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Study on the Impact of Carbon Tax Levying on Shanxi's Industrial Structure Transformation under the Dual Carbon Goals

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Abstract: *Under the background of dual carbon goals, the high dependence of China's economy on energy puts forward higher requirements for carbon emission reduction work. Shanxi, as a major energy province, faces typical issues such as high energy consumption and high pollution. Therefore, the transformation and adjustment of Shanxi's industrial structure can provide profound reference significance for the carbon emission reduction actions of China's energy-related industries. Carbon tax, widely applied by many countries worldwide as an effective tool for carbon emission reduction, will inevitably have a tax burden impact on the development of energy-related industries. Therefore, continuously improving supporting measures and reasonably setting tax rates are not only related to the timely realization of dual carbon goals but also promote the high-quality development of China's economy.*

Keywords: *Dual carbon goals; Carbon tax; Industrial transformation*

1. Research Background

The NPC and CPPCC, which ended on March 13, 2023, once again put forward suggestions and protective measures on environmental protection. The CPPCC added a new sector of environmental resources, which is the first new sector of the CPPCC since the 21st century. By gathering experts and scholars in the field of environmental resources, this move aligns with the important conclusion that "lucid waters and lush mountains are invaluable assets." It also embodies the green development concept and represents another significant measure for China to actively implement the white paper on "Green Development in the New Era of China."

In the eyes of the president, there is no substitute for the ecological environment. The construction of an ecological civilization is crucial to the sustainable development of the Chinese nation. It's necessary to actively practice environmental protection and promote the advocacy of green and low-carbon development. According to the United Nations Framework Convention on Climate Change, as a developing country, China is not required to undertake mandatory emission reduction obligations. However, as a responsible major country, on September 22, 2020, China officially made a commitment to the international community at the 75th United Nations General Assembly to enhance its nationally determined contributions, striving to reach the peak of carbon dioxide emissions by 2030 and achieve carbon neutrality by 2060. As per the government work report, China will continue to formulate a series of policies and proactive measures related to the "dual carbon" goals, such as improving the dual control system for energy consumption, and accelerating the construction of a nationwide energy consumption rights and carbon emission rights trading market. This demonstrates China's determination to reduce emissions and protect the environment.[1]

Although countries around the world have begun to actively work on carbon emission reduction, air quality continues to deteriorate worldwide, the greenhouse effect intensifies, and climate change and global warming have become established facts. The resulting sea-level rise, reduced biodiversity, frequent extreme weather events, and rampant diseases pose an even greater threat to the Earth on which humans depend for survival in the future. According to the "Greenhouse Gas Bulletin" released by the World Meteorological Organization (WMO) in 2022, carbon dioxide contributes approximately 66% to global warming. It is evident that controlling greenhouse gas emissions, mainly carbon dioxide, is crucial in addressing climate change, and carbon dioxide reduction measures are imperative. The

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International Energy Agency (IEA) pointed out in "CO2 Emissions in 2022" that global energy-related carbon dioxide emissions reached a new high in 2022, exceeding 36.8 billion tons, an increase of 321 million tons from the previous year, with a growth rate of 0.9%.[2] Energy consumption, mainly from fossil fuels such as coal, oil, and natural gas, is the primary source of carbon dioxide emissions, and the drawbacks of traditional energy sources are becoming increasingly apparent.

In China, the country is characterized as rich in coal, poor in oil, and scarce in natural gas. Due to the characteristics of resource endowment,the past industrial structure was dominated by the secondary industry for a long time. The extensive industrial production method in the primary stage of socialism and the energy utilization rate far lower than that of developed countries jointly determined China's rigid demand for primary fossil fuels, high reliance, and large consumption during the development process. According to the accounting data released by the National Bureau of Statistics in the "Statistical Bulletin on National Economic and Social Development of the People's Republic of China in 2022", coal consumption with high carbon emission characteristics accounts for 56.2% of China's total energy consumption.As a major province of coal energy production and consumption in China, Shanxi Province is a typical resource-based city. The province has a coal reserve of 507.25 billion tons, accounting for 31.26% of the national reserve, ranking first in the country. In addition, Shanxi Province has advantages such as a wide variety of coal, high-quality mining conditions, and concentrated distribution. Shanxi Province bears the supply of coal resources for most regions of China and undertakes the important mission of ensuring national energy security, which is related to national economic and social development. In September 2021, the national coal market experienced a shortage of supply and high coal prices. Shanxi Province fully played the role of a major coal-producing province, increased coal production, stabilized coal prices dynamically, and signed medium and long-term coal contracts with 14 provinces and cities such as Hebei and Shandong, stabilizing coal energy supply.Relying on abundant coal resource reserves, Shanxi has established many energy enterprises dependent on coal in the past, forming a high-energy consumption, high-emission, and high-pollution extensive industrial production and processing method and a "two-three-one" industrial structure, with greenhouse gas emissions ranking among the top in the country. Although this model has promoted the rapid rise of Shanxi's economy in a short period, ranking 11th in the country in 2018, the development mode at the cost of resource consumption has brought environmental problems such as ecological degradation, river pollution, and a significant decline in air quality to Shanxi. Nowadays, problems such as a single industrial structure, slow development of emerging industries, and difficulties in industrial transformation are gradually emerging, becoming the shackles of Shanxi's development progress.[3] Therefore, under the dual-carbon background, industrial structure transformation and upgrading, and the development of a low-carbon economy will become a necessary path for Shanxi's transformation.

