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Decision-making of Enterprise Greenwashing Behavior Under The Background of Carbon Tariff

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Abstract

Research background: As the EU deals with carbon leakage through carbon tariffs, export enterprises of some countries that do not meet the carbon emission standards face the problem of increasing export costs, so these enterprises have the tendency of "green washing". Therefore, how enterprises make decisions to deal with carbon tariffs and avoid the impact of changes in the terms of trade has become a hot topic. Based on the cost constraints of enterprises in developing countries, the information asymmetry between upstream and downstream enterprises, and the external environment constraints such as government and enterprise regulation and subsidy strategies, enterprises will make different decisions, including "brown enterprise" behavior that only considers economic benefits and "green enterprise" behavior that considers both economic benefits and environmental benefits. The research approach in this paper is based on game-theoretic analysis and adopts the supply chain game model proposed by Pretis (2022) [1]and Dong (2023[2]). This paper mainly discusses the different situations of maximizing the profit of individual enterprise and the profit of the whole supply chain through the game of the manufacturer's cost information advantage and the retailer's market information advantage. Finally, let business and government work together to get business to cancel the green washing practices that have been adopted. Conclusion: Based on the hypothesis that the EU is imposing carbon tariffs on developing countries, the greenwashing behavior of manufacturers and retailers is related to the green investment return rate of enterprises, the cost and rate of return of blockchain technology, and government subsidies.

Keywords

Greenwash; Blockchain; Government subsidies; Green supply chain.

1. Research Background

Carbon tariffs, alternatively referred to as Carbon Border Adjustment Mechanisms (CBAM), represent policy initiatives primarily aimed at environmentally mitigating or preventing the so-called carbon leakage that may arise from international trade activities, while simultaneously safeguarding the competitive edge of domestic products from an economic standpoint (Wojciech, 2024[3]). As articulated by the United Nations Framework Convention on Climate Change (UNFCCC, 2011), carbon leakage is characterized as a spillover effect that triggers the transfer of carbon emissions due to the allowance given to developing countries to transition from lenient to stringent emission regulations at a gradual pace. This spillover effect, however, leads to a paradoxical situation where the carbon emissions reduced in developed countries are negated by the increased emissions in developing countries. Analyzing this social phenomenon from an economic lens, Fang et al. (2020)[4] assert that the asymmetry in carbon emission regulations gives rise to a cost advantage for production activities in developing countries, attributed to their relatively lower emission control costs. Consequently, this dynamic encourages developed countries to source more goods from developing nations. To address carbon leakage and shield the trade environment of developed countries, the European

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Union has introduced and enforced a carbon tariff policy targeting imports from developing countries lacking emission regulations, a measure that has exacerbated the trade conditions for developing countries and imposed greater cost burdens on their exporters (Kilolo, 2018)[5]. In practical scenarios, grounded in governmental policies, Bounds (2010)[6] delineates greenwashing as a phenomenon where consumers struggle to ascertain a company's genuine commitment to environmental protection, often clouded by vague or exaggerated claims regarding its environmental performance and product friendliness. Greenwashing can garner favor from consumers who prioritize environmental considerations, leading to increased willingness to pay for such products, and may also attract preferential policies from governments. Consequently, engaging in greenwashing grants these companies a competitive advantage in their respective industries.

2. Behavioral Decision-Making Model and Hypotheses for Corporate Greenwashing

2.1. Enterprise greenwashing

Lyon and Montgomery (2015) [1] argue that corporate greenwashing is a widespread phenomenon influenced by factors such as information asymmetry, inadequate environmental regulation, and weak enforcement of penalties. Dong et al. (2023) [2] contend that whether a company engages in greenwashing depends on the probability of its greenwashing activities being exposed and the corresponding punishment. Only when the exposure probability and penalties for greenwashing are low can enterprises reap profits from such behavior. Yang et al. (2016) [8] suggest that corporate greenwashing arises when the introduction of carbon policies reduces a company's original profits and the enterprise lacks sufficient funds for technological upgrades to reduce emissions. It is evident that greenwashing results from a combination of internal cost pressures, lax external management, opaque market information, and the temptation of short-term gains from greenwashing behavior. Rahman et al. (2015) [9] argue that once corporate greenwashing is exposed, substantial funds are required to rebuild consumer confidence in the enterprise, not only undermining environmental benefits but also causing significant economic losses. Loannou et al. (2023) [10] research indicates that when corporate propaganda regarding green initiatives fails to meet consumers' green demands, it is perceived as greenwashing, leading consumers to doubt the enterprise's integrity. Therefore, from a long-term perspective, temporary economic gains are insufficient to build a solid brand reputation and customer base; instead, they undermine the enterprise's long-term competitiveness in the market.

