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The Impact of the Establishment of the Carbon Trading Market in China

G.N. Huang and W.Y. Leong*

INTI International University, 71800 Nilai, Malaysia

Carbon emission trading has become the main method for global governance of greenhouse gas emissions, covering about 23% of global emissions. As climate issues become increasingly serious, countries or regions seek a balance between profits and environmental protection and formulate strict emission policies. Carbon emission trading not only affects the environment, but also has a significant impact on global trade, promoting green innovation and low-carbon transformation of Chinese companies. This paper compares four models and uses the model in Wang and Ren's article for regression analysis. The results show that the establishment of a carbon trading market has significantly suppressed China's exports of high-polluting products but promoted the export of green products and driven the green transformation of enterprises. It is also proposed that China should gradually improve the carbon trading market, establish a legal system and trading system, promote the green transformation of products, accelerate the green and low-carbon transformation of enterprises, deepen the influence of the international carbon market, and promote the development of global low-carbon undertakings.

Keywords: carbon trading; carbon market; regression model; climate action

I. INTRODUCTION

Faced with increasing greenhouse gas emissions, countries have adopted a variety of environmental policy tools to curb the trend of environmental quality deterioration and curb global climate warming. Among them, policy tools mainly include command-control mode, carbon tax and carbon emission rights trading. Global cooperation in emission reduction can effectively promote the process of global climate governance. Some people have proposed that the use of carbon emission rights trading is the most cost-effective emission reduction model (Schmalensee & Stavins, 2017).

Carbon emissions trading has covered about 18% of global carbon dioxide and other greenhouse gas emissions and is currently the main method for global control of carbon dioxide and other greenhouse gas emissions. Figure 1 shows the proportion of global greenhouse gas emissions covered by the carbon market from 2005 to 2024, after the implementation of the carbon trading market. It can be seen that the proportion of covered emissions to global greenhouse gases has increased significantly. Countries around the world are paying close attention to environmental issues, and the establishment of the carbon trading market is gradually increasing its global impact. As of the end of 2021, a total of 34 countries or regions in the world have implemented carbon emission rights trading for emission reduction, 26 countries or regions have used carbon taxes for emission reduction, and a total of 17 countries or regions have used both carbon emission rights trading and carbon taxes to more strictly control carbon emissions (Bushnell & Chong, 2013). Moreover, the proportion of global greenhouse gas emissions covered by China's carbon market and Chinese Pilots is shown in the Figure 1, which is the largest proportion. It can be seen that the number of transactions in China's carbon market is huge.

