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THE IMPACT OF CARBON PRICING POLICY ON THE STRUCTURAL ADJUSTMENT OF THE ECONOMY

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The article analyses the specifics and key characteristics of carbon pricing policy at the present stage. Econometric analysis of panel data of the applied carbon pricing policy in the experimental provinces of China was carried out.

Keywords: carbon pricing policy; carbon trading system; economic structural adjustment.

ВЛИЯНИЕ ПОЛИТИКИ УГЛЕРОДНОГО ЦЕНООБРАЗОВАНИЯ НА СТРУКТУРНУЮ ПЕРЕСТРОЙКУ ЭКОНОМИКИ

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В статье проанализирована специфика и ключевые характеристики политики углеродного ценообразования на современном этапе. Проведен эконометрический анализ панельных данных применяемой политики углеродного ценообразования в экспериментальных провинциях Китая.

Ключевые слова: политика ценообразования на выбросы углерода; система торговли выбросами углекислого газа; структурная перестройка экономики.

According to the definitions of the World Bank and the United Nations, carbon pricing is a cost-effective policy tool that links the cost of climate change caused by greenhouse gas emissions to emission behavior through a price policy. Its core is the pricing of units of carbon dioxide or other greenhouse gas emissions. This policy effectively guides enterprises to weigh costs and benefits in economic activities through the transmission of price signals, thereby actively reducing greenhouse gas emissions and slowing the pace of global warming. Its principle is that it is closely integrated with the supply and demand relationship in the market economy. Specifically, when carbon emission rights become a scarce resource in the market, their prices will naturally rise. When enterprises carry out production and operation activities, they will face additional costs caused by greenhouse gas emissions. The existence of this cost forces enterprises to consider how to reduce emissions in the decision-making process to reduce the financial burden of enterprises. The implementation of the carbon pricing policy will not only help promote enterprises to adopt more environmentally friendly production methods and reduce pollution to the environment, but also stimulate enterprises' enthusiasm for research and development and investment in low-carbon technologies and clean energy. Because when enterprises can reduce costs by reducing emissions, they will be more inclined to choose technologies and products that can both reduce emissions and improve efficiency.

Carbon pricing policies are divided into two categories: explicit carbon pricing policies and implicit carbon pricing policies [1, p. 41].

Explicit carbon pricing policies directly price carbon emissions, including carbon emissions trading systems (ETS), carbon taxes, carbon tariffs, carbon credit policies, results-based climate finance, internal carbon prices, etc. Among them, carbon emissions trading systems and carbon taxes have the widest coverage and the greatest influence, representing the mainstream of international carbon pricing policies. Implicit carbon pricing policies cover a wider range of policy arrangements that affect carbon emissions, such as fuel taxes, energy efficiency standards, etc.

This research mainly studies the impact of the carbon emissions trading system on the economic structure under the explicit carbon pricing policy.

The basic goal of the ETS is to encourage companies to achieve emission reductions at the lowest cost by limiting the total emissions within the coverage area. At the same time, the ETS closely combines corporate operating profits with low-carbon innovation and investment, thereby promoting sustainable economic transformation.

The promotion of greenhouse gas emission reduction is complementary to a wide range of social and environmental benefits, including improved air quality, enhanced energy security, guiding technological change, and creating green jobs. In addition, by issuing quotas in the form of auctions, the ETS can also generate fiscal revenue for the government, which can be used to support specific projects and policies related to social and environmental benefits, further amplifying the positive impact of the carbon pricing policy [2].

According to the World Bank, by 2023, the share of global emissions covered by carbon taxes and emissions trading systems (ETS) has increased to about 24 %. The list of countries that have implemented carbon pricing policies is shown in the tab. 1.

Table 1

List of countries implementing carbon pricing policies around the world on 2024

Countries that have implemented carbon trading	Countries that have imposed carbon taxes	Countries planning to implement carbon trading and carbon tax
China	Chile	Vietnam
European Union	Mexico	Colombia
Canada	Brazil	turkey
Australia	Australia	India
United States (some states)	Canada (some provinces)	Saudi Arabia
New Zealand	Sweden	Indonesia
Switzerland	Norway	Malaysia
Japan	Finland	Nepal
South Korea	Denmark	Bangladesh
Poland	Netherlands	Ethiopia
Czech Republic	Portugal	Cameroon
Romania	Spain	Nepal
Slovakia	Austria	Morocco
Iceland	Belgium	Chile
Ireland	Ukraine	Vietnam
Denmark	Norway	Russia

Also, the global market is represented by quite a wide range of financial instruments of carbon policy (tab. 2).

Table 2

Existing carbon finance products

Category of Carbon Finance Products	Specific Products/Instruments
Carbon Market Trading Instruments	Carbon Emission Allowance Trading (including spot, futures, options, and other derivatives)
Financing Carbon Finance Products	Carbon Credits Loans
	Carbon Bonds
	Carbon Repurchase Agreements
	Structured Carbon Products
Investment Carbon Finance Products	Carbon Funds
	Carbon Emission-related Price Indices and ETF
Risk Management Carbon Finance Products	Carbon Swaps
	Carbon Forwards
	Carbon Insurance
Other Carbon Finance Products	Low-Carbon Wealth Management Products
	Carbon Credits Currency

In order to analyze the data more accurately and obtain accurate results, this paper conducts an empirical analysis of the data by establishing a panel data model. Panel data is a type of data that combines the characteristics of time series and cross-sectional data. It observes the same group of individuals (such as individuals, enterprises, countries, etc.) at multiple time points, which can not only reflect the differences between individuals, but also show the dynamic changes of individuals over time. Mixed effect models, random effect models and fixed effect models are the three common forms of panel data models. In this research based on additional tests results (F-test, Breusch-Pagan test, Hausman test) a fixed effect model was chosen. Variable description is represented in the tab. 3.

