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Research on Carbon Tariff Rate Forecasting Based on EU Carbon Border Adjustment Mechanism

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Abstract: The current international trade rules are facing profound changes, green trade barriers represented by carbon tariffs and their impact have become an important issue in the evolution of global trade. Some countries are reshaping international trade rules with green standards. These measures put pressure on high-carbon emitting industries in developing countries and have an impact on their trade competitiveness. Based on this background, this paper studies the future carbon tariff level and discusses the impact of international trade and industrial competition pattern. The GTAP-E model was used to simulate the implementation of carbon tariffs in different scenarios to study the impact of carbon tariffs on trade in various industries and some countries and economic organizations. The study found that high-carbon industries will face a greater impact, while low-carbon industries will be relatively less affected. Therefore, developing countries should actively participate in the formulation of global green trade rules and build their own discourse system. Optimize the industrial structure, promote the transformation of high-carbon industries to low-carbon, and enhance the innovation capacity of green technology; Improve the carbon accounting system and carbon trading market, better adapt to the international green trade environment, and jointly write a new chapter of green trade rules.

Keywords: international trade; carbon tariff; CBAM; GTAP-E

1. Introduction

The “green” development trend of international trade rules is obvious, and adapting to absorb and participate in the construction of low-carbon international economic and trade rules will become an important direction of international trade work of countries in the future. Major developed countries and economies have formulated corresponding policies to promote the development of green international trade rules. In September 2022, the Inflation Reduction Actof 2022 was passed into law. The bill supports the development of domestic green industry and low-carbon economy through subsidies, tax credits and other ways, which will form a comparative advantage over low-carbon products in the global region, and the proposal on carbon tariffs in the United States has taken shape. In July 2021, the EU issued the “Climate change Package” around the “European Green Agreement”, which proposed to establish a Carbon Border Adjustment Mechanism (CBAM). The plan aims to reduce carbon emissions by imposing additional charges on green products exported from countries and regions that are lagging behind in low-carbon development. In May 2023, the EU CBAM passed legislation, which refers to the use of greenhouse gas emissions as a unit of pricing in international trade, combined with carbon price spreads, by importing countries to levy carbon emission tariffs on the country of origin. According

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to the "Brussels Effect", the EU and other important countries that first formulate green trade rules in the international market are enough to convert their national standards into global standards with their own market power, and then export their own low-carbon product import and export standards through the trade import and export process, changing the global market trade rules. In this context, it is of practical significance to predict the tax rate of carbon tariff.

2. Literature Review

2.1. Research on Carbon Tariff and Its Impact

Some scholars discussed different scenarios of Carbon Tariffs from the perspective of Western countries [1]. Arguing that this policy will weaken the competitiveness of national industries that are more dependent on high-carbon industries and exacerbate trade disputes [2]. This negative impact on competitiveness is seen in countries at different levels of development. More often, the imposition of carbon tariffs is a strategy to ease the competitive pressure faced by the industries of the taxing countries and protect the position of their own energy industries in international trade [3]; Carbon tariffs help to improve the relative competitive disadvantage of energy-intensive industries caused by carbon prices and protect domestic energy-intensive products [4]. will help secure global climate leadership [5]. Given the decline in import demand in the countries where carbon tariffs are imposed, carbon tariffs may become a coercive strategic trade policy, disrupting the balance of trade competitiveness and triggering trade conflicts.