*Corresponding author's e-mail: waiyie@gmail.com

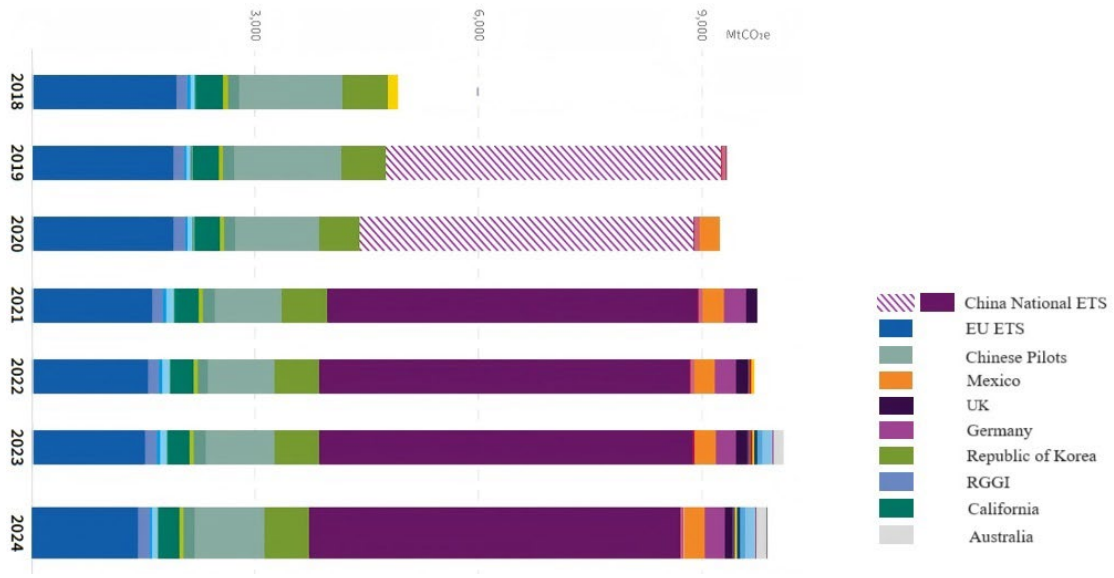

Figure 1. Global carbon market trading volume.
(Source: ICAP, Emissions Trading Worldwide Status Report 2024)

When no one paid attention to global climate governance, most of the development plans formulated by all countries or regions and even enterprises were based on development priority and profit maximisation and rarely took environmental issues into consideration. However, when climate issues become more serious, countries or regions will change the principle of profit priority due to climate issues and instead look for a balance between profit and environmental protection. This can not only ensure the continued development of the country or region but also achieve the goal of climate governance. When a country or region formulates a standard and strict emission policy, the operating policy of the enterprise will also change accordingly, and the production technology, operating methods and other aspects will be continuously improved to meet the corresponding requirements. The carbon emissions trading is an effective policy tool for improving the environment. While reducing carbon emissions, it also has an impact on global trade. As a major developing country and one of the five permanent members of the UN Security Council, China has an unsinkable responsibility and obligation to improve the global climate. Carbon emissions trading will naturally bring about huge changes to China's foreign trade. The most intuitive change is that the implementation of carbon emissions trading will promote green innovation and low-carbon transformation of domestic enterprises (Tian and Xiao, 2023). This also introduced supporting measures for the EU ETS reform, namely the EU Carbon Border Adjustment Mechanism (CBAM). This policy reduces the carbon cost of domestic and imported products in the EU and enhances the product competitiveness of EU companies under the social concept of emphasising green and low carbon. Subsequently, other countries such as the United States have also successively implemented ETS and carbon emission control measures that combine ETS with carbon tariffs. This will undoubtedly further deepen the concept of green and low-carbon, improve the competitiveness of green and low-carbon products, and will also have a significant impact on my country's foreign trade. At the same time, due to the short development time of China's carbon trading market, the trading market is not yet mature, and the carbon price is also lower than other carbon trading markets such as Europe and the United States, as shown in Figure 2. And the comparison between China's carbon unit price and Europe's carbon unit price is shown in Figure 3. Therefore, the cost increase caused by carbon price or carbon tax will be less, which is also an advantage compared with the products in the European and American markets. At the same time, when countries around the world pay attention to climate issues, they will also pay attention to the import and export of green and low-carbon products. Moreover, due to the promotion of carbon emission trading, various companies will also reduce corporate profits to carry out low-carbon transformation,

making their products low-carbon green products, accepted by more countries or regions, thus conforming to the trend of the times and gaining a broader market.

