	−18.65
Non-metallic Mineral Products	15.20	6.33	15.31	9.85	−12.29	−12.32	7.99	−46.06	−28.48	−35.02
Iron and Steel	22.56	12.39	22.58	−3.47	−2.40	−13.01	20.62	22.77	14.61	−50.26
Non-ferrous Metals	10.45	3.02	10.00	10.12	−8.86	−29.52	9.39	−56.52	4.47	−24.14

	Percent Change in 2030 for GEM Regions									
Sector	**Rest of Western European Union**	**Rest of European Union**	**Northern Europe**	**Latin and Central America**	**Other oil exporters**	**Middle East, North Africa**	**Sub-Saharan Africa**	**Southern Asia**	**Eastern Asia; Rest of World**	**Former Soviet Union**
Coal	0.00	0.00	0.00	−1.93	0.00	0.00	−1.80	0.00	0.00	−28.39
Oil	−7.68	0.00	−2.94	−7.46	−4.50	−2.84	−2.70	0.00	−3.16	−7.40
Gas	1,032.49	2,26.19	608.82	−32.77	1,026.38	−25.03	957.36	0.00	76.84	374.49
Petroleum Refining	0.54	−8.20	6.89	−4.49	−3.60	7.33	7.04	7.32	4.10	−4.43
Pulp and Paper	6.33	1.84	6.42	−0.28	−31.90	−4.56	4.28	−1.25	−12.64	−25.00
Non-metallic Mineral Products	21.67	7.19	23.88	9.09	−15.93	−17.14	7.45	−51.52	−37.11	−44.23
Iron and Steel	34.88	14.92	34.89	−6.20	−3.03	−17.46	23.84	32.92	14.30	−59.31
Non-ferrous Metals	13.59	2.48	13.37	13.42	−12.07	−36.09	8.57	−59.39	1.20	−32.55

Table A12. Total Effects of Carbon Tariffs on CCA-covered Imports into the United States (Percent Change)

Sector	2017	2025	2030
Coal	–0.9	–1.3	–1.9
Oil	–1.2	–2.3	–4.3
Gas	–28.1	–49.1	–67.1
Petroleum Refining	0.3	–0.1	–0.9
Pulp and Paper	–0.1	–0.3	–1.1
Non-metallic Mineral Products	–2.4	–4.9	–7.3
Iron and Steel	–2.2	–5.0	–7.0
Non-ferrous Metals	–1.6	–3.0	–5.0

We first note that the big shift in imports from high tariffed sources to low tariff ones are due to the assumed high substitutability between different sources of imports—a high elasticity of substitution parameter. There is a reduction in aggregate imports of all but one of the covered categories, despite the carbon fee burden on US producers due to two features of the economy and the model. One is the low share of US production exceeding the benchmark carbon intensity, resulting in low equivalent tax rates on US output (as shown in the first column of Table A7). The second reason is that the high elasticity of substitution between domestic and imported varieties of each sector's products, where elasticities are in the 3–4 range. The only sector which has higher imports is Petroleum products. Here we summarize the results by sector:

- **(i,ii) Coal and Crude Oil extraction**: Coal imports into the United States are very small to begin with ($0.4 billion); further reduction due to CCA tariffs is 1 percent. Crude Oil imports are large but only fall 1 percent in the aggregate. There is a 4 percent reduction of imports from Russia and 1 to 2 percent from Canada and Brazil, offset by very small reductions from Mexico and Saudi Arabia.
- **(iii) Gas extraction**: The United States, essentially, only imported natural gas from Canada and some Latin American countries in 2017. The estimated tariff rate is 9 percent for Canada and 3 percent for Latin America. There is, thus, a big reduction in imports from Canada (–35%), offset somewhat by higher imports from Latin America (+24%), leaving a net 28 percent reduction in total gas imports.

