Carbon Border Adjustment Mechanism and Supply Chain Decarbonization Strategies: A Systematic Literature Review

Bowen Tang, Xiaohan Zhang and Qiaoli Lai *

School of Economics and Management, Nanjing University of Science and Technology, Nanjing, 210094, China

* Corresponding Author Email: laiqiaoli@njust.edu.cn

Abstract. Carbon emissions and carbon governance have long been a focal point in environmental research, giving rise to numerous international policies. Among these, the carbon tariff is one of the measures proposed by European Union member states as part of their response to global carbon governance. This study adopts a literature review approach, systematically reviewing and summarizing the relationships between carbon tariffs and the environment, derivative policies, and supply chains. It organizes and analyzes the concept and impact mechanisms of carbon tariffs, while also identifying potential research directions for future studies on carbon tariffs in the supply chain sector.

Keywords: Systematiature Review, Carbon Tariffs, Green Supply Chain.

1. Introduction

Environmental issues have always been a focal point of global concern. Against the backdrop of the European Union proposing concepts such as " carbon tax" and " carbon tariff" , related issues have sparked extensive academic research. Tariffs are a traditional and commonly used trade policy tool that play an indispensable role in the global trade system. Compared to tariffs, carbon tariffs are a type of tax rate based on carbon emissions as a measurement standard.

Carbon tariff rates are set by relevant government departments based on the social welfare they generate. These rates influence the prices of goods and trade flows, and also impact corporate decision-making through product costs and profits. To date, research has explored the economic effects of carbon tariffs from multiple angles, such as trade distortion, welfare losses, price transmission effects, and the restructuring of global value chains. However, current research still has some discrepancies and shortcomings, such as carbon leakage and companies' offshore production strategies, the impact of government subsidies on companies' production and investment decisions, and companies' decisions under different contractual mechanisms.

Therefore, this paper aims to systematically review existing literature on carbon tariffs and their impacts on supply chains under different mechanisms, clarify the main research perspectives and evolutionary paths, analyze their research methods and theoretical foundations, and further identify research gaps and future directions. This review will cover the development of carbon tariffs and their derivative policies, their impacts on supply chains, and green supply chains, encompassing mainstream research findings from both domestic and international sources in recent years, with a particular focus on the latest advancements in empirical research and model analysis.

The structure of this paper is as follows: Section Two will describe the selection, statistics, and analysis of the literature; Section Three will outline the theoretical foundations of carbon tariffs' impacts on policy, strategy, and supply chains, and review the main findings from empirical studies or model analyses; Section Four will summarize the current research's shortcomings and challenges, present the main conclusions of this paper, and propose future research directions.

2. Literature statistical analysis

2.1. Screening Criteria

This paper selects academic papers related to low-carbon economy, supply chain management, and carbon policy from authoritative domestic and international databases such as Web of Science, Scopus. The selected papers cover English journals (e.g., Production and Operations Management, International Journal of Production Economics and Transportation Research Part E: Logistics and Transportation Review).

Given the timeliness and cumulative nature of the research topic, the publication date of the literature is restricted to 2010-2025 to cover the critical stages of the emergence and rapid development of concepts such as carbon tariffs and low-carbon supply chains.

2.2. Keyword Analysis

2.2.1 Cluster analysis

The network consists of 9 clusters. The largest 9 clusters are summarized as follows, Cluster #0 o2o retail supply chain, Cluster #1 contracting emission reduction, Cluster#2 search, Cluster #3 transnational remanufacturing decision, Cluster #4 carbon tariff, Cluster #5 carbon tax policy, Cluster #6 carbon emissions tax, Cluster #7 comparative analysis, Cluster #8 low carbon emission.

