Hindawi
Mathematical Problems in Engineering
Volume 2021, Article ID 8862590, 21 pages
https://doi.org/10.1155/2021/8862590

Research Article

Exclusivity or Competitor Retail? Impacts of Channel Structures on Multinational Supply Chains considering Green Manufacturing

Luqing Rong[1,2] **Maozeng Xu**[1] **Xiaofeng Chen**[1] **and Qian Wen**[3]

[1]*School of Economics and Management, Chongqing Jiaotong University, Chongqing, China*
[2]*School of Economics and Management, Guangxi University of Science and Technology, Liuzhou, Guangxi, China*
[3]*School of Environment, Education and Development, University of Manchester, Manchester, Lancashire, UK*

Correspondence should be addressed to Maozeng Xu; 24034090@qq.com

Received 26 August 2020; Revised 13 January 2021; Accepted 22 January 2021; Published 9 February 2021

Academic Editor: Bekir Sahin

The development of green supply chains by multinational manufacturers (MNMs) in emerging markets promotes a better corporate reputation and competitive advantage. Selecting viable marketing channels will help reduce risks in overseas markets while positively impacting the green level and the stakeholders. This paper analyzes channel decisions under different scenarios in a game analytical framework and identifies that both exclusive and competitive channels promote the green supply chain, and that the latter leads to a higher green level and benefits the local manufacturer. Whatever profit-seeking or corporate social responsibility- (CSR-) seeking follows, the MNM prefers the competitive channel when the green research and development (R&D) investment coefficient is relatively low and vice versa for the exclusive channel. Moreover, transaction cost undermines the green supply chain, the competitive structure lowers the loss of greenness, and the exclusionary mode raises the MNM's profits. Another interesting finding is when subsidies are offered by the importing country, the competitive structure is more conducive to the green and the participant's gains, while the exclusive structure is detrimental to the green and only advantageous for the domestic manufacturer's benefits. Besides, the revenue-sharing contract results in a higher green level of the supply chain in the channels than before, but the MNM tends to select the exclusive marketing channel with a relatively lower green level due to the profits. Subject to the findings, we propose an improved revenue-sharing contract that achieves the MNM's competitive retailing option and ensures the emergence of the manufacturers' win-win solution.

1. Introduction

While globalization works miracles for the economic growth of various countries, it brings environmental deterioration around the world [1–3]. To accommodate the social, economic, and environmental dimensions, the United Nations DESA [4] released "Transforming our world: The 2030 agenda for sustainable development" in 2015, which contains 17 sustainable development goals. In fact, the concept of sustainable development has been widely embraced by governments and the general public [5], and most emerging economies have identified "taking urgent action to counteract climate change and its impacts" as an important strategy for national development in the future, as well as improving environmental regulations and motivating businesses to launch the green [6]. However, as research and development (R&D) expenses increase with product greenness, diseconomies of scale in green products will deter local firms from participating in the sector [7, 8], and a multinational manufacturer (MNM) with a good reputation and technical competence would achieve substantial commercial value by launching the green in emerging markets. For example, Tesla [9] keeps listing Model 3 in China due to tax incentives, where it made a revenue of $1.4 billion in the second quarter of 2020, roughly equivalent to 23.2% of Tesla's total global revenue. To mitigate overseas operational risks and expand market shares, the MNMs confront a decision on marketing channels. Establishing a direct

channel (e.g., showrooms and brick and mortar stores) and dedicating marketing efforts (e.g., advertising promotions and free trials) can eliminate consumers' uncertainty about green products and help to establish a market [10, 11], but the MNM will have to incur high transaction costs [12, 13]. Actually, direct distribution in some overseas markets could suffer from dealers' exclusion and legal restrictions, such as the current ban on Tesla from selling cars directly to consumers and providing manufacturer service and repair in more than 10 states in the United States [14–17]. Moreover, with the COVID-19 pandemic worldwide [18], many governments have banned foreigners from entering their countries, and adopted quarantine measures for residents, which will impose additional burdens on MNMs' direct channel. Deloitte [19] shows that about 83% of the Chinese firms have been affected by the epidemic in distribution and marketing, and more than 70% will suffer a cash flow shortage; and the situation is now even worse in the US and Europe.

Alternatively, the MNMs could establish a nonexclusive channel by selecting multiple retailers in the emerging markets, but price competition among retailers for capturing market share leads to a reduction in the quality of customer service and a loss of the manufacturer's brand reputation [20, 21]. Both the exclusive and the competitive retail channels can be useful in mediating the conflicts [22, 23]. The former generally refers to a marketing channel configured by a retailer that is solely appointed and only distributes the manufacturer's products within a particular area [24, 25], while the latter is related to the channel consisting of domestic competitors [26, 27]. Intuitively, the MNM benefits from developing the exclusive channel by assigning an overseas retailer to preserve the pricing power, while the MNM reaps the profits of offering green products to a local competing manufacturer that sells regular products with alternative features, thus lessening competition with the local manufacturer and weakening the market share of the regular product. Moreover, the two channels will relieve the financial pressure of the MNMs and allow them to focus on the green supply chains.

Although the two channels have many significant advantages, they also face some challenges. For the former, the manufacturer's excessive pricing power will intensify the double marginalization effect (i.e., neither the green level nor the demand can reach the ideal state). For the latter, the green advantage of the multinational product will lead to self-competition in the market share, which will undermine the regular product potentials and discourage the local manufacturer from retailing green products. The trade-off between the pros and cons of the two channels motivates us to pose the first research question—*Under what conditions would the MNM prefer the exclusive (or the competitive) marketing channel to promote the green supply chain?* In reality, reputable multinational manufacturers will concern themselves with corporate social responsibility (CSR) aside from economic earnings to achieve sustainability objectives [28]; for instance, Adidas employs green manufacturing techniques to diminish harmful substances and minimize the waste used in packaging materials [29]. Pepsi and Coca-Cola adopt renewable PET materials packaging in soft drinks [30]. In addition, governments in emerging markets would encourage manufacturers to import green products with subsidies or tariff policies. This leads to the second research question—*What is the impact of some commonly experienced sensitive factors (e.g., CSR, subsidies, and tariffs) on the MNM's channel selection?* In addition, environmental degradation triggers a growing number of green preference consumers. Thus, the manufacturer's greening investments will generate benefits for overseas retailers while increasing individual economic burden in the short run. The research [31–33] demonstrates that supply chain participants leveraging coordination designs can help cope with the matter, which presents the third research question—*Does the revenue-sharing contract change the MNM's channel preferences?*

This study provides theoretical and practical contributions in the following areas of the multinational green supply chain. Firstly, motivated by the current external environment hitting the direct marketing channels, we explore the trade-offs between exclusive and competitive marketing for MNMs. Secondly, we discuss the impact of sensitive factors on marketing channel options, which benefits the green supply chain and individual interests. Such an analysis could assist the MNMs in identifying the retail structure under different conditions. Thirdly, we verify the role of revenue-sharing contracts in eliminating the dual marginal effect of supply chains under two channels and propose an improved revenue-sharing coordination to promote the MNMs' long-term development. Besides, we investigate the impact of stakeholders' friend and foe relationship on the product green level, which will fill the gap in the multinational supply chain literature.

The remainder of this article is arranged as follows. In Section 2, we conduct a comprehensive literature review. In Section 3, we propose the problem description and hypothesis. In Section 4, we explore the MNM's channel decision based on the profit-seeking principle. In Section 5, we investigate the MNM's channel decision based on the CSR-seeking principle. Extensions, numerical examples, and sensitivity analysis are presented in Section 6. Finally, we conclude the research and denote possible limitations and future research. Also, the proofs of propositions are provided in the Appendix.

2. Literature Review

This paper covers three main aspects of literature. The first field concerns the operations of multinational supply chains. To address the risks associated with uncertainty in overseas demand and exchange rates, Ogunranti et al. [34] show two categories of currency-exchange-flexibility contracts in which the payments by the buyer in the global supplier's currency lead to a higher expected profit for the two parties and vice versa, while exchange rate volatility results in a reduction of the optimal product order quantities. Many multinationals move their business to low-tax countries due to cost pressures, Wu and Lu [35] study the effectiveness of the cost-plus or resale price approach to improve multinational earnings. To lower the procurement cost of raw

materials, Niu et al. [26] investigate the risk of technology spillovers from the local sourcing implemented by the MNMs in a tariff increase setting and confirm that the benefits to the MNMs and the local manufacturers would increase when the risk is low. Many famous raw material suppliers have begun to operate their brand products for more revenue. Niu et al. [36] investigate the competition and cooperation between original equipment manufacturers and competitive suppliers. They find that the original equipment manufacturers will choose supplier diversification even though the alternative supplier is unreliable. The extant literature has examined the impact of risks [37–41] encountered by MNMs in emerging markets, such as tariff barriers; exchange rate changes; trade protection; public health emergencies; and differences in social culture, regulations and laws, consumer preferences, and economic development. Little attention is given to the MNM's challenge of developing the green supply chain in the emerging market while competing with the manufacturer that dominates the local market.

The second field is the research on green supply chain. To counter the worsening global hazards of the GHG, many scholars have proposed strategies to minimize carbon emissions from various aspects. Pollution tax is deemed to be an important measure to address environmental issues, including direct tax, indirect tax, direct emission tax, trading license with quota, emission reduction subsidy, and carbon tax [42–44], in particular the last one; although there are disputes over legality and anticompetitiveness, some advocates still favor using it to slash carbon footprints in global supply chains [45–47]. Wang et al. [48] investigate the impact of carbon tax on the global environment, and the study shows that the measure could reduce the total carbon emissions while reducing global social welfare. In addition, supply chain coordination is essential for improving the greening. Against the backdrop of uncertain demand and high green R&D and marketing expenses for the product, Xin et al. [49] explore the effects of the wholesale price contract, the revenue-sharing contract, and the two-part tariff contract on the green level and the participants' benefits of the supply chain, and verify that the last one is the most favorable for the green supply chain. Considering social utility, Hafezalkotob [50] analyzes the role of government intervention in improving the green level of enterprises and finds that nonself-interest intervention policies can significantly improve social utility and the green level. Based on optimal environmental improvement, Nielsen et al. [51] untangle the impact of two incentive policies on green technology adoption in the supply chain, showing that selecting the right ones is critical to achieve sustainability goals with limited subsidies. Zhu and He [52], Song and Gao [32] show the impact of participant power structures on the green supply chain. They suggest that deepening collaboration in the manufacturer-led and the retailer-led leads to a higher greenness. Furthermore, there is extensive literature on incorporating CSR in green supply chains [53–55], and the findings suggest that stakeholders' CSR will lead to optimal performance for the whole supply chain. However, the party adopting CSR will often suffer revenue loss, and coordination contracts and government subsidies contribute to the green supply chain stability [56–58]. Most of the above literature concerns how supply chain participants within the framework of one country achieve the benefits through optimization and collaboration. There has been a lack of research on the impact of different partners on cross-border green supply chains. When the participants are located in various countries and have diverse value profiles, their competition and cooperation have profound implications for global sustainable development.

