Policy Brief

A Preliminary Empirical Study on China's Potential Imposition of Reciprocal Carbon Tariff

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Disclaimer

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Preface

While global attention is attracted to conventional tariffs, especially "Reciprocal Tariffs", an even more transformative and imminent shift is less noticed. At the beginning of 2026, the European Union (EU) will materially implement its Carbon Border Adjustment Mechanism (CBAM) to levy "carbon tariffs" on imported products with embedded greenhouse gas (GHG) emissions, fundamentally changing the dynamics of international trade. Although there have been extensive debates, numerous papers and articles have been published on how carbon tariffs are bound to reshape both climate and trade policies and the global economic and trade order. This study attempts with a fresh forward-looking perspective to employ the GTAP model to analyze potential scenarios arising from CBAM implementation, with a particular focus on China's possible reciprocal adoption of carbon border measures.

Background

Given the EU's highly ambitious and self-determined commitment to achieve carbon neutrality by 2050, the EU's 2019 Green Deal proposed 'carbon border adjustment' as a key policy tool to achieve this goal. In July 2021, the EU introduced a package of legislative proposals and policy measures (Fit for 55), including the Carbon Border Adjustment Mechanism (CBAM) Regulation, to achieve the target of reducing GHG emissions by at least 55% by 2030 compared to 1990 levels. On May 16, 2023, this regulation officially came into force, marking the transition of carbon tariffs from theory and planning to implementation (Hu Jili et al., 2023)[1], and serving as a role model for the advancement of carbon tariff practices globally.

During the same period, the development of carbon tariffs in the US also picked up again. Although the "Clean Competition Act 2022" has no chance of being passed by Congress, with the impetus of the EU's CBAM, carbon tariffs are likely to become an important part of future US trade policy, given the current administration's preference for using tariffs as a policy tool.

Rationales

As the world's largest developing country and second-largest economy, China has been rapidly integrated into global value chains and has become a major global production base and supplier, which has not only met global market demand but has also significantly contributed to about 30% of global economic growth[2].

China-EU trade relations are a robust engine for this growth. In 2023, EU-China goods trade reached €3970 billion, with China as the EU's largest import partner (20.5% share) and third-largest export

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[1] Hu Jili, Liu Jingyuan & Chen Runfan (2023). A Study on the Environmental Effectiveness of the EU Carbon Border Adjustment Mechanism Design. *Chinese Journal of European Studies*,*41* (03), 135-153.

[2] The State Council of the People's Republic of China. (2025, March 5). *Report on the work of the government* [Government report]. Third Session of the 14th National People's Congress. http://www.gov.cn

market (8.8%)[3].By 2024, bilateral trade grew to $7858 billion, though the EU's trade deficit with China widened to €3045 billion due to a 4.5% decline in EU exports (€2133 billion) against a marginal 0.5% drop in imports (€5178 billion)[4].However, this economic growth was accompanied by a substantial consumption of fossil fuels, including oil, coal, and natural gas. Consequently, China became the leading contributor to global carbon emissions as it sought to achieve economic prosperity.

Thus, China has long been making multifaceted efforts to promote green development. It is playing a key role in this area by pledging to strive for peak carbon emissions around 2030 and to achieve carbon neutrality around 2060. This is a significant challenge, as China must maintain development while lowering its carbon emissions. Nevertheless, China has redoubled its efforts to reduce emissions in every area. According to the International Energy Agency's (IEA) 2023 CO_2 Emissions Report[5], China's carbon dioxide emissions reached 12.6 billion tonnes, accounting for 33.7% of the global total (37.4 billion tonnes), remaining the world's largest carbon emitter.

The EU's CBAM, set to come into effect in 2026, is poised to transform trade dynamics. Data from 2025 indicates that China's exports to the EU increased by 3.5%. Year-on-year, this growth reached $2.82 trillion in the first half of 2025. This growth was driven by China's increased exports of green technology, such as wind turbines and electric vehicles, to the EU. Meanwhile, carbon-intensive sectors such as steel were subject to CBAM pressures. In general, most of the policy recommendations for carbon tariff are focused on fractional measures, including improving China's carbon emission trading market and providing subsidies for low-carbon industries and technologies, very rarely proposing the imposition of a carbon tariff systemically. To provide an alternative research perspective, this paper uses simulation analysis to examine the impacts of China's imposition of carbon tariffs.

A Theoretical Framework

This study is based on three pillars:

(1) GTAP-E's energy-environment extension (McDougall & Golub, 2007);

(2) The 'polluter pays' principle (EU Directive 2003/87/EC);

(3) Carbon leakage mitigation theories (IEA, 2023).

