

The Impact of Low-carbon Economy on China's International Trade Development

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Abstract. With the steady improvement of global living standards, economic and societal advancements have accelerated unabated, resulting in a surge in energy consumption. This escalation has brought to the forefront pressing ecological and environmental concerns, notably the exacerbation of the "greenhouse effect." Consequently, the imperative of harmonizing economic growth with the imperative to mitigate ecological and environmental degradation has garnered global attention. Within this milieu, the concept of the low-carbon economy has gained ascendancy and garnered widespread resonance and endorsement. Nations across the world have accordingly launched a plethora of policies and measures aimed at propelling low-carbon development into a novel vector for economic progress. Simultaneously, this shift has reverberated within the realm of international trade. This paper endeavors to delineate the parameters of the low-carbon economy and international trade, followed by a meticulous dissection of the prospects and tribulations engendered by the low-carbon economy's maturation within the context of China's international trade landscape. Lastly, it proffers a compendium of strategies tailored to steer China's international trade towards a trajectory that is congruent with the imperatives of the low-carbon economy, serving as a valuable point of reference for policymakers and stakeholders alike.

Keywords: Low-carbon, economy, international trade.

1. Introduction

Currently, energy conservation and emission reduction have gained unanimous consensus across society, catalyzing earnest endeavors to cultivate economies characterized by reduced energy consumption. This collective pursuit not only aligns with contemporary development paradigms emerging within the context of global climate change but also represents a transformative revolution poised to reshape the energy landscape and advance the sustainability of humanity. Within this framework, the emergence of a low-carbon economy signifies a necessary evolution when an economy attains a certain level of maturity. Within this economic model, energy resources are harnessed to their fullest potential, environmental degradation is effectively mitigated, and society and the economy embark on an advanced trajectory characterized by low-carbon, circular development. This paper commences by providing a theoretical exposition of the greenhouse effect, systematically delving into the public and global facets of climate issues. Subsequently, it formally introduces the concept of a "low-carbon economy" and elucidates its pivotal role in addressing contemporary climate challenges. Consequently, prioritizing the cultivation of a low-carbon economy as a strategic objective for the nation's foreign trade economic development assumes paramount significance. It is imperative to undertake a thorough reassessment of how a low-carbon economy affects the development of China's international trade, along with a meticulous exploration of the avenues that promote international trade's expansion amidst China's low-carbon economic framework. In the scope of this paper, it delves into the prospects and obstacles facing China's international trade within the ambit of a low-carbon economy. This involves an intricate analysis of recent transformations in global trade regulations and industrial restructuring. Furthermore, it examines the influence of a low-carbon economy on international trade, considering aspects such as energy composition, existing trade regulations, and trade patterns. Our research revolves around an examination of how the low-carbon economy impacts China's international trade trajectory, leading us to propose a set of strategic measures designed to bolster the resilience and vitality of international trade.

Within Earth's atmosphere, there exist greenhouse gases, comprising natural and human-induced elements. These gases possess the unique capacity to absorb and emit radiation within precise infrared wavelengths. As the Earth's surface warms, it emits long-wave energy into the surrounding atmosphere. Greenhouse gases, among which water vapor, carbon dioxide, ozone, methane, nitrous oxide, halocarbons, and industrial emissions are notable, play a crucial role in our planet's energy dynamics by trapping heat through reflecting some of the emitted long-wave radiation back towards the Earth's surface. Although these greenhouse gases constitute less than 1 percent of the atmosphere's composition, they wield sufficient influence to drive the natural greenhouse effect. However, it is essential to recognize that substantial quantities of greenhouse gases are generated by human activities, contributing significantly to climate change. For instance, almost 80 percent of global carbon dioxide (CO₂) emissions, one-fifth of methane (CH₄) emissions, and a substantial portion of nitrous oxide (N₂O) emissions stem from fossil fuel production and consumption. Furthermore, the processes associated with fossil fuel extraction, refinement, transportation, and distribution release additional greenhouse gases into the atmosphere (Source: Climate Change Information Kit). In recent years, the reality of climate change has become increasingly apparent, resulting in significant repercussions. Multiple reports highlight global climate risks and impacts, including rising sea levels, retreating glaciers, extreme weather events, shifts in biodiversity, threats to food security, and implications for public health [1]. A pivotal moment in the global response to climate change occurred at COP21 in December 2015 when 195 countries came together to adopt the world's first universal and legally binding global climate agreement. The Paris Agreement outlined a comprehensive global action plan aimed at steering the world away from catastrophic climate change by limiting global warming to well below 2°C. Cutting-edge scientific research underscores the urgency of reducing global net emissions by approximately 45% by 2030 and ultimately achieving "net zero" emissions around 2050 to effectively mitigate the most severe consequences of climate change (Source: IPCC, 2021: Summary for Policymakers). To realize the goal of net-zero emissions, China must make substantial investments in renewable energy (RE), energy efficiency (EE), zero-carbon technologies (ZC), and advanced energy storage solutions. This endeavor is projected to necessitate a substantial investment of RMB 70 trillion. As showed in Fig. 1.