2.2. Research on CBAM and Its Influence

Luo Bixiong (2023) used the global multi-regional recursive dynamic computable general equilibrium model to study the impact of carbon border adjustment mechanism on GDP, exports and industries of major economies in the world and the development trend of international industries under this scenario. The conclusion shows that because Russia exports more steel products to the EU, its total exports will decline significantly; EU GDP would rise; In the specific industries of the EU, the exports to the industries related to the carbon border adjustment mechanism all increased; Russia, Turkey and China and other economies of steel, non-metal, non-ferrous metals and chemical industry output exports have been affected to varying degrees, China's non-ferrous metal industry's international market share will tend to rise with its competitive advantages. The output of global key industries shows a trend of transferring from developing economies with a large proportion of high-carbon products exports to developed economies or developing economies with strong international competitiveness [6]. Dong Kangyin et al. (2023) established a CGE model including 12 sub-regions of the world based on the theory of general equilibrium model. The model has five modules, namely, production, income, expenditure, investment and international trade. It is found that the carbon tariff policy mainly driven by Europe and the United States has resulted in the loss of China's GDP and residents' welfare to a certain extent, and has a large negative effect on the export of commodities with high carbon density, but has little impact on China's overall emission reduction. The carbon tariff policies in Europe and the United States have no obvious effect on their own carbon emission reduction, which belongs to the behavior of "harming others and not benefiting themselves". To some extent, China's export tax rebate policy can mitigate the negative impact of carbon tariff policies implemented by Europe and the United States on China's economy [7]. According to Tu Xinquan et al. (2023), developed countries and developing countries are on opposite sides in the issue of carbon tariff regulation mechanism, the essence of which is the dispute over the right to development in green trade. In recent years, developed countries have continuously competed for the international right to speak on climate governance standards, and by virtue of their advantages in green technology and climate standards, they have accelerated the establishment of a "climate club" and constructed green trade barriers, with the aim of curbing the trade and economic development of countries with low levels of green economic development and reshaping the global green economic and trade pattern. In terms of products only initially covered by carbon tariffs, China is the top target, followed by India and Russia. When the carbon tariff mechanism covers all products under the EUETS, the amount of carbon tariffs paid by China is much lower than that of Russia. On the other hand,

CBAM causes changes in terms of trade and relative trade competitiveness among countries, reshaping the pattern of trade advantages. Sectors with higher carbon intensity and greater trade exposure (such as mining, metals, etc.) and countries (Russia, China, India) will be greatly affected [8].

3. Analysis of the Status Quo of Green Trade Barriers

3.1. EU Carbon Border Regulation Mechanism

The EU has always been a global "leader" in the fight against climate change. In December 2019, the European Commission proposed the Green Deal ("Green New Deal") to combat climate change and promote sustainable development. In July 2021, the EU proposed "Fit for 55" (emission reduction "package"), aiming to achieve the climate action goal of reducing greenhouse gas emissions by 55% compared with 1990 by the end of 2030, covering a total of 12 emission reduction measures in energy, industry, transport, buildings and other fields, including to avoid the risk of "carbon leakage". We plan to implement the Carbon Border Adjustment Mechanism (CBAM). CBAM, the first global carbon tariff scheme, is a charge on the carbon emissions of goods imported into the EU. The EU believes that if its own climate targets are too high, it may lead to the transfer of high-carbon emission industries to countries and regions with relatively loose climate policies, affecting the competitiveness of local carbon-intensive commodities. In this context, the implementation of CBAM will not only help to better protect enterprises in the EU in the context of trade globalization, but also encourage other countries to increase emission reduction efforts.

CBAM has mainly made adjustments to the following provisions in the new draft. One is to delay the formal implementation by one year. From 2023 to 2026, enterprises are not required to pay CBAM fees, but they are required to submit a report to the CBAM management authority every quarter, which mainly includes: the total amount of imported products in the quarter by category (indicating the manufacturer), the direct and indirect emissions of each type of product, and the carbon emissions cost paid by the product emissions in the country of origin. Starting from 2027, CBAM fees will be paid based on the carbon emissions of imported products. The second is to expand the scope of application of CBAM. On the basis of the five major industries of cement, electricity, fertilizer, steel and aluminum, organic chemicals, hydrogen, ammonia and plastic products are included. The third is to accelerate the exit process of free allowances from the EU Emissions Trading System (EU ETS). The original plan was to reduce the free quota by 10% per year from 2026, and to withdraw completely by 2035. It is proposed that from 2027 to 2032, the proportion of ETS carbon tariff free allowances will be reduced to 93%, 84%, 69%, 50%, 25% and 0, respectively, that is, the withdrawal of free allowances will be completed three years in advance. Fourth, expand the scope of carbon emission calculation for carbon tariffs. In the March 2022 draft, the category of carbon tariffs only includes "direct emissions," that is, carbon emissions directly generated by the production of products. In order to better reflect the carbon cost of the European industrial sector and be compatible with the relevant WTO principles, the new draft proposes to include "indirect emissions", that is, the carbon emissions generated by the electricity consumed in the production of products, into the total emissions accounting, which means that the carbon emissions generated by the purchase of electricity from the manufacturing industry will also be subject to carbon tariffs. The fifth is to set up a unified executive body at the EU level. The aim is to ensure the effectiveness of the subsequent implementation of the CBAM mechanism and to use the carbon tax to support the decarbonization of manufacturing in LDCS. The sixth is to clarify the relevant punishment mechanism and fine amount. In case of failure to submit CBAM-related certificates or false information to the CBAM authority before May 31 of each year, a penalty of three times the average price of the CBAM certificate in the preceding year shall be imposed along with the replacement of the outstanding number of CBAM certificates.