2.2.2 Citation counts

The top ranked item by citation counts is policy in Cluster #7, with citation counts of 11. The second one is coordination in Cluster #0, with citation counts of 10. The third is decisions in Cluster #4, with citation counts of 10. The 4th is carbon tax in Cluster #3, with citation counts of 8. The 5th is model in Cluster #5, with citation counts of 7. The 6th is supplying chain in Cluster #0, with citation counts of 7. The 7th is cap in Cluster #3, with citation counts of 6. The 8th is game theory in Cluster #4, with citation counts of 6. The 9th is design in Cluster #3, with citation counts of 5. The 10th is emissions in Cluster #4, with citation counts of 5.

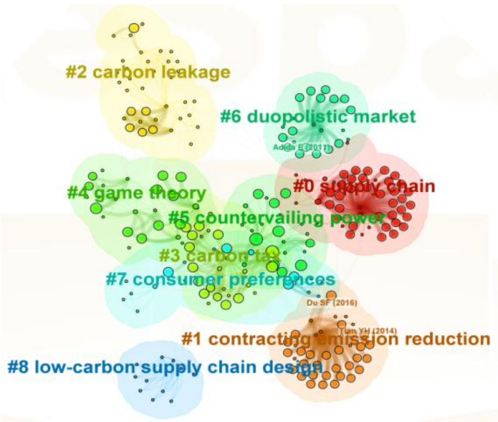

Fig 1. Keyword Clustering Map.

Citation Counts	Node Name	DOI	Cluster ID
11	policy		7
10	coordination		0
10	decisions		4
8	carbon tax		3
7	model		5
7	supply chain		0
6	cap		3
6	game theory		4
5	design		3
5	emissions		4

Fig 2. Citation counts.

2.3. Time trend analysis

From the chart data, from 2010 to 2025, research on supply chains and low-carbon initiatives has shown significant dynamics. Early concepts such as “cooperation” and ‘Bertrand’ served as the foundation, followed by in-depth exploration of low-carbon policy tools such as “carbon tariffs” and “cap-and-trade,” as well as supply chain management strategies like “closed-loop supply chains” and “sustainable pricing”.

As time progressed, terms like “O2O retail supply chain” and “optimizing supply chain configuration with low carbon emissions” emerged, reflecting the growing integration of practical scenarios with emission reduction goals. The continued development of concepts like “contracting emission reduction” and “carbon emission reduction” indicates that the design of supply chain emission reduction mechanisms remains a central focus of research. Overall, the research has evolved from establishing foundational concepts to policy application, optimizing supply chain models across multiple scenarios, and developing precise emission reduction strategies. This reflects the trend of theoretical and practical development in response to the demands of a low-carbon economy, while also indicating that there is still room for expansion in areas such as cross-domain integration and dynamic mechanism innovation.

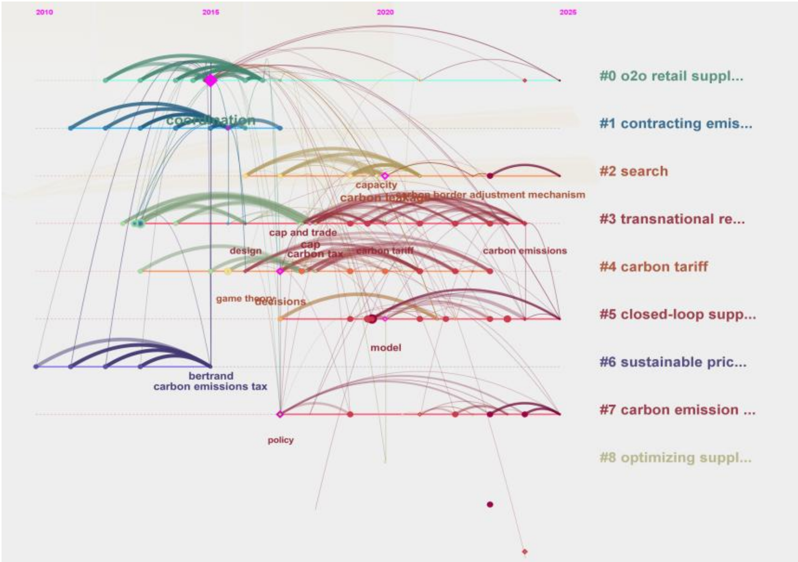

Fig 3. Time trend chart.