- **(iv) Petroleum Refining**: The main sources of refined petroleum products are Russia, Canada, Brazil and other Latin American countries. Of these, only Russia faces a positive (0.4%) tariff. Other sources have low intensities, and therefore see zero tariffs. There is a higher tariff on Mexico but only a small quantity. The CCA fees on US producers are equivalent to a 0.6 percent output tax; thus, there is a rise in imports from the zero tariffed countries. Total imports rise by 0.3 percent.
- **(v) Pulp and Paper**: The main sources of paper are Canada, China and Rest of Western EU with $9, $5 and $2 billion, respectively. Canada faces a 1 percent tariff while India has 4 percent and China 0.1 percent. The domestic output tax equivalent is 0.2 percent. There is, thus, a reduction in imports from Canada, India and East Asia, offset by higher imports from China and Europe. This results in a 0.1 percent net reduction in total Pulp and Paper imports.
- **(vi) Non-metallic Mineral (NMM) Products**: Total NMM imports are only $28 billion and comes mainly from China, Canada and Mexico. China faces a 2 percent tariff while Mexico has 5 percent and Canada 0 percent. There is a 2 percent reduction (–$0.7 billion) in the total NMM in year 1. This is made up reductions from China (–$0.3 billion), Mexico (–0.5 billion) and India (–0.2 billion) partly offset by higher imports from Canada (+$0.2 billion), Italy (+$0.1 billion) and Germany (+$0.1 billion).
- **(viii) Iron and Steel**: Iron and Steel imports totaled to $43 billion in 2017, mainly from Canada ($7 billion), and $3 billion each from Brazil, Mexico and Russia. The tariff rates vary widely: Canada (1%), Brazil (0.2%), Mexico (2%), Russia (16%), Germany (0%), Rest of Western EU (0%). Total imports fall by 2 percent ($1 billion), a net fall made up of reductions from Russia (–$1.5 billion), India (–$1 billion), China (–$0.5 billion) offset by higher imports from Canada (+$0.5 billion), South Korea (+$0.4 billion), Rest of Western EU (+$0.4 billion), Brazil (+$0.3 billion).
- **(ix) Non-ferrous Metals**: This sector includes aluminum, copper and other products; and, as Table A5 shows, only 21 percent of imports in this sector are covered by the CCA. Total imports of Non-ferrous Metals are the highest in the manufacturing group covered by the CCA ($62 billion). The main sources in 2017 are Canada ($17 billion), Mexico ($7 billion), Latin America ($9 billion), and $3 billion each from China, Russia and South Africa. Canada and Mexico face a mere 1 percent tariff rate, while China, Russia and South Africa have 3 to 5 percent rates. Total imports fall by 2 percent ($1 billion) made up of reductions from Russia (–$0.8 billion), China (–$0.5 billion), South Africa (-$0.3B), Brazil (–$0.2 billion) and Australia (–$0.2 billion). These are offset by higher imports from Canada (+$0.4 billion), Latin America (+$0.7 billion), Germany ($0.2 billion), and Northern Europe (+$0.1 billion).

A4.2. Changes in US Output and GDP Due to CCA

Figure 3c of the report presents the changes in US industry output for main US industries, and Table A13 below presents the numerical percentage change for each of the 30 sectors. In Table A13, the CCA covered sectors are shown in green. We first discuss the changes in the covered sectors, then the other sectors.

Table A13. Effects of the CCA on US Industry Prices and Output in Years 1 and 10

	2017			2026		
Sector	**US prices**	**US output**	**US imports**	**US prices**	**US output**	**US imports**
Agriculture	0.00	0.03	−0.05	0.01	0.04	−0.09
Forestry	−0.03	0.01	−0.14	−0.05	0.00	−0.31
Fishing	0.03	0.00	0.00	0.05	−0.01	−0.01
Coal	0.02	−0.65	−0.87	0.09	−1.15	−1.44
Oil	−0.10	−0.36	−1.19	−0.23	−0.75	−2.77
Gas	1.42	−2.76	−28.09	2.49	−3.92	−47.98
Petroleum refining	0.80	−1.20	0.28	1.86	−2.75	−0.27
Electricity	0.16	−0.46	0.85	0.25	−0.70	1.36
Other mining	−0.05	−0.12	−0.28	−0.11	−0.16	−0.49
Food and tobacco	0.03	0.00	0.01	0.05	−0.01	0.00
Textiles and apparel	0.02	0.11	−0.05	0.03	0.15	−0.09
Wood and other manufactoring	0.00	0.05	−0.16	0.00	0.06	−0.25
Pulp and Paper	0.48	−0.27	−0.14	0.78	−0.48	−0.38
Chemicals	0.10	−0.13	0.13	0.17	−0.28	0.21
Pharmaceuticals	−0.04	0.26	−0.14	−0.06	0.37	−0.21