3.2. The American Clean Act

Since the end of the 21st century, the United States has actively tried to put forward a series of proposals on carbon border regulation, cap-and-trade, and carbon tax systems at the federal level. However, due to the lack of a greenhouse gas emissions trading system similar to the EU ETS, and the lack of uniform carbon pricing at the

federal level, the United States has never formally introduced a national carbon tax document. With the proposal and continuous promotion of the EU CBAM, the relevant legislation of carbon pricing and carbon border adjustment was more active during the 116th and 117th U.S. Congress. In June 2022, U.S. Democratic Senator Whitehouse, together with three other Democratic senators, formally submitted a bill called the Clean Competition Act (CCA) to the Senate Finance Committee.

The CCA does not follow the European Union in imposing a carbon price tax, but instead imposes a carbon fee on products that contain more carbon than the industry average. In other words, the EU's carbon tax standard is to see whether the country's carbon price is "expensive", and the United States' tax standard is to measure the "green" of imported products. This design cleverly avoids the current situation of the United States without a unified carbon market and a unified carbon price, and successfully realizes the shift from punishing low carbon prices to punishing high carbon content. CCA's practice is to take the average carbon content of US products as the base line, for imported products and US products with carbon content higher than the base line, it charges a carbon fee of US $55 per ton, and it increases by 5% per year considering inflation. Of this, 75% of carbon tax revenue is used to fund competitive grant programs for carbon-intensive industries, and 25% is used to help developing countries decarbonize and achieve net zero emissions. Although CCA and CBAM are both punitive tariffs, the former reflects its idea of transforming into a mature carbon tax system, such as the carbon content baseline set will be calculated based on the emissions, electricity consumption and production reported by US enterprises to the Treasury Department, and has transitional characteristics: From 2025 to 2028, the baseline carbon content will be lowered by 2.5% per year, and from 2029 by 5% per year and eventually to zero. However, on 14 October 2024, the United States comprehensively raised the tariffs on Chinese trams exported to it, and the tariff increase was finally fixed at 100%, which seems that the United States has to implement this move.

4. Data and Model Processing

4.1. Data Processing

This article analyzes the 11A database using GTAP, which is the latest version of the GTAP database with data updated to 2017. The database covers a total of 160 countries and 65 production sectors. Before using the database, countries, regions and production sectors need to be classified according to the research content. The country setting (Table 1) takes into account information from the EU's major trading partners, the EU carbon border Adjustment Mechanism, the European Emissions Trading System, the development direction of China's export industry and relevant economic cooperation organizations. The production sector setting (Table 2) is combined with China's "Classification of National Economic Industries" (GB/T 4754-2017), the EU carbon border adjustment mechanism Act document "Regulation of the European Parliament and the Council on the establishment of carbon border adjustment mechanism (EU) 2023/956" and the European emissions Trading System document "Commission Regulation (EU) 2024/873" included in the carbon tariff-related industries as well as the quality improvement and carbon reduction path of China's export products The CONTENT.

Table 1. GTAP 11A database country Settings.

National and Regional Establishment	The Initial Country in the Database
chn	China
EU_27	Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden
usa	United States of America

Table 1. Cont.

National and Regional Establishment	The Initial Country in the Database
uk	United Kingdom
can	Canada
RCEP_otr	Australia, New Zealand, Japan, Korea, Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, Viet Nam
e&s_a	Rest of East Asia, Rest of South Asia
br_otr	India, Brazil, Russian Federation, South Africa
eu_ets'otr	Switzerland, Norway, Rest of EFTA
xtw	Other countries and regions listed in the database in addition to the above countries and regions

Source: Compiled by GTAP 11A database.

Table 2. GTAP 11A database production department Settings.