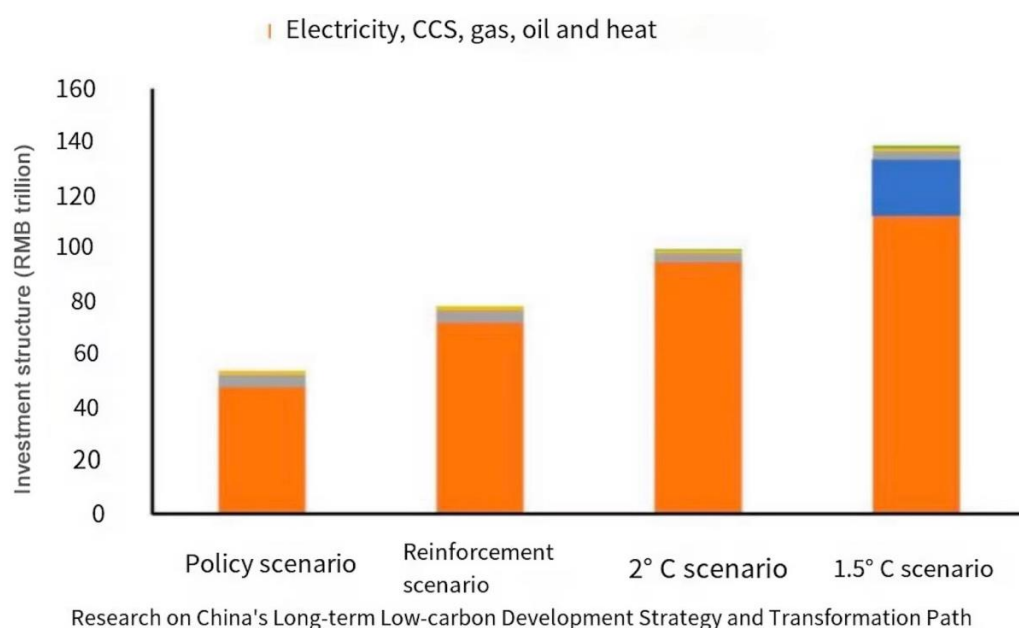


Figure 1. Green Investment Needed for a Net Zero Future

Souce: China's Long-term low-carbon Development Strategy and Transition Path

The Chinese government has instituted an emissions trading system as a strategic measure to curtail greenhouse gas emissions. The establishment of a nationwide carbon emission trading market holds profound implications for China's pursuit of carbon peak and carbon neutrality, manifesting