Table 3

Variable description

Variable type	Meaning	Code	Illustrate
Explained variables	Changes in the secondary industry structure	ind	$ind = \frac{Q_{j0} - Q_j}{\sum_i^3 \lvert Q_i - Q_{i0} \rvert}$
Explanatory variables	Carbon emission rights trading amount	pcarbon	100×Carbon emissions trading amount/GDP
Control variables	Energy consumption	penergy	tons of standard coal/10,000 yuan GDP
	R&D level	RD	100×Ratio of technology market transaction value to GDP

The results obtained by the stepwise regression method are shown in the tab. 4. In model (1), the carbon emission trading intensity is significant at the 10% level, and the constant term is significant at the 1 % level, but the model does not explain much. In model (2), the carbon emission trading intensity is significant at the 10 % level, and the energy consumption intensity and the constant term are significant at the 1 % level. In model (3), the carbon emission trading intensity is significant at the 5 % level, while the energy consumption intensity, R&D intensity, and the constant term are all significant at the 1 % level.

From the stepwise regression results, we can see that model (3) has a strong explanatory power, its fit is higher, and the regression coefficients of each variable are consistent with the economic meaning. Therefore, we finally choose model (3), which is expressed as:

$$ind = 2.081 + 18.181pcarbon - 2.121penergy - 0.187rd.$$

Table 4

Stepwise regression application

Variable	model (1)	model (2)	model (3)
pcarbon	12.160*	7.516*	18.181**
penergy		-1.455***	-2.121***
rd			-0.187***
_cons	0.356***	1.013***	2.081***
N	30	30	30
R^2	0.015	0.332	0.532
F	0.354	5.458	7.965

***, ** and * – indicate significance levels of 1 %, 5 % and 10 %, respectively.

In this model, ind represents the proportion of changes in the secondary industry structure. The larger its value, the greater the proportion of changes in the secondary industry in the overall changes in the industrial structure. $pcarbon$ represents the intensity of carbon emission trading, $penergy$ represents the intensity of energy consumption, and rd represents the intensity of R&D investment (the ratio of the transaction amount in the technology market to GDP). From the results, the intensity of carbon emission trading has a significant positive impact on the proportion of changes in the secondary industry structure, while the intensity of energy consumption and the intensity of R&D investment have an inhibitory effect on the change in the proportion of the secondary industry.

The coefficient of carbon emission trading intensity ($pcarbon$) is 18.181, indicating that it has a significant positive impact on the proportion of changes in the secondary industry structure. This means that the increase in the intensity of carbon emission trading will significantly drive the proportion of the secondary industry in GDP to decline. This phenomenon can be explained from the perspective of policy effects. The carbon emission trading policy forces high-carbon emission secondary industries (such as manufacturing, heavy industry, etc.) to reduce emissions or transform and upgrade by setting carbon emission limits and trading markets. This policy pressure prompts enterprises to adopt cleaner production technologies or turn to low-carbon industries, thereby reducing the proportion of the secondary industry in GDP. In addition, carbon emission rights trading may also promote the transfer of resources to the tertiary industry (such as the service industry and high-tech industries), further accelerating the decline in the proportion of the secondary industry.

The coefficient of energy consumption intensity ($penergy$) is –2.121, indicating that it has a significant negative impact on the proportion of changes in the secondary industry structure. This means that the increase in energy consumption intensity will inhibit the decline in the proportion of the secondary industry in GDP. This phenomenon can be explained from the perspective of energy dependence. The secondary industry is usually an energy-intensive industry. The increase in energy consumption intensity may mean that the production activities of these industries still rely on traditional high-energy consumption models and lack the motivation to transform to low-carbon or efficient energy. This dependence not only delays the adjustment of the industrial structure, but also may make it difficult for the secondary industry to be replaced by other industries in the short term, thereby slowing down the decline in its proportion.

The coefficient of R&D investment intensity (rd) is –0.187, indicating that it has a slight negative impact on the proportion of changes in the secondary industry structure. This means that the increase in R&D investment intensity will slightly inhibit the decline in the proportion of the secondary industry in GDP. This phenomenon can be explained from the perspective of technology path dependence. High R&D investment may make enterprises more inclined to optimize existing technologies rather than explore new areas, resulting in the technological innovation of the secondary industry focusing more on improving the existing production model rather than promoting fundamental changes in the industrial structure. In addition, the transformation and application of R&D results usually take a long time, and it is difficult to have a significant impact on the industrial structure in the short term. At the same time, if R&D investment is concentrated in a few industries or enterprises, it may lead to uneven resource allocation, inhibit the innovation and development of other industries, and thus slow down the adjustment of the overall industrial structure.

In conclusion, the results of empirical analysis show that the intensity of carbon emission rights trading is an important factor in promoting the decline in the proportion of the secondary industry in GDP, while the intensity of energy consumption and the intensity of R&D investment have a restraining effect on the change in the proportion of the secondary industry. This result not only supports the role of carbon emission rights trading policies in promoting industrial structure adjustment, but also reveals the restrictive effect that energy consumption and R&D investment may have on changes in industrial structure.

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