Production Department Setting	Original Production Department Category in the Database
agr	paddy rice, wheat, cereal graints nec, vegetables/fruit/nuts, oil seeds, sugar cane/sugar beat, plant-based fibers, crops nec, forestry, fishing
fop	bovine cattle/sheep/goats, animal products nec, raw milk, wool/silk-worm cocoons, bovine meat products, meat products net, vegetable oil and fats, dairy products, processed rice, sugar, food products nec, beverages and tobacco products
clo	textiles, wearing apparel, leather products
li_ind	wood products, paper products/publishing
che	chemical products, rubber and plastic products
min	minerals nec, mineral products nec, water
coa	coal
oil	oil
gas	gas, gas manufacture/distribution
o_p	petroleum/coal products
elc	electricity
met	ferrous metals, metals nec, metal products
new_tec	electrical equipment, machinery and equipment, manufacturess nec
mech_m	motor vechicles and parts, transport equipment nec
trans_m	basic pharmaceutical products, computer/electronic/optic
cns	construction
trd	trade
trans_sup	water transport, air transport, transport nec, warehousing and support activic
com_ser	communication, financial services nec, insurance, real estate activities, business services nec, accommodation/food servic, dwellings
otr_ser	recreational and other service, public administration and defe, education, human health and social word activities

Source: Compiled by GTAP 11A database.

4.2. Carbon Tariff Rate Setting

The carbon tariff imposed in the GTAP model is AD valorem tax, and the EU carbon border regulation mechanism actually collects AD valorem tax. We need to convert the AD valorem tax into AD valorem tax according to a certain formula, and then input it into the model for discussion. The formula for calculating the AD valorem tax rate of carbon tariff is:

$$\tau' = \tau * VCIF_i * \xi_i / VPM_i * 100\%$$

τ' is the AD valorem rate of carbon tariff, and the unit is percentage; τ is the specific carbon tariff rate, the unit is USD/ton; VCIFi is the CIF price of product *i* from the exporting country to the country where the carbon tariff is imposed, in millions of US dollars; ξ_i is the implied carbon emission intensity of product *i*, expressed in tons/USD; VPMi is the market value of product *i* exported to the taxing country in millions of US dollars.

4.3. Simulation Scenario Setting

Based on a detailed simulation of carbon tariffs based on a dynamic GTAP-E model, we set up a simulation scenario covering different tax entities, applicable industries and tax rates (USD/ton) to analyze the potential impact of carbon tariff policies. Simulation scenarios are divided into three main categories: basic scenario, industry-wide levy and countermeasures, each containing multiple simulation scenarios. The tax rate is $60/ton and $120/ton respectively.

In the base scenario, the carbon tax is mainly levied by the EU and applies to certain high-carbon emitting industries. S01 includes power, cement, steel, hydrogen, aluminum, fertilizer, and S02 includes power, cement, steel, hydrogen, aluminum, fertilizer, organic chemistry, heat, oil refining, metals, lime, glass, ceramics, paper products, aviation, and Marine. In the S02 phase, the scope of the EU carbon tax has been further expanded, adding organic chemicals, thermal energy, oil refining, metals, lime, glass, ceramics, paper products, aviation, shipping and other industries.

In the S1 scenario, the EU is aligned with the EU-ETS standard, which no longer limits taxes on specific sectors, but imposes carbon taxes on all sectors. The S11 carbon tariff rate is $60/ton, and the S12 carbon tariff rate is increased to $120/ton.

In the S2 scenario, China and other non-Chinese economic organizations jointly retaliate by imposing reciprocal carbon tariffs. The EU will not be the only country to impose carbon tariffs. S21 took countermeasures only for China. The EU and other EU-ETS participating countries impose carbon tariffs on all sectors. In the S22 scenario, China and other economic organizations other than China impose carbon tariffs at the same level as the EU and EU-ETS participating countries, with the EU and EU_ETS jointly imposing two levels of carbon tariffs on all sectors.

In summary, we simulated carbon tariff policies in different scenarios, and the industry setting took into account the EU carbon border regulation mechanism and EU-ETS related act documents. Includes a carbon tariff with two tax levels ($60/ton and $120/ton). The scenarios take into account a broader global carbon tax policy, including the participation of China and international cooperation organizations in taking countermeasures. These simulations help to assess the potential impact of different carbon tariff policies on the global economy, industrial competitiveness and international trade flows.