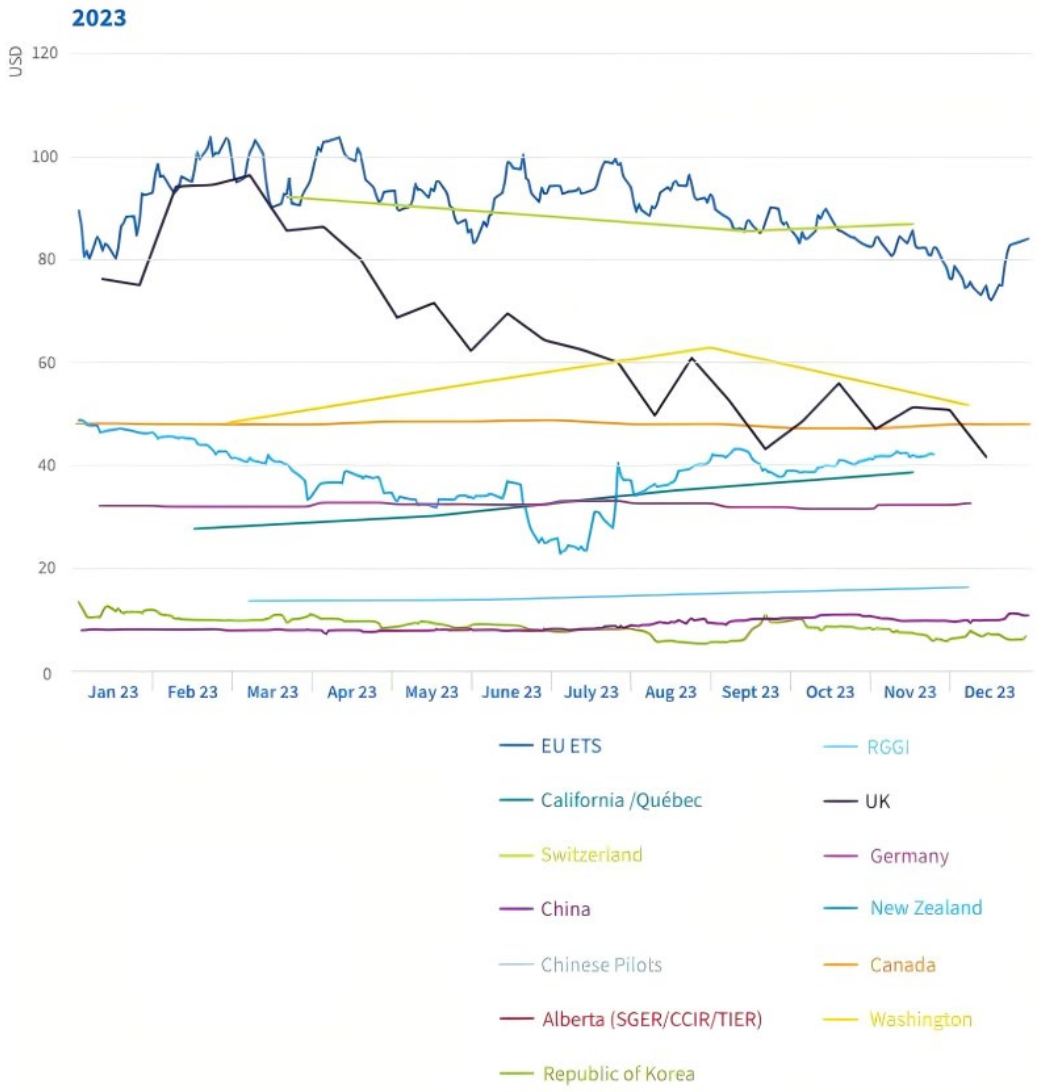

Figure 2. Carbon unit prices in global carbon trading markets in 2023.

(Source: ICAP, Emissions Trading Worldwide Status Report 2024)

