

Research Article

Research Progress of the International Carbon Tariff: A Review

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Abstract.

Under the constraints of the target peak carbon dioxide emissions and carbon neutrality, how the international carbon tariff can be levied have become an important question for scholars and research institutions all over the world. This paper aimed to comprehensively sort the relevant literature on the Carbon Border Adjustment Mechanism from an economic perspective. Based on defining the concept connotation and extension of carbon tariff, we summarized and determined the price mechanism, institutional mechanism, and coordination mechanism of the carbon tariff, and analyzed the impact of carbon tariff on the economic environment and other fields. Further, this paper makes an international comparison of the existing reasonably operable carbon tariff, points out the focus and direction of the next research, and strives to provide valuable experience and theoretical reference for the innovative practice of building the international Carbon Border Adjustment Mechanism.

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1. Introduction

Since the 20th century, excessive emissions of greenhouse gases such as CO₂ have led to climate warming, which has become an obvious feature of global climate change. In response to the challenge of natural disasters caused by climate change, “Transforming our World: The 2030 Agenda for Sustainable Development” by the United Nations calls on countries around the world to take positive action to respond. In this context, the concept of “carbon neutrality” emerged and rapidly received widespread support from countries around the world. More than 120 countries or organizations have announced or planned to set “carbon neutrality” targets. As an important means to achieve the goal of “carbon neutrality”, the European Commission adopted the “European Green Deal” and formally proposed the Carbon Border Adjustment Mechanism (CBAM), which aims to protect the international competitiveness of European enterprises and solve the carbon leakage problem. With the establishment of the goal of “carbon neutrality”, trade

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and carbon emission issues have become hot research points of the interdisciplinary field of environmental economy and international trade, and scholars have gradually deepened their research on carbon emission issues.

CNKI was used as the data source to retrieve articles with the theme of "Carbon Border Adjustment Mechanism". According to the number of articles published over the years, it was found that few scholars explicitly issued articles with the theme of "Carbon Border Adjustment Mechanism" before 2013. In 2021, after the European Commission formally adopted the CBAM, the number of documents that can be retrieved on the CNKI reached a peak of 28. At the same time, Carbon Border Adjustment Mechanism was searched as topic in the Web of Science with a total of 74 articles, of which the number of articles reached a small peak in 2021.

2. Connotation and Extension of Carbon Tariff

2.1. Connotation and Definition of Carbon Tariff

"Carbon tariff" is equivalent to "Carbon border tariff", as policies and measures to promote carbon emission reduction, there are mainly price adjustment tools represented by carbon tax and carbon tariff and quantity control tools represented by cap and trade that are widely accepted by the international community. Countries or regions implementing carbon tax or energy tax require imported products to bear the same tax burden as domestic products, or refund the domestic tax already collected when exporting domestic products.

According to the European Green Deal issued by the European Commission, Carbon Border Adjustment Mechanism refers to the carbon pricing measures taken to prevent their own climate actions caused by carbon leakage, among which "carbon border tariff" is an important means. At present, countries and international organizations have not reached a unified standard on the definition and form of carbon tariff. A clearer definition is that carbon tariff is a tariff means that complements the carbon market, carbon tax and other internal carbon pricing mechanisms, and aims to internalize the negative externalities caused by carbon emissions contained in imported goods, and is reflected in commodity prices (Zhou Jieyu, 2021).

2.2. The Historical Origin and Extension Change of Carbon Tariff

As early as the early 1990s, some European countries such as Finland, Denmark, Sweden, Norway, the Netherlands were the first to introduce carbon taxes (Barde,2004.) In 2002, the UK was the first country to implement both carbon tax and carbon emission trading scheme (UK ETS) policies (Dresner S et al., 2006).Later, developed economies such as Japan and the European Union also combined the carbon tax and carbon emission trading scheme with the border adjustment tax, and used the carbon pricing system to smooth the production cost of imported products and domestic products.The current more common coexistence mechanism is formed.In 2009, it was first proposed that governments could balance the adverse effects of a country's trade from carbon emission prices through "border tax adjustments on carbon and energy taxes" in the report "Trade and Climate Change" jointly published by the WTO and the UNEP.In March 2021, the European Parliament adopted a resolution to "establish an EU Carbon Border tariff compatible with the WTO", which aroused a strong response from the international community.To this end, it is necessary to study deeply and pay continuous attention to its progress.