5. Prediction and Analysis of Carbon Tariff Rate

5.1. EU Carbon Tariff Rates for China

Table 3 shows the AD valorem carbon tariff rates imposed by the EU on different industries in China under different simulation scenarios. We will discuss the potential impact of the implementation of the EU's carbon border adjustment mechanism on various industries in China in the future. Overall, the manufacturing industry is under the most pressure from carbon tariffs, especially the machinery and equipment manufacturing industry, chemical industry, metal mining and processing industry, among which the machinery and equipment manufacturing industry has a tax rate of 31.40% under S02 and S04 scenarios, and the chemical industry has a

tax rate of more than 23% under S02, S04 and S12 scenarios. The metal mining and processing industry is also taxed at around 13%. Due to their high carbon emissions, these industries face stricter carbon emission reduction requirements and greater cost pressure. For example, the tax rate of the transportation manufacturing industry and commercial commodity service industry is 8.90% in the S02 scenario, while the tax rate of the commercial commodity service industry is as high as 13.31% in the S12 scenario. With the expansion of the scope of the EU carbon tariff collection industry, the industry will be more affected. Agriculture, food manufacturing, textiles, wood manufacturing, construction, trade and other service industries may face a lower carbon tariff rate and be relatively less affected, among which the construction industry has the lowest tax rate, the carbon tariff rate ranges from 0.70% to 2.36%, and the tax rate of trade industry does not exceed 7.46% under most scenarios. Other services are even as low as 1.10%. This shows that the EU's carbon tariff policy is mainly aimed at high-carbon emission industries to promote the transformation of high-energy consumption industries to green and low-carbon, while the impact on low-carbon industries is relatively small. At the same time, the changes in tax rates under different scenarios reflect the uncertainty of policies, which may bring different degrees of impact due to the adjustment of EU policies in the future, and relevant industries should pay close attention to and take positive countermeasures.

Table 3. AD valorem carbon tariff rates of the EU against China under different scenarios%.

Sector	S01	S02	S03	S04	S11	S12	S2
agr					2.40	4.79	2.87
fop					2.30	4.60	2.13
clo					2.67	5.33	1.69
li_ind			3.48	6.95	3.48	6.95	2.83
che	11.70	23.40	11.70	23.39	11.70	23.39	5.75
min	6.88	13.80	6.88	13.77	6.88	13.77	3.75
met	6.7	13.60	6.79	13.58	6.79	13.58	3.42
new_tec	15.69	31.40	15.69	31.39	15.69	31.39	6.72
mech_m	4.43	8.90	4.43	8.86	4.43	8.86	1.91
trans_m	0.70	1.40	0.70	1.40	0.70	1.40	2.36
cns			7.60	15.20	7.60	15.20	3.84
trd			6.85	13.70	6.85	13.70	1.26
trans_sup					1.37	2.73	7.46
com_ser					6.65	13.31	4.90
otr_ser					1.15	2.31	1.10

Source: Compiled by GTAP 11A database.

5.2. EU Carbon Tariff Rates for Other RCEP Countries

From Table 4, it can be seen that from the first to the third stage, the AD valorem carbon tariff rates of the EU on different production sectors of RCEP countries have a large span, and high-carbon emission industries will generally face higher tax rates, while low-carbon industries will be relatively little affected. The transportation manufacturing industry, chemical industry, metal mining and processing industry are the main targets of the carbon tax policy. At the level of 120 US dollars/ton, the carbon tariff of the transportation manufacturing industry is as high as 25.40%, the carbon tariff of the chemical industry is 22.77%, and the carbon tariff of the metal mining and processing industry is 8.94%. Machinery and equipment manufacturing is also among the most affected industries, with a carbon tariff rate of 9.88%. These industries will be more affected due to their high carbon emission characteristics, indicating that the EU carbon tariff policy aims to exert greater carbon cost pressure on high-polluting industries and promote their transition to green and low-

carbon. In contrast, agriculture, food manufacturing, textiles, wood manufacturing, construction, trade and other services will face lower carbon tariffs and be relatively unaffected. In the S12 scenario, the tax rate of agriculture, forestry, animal husbandry and fishery is 3.41%, the highest rate of food manufacturing is 4.05%, the highest rate of textiles is 4.59%, the highest rate of construction is 4.94%, the highest rate of trade industry is 15.41%, and the carbon tariff rate of commercial commodity service industry is 15.25%, and the lowest rate is only 7.62%. Cross-industry comparison, other services will face a carbon tariff rate of up to 3.77% and a minimum of 1.10%, which is the least affected of all industries. Low-carbon industries are less directly affected by the EU's carbon tariff policy, and the overall tax rate is kept at a low level.