Rubber and plastic	0.06	−0.06	−0.04	0.10	−0.15	−0.07
Non-metallic Mineral Products	0.96	−0.02	−2.44	1.70	−0.02	−4.36
Iron and Steel	1.70	−0.63	−2.19	2.88	−0.94	−4.41
Non-ferrous Metals	0.90	−1.93	−1.55	1.21	−2.70	−2.65
Fabricated metal production	0.34	−0.42	0.69	0.56	−0.74	1.11
Transportation equiptment	0.14	−0.24	0.03	0.23	−0.45	0.04
Machinery and electrical equiptment	0.10	−0.21	−0.03	0.16	−0.38	−0.06
Construction	0.04	−0.04	−0.07	0.07	−0.09	−0.12
Transportation	0.11	−0.11	0.02	0.15	−0.17	−0.02
Trade	−0.05	−0.01	−0.20	−0.08	−0.03	−0.32
Market Services	−0.05	0.02	−0.17	−0.08	0.03	−0.27
Public Services	−0.05	0.02	−0.17	−0.08	0.02	−0.28
Housing	−0.06	0.03	−0.21	−0.09	0.03	−0.31

Note: Effects of the CCA are shown through its tariffs and domestic performance standards. Sectors highlighted in green are producing goods covered under the CCA.

A4.2.1. Covered Sectors

Figure 3a shows the change in imports and output for the five manufacturing sectors covered under the CCA. There are distinct differences between the change in US output and imports among these sectors. The fall in year 1 imports (blue) of Iron and Steel (–2.2%, –$0.9 billion) are somewhat similar to the fall in domestic output (–0.6%, –$1.0 billion). The CCA carbon fees acted in the same direction—reducing total demand for Iron and Steel.

The fall in imports of Pulp and Paper (–0.1%, –$0.04 billion) and Non-ferrous Metals (–1.6%, –$1.0 billion) are accompanied by larger reductions in US output, where Pulp and Paper (–0.3%, –$0.8 billion) and Non-ferrous Metals (–1.9%, –$3 billion). In these cases, the rises in US production costs due to the CCA fee are higher than the change in import costs after the shift of imports from the high intensity sources to cleaner ones.

US Non-metallic Mineral Products (NMM) output, on the other hand, enjoys higher net protection, and domestic output loss (–0.0%, –$0.02 billion), which is much smaller than the reduction in total imports of NMM (–2.4%, $0.7 billion).

For Petroleum Refining, there is a very small increase in imports indicating that the actual tariffs are negligible after the shift from the high intensity countries to European and other sources with zero tariff rates. The US producers face the domestic carbon fees and suffer a distinct cost disadvantage leading to a 0.8 percent rise in prices for their products and output falls by 1.2 percent (–$4.7 billion).

For the non-manufacturing sectors, Oil imports fall by 1.2 percent (–$1.6 billion) and US output falls by 0.4 percent (–$0.6 billion). There is a sharp fall in gas imports (–28%, –$5 billion) due largely to the high tariffs on Canada, and the domestic carbon fees raise prices by 1.4 percent and cut US output by 2.8 percent (–$3 billion).

A4.2.2. Sectors Not Covered by CCA

At the aggregate level, the change in US and world GDP is very small. Table A14 gives the effect of the CCA on GDP for all 29 regions for 2017, 2025 and 2030. The changes, positive or negative, are trivial given the small quantities of imports affected. For the United States, GDP falls by a tiny 0.01 percent in the first year due to the conventional distortionary effects of a tax that introduces a wedge between the price faced by the consumer and the price received by the seller. The tiny aggregate change is made up of bigger shifts at the industry level shown in Table A13. The CCA fees on US producers raise their production costs, lowering demand for US goods even in cases where tariffs are limiting the number of imports. As these CCA-covered sectors raise prices, industries downstream suffer higher costs of inputs and are forced to raise their output prices and face reductions in demand. These include Electricity (–0.5%), Fabricated metal products (–0.4%), Rubber and plastic (–0.1%), Transportation equipment (–0.2%), Transportation services (–0.1%), and a others as shown in Table A13. In the model, labor and capital leave these industries and are reallocated to other sectors that enjoy a relative price change—those with fewer inputs from the affected sectors. These include Pharmaceuticals (+0.3%), Market services (+0.02%), and Housing (+0.03%).