The third field is the research on the decisions of the supply chain marketing channel selection. The establishment of distribution channels contributes to the enhancement of supply chain performance. Choi [59] analyzes the noncooperative games of two manufacturers and a public retailer under different power structures, and the findings indicate that manufacturers gain more from maintaining their exclusivity, while the retailer has the motivation to deal with multiple manufacturers. Either nonexclusive or exclusive channels can distribute new products. Yu et al. [20] argue that new products do not receive the priority of deployment in the nonexclusive channel, while the exclusive channel benefits quality control and enhances consumer experience. Andritsos and Tang [21] find that manufacturers earn more profit in the exclusive channel through charging higher wholesale prices when the authorized retailer has a market share beyond a given threshold. To boost corporate economic and environmental performance, Modak et al. [60] propose feasible channel strategies for collecting used products in closed-loop supply chains, including manufacturer-led, retailer-led, and third-party-led recycling. The study shows that the first strategy is the best, and the last one is the least advantageous. When referring to the distribution of overseas vaccines in the domestic market, Niu et al. [61] believe that the competitive marketing channel is preferable to both domestic and foreign vaccine manufacturers, irrespective of whether the principle of social-responsibility-seeking or profit-seeking applies. Meanwhile, there is much more literature that works on how manufacturers frame dual-channel supply chains. This paper is most similar to the research by Niu et al. [61], which focuses on the impact of the exclusive and the competitive channels on the MNMs' benefits and utilities. However, the perception differentiation between green products and regular products in supply chain channels is poorly considered in the available literature.

From the above reviews, although the impact of channel strategies and coordination contracts on global supply chain performance and risk aversion has been addressed in the previous literature, their effects have seldom been investigated in the multinational green supply chain. Our investigation highlights the impact of these channel structures on the green supply chain in the emerging market, accompanied by domestic manufacturer competition and consumer green awareness of regular products. Besides that, to better achieve the objective of environmental and economic sustainability, we further propose an improved revenue-sharing contract, which makes the stakeholders more willing to adopt the competitive channel under the CSR-seeking principle.

3. Problem Description and Hypothesis

In an emerging market (*Market 1*), there is a multinational supply chain that involves a global manufacturer (*Manufacturer 1*), a local manufacturer (*Manufacturer 2*), and an authorized exclusive retailer that distributes the MNM's products, and manufacturers 1 (*he*) and 2 (*she*) produce the green product (*product 1*) and the regular product (*product 2*), respectively. Manufacturer 1 has an international reach and will have a leadership role once entering the emerging market, while Manufacturer 2 is the sole competitor for green products in the market. It is assumed that consumers in Market 1 preserve the green preference and, equivalently, purchase green products in priority and derive a larger psychological utility as a consequence. We refer to the approach of Li et al. [62], Taleizadeh et al. [63], Altug and Sahin [64], and designate $U_i = \delta_i v_i - p_i + \theta, i \in \{1, 2\}$ to denote the consumer's net utility and $\delta_i v_i$ to denote the consumer perception valuation from purchasing the product i, where δ_i is the green perception coefficient of product i, which measures the consumer acceptance level of the product green properties, $\delta = 1$ indicates that the consumer completely approves that the product is green, and the smaller δ indicates the likelihood of the consumers disapproving of the product being green. v_1 represents Market 1's consumer willingness-to-pay for comparable function products and assesses the value of a category of products, and it follows the uniform distribution of $[0, 1]$. p_i, θ denote the price of product i and the green level of the MNM's product, respectively. To reflect the difficulty of upgrading the green level, we adopt the practices of Bhaskaran and Krishnan [65], Zhai et al. [66], and use $(k\theta^2/2)$to construct the green R&D expenses. k is the green investment coefficient, which weighs the costs in green R&D.

Assuming that the MNM's green product is adequately acknowledged, the consumer utility of product 1 is $U_1 = v_1 - p_1 + \theta$. Meanwhile, due to the influence of advertisements and consumption patterns in the local market, the regular products without the green level will be considered by the consumers as having green features, and the utility of product 2 is $U_1 = \delta v_1 - p_2$. Therefore, the consumers need to meet $v_1 - p_1 + \theta = \delta v_1 - p_2$ if they purchase products 1 and 2 without any difference, i.e., $v_1^1 = (p_1 - p_2 - \theta/1 - \delta)$. Similarly, the consumers have no difference between buying or not buying products from manufacturer 2 if $\delta v_1 - p_2 = 0$ is satisfied, i.e., $v_1^2 = (p_2/\delta)$. Hence, when the consumers think that the valuation is higher than $v_1^2 = (p_2/\delta)$, they will buy product 1, the MNM's demand in market 1 derives as follows:

$$q_1 = \int_{v_1^1}^{1} \frac{1}{v_1} \mathrm{d}x = 1 - \frac{p_1 - p_2 - \theta}{1 - \delta}. \tag{1}$$

If the consumers evaluate the valuation between v_1^1 and v_1^2 and choose product 2, the local manufacturer's demand is,

$$q_2 = \int_{v_1^2}^{v_1^1} \frac{1}{v_1} \mathrm{d}x = \frac{p_1 - \theta}{1 - \delta} - \frac{p_2}{(1 - \delta)\delta}. \tag{2}$$

From equations (1) and (2), the price for the green and regular products is derived as follows:

$$p_1 = 1 - q_1 - \delta q_2 + \theta, \tag{3}$$

$$p_2 = \delta(1 - q_1 - q_2). \tag{4}$$

By comparing equations (3) and (4), a higher δ means that it will be increasingly difficult to distinguish the green properties of the MNM's products from those of the local manufacturer and that there will be incentives for the local manufacturer to attract consumers by offering low prices, which in turn will harm the green supply chain. However, with the disclosure of green product information and the promotion of green energy efficiency labels, the level of regular product's green perception exists at an upper bound, so we assume $\delta < (2/3)$. At the same time, to ensure that the manufacturers' market demand under the channels is positive, we suppose $k > (1/2(1 - \delta))$. For a discussion on the impact of the channel structures on the MNM's decisions, the basic model presumes zero production costs and tariffs on the green, and the condition will be eased in the model extension.

While the entry of large-scale green products into emerging markets helps countries to achieve sustainable development goals [67], the MNMs in emerging markets will face challenges [26, 68]. For example, the local manufacturers will compete for the market with a large quantity of low-cost regular goods. Referring to literature [69–71], the decision-making sequences of the stakeholders are further revealed for two channel structures under the assumption that the competition between the MNM and the local manufacturer satisfies the Cournot model. In the exclusive retail channel (Scenario E), at the first stage, the multinational manufacturer chooses an exclusive franchised retailer in overseas markets and determines the green level θ and wholesale price w_1 of product 1. At the second stage, in the emerging market, the retailer and the local manufacturer simultaneously decide the product quantities q_1 and q_2, respectively; finally, consumers purchase products according to their preferred demand, and supply chain participants obtain the profits. In the competitive retail channel (Scenario C), at the first stage, the MNM decides product 1's θ and w_1, and appoints the local manufacturer in the emerging market to distribute the product. At the second stage, the local manufacturer determines q_1 and q_2, respectively; finally, consumers purchase products, and the participants obtain benefits. The two overseas marketing channel structures are displayed in Figure 1. For future discussion, all parameters and variables are summarized in Table 1.

4. The MNM's Channel Decision Based on the Profit-Seeking Principle

To facilitate comparison, we first assume that the MNM aims at the profit-seeking principle; then, the fundamental approach for profit improvements is to enhance the green level of products. Hence, the MNM needs to balance the

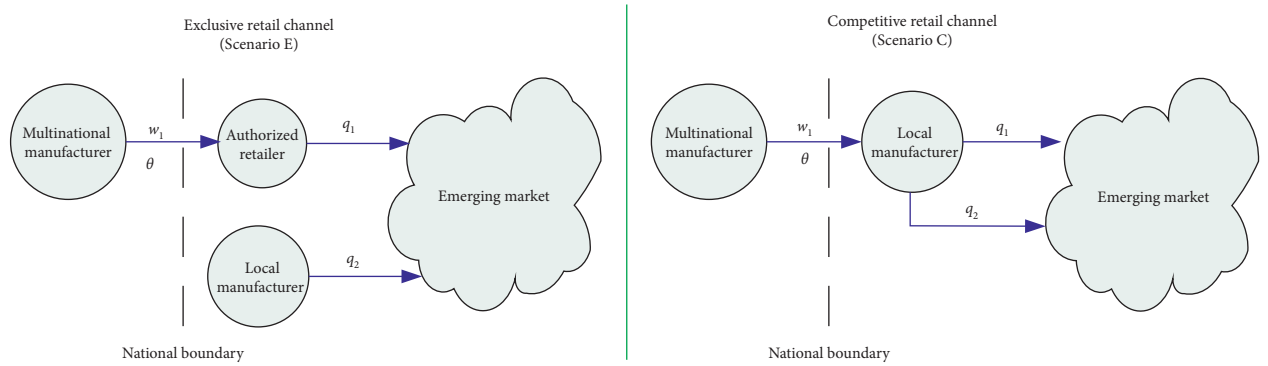

Figure 1: Overseas marketing channel structures.

Table 1: Notations.