In the fourth stage, except for the EU, China and the Economic Cooperation Organization jointly adopted countermeasures to impose the same carbon tariff, and the carbon tariff rate of all industries was significantly reduced, the tax rate of transportation manufacturing was reduced to 6.88%, the chemical industry was reduced to 6.27%, the machinery and equipment manufacturing industry was reduced to 4.09%, and the metal mining and processing industry was reduced to 4.80%. The tax rates for agriculture, food, construction, trade and services are also further reduced in this scenario, to 2.95% for agriculture, 2.25% for food manufacturing, 2.10% for construction and 6.76% for trade. This suggests that taking countermeasures would reduce the overall negative impact of carbon tariffs on other RCEP countries. Under different scenarios, the fluctuations in tax rates by industry reflect the uncertainty of the EU's carbon tariff policy, which may have different impacts in the future due to international policy changes or adjustments to industry carbon emission standards. Therefore, high-carbon industries should actively take carbon emission reduction measures to reduce potential tax costs, while low-carbon industries should also pay attention to policy changes, and appropriate countermeasures can be taken to build international trade rules and order.

Table 4. AD valorem carbon tariff rates of the EU against RCEP under different scenarios%.

Sector	S01	S02	S03	S04	S11	S12	S2
agr					1.71	3.41	2.95
fop					2.03	4.05	2.25
clo					2.30	4.59	1.80
li_ind			3.01	6.03	3.01	6.03	2.93
che	11.38	22.77	11.38	22.77	11.38	22.77	6.27
min	2.30	4.59	2.30	4.59	2.30	4.59	3.66
met	4.47	8.94	4.47	8.94	4.47	8.94	4.80
new_tec	4.94	9.88	4.94	9.88	4.94	9.88	4.09
mech_m	12.70	25.40	12.70	25.40	12.70	25.40	6.88
trans_m	2.47	4.94	2.47	4.94	2.47	4.94	2.10
cns			1.56	3.11	1.56	3.11	2.30
trd			1.98	3.96	1.98	3.96	1.25
trans_sup					7.70	15.41	6.76
com_ser					7.62	15.25	4.90
otr_ser					1.89	3.77	1.10

Source: Compiled by GTAP 11A database.

5.3. EU Carbon Tariff Rates for Other BRICS Countries

Table 5 shows the AD valorem carbon tariff rates imposed by the EU on other BRICS countries under different scenarios. On the whole, the carbon tariff rate of the high-carbon emission industry is much higher than the carbon tariff rate of the low-carbon industry. Among them, the transportation manufacturing industry, the chemical industry, metal mining and processing industry has the highest tax rate, and will face more severe

carbon tariff pressure. The carbon tariff rate of the transportation manufacturing industry is 21.07% at the level of $60/ton, and 42.13% at the level of $120/ton, more than double, which shows the high carbon emissions of the industry and the great impact of the EU carbon border adjustment mechanism policy. The carbon tariff rate of the chemical industry is 14.84% at the level of $60/ton and 29.67% at the level of $120/ton, and the increase in carbon price will greatly increase the carbon emission cost of the industry. In addition, the metal mining and processing industry also faces a higher carbon tax burden, with carbon prices rising, it faces a carbon tariff rate increased from 13.48% to 26.97%. Although the carbon tax rate of the machinery and equipment manufacturing industry, construction industry and other mineral resources industry is lower than the above industries, but will still face not low carbon tariffs, high carbon price level, the tax rate of machinery and equipment manufacturing industry reached 16.29%, the tax rate of the construction industry is 11.60%, and the tax rate of other mineral resources industry is 9.56%. At the same time, agriculture, food manufacturing, textiles, wood manufacturing, high-tech industries, transportation and ancillary industries, trade and services face relatively low carbon tariff rates and less pressure on carbon emissions costs. At the high carbon price level, agriculture, forestry, animal husbandry and fishery accounted for 7.10%, food manufacturing 5.38%, textiles 5.18%, and high-tech industries 6.41%. The tax rate for trade and commercial goods services increases under the S12 scenario to 15.27% and 17.94% respectively, but the overall level is lower than that for high-carbon industries.