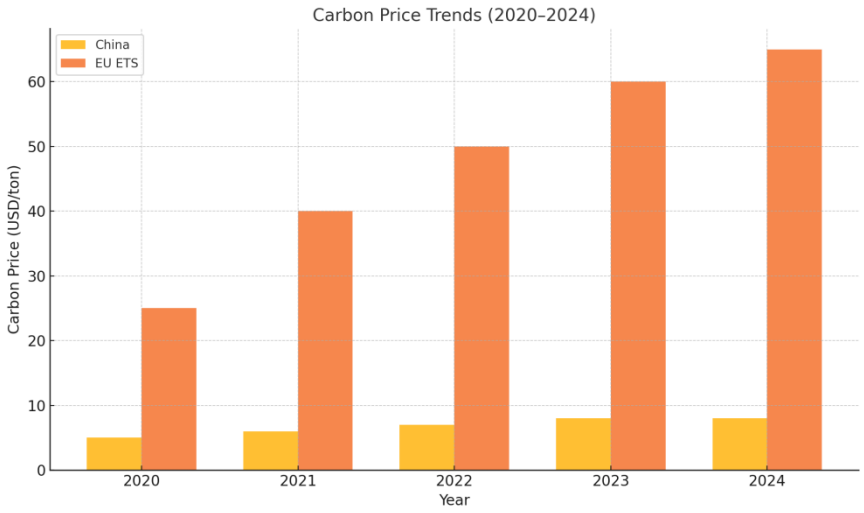

Figure 3. Carbon Price Trends (2020–2024) in China and the EU ETS.
(Source: Huang and Leong, China's Carbon Trading Market Globalization Strategy: A Conceptual Review)

II. MATERIALS AND METHOD

A. Literature Review

Yang (2024) used the Vector Autoregression (VAR(p)) Model in his research on the influencing factors of the EU carbon trading market. The expression of the Vector Autoregression (VAR(p)) Model with *n* variables is (1). Then Yang processed the data of the four influencing variables, London Brent crude oil futures, Rotterdam Port thermal coal futures, New York Stock Exchange natural gas futures and Euro Stoxx 50 Index, calculated the beta value and brought it into (1) to get a specific model (2). y_t is ln_{EUA}. -12.818, -6.760, 20.753 and 5.356 means β_1, β_2, β_3 and β_4, influencing variables ln_{Coal}, ln_{Coal}, ln_{Coal} and ln_{Coal} means y_{t-1}, y_{t-2}, y_{t-3} and y_{t-4}.

$$y_t = \theta + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \cdots + \beta_q y_{t-q} + u_t, \quad t = 1, 2, 3, \ldots, T \tag{1}$$

$$ln_{EUA} = -12.818\, ln_{Coal} - 6.760\, ln_{Oil} + 20.753\, ln_{Gas} + 5.356\, ln_{Index} \tag{2}$$

Referring to the research of Wang and Ren (2024), Wang and Ren further introduced the interaction term between the green product dummy variable and the core explanatory variable, and the interaction term between the high-pollution product dummy variable and the core explanatory variable on the basis of the traditional gravity model, aiming to analyse the impact of the establishment of the international carbon emission trading market on China's green product and high-pollution product exports. The regression model created by Wang and Ren is as follows:

$$ln\,(E(control)_{ijt}) = \alpha + \beta * ETS_{jt} + \delta * control_{ijt} + \emptyset_i + \emptyset_j + \emptyset_t + \varepsilon_{ijt} \tag{3}$$

$$ln(E(Green)_{ijt}) = \alpha + \beta * ETS_{jt} * Green_i + \gamma * ETS_{jt} + \delta * control_{ijt} + \emptyset_i + \emptyset_j + \emptyset_t + \varepsilon_{ijt} \tag{4}$$

$$ln\,(E(Pollution)_{ijt}) = \alpha + \beta * ETS_{jt} * Pollution_i + \gamma * ETS_{jt} + \delta * control_{ijt} + \emptyset_i + \emptyset_j + \emptyset_t + \varepsilon_{ijt} \tag{5}$$

He (2022) is in his article on the impact of carbon trading market on enterprise innovation strategy and its mechanism. By matching the data of carbon trading market pilot enterprises with the green patent data of listed Chinese enterprises from 2010 to 2019. The index of enterprise innovation strategy is constructed from the aspects of patent citation structure, patent technology field and patent influence. The effects of the carbon trading market on the innovation strategy of enterprises are empirically tested by the methods of differential and synthetic differential. The dynamic effect of the carbon trading market is empirically tested. The test equation is as follows (7). The author selects the year when the carbon trading market is implemented as the base period, and the subscript k represents the number

of periods different from the base period.

$$Innovation_{it} = \alpha + \beta_1 ETS_i * TP_t + \beta_2 Z_{ct} + \eta_i + \lambda_t + \delta_j + \varepsilon_{it} \quad (6)$$

$$Innovation(test)_{it} = \alpha + \sum_{k=-4}^{4} \beta_t ETS_i * TP_t + \eta_i + \lambda_t + \delta_j + \varepsilon_{it} \quad (7)$$