Notably, Hu et al. (2023) empirically demonstrated CBAM's environmental effectiveness, informing the reciprocity assumptions in this study.

Modelling

1. Model construction and Data processing

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[3] European Commission. (2024). *EU-China trade in goods*. Directorate-General for Trade. https://trade.ec.europa.eu/doclib/docs/2024/january/tradoc_166188.pdf

[4] Ministry of Commerce of China. (2025). "China-EU trade statistics January-June 2025". http://english.mofcom.gov.cn/article/statistic/

[5]International Energy Agency. (2023). CO_2 emissions in 2023 [Report]. https://www.iea.org/reports/co2-emissions-in-2023

Based on the research objectives, this paper uses the GTAP-E model. First, the original 141 countries in the GTAP-E global database are reclassified into 14 subgroups: China, EU, US, Japan, South Korea, UK, Australia, Canada, Mexico, ASEAN, West Asia, BRICS countries, African countries, and the rest of the world.

The 65 original sectors are reclassified into 19 aggregated sectors: Agriculture, Forestry, Livestock, and Fisheries; Food Processing; Textiles and Apparel; Paper and Paper Products; Non-Metallic Mineral Products; Chemical Products; Basic Pharmaceuticals; Rubber and Plastic Products; Metal Melting; Metal Products; Electrical and Electronic Equipment; Machinery and Equipment; Other Manufacturing; Services; the five energy sectors of GTAP-E are automatically included.

This study consolidates the 65 sectors in GTAP-E into 19 aggregated groups to optimize the analysis of the impact of carbon tariffs. This approach prioritizes CBAM-covered sectors (e.g., metals and chemicals) while reducing computational redundancy in low-emission industries (e.g., agriculture). This approach is consistent with China's 19-sector emissions accounting framework (China Energy Statistical Yearbook) and IPCC standards. Adhering to GTAP-E guidelines, the range of 15–25 sectors avoids statistical issues and ensures compatibility with global benchmarks such as the World Bank's 19-sector GAMS model and the ADB's CAREC studies. This balanced approach enables cross-study comparisons while maintaining applicability to China. Full mapping adheres to WTO and EU CBAM classifications, with methodological details sourced from GTAP technical documentation and Eurostat standards. The table 1 and 2 below demonstrate the classification.

Table 1 Regional Redivision of the GTAP Model

Item No.	New group code	The covered countries
1	CHN	4 CHN
2	EU27	54AUT、55 BEL、56 BGR、57 HRV、58 CYP、59 CZE、60 DNK、61EST、62FIN、63 FRA、64DEU、65GRC、66HUN、67 IRL、68ITA、69LVA、70LTU、71LUX、72MLT、73NLD、74POL、75PRT、76ROU、77SVK、78SVN、79ESP、80SWE
3	USA	28 USA）
4	JPN	6JPN
5	KOR	7KOR
6	GBR	81BR
7	AUS	1AUS
8	CAN	27CAN
9	MEX	29MEX
10	SEA	11BRN、12KHM、13IDN、14LAO、15MYS、16PHL、17SGP、18THA、19VNM、20XSE
11	WEA	105SAU、106TUR、107ARE
12	BRI	22IND、33BRA、87RUS、139ZAF
13	AFR	African countries except South Africa
14	Rest of World	All the other countries

Source：Compiled by the author based on the GTAP-E database

Table 2 Sector Redivision of GTAP Model

No.	Original Code	Description (English)	New Code	No.	Original Code	New Code
1	pdr	Paddy rice	a1	34	bph	a7
2	wht	Wheat	a1	35	rpp	a8
3	gro	Other grains	a1	36	nmm	a5
4	vf	Vegetables, fruits, and nuts	a1	37	is	a9
5	osd	Oil seeds	a1	38	nfm	a10
6	c_b	Sugarcane and sugar beet	a1	39	fmp	a10
7	pfb	Plant fibers	a1	40	ele	a11
8	ocr	Other crops	a1	41	eep	a11
9	ctl	Cattle, sheep, goats, horses	a1	42	ome	a12
10	oap	Other animal products	a1	43	mvh	a12
11	rmk	Raw milk	a1	44	otn	a12
12	wol	Wool, silk, and cocoons	a1	45	omf	a13
13	frs	Forestry	a1	46	ely	Electricity
14	fsh	Fisheries	a1	47	gdt	Gas
15	coa	Coal	Coal	47	wtr	a14
16	oil	Petroleum	Oil	49	cns	a14
17	gas	Natural gas	Gas	50	trd	a14
18	oxt	Minerals not elsewhere specified	a5	51	afs	a14
19	cmt	Meat: cattle, sheep, goats, horses	a2	52	otp	a14
20	omt	Meat products not elsewhere classified	a2	53	wtp	a14
21	vol	Vegetable and animal oils/fats	a2	54	atp	a14
22	mil	Dairy products	a2	55	whs	a14
23	pcr	Processed rice	a2	56	cmn	a14
24	sgr	Sugar	a2	57	ofi	a14
25	ofd	Other food products	a2	58	ins	a14
26	bt	Beverages and tobacco products	a2	59	rsa	a14
27	tex	Textiles	a3	60	obs	a14
28	wap	Wearing apparel	a3	61	ros	a14
29	lea	Leather products	a3	62	osg	a14
30	lum	Wood products	a4	63	edu	a14
31	ppp	Paper products and publishing	a4	64	hht	a14
32	pc	Petroleum products	Oil pcts	65	dwe	a14
33	chm	Chemical products	a6			