3. Literature References

3.1. Carbon Tariffs

3.1.1. Carbon Taxes and Carbon Emissions

Carbon taxes and carbon emissions trading systems serve as the primary carbon pricing tools aimed at reducing greenhouse gas emissions (Hua et al., 2024). To date, such carbon emission policies are being gradually implemented. Among these, Zhou et al. (2024) argue that differences in carbon emission regulations are the primary obstacle to global carbon emission reductions and, based on this, conducted a study analyzing two strategies for countries with lower levels of carbon emission regulation. Due to varying levels of development among nations and regions, their carbon emission standards have different restrictions. For countries with higher regulatory standards, there are strict limits on product carbon emissions, so they may choose to impose tariffs on imported products. For countries with lower regulatory standards, they can opt to allocate carbon quotas to manufacturers or provide subsidies. Zhou et al. (2024) primarily focused on the social welfare of the two types of countries, examining the impact of emission reduction costs on countries with lower carbon emission regulatory standards under two strategies: carbon quota allocation and subsidy provision. Zhou et al. (2024) argue that, under constant emission reduction costs, both carbon quota and subsidy strategies can achieve a win-win situation for countries with high and low carbon emission regulation levels; however, under increasing emission reduction costs, only the carbon quota strategy can achieve a win-win situation for countries with high and low carbon emission regulation levels. Zhang et al. (2023) also use social welfare as the standard, but the article discusses carbon tariff rates, exploring the optimal rates for maximizing social welfare and trade surpluses, respectively. It is worth noting that when the government sets the carbon tariff rate with the goal of maximizing social welfare, if the utility of overseas products exceeds that of domestic products, the government will incentivize the entry of overseas products; however, when the government sets the tax rate with the goal of maximizing the trade surplus, the government will hinder the entry of overseas products under any circumstances. Therefore, Zhang et al. (2023) argue that when the utility of overseas products exceeds that of domestic products, shifting the carbon tariff rate from the rate under social welfare maximization to the rate under trade surplus maximization not only harms the interests of domestic enterprises but also undermines social welfare. Traditional views hold that carbon tariffs can reduce carbon emissions, but Fang et al. (2020) found that under excessively high carbon tariff rates, global carbon emissions may not necessarily decrease. Additionally, Huang et al. (2021) explored two policy scenarios using uncertainty in emission prices as a variable: a "punitive" border tax based on measures and an "incentive-based" allocation based on output. Interestingly, Huang et al. (2021) also included carbon leakage in their study. Companies may strategically relocate production to regions with less stringent regulations, so inconsistencies in global emissions regulation could lead to emissions shifting. Huang et al. (2021) show that in the absence of leak-proofing policies, uncertainty in emission prices may have the opposite effect: when expected emission prices are low (high), higher uncertainty exacerbates (mitigates) carbon leakage.

3.1.2. Carbon leakage and related measures

To address this issue, the concept of "carbon quotas" has gradually emerged in global carbon governance. The primary methods of carbon quota allocation include free allocation, paid allocation, and a hybrid approach. Among these, the grandfathering mechanism and the benchmarking mechanism are the two main allocation methods. Ji et al. (2017) compared the impacts of the grandfathering mechanism and the benchmarking mechanism on corporate decision-making, profits, and social welfare, demonstrating that the unit carbon quota plays a decisive role in corporate decision-making. Specifically, compared to the grandfathering mechanism, the benchmarking mechanism is more effective in encouraging manufacturers to produce low-carbon products and incentivizing retailers to promote low-carbon products. From the perspective of retailers, they are more likely to prefer the benchmarking mechanism over the grandfathering mechanism; from the government's perspective, applying the grandfathering mechanism to low-carbon emitting enterprises and the benchmarking mechanism to high-carbon emitting enterprises is more advantageous.