Symbol	Description
k	Green level investment coefficient, where $k \in ((1/2 - 2\delta), \infty)$
δ	Regular product green perception coefficient (RPPC), where $\delta \in (0, 2/3)$
p_i	Product price for the supply chain stakeholder i, where $i \in \{1, 2, 3\}$, the symbols in the set denote the MNM, the local manufacturer, and the exclusive retailer, respectively
π_i^j, U_i^j	Profits and utilities of participant i, where $j \in \{L, M, E, C, \mathrm{RE}, \mathrm{RC}, \mathrm{SL}, \mathrm{SM}, T, \mathrm{RS}\}$, the symbols in the set stand for the local manufacturer, the MNM, the exclusive structure, the competitive structure, the exclusive structure with social responsibility objectives, the competitive structure with social responsibility objectives, the strategy of subsidizing the local manufacturer, the strategy of subsidizing the MNM, the tariff imposing, and the revenue-sharing contract, respectively
α	The value of corporate social responsibility for unit green product
θ^j	Product green level for the MNM
w_1^j	Wholesale price for the MNM
q_i^j	Product quantities for participant i, where $i \in \{1, 2\}$

relationship between investment and revenue to improve the green level under Scenarios E and C, respectively.

Under Scenario E, the profit functions of the MNM, the local manufacturer, and the exclusive retailer are as follows:

$$\begin{aligned} \pi_1^E &= w_1 q_1 - \frac{1}{2} k\theta^2, \\ \pi_2^E &= p_2 q_2, \\ \pi_3^E &= (p_1 - w_1) q_1. \end{aligned} \tag{5}$$

Due to $k\delta - 4k + 1 < 0$, then $|H_{\pi_1}| > 0$ and $(\partial \pi_1 / \partial w_1) < 0$and $(\partial \pi_1 / \partial \theta) < 0$, namely, the Hessian matrix of manufacturer 1's profit function is a negative definite. Therefore, there is an optimal equilibrium solution to the multinational green supply chain (Table 2).

Under Scenario C, the profit functions of the MNM, the local manufacturer, and the franchised retailer are, respectively, as follows:

$$\begin{aligned} \pi_1^C &= w_1 q_1 - \frac{1}{2} k\theta^2, \\ \pi_2^C &= (p_1 - w_1) q_1 + p_2 q_2. \end{aligned} \tag{6}$$

For $4k\delta - 4k + 1 < 0$, then $|H_{\pi_1}| > 0$, and $(\partial \pi_1 / \partial w_1) < 0$ and $(\partial \pi_1 / \partial \theta) < 0$, namely, the Hessian matrix of manufacturer 1's profit function is a negative definite, and the supply chain participants will reach the optimal scheme (Table 3).

where $\pi_2^C = (4k(1-\delta)(k + 2\delta k - 3\delta^2 k - 2\delta) + \delta/4(4k - 4\delta k - 1)^2) = 4(1-\delta)^2(1+3\delta)(k + (\delta/(\delta - 1)(1 + 3\delta)))^2 + (\delta - \delta^2/1 + 3\delta) > 0$.

Proposition 1. *Under the Scenarios E and C,*

(a) the MNM's green level has the following rules: $\theta^E < \theta^C$

(b) $(\partial \theta^C / \partial k) < (\partial \theta^E / \partial k) < 0$

(c) $(\partial \theta^E / \partial \delta) < 0$ *and* $(\partial \theta^C / \partial \delta) > 0$

Proposition 1 illustrates the following facts: firstly, if grounded in the profit-seeking principle, the green level of the MNM's product will be higher in competitive manufacturer marketing than in exclusive marketing. The reason is that the MNM relies on the franchised retailer to distribute the green product in the exclusive structure, and the retailer's marketing efforts will reduce his or her incentive to further increase the green level; on the contrary, the MNM that depends on local manufacturer retailing in the competitive structure will develop strategies to further enhance product greenness for achieving competitive advantage and market share.

Secondly, with increasing green R&D investment expenses, the green level of the product declines in either the exclusive or competitive channel, and more rapidly in the latter scenario. A reasonable explanation is that, when business operates on the profit motive, the MNM will have incentives to cut the green level once it experiences increased green R&D costs in both channels; furthermore, it will encounter a greater product competitive pressure in the

Table 2: Optimal solution based on benefit-seeking under Scenario E.

$q_1^E = (k(2-\delta)/2(4k-\delta k-1))$	$q_2^E = (6k-\delta k-2/4(4k-\delta k-1))$	$\theta^E = (2-\delta/2(4k-\delta k-1))$	$w_1^E = (k(\delta^2-6\delta+8)/4(4k-\delta k-1))$
$\pi_1^E = (k(2-\delta)^2/8(4k-\delta k-1))$	$\pi_2^E = (\delta(6k-\delta k-2)^2/16(4k-\delta k-1)^2)$		$\pi_3^E = (k^2(2-\delta)^2/4(4k-\delta k-1)^2)$

Table 3: Optimal solution based on benefit-seeking under Scenario C.

$q_1^C = (k(1-\delta)/4k-4\delta k-1)$	$q_2^C = (2k-2\delta k-1/2(4k-4\delta k-1))$	$\theta^C = (1-\delta/4k-4\delta k-1)$	$w_1^C = (2k(1-\delta)^2/4k-4\delta k-1)$
$\pi_1^C = (k(1-\delta)^2/2(4k-4\delta k-1))$			$\pi_2^C = (4k(1-\delta)(k+2\delta k-3\delta^2 k-2\delta)+\delta/4(4k-\delta k-1)^2)$

competitive channel than in the exclusive one, namely, the local manufacturers' decision-making power on the product quantity makes the MNM reduce the green level to improve the price advantage.

Thirdly, the green level declines in exclusionary retailing as the consumer's green perception increases and the opposite is true in competitive retailing. The reason is that, in the exclusive structure, an increase in the green feature perception of the regular product will lead to more market demand for the local manufacturer's products, and the MNM will lower the price by reducing the product greenness to minimize the loss of market share; however, in the competitive structure, the MNM will offer a premium to the local manufacturer by increasing the greenness so that the latter will increase the green product distribution.

Proposition 2. *Under the different distribution channel structures,*

(a) the manufacturer's product pricing laws are subject to the following, $p_1^E < p_1^C$ *and* $p_2^E < p_2^C$

(b) $(\partial p_1^C/\partial k) < (\partial p_1^E/\partial k) < 0$, $(\partial p_2^E/\partial k) > 0$ *and* $(\partial p_2^C/\partial k) = 0$

(c) $(\partial p_1^E/\partial \delta) < 0$, $(\partial p_1^C/\partial \delta) > 0$ *and* $(\partial p_2^C/\partial \delta) > (\partial p_2^E/\partial \delta) > 0$

Proposition 2 reveals that, firstly, the product price of both the local and the multinational manufacturers will be higher in competitive marketing than in exclusionary marketing. The reason is that the green level of the product affects the MNM's product pricing, and a relatively low green level in the exclusive channel will reduce R&D expenditure. Also, it is more profitable for the local manufacturers to promote green products in the competitive channel, and they can attract more customers to purchase them by strategically increasing the prices of both the products.

Secondly, as the green investment goes up, the MNM's product prices decrease in distribution structures and to a lesser extent in the exclusive structure; meanwhile, the local manufacturer' product prices increase incrementally in the exclusive channel and remain unchanged in the competitive channel. The reason is that higher R&D expenses result in a lower green level and consequently lesser market demand, while price-cutting will boost consumers' demand. The MNM in the exclusive structure has relatively small reductions in the green level and lower price-cut to mitigate the revenue loss, while in the competitive structure the green level decreases faster, and therefore the price should be even more reduced to capture customers. At the same time, with the increase in R&D spending, the local manufacturer's competitive advantage will increase, and the price reduction of exclusive retailing will benefit market expansion and discourage the MNM's revenue growth. Conversely, the local manufacturer has the option of marketing products 1 and 2 in the competitive structure, and either an increase or a decrease in the generic product price will result in a total revenue loss when the green expenditure increases.

Thirdly, as the product green perception level increases, the MNM's product price will fall in the exclusive channel and rise in the competitive channel, while the regular product price increases in both channels and more rapidly in the competitive channel. Possibly, the reason is that in the exclusive structure, the increase in the consumer awareness of the green properties will boost the demand of the regular product motivating the local manufacturer to raise the price, while the franchised retailer lowers the price to capture the market share. In a competitive structure, the local manufacturer will raise the prices of all products to reap more benefits because of his or her power in controlling the product quantity.

Proposition 3. *Under the Scenarios E and C,*

(a) The product quantities of the multinational and the local manufacturers, respectively, satisfy the following, $q_1^E < q_1^C$, *and* $q_2^E > q_2^C$

(b) $(\partial q_1^E/\partial k) < 0$, $(\partial q_1^C/\partial k) < 0$, $(\partial q_2^E/\partial k) > 0$, *and* $(\partial q_2^C/\partial k) > 0$

(c) $(\partial q_1^E/\partial \delta) < 0$ *and* $(\partial q_1^C/\partial \delta) > 0$; $(\partial q_2^E/\partial \delta) > 0$ *and* $(\partial q_2^C/\partial \delta) < 0$

It emerges from Proposition 3 that, firstly, the green product demand is higher in competitive marketing than in exclusive marketing, while the opposite will be true for the local manufacturer's demand. The reason is that a higher green level in the competitive channel induces the MNM to capture customer demand, while the local manufacturer reduces the regular product quantities for increasing individual revenues.

Secondly, in both channels, the green product demand decreases as the green investment coefficient increases, while the demand of the local manufacturer rises. Regardless of the channels, an increase in the green costs will prompt the MNM to reduce the greenness and trigger a shrinking and a shift in demand, which will ultimately contribute to a higher demand for regular products.

Thirdly, with the consumer green perception level growing, the global manufacturer's demand decreases in exclusive marketing and increases in competitive marketing;

however, in the case of the local manufacturer's product quantity, it is the opposite. The potential reason is that as consumer recognition of the green features on the regular product increases, the market for the green product in the exclusive structure will be cannibalized by the local manufacturer's low price strategy (i.e., $(\partial q_1^E/\partial\delta) < 0$ and $(\partial q_2^E/\partial\delta) > 0$); on the contrary, the local manufacturer in the competitive structure will adopt a strategic pricing scheme for acquiring the premium profits of the MNM's products, which will lead to a large scale occupation of the regular product market shares by the green (i.e., $(\partial q_1^C/\partial\delta) > 0$ and $(\partial q_2^C/\partial\delta) < 0$).