Tian and Xiao (2023) based on the data of listed companies in 37 industrial sectors in 31 provinces of China from 2008 to 2019. By constructing a triple difference model (DDD), the influence mechanism and action path of China's carbon trading pilot market on enterprises' low-carbon transformation were investigated.

i, j and *t* represent region, enterprise and time respectively; $LCTe_{ijt}$ is the explained variable, namely the low-carbon transformation of enterprises; The key explanatory variable is the triple difference term $Time \times Treat \times Group$, that is DDD_{ijt}; β_1 is a triple difference coefficient, which is used to measure the direction and magnitude of the impact of the carbon trading pilot market on the low-carbon transformation of the involved enterprises. $Treats_{ij}$ is the interaction item of Treat×Group; $Times_{jt}$ is the interaction item of Group×Time. DID_{it} is the interaction term of Treat×Time. In addition, the multi-dimensional fixed effect model is used for regression test, where: δ_i represents the regional fixed effect; λ_t is a time-fixed effect. ξ_j is the fixed effect of enterprise individual; ε_{ijt} is the residual; X_{ijt} is the relevant control variable.

$$LCTe_{ijt} = \beta_0 + \beta_1 DDD_{ijt} + \beta_2 Treats_{ij} + \beta_3 Times_{jt} + \beta_4 DID_{it} + \beta_5 X_{ijt} + \xi_j + \delta_i + \lambda_t + \varepsilon_{ijt} \quad (8)$$

Table 1. Summary of the Selected Studies

SL	Year	Author	Publisher Name	Findings
1	2024 [1]	Yang Shu	China Academic Journal Electronic Publishing House	This paper explores the influencing factors of the EU carbon trading market through the daily returns of EU emission quota (EUA) futures. The results show that there is a long-term equilibrium relationship between EUA futures prices and various influencing factors.
2	2024 [2]	WANG Wenzhi and REN Haokai	Prices Monthly	This article analyses the impact of the establishment of the international carbon emissions trading market on China's product exports and green transformation. Research has found that the establishment of a carbon emissions trading market will significantly inhibit the total product exports of Chinese companies and the export of highly polluting products, while also significantly promoting the export of green products by Chinese companies, thereby driving the green transformation of Chinese company product exports.
3	2022 [3]	HE Yanni	China Population, resources and environment	This paper uses carbon trading market pilot enterprise data and Chinese listed enterprise green patent data to construct corporate innovation strategy indicators from three dimensions: patent citation structure, patent technology field and patent impact, and comprehensively uses double-difference method, comprehensive double-difference method and other methods for empirical testing The impact of carbon trading market on corporate innovation strategies. The study found that the carbon trading market significantly promoted breakthrough innovation activities for companies to explore new knowledge.

4	2023 [4]	TIAN Chao and XIAO Liming	East China Economic Management		Based on the data of listed companies in the industrial industries of various provinces in China, this paper constructs a triple difference model (DDD) to examine the impact mechanism and path of my country's carbon trading pilot market on the low-carbon transformation of enterprises. The study found that the carbon trading pilot market has significantly promoted the low-carbon transformation and development of Chinese enterprises. The carbon trading pilot market has a significant positive impact on the low-carbon transformation of state-owned enterprises and large enterprises, but the impact on private enterprises and small businesses is not obvious.

B. Analysis of Different Analysis Models

This article wants to explore the impact of the establishment of a carbon trading market on China. The Vector Autoregression (VAR(p)) Model used by Yang uses data from the EU market. The parameters obtained have strong limitations and cannot be directly applied to the model.

The model used by He focuses on the impact of green innovation, innovation strategy and green patents. The model used by Tian and Xiao focuses on the impact of the establishment of a carbon trading market on low-carbon transformation. Both sets of analysis models focus on the impact of domestic factors.