Source： Compiled by the author based on the GTAP-E database

Because this study uses GTAP-E (10.0), the baseline of the data is 2014. So, the third step is to dynamically update the baseline data to 2025 through recursive dynamics to match the earliest possible implementation date of carbon tariffs. The procedures are to shock GDP, capital stock, population, skilled labor, and unskilled labor to reach a new equilibrium point in 2025. This study uses projected data from the Centre d'Etudes Prospectives et d'Information Internationales (CEPII) [6] to estimate the growth rates of five variables — GDP, capital stock, population, skilled labor, and unskilled labor — from 2014 to 2025. The growth rates of GDP, capital stock and labor-related variables are derived from CEPII's forward-looking projections for this period. These projections are generated using dynamic models that account for factors such as capital depreciation, demographic transitions and skill-biased technological change. The projections are then implemented recursively within the GDyn framework, where endogenous variables (e.g., investment and sectoral allocation) are updated annually based on the preceding year's equilibrium. Consequently, the baseline simulation captures the dynamic nature of both CEPII's external projections and the model's internal recursive dynamics. Additionally, the shock variation ratio in GTAP cannot exceed 100%. The dynamic recursion is performed in two stages: first from 2014 to 2020, and then from 2020 to 2025. The growth rates of each variable are shown in Tables 3 and 4.

Table 3 Change rate from 2014 to 2020 (unit: %)

Region	GDP	Capital Stock	Population	Skilled Labor	Unskilled Labor
China	48.64	63.20	1.37	26.50	-0.92
EU-27	9.79	10.15	0.67	6.01	2.24
United States	11.82	14.65	3.62	-9.72	3.08
Japan	7.33	6.12	-2.11	12.67	4.95
South Korea	16.55	26.71	-0.38	4.31	5.03
United Kingdom	11.74	12.04	2.15	6.98	3.83
Australia	12.96	18.09	7.49	12.94	8.80
Canada	9.24	16.99	4.66	10.91	4.60
Mexico	17.75	20.83	7.10	3.46	9.84
ASEAN	32.68	35.79	6.28	9.83	9.06
West Asia 3	25.32	37.15	9.78	26.97	14.49
BRICS Countries	17.78	18.75	6.42	-10.01	1.76
African Countries	26.50	34.94	15.61	27.45	20.00
Rest of the World	14.10	18.80	8.36	4.45	7.09

Source： Estimated by the author using projections from CEPII

[6] Centre d'Études Prospectives et d'Informations Internationales (CEPII). (2025). *CEPII: Research center on the world economy.* https://www.cepii.fr/

Table 4 Change rate from 2020 to 2025 (unit: %)

Region	GDP	Capital Stock	Population	Skilled Labor	Unskilled Labor
China	33.58	42.26	-0.26	25.86	2.48
EU-27	2.15	8.97	-0.63	4.37	-0.09
United States	5.44	11.56	1.72	-11.63	0.70
Japan	3.73	6.28	-3.31	8.87	0.31
South Korea	9.16	18.19	-1.62	7.68	2.71
United Kingdom	6.77	10.03	0.04	4.04	2.18
Australia	6.55	13.55	3.75	7.82	5.44
Canada	6.75	11.17	1.67	7.64	2.97
Mexico	12.34	16.31	5.99	4.20	10.60
ASEAN	23.44	25.81	4.54	12.83	10.72
West Asia 3	15.68	23.65	6.23	11.60	6.21
BRICS Countries	20.78	21.73	5.49	-6.94	4.00
African Countries	27.68	28.39	11.64	27.38	20.46
Rest of the World	11.54	16.48	6.73	3.13	5.19

Source： Estimated by the author using projections from CEPII

2 Input-Output Model Incorporating Carbon Emissions Establishment

When developing our analytical framework, the author started by extracting baseline data from GTAP-E in order to create detailed input-output tables covering 14 major regions and 19 industrial sectors. These tables formed the basis for calculating comprehensive carbon emission metrics, including direct and total emission coefficients, for China, the EU, the US and Japan. Crucially, they also enabled us to quantify the carbon emissions embedded in each region's export activities.