Given the above propositions, we observe that the MNM achieves a further greenness improvement in the competitive channel due to mitigating the pressure, and the consequent spillover effect will be more profitable for the local manufacturer. On the one hand, he or she will attempt to generate green awareness and strategically charge higher prices for all products, which will have an anchoring effect [72] on consumers' green preference (i.e., a better price-quality relationship). On the other hand, the market gains can be sufficiently carved out if the local manufacturer raises the quantities of green products while reducing regular products. Moreover, the MNM will benefit more in the competitive channel if the product's green R&D expenses are held at a reasonable level.

Theorem 1

(a) $\pi_1^E < \pi_1^C$, *if and only if* $(1/2(1-\delta)) < k < (4-3\delta/4(1-\delta))$; $\pi_1^E \geq \pi_1^C$, *if and only if* $k \geq (4-3\delta/4(1-\delta))$

(b) $\pi_2^E < \pi_2^C$, *if and only if* $k > (1/4(1-\delta))$

According to Theorem 1, the MNM is more profitable by choosing competitive marketing channels if the green level investment coefficient is in the range of a particular threshold; however, the exclusive channel is more advantageous to ease the competitive pressure from the product and increase the revenue when the green investment cost of the product is too expensive. Simultaneously, the local manufacturer would always derive more earnings from the competitive channel.

To directly compare the differences in the MNM's profitability under Scenarios E and C, we can derive the benefit gap at different green perception levels ($\delta < (2/3)$) and have Figure 2, which shows that the exclusive marketing channel is more favorable to the MNM as the green investment coefficient increases, although this will not contribute to the greening of the supply chain. If the green investment costs can be effectively controlled, the MNM would not only enjoy a greater market share in the competitive channel but also contribute significantly to the promotion of the green supply chain.

5. The MNM's Channel Decision Based on the CSR-Seeking Principle

Generally speaking, MNMs in practice will not only focus on profits but also take CSR [57, 73], and how to strengthen the green level of the supply chain is an essential issue in operational decision-making. Based on the CSR-seeking principle, the MNMs have trade-offs between green investments and individual utility under Scenarios E and C. We assume that α denotes the evaluation value of CSR, where a larger valuation indicates that each unit green product assigns a larger social responsibility utility to the MNM, and the total utility for the MNM consists of both green product earnings and CSR benefits. In particular, when $\alpha = 0$, the MNMs will shift their marketing channel selection criteria to the profit-seeking.

Under scenario E, the utility functions for the MNM, the local manufacturer, and the franchised retailer are, respectively,

$$U_1^{\mathrm{RE}} = w_1 q_1 - \frac{1}{2}k\theta^2 + \alpha q_1, \tag{7}$$

$$U_2^{\mathrm{RE}} = p_2 q_2, \tag{8}$$

$$U_3^{\mathrm{RE}} = (p_1 - w_1)q_1. \tag{9}$$

For $k\delta - 4k + 1 < 0$, then $|H_{U_1^{\mathrm{RE}}}| > 0$, $(\partial U_1^{\mathrm{RE}}/\partial w_1) < 0$ and $(\partial U_1^{\mathrm{RE}}/\partial\theta) < 0$, namely, the Hessian matrix of manufacturer 1's utility function is a negative definite. Therefore, there is an optimal solution to the green supply chain (Table 4).

Under Scenario C, the utility functions for the MNM and the local manufacturer are

$$U_1^{\mathrm{RC}} = w_1 q_1 - \frac{1}{2}k\theta^2 + \alpha q_1, \tag{10}$$

$$U_2^{\mathrm{RC}} = (p_1 - w_1)q_1 + p_2 q_2. \tag{11}$$

Because $4k\delta - 4k + 1 < 0$, we have $|H_{U_1^{\mathrm{RC}}}| > 0$, $(\partial U_1^{\mathrm{RC}}/\partial w_1) < 0$ and $(\partial U_1^{\mathrm{RC}}/\partial\theta) < 0$, namely, the Hessian matrix of manufacturer 1's function is a negative definite. Thus, the supply chain has an equilibrium solution (Table 5). When comparing Tables 2–5, we observe that the MNM who follows the CSR-seeking principle will make a greener product and have a lower wholesale price than one based on profit-seeking.

Proposition 4. *Under the Scenarios E and C,*

(a) The green level of the product by the MNM in pursuit of the CSR-seeking principle follows $\theta^{RE} < \theta^{RC}$

(b) $(\partial\theta^{RC}/\partial k) < (\partial\theta^{RE}/\partial k) < 0$ *when* k *rises*

(c) $(\partial\theta^C/\partial\delta) > 0$ *when* δ *increases;* $(\partial\theta^E/\partial\delta) < 0$ *if and only if* $k > (1/2 - 2v)$, *and conversely,* $(\partial\theta^E/\partial\delta) > 0$

It follows from Proposition 4 that, firstly, competitive marketing is better than exclusive marketing for increasing the product greenness when the MNM values the CSR-seeking principle. The reason is that the competitive channel will impose a greater competitive pressure on the MNM to motivate him or her to further upgrade the green level. Secondly, as the green R&D expenses rise, the green level drops in channels and more rapidly in the former. The reason is that increasing green costs give the MNM an incentive to reduce the greenness, especially when he or she is under intensive

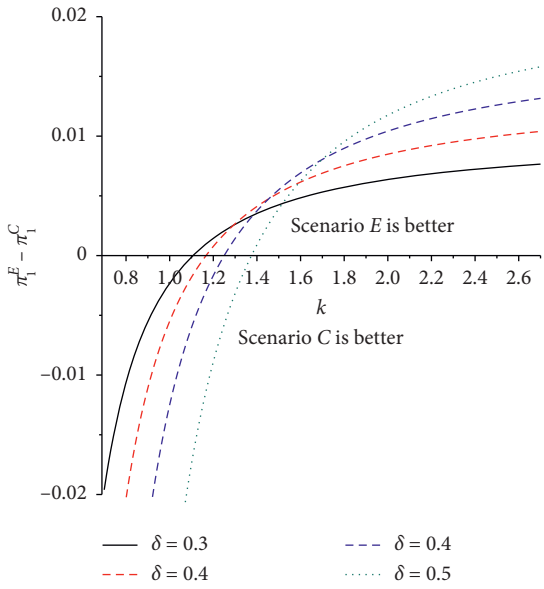

FIGURE 2: Comparison of MNM's revenues under different channels.

price competition. Thirdly, the green level in competitive marketing increases with a growth in the consumer green perception; when the green cost coefficient passes the cutoff value, the product greenness in the exclusive channel diminishes as the perception of greenness expands, and the reverse is true. A plausible explanation is that the MNM will continuously raise the green level in the competitive structure to encourage the local manufacturer to distribute more of his products when the consumer perception of the green properties of regular products increases; however, the MNM lacks the competitive pressure from the local manufacturer in exclusive marketing and will only raise the green level when the R&D cost coefficient is below the threshold, or vice versa.

Proposition 5

(a) $(\partial w_1^{RC}/\partial k) < (\partial w_1^{RE}/\partial k) < 0$

(b) $(\partial w_1^{RC}/\partial \delta) > 0 > (\partial w_1^{RE}/\partial \delta)$

(c) $(\partial w_1^{RE}/\partial \alpha) < (\partial w_1^{RC}/\partial \alpha) < 0$

It follows from Proposition 5, that firstly, the MNM under two channels reduces the wholesale price with the green expenses increasing, and more rapidly in the competitive channel. A reasonable explanation is that the higher green R&D costs stress the multinational manufacturer's capital, so he or she would achieve a quick payback by lowering wholesale prices, especially in the competitive marketing channels that directly face the local manufacturer's products. Secondly, the MNM's wholesale price in exclusive marketing drops as the green perception level rises, while increasing in competitive marketing. Because the substitutability of the products and the increase in the green perception make consumers prefer the local manufacturer, the MNM will reduce the wholesale price to attract consumers when the exclusivity structure is in place. However, in the competitive mode, the local manufacturer will increase the pricing of two products for revenue, which induces the wholesale price rise. Thirdly, the MNM under both structures reduces the wholesale price as the social responsibility value of the product increases, and the wholesale price reduction is greater in the exclusive channel. The reason is that the MNM will lower the wholesale price to sell more green products when social responsibility assessment increases, especially in the competitive structure that involves direct exposure to the local manufacturer.

Proposition 6

(a) $(\partial \theta^{RC}/\partial \alpha) > (\partial \theta^{RE}/\partial \alpha) > 0$

(b) $(\partial \pi_1^{RC}/\partial \alpha) < (\partial \pi_1^{RE}/\partial \alpha) < 0$

It follows from Proposition 6 that the greenness of the MNM's product increases with the level of social responsibility valuation and grows faster under the latter structure regardless of which channel the MNM is in, and that the MNM's actual gains under the competitive channel are diminishing and declining more sharply. The reason is that the MNM will enhance the green level to motivate consumers for the products when the CSR valuation is growing, especially in the competitive structure where the local manufacturer simultaneously sells two alternative products. Correspondingly, a higher green level leads to an excessive increase in green R&D investment and ultimately decreases the MNM's revenue.

Theorem 2

(a) $\pi_1^{RE} < \pi_1^{RC}$, *if and only if* $(1/2(1-\delta)) < k < (4 - 3\delta/4(1-\delta) + 12v^2)$ *and* $\delta < (5 - \sqrt{72v^2+1}/6)$

(b) $\pi_2^{RE} < \pi_2^{RC}$, *if and only if* $k > (1/4(1-\delta))$

From Theorem 2, we can conclude that the MNM gains more from the competitive marketing channel if the green investment coefficient is in a threshold range and the minimum for the consumer green perception level is lower than a certain cutoff value, and conversely, the MNM benefits more from the exclusive retail channel. For the local manufacturer, deep cooperation with the MNM under the competitive structure is better than competing in the market under the exclusive channel. A reasonable explanation is that the local manufacturer is more competent than the retailer in the green product distribution because he or she can avoid excessive competition between two kinds of substitute products, and generate more profits in the market. Specifically, on the one hand, the local manufacturer will strategically increase the green perception level and the prices; on the other hand, he or she will reduce the quantities of individual products while increasing the green products.