In December 2022, the European Parliament, the European Commission, and the Council of the European Union reached an agreement on the Carbon Border Adjustment Mechanism (CBAM), which will be implemented at the EU border to offset the carbon prices paid by EU producers, thereby preventing carbon leakage and restoring a fair competitive environment in high-emission industries. Bellora & Fontagné (2023) quantified the environmental and economic impacts of different CBAM design schemes, including carbon leakage, GDP, trade, and value added by industry, demonstrating the effectiveness of the CBAM in reducing carbon leakage. Additionally, the study found that the design of the CBAM increases carbon prices within the European Emissions Trading System (ETS). For downstream industries not covered by the CBAM and exporters from high-emission industries in Europe, competitiveness losses in export markets remain inevitable, even with a refund mechanism in place (Bellora & Fontagné, 2023). However, it is worth noting that Zhao & Lin (2025) indicate that the EU's proposed CBAM generates significant profits for EU countries through carbon costs. Although the opportunity costs of forest conservation vary significantly among the 62 REDD+ countries, they remain below the average carbon price of developed countries. Therefore, Zhao & Lin (2025) propose establishing consistent carbon credit standards between the VCM and CBAM, integrating REDD+ projects from the voluntary carbon market (VCM) into CBAM to enhance their emission reduction flexibility and achieve greater ecological benefits.

3.1.3. Carbon Reduction Investment Decisions and Supplier Profits

From the supplier's perspective, Luo et al. (2022) and Zhang et al. (2024) analyzed the decision-making of manufacturers and retailers regarding carbon reduction investments under different circumstances. Zhang et al. (2024) set up two scenarios: retailers with capital constraints and retailers without capital constraints. When retailers have capital constraints, manufacturers will always make carbon reduction investments; However, when retailers are not subject to capital constraints, manufacturers only invest in carbon emissions reduction when the carbon tax rate is low. Luo et al. (2022) incorporated centralized and decentralized closed-loop supply chains into the decision-making of manufacturers and retailers to assess the impact of their manufacturing and remanufacturing decisions. The results show that carbon taxes can effectively encourage manufacturers to invest in carbon reduction technologies or engage in remanufacturing to reduce carbon emissions. However, if carbon taxes are designed improperly, they may weaken manufacturers' willingness to engage in remanufacturing. Therefore, governments must establish reasonable standards when imposing carbon taxes and provide moderate low-carbon subsidies to optimize social welfare. (Wu et al., 2022) Similarly, based on carbon reduction strategies from the manufacturer's perspective, Cheng et al. (2025) constructed a mixed-integer linear programming (MILP) model aimed at profit maximization, confirming that carbon emission reduction investments and carbon commitment financing can simultaneously reduce manufacturers' carbon emissions and enhance supply chain profitability. Through sensitivity analysis, they concluded that carbon quota prices and consumers' green preferences have a positive impact on profits and carbon emission reductions in green supply chains. Nie et al. (2020) explicitly considered carbon emission caps and transaction prices in a supply chain configuration setting that accounts for operational capacity, and established a mixed-integer nonlinear programming (MINLP) model to solve for the optimal solution. Government-imposed carbon emission policies have a significant impact and interaction on optimal supply chain configuration and performance.

3.2. The Impact of Carbon Taxes on Supply Chains

3.2.1. The Impact of Carbon Taxes on Supply Chain Structure and Operating Models

Carbon tax policies are driving supply chains to transition from traditional linear models to low-carbon, closed-loop systems. Early studies have primarily focused on the emissions reduction effects of single-stage supply chains. For example, Drake (2018) constructed a partial equilibrium model indicating that carbon taxes may lead firms to relocate production to regions without carbon taxes, resulting in “carbon leakage.” However, when CBAM is introduced, this leakage may transform into “clean leakage”, prompting firms to adopt lower-carbon technologies. Subsequent research has expanded to multi-stage supply chains. For example, Chakraborty et al. (2025) studied how electric vehicle supply chains can collaborate and compete to maximize profits simultaneously, discovering that the synergistic effects of carbon taxes and green technology investments can significantly reduce overall supply chain emissions, and integrated supply chains are more likely to achieve a balance between emissions reduction and profit maximization.