However, it should be noted that low-carbon environmental protection is a global strategy, and every country in the world attaches great importance to environmental protection. This results in the influencing factors of the establishment of a carbon market not only coming from domestic factors but also being affected by international factors. The model established by Wang and Ren not only takes into account domestic factors such as whether the products produced are green products, but also international factors such as total imports and exports, geographical distance etc. The impact of the establishment of a carbon trading market is judged through comprehensive analysis results.

C. Build Analytical Models

By constructing a trade gravity model, the impact of the establishment of an international carbon emissions trading market on China's product exports and its green transformation is analysed. Equations (3), (4) and (5) are used to substitute data for regression analysis and obtain the results.

D. Regression model interpretation

Variable E_{ijt} is the trade volume of China's exports of product *i* to country (region) *j* in year *t*.

The core explanatory variable ETS_{jt} is whether the export destination country (region) *j* has implemented the carbon emission trading market in year *t*, if implemented, it is 1, otherwise it is 0.

$Green_i$ represents whether product *i* is a green product.

$Pollution_i$ represents whether product *i* is a high-pollution product.

$control_{ijt}$ is a series of control variables for the export destination country (region).

The coefficient of ETS_{jt}, $ETS_{jt} * Green_i$, $ETS_{jt} * Pollution_i$ in the econometric model is the core coefficient that the author is concerned about, which represents the impact of the implementation of the international carbon emission trading market on China's total exports, green product exports and high-pollution product exports on China's product trade.

$\emptyset_i$, $\emptyset_j$ and $\emptyset_t$ represent product fixed effects, export destination country (region) fixed effects and year fixed effects respectively. The influence of factors that do not change over time at the product level, factors that do not change over time at the export destination country (region) level and systematic factors on China's product exports at the global level are controlled.

ε_{ijt} represents random interference, and clustered standard errors are used to mitigate the impact of heteroskedasticity on the empirical results.

E. Control Variable

Based on the studies of Shi (2016), Guo and Ma (2022), the selected control variables include: (1) whether there is a common language, whether China and the export destination country or region have a common official language or a common ethnic language; (2) Whether it is bordered, if it is bordered, take 1, and the part bordered by 0; (3) Geographical distance. According to the numerical value of the distance between Beijing and the capital of the export destination country or region, theoretically, the longer the geographical distance, the smaller the scale of China's export to this country or region; (4) Whether it is a landlocked country, if it is a landlocked country or region, take 1, otherwise take 0; (5) Economic size, measured by the GDP of the export destination country or region. In general, the larger the economy of a trading partner, the larger the scale of China's exports.

Table 2. Descriptive statistics of relevant variables

Control variable	Variable name	Obs	Mean	Std	Min	Max
ln(E)	Product export scale	4410234	11.557	2.924	0	25.002
Language	Whether there is a common language	4410234	0.041	0.199	0	1
Bordered	Border or not	4410234	0.083	0.277	0	1
Distance	geographical distance	4410234	8.871	0.6	6.863	9.868
Landlock	Is not a landlocked country or region	4410234	0.093	0.291	0	1
ECS	Economic size	4410234	11.557	2.924	0	25.002

(Data Source: WANG and REN, can international carbon emissions trading promote China's green product exports?)

III. RESULT AND DISCUSSION

A. Model regression results

Table 3 shows the results of regression models (3), (4) and (5) above.

Table 3. Regression result

	(3)	(4)	(5)
	InE	*InE*	*InE*
ETS	-0.37264***	-0.37932***	-0.35057***
	(-32.75)	(-32.09)	(-29.89)
ETS-Green		0.13695**	
		(2.37)	
ETS-Pollution			-0.47929***
			(-7.70)
Language	1.42065***	1.42042***	1.42085***
	(74.91)	(74.91)	(74.91)
Bordered	0.18390***	0.18393***	0.18383***
	(20.56)	(20.57)	(20.56)
Distance	-0.47806***	-0.47800***	-0.47794***
Landlock	-0.83516***	-0.83515***	-0.83605***
	(-78.08)	(-78.08)	(-78.26)
ECS	0.74075***	0.74076***	0.74095***
	(173.65)	(173.66)	(173.72)
Constant	1.66226***	1.66168***	1.65727***
	(15.43)	(15.43)	(15.39)

(The values in brackets are T-test statistics; ***, ** and * are significant at the level of 1%, 5% and 10% respectively.)