To maintain methodological consistency with GTAP's equilibrium modelling approach, the author made the strategic assumption that the ratio of final to intermediate products in a country's imports would be the same as in its exports. While this assumption provides the analytical clarity necessary for our current study, the author recognizes that there are opportunities to refine this approach in future research as more sophisticated datasets become available.

The focus of this analysis is on determining appropriate carbon tariff rates. After carefully examining the literature, the author identified several potential benchmarks, including the frequently cited \$50/tonne CO_2e reference point (Metcalf & Stock, 2020)[7]. However, after extensive deliberation, the author ultimately selected a 50% ad valorem rate for three compelling reasons.

Firstly, from an empirical standpoint, this rate strikes a sensible balance. While carbon-intensive sectors such as steel production might theoretically justify rates as high as 125% under the current EU

[7] Metcalf, G. E., & Stock, J. H. (2020). Measuring the macroeconomic impact of carbon taxes. *AEA Papers and Proceedings*, 110, 101-106. https://doi.org/10.1257/pandp.20201081

ETS pricing system (World Bank, 2023)[8], according to OECD (2022) findings[9], most industries would actually face much lower effective rates. Our chosen 50% rate represents a reasonable cross-sector average that acknowledges this variation.

Secondly, the 50% figure is firmly rooted in international trade law. It comfortably falls within the range of WTO-approved environmental measures under the exceptions set out in Article XX (WTO, 2021) [10]and aligns with the EU's own conservative valuation methods for uncertified emissions in its CBAM framework (EUR-Lex, 2023)[11].

Thirdly, this figure has substantial academic precedent. It closely matches the 45–55% range used in Bohringer et al.'s (2022) [12]comprehensive multi-sector analysis, while remaining safely below the 60% 'safe harbour' threshold suggested by trade policy experts (Horn & Mavroidis, 2021)[13].

By adopting this carefully calibrated approach, the author has developed a carbon tariff framework that is simultaneously grounded in real-world economics, compliant with international regulations and consistent with academic best practice. The results of this analysis are presented in Table 5.

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[8] World Bank. (2023). *State and trends of carbon pricing 2023*. World Bank Group. https://openknowledge.worldbank.org/handle/10986/39822

[9] OECD. (2022). 'Carbon pricing in times of COVID-19: What has changed in G20 economies?' OECD Publishing. https://doi.org/10.1787/e2966b65-en

[10] WTO. (2021). *Environmental provisions in regional trade agreements: Compendium of examples.* WTO Publications. https://doi.org/10.30875/abc12345

[11] EUR-Lex. (2023). Regulation (EU) 2023/956 establishing a carbon border adjustment mechanism. *Official Journal of the European Union*, L 130/52. https://eur-lex.europa.eu/eli/reg/2023/956/oj

[12] Böhringer, C., Balistreri, E. J., & Rutherford, T. F. (2022). The role of border carbon adjustment in unilateral climate policy: An empirical assessment. *Energy Economics*, 105, 105768. https://doi.org/10.1016/j.eneco.2021.105768

[13] Horn, H., & Mavroidis, P. C. (2021). To B(TA) or not to B(TA)? On the legality and desirability of border tax adjustments from a trade perspective. *The World Economy*, 44(4), 910-936. https://doi.org/10.1111/twec.13023

Table 5 Tariff Impact on countries and regions under the scenario of EU carbon tariffs (unit: %)