Table A14. Effects of Carbon Tariffs on GDP Under the CCA (percent)

	Year 1 (2017)	Year 9 (2025)	Year 14 (2030)
United States	−0.011	−0.031	−0.056
Argentina	−0.001	0.007	0.002
Australia	0.000	−0.027	−0.057
Brazil	0.000	−0.006	−0.020
Canada	−0.008	−0.038	−0.071
China	−0.001	0.027	0.037
France	0.000	−0.009	−0.012
Germany	0.001	−0.016	−0.025
India	−0.002	0.109	0.158
Indonesia	0.000	0.025	0.024
Italy	0.001	−0.021	−0.033
Japan	0.000	−0.021	−0.025
Mexico	−0.003	−0.019	−0.049
Russia	0.000	0.021	0.008

Saudi Arabia	−0.001	0.047	0.024
South Africa	0.000	−0.037	−0.065
South Korea	0.001	−0.050	−0.066
Turkey	0.001	0.045	0.061
United Kingdom	0.000	−0.002	−0.003
Rest of western European Union	0.000	−0.021	−0.034
Rest of European Union	0.000	−0.005	−0.010
Northern Europe	−0.001	−0.008	−0.019
Latin and Central America	−0.003	0.003	−0.013
Other oil exporters	0.003	0.059	0.029
Middle East and North Africa	0.000	0.031	0.040
Sub-Saharan Africa	0.000	0.047	0.048
Southern Asia	−0.001	0.035	0.046
Eastern Asia and Rest of World	0.000	0.002	0.005
Former Soviet Union	0.000	0.002	0.000

A4.3. Effects on Output Over Time

We simulated the policy effects over the time horizon of the model—2017-2030—a 14-year span starting from the year with the latest GTAP database. The 2024 global economy is different in many ways from the 2017 economy (e.g., the origins of imports into the United States for each product) and our estimates should be interpreted with that in mind. The simulated results for 2030 should be interpreted as the effects in the 14th year of the policy implementation; we point out below how the size of many of the changes are larger compared to the changes in the first year.

The most important difference in CCA impacts in between the initial and out years comes from the investment and capital accumulation channel. The policy affects the price of investment goods (e.g., machinery and steel), raising them relative to the price of services and labor; and, thus, the quantity of investment falls slightly. Over time, however, this small annual fall accumulates into a noticeably smaller capital stock. Table A14 reports the change in US GDP in year 14 (2030), which is –0.06 percent compared to a –0.01 percent change in the first year. This lower GDP leads to lower revenues for the US government, from both regular taxes and the new CCA fees, compared to estimates made ignoring this investment effect.

Table A15 shows the impact the CCA has on US output of the 8 covered sectors over the 14 years simulated. In the no-policy base case, imports are rising for each product from virtually all regions along with the growing economies of the world. The different regions of the world are growing at different projected rates: China, India and many developing countries are catching up with the developed regions with higher productivity and more rapid GDP growth. These fast-growing regions, thus, also see falling relative prices; that is, the price of Iron and Steel metals from India is falling relative to US price over time. On the other hand, other advanced countries like Europe and Japan are projected to grow slower than the United States. There is, thus, a twist in relative prices between United States, Europe and other high-income countries, middle-income countries and low-income countries.

These changes in relative world prices add to the effect of rising carbon prices in the CCA (at a 6 percent real rate per year). The result of these two trends leads to a significant rising impact of the CCA tariffs on imports (Table A10) into the United States and on US output (Table A15) of the covered sectors. For example, the fall in total Iron and Steel imports changes from –2.2 percent in 2017 to –5.0 percent in 2025, to –7.0 percent in year 14 (2030). This is accompanied by the fall in US Iron and Steel output of –0.63 percent, –0.83 percent and –1.7 percent in the corresponding years. These changes also lead to changes in CCA revenues collected over time, as discussed next.