2.2. Blockchain Technology

Blockchain technology, with its decentralized, transparent, and immutable characteristics, demonstrates significant potential in carbon footprint management. Through blockchain, enterprises can accurately track carbon data throughout the entire lifecycle, from production and transportation to consumption and recycling, allowing for the attachment of credible carbon labels to products. This not only helps enterprises enhance the credibility of their carbon footprint data but also strengthens their competitiveness in the global market. By reducing information asymmetry and establishing a reputation mechanism, blockchain technology can effectively mitigate the greenwashing dilemma. Furthermore, blockchain technology promotes collaboration among upstream and downstream enterprises within the industry chain, enhancing data circulation and utilization efficiency, thereby amplifying the value of data elements. These factors collectively assist enterprises in making more rational decisions and avoiding greenwashing behavior. Song et al. (2023) [11] utilize blockchain technology to address information asymmetry, improve the transparency, traceability, and

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verifiability of information transmission, and facilitate the transition of enterprises to new business models to address greenwashing issues across various supply chain scenarios.

2.3. Government Subsidies

Government subsidies have played a pivotal role in fostering green technological innovation. By providing financial support, tax incentives, and research and development (R&D) grants, governments encourage enterprises to increase investments in green technology research and development, thereby driving technological advancements in fields such as clean energy, energy conservation and emission reduction, and circular economy. Through the provision of transition funding, tax incentives, and other policies, governments encourage enterprises to adopt more environmentally friendly production methods and products, thereby reducing carbon emissions and environmental pollution. By requiring enterprises to disclose their environmental information and technological innovation achievements, government subsidies enhance public oversight of enterprises, thereby reducing the occurrence of greenwashing. Additionally, governments can establish green technology assessment and certification systems to evaluate and certify the innovation and application of enterprises' green technologies, enhancing public awareness and trust in green technologies. In the face of severe external challenges, research by Xu et al. (2023) [12] demonstrates that, for social welfare, the level of resident welfare under a combined model of carbon taxes and subsidies is significantly higher than that under a single carbon tax or subsidy.

The model used is shown below:

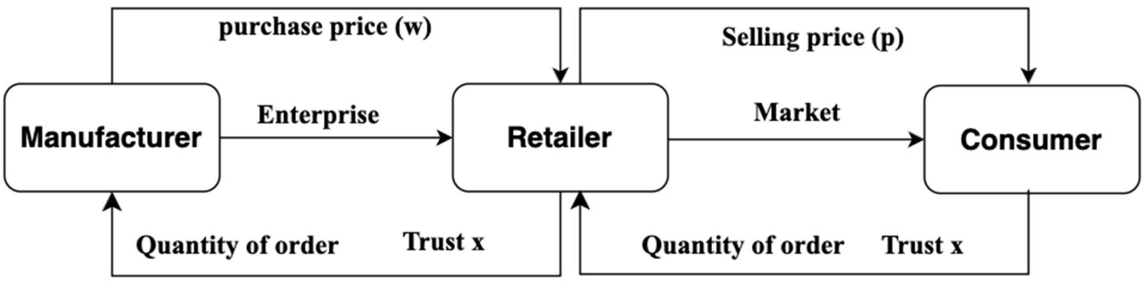

Figure 1. Transnational Supply Chain Model

3. Research Methods

3.1. Model Assumptions

Assumption 1: In a two-tier supply chain dominated by either manufacturers or retailers, under the carbon border adjustment mechanism (CBAM) policy, enterprises must consider not only their original production and operational costs but also an additional carbon tariff, denoted as T. The CBAM imposes carbon tariffs on China and other major trading partners of the European Union. The calculation formula for the carbon tariff is as follows: $Tariff = trade \times f_i \times max\{0, P_{EU} - P_s\}$, where "$trade$" represents the import value of product i from country s to the European Union; f_i is the carbon emission intensity per unit of output for product i in countries' production sector, measured through a multi-regional input-output model; $P_{EU} - P_s$ represents the difference between the CBAM carbon price and the carbon price in country s. Let $A = f_i \times max\{0,\ P_{EU} - P_s\}$, thus the carbon tariff T can be expressed as $T = AQ$, where Q represents the quantity of imports.