Emission reduction actions can mainly be carried out from two aspects: promoting the use of clean energy and reducing fossil fuel consumption. At present, China has introduced many supporting preferential policies in encouraging the use of new energy and pollution control, achieving significant results, but there is still a gap in energy emission reduction. The 14th Five-Year Plan proposes to improve the energy-saving and emission-reduction mechanism, continuously improve the pollution emission control system, and improve laws and regulations standards. The "Action Plan for Carbon Peaking by 2030" released by the State Council also clearly states the establishment of a sound tax system conducive to green and low-carbon development, better playing the role of taxation in promoting low-carbon production of market entities.[4]

At the current stage, there are two policies related to carbon emissions worldwide: one is the carbon tax, and the other is the carbon emissions trading. Carbon emissions trading is an important mechanism that uses price measures and market economy to promote environmental protection. It allows companies to use or trade the reduced carbon emissions within the company and domestically and internationally, as long as the total amount of emissions does not exceed the specified limit. Compared to the carbon tax, it mainly targets large companies that emit greenhouse gases, has a limited coverage, a complex trading system, and requires efficient clearing and monitoring technology as the carrier, with high demands for facility improvement. Furthermore, the measurement of carbon dioxide emissions is difficult, making it challenging to implement widely.On the other hand, the carbon tax is a type of tax levied on the carbon emissions and the carbon content itself produced by the combustion of fossil fuels (including coal, natural gas, and petroleum). It converts the environmental cost of carbon dioxide emissions into business operating costs through tax measures, characterized by fast effectiveness, easy implementation, efficiency, and low collection costs. Its main purpose is to control and reduce carbon dioxide emissions, alleviate the greenhouse effect, and slow down the pace of global warming. Although the existing resource tax on fossil fuels and the consumption tax on refined oil in China are

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beneficial to reducing carbon emissions to a certain extent, their effects are indirect and not specifically designed for carbon reduction. Therefore, they cannot be regarded as a carbon tax. Moreover, the current tax collection for the environment in China is still mainly based on economic goals and has not truly incorporated environmental benefits into the primary considerations.

Many scholars at home and abroad have conducted in-depth research and analysis on the effects of carbon taxes. Zhang Pengcheng et al. (2022) believe that the imposition of a carbon tax will have a significant impact on China's petrochemical industry structure, capital structure, and non-economic effects, etc. Baranzini et al. (2000) found that a carbon tax is an effective way for reducing greenhouse gas emissions, and its negative effects on the economy can be compensated through tax design and the use of fiscal revenue. Wei Lang et al. (2016) used panel data from 30 provinces between 2000 and 2014 and conducted research based on a proposed three-tier carbon tax rate. Their conclusion suggests that China should adopt a low tax rate at the beginning of carbon tax implementation. Zhang Mingwen et al. (2009) found through the panel data econometric model that the imposition of a carbon tax has a restraining effect on energy consumption in the eastern region. Guan Zhihua (2011) concluded that imposing a carbon tax would constrain the economic development of the central and western regions, gradually widening the economic gap between the eastern and western regions and changing China's regional economic development pattern. He also believes that a carbon tax is unfavorable for the development of the secondary industry but can improve the position of the tertiary industry in the national economy. It can be seen that the introduction of a carbon tax is of positive significance for achieving the dual carbon goals, protecting the ecological environment, implementing green development concepts, and achieving sustainable economic development. The innovation of this paper focuses on Shanxi Province, analyzing the impact of imposing a carbon tax on the industrial structure transformation of Shanxi under the background of achieving dual carbon goals, thereby improving the ecological environment and promoting the construction of ecological civilization. Due to the "three highs" industrial structure characteristics of Shanxi Province, this paper will also provide more extensive demonstration effects and reference significance for the transformation of national energy consumption and industrial upgrading. [5-9]