The price and green premium of carbon quotas are related to the carbon tariff or as an alternative tool to affect the carbon market transaction price. Different countries set free or low-cost quotas for carbon emission rights according to the level of economic development and the process of industrialization. Some countries may adopt government subsidies to affect the effect of carbon tariff. (CICC Global Institute,2021).At the same time, the collection of carbon tariff is closely related to carbon market, carbon price and carbon cost.The extension scope of efficiency and fairness to be considered is also constantly increasing.

3. Mechanism Design of Carbon Border Tariff

3.1. Price Mechanism

The Carbon Border tariff is a policy measure proposed by developed countries to avoid or reduce carbon leakage caused by international trade and protect the competitiveness of their own products. In essence, it is a new green trade barrier. Its transmission mechanism is different from the "quantity control-price control-quantity control" cycle transmission mechanism of general technical barriers to trade, but a combination of the price transmission mechanism of tariffs and the cycle transmission mechanism of

technical barriers to trade (Zhiyou Chen, 2004). When an importing country imposes a carbon tariff on a high-carbon product of an exporting country, it will lead to an increase in the price of the commodity purchased by consumers in the importing country, and a decrease in the profit earned by the producer from selling the commodity, which in turn reduces the competitiveness of the exporting country's high-carbon products. And at the same time may cause exporting countries to impose environmental controls on the production of high-carbon products, forcing high-carbon industries to invest a lot of technology and capital. The shrinking of the carbon industry is very unfavorable for the development of a large number of traditionally advantageous high-carbon industries in developing countries.

3.2. Institutional Mechanism

Regarding the controversy of Carbon Border tariff, the most researches mainly focus on its legality. Controversy over the legality of Carbon Border tariff under the WTO framework. The Carbon Border tariff can be regarded as green trade barrier in essence. Therefore, the key to judging its legitimacy lies in its relationship with the WTO. In this regard, there are mainly two different views at present. One is that scholars from developed countries believe that Carbon Border tariff can be designed to be consistent with WTO rules. Keith Kendall (2012) and Jasper L Ozborn (2009) both argue that Carbon Border tariff can be designed to be consistent with the substantive rules of the WTO. If the design of Carbon Border tariff does violate the substantive requirements of the WTO, it can be justified by the exceptions provided for in GATT Article 20. Secondly, scholars from developed countries believe that Carbon Border tariff does not accord with the principle of Most-Favored-Nation treatment and national treatment in WTO. Rationalizing Carbon Border tariff in the name of "border tax adjustment measures", "anti-dumping duties" or "countervailing duties" is not in line with the current WTO rules, and Carbon Border tariff is a new type of trade barrier (Yinhua He, 2015; Hongyan Chen, 2015).

Controversy over the legality of Carbon Border tariff under the framework of the Climate Convention. Regarding Carbon Border tariff and the principle of common but differentiated responsibilities, domestic and foreign literatures basically agree that the design of Carbon Border tariff is inconsistent with the principle of common but differentiated responsibilities. The Paris Agreement is clearly based on equity and embodies the principle of common but differentiated responsibilities and respective capabilities, and advocates that developed countries provide technical assistance to

developing countries while achieving absolute emission reduction targets, and developing countries will gradually increase their national determined contributions to emission reduction according to their national condition (Bing Liu et al., 2013).