Assumption 2: There exist two types of consumers in the market. Consumers with a proportion of λ are green consumers who prefer green products. The remaining proportion of $1 - \lambda$ are non-green consumers who do not concern themselves with the greenness of products. The value coefficients for green consumers and non-green consumers are V_p and V_p, respectively,

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both assumed to follow a uniform distribution [0,1]. Let $x(0 < x < 1)$represent the probability that consumers believe enterprises invest in unobservable activities. Consequently, green consumers obtain an additional positive utility of $\alpha e_o + x(1-\alpha)e_u$, where p denotes the retail price of the product in the market. Thus, the utility for green consumers is: $U_P = V_p - P + \alpha e_o + x(1-\alpha)e_u$, and the utility for non-green consumers is: $U_N = V_N - p$. The market size is standardized to 1. Consumers will purchase the product when their utility is positive, i.e., $U_P > 0$ and $U_N > 0$. Therefore, the demand for the product equals $D_A = \lambda(1 - P + \alpha e_o + x(1-\alpha)e_u) + (1-\lambda)(1-p)$. If blockchain technology is incorporated, the positive utility x becomes 1, hence the demand at this time is $D^0 = \lambda(1 - P + \alpha e_o + (1-\alpha)e_u) + (1-\lambda)(1-p)$.

Assumption 3: Greenwashing refers to the behavior where enterprises do not invest in unobservable activities but mislead consumers by claiming they have invested in a certain level of greenness. Let $\alpha \in (0,1)$ represent the transparency of green information, which reflects the observability of an enterprise's green activities. There are two types of green activities: observable and unobservable, each with associated costs. Denote e_o and e_u as the greenness levels of observable and unobservable activities, respectively. Assume that the costs of these green activity levels are $\frac{1}{2}\alpha e_o^2$ and $\frac{1}{2}(1-\alpha)e_u^2$ for observable and unobservable activities, respectively. Furthermore, it is assumed that an increase in greenness levels does not affect the marginal cost of the enterprise.

Assumption 4: Assume that the cost of information disclosure is zero, as our focus is on green investment rather than disclosure. Greenwashing may or may not be discovered by the public. Let k represent the probability that greenwashing is disclosed, with the corresponding entity facing a penalty L, and the likelihood of detection being $K(0 < K < 1)$. If the penalty cost exceeds a threshold (i.e., the penalty cost outweighs the cost of upgrading technology), any potential benefits of greenwashing will be offset by the penalty. Conversely, if the penalty is too low (where the cost of being caught and penalized is less than the benefits of greenwashing), enterprises may engage in speculative behavior for their own profit. Therefore:

$$\frac{\frac{1}{4}(1-\alpha)e_u^2 + (P_S - W_S)Q_S - f_i \times max\{0,\ P_{EU} - P_S\}Q_S}{(1-k)} < L < \frac{\frac{1}{2}(1-\alpha)e_u^2 + (1-k)(P_S - W_S)Q_S - f_i \times max\{0,\ P_{EU} - P_S\}Q_S}{(1-k)}.$$

Assumption 5: Assume that the demand D in the market equals the order quantity Q, eliminating the possibility of stockouts and production surpluses. Furthermore, the transfer of demand between markets is limited to the scenario where the greenwashing behavior of manufacturers and retailers is discovered by end-customers in the supply chain, posing a risk of losing those customers.