chiefly in the following four dimensions: (1) Facilitating Green Industrial Transformation: The carbon market endeavors to steer high-emission industries towards a greener and low-carbon industrial structure and energy consumption patterns. It propels high-emission sectors to take the lead in attaining emission peaks. (2) Emitting Price Signals for Emission Reduction: It issues price signals for carbon emission reductions, thereby offering economic incentives to channel capital into industries with considerable potential for emission abatement. This mechanism encourages innovation in green and low-carbon technologies and propels breakthroughs in cutting-edge technologies, expediting the transition towards green and low-carbon development in high-emission industries. (3) Fostering Carbon Sink Expansion and Renewable Energy: The carbon market promotes the expansion of carbon sinks through forestry, advances renewable energy development, and encourages regional coordination, ecological protection compensation, and the advocacy of green and low-carbon production and consumption modes. This is accomplished through the establishment of a national carbon market offset mechanism. (4) Enabling Financing for Low-Carbon Transformation: Leveraging the national carbon market, funding avenues are created to support the transformation towards green and low-carbon development in both industries and regions, with the ultimate aim of achieving carbon peak and carbon neutrality. Consequently, the carbon trading market effectively optimizes the allocation of carbon resources, enabling cost-effective carbon reduction. This market-driven approach represents a pivotal innovation in environmental economic policy, resolving environmental challenges through a market-oriented framework. The evolution of carbon market mechanisms, particularly carbon finance, serves to catalyze the flow of societal capital into low-carbon domains. This, in turn, stimulates the development and deployment of low-carbon technologies and products by enterprises, propelling shifts in business models, enhancing market competitiveness, and serving as a catalyst for nurturing and innovating the low-carbon economy.

2. Overview for Low-carbon Economy and International Trade

The low-carbon economy represents the prevailing paradigm of economic development designed to address the challenges posed by global warming and the imperative to curtail carbon dioxide emissions. It stands as an inexorable trajectory within the broader framework of international community development. The crux of the low-carbon economy hinges upon a dual commitment to diminished energy consumption and reduced emissions, accomplished through the utilization and advancement of modern energy sources, enhancement of energy efficiency, optimization of industrial composition, recalibration of economic development modalities, curtailment of greenhouse gas emissions, deceleration of the climate warming process, and realization of sustainable economic progress. Aligned with the overarching ethos of sustainable development, the low-carbon economy represents an innovative approach to economic advancement. It addresses the concomitant issues of energy utilization and environmental pollution through a synthesis of institutional and technological innovations. This innovative framework, aimed at simultaneously achieving economic prosperity and ecological well-being, exemplifies a transformative solution to contemporary challenges [2].

The essence of a low-carbon economy lies in its pivotal role in orchestrating a profound transformation of the energy landscape. Firstly, a low-carbon economy is contingent upon harnessing renewable and eco-friendly energy sources, thereby instigating a pivotal reshaping of the energy matrix. This fundamental shift mitigates the reliance on conventional fossil fuels, enhances energy efficiency, and fosters economic sustainability. Secondly, a low-carbon economy galvanizes sustainable economic progress through the curbing of carbon emissions and prudent management of finite resources. This stratagem preemptively circumvents the deleterious ramifications of resource depletion and environmental degradation on the economic sphere while concurrently augmenting corporate competitiveness. Thirdly, the development of a low-carbon economy mandates enterprises to enact comprehensive measures encompassing energy conservation, emission abatement, and technological innovation. These measures serve to fortify international collaboration, propel innovation capabilities, and bolster competitive prowess. Fourthly, the low-carbon economy

transcends national borders and assumes the mantle of a global concern, necessitating collective endeavors from all nations. This collective endeavor is directed at addressing the multifaceted challenges posed by climate change and environmental degradation through the facilitation of heightened international cooperation, exchange of cutting-edge technologies, and intensified energy collaboration. In effect, a low-carbon economy not only underpins sustainable economic advancement and corporate competitiveness but also advances the cause of global climate governance and environmental preservation [3].

International trade, commonly referred to as import-export trade, signifies the intercontinental trade of goods and services among countries. On a global scale, the pivotal function of international trade lies in nurturing domestic economic growth and promoting economic collaboration and interaction between nations. This phenomenon is instrumental in optimizing the utilization of domestic production factors while simultaneously bolstering bilateral supply and demand dynamics with partner nations [4]. Consequently, every nation attaches significant significance to international trade. In the conduct of trade operations, foreign trade enterprises must meticulously monitor foreign policies to effectively circumvent trade barriers.