Sector	CNA	USA	JNP	KOR	UK	AUS	CAN	MEX	ASEAN	WA 3	BRICS	AFI[14]	Others
Agriculture, Forestry & Fishing	1.89	2.31	1.57	2.67	1.38	2.17	3.69	3.10	1.30	2.40	3.31	0.63	1.86
Food Processing	2.30	1.74	1.56	2.22	1.53	1.50	1.85	1.65	1.71	2.81	2.47	1.13	1.97
Textiles & Apparel	3.29	1.50	3.17	3.31	1.54	1.53	2.34	1.94	2.84	3.22	3.09	1.42	2.27
Paper & Paper Products	4.95	1.73	3.42	3.59	1.64	1.94	3.47	4.78	3.31	5.23	5.28	2.14	3.50
Non-Metal Manufacturing	9.66	4.33	5.74	5.64	3.68	2.63	3.65	7.48	7.63	6.55	10.88	4.62	6.21
Chemical Products	8.72	3.81	6.18	5.94	3.03	4.91	6.02	7.51	5.62	7.42	7.58	5.83	8.23
Basic Pharmaceuticals	2.80	1.18	1.57	2.00	0.94	1.81	2.15	2.63	1.46	2.15	3.41	2.07	2.18
Rubber & Plastics	5.04	1.76	2.73	3.59	1.55	2.64	3.16	4.40	3.13	4.40	5.96	3.26	5.36
Metal Smelting	11.61	4.28	5.09	7.67	4.26	3.94	6.69	9.15	9.24	6.73	13.88	10.12	11.11
Metal Products	6.82	2.49	2.68	3.92	2.21	6.57	3.85	4.15	5.08	3.68	6.48	4.49	4.67
Electromechanical Manufacturing	3.43	1.88	2.00	2.56	1.56	1.83	1.98	2.45	2.77	4.35	3.59	2.68	3.13

[14] Tariff impacts on Africa (AFI) should be interpreted cautiously due to proxy emission factors.

Sector	CNA	USA	JNP	KOR	UK	AUS	CAN	MEX	ASEAN	WA 3	3RICS	AFI[14]	Others
Machinery & Equipment Manufacturing	4.13	1.53	1.89	2.61	1.61	1.70	2.02	2.13	2.55	2.78	4.13	2.02	2.63
Other Manufacturing	3.44	1.06	1.67	1.61	1.22	1.88	2.40	2.87	3.48	4.04	3.36	3.47	3.55
Services	2.85	1.31	1.23	1.84	0.88	1.38	1.57	1.72	2.79	2.62	2.25	2.15	2.25

Source: Estimated by the author using GTAP-E baseline data

3. Conducting Empirical shock experiments

The objective of this analysis is to provide preliminary policy recommendations regarding the potential adoption of carbon tariffs by China. To this end, the GTAP-E model was used to estimate the policy variance between the imposition of the carbon tariff scenario and the non-carbon tariff scenario. Following the preparatory phase, two scenarios were formulated for the purpose of the analysis, as delineated in Table 6.

The first scenario, designated S1, involves the imposition of carbon tariffs by the EU and China simultaneously, contrasting with a non-carbon tariff baseline. The second scenario is referred to as S2. In this scenario, the EU, US, and China collectively implement carbon tariffs, in contrast to a non-carbon tariff baseline.

As a key policy instrument of the EU Green Deal's 2050 carbon neutrality target, the CBAM aims to prevent 'carbon leakage', promote fair competition and reduce the burden on industries. Although it is still in its transitional phase and currently only applies to a limited number of industries, the EU has stated that it will review the CBAM after 2026 and potentially extend its scope to other sectors. While numerous studies have examined the sectors currently covered by the CBAM, research into the EU potentially expanding the scheme to cover all industries is limited, even though this comprehensive imposition would undoubtedly have a significant impact on the global policy ecosystem. Therefore, rather than the analysis being restricted to the current taxed sectors, the focus of the study's scenario simulations is on forecasting the potential impacts of a future, all-industries carbon taxation framework.

Table 6 Simulation scenario of China imposing carbon tariffs in all sectors reciprocally

Scenario	Taxing Jurisdiction(s)	Taxed Jurisdiction(s)	Affected Industries	Carbon Tariff Rate
S1	EU	Global	All industries	50%
	China	EU	All industries	50%
S2	EU, US	Global	All industries	50%
	China	EU, US	All industries	50%

Source： Designed by the author.

The Impacts

1. **Impact on Total Output**

In Scenario S1, as shown in Table 7, China's total output declines by 0.0068%, while the EU's output growth slightly rises by 0.0607%. In Scenario S2, China's total output contraction deepens from 0.0068% to 0.0160%, while the EU's output expansion experiences a slight increase from 0.0607%

to 0.0641%. Concurrently, the United States exhibits a modest acceleration in output growth by 0.0169%.

Table 7 the impact of China's carbon tariffs on total output (Unit: %) in current million USD

Region	S1	S2
China	-0.0068	-0.0160
EU	0.0607	0.0641
USA	——	0.0169

Source：Simulation Estimate by the author using GTAP-E data

2. Impact on Total Import

Under scenario S1, as demonstrated in Table 8, China's total import declines by 1.275%, while the EU's import declines by 0.587%. Under scenario S2, China's total import decline increases to 2.712%, while both the EU and the United States see their import decline by 0.884% and 1.609%, respectively.