3.3. Coordination Mechanism

At present, various countries hold different positions on whether to impose Carbon Border tariff. The developing countries emphasize the "common but differentiated" responsibilities, while the attitude of the developed countries is that the developed countries have already undertaken the obligation of emissions reduction and produce products with lower carbon emissions than developing countries, so developing countries should also undertake emission reduction obligations (Bin Chen. 2011). If the two sides cannot reach an agreement on this issue and adopt a unilateral carbon tax, this will not only affect international competition, but also cannot effectively suppress the generation of externalities. If a carbon tax is implemented at a uniform rate around the world, in other words, if a multilateral carbon tax policy is adopted, the impact on the unit cost of a given industry will be uniformly distributed around the world, and the impact on international competition will be relatively small, can achieve cost-effective reduction of carbon dioxide emissions, but it will bring a heavy economic burden to developing countries, and such a policy will be opposed by developing countries because it violates the "common but differentiated principle". K Matsumoto and T Fukuda (2006) proposed different global carbon tax rates and taxation of upstream industries to achieve better economic fairness and policy effectiveness, but this would lead to the problem of distribution of benefits, and could not avoid the free-riding problem of some small countries.

Yong Liang (2010), Sarah Davidson Ladly et al. (2012), Ma Yanyan et al. (2020) believe that although it is difficult for countries to reach an agreement on whether to impose Carbon Border tariff, developed countries have more developed economy and trade, more reasonable industrial structure, and more advanced low-carbon technology. Therefore, it plays a greater role in international affairs. Meanwhile, developing countries have a stronger dependence on developed countries in terms of economy, science and technology. Negotiations will be in a passive position. Therefore, developing countries must seek a balance between efficiency and strategy at both the international and domestic levels, coordinate the two sides of interests, and maximize the protection of their own interests.

3.4. International Comparison

There are differences in the effects and roles of the Carbon Border tariff and the carbon price mechanism. Compared with the marginal carbon tax, the Carbon Border tariff has a more obvious effect on cap-and-trade. Some scholars have found that the carbon tax will reduce carbon emissions, but there is no obvious downward trend (Erik Haites, 2018). Compared with the cap-and-trade, the transaction cost of the Carbon Border tariff is relatively small. The collection of Carbon Border tariff can make use of the existing tariff system. The cap-and-trade transaction costs are relatively high, involving exchange intermediaries, investors trading products, spot, futures, etc., and a new MRV system needs to be built. From the perspective of carbon price income distribution, carbon tax can promote fairness, while cap-and-trade is more focused on improving efficiency. The EU countries use part of carbon tax revenue for pension projects as an example (OECD, 2019). In fact, some countries in the world have already begun to impose Carbon Border tariff explicitly and implicitly. The collection strategies are shown in Table 1.

TABLE 1: Comparison of adjustment mechanisms related to international carbon tariff

class	content
Tax rate level	Carbon tax rates vary widely among countries internationally, ranging from \$0.08 / ton CO _{2e} equivalent in Poland to \$137.24 / ton CO _{2e} equivalent in Sweden
tax base	Direct tax on carbon emissions or carbon content is adopted by a few countries such as Poland and Czech Republic; and adopted by Finland, Denmark, UK, Japan and other countries based on total fuel consumption or its carbon content
Tax link	Tax on fossil fuel production, such as Japan and Canada, on fossil fuel consumption, such as Poland and Britain, and on the production and consumption of fossil fuels, such as the Netherlands
tax preferences	Reason: (1) carbon tax may be double taxation with other taxes; (2) because of the international competitiveness of energy-intensive enterprises and export-trade industries; case: European countries set carbon tax exemption clauses, and Canadian provinces have partial exemptions for energy-intensive industries such as aviation and transportation
Income use	Most countries include carbon tax revenue in general budget and keep carbon tax neutral; Case: Finland implements tax rebates for energy-intensive industries; Britain realizes tax refund by reducing the national insurance money paid by enterprises for employees, increasing investment subsidies for energy conservation and environmental protection technologies and establishing a carbon fund.

Source: According to Lu Shuling, Bai Yanfeng's "international practice of carbon tax and its enlightenment for China to achieve the goal of" carbon peak "by 2030 (2021)".