3. Opportunities for China's International Trade Arising from the Development of a Low-carbon Economy

3.1. Help to Build an International Trade Protection Circle

The global consensus on the imperative of a low-carbon economy is ubiquitous, with nations worldwide acknowledging the transformative role of environmental preservation as a catalyst for economic advancement. Consequently, there is an emerging paradigm of "low-carbon environmental protection" shaping the contours of a novel international trade framework. This protective framework is characterized by the recurrent delineation of contemporary prerequisites and global standards within the realm of international trade. Its core premise lies in aligning the import and export of commodities with green and low-carbon benchmarks, thereby applying varying degrees of tariffs to foster the symbiotic relationship between ecological and economic gains. This systemic model holds considerable promise in solidifying the pivotal role of the low-carbon economy within the sphere of international trade. It serves as a guiding beacon for the establishment of a fresh international trade order, compelling nations worldwide to conscientiously adhere to carbon emission standards. This, in turn, incentivizes the production and circulation of products that conform to green and low-carbon criteria, ultimately propelling sustainable trade economic development [4].

3.2. Contribute to the Transformation and Upgrading of Industrial Structure

In alignment with the foundational tenets of a low-carbon economy, the global economic and trade landscape is inexorably steering toward a paradigm characterized by environmental sustainability, purity, and ecological harmony. Within this transformative context, novel industrial models are poised to incubate, giving rise to emergent economic modalities. As a nation renowned for its extensive manufacturing capabilities, China's primary engagement in international trade predominantly revolves around industrial semi-finished goods and manufactured products. The resolute pursuit of a low-carbon economy exerts a compelling impetus upon enterprises, compelling them to fortify their commitment to technological research, development, and innovation. This impetus is particularly pronounced in the realm of clean energy and environmentally conscientious production methodologies. Consequently, there exists a discernible contraction in the production capacity at the lower echelons of the industrial spectrum, facilitating a concomitant elevation of the industrial value chain. This ascent substantially augments the intrinsic worth of traded goods. The tabulated data in Table 1, covering the period spanning 2017 to 2022, offers a comprehensive view of China's aggregate import and export volumes. Evidently, the export figures for China's conventional trade sectors have registered a marked decline, notably in the domains of mechanical

and electrical commodities, as well as fossil energy-related products. In stark contrast, trade segments accentuating the valorization of environmental preservation exhibit an ostensible surge in trading volume [5]. Following a methodical recalibration of its economic landscape, China is poised to assume a pioneering role in international trade undertakings. This transition involves a shift away from primary processing trade, with a concomitant expansion of deeply rooted service-oriented trade. The net result is a substantial amplification in the economic output derived from trade activities, thereby establishing the foundation for a robust economic cycle. It is evident that the low-carbon economy has been a pivotal catalyst in effecting the reform and rejuvenation of China's traditional trade structure, concurrently fostering the elevation of its industrial framework.

Table 1. China's total import and export of goods from 2017 to 2022

Years	Import amount of goods / 100 million yuan	Export volume of goods / 100 million yuan
2017	124790	153309
2018	140880	164129
2019	143254	172374
2020	142936	179279
2021	173608	216908
2022	181024	239654

Source: Study on the impact of low-carbon Economy on the development of international trade Management and Technology of Small and Medium-sized Enterprises