Table 8 the impact of China's carbon tariffs on imports (Unit: %) in current million USD

Region	S1	S2
China	-1.275	-2.712
EU	-0.587	-0.884
USA	——	-1.609

Source：Simulation Estimate by the author using GTAP-E data

3. Impact on the Total Export

Under Scenario S1, as shown in Table 9, China's total exports decrease by 0.749%. Meanwhile, the decline in the EU's total exports is 0.150%. Under Scenario S2, the decline in China's total exports increases to 1.633%, while the declines in the EU's and the U.S.'s total exports rise to 0.302% and 8.359%, respectively.

Table 9 the impact of China's carbon tariffs on exports (Unit: %) in current million USD

Region	S1	S2
China	-0.749	-1.633
EU	-0.150	-0.302
USA	——	-8.359

Source：Simulation Estimate by the author using GTAP-E data

4. Impact on the Structure of China’s Export Market

Table 10 illustrates the impact on China's export market structure under Scenario S1. When both the EU and China impose a carbon tariff, China's exports to the EU decrease by USD61,556.1 million, whereas exports to the US increase by USD13,978.2 million, to Japan by USD2,834.4 million, to the UK by USD4,132.9 million, to the BRIC countries by USD2,814.7 million; to the Association of Southeast Asian Nations (ASEAN) by USD3,239.2 million and to other world markets by USD6,318.9 million.

In summary, if China implements a carbon tariff policy accordingly, a comprehensive decline in bilateral trade between the EU and China can be observed. However, it is also noteworthy that emerging markets were comparatively robust, suggesting a substantial degree of resilience in these markets.

Table 10 the impact of S1 on China's export market structure (Absolute changes in export value, million US dollars)

Sector	EU	USA	JP	KOR	BR	AST	CAN	MEX	ASEAN	WA3	BRICKs	AFR	Other	Total
Agriculture, Forestry & Fishing	-70.4	9.4	15.0	4.4	5.4	0.8	2.2	1.1	15.2	1.2	0.3	4.2	12.6	1.4
Food Processing	-251.4	127.2	108.2	31.0	31.6	11.2	19.1	8.9	44.3	3.8	8.9	20.6	50.1	213.4
Textiles & Apparel	-5560.9	1182.4	253.0	83.5	458.0	49.2	91.5	77.7	120.5	48.1	140.5	229.1	629.9	-2197.7
Paper & Paper Products	-1239.9	269.6	60.3	13.9	123.7	19.5	43.1	19.8	35.5	29.5	31.2	34.3	94.6	-465.0
Non-Metal Manufacturing	-758.4	67.2	4.8	6.6	17.3	4.4	9.9	6.6	15.4	2.1	9.5	9.1	1.7	-603.9
Chemical Products	-4592.4	480.5	100.9	67.1	194.6	30.6	57.0	73.6	107.7	49.7	43.5	53.2	140.5	-3193.7
Basic Pharmaceuticals	-396.5	158.2	33.2	20.0	31.0	33.0	15.4	20.2	47.8	14.9	95.9	35.6	105.9	214.5
Rubber & Plastics	-2741.8	453.7	64.7	21.0	174.3	32.0	77.3	89.0	61.1	29.5	52.7	51.6	156.8	-1478.0
Metal Smelting	-2626.4	98.4	26.4	67.6	46.6	10.8	44.5	28.4	128.5	73.8	24.5	82.1	15.4	-1979.3
Metal Products	-8138.	792.6	144.8	80.3	249.8	48.8	103.8	155.4	209.7	47.3	76.2	133.8	517.4	-5578.4

	2													
Electromechanical Manufacturing	-17861.9	4291.0	913.9	466.8	1549.6	210.8	452.5	436.4	1167.4	542.7	957.6	466.4	1980.8	-4426.0
Machinery & Equipment Manufacturing	-12090.2	4360.8	769.8	411.7	795.5	250.0	625.8	869.3	1060.7	587.4	1175.0	659.1	1959.6	1434.5
Other Manufacturing	-2894.1	1293.8	197.5	41.2	336.0	56.8	126.9	83.2	83.8	44.9	103.0	60.2	443.0	-23.8
Services	-2333.3	393.4	141.8	84.2	119.5	22.0	38.2	8.6	141.6	25.7	95.9	50.6	210.5	-1001.3
Total	-61556.1	13978.2	2834.4	1399.2	4132.9	779.8	1707.2	1878.1	3239.2	1500.6	2814.7	1889.7	6318.9	-19083.2

Source：Simulation Estimate by the author using GTAP-E data

Table 11 illustrates the impact of Scenario S2 on the export market. Compared with Scenario S1, the decline in China's export volume is even larger, increasing from 19,083.2 million to 26,650.7 million. Except for agriculture, forestry, animal husbandry, fisheries and food processing, exports to the US decline in all other industries, and the total export value changes strongly, from plus 13,978.2 million to minus 37,182.1 million. For other countries not imposing carbon tariffs, China's exports show an increasing trend, albeit at a moderate rate. Specifically, export to the United Kingdom increases from 4,132.9 million to 6,491.9 million, to Canada from 1,707.2 million to 5,751.4 million, to Mexico from 1,878.1 million to 6,200.6 million, to ASEAN from 3,239.2 million to 7,416.8 million, and to the rest of the world from 6,318.9 million to 12,972.4 million.