Table A15. Effects of CCA Carbon Tariffs and Domestic Fees on Domestic Prices Over Time (percent change from base case)

	US domestic prices			US domestic output		
	2017	2025	2030	2017	2025	2030
Coal	0.022	0.086	0.124	–0.648	–1.075	–1.543
Oil	–0.101	–0.198	–0.418	–0.358	–0.697	–1.004
Gas	1.420	2.342	3.117	–2.756	–3.775	–4.713
Petroleum Refining	0.799	1.663	3.112	–1.200	–2.474	–4.432
Pulp and Paper	0.484	0.723	1.130	–0.267	–0.444	–0.695
Non-metallic Mineral Products	0.961	1.563	2.531	–0.017	–0.004	–0.258
Iron and Steel	1.702	2.661	4.193	–0.632	–0.835	–1.718
Non-ferrous Metals	0.901	1.164	1.418	–1.930	–2.604	–3.140

Note: The prices are those paid by domestic purchasers for US produced commodities.

A4.4. Revenues Raised by the CCA

Our report describes how revenues are recognized in a way consistent with the observation in Table A5, which is that the CCA-covered items are only part of the GEM model sector (e.g., CCA does not cover copper imports that are part of our Non-ferrous Metals sector). When simulating the tariff rates, we had to apply the tariffs to the entire model sector. That is, we estimate the total revenue as if the carbon tariff applied to the whole sector. However, we also report "CCA revenues" as an amount equal to the covered shares in Table A5 multiplied by this total revenue for each of the 8 covered sectors. This is to provide a more accurate estimate of the revenues. Similarly, in reporting the fees collected from US producers, we calculated total fees and a separate "CCA domestic fees" that applies the Table A5 shares. We emphasize that the simulated impacts on output, GDP, and trade flows are due to the tariffs on the entire model sector.

The CCA tariff revenues and domestic fees for the manufacturing sectors are summarized in Table 2 for the first 10 years (in 2024 US$). Tables A8, A9, and A16 provide additional detail. CCA tariff revenues from all modeled sectors rise from $3.4 billion in year 1 to $5.9 billion in year 10, while revenues from domestic fees rise from

$8.6 to $16 billion. If we consider only the manufacturing sectors, the tariff revenue rises from $1.5 to $3.4 billion. Here we elaborate on the products and regions that contribute most to these revenues that are given in Table A8 (in model 2017 US$).[14]

In section 3.1 of this appendix, we discussed how imports from high intensity sources with high tariff rates fall significantly, being replaced partially by imports from countries with very low or even zero tariff rates. Thus, revenue is much smaller than it would be under a simple calculation that assumes no shifts in import sources. The high rates on imports from China, India, Russia and South Africa reduced imports from them significantly, but not to zero. Revenues from those countries in year 1 are non-trivial (from all sectors, not just manufacturing): Russia ($270 million), China ($230 million), India ($100 million) and South Africa ($90 million). Canada has mostly low tariff rates with one important exception for gas. This is a result of the high rate on Canadian gas and the large volume of oil imports—giving a total of $1.6 billion of CCA revenue from Canada. Mexico has moderate tariff rates but high imports, resulting in $190 million of tariffs collected. These top 6 countries contribute the dominant share of the total $2.7 billion CCA tariff revenue in year 1.

Table A8 shows the total across all modeled countries. Looking across the 8 covered sectors, natural gas extraction provides $1.0 billion in CCA tariff revenues in year 1, followed by Iron and Steel ($700 million), Oil extraction ($500 million), Non-metallic Mineral Products ($170 million), and other sectors provide about $100 million each. Coal imports are low and contribute trivial revenues.

Over time the CCA benchmarks are tightened, and tariff rates and domestic fee rates rise. In addition, the volume of US output and imports are rising in both the base case and policy case and we show how the simulated revenues evolve in Table A16. Tariff revenues rise from $3.4 billion in 2017 to $7.7 billion in 2030 (in 2024 US$). Revenues from domestic CCA fees rise from $9 to $24 billion at the same time.

We noted how the natural gas extraction sector is a large share of total revenue due to the large differences in estimated gas extraction intensities from the GTAP data. Given the greater interest in the manufacturing sector (and possibly more reliable estimates of manufacturing intensities) we give the subtotal for just the manufacturing group in Table A16 (ii). For these five manufacturing sectors, total tariff revenue rises from $1.5 billion to $5 billion in 2030 while total domestic fees rise from $6 to $18 billion.

14 The revenues given in Table 2 are in 2024 US$. The $1.2 billion from manufacturing goods in Tables A8 and A9 for 2017 corresponds to the $1.5 billion (2024 US$) in Table 2.