In the fourth phase, the carbon tax rates for all sectors were significantly reduced, indicating that the implementation of countermeasures by China and other economic organizations will have a significant impact on the adjustment of the EU's carbon tariff policy. The tax rate of the transportation manufacturing industry was reduced to 7.15%, the chemical industry to 6.41%, the machinery and equipment manufacturing industry to 4.30%, the metal mining and processing industry to 4.31%, the other mineral resources industry to 4.04%, and the construction industry fell more sharply and dropped to 2.13%. In addition, the tax rates for agriculture, food manufacturing, textiles and wood manufacturing have been reduced to 2.96 percent, 2.34 percent, 1.89 percent and 2.96 percent respectively. It is worth noting that although the level of carbon tariffs in trade and commercial goods services has also decreased, the level is relatively high, 9.44% and 5.21%, respectively, meaning that even in a looser policy environment, these industries still need to bear a higher carbon tax cost. To sum up, the overall tax rate in the S2 scenario is reduced, and considering that more countries take countermeasures, the EU will adjust its carbon tariff policy.

6. Policy Recommendations

In order to further reduce the trade pressure on those countries that are most affected by green trade barriers, this paper proposes the following policy recommendations:

First, countries need to break out of the climate trade discourse system dominated by western regimes such as the EU, build their own green trade response strategies and logical structures, and negotiate with other countries and economic organizations in an orderly manner while negotiating with the EU, so as to explore contractual methods to deal with unfair green competition. While conducting international trade, multilateral dialogue and cooperation mechanisms should be used to formulate reasonable countermeasures. Countries that affect free trade due to unilateral discriminatory policies should work together to improve export conditions and face risks together.

Second, developing countries should take this opportunity to update, better and more accurately design the export pattern and micro-ecology of their industries, continue to give full play to their export advantages in textiles and light processing, help the export products of the construction industry expand overseas business, encourage machinery and equipment, ships, automobiles and other large equipment or whole parts to expand into the field of energy conservation and environmental protection, and give full play to the advantages of the service industry. Extend the industrial chain value chain and construct a multi-level supply chain system; Seize the good opportunity of international cooperation and the Belt and Road Initiative to leverage our comparative advantages; Optimize the green export industry system, solid soil, to cope with the new pattern of international trade in the future.

Third, we need to continuously improve the carbon accounting and carbon trading system, so that products

Table 5. AD valorem carbon tariff rates imposed by the EU on other BRICS countries under different scenarios%.

Sector	S01	S02	S03	S04	S11	S12	S2
agr					3.55	7.10	2.96
fop					2.69	5.38	2.34
clo					2.59	5.18	1.89
li_ind			3.75	7.49	3.75	7.49	2.96
che	14.84	29.67	14.84	29.67	14.84	29.67	6.41
min	4.78	9.56	4.78	9.56	4.78	9.56	4.04
met	13.48	26.97	13.48	26.97	13.48	26.97	4.31
new_tec	8.15	16.29	8.15	16.29	8.15	16.29	4.30
mech_m	21.07	42.13	21.07	42.13	21.07	42.13	7.15
trans_m	5.80	11.60	5.80	11.60	5.80	11.60	2.13
cns			3.21	6.41	3.21	6.41	2.42
trd			1.94	3.88	1.94	3.88	1.34
trans_sup					7.64	15.27	9.44
com_ser					8.97	17.94	5.21
otr_ser					1.80	3.60	1.14

Source: Compiled by GTAP 11A database.

can better integrate into the green trade chain. Improve the hidden carbon emission accounting system for the whole life cycle of products from enterprise production, product molding, transportation and other links, so that carbon accounting is accurate and scientific, so that carbon footprint covers the industrial chain system completely. Promote the construction of carbon emission trading systems and carbon markets to safeguard the real economy involved in export trade and the goal of carbon neutrality in trade.

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