2. The Impact Path of Carbon Tax on Shanxi's Energy-consuming Industries

2.1. Overview of Shanxi Province's Industrial Structure

Since 2013, Shanxi Province has steadily promoted the transformation and upgrading of its industrial structure and continued to accelerate the strategic adjustment of the regional economy. According to data from the Shanxi Provincial Bureau of Statistics, the proportion of the three industries in the province has evolved and optimized from 2012, with the primary industry accounting for 5.5%, the secondary industry accounting for 58.6%, and the tertiary industry accounting for 35.9%, to 2020 with the proportions of the primary, secondary, and tertiary industries being 5.4%, 43.4%, and 51.2%, respectively. The industrial share decreased by 15.2 percentage points, while the service sector's share increased by 15.3 percentage points. However, since 2021, with the continuous rise in the prices of bulk commodities such as raw coal and steel, the industrial share has increased, with the proportions of agriculture, industry, and services being 5.7%, 49.6%, and 44.7%, and in 2022, the proportions of the three major industries were 5.2%, 54%, and 40.8%. Through the above, it is not difficult to see that after a series of structural measures, Shanxi has developed a "3-2-1" industrial pattern with great difficulty. However, the tertiary industry's service sector share is only slightly higher than that of the industry, with insufficient advantages, obvious shortcomings, and still in need of strong support. Moreover, in recent years, affected by the pandemic, the service industry's development is inherently inadequate, with weak risk resistance capabilities and a rapid decline in output value, which is lower than the contribution of the secondary industry to the province's GDP.[10] Therefore, industrial reform must continue to strengthen guidance for the tertiary industry, promote the rationalization of the internal structure of the secondary industry, ensure economic growth while promoting the coordinated development of the three major industries.

2.2. Specific Analysis of Shanxi Province's Industrial Structure

2.2.1. Insufficient Development Momentum in the Primary Industry

The overall level of agricultural development in Shanxi Province is not high and has a single structure. In the past, extensive, large-scale, and long-term continuous mining of coal mines led to

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ecological imbalance, soil erosion, and a decrease in groundwater, resulting in a weak natural basis for agricultural development. In 2019, the number of employed persons in the primary industry was 6.667 million, accounting for as high as 35.0%, which was 14.1 percentage points higher than the employment share of the secondary industry. [11] The growth in output value mainly relied on a large labor force, indicating insufficient economic benefits and a lower resource utilization rate. Factors such as backward infrastructure, low mechanization levels, and insufficient investment in science and technology are all restricting the path to modernization for Shanxi's agriculture.

2.2.2. Prominent Structural Problems in the Secondary Industry

For a long time, the heavy industry development model based on rich coal resources has brought many contradictions and hidden risks to industrial manufacturing, and the resource curse has gradually emerged. In 2019, Shanxi Province's total energy consumption CO2 emissions amounted to 526 million tons, ranking fifth in the country; the CO2 emissions from energy consumption per unit GDP were 3.10 tons/10,000 yuan, 2.95 times the national average. Shanxi's high dependence on energy consumption in economic operation cannot be changed in a short time. The increasingly scarce energy supply and low utilization rate, serious waste; coal mining, dust pollution, overcapacity, and low added value of products are all threatening the virtuous cycle and healthy development of Shanxi's secondary industry. At the same time, there is a significant gap between the secondary industries, and the connection and relevance are not high. The contradictions of the petrochemical industry, such as low level and outdated structure, are also intensifying.The Shanxi Provincial People's Government's latest "2022 Shanxi Top 100 Enterprises Analysis Report" lists the top five companies in Shanxi Province in terms of operating income: Jinneng Holdings Group Co., Ltd., Lu'an Chemical Group Co., Ltd., Shanxi Coking Coal Group Co., Ltd., Huayang New Material Technology Group Co., Ltd., and Shanxi Construction Investment Group Co., Ltd. It can be seen that the secondary industry, especially the high-energy-consuming group companies mainly in the chemical and energy sectors, still maintains a monopoly advantage in economic scale and volume and occupies a dominant position in Shanxi Province's industrial development.Therefore, Shanxi Province should continue to deepen the adjustment of the internal structure of the secondary industry, focus on the coordination of light and heavy industries, and promote industrial diversification. For traditional heavy industries, it is necessary to accelerate the elimination of backward production capacity, shut down and rectify non-compliant production and mining enterprises. Supervise companies to reasonably develop coal resources, improve energy utilization, extend the industrial chain, carry out deep processing of coal products, increase added value, and thereby enhance product competitiveness. For light industries, continue to expand the popularity of local brands such as aged vinegar, Fenjiu, and Qinzhou millet in Shanxi Province, expand market share, increase the exploration of local specialties, and encourage the research and development and production of new products. For high-tech enterprises, innovation and research and development should be encouraged, corresponding tax incentives and financial support should be provided, clean energy development should be stimulated, and energy consumption diversification should be promoted. Push the industry towards a higher level, low-carbon emission, and green innovation direction.