In addition, the MNM's selection of the distribution channel not only involves the green level but also incorporates pricing power, individual net utility, and corporate profitability. To analyze the impact of those factors on channel decisions, Figures 3–5 are constructed within the feasible ranges of k, δ, and α. From Figure 3, we can observe that the MNM's pricing power is weaker in the competitive channel (i.e., $w_1^{RE} > w_1^{RC}$) as the level of green R&D investment and consumer green perception increases, since the green product is simultaneously exposed to horizontal and vertical competition from the local manufacturer's product. However, the weaker pricing power can contribute

Table 4: Optimal solution based on CSR-seeking under Scenario E.

$q_1^{RE} = (k(2-\delta+2\alpha)/2(4k-\delta k-1))$	$q_2^{RE} = (6k-\delta k-2-2\alpha k/4(4k-\delta k-1))$	$\theta^{RE} = (2-\delta+2\alpha/2(4k-\delta k-1))$	$w_1^{RE} = (k(\delta^2-6\delta+8)-2\alpha(4k-\delta k-2)/4(4k-\delta k-1))$
$U_1^{RE} = (k(2-\delta+2\alpha)^2/8(4k-\delta k-1))$	$U_2^{RE} = (\delta(6k-\delta k-2-2\alpha k)^2/16(4k-\delta k-1)^2)$		$U_3^{RE} = (k^2(2-\delta+2\alpha)^2/4(4k-\delta k-1)^2)$

Table 5: Optimal solution based on CSR-seeking under Scenario C.

$q_1^{RC} = (k(1-\delta+\alpha)/4k-4\delta k-1)$	$q_2^{RC} = (2k-2\delta k-1-2\alpha k/2(4k-4\delta k-1))$	$\theta^{RC} = (1-\delta+\alpha/4k-4\delta k-1)$	$w_1^{RC} = (2k(1-\delta)^2-\alpha(2k-2\delta k-1)/4k-4\delta k-1)$
$U_1^{RC} = (k(1-\delta+\alpha)^2/2(4k-4\delta k-1))$		$U_2^{RC} = ((4k(1-\delta)(k+2\delta k-3\delta^2 k-2\delta)+\delta)+4\alpha k^2(1-\delta)(2+\alpha-2\delta)/4(4k-4\delta k-1)^2)$	

to mitigating the double marginal effects of green supply chains and promoting the higher penetration of emerging markets by green products.

As shown in Figures 3 and 5, and Proposition 4, as the level of green investment coefficient, the green perception, and the social responsibility valuation coefficient change, the MNM achieves a higher individual utility in the exclusive channel, which does not foster further improvement in the green level than in the competitive channel. If the level of green investment can be constrained, the selection of the competitive channel would promote the MNM's returns and ensure a greener product.

6. Extensions and Numerical Examples

The above analytical findings reveal that the channel preference largely depends on the relationship between green R&D investment costs, green perception level of the regular product, and CSR value. Furthermore, there are significantly sensitive factors, such as subsidies, tariffs, and marketing costs, in emerging markets that may influence the MNM's channel choice, and numerical analysis would clarify the effect of these factors. To respond to the impact of double marginal effects on the supply chain performance, the participants in the supply chain have the an incentive to develop coordination contracts, and how these contracts influence the MNM's channel selection and the green level will be examined in this section.

6.1. Impact of Government Subsidies on the Manufacturer's Channel Selections

6.1.1. Government Subsidies to the Local Manufacturer in the Importing Country. For achieving sustainable development goals, the emerging economies, on the one hand, will encourage the launch of the green in the local market [74]. On the other hand, considering that the MNM's advantage may hurt the domestic manufacturer, the government provides subsidies to consumers who purchase the regular product [75, 76]. We suppose that the government subsidy rate is $\mu_1 \in (0,1)$ and the consumer's utility from acquiring the regular product is $U_1 = \delta v_1 - (1-\mu_1)p_2$, the nondifference between the green and the regular is equivalent to $v_1 - p_1 + \theta = \delta v_1 - (1-\mu_1)p_2$, namely, the consumer's valuation of the green product is $v_1^{SL1} = (p_1 - (1-\mu_1)p_2 - \theta/1-\delta)$. Similarly, no distinction between buying or not buying the local manufacturer's product leads to$\delta v_1 - (1-\mu_1)p_2 = 0$, namely, $v_1^{SL2} = ((1-\mu_1)p_2/\delta)$. Consequently, the MNM's demand is

$$q_1^{SL} = \int_{v_1^{S1}}^{v_1} \frac{1}{v_1}\mathrm{d}x = 1 - \frac{p_1 - (1-\mu_1)p_2 - \theta}{1-\delta}. \tag{12}$$

Emerging market consumers will buy the regular product if they perceive the valuation of the green product to be greater than v_1^{SL2} and less than v_1^{SL1}, and the product demand for the local manufacturer is

$$q_2^{SL} = \int_{v_1^{SL2}}^{v_1^{SL1}} \frac{1}{v_1}\mathrm{d}x = \frac{p_1 - (1-\mu_1)p_2 - \theta}{1-\delta} - \frac{(1-\mu_1)p_2}{\delta}. \tag{13}$$

Furthermore, we derive the price functions for the MNM and the local manufacturer as follows when the government subsidizes the local manufacturer,

$$\begin{aligned} p_1^{SL} &= 1 - q_1^{SL} - \delta q_2^{SL} + \theta, \\ p_2^{SL} &= \frac{\delta\left(1 - q_1^{SL} - q_2^{SL}\right)}{1-\mu_1}, \end{aligned} \tag{14}$$

The profit for the MNM, the local manufacturer, and the franchised retailer under Scenario E are

$$\begin{aligned} \pi_1^{SLRE} &= w_1^{SL} q_1^{SL} - \frac{1}{2}k\theta^2, \\ \pi_2^{SLRE} &= p_2^{SL} q_2^{SL}, \\ \pi_3^{SLRE} &= \left(p_1^{SL} - w_1^{SL}\right)q_1^{SL}. \end{aligned} \tag{15}$$

Meanwhile, under Scenario C, the profit for the multinational and the local manufacturers are

$$\begin{aligned} \pi_1^{SLRC} &= w_1^{SL} q_1^{SL} - \frac{1}{2}k\theta^2, \\ \pi_2^{SLRC} &= p_2^{SL} q_2^{SL} + \left(p_1^{SL} - w_1^{SL}\right)q_1^{SL}. \end{aligned} \tag{16}$$

Proposition 7. *When the emerging market government provides a subsidy to the local manufacturer, there is a rule under Scenario E as follows,* $\theta^{SLRE} = \theta^E$, $\pi_1^{SLRE} = \pi_1^E$ *and* $\pi_2^{SLRE} > \pi_2^E$.

From Proposition 7, it is evident that the local manufacturer's revenues will improve if the governments of emerging economies provide subsidies to the manufacturer, while the product green level and the revenues of the MNM in exclusive marketing will remain unchanged. Given that a high subsidy will raise the financial pressure on the government, the subsidy rate remains in a certain range, $\mu_1 \in (0, 0.5)$; we could examine the changes in the product green level and the manufacturers' revenues in the competitive channel with or without the subsidies (Figures 6 and 7). From the figures, we can observe that regardless of the channel structure, subsidizing the local manufacturer will rarely promote the green supply chain and even damage the MNM's earnings. Therefore, it is optimal for the MNM to select exclusive retailing if the government is concerned about protecting the local manufacturer.

6.1.2. Government Subsidies to the MNM in the Importing Country. For global sustainable development, emerging economies will consider a subsidy strategy to develop green supply chains when the MNM bears excessive financial burdens in developing the green [77], that is, the government offers a discount to consumers that purchase the MNM's products. Referring to the above analysis, we assume that the subsidy rate is $\mu_2 \in (0,1)$; then, the product demand functions of the MNM, the local manufacturer are as follows:

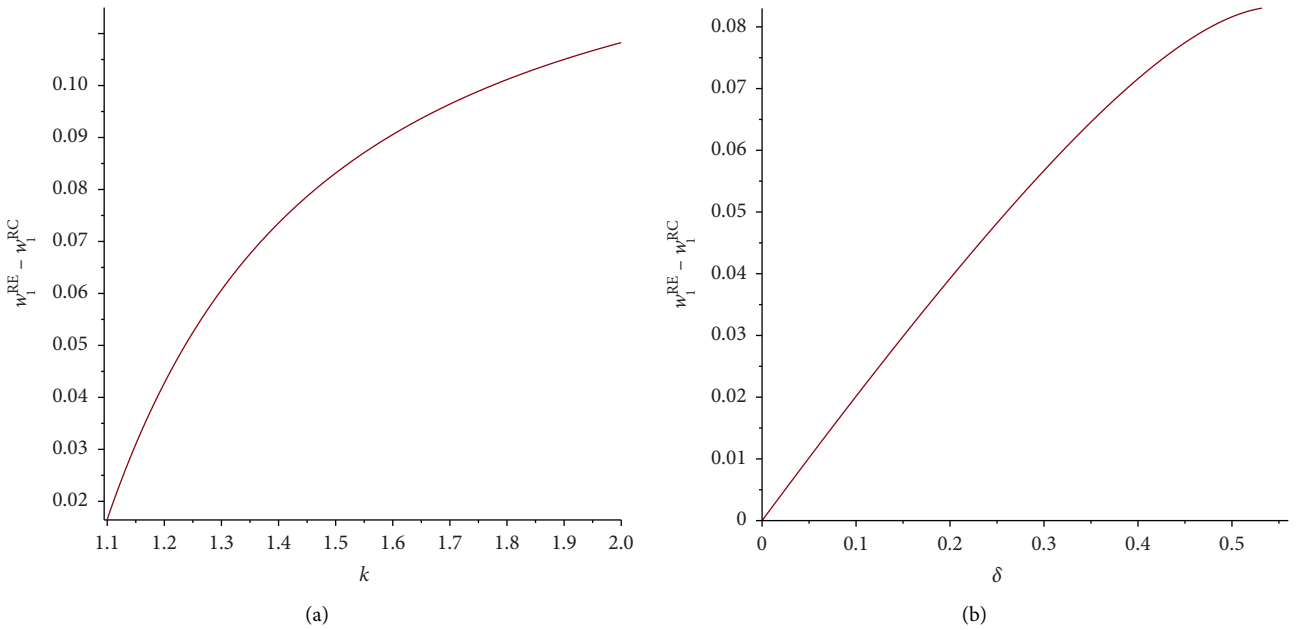

Figure 3: Comparison of the MNM's wholesale price under different channels ($\alpha = 0.05$).