3.2. Basic Model

Scenario 1: Manufacturer and Retailer Do Not Engage in Greenwashing

The manufacturer: $f_{sm} = (W_s - C)Q_s - \frac{1}{2}\beta e_o^2 - \frac{1}{2}(1-\beta)e_u^2$

The retailer: $f_{sr} = (P_s - W_s)Q_s - \frac{1}{2}\alpha e_o^2 - \frac{1}{2}(1-\alpha)e_u^2$

Scenario 2: Manufacturer Engages in Greenwashing, Retailer Does Not

The manufacturer: $f_{fm} = k(W_s - C)Q_s - \frac{1}{2}\beta e_o^2 - (1-k)L$

The retailer: $f_{sr} = (P_s - W_s)Q_s - \frac{1}{2}\alpha e_o^2 - \frac{1}{2}(1-\alpha)e_u^2 - f_i \times max\{0,\ P_{EU} - P_s\}Q_s$

Scenario 3: Manufacturer Does Not Engage in Greenwashing, Retailer Engages in Greenwashing

The manufacturer: $f_{sm} = (W_s - C)Q_s - \frac{1}{2}\beta e_o^2 - \frac{1}{2}(1-\beta)e_u^2$

The retailer: $f_{fr} = k(P_s - W_s)Q_s - \frac{1}{2}\alpha e_o^2 - (1-k)L$

Scenario 4 Profit Functions When Both the Manufacturer and the Retailer Engage in Greenwashing:

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The manufacturer: $f_{fm} = k(W_s - C)Q_s - \frac{1}{2}\beta e_o^2 - (1-k)L$

The retailer: $f_{fr} = k(P_s - W_s)Q_s - f_i \times max\{0，P_{EU} - P_s\}Q_s - \frac{1}{2}\alpha e_o^2 - (1-k)L$

3.3. Derivative Model: After Enterprises Adopt Blockchain Technology

The manufacturer: $f_{sm} = (W_s - C^o)Q_s^0 - \frac{1}{2}\beta e_o^2 - \frac{1}{2}(1-\beta)e_u^2 + [1-\varphi]\left[\frac{1}{2}(K_m e_m + K_s e_s)^2 + (K_m e_m + K_s e_s) - \frac{1}{2}\eta(e_m^2 + e_s^2)\right]$

The retailer: $f_{sr} = (P_s - W_s)Q_s^0 - \frac{1}{2}\alpha e_o^2 - \frac{1}{2}(1-\alpha)e_u^2 + \varphi\left[\frac{1}{2}(K_m e_m + K_s e_s)^2 + (K_m e_m + K_s e_s) - \frac{1}{2}\eta(e_m^2 + e_s^2)\right]$

3.4. Derivative Model: Government Adoption of a Greenness Subsidy Model

Scenario 1: Manufacturer and Retailer Do Not Engage in Greenwashing

The manufacturer: $f_{sm} = (W_s - C + \sigma e_u^2)Q_s - \frac{1}{2}\beta e_o^2 - \frac{1}{2}(1-\beta)e_u^2 + se_u^2$

The retailer : $f_{sr} = (P_s - W_s + \sigma e_u^2)Q_s - \frac{1}{2}\alpha e_o^2 - \frac{1}{2}(1-\alpha)e_u^2 + se_u^2$

Scenario 2: Manufacturer Engages in Greenwashing, Retailer Does Not

The manufacturer: $f_{fm} = k(W_s - C)Q_s - \frac{1}{2}\beta e_o^2 - (1-k)L$

The retailer: $f_{sr} = (P_s - W_s + \sigma e_u^2)Q_s - \frac{1}{2}\alpha e_o^2 - \frac{1}{2}(1-\alpha)e_u^2 + se_u^2 - f_i \times max\{0, P_{EU} - P_s\}Q_s$

Scenario 3: Manufacturer Does Not Engage in Greenwashing, Retailer Engages in Greenwashing

The manufacturer: $f_{sm} = (W_s - C + \sigma e_u^2)Q_s - \frac{1}{2}\beta e_o^2 - \frac{1}{2}(1-\beta)e_u^2 + se_u^2$

The retailer: $f_{fr} = k(P_s - W_s)Q_s - \frac{1}{2}\alpha e_o^2 - (1-k)L$

Scenario 4 Profit Functions When Both the Manufacturer and the Retailer Engage in Greenwashing: As Before, with No Changes to the Formulas.