Table A16. Total US CCA revenues from Carbon Tariffs and Fees on Domestic Producers Over Time (Billion 2024 US$)

	All Industries Modeled					
	From whole model sector		From CCA-covered products only		CCA-covered products share of whole sector	
	CCA tariff revenue	CCA revenues from US producers	CCA tariff revenue	CCA revenues from US producers	CCA tariff revenue	CCA revenues from US producers
2017	4.6	11.3	3.4	8.6	74%	76%
2018	4.8	11.8	3.5	8.8	73%	75%
2019	5.1	12.4	3.7	9.3	73%	75%
2020	5.4	13.1	3.9	9.7	73%	75%
2021	5.7	13.8	4.1	10.3	73%	75%
2022	6.1	14.9	4.4	11.2	73%	75%
2023	6.6	16.1	4.8	12.1	73%	75%
2024	7.0	17.5	5.1	13.1	73%	75%
2025	7.6	19.0	5.5	14.3	72%	75%
2026	8.2	20.8	5.9	15.6	72%	75%
2027	8.8	22.8	6.3	17.2	72%	76%
2028	9.4	25.0	6.7	19.0	71%	76%
2029	10.1	27.7	7.2	21.0	71%	76%
2030	11.0	30.9	7.7	23.5	71%	76%

Manufactoring Industries Only (Excluding Mining)						
	From whole model sector		From CCA-covered products only		CCA-covered products, share of whole sector	
	CCA tariff revenue	CCA revenues from US producers	CCA tariff revenue	CCA revenues from US producers	CCA tariff revenue	CCA revenues from US producers
2017	2.7	8.5	1.5	5.7	56%	67%
2018	2.9	8.8	1.6	5.8	56%	66%
2019	3.1	9.3	1.8	6.2	57%	66%
2020	3.3	9.9	1.9	6.5	57%	66%
2021	3.5	10.5	2.0	7.0	57%	66%
2022	3.9	11.4	2.2	7.6	58%	67%
2023	4.3	12.4	2.5	8.4	58%	67%
2024	4.7	13.6	2.8	9.2	59%	68%
2025	5.2	14.9	3.1	10.2	59%	68%
2026	5.7	16.5	3.4	11.3	60%	69%
2027	6.2	18.3	3.8	12.7	60%	69%
2028	6.9	20.3	4.2	14.2	61%	70%
2029	7.6	22.8	4.6	16.1	61%	71%
2030	8.4	25.7	5.2	18.3	62%	71%

A4.5. Effects on Carbon Emissions

Figure 4 in this report illustrates how the CCA produces only a small initial change in global carbon emissions (–0.2%) coming from a reduction in the United States, combined with lower emissions from the high intensity countries, which are also exporting less to the United States and is slightly offset by higher emissions from countries who are exporting more. Table A17 shows the percentage change in emissions for all regions as well as the global total. The biggest reduction is in the

United States (–1.3%) due to an explicit modeling of the incentives to reduce fossil fuel and electricity input. The second biggest reduction is in Mexico (–0.4%) due to the moderate tariffs and high volume of exports to the United States. This is followed by Canada (–0.4%) with the cut in natural gas production, Russia (–0.4%) with high tariff rates, and –0.2% for both South Africa and India with their high intensities.

Table A17. Effects on Carbon Emissions of Carbon Tariffs by the United States Under the CCA