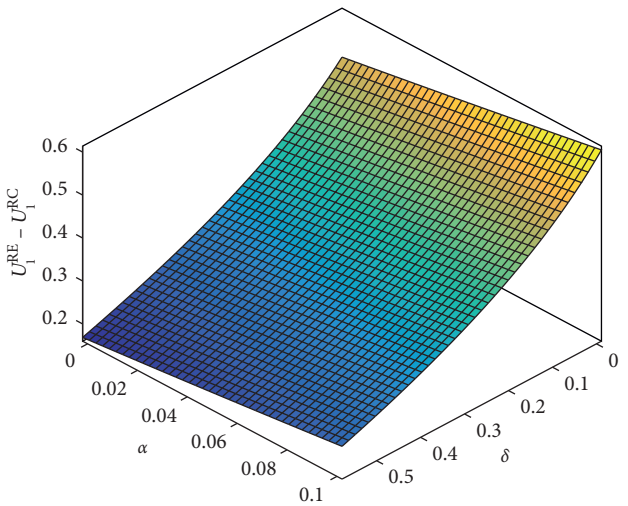

Figure 4: Comparison of the MNM's utility.

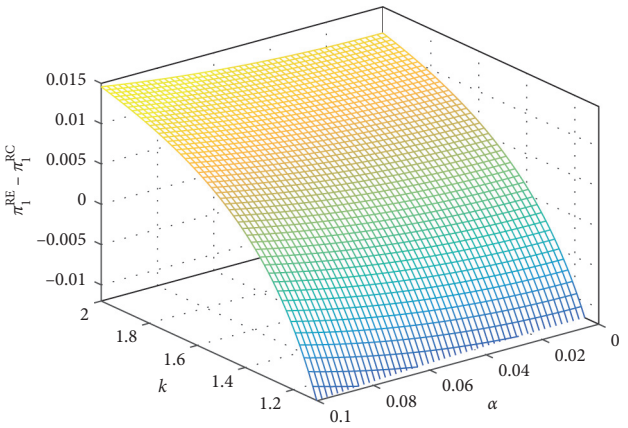

Figure 5: Comparison of the MNM's revenue ($\delta = 0.56$).

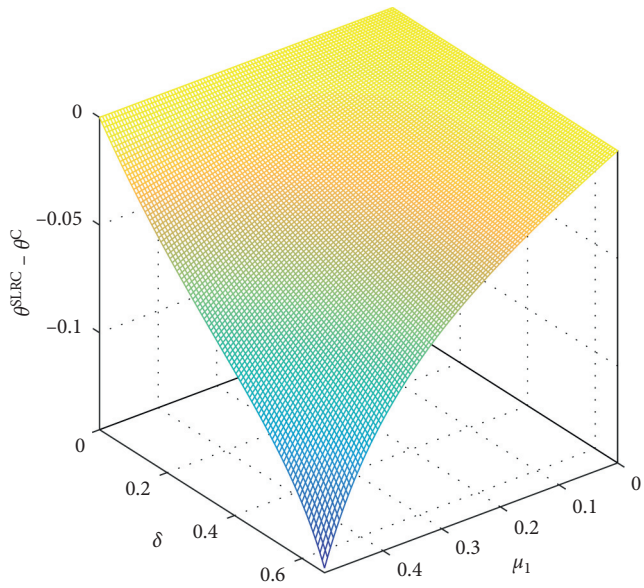

Figure 6: Comparison of the green level in different channels.

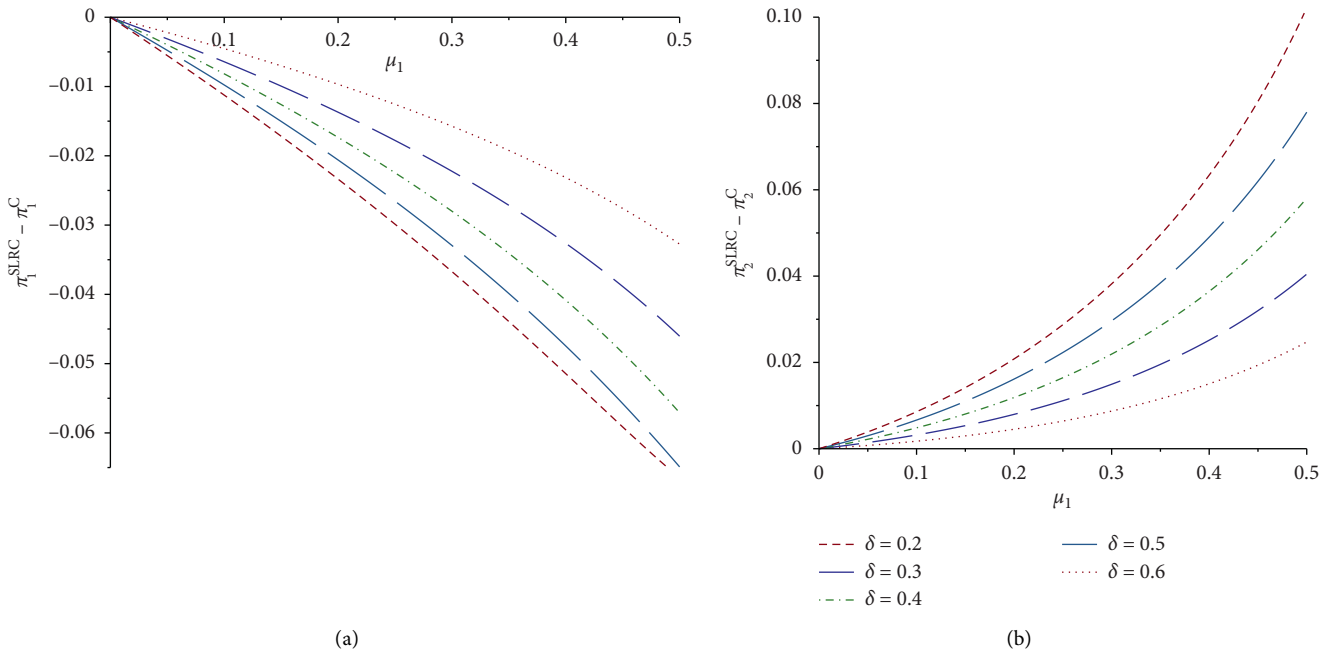

Figure 7: Comparison of the manufacturers' revenues in different channels.

$$q_1^{SM} = \int_{v_1^{SM1}}^{v_1} \frac{1}{v_1} dx = 1 - \frac{(1-\mu_2)p_1 - p_2 - \theta}{1-\delta}. \tag{17}$$

Consumers would select the regular product if the valuation of the product green perception is in the range of v_1^{SM1} and v_1^{SM2}, and the local manufacturer's demand function is

$$q_2^{SM} = \int_{v_1^{SM2}}^{v_1^{SM1}} \frac{1}{v_1} dx = \frac{(1-\mu_2)p_1 - p_2 - \theta}{1-\delta} - \frac{p_2}{\delta}. \tag{18}$$

In addition, we can deduce the price functions of the multinational and the local manufacturer when the government subsidizes the MNM as follows:

$$\begin{aligned} p_1^{SM} &= \frac{1 - q_1^{SM} - \delta q_2^{SM} + \theta}{1-\mu_2}, \\ p_2^{SM} &= \delta\left(1 - q_1^{SM} - q_2^{SM}\right). \end{aligned} \tag{19}$$

Consequently, the revenue functions for the MNM, the local manufacturer, and the exclusive retailer under Scenario E are

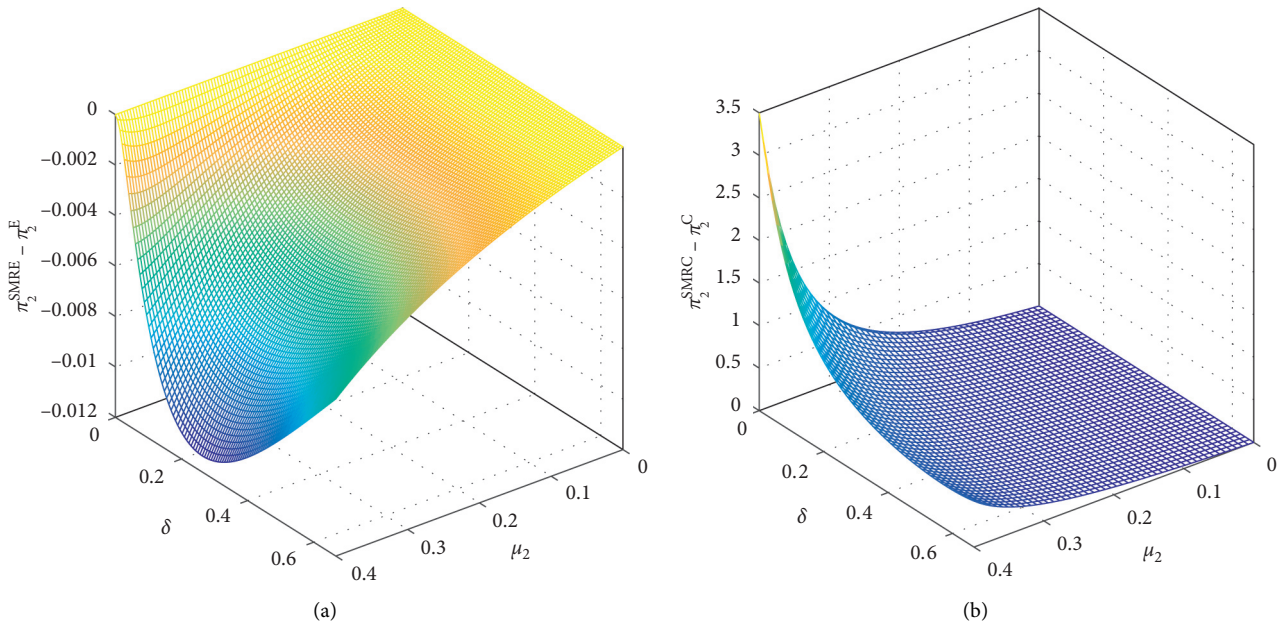

Figure 8: Comparison of the local manufacturer's benefits considering subsidies.