4. Analysis of results

4.1. Data information

	Behavioral decision-making	Manufacturers		Retailer	
Cost	No subsidy	greenwashing	$CQ + \frac{1}{2}\beta e_o^2$	greenwashing	$WQ_m + f_i \times max\{0, P_{EU} - P_s\}Q_s + \frac{1}{2}\alpha e_o^2 + (1-k)L$
		No greenwashing	$CQ + \frac{1}{2}\beta e_o^2 + \frac{1}{2}(1-\beta)e_u^2$	No greenwashing	$WQ_m + \frac{1}{2}\alpha e_o^2 + \frac{1}{2}(1-\alpha)e_u^2$
	Green subsidy	greenwashing	$CQ + \frac{1}{2}\beta e_o^2$	greenwashing	$WQ_m - f_i \times max\{0, P_{EU} - P_s\}Q_s + \frac{1}{2}\alpha e_o^2 - (1-k)L$

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		No greenwashing	$(C-\sigma e_u^2)Q_s + \frac{1}{2}\beta e_o^2 + \frac{1}{2}(1-\beta)e_u^2 - se_u^2$	No greenwashing	$(W_s-\sigma e_u^2)Q_s + \frac{1}{2}\alpha e_o^2 + \frac{1}{2}(1-\alpha)e_u^2 - se_u^2$
	Use blockchain technology	No greenwashing	$C^o Q_s^0 + \frac{1}{2}\beta e_o^2 + \frac{1}{2}(1-\beta)e_u^2 + \frac{1}{2}\eta\varphi(e_m^2 + e_s^2)$	No greenwashing	$W_s Q_s^0 + \frac{1}{2}\alpha e_o^2 + \frac{1}{2}(1-\alpha)e_u^2 + \frac{1}{2}\eta\varphi(e_m^2 + e_s^2)$
Order Quantity	No Subsidy	No greenwashing	$Q_m^p: \lambda(1-P + \alpha e_o + x(1-\alpha)e_u) + (1-\lambda)(1-p)$	No greenwashing	$Q_r^p: \lambda(1-P + \alpha e_o + x(1-\alpha)e_u) + (1-\lambda)(1-p)$
		greenwashing	$K[\lambda(1-P + \alpha e_o + x(1-\alpha)e_u) + (1-\lambda)(1-p)] - (1-k)L$	greenwashing	$K[\lambda(1-P + \alpha e_o + x(1-\alpha)e_u) + (1-\lambda)(1-p)] - (1-k)L$
	Green subsidy	No greenwashing	$Q_m^p: \lambda(1-P + \alpha e_o + (1-\alpha)e_u) + (1-\lambda)(1-p)$	No greenwashing	$Q_r^p: \lambda(1-P + \alpha e_o + (1-\alpha)e_u) + (1-\lambda)(1-p)$
		greenwashing	$K[\lambda(1-P + \alpha e_o + x(1-\alpha)e_u) + (1-\lambda)(1-p)] - (1-k)L$	greenwashing	$K[\lambda(1-P + \alpha e_o + x(1-\alpha)e_u) + (1-\lambda)(1-p)] - (1-k)L$
	blockchain technology	No greenwashing	$\lambda(1-P+\alpha e_o + (1-\alpha)e_u) + (1-\lambda)(1-p)$	No greenwashing	$\lambda(1-P+\alpha e_o + (1-\alpha)e_u) + (1-\lambda)(1-p)$

4.2. Conclusion Multiple

(1) When carbon tariffs are imposed on enterprises, the export costs of enterprises in developing countries increase after being levied with carbon tariffs, leading to a loss of competitive advantage in the international market compared to other countries. Therefore, they are more inclined to adopt greenwashing behavioral measures to obtain higher profits. At this point, the manufacturer's cost is represented as $CQ + \frac{1}{2}\beta e_o^2 + \frac{1}{2}(1-\beta)e_u^2$, and the retailer's cost is $\mathrm{WQ} + \frac{1}{2}\alpha e_o^2 + \frac{1}{2}(1-\alpha)e_u^2$. After greenwashing, the manufacturer's cost decreases by $\frac{1}{2}(1-\beta)e_u^2$, while the retailer's cost gap is $\frac{1}{2}(1-\alpha)e_u^2 - f_i \times max\{0,\ P_{EU} - P_s\}Q_s - (1-k)L$. Simultaneously, the order quantities of manufacturers and retailers remain unchanged. Therefore, greenwashing will definitely benefit the manufacturer, making them more inclined to engage in it. The retailer's cost mainly involves the gap between innovation costs and penalty costs. Hence, as long as the supervision intensity (i.e., the penalty cost L) is sufficiently large and the carbon tariff rate f_i is excessively high, greenwashing will reduce the retailer's profits.