4. Challenges to China's International Trade Arising from the Development of a Low-carbon Economy

4.1. Low-carbon Technology Becomes a Current Barrier to International Trade

As global efforts to address carbon emissions intensify and regulations become more stringent, the realm of international trade is inevitably confronted with the imposition of carbon tariffs, which necessitate the implementation of distinct strategies for managing cross-border trade activities. Carbon tariffs, constituting a fiscal measure, represent a specialized imposition of levies on carbon emissions. These tariffs have been devised and enacted by certain sovereign nations and regions, primarily as a mechanism to assess a surcharge on products with conspicuous energy consumption during their importation. This strategic approach aims to ensure that products engaged in actual export transactions conform to low-carbon standards [6]. The advent of carbon tariffs fundamentally raises the barriers to international trade, thereby instituting a discernible constraint on China's import and export activities. Despite China's remarkable economic progress and its sustained, substantial growth rate, the nation confronts limitations stemming from its relatively underdeveloped state of scientific and technological research and development. This deficiency has resulted in an absence of advanced carbon emission control technologies within its grasp, consequently subjecting its export trade to various regulatory controls, ultimately affecting the country's trade and economic interests. Concurrently, the emergence of carbon labeling has gained traction in developed Western countries, as they gradually propagate this technology. Carbon labeling encompasses the practice of affixing information regarding raw materials, production methods, quality standards, and other pertinent details on a product's packaging, enabling consumers to make informed choices in selecting low-carbon products. The advocacy for carbon-labeled products (CLP) inherently promotes energy conservation and emission reduction. However, the adoption rate of CLP among Chinese consumers remains relatively low, impeding the establishment of a comprehensive low-carbon consumption environment. Furthermore, the steep cost associated with this technology and China's current incapacity to effectively promote and popularize it contribute to the country's inability to attain a dominant position in current trade activities [7].

4.2. The Growth Pattern of International Trade Exports Has Changed

In conventional trade paradigms, China has predominantly adhered to an approach characterized by extensive processing and production. This approach entails engaging in trade activities centered around the exportation of raw materials or minimally processed products. Within this conventional framework, the exported products exhibit a low added value, resulting in modest economic profits. Moreover, the focus on technological innovation is limited, with a heavy reliance on energy consumption and resource inputs. The performance of hidden carbon emission competitiveness of different product sectors in international trade and inter-provincial trade is quite different [6]. Presently, a significant portion of China's exports comprises items susceptible to environmental pollution, including machinery, chemicals, and light textile goods, among others. These export commodities do not align with the stringent criteria for low-carbon emission production as stipulated in contemporary standards [2]. In light of the burgeoning low-carbon economy, it is imperative for China to transition from its resource-dependent trade model to one that prioritizes technology research and development. This transformation must be underpinned by a commitment to environmental preservation, as it is the key to active integration into the global trade arena. Failing to make this shift would impede the sustainable advancement of China's import-export trade, hampering substantive progress and jeopardizing the sustainable development of ecological resources. Consequently, it would undermine the quality of living environments and limit economic growth prospects.

5. Strategies for the Development of China's International Trade in the Context of a Low-carbon Economy

5.1. Improving the Energy Mix

In accordance with the foundational principles of sustainable development, industries characterized by high emissions and excessive resource consumption not only precipitate ecological degradation but also exacerbate non-renewable energy depletion, thus manifesting a spectrum of energy-related challenges [8]. These challenges, in varying degrees, undermine economic advancement, catalyzing a detrimental cycle that is incongruent with contemporary economic imperatives. Consequently, it is imperative that it proactively recalibrates existing energy infrastructure, harmonizing it with the tenets of a low-carbon economy. This necessitates a gradual diminishment in the reliance on high-carbon energy sources, coupled with a concerted effort to amplify the development and deployment of both clean and renewable energy technologies [9-10]. This iterative process entails continual enhancements in technological prowess, aimed at curtailing energy consumption within the ambit of traded goods, thereby aligning with the trajectory of future international trade dynamics [11]. Within the context of China's unique circumstances, it is imperative to intensify research and development endeavors dedicated to low-carbon technologies. This mandate calls for substantial investments in financial and material resources, the cultivation of emerging scientific and technological talent, and the vigorous pursuit of clean energy modalities, such as solar, nuclear, and wind power. These innovations must be methodically assimilated into the production and manufacturing domains, reducing the ecological footprint of economic activities. Furthermore, synergistic collaborations with technologically advanced nations should be fostered, facilitating the introduction of cutting-edge energy technologies. In-depth scrutiny of these technologies' underlying principles should be pursued, with the ultimate goal of mastering pivotal low-carbon energy solutions. By doing so, it can significantly enhance energy efficiency and utilization, bolstering our commitment to a sustainable future.