$$\begin{aligned}
\pi_1^{\mathrm{SMRE}} &= w_1^{\mathrm{SM}} q_1^{\mathrm{SM}} - \frac{1}{2} k\theta^2, \\
\pi_2^{\mathrm{SMRE}} &= p_2^{\mathrm{SM}} q_2^{\mathrm{SM}}, \\
\pi_3^{\mathrm{SMRE}} &= \left(p_1^{\mathrm{SM}} - w_1^{\mathrm{SM}}\right) q_1^{\mathrm{SM}}.
\end{aligned} \tag{20}$$

Meanwhile, the revenue functions for the multinational and the local manufacturer under Scenario C follow

$$\begin{aligned}
\pi_1^{\mathrm{SMRC}} &= w_1^{\mathrm{SM}} q_1^{\mathrm{SM}} - \frac{1}{2} k\theta^2, \\
\pi_2^{\mathrm{SMRC}} &= p_2^{\mathrm{SM}} q_2^{\mathrm{SM}} + \left(p_1^{\mathrm{SM}} - w_1^{\mathrm{SM}}\right) q_1^{\mathrm{SM}}.
\end{aligned} \tag{21}$$

Proposition 8. *When the government grants subsidies to the MNM, the rules under Scenario E are, $\theta^{SMRE} > \theta^E$ and $\pi_1^{SMRE} > \pi_1^E$.*

From Proposition 8, it follows that the MNM's product greenness and individual revenues in the exclusivity channel will improve if the government grants him or her a subsidy. Similarly, subsidizing nondomestic firms imposes an economic burden on the government, so let's assume that the subsidy level should not be too large ($\mu_2 \in (0, 0.4)$), where we can compare the change in revenues for the manufacturers with or without government subsidies, and the green level of the supply chain in both scenarios (Figures 8 and 9).

Subsidizing the MNM will boost the local market appeal despite the additional financial pressure on the government. Proposition 8, and Figures 8 and 9, show that the exclusive channel raises the MNM benefits and the green level, but results in a loss to the local manufacturer. On the contrary, competitive marketing will increase the stakeholder benefits and the green level. Therefore, instead of subsidizing the local manufacturer, the government should provide subsidies to the MNM under the competitive channel.

6.2. Impact of Transaction Cost on the Manufacturer's Channel Selections. While it is true that there are many advantages for multinational companies entering emerging markets, they also need to bear various marketing costs, tariffs, and advertising costs for the market benefits, which are collectively referred to as transaction cost for achieving the trade [78, 79]. We use t to denote the transaction fees of per unit green product demand. Based on equations (7)–(11), the optimal green level, and the MNM's revenue and utility considering the transaction cost are the following:

$$\begin{aligned}
\theta^{\mathrm{TRE}} &= \frac{2 - \delta + 2\alpha - 2t}{2(4k - \delta k - 1)}, \\
\theta^{\mathrm{TRC}} &= \frac{1 - \delta + \alpha - t}{4k - 4\delta k - 1}, \\
\pi_1^{\mathrm{TRE}} &= \frac{k(2 - \delta + 2\alpha - 2t)(2 - \delta - 2\alpha - 2t)}{8(4k - \delta k - 1)}, \\
\pi_1^{\mathrm{TRC}} &= \frac{k(1 - \delta + \alpha - t)(1 - \delta - \alpha - t)}{2(4k - 4\delta k - 1)}, \\
U_1^{\mathrm{TRE}} &= \frac{k(2 - \delta + 2\alpha - 2t)^2}{8(4k - \delta k - 1)}, \\
U_1^{\mathrm{TRC}} &= \frac{k(1 - \delta + \alpha - t)^2}{2(4k - 4\delta k - 1)}.
\end{aligned} \tag{22}$$

From the optimal solution, the MNM's green level, revenue, and utility will decrease with the transaction cost. By supposing $k = 1.1, \delta = 0.5, \alpha = 0.05$, we can compare

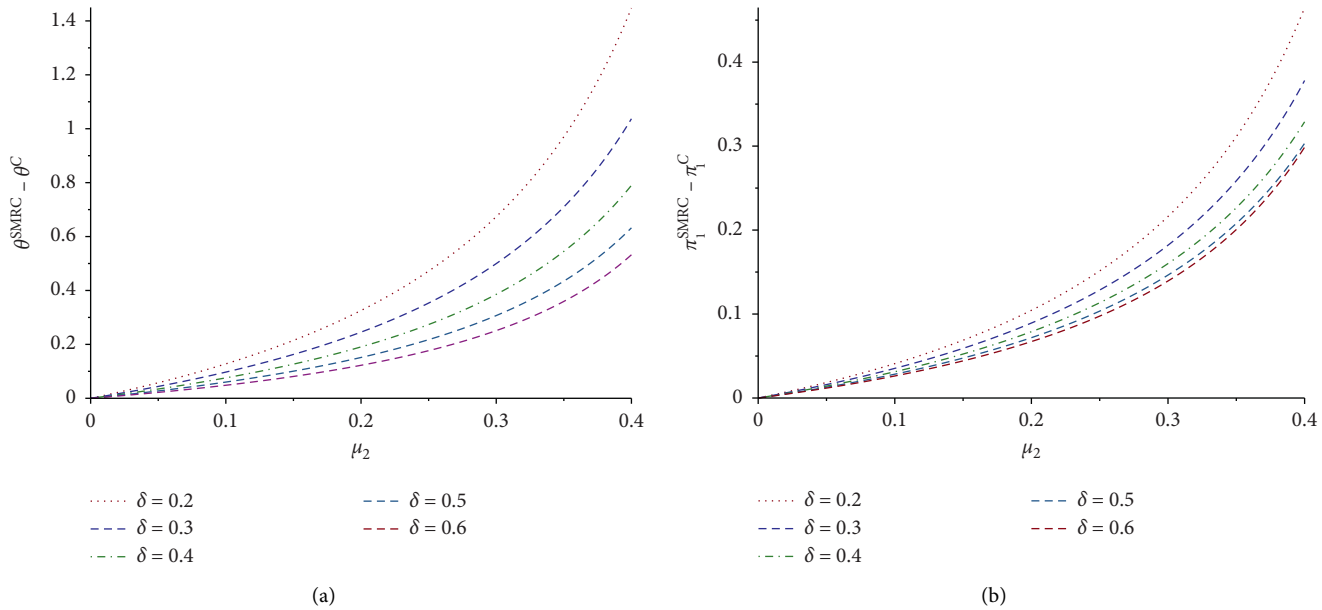

Figure 9: Comparison of the green level and benefits of the MNM considering subsidies.

them under different scenarios with changing transaction cost and get Figure 10. When the transaction cost is low, the MNM is in a better position to control the reduction of the green level, the utility, and the revenue in competitive retailing; conversely, the MNM's preference for the exclusive channel will reduce the loss of individual utility and revenue while further hindering the green supply chain.

6.3. Impact of Revenue-Sharing Contracts on the Manufacturer's Channel Selections. When the green R&D expenses of products are high or uncontrollable, the MNM's decisions are adverse to the individual utility and revenue [29, 80]. Therefore, we apply the revenue-sharing contract to reduce the greening costs and mitigate the double marginal effects on the supply chain [31]. More concretely, the MNM commits to increase the green level and reduce the wholesale price, meanwhile, to alleviate the green cost burden, and the exclusive retailer or the competitive manufacturer shares a part of the gains from the distribution of the green products. Assuming that the revenue-sharing ratios under Scenarios E and C are ρ, ψ, respectively, then we can derive, depending on equations (7)–(11), that the optimal revenue-sharing ratio, the green level, and the manufacturer's revenue under different channels are, $\rho = (\delta k + 1/2k)$,

$$\begin{aligned}
\pi_1^{RSRE} &= \frac{k(2-\delta+2\alpha)(2-\delta+2\alpha)}{2k-\delta k-1},\\
\pi_2^{RSRE} &= \frac{\delta(3\delta k+2k\alpha-6k+4)^2}{64(2k-\delta k-1)^2},\\
\psi &= \frac{2(1-\delta)}{4k-4\delta k-\delta},\\
\theta^{RSRC} &= \frac{(1-\delta+\alpha)(4k-4\delta k-\delta)}{(4k-4\delta k-1)^2-(1-\delta)},\\
\pi_1^{RSRC} &= \frac{k(1-\delta+\alpha)(1-\delta-\alpha)(4k-4\delta k-\delta)}{2(4k-4\delta k-1)^2-2(1-\delta))},\\
\pi_2^{RSRC} &= \frac{12\delta^3k^2+8\delta^2k^2\alpha-4\delta k^2\alpha^2-20\delta^2k^2-16\delta k^2\alpha+4k^2\alpha^2+8\delta^2k+4\delta k^2+8k^2\alpha+\delta^2-8\delta k+4k^2}{4(4k-4\delta k-1)^2-4(1-\delta)}.
\end{aligned} \tag{23}$$