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(2) When blockchain technology is utilized, neither manufacturers nor retailers have the opportunity to engage in greenwashing, and they bear the additional costs associated with using blockchain. Even so, due to the presence of green consumers in the market, who are willing to bear additional costs for "green products," the sales volumes of both manufacturers and retailers at this time are $Q^o = D^0 = \lambda(1 - P + \alpha e_o + (1-\alpha)e_u) + (1-\lambda)(1-p) > D_A = \lambda(1 - P + \alpha e_o + x(1-\alpha)e_u) + (1-\lambda)(1-p)$. Comparing this to enterprises' decisions to engage in greenwashing, the manufacturer's cost increases by $\frac{1}{2}(1-\beta)e_u^2 + \frac{1}{2}\eta\varphi(e_m^2 + e_s^2)$, and the retailer's cost increases by $\frac{1}{2}(1-\alpha)e_u^2 + \frac{1}{2}\eta\varphi(e_m^2 + e_s^2) - f_i \times max\{0,\ P_{EU} - P_s\}Q_s - (1-k)L$; Meanwhile, the manufacturer's revenue increases by $\lambda(1-x)(1-\alpha)e_u * P$, and the retailer's revenue changes by $\lambda(1-x)(1-\alpha)e_u * W_s$, Therefore, when consumers' green preferences λ are sufficiently high, both manufacturers and retailers can obtain higher profits from using blockchain technology than from adopting greenwashing behavior. (Compared to the situation where both manufacturers and retailers engage in greenwashing.)

(3) When the government initiates a subsidy strategy, it mainly affects the selling prices of enterprises (assuming the same increase for $P\ and\ W$) and the "subsidy for green products." Therefore, under government subsidy policies, enterprises should focus more on actual green investments compared to adopting greenwashing behavioral decisions. The manufacturer's cost function decreases by σe_u^2 per unit, with an additional one-time subsidy of se_u^2, for "green products." Consequently, the manufacturer's cost decreases by $\frac{1}{2}\beta e_o^2 - \sigma e_u^2 Q_s + se_u^2$, the retailers' cost decreases by $\frac{1}{2}\ \sigma e_u^2 Q_s + \frac{1}{2}(1-\alpha)e_u^2 + f_i \times max\{0,\ P_{EU} - P_s\}Q_s + (1-k)L - se_u^2$ .From the perspective of revenue, manufacturers' revenue increases $\sigma e_u^2 Q_s - \frac{1}{2}(1-\beta)e_u^2 + se_u^2$, retailers' revenue increases by $\sigma e_u^2 Q_s - \frac{1}{2}(1-\alpha)e_u^2 + se_u^2$, Hence, with government subsidies, enterprises are incentivized to shift from greenwashing tendencies towards adopting innovative technologies.

5. Discussion and Suggestions

5.1. Discussion

(1) The investment level of enterprises in green action. From the formulation point of view, the decision of a company to carry out "green washing" is affected by internal factors such as the level of corporate funds and the degree of green preference, as well as external factors such as the degree of regulatory punishment. Among them, some enterprises with "green" preferences may consider not only their own economic benefits, but also environmental benefits. Not only do they invest in visible green actions for consumers and actively advertise their green credentials, but they also invest in the invisible investment of actually reducing their own carbon emissions. However, due to cost pressures, some "brown" firms may only focus on maximizing their own profits. They resort to "greenwashing" tactics, such as manufacturers falsely claiming that they meet green standards in order to deceive retailers, resulting in retailers buying products at green product prices but still facing carbon tariffs. Retailers may also try to cheat consumers to obtain higher selling prices, but they also risk being punished if caught.

(2) The green preference degree of consumers in the market. The degree of green preference of consumers in the market significantly affects the behavioral decisions of firms, especially in today's consumer-driven buyer's market. With the enhancement of consumer green preference, consumers pay more and more attention to the environmental performance of products and the environmental protection behavior of enterprises. This increased attention makes it easier for consumers to expose the greenwashing practices of companies, thus increasing the risks

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and costs of greenwashing. The green preference of consumers is a signal of potential demand for green products in the market. In order to meet this demand, enterprises will increase their investment in the research and development and production of green products, thus promoting real environmental protection behavior.