	GEM Countries																	
Sector	Argentina	Australia	Brazil	Canada	China	France	Germany	India	Indonesia	Italy	Japan	Mexico	Russia	Saudi Arabia	South Africa	South Korea	Turkey	UK
	Percent Change from Base Case																	
2017	–0.058	–0.015	0.016	–0.420	0.005	0.000	0.042	–0.245	–0.041	0.017	0.027	–0.444	–0.376	–0.005	–0.244	0.075	–0.024	0.019
2025	–0.068	–0.036	–0.029	–0.885	0.040	–0.019	0.041	–0.164	–0.031	0.009	0.011	–0.766	–0.455	0.052	–0.243	0.032	–0.015	0.014
2026	–0.073	–0.039	–0.041	–0.950	0.044	–0.021	0.043	–0.154	–0.031	0.010	0.012	–0.824	–0.462	0.048	–0.243	0.029	–0.017	0.015
2030	–0.102	–0.053	–0.106	–1.198	0.058	–0.028	0.056	–0.112	–0.032	0.023	0.019	–1.104	–0.480	0.032	–0.235	0.029	–0.025	0.021
	Change in Million Tons of Carbon																	
2017	–0.11	–0.06	0.07	–2.46	0.51	0.00	0.32	–5.41	–0.20	0.06	0.31	–1.98	–6.01	–0.03	–1.06	0.45	–0.10	0.08
2025	–0.12	–0.14	–0.12	–5.04	4.64	–0.06	0.28	–5.85	–0.22	0.02	0.11	–3.60	–7.50	0.29	–1.03	0.19	–0.08	0.06
2026	–0.13	–0.15	–0.17	–5.42	5.14	–0.06	0.30	–5.78	–0.23	0.02	0.12	–3.91	–7.63	0.28	–1.03	0.17	–0.09	0.06
2030	–0.19	–0.20	–0.45	–6.89	7.33	–0.08	0.36	–5.18	–0.27	0.05	0.18	–5.47	–8.03	0.19	–0.99	0.17	–0.13	0.08

	GEM Regions											
Sector	**World**	**United States**	**Rest of Western European Union**	**Rest of European Union**	**Northern Europe**	**Latin and Central America**	**Other oil exporters**	**Middle East, North Africa**	**Sub-Saharan Africa**	**Southern Asia**	**Eastern Asia; Rest of World**	**Former Soviet Union**
	Percent Change from Base Case											
2017	-0.245	-1.273	0.019	0.016	0.016	-0.045	-0.059	-0.054	-0.004	-0.021	0.015	-0.142
2025	-0.352	-2.282	0.011	0.012	0.020	-0.105	-0.029	-0.063	0.036	0.010	0.005	-0.192
2026	-0.372	-2.474	0.010	0.012	0.021	-0.125	-0.039	-0.067	0.035	0.013	0.005	-0.197
2030	-0.478	-3.486	0.015	0.015	0.022	-0.258	-0.083	-0.089	0.022	0.028	0.009	-0.208
	Change in Million Tons of Carbon											
2017	-81	-63	0.18	0.11	0.02	-0.29	-0.94	-0.30	-0.01	-0.07	0.21	-0.85
2025	-130	-110	0.09	0.08	0.02	-0.73	-0.51	-0.41	0.13	0.04	0.10	-1.37
2026	-140	-119	0.09	0.08	0.02	-0.88	-0.72	-0.45	0.13	0.06	0.10	-1.43
2030	-192	-167	0.11	0.10	0.02	-1.93	-1.64	-0.64	0.10	0.13	0.20	-1.66

Countries with low intensities and trivial tariff rates raise their exports to the United States and their emissions rise small amounts—South Korea by less than 0.1 percent, and Japan, Germany and other European regions by less than 0.05 percent. China's emissions increase slightly. The net result is that global emissions fall by 0.2 percent in year 1.

Over time, with the tightening benchmarks and higher tariff rates, change in United States emissions rise from –1.3 percent in year 1 to –3.5 percent in year 14, while Mexico's rise from –0.4 percent to –1.1 percent. The reduction in global carbon emissions will rise from –0.2 percent to –0.5 percent.

A4.5.1. Sources of change in US emissions

This report mentions how the net reduction in US carbon emissions is decomposed to three sources: a) change in energy intensity, b) change in the level of output, and c) change in household energy use. Here we give a definition and an explanation of this decomposition which is given in Table A18.

Table A18. Sources of the Change in US Emissions due to the CCA

	Change in US CO_2 output due to CCA (Million tons)	Contribution to total change in CO_2		
		Percent change in energy intensity	Percent change in industry output	Percent change in household energy
2017	–63	70	22	8
2025	–110	70	19	11
2030	–167	68	19	13

The contribution from the "change in energy intensity" is the sum of the changes in coal, oil and gas use per unit output. The "change in industry output" is the sum over the changes in output in all 28 sectors, some of which contracted and some expanded. The "change in household energy" is sum of coal, oil and gas use in consumption.