2.2.3. Slow Development and Obvious Shortcomings in the Tertiary Industry

The distorted development and severe imbalance of Shanxi Province's industrial structure have resulted in a low level of service industry development. The tertiary industry is still at a relatively low level, with a significant gap compared to the developed areas in the eastern region. The development momentum is insufficient, and the advantages are not fully utilized. Due to Shanxi's overdependence on the secondary industry, the agglomeration effect of personnel and resources in the secondary industry is apparent, so the development of the tertiary industry in the province is still dominated by traditional services. The modernization level is not high, and the driving effect on the economy is weak. Shanxi can focus on its rich tourism and historical and cultural resources, pay attention to the restoration of ancient buildings, and increase the promotion of characteristic scenic spots. As a typical representative of industries with strong associations, the tourism industry can drive the rapid development of modern service industries such as catering services, commerce, hotels, air transportation, and cultural creativity while consolidating the advantages of traditional service industries and promoting the rise of emerging industries. It is evident that the tertiary industry, which has a high degree of economic correlation and low energy consumption requirements, will continue to play an essential role in China's economic operation.

2.3. The Impact of Carbon Tax on the Transformation of Energy-Consuming Industries

Green development means green production and green consumption. As the previous analysis

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shows, the structural contradictions in the secondary industry have the most profound impact on Shanxi Province's industrial layout. Therefore, under the dual-carbon goal background, the transformation and upgrading of the secondary industry are of great significance to Shanxi Province's green and low-carbon development path, and the implementation of a green tax - carbon tax can provide an effective approach for optimizing and adjusting its industrial manufacturing.

Green taxation is an essential means for the government to effectively govern the ecological environment through tax measures, with the ultimate goal of protecting the environment. The government should fully leverage the role of taxation in promoting the transformation of industrial structures, encourage enterprises to produce green products, promote the use of environmentally friendly equipment, and encourage the research and development of green and clean technologies and the application of clean energy sources such as wind power. The extensive production and consumption model of "mass production, mass consumption, and mass emissions" should be transformed to optimize the past unreasonable industrial layout, improve the utilization rate of fossil resources, achieve efficient and high-quality economic development, and use green taxation tools to help China achieve its dual-carbon goals as soon as possible.

The direct purpose of levying a carbon tax is to reduce carbon emissions. The carbon emissions from fossil energy in industry are the most significant, so the taxable objects of the carbon tax are mainly primary fossil energy sources like coal and oil based on their carbon content. The tax basis is as follows: first, define the scope and categories of energy subject to the carbon tax, calculate the carbon content of each taxable energy type, determine the pricing standards through carbon tax legislation, and then set quotas for energy consumption in industrial production, i.e., carbon tax = specified energy consumption (in tons) × the corresponding fixed tax rate. The fixed tax rate should comply with the principle of tax neutrality, aiming at non-intervention in the economy and equal treatment of all taxpayers. It is important to minimize the negative impact of the carbon tax on China's economic operation, while also providing positive incentives for enterprises to reduce carbon emissions and transform into a greener model. However, since the carbon tax is initially intended to curb energy consumption and achieve emission reduction goals, providing tax incentives may backfire, and some enterprises may even choose to maintain their original high-pollution extensive production mode rather than paying taxes. Therefore, it is possible to effectively resolve this contradiction by providing policies such as pre-tax deductions for purchasing clean equipment and additional deductions for corporate income tax for enterprises that develop low-carbon technologies. The tax rate should take into account both effectiveness and rationality, allowing enterprises to genuinely consider emission reduction while minimizing the negative impact of the carbon tax on their benefits.