(3) Investment Cost and Return on Investment of Blockchain Technology and Government Subsidies for Green Enterprises.The development, deployment, and maintenance of blockchain technology require significant investment in capital, technology, and human resources, putting cost pressure on enterprises, especially small and medium-sized enterprises (SMEs), which are already facing financial constraints. In response to this cost pressure, some firms may use greenwashing as a cost-reducing strategy, such as exaggerating environmental achievements in order to reduce investment in environmental protection. When considering return on investment, blockchain technology enhances supply chain transparency and traceability, making it easier for companies to demonstrate their true environmental efforts to consumers and regulators, and easier to obtain government subsidies and green consumer preferences. At the same time, the degree of government subsidies to green enterprises significantly affects the green washing decisions of enterprises. Subsidies not only encourage companies to adopt environmentally friendly practices, but they can also lead to dependence or misuse of subsidized funds. Government-subsidized green companies are often seen as leaders in environmental protection, which enhances the social image and brand value of the company and cultivates consumer trust. In addition, government subsidies encourage green enterprises to increase investment in research and innovation of environmental protection technologies.

5.2. Recommendations

5.2.1. Different Investment Return Rates for Manufacturers and Retailers

This paper assumes a uniform return on investment (ROI) for carbon emission reduction initiatives across enterprises. However, the ROI varies across different industries and even among individual enterprises. From the manufacturer's perspective, significant investments are typically required in production technology and equipment to enhance production efficiency, product quality, and reduce production costs. Due to the complexity of product manufacturing and the rapid pace of technological advancements, the ROI for manufacturers' technological investments can be influenced by various factors, including market demand, the speed of technological upgrades, and the policy environment. On the other hand, retailers primarily invest in sales technology, supply chain management, and customer service to improve sales efficiency, customer satisfaction, and market share. The ROI for retailers' technological investments is usually closely linked to key performance indicators such as sales volume, inventory turnover rate, and customer satisfaction. In general, manufacturers with high ROIs may be more willing to invest in the research and application of emission reduction technologies, while those with low ROIs may be more inclined to engage in greenwashing. Therefore, both countries and enterprises need to continuously improve their overall ROI.

5.2.2. Perfect Symmetry of Supply and Demand is Rare

In the market, due to factors such as information asymmetry, market monopolies, and government interventions, perfect symmetry between supply and demand is rarely achieved. From the perspective of enterprises selling to consumers, retailers often have more detailed information about products, including quality, performance, and cost, than consumers. This information asymmetry may lead sellers to raise prices or provide false information, thereby harming consumers' interests. Similarly, from the perspective of manufacturers selling to retailers, retailers may lack sufficient information to make informed purchasing decisions, resulting in a mismatch between demand and supply. In summary, achieving perfect symmetry between supply and demand in the market is extremely difficult, primarily due to the combined effects of information asymmetry, market monopolies and inadequate competition, diversity in

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consumer preferences, complexity in production and supply chains, policy and regulatory restrictions, and uncertainty in market forecasts. Therefore, enterprises need to continuously adapt to market changes, strengthen supply chain management, improve product quality and service levels, in order to better meet consumer demands and achieve sustainable development.

5.2.3. Varying Transportation Costs and Sales Performance in Different Markets

The main context of this paper is the behavioral decisions made by enterprises from developing countries exporting products to the European Union, which face cost pressures due to the introduction of carbon tariffs by the EU. When considering corporate decisions, enterprises in developing countries can choose to sell to countries that do not impose carbon tariffs or directly shift to domestic markets for sales. The implementation of carbon tariffs will increase the transportation costs of high-carbon products, as enterprises need to pay additional fees for carbon emissions generated during transportation. This cost increase may prompt enterprises to seek ways to reduce transportation carbon emissions, such as using more environmentally friendly transportation modes or optimizing transportation routes. Additionally, the level of regulation and penalties differs across markets. With the implementation of carbon tariff policies and strengthening of regulatory enforcement, enterprises face greater compliance risks. To avoid penalties and reputational damage due to greenwashing, enterprises may handle environmentally related promotions and information disclosure with greater caution.

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