In closed-loop supply chains, the impact of carbon taxes on remanufacturing and recycling processes is particularly significant. Miao et al. (2018) found that carbon tax policies enhance the competitive advantage of remanufactured products, and manufacturers with emission advantages under high subsidies and high tax rates tend to increase their remanufacturing ratios. Luo et al. (2022) examined manufacturing and remanufacturing decisions under carbon tax policies, finding that reasonable carbon taxes can incentivize manufacturers to invest in carbon reduction technologies or make remanufacturing decisions to reduce carbon emissions. Li et al. (2024) further pointed out that carbon tax policies do not always encourage manufacturers to engage in remanufacturing; high carbon taxes may force manufacturers to abandon trade-in and remanufacturing. Li et al. (2024) studied how the dual effects of carbon taxes and tariffs influence corporate production decisions in cross-border remanufacturing scenarios.

As a policy tool to address cross-border emissions, many studies have examined the impact of carbon tariffs on carbon emissions from a global supply chain perspective. Zhou et al. (2024) analyzed the impact of low-carbon regulatory strategies on global supply chains and carbon emissions. Fang et al. (2020) found that carbon tariffs do not necessarily reduce carbon emissions when suppliers have both domestic and international sales channels, as suppliers can produce more products for the unregulated domestic market, leading to “carbon leakage” issues. Hua et al. (2024) further examined companies' domestic or foreign investment production strategies under different carbon tax pricing scenarios, with firms balancing carbon costs and technology investment costs to allocate cross-regional production. Carbon tax policies also significantly alter multinational corporations' production location decisions. Yang et al. (2021) investigated the impact of tariffs and production costs on the repatriation decisions of multinational corporations under dual constraints of tariffs and production costs. Under low tariffs, multinational corporations tend to relocate production facilities to low-cost countries.

3.2.2. Corporate Production and Emissions Reduction Decisions under a Carbon Tax

Production mode selection and emissions reduction investments are core strategies for companies responding to carbon taxes. Tian et al. (2024) found that as unit emissions increase, high-carbon product manufacturers subject to strict carbon policies are more likely to increase their emissions reduction investments, thereby lowering product prices and expanding market share. Cheng et al. (2025) proposed a MILP model showing that under carbon tax pressure, firms prioritize the production of high-profit products with low transportation and production carbon emissions. Chu et al. (2024) found in their study of Vietnam's steel industry that CBAM incentivizes firms to adopt low-carbon technologies and accelerate the transition to clean energy, but low carbon prices cannot enable Vietnam to achieve its emissions reduction intensity targets.

Carbon taxes also drive companies to innovate technologically and redesign their product lifecycle strategies. Jin et al. (2025) confirmed through empirical research that improved digitalization levels among downstream customer firms significantly enhance the green total factor productivity of state-owned upstream suppliers, thereby raising the low-carbon level of the entire supply chain. Under the sustainable circular economy supply chain model constructed by Jauhari et al. (2025), the combination of carbon tax policies and delayed payment mechanisms controls emissions during production. Nie et al. (2020) propose from a supply chain configuration perspective that carbon taxes will prompt companies to expand their carbon emission operational capabilities and optimize inventory layout.