Due to China's vast territory and scattered fossil resource distribution, setting a uniform tax rate may exacerbate regional development disparities and wealth gaps. In areas such as Shanxi Province and the northeastern provinces where heavy industries dominate, a significant tax increase may bring apparent emission reduction effects, but it will inevitably cause significant impacts on these industries, affecting their output and profits and, in turn, causing substantial fluctuations in China's macroeconomy. Therefore, the carbon tax should be implemented with differentiated tax rates according to China's specific national conditions, upholding the principle of tax fairness. It can be piloted in eastern China and industries with less dependence on energy, followed by extensive publicity to increase enterprises' acceptance of the carbon tax, reduce the difficulty of tax collection, and alleviate resistance. Gradually, the carbon tax can be expanded nationwide. In addition, it is necessary to continuously improve the dynamic adjustment mechanism, designing tax rates and preferential subsidy policies based on the actual situation of carbon emission reduction.The impact path of the carbon tax is as follows: by levying the carbon tax, the cost of ecological pollution control is internalized into the operating cost of enterprises. By increasing the price of energy and production costs, the use of fossil energy can be reduced, and the development of high-energy-consuming, high-polluting, and high-carbon-emitting industries in the secondary industry can be curbed. On the other hand, it stimulates investment in green energy industries, high-tech industries, and service industries such as catering and tourism. The advantage in production costs will significantly promote the development of the tertiary industry, improve the industrial structure, and achieve high-level transformation. While achieving direct objectives, it will promote green production and consumption to a greater extent and achieve long-term development of the national economy. In terms of the revenue right of the carbon tax, allocating the income to local governments can not only mobilize their enthusiasm for tax collection but also help strengthen the monitoring of high-carbon-emitting enterprises.[12] Local governments should use the income from the carbon tax precisely and specifically, provide tax refunds or financial subsidies to enterprises that achieve emission reduction quotas or upgrade high-energy-consuming industrial chains, and offer income tax exemptions to enterprises that participate in environmental protection projects

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according to their contributions. This will increase enterprises' intention and initiative.

3. Suggestions for Implementing Carbon Taxation

(1) Carbon taxation should be implemented gradually. The introduction of a carbon tax should start with a small scope and a relatively low, reasonable tax rate, gradually progressing. As society advances and carbon tax legislation is enacted, the tax collection scope can gradually extend from corporate production to energy consumption in the living sector. Moreover, the substitution of new energy sources and the research and development of high-tech clean emission reduction technologies require a long period of time, so the country should give enterprises sufficient time for transition, ensuring a smooth transition for China's energy-related pillar industries at the beginning of carbon tax implementation, and maintaining China's industrial competitiveness in the international market. The government should provide positive guidance to enterprises, enabling them to generate endogenous motivation for energy conservation and emission reduction, voluntarily assume social responsibilities for carbon emission reduction and economic development, and actively fulfill environmental functions of carbon emission reduction, thereby promoting the high-quality transformation and development of China's economy under new goals in the new era. China's carbon tax design can draw extensively on international experience. For example, Finland in the Nordic region was the first country to use carbon taxation to mitigate climate change, and after continuous improvements, it now has a relatively mature carbon tax system, with significant environmental effects of carbon emission reduction.

(2) Emphasize the dissemination and promotion of carbon tax knowledge in the early stages. For example, Japan carried out extensive groundwork and preparations in terms of environmental issues and the greenhouse effect caused by carbon emissions before implementing carbon taxation, making the subsequent carbon tax work proceed smoothly. Deepening public understanding of carbon taxes and their significance, and enhancing the willingness to pay carbon taxes voluntarily, not only play a positive guiding role in encouraging citizens to actively practice green and environmentally friendly lifestyles and improve energy utilization but also help to create a more friendly social environment for the subsequent implementation of carbon taxes by increasing public acceptance. China can make use of short videos, advertisements, public venue screen displays, and other methods to continuously deepen public recognition of carbon tax payments, reinforce the belief that everyone should contribute to carbon emission reduction, and encourage active emission reduction, resource conservation, and green living.

(3) The carbon tax should be coordinated with multiple taxes. Carbon tax should be combined with value-added tax, environmental protection tax, enterprise income tax and other taxes to establish a green tax system supported by carbon tax and assisted by other taxes. It is necessary to improve the vacancy of China's environmental protection tax and alleviate the distortion effect caused by carbon tax. It is also necessary to continuously optimize the internal structure of China's tax system, with multiple taxes working together to reduce the dependence of economic growth on energy and help achieve the double-carbon goal.

(4) Continuously improve related policies and supporting measures, and use innovative forces to lead carbon emission reduction. The government should actively practice talent introduction strategies and innovation-driven development strategies, vigorously support new technologies and achievements related to carbon emission reduction, provide government funding support, and increase research funding. Truly enable researchers to focus on research and provide more robust scientific evidence and technical guidance for the low-carbon transformation of China's energy consumption structure. At the same time, the government should also improve and perfect relevant preferential policies for the modern service industry, strengthen market supervision, and strive to provide a fair, open, transparent, and friendly business environment for accelerating the development of the tertiary industry.

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