For year 1, US emissions fall by 63 million tons (1.3 percent of total US emissions). We estimate that 70 percent of this is due to the reduction in coal, oil, gas and electricity inputs per unit output of the various sectors, 22 percent due to the shrinking of the carbon-intensive industries and expanded output of the service industries, and 8 percent due to lowered household consumption of fuels. To get this, we start with the equation that has total US emissions as the sum over industries of the primary emissions of each industry plus the household primary emissions. Let $\mathrm{F_{fj}}$ be the quantity of fossil fuel *f* used by industry *j*, θ_j^f be the carbon emission intensity of the fuels, and $\mathrm{F_{ft}^{HH}}$ be the quantity used by households, then the total emissions in year *t* is given by:

$$\mathrm{CO_2}_t^{US} = \sum_j \sum_{f=\{coal,oil,gas\}} \theta_j^f \mathrm{F}_{fjt} + \sum_f \theta_{hh}^f \mathrm{F}_{ft}^{HH} = \sum_j \sum_{f=\{coal,oil,gas\}} \theta_j^f A_{fjt} Q_{jt} + \sum_f \theta_{hh}^f \mathrm{F}_f^{HH} \quad \text{(A15)}$$

The quantity of fuel used is input-output coefficient (energy intensity), $\mathrm{A_{fjt}}$, multiplied by the level of output, $\mathrm{Q_{jt}}$. We drop the US superscript on the right-hand side to avoid cluttering the notation. The change in emissions from *t-1* to *t* is then written as:

$$\Delta\mathrm{CO_2}_t^{US} = \sum_j \sum_f \theta_j^f \Delta A_{fjt} Q_{jt} + \sum_j \sum_f \theta_j^f A_{fjt} \Delta Q_{jt} + \sum_f \theta_{hh}^f \Delta \mathrm{F}_f^{HH} \quad \text{(A16)}$$

The contribution of the change in intensity (i.e., change in energy efficiency) to the total change of emissions is the first sum involving $\Delta\mathrm{A}$, the change in industry *j* output level is the second term ($\Delta\mathrm{Q_{jt}}$), and the change in household fuel use is the third term ($\Delta\mathrm{F_f^{HH}}$). In this primary emission accounting system, electricity emissions are counted under $\mathrm{Q_{Electricity,t}}$. The share contributions given in Table A18 are the shares given by dividing each term on the right-hand side of equation (A16) by the total change.

The CCA changes the price of fuels used by the covered industries. They do so by substituting a) more carbon intensive for less carbon intensive fuels and b) capital for energy. This leads to a small shift in market prices for fossil fuels, which then affects the price of electricity. New prices of energy inputs then affect the intensities of all the other sectors. We discuss in Table A13 how the CCA changes prices and output of all industries. These price changes, and changes in aggregate GDP, then affect household energy consumption.

A5. Comments and Caveats

We have simulated a simplified version of the CCA in a global model of the economy that abstracts from some important detail and economic dynamics. Let us restate our caveats:

4. The CCA is imposed at a detailed product level, such as hydrogen production; however, the database used in the modeling does not identify activity at this level of detail, but only at the level of chemicals manufacturing. First, this means that the intensities used to simulate the policy effects are based on model sector averages, not intensities at the detailed product level. Second, the tariffs and

domestic carbon prices are imposed at the model sector level; that is, all non-metallic mineral products are taxed, not just cement and glass products that are covered explicitly by the CCA. In the case of non-metallic mineral products, only 36 percent of the value of the imports in this sector is liable for CCA tariffs.

5. Since the entire sector is taxed, the impact on downstream industries buying the iron and steel, cement, and other covered products (which really impact the rest of the economy) is exaggerated when compared to a simulation that taxes only the CCA-covered products.
6. The domestic fees (which are at $60 per ton CO_2) are imposed on firms above the industry-average benchmark in each sector. This would incentivize firms above the benchmark to reduce emissions but have no incentives for clean firms. In the model simulation, we represent this fee as the full $60 price multiplied by the share of sector output that is liable. This may be different from averaging the effects on taxed and untaxed firms.
7. We assume that countries exporting to the United States who face carbon tariffs do not respond by imposing carbon policies or retaliatory policies since the United States is not a dominant market for most cases. A response over time would reduce their liable tariffs and obviously change the longer-run results.
8. The benchmark year is 2017. There are some notable changes in imports (e.g., level and country source), exports, and domestic output since then. In particular, the trade in oil and gas products as well as the volume of trade between the United States and Russia.