3.2.3. Supply Chain Coordination and Contract Design Under Carbon Tax Policies

Under carbon tax policies, coordination mechanisms among supply chain members become increasingly critical, and supply chain collaboration and contract design are key strategies for addressing carbon taxes. Wang et al. (2016) found that through cost-sharing and wholesale premium contracts, retailers and manufacturers can achieve their common goal of reducing carbon emissions while maximizing overall profits. Liu et al. (2021) found that when manufacturers and retailers form a centralized supply chain, they can achieve a win-win situation in terms of environmental protection and profit increase. Yu et al. (2025) designed a two-part tariff contract in a retailer-dominated supply chain, using incentive mechanisms to encourage suppliers to disclose their true emission reduction costs, thereby maximizing the overall emission reduction efficiency of the supply chain. Wang and Su (2025) constructed a bidirectional carbon emission right option tradeing, showing that revenue-sharing and cost-sharing contracts can coordinate a two-stage supply chain under a carbon quota trading mechanism, forming a virtuous cycle of “emission reduction - revenue.” Zhang et al. (2024) found that manufacturers may fall into a “low investment trap” in competitive supply chains under the prisoner's dilemma.

In terms of cost and pricing decisions in supply chains, Chen & Hao (2015) found through a game theory model that carbon tariffs increase the unit product cost for exporting firms, leading to divergent pricing and production strategies between high-efficiency and low-efficiency firms. High-efficiency firms can maintain lower prices and higher profits under carbon tariffs due to their cost advantages, while low-efficiency firms are more significantly impacted by carbon tariffs in terms of profits and carbon emissions reductions. Mei et al. (2024) explored the impact of manufacturers' fairness concerns on pricing decisions, finding that unfavorable fairness issues have a negative impact on wholesale prices. Manufacturers are more willing to increase carbon reduction efforts and attract more consumers through more sustainable products to bridge the income gap.

Regarding carbon tariff policy design, Wu et al. (2022) compared policy tools such as carbon taxes and low-carbon subsidies, finding that a single policy struggles to balance emissions reduction and economic efficiency. They propose a “carbon tax + subsidy” combination strategy, imposing carbon taxes on high-emission firms while providing subsidies for low-carbon technology investments to maximize environmental and economic benefits. Ji et al. (2017) studied the impact of different carbon quota allocation mechanisms on supply chain decisions, profits, and social welfare, while considering manufacturers' low-carbon innovation and retailers' low-carbon promotion, providing policy recommendations for governments.

3.3. Green Supply Chain

3.3.1. Green Supply Chain-Based Corporate Emissions Reduction Strategies

Climate change poses a serious threat to economic and financial stability, making action to address global warming increasingly urgent. Carbon tax policies implemented by many national governments are key tools in addressing this challenge. Nie et al. (2020) considered carbon emission caps and trading prices to study supply chain configurations with low carbon emissions. Through a MILP model, they found that government carbon emission policies have a significant impact on optimal supply chain configurations and performance. Further, Ramadorai & Zeni (2024) established two models based on corporate disclosure data. The first is a dynamic model representing how typical firms balance emissions reduction and capital growth in the face of future carbon taxes. The second is a two-firm model incorporating cross-firm reputational externalities, differing perceptions of climate regulations, and emissions reduction follow-up interactions. The results show that the second model aligns with the data, indicating that firms' perceptions of regulations significantly influence emissions reduction, and cross-firm interactions amplify regulatory impacts. Regarding whether firms have incentives to reduce emissions, Cheng et al. (2025) developed a MILP model aimed at profit maximization. They found that emissions reduction investments and carbon emissions financing can simultaneously reduce manufacturers' carbon emissions and enhance supply chain profitability. Additionally, carbon allowance prices and consumers' environmental preferences positively influence green supply chain profits and emissions reductions.