From the comprehensive results of (3), (4) and (5), the coefficient of species distance obtained by the three models is negative at the level of 1%; The coefficient of whether there is a border is negative at the level of 1%; The coefficient of economic size is positive at the 1% level. These data all show that the greater the distance, the smaller the export volume, the larger the economic scale, the higher the export volume, and the increase in the cost of goods transportation and the increase in difficulty lead to the decrease in export volume. These theories have been confirmed, so the reliability of the results of this model is high. Now look at the variables that we need to account for. The ETS-Green coefficient is positive at the 5% level, indicating that the establishment of the carbon trading market has promoted the export of green products in China. The coefficient of ETS-Pollution is negative on the level, which indicates that the establishment of the carbon market has hindered the export of highly

polluting products from China. Observing the ETS of (3), (4) and (5), it is found that the results of the three regression models are all negative at the 1% level. This shows that the establishment of the carbon trading market has hindered the export volume of China's products to a certain extent. Although it has promoted the export volume of China's green products, it has also hindered the export of China's highly polluting products, which shows from the side that China's export products are still dominated by highly polluting products, and green products are less exported.

B. Discussion of Regression Results

The establishment of carbon emission trading market will significantly inhibit the total export of products and exports of highly polluting products of Chinese enterprises but significantly promote the export of green products of Chinese enterprises, and then effectively drive the green transformation of product exports of Chinese enterprises. At the same time, when enterprises find this problem, they will increase investment in green products and gradually abandon high-polluting products, which will accelerate the green transformation of enterprises to a certain extent. When increasing investment in green products, green technology will also be enhanced. Thus, gradually accelerate and deepen the green transformation of enterprises.

Since the establishment of carbon trading market can effectively promote the export of green products, China's carbon trading market should be gradually improved, and a sound legal system and trading system should be established. Further promote the green transformation of enterprises and production products and lay a good foundation for enterprise transformation. At the same time, the gradual improvement of China's carbon trading market will gradually deepen its influence on the international carbon market and gradually establish an international carbon trading centre. And the European and American carbon trading markets complement each other, through their own influence to promote the development of global low-carbon cause.

IV. CONCLUSION

Countries or regions around the world strictly control carbon emissions and seek a balance between profits and environmental protection by implementing carbon emission trading and carbon tax and other policy measures. This not only helps to ensure the sustainable development of countries or regions but also achieves the goal of climate governance.

The implementation of carbon emission trading has brought about tremendous changes in foreign trade. Carbon emission trading has promoted the export of green products of domestic enterprises and improved the competitiveness of green products; it has also hindered the export of high-pollution products in China, forcing enterprises to increase their investment in green products and accelerate green transformation. This trend is also in line with the global trend of green and low carbon development and provides strong support for the green transformation of Chinese corporate product exports.

Under the influence of carbon emission trading, the business policies of enterprises will also change. In order to meet the strict emission policy requirements, enterprises need to continuously improve various business strategies such as production technology and business methods to adapt to the new market environment. In this process, carbon emission trading not only promotes the green innovation and low-carbon transformation of enterprises but also promotes the deepening of the global green and low-carbon concept.

The establishment of the carbon trading market has also had a profound impact on China's influence in the international carbon market. As China's carbon trading market gradually improves, its influence will gradually increase, and it is expected to become one of the international carbon trading centres. Then, through complementary cooperation with the European and American carbon trading markets, the development of the global low-carbon cause will be further promoted.

Therefore, carbon emission rights trading is a key tool to promote global climate governance and corporate green transformation. China should continue to improve the carbon trading market, establish a more complete legal system and trading system, and provide a more solid foundation for the green transformation of enterprises. At the same time, by deepening cooperation and exchanges with the international carbon market, we will jointly promote the development of the global green and low-carbon cause.

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