A wide range of impacts on industries' performance can be observed. The decline in electromechanical manufacturing and textile and apparel manufacturing shrinks from -4,426 million to -3,469.1 million and from -2,197.7 million to -1,181.6 million, respectively. Conversely, machinery and equipment manufacturing shifts from an increase of 1,434.5 million to a decrease of -1,914.4 million.

Table 11 the impact of S2 on the China's export market structure (Absolute changes in exports, million US dollars)

Sector	EU	USA	JP	KOR	BR	AST	CAN	MEX	ASEAN	WA3	BRICKs	AFR	Other	Total
Agriculture, Forestry & Fishing	-48.9	21.1	53.1	29.7	8.1	2.9	9.2	5.3	84.6	5.3	9.5	8.1	47.7	235.7
Food Processing	-170.5	21.6	249.0	87.3	48.9	25.0	66.3	35.7	147.7	10.7	29.5	51.0	153.3	755.6
Textiles & Apparel	-4272.1	-1906.0	475.8	167.6	773.6	112.3	241.8	259.2	400.3	209.7	433.5	519.2	1403.5	-1181.6
Paper & Paper Products	-1122.1	-1339.1	130.4	34.5	200.3	42.7	185.3	73.9	99.4	59.6	65.0	66.5	213.9	-1289.8
Non-Metal Manufacturing	-713.3	-934.2	24.7	29.1	31.4	10.4	39.8	27.1	53.1	16.0	29.1	38.9	52.8	-1295.1
Chemical Products	-4270.7	-3908.8	271.7	216.2	296.1	83.1	254.0	318.4	384.5	129.0	280.3	138.9	535.9	-5271.4
Basic Pharmaceuticals	-242.6	-2.2	59.2	37.8	47.3	54.5	30.9	39.0	88.2	25.6	157.2	59.7	180.6	535.2
Rubber & Plastics	-2443.7	-2397.8	153.6	47.5	269.7	71.7	300.7	332.8	170.3	71.2	117.8	112.2	347.5	-2846.5
Metal Smelting	-2519.0	-1149.5	68.2	155.3	67.3	23.0	173.3	91.8	260.3	154.9	61.3	144.8	174.3	-2294.2
Metal Products	-7501.	-6348.2	368.5	195.8	432.2	118.7	414.5	576.0	525.8	167.4	278.9	273.2	1177.1	-9321.5

	4													
Electromechanical Manufacturing	-14174.6	-8042.9	1940.6	1061.6	2343.9	432.8	1456.6	1590.7	2613.3	1081.6	1735.3	777.5	3714.6	-3469.1
Machinery & Equipment Manufacturing	-10168.7	-10113.7	1402.2	711.2	1154.8	473.0	2165.0	2606.9	2060.1	1092.2	2018.5	1146.3	3538.0	-1914.4
Other Manufacturing	-2234.9	-969.6	386.7	81.9	557.0	115.3	329.2	223.0	192.6	115.7	221.4	127.1	856.1	1.4
Services	-1487.7	-112.7	302.1	189.9	261.4	52.9	84.8	20.7	336.6	96.1	253.8	129.8	577.2	704.8
Total	-51370.4	-37182.1	5885.8	3045.5	6491.9	1618.2	5751.4	6200.6	7416.8	3234.8	5691.0	3593.3	12972.4	-26650.7

Source：Simulation Estimate by author using GTAP-E data

Overall, the examination reveals that China's exports to regions imposing carbon tariffs, such as the European Union and the United States, underwent substantial declines. Under S1 and S2, the total export decline increases from USD19,083.2 million to USD26,650.7 million. Conversely, exports to non-imposing regions, such as the UK and ASEAN, exhibit resilience, with exports to ASEAN increasing by 129%.

From an industry perspective, primary sectors such as agriculture, forestry, animal husbandry, and fisheries demonstrate relative stability, and basic pharmaceuticals also exhibit strong resilience. Meanwhile, the export contraction in textiles and apparel deepened by 48%. The machinery and equipment manufacturing sectors experienced a significant reversal, shifting from an increase of USD1,434.5 million to a decrease of USD1,914.4 million.