Product recycling and remanufacturing are also considered to have positive environmental impacts, typically considered within closed-loop supply chains. Modak et al. (2025) examined green investment strategies for firms in closed-loop supply chains with price-dependent demand and remanufacturing. Luo et al. (2022) analyzed the impact of carbon taxes on manufacturing and remanufacturing decisions in closed-loop supply chain, establishing four game theory models, then found that carbon taxes can incentivize manufacturers to invest in carbon emissions reduction or engage in remanufacturing. However, inadequately designed carbon taxes may cause manufacturers to lose motivation for remanufacturing. Additionally, it was found that centralized supply chains yield higher profits and carbon emissions than decentralized supply chains. Further, Li et al. (2024) developed models from the perspectives of emerging and mature markets for their research, which also found that carbon tax policies do not always encourage manufacturers to engage in remanufacturing. Additionally, it was found that carbon taxes have similar effects on optimal decisions, total carbon emissions, and profits in both markets, but different effects on carbon emissions of remanufactured products and the residual value of used products.

Some scholars have considered equilibrium games in green supply chains under other conditions, Yu et al. (2025) studied a retailer-dominated Starberg game framework under asymmetric information costs for green investments, considering the impact of manufacturers retaining private investment cost information on retailers. They found that such information asymmetry encourages low-cost manufacturers to actively invest while deterring high-cost manufacturers from investing. Trading with low-cost manufacturers under information asymmetry is disadvantageous for retailers, while the opposite is true for high-cost manufacturers. Zhang et al. (2024) studied the game between manufacturers and retailers with funding constraints, finding that retailers' financing decisions primarily depend on carbon tax rates, while manufacturers' investment strategies primarily depend on their original carbon emissions.

3.3.2. Green Supply Chain Contract Design and Technology Application

How to optimize the interactions among all parties in the supply chain to achieve mutual benefits or promote emissions reduction has also become a key focus of green supply chain research. Wu et al. (2024) considered a decentralized capital-constrained green supply chain model consisting of a capital-constrained manufacturer and a retailer, where the manufacturer relies on the retailer to provide working capital and invest in green technology. The study examined three widely used green subsidy strategies by retailers, including price increase strategies, interest rate reduction strategies, and cost-sharing strategies. It found that retailers and manufacturers prefer interest rate reduction and cost-sharing strategies. Further research revealed that when retailers have environmental concerns, they are more inclined to adopt cost-sharing strategies. Regarding the wholesale price premium strategy and cost-sharing strategy, Wang et al. (2016) considered a bilateral supply chain composed of suppliers and retailers, and analyzed the game under two conditions: retailer dominance and power balance. They found that cost-sharing and wholesale premiums can enable retailers and manufacturers to jointly achieve carbon emission reduction targets while enhancing supply chain profits. Cost-sharing can achieve Pareto improvements under both retailer-dominated and power-balanced conditions, but wholesale premiums only increase supply chain profits under retailer-dominated conditions when there is a high preference for low-carbon levels. Under power-balanced conditions, even with a low preference for low-carbon levels, Pareto improvements can still be achieved.

Yang et al. (2024) considered distrust as a major obstacle to supply chain green transformation and incorporated blockchain technology into the game model. Based on this complex network evolution game model, they revealed the transformative potential of blockchain in promoting supply chain green transformation.

3.3.3. Global Green Supply Chains Considering Tariffs

Under policies such as CBAM, cross-border production is subject to the impact of carbon tariffs. Fang et al. (2020) explored the effects of carbon tariffs on global emissions control, constructing a global supply chain model that includes retailers in emissions-regulated countries and suppliers in non-emissions-regulated countries. They found that, in certain cases, carbon tariffs may not necessarily reduce global emissions. Zhou et al. (2024) found that for manufacturers with low emissions reduction costs, carbon tariffs increase both production and profits. Carbon tariffs always have a negative impact on low-carbon regulated countries. They further compared two strategies to reduce emissions reduction costs: carbon quotas and subsidies in low-carbon regulated countries. They found that for both countries and social welfare, both strategies are win-win under moderate emissions reduction subsidies. When subsidies are too high, carbon quotas become the win-win strategy.