5.2. Participate in the Formulation of Multilateral Trade Rules

The extensive promotion of a low-carbon economy is poised to catalyze significant transformations in international trade regulations, ushering in a paradigm shift in conventional trade dynamics. In view of this overarching shift, trading nations must expeditiously acknowledge the

evolving trade landscape. They should actively engage in the formulation of trade regulations within the low-carbon framework, with a steadfast commitment to advancing the interests of Chinese trade and economic endeavors. This proactive engagement is essential to fostering greater fairness and integrity in international trade activities. To effectively navigate this changing landscape, China must adopt a multifaceted approach. Firstly, in the process of contributing to the establishment of standards, China should meticulously assess its unique developmental context. By doing so, it can craft judicious low-carbon economy standards that align with the pertinent provisions of the United Nations Climate Convention. This approach ensures that China's international trade flourishes while simultaneously aligning with the overarching objective of advancing a low-carbon economy. Secondly, an emphasis should be placed on conducting in-depth research pertaining to international low-carbon standards and trade classifications. This research should be aimed at tailoring the development of environmentally sustainable products that conform to stringent low-carbon benchmarks [12]. Simultaneously, concerted efforts should be directed towards reducing international trade barriers associated with such products. These endeavors will enhance China's capacity to adeptly navigate the evolving international trade milieu under the auspices of the low-carbon framework.

5.3. Improve the Product Trade Structure

In light of the prevailing low-carbon economic standards, it is imperative for all trading entities to engage in a comprehensive examination of international carbon emission standards. These standards should be meticulously adapted to precise product manufacturing requirements, with a concerted effort to curtail the exportation of high-carbon products and to actively foster the growth of service-oriented trade. In this intricate milieu, China must proactively cultivate its tertiary sector, actively propel advancements in science, technology, environmental preservation, and emerging energy sectors. Concurrently, it must implement efficacious strategies to recalibrate its industrial composition, ultimately realizing a symbiotic relationship between economic development and international trade expansion. On one front, stringent benchmarks for carbon-intensive products should be established in accordance with China's unique circumstances. Stringent inspections must be intensified for high-carbon goods, while endeavors should be made to reduce their proportion in export volumes to the greatest extent possible. On the other hand, encouragement and support should be extended to the growth of service trade sectors such as healthcare, education, and cultural services. These sectors have the potential to mitigate energy consumption arising from imports and exports, align with trade regulations, and invigorate the nation's trade-based economy. Moreover, a heightened commitment to financial and material investments is crucial. The infusion of top-tier technical talent and the reinforcement of low-carbon technology research and development are paramount [13]. These measures will provide the essential technical underpinnings required for the advancement of low-carbon industries and will augment the nation's competitive edge in international trade [14, 15].

6. Conclusion

In conclusion, the burgeoning low-carbon economy has emerged as a prevailing paradigm in contemporary economic development, commanding escalating attention and recognition from a multitude of nations in recent years. The ascendance of the low-carbon economy is an inexorable global trajectory, resonating not only within expansive international trade markets but also within the broader economic landscape, in harmonious alignment with the inherent laws governing economic and societal evolution. The low-carbon economy exerts a pivotal influence on China's international trade landscape, serving as a catalyst for the metamorphosis and advancement of China's economic growth paradigm, as well as instigating reforms in China's trade architecture. This transformative impetus has engendered diverse models and manifestations within the realm of commerce. However, it is crucial to acknowledge that, in the actual progression, certain incongruities persist between international trade and the low-carbon economy. In light of these challenges, the promotion of China's international trade necessitates the implementation of efficacious measures aimed at continually

enhancing legal and regulatory frameworks pertinent to the low-carbon economy. Concurrently, proactively adapting industrial structures and innovating extant technological methodologies are imperative steps in nurturing an enabling environment conducive to sustainable development.

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