According to the World Bank's annual report "Price Development Status and Future Trends in 2022", the global carbon pricing revenue in 2021 will be about 84 billion US dollars, an increase of nearly 60% compared with 2020. And, there are currently 68 direct carbon pricing mechanisms in operation: 36 carbon taxes and 32 Emissions

Trading (ETS) systems. By sorting out the tax laws and regulations of various countries, the relevant tax elements of some representative countries that levy carbon tax are selected for research, as shown in Table 2 below.

TABLE 2: Related tax situation of some countries

Country and commencement date	Levy object	Carbon tax per ton of carbon dioxide
Finland (1990)	liquefied natural gas, coal products, etc	forty-eight dollars
Sweden (1991)	Coal, oil, natural gas, etc	one hundred and thirty-two dollars
Denmark (1992)	Gasoline, oil, fuel oil, etc	thirty-one dollars
Canada (2008)	Coal, natural gas, aviation fuel, etc	30 Canadian dollars
Japan (2012)	Crude oil products, coal products, etc	two dollars
UK (2013)	Fossil energy (exclusively for power generation)	fifteen point seven five dollars
France (2014)	Fossil fuel products	twenty-two euros
South Africa (2019)	Emissions and combustion of non-clean energy sources	6 Saudi Arabia

4. The Impact of the Carbon Tariff on the National Economy

Carbon tariff on the impact of economic welfare has been an important content of CBAM research. Many scholars have discussed the positive and negative effects of carbon tariff on environmental economy, international trade and industrial development from different angles by combining qualitative and quantitative research.

4.1. Study on the Environmental Effects of Carbon Tariff

It has become a global consensus to take corresponding measures to deal with the drastic climate change. Some scholars believe that the Carbon Border tariff has increased the international trade cost of carbon assets from the perspective of carbon tariff, effectively reduced the risk of carbon leakage, and promoted the global green development. In his research report “Can Carbon Based Import Tariffs Effectively Reduce Carbon Emission”, Hubler (2009) analyzed different pressures on developing countries and developed industrial countries in the face of emissions reduction, believing that developing countries accepting the mechanism will produce positive environmental effects and increase their welfare levels. Manders and Veenendaal (2009) believe that implementing carbon tariffs under the EU emissions system can effectively reduce the

occurrence of carbon leakage and benefit EU countries. Dong and Whalley (2010) and Bohringer et al. (2012) quantitatively assessed the impact of carbon tariff by using CGE model. Data show that introducing carbon tariffs reduces carbon leakage by 2-12%, agreeing that carbon-motivated regional agreements can reduce global emissions with poor results. Branger and Quirion (2014) examined the impact of Carbon Border tariff on carbon leakage and international competitiveness through Meta analysis. The results showed that the carbon leakage is about 5-25% (14%), while the average carbon leakage is reduced by 8 percentage points; it believes that extending the mechanism to all industries and adding export rebate policy is more effective.

The United Nations Conference on Trade and Development (2021) quantitatively calculates the effect of Carbon Border tariff on global emission reduction. The results show that the global carbon emissions will be reduced by 13% if the carbon tariff is introduced at the rate of \$44 per ton CO₂e; If the carbon price is raised to \$88 per ton CO₂e, the global carbon emissions will be reduced by 21%, and the global carbon emission reduction can be increased by 0.8% to 1.3%. Overall, CBAM reduced the carbon leakage to some extent, but with little effect. Lan Qingxin (2022) believes that carbon tariffs under the guise of environmental protection are actually an unfair trade protection behavior by developed countries. Zeng An and Tan Xianchun (2022) stressed that CBAM violated the common but differentiated responsibility principle, fairness principle and respective capabilities of international climate governance, and intensified the "green barriers".