Similarly, considering the scenario of remanufacturing, Niu et al. (2024) analyzed the strategic decisions of domestic brands that source overseas components from the perspective of a local supplier with its own branded end products and sells remanufactured components, considering the probability of overseas supply disruptions. They found that when the probability of disruption is high, some orders are allocated to local suppliers, and when it is at an intermediate level, local suppliers have an incentive to sell manufactured components to domestic brands. Further incorporating carbon tariffs, Li et al. (2024) studied the cross-border remanufacturing models of original equipment manufacturers (OEMs) in exporting countries under tariff and carbon tax conditions, including self-remanufacturing and authorizing remanufacturing operations to retailers in importing countries. They found that when carbon tariffs are high, the optimal sales volume of remanufactured products increases, Carbon tariffs cannot effectively incentivize original equipment manufacturers to invest in emissions reduction efforts. Remanufactured products must have carbon emissions comparable to new products for manufacturers to prefer authorizing retailers to perform remanufacturing. If importing countries impose high carbon tariffs to protect domestic firms, profitability cannot be achieved.

4. Summary

Existing relevant literature research primarily focuses on supply chain coordination and mechanism design using game theory models, with research content concentrated on carbon taxes, carbon tariffs, and remanufacturing. Additionally, some literature employs empirical analysis and the establishment of optimization decision models to investigate the significance of relevant factors on green supply chain emissions reduction. From a temporal trend perspective, research has evolved from the establishment of foundational concepts toward policy applications, optimization of multi-scenario supply chain models, and precise emissions reduction strategies. This reflects a trend toward theoretical and practical synergy in response to the demands of a low-carbon economy, while also indicating that there remains room for expansion in areas such as cross-disciplinary integration and dynamic mechanism innovation.

This paper reviews a large body of relevant literature from three angles—carbon tariffs, the impact of carbon tariffs on supply chains, and green supply chains—to introduce the current state of research and summarizes the following conclusions: (1) The dual nature of carbon tariffs: on one hand, carbon tariffs can effectively reduce carbon leakage, promote the low-carbon transformation of global supply chains, incentivize enterprises to invest in emission reduction technologies, and facilitate carbon governance coordination between developed and developing countries; on the other hand, improper tax rate design may exacerbate trade distortions, such as high tax rates leading to production shifts to unregulated markets, harming social welfare and corporate profits, and even increasing global emissions. (2) Pathways for supply chain decarbonization: Carbon taxes drive supply chains to evolve from linear models toward closed-loop and digitalized systems; emissions reduction investments are influenced by multiple factors including carbon tax rates, consumer green preferences, and financing capabilities; remanufacturing strategies require reasonable carbon tax and subsidy support; contractual designs such as cost-sharing and two-way carbon options can optimize supply chain profits and emissions reduction targets. (3) Necessity of Policy Coordination: A single carbon tax policy has limited effectiveness; a “carbon tax + subsidy” combination (taxing high emissions and subsidizing low-carbon technologies) can balance environmental and economic efficiency; carbon quota allocation mechanisms (such as benchmarking methods) must align with corporate emissions reduction costs to enhance social welfare.

For future research, the following can be considered: dynamic mechanism modeling to explore supply chain dynamics under policy iterations across multiple countries (e.g., CBAM expansion to a global scale), and quantifying the impact of policy changes on corporate long-term strategies (e.g., cross-border capacity layout); Existing research generally analyzes the constraints faced by small and medium-sized enterprises under carbon taxes rather than carbon tariffs. Further research could analyze the resilience of small and medium-sized enterprises under carbon tariffs (financing constraints, technological barriers) and design differentiated policy support tools; Research the application of blockchain and AI in green supply chains (such as real-time carbon footprint tracing) and verify their effectiveness in reducing regulatory costs and enhancing transparency; Multi-objective policy optimization: construct a “carbon tax-subsidy-carbon trading” coordination model, design relevant coordination mechanisms, and achieve a balance between emissions reduction, economic growth, and social equity objectives.

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