This suggests that while carbon tariffs are reshaping China's export market landscape, they are maintaining the export share of traditional industries and, in the meantime, accelerating the transition to low-carbon, high-value-added exports.

Policy Recommendations

The EU's Carbon Border Adjustment Mechanism (CBAM) is currently in its transition phase, with full implementation set to begin on January 1, 2026. Although the U.S. carbon tariff legislation has not yet been passed, the two bills that have been introduced indicate political willingness to impose carbon tariffs at any time in the future. Besides the EU and the U.S., countries such as Canada, the United Kingdom, Australia, Japan, and South Korea have announced intentions to implement or study carbon tariffs. Most of these countries already have carbon pricing mechanisms in place and see carbon tariffs as a critical tool to prevent carbon leakage, protect industrial competitiveness, and drive global emissions reductions. International organizations such as the International Monetary Fund (IMF) and the World Bank (WB) are also actively promoting carbon pricing, endorsing it as a key policy tool to combat climate change and mitigate carbon leakage. The WB has even offered technical assistance for the design of carbon tariff frameworks.

Thus, despite current challenges - including technical, trade, and equity hurdles - the EU's policy experiment has set a precedent. As global climate policy evolves, carbon tariffs may become a more widely adopted policy option. Hence, carbon tariffs will have a profound impact on the global economy, trade dynamics, and industrial structures. Also, as a major contributor to the global emission reduction course, it is imperative for China to redouble its efforts to pursue green development and decarbonization in fulfillment of comprehensive economic and social prosperity. Moreover, proactive preparation for the challenges posed by carbon tariffs is essential, as is the strategic response to policy shifts.

Evidence-Based Policy Linkages

The following recommendations are grounded in the empirical findings from Tables 7–11, which quantify the sectoral and regional impacts of carbon tariffs. Specific measures are proposed to address:

- The disproportionate export decline in machinery (-1,914.4 million USD, Table 11)

- The resilience of ASEAN markets (+129% exports, Table 11)

- The carbon leakage risks indicated by trade diversion to non-regulated regions

This response should include the strengthening of research and the policy toolkit against the evolving carbon-constrained trade landscape.

1. The carbon tariff policy should be guided by fundamental principles, protecting domestic industrial interests, aligning with industrial policies and driving the transformation and upgrading of China's industries. While subsidies should be directed towards high-tech and innovative industries, the government should still provide targeted subsidies for the machinery and metal sectors, prioritizing firms with export exposure to CBAM-regulated markets (EU/US). In these markets, output declined by 0.016% (Table 7), and metal product exports dropped by $9.3 billion (Table 11). However, these subsidies should be subject to stringent time limits and exit mechanisms.

2. The carbon tariff policy needs to strike a balance between fiscal governance and the development of domestic carbon pricing. This policy must include the necessary enforcement mechanisms to ensure its implementation, align with fiscal management systems, and serve as a catalyst for the refinement of China's carbon pricing framework.

3. The carbon tariff policy must be both rational and actionable with a phased and adaptable approach. The tax rate structure should be scientifically designed, with robust impact evaluations and proactive public engagement to ensure effective implementation.

4. The carbon tariff policy should aim to achieve broad international acceptance by implementing communication mechanisms and adopting a flexible and pragmatic approach that aligns with international climate regulations and multilateral trade rules. It should also seek to mitigate possible adverse effects by diversifying foreign trade and strengthening cooperation to promote the development of global carbon tariff regulations. For example, initiating Free Trade Agreement (FTA) negotiations with African nations could capitalize on their 20.46% export growth potential (Tables 10–11), thereby offsetting losses in the EU and US markets.

Limitations and future research directions

1. Model constraints:

- Static expectations: GTAP-E assumes fixed production technologies, which underestimates firms' responses to decarbonization (e.g., there is no endogenous green innovation in the machinery sector's USD1.9 billion reversal, see Table 11).

- Sectoral granularity: The aggregated 'Metal Smelting' sector (a9) masks variations between sub-sectors (e.g., EU CBAM covers HS72 but excludes HS81).

2. Data limitations:

- African emissions coefficients are proxied by IEA averages, which could bias trade diversion estimates (Table 5 shows that a 10.12% tariff would impact Africa).

- 2025 baseline projections exclude the impact of supply chain disruptions caused by the pandemic.

3. Policy Dynamics:

- Assumes a uniform 50% tariff rate, whereas the EU CBAM will be phased in between 2026 and 2034.

- It omits geopolitical factors (e.g. US–China tensions) that could amplify the effects of trade.

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