4.2. Study on the Economic Effects of Carbon Tariff

The research on the economic effects of carbon tariff collection mainly focuses on international trade and industrial development. Bohringer et al. (2012) Summarize the efficiency and distribution impact of carbon border regulation in the EMF 29, concluded that the economic effects of carbon tariff depend on trade patterns, carbon intensity in the production process of countries and the carbon policies of EU trading partners. Carbon tariff shifts the economic burden of emission reduction to non-emission reduction countries through implicit changes in international prices. If the carbon tariff applies to all goods covered by the EU carbon emissions trading system, developing countries' exports to the EU may face an additional cost of up to US \$16 billion (Lowe, 2021). In particular, when countries with carbon taxes and adopting greener production procedures are not restricted by EU Carbon Border tariffs, implementing carbon tariffs will affect the development of poorer countries and reduce the development opportunities for their

export-leading economies. The carbon tariff imposed by Europe and the United States has an objective trade protection effect, and its impact on the economic effect is mainly reflected in the impaired competitiveness of enterprises and reduced trade volume (Jiang Tingting and Xu Haiyan, 2021).

Meanwhile, many scholars (Yang Liqiang and Ma Man, 2011; Lin Boqiang and Li Aijun, 2010; Li Yuan and Zhu Lei, 2016; Zhuang Guiyang and Zhu Xianli, 2021; Cao Hui, 2021; Jiang Hua and Wang Siyi, 2022) studied the impact of carbon tariff in developed countries from the perspective of rationality and legitimacy of carbon tariff, focusing on two aspects: First, the carbon tariff directly affects the export level of cement, power, fertilizer, steel and aluminum industries. Second, the carbon tariff has an incalculable indirect impact on China's economic and social development, international trade and technology improvement. According to UN Comtrade data, from 2015 to 2019, China's steel exports to the EU (excluding the UK) accounted for about 30%, 15% of aluminum exports were exported to the EU, and fertilizer and cement exports to the EU were only 2.3% and 3.5%. The implementation of the Carbon Border tariff will directly reduce Chinese exports of steel, aluminum, fertilizer and cement products. Wang Li and Zhang Jinxian (2022) proposed that the impact of carbon tariff on the cement industry is mainly the reduction of export volume, the increase of export costs, and the intensification of employment pressure in Chinese cement industry. Chen Guangwei (2021) analyzed that the carbon tariff drives the national carbon trading price to rise rapidly, intensifying the petrochemical product competition; the export cost of refined oil products increases significantly, and the plastic industry faces more challenges. Pan Mengna (2021) compared the current price difference between steel products and the implementation of carbon tariff and found that after the official implementation of CBAM in 2026, the price of Chinese steel exports to the EU will be slightly pushed up by about 10%. However, as China's steel exports to the EU only account for 3% of the total EU imports, the direct impact of the carbon tariff is limited. Yang Hongying (2021) believes that the carbon tariff will lose China's competitive advantage in electrical appliance manufacturing and directly change the competitive pattern of the international electrical appliance industry. Longfeng and Dong Zhanfeng (2022) proposed that China has to adjust its long-term production structure in advance and develop energy conservation and carbon reduction technologies, and find new short-term buyers of carbon-intensive products such as fertilizer, steel and aluminum in emerging developing countries, so as to hedge the risk of climate change exported to the European Union or other developed countries.

5. Review and Prospect

At present, experts and scholars on the study of international carbon tariff has made preliminary results, mainly focus on the rationality and legitimacy research, feasibility analysis, environmental economic and political influence and the coping strategy of the world, etc. The research method is mainly qualitative analysis, and only a small number of documents have carried out quantitative calculation. With the restriction of the goal of "peak carbon dioxide emissions and carbon neutralization", it is more urgent to reduce carbon emissions and solve the problem of global externality. Carbon tariff is essentially a tariff, a fixed carbon price that affects the trade price of import and export commodities. Related research topics including Carbon Border tariff and interest communication mechanism, carbon tariff country heterogeneity and industry differences, carbon quotas and government subsidies, carbon tariff digital, carbon market and carbon pricing mechanism, carbon cost and carbon border income, carbon tariff and world industry transfer, especially the continuity relationship between countries need to be further research.

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