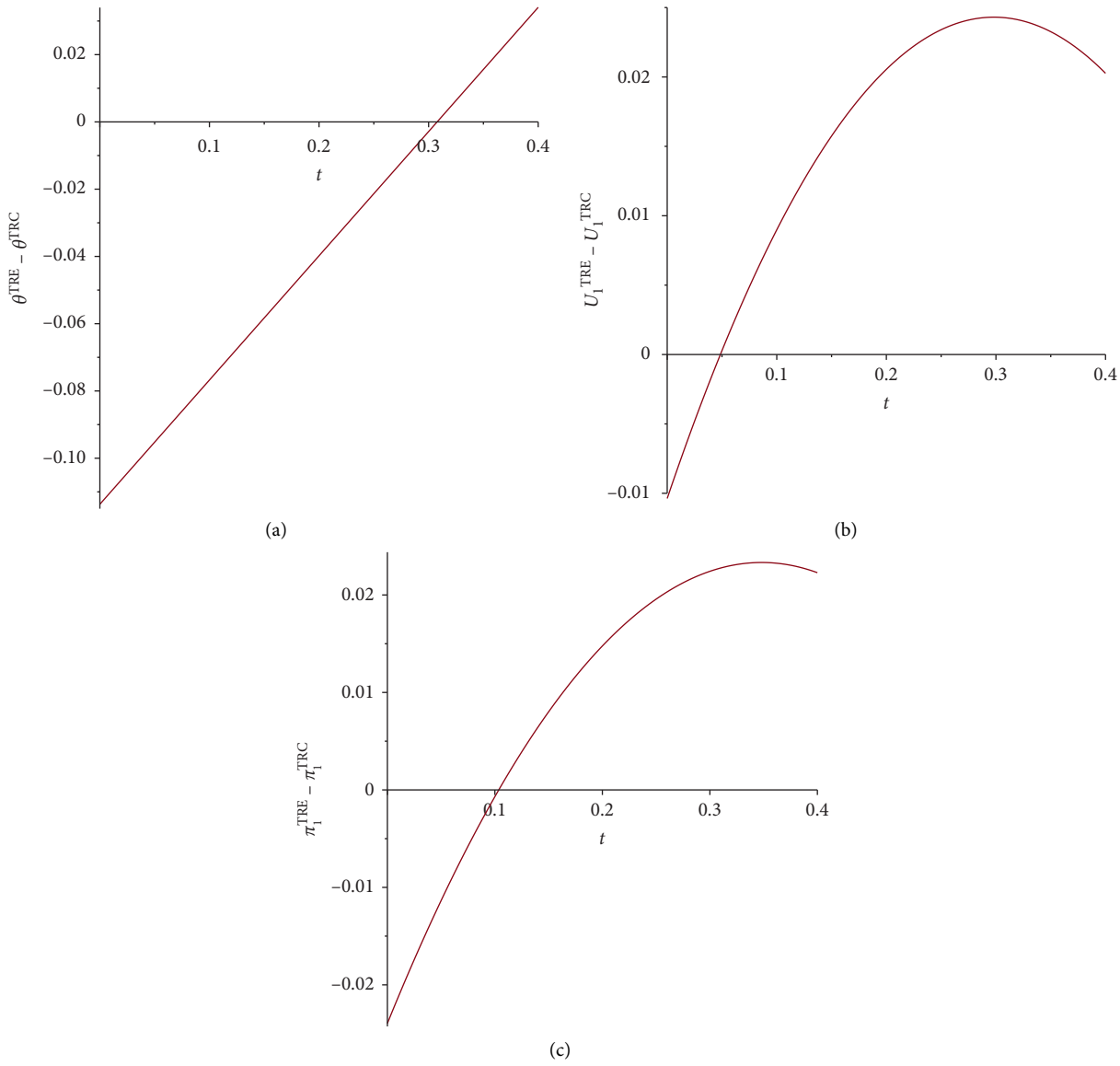

Figure 10: Comparison of the green level, utility, and benefits of the MNM considering transaction cost.

Theorem 3. *When introducing revenue-sharing contracts, the green level under different scenarios complies with the following laws:*

(a) $\theta^{RSRE} < \theta^{RSRC}$, $\rho > \psi$

(b) $(\partial\rho/\partial k) < 0$, $(\partial\psi/\partial k) < 0$

(c) $(\partial\rho/\partial\delta) > 0$, $(\partial\psi/\partial\delta) > 0$.

Theorem 3 implies the following: firstly, in the revenue-sharing contract, the competitive structure will generate a higher green level and result in a smaller share of the stakeholder's revenue, which achieves the development of the green supply chain while simultaneously reducing the participant's burden. However, it will harm the MNM's revenue improvement. Secondly, increasing the R&D expenses motivate the distributors to lower the revenue-sharing rate, which suggests that excessive investment in green R&D is always a significant economic burden for the stakeholders. Thirdly, the increasing consumer perception of the green features encourages the distributors in the two channels to expand their revenue-sharing ratios. To analyze the impact of the revenue-sharing contract on the multinational supply chain under different product green perceptions, we assume that the green R&D investment level and the multinational supplier's CSR valuation are $k = 1.5, \alpha = 0.05$ and denote the change rates of the supply chain performance indicators with and without the revenue-sharing by $\nabla Y = (Y^{RS} - Y_E)/Y_E$, where Y^{RS} represents the value of the indicators after the coordination and Y^{RS} denotes the value of the relevant performance indicators for the uncoordinated exclusive channel when the green perception of the product is 0.05. The indicators include the revenue of the multinational and the local manufacturers, the green level, and the product quantities. In particular, we suppose

Table 6: Comparison of supply chain performance pre- and post-contract coordination (a).

Scenario E	$\delta = 0.05$	$\delta = 0.1$	$\delta = 0.2$	$\delta = 0.3$	$\delta = 0.4$	$\delta = 0.5$
π_1^{RSRE} (%)	27.92	26.37	23.42	20.75	18.42	16.57
π_2^{RSRE} (%)	−22.20	52.98	194.20	320.71	428.50	512.01
θ^{RSRE} (%)	27.92	29.70	33.71	38.50	44.32	51.54
q_1^{RSRE} (%)	27.92	29.70	33.71	38.50	44.32	51.54
q_2^{RSRE} (%)	−11.79	−12.54	−14.24	−16.26	−18.72	−21.77

Table 7: Comparison of supply chain performance pre- and post-contract coordination (b).

Scenario C	$\delta = 0.05$	$\delta = 0.1$	$\delta = 0.2$	$\delta = 0.3$	$\delta = 0.4$	$\delta = 0.5$
π_1^{RSRC} (%)	24.96	20.48	11.82	3.78	−3.11	−7.49
π_2^{RSRC} (%)	1579.29	1742.77	2076.25	2423.24	2795.50	3223.78
θ^{RSRC} (%)	28.25	30.52	36.28	44.55	57.44	80.40
q_1^{RSRC} (%)	28.25	30.52	36.28	44.55	57.44	80.40
q_2^{RSRC} (%)	−47.89	−49.30	−52.87	−57.95	−65.83	−79.68

Table 8: Comparison of supply chain performance pre- and post- improved coordination ($F = 0.05$).

Scenario C	$\delta = 0.05$	$\delta = 0.1$	$\delta = 0.2$	$\delta = 0.3$	$\delta = 0.4$	$\delta = 0.5$
π_1^{RSRC} (%)	59.50	55.02	46.36	38.32	31.43	27.05
π_2^{RSRC} (%)	770.02	933.51	1266.98	1613.97	1986.23	2414.51
θ^{RSRC} (%)	28.25	30.52	36.28	44.55	57.44	80.40
q_1^{RSRC} (%)	28.25	30.52	36.28	44.55	57.44	80.40
q_2^{RSRC} (%)	−47.89	−49.30	−52.87	−57.95	−65.83	−79.68

that the product green perception coefficient is below 0.53 to ensure that the corresponding optimal output is positive, which leads to Tables 6 and 7.

As the product green perception level increases, it is clear from Tables 6 and 7 that, firstly, revenue-sharing coordination in the competitive marketing is more conducive to increasing the local manufacturer revenue, the green level, and the product quantities of the MNM, which will contribute to the green supply chain and the market share; secondly, the revenue-sharing contract is more advantageous to the MNM in the exclusive channel as the product green perception level increases. Consequently, considering the principle of benefit and utility seeking, the direct exploitation of revenue-sharing contract may induce the MNM to favor the exclusive channel rather than the competitive channel that generates a higher green level.

In fact, the revenue-sharing contract significantly benefits the local manufacturer, while the increase in the MNM's revenues is relatively minor and even declines in competitive retailing. Therefore, the local manufacturer's benefits would be greatly affected if the MNM abandons the competitive channel in favor of the coordination contract in the exclusive channel. To further develop the green supply chain, we introduce the two-part tariff contract in the revenue-sharing contract [57, 81, 82]. Specifically, when the MNM faces to determine the marketing channel, the local manufacturer initially pays an agency-fee to the MNM, which then determines whether to adopt the revenue-sharing contract in the competitive structure based on the fee. In the improved contract, the MNM must satisfy $\pi_1^{RSRC} + F \geq \pi_1^{RSRE}$, i.e., $F_L \geq \pi_1^{RSRC} - \pi_1^{RSRE}$. At the same time, the local manufacturer must meet $\pi_2^{RSRC} - F \geq \pi_2^{RERE}$, i.e., $F_U \leq \pi_2^{RSRC} - \pi_2^{RSRE}$. Therefore, if and only if $F \in [F_L, F_U]$, the multinational and the local manufacturers can reach a meaningful cooperation and have incentives to comply with the contract. According to the data in this section, the supply chain achieves the improved coordination, where $F \in [0.03, 0.99]$, and the related performance indicators are subsequently improved (Table 8).

7. Conclusions

Deploying green supply chains is a promising approach to address worldwide environmental problems and contribute to global sustainable development, and the selection of different product retail distribution channels has a significant impact on further promoting the green level of multinational supply chains and the participants' profitability. By analyzing and comparing the channel decisions in different scenarios, the following managerial insights can be derived:

Firstly, both the exclusionary and the competitive channels are conducive to the development of the multinational green supply chain, and the latter generates a higher level of greenness and consistently benefits the local manufacturer. Secondly, based on the principle of profit-seeking, the MNM will gain more by choosing the competitive marketing structure when the green R&D investment coefficient is relatively low; conversely it should pick exclusive retailing to ensure the revenue. Thirdly, based on the principle of CSR, the

MNM will always achieve a greater utility and a higher profit than the competitive retailing when the green R&D is more costly; the opposite will be more advantageous if the competitive structure is chosen. Fourthly, subsidizing the local manufacturer in the importing country of green products would be detrimental to the green supply chain and the MNMs' profitability, but providing subsidies to the MNM in the competitive structure would facilitate the green supply chain and result in a higher return for both the manufacturers. Fifthly, transactions costs reduce the product green level, while more gains are obtained in the competitive structure when the costs remain comparatively low, and otherwise opt for the exclusionary structure. Sixthly, the revenue-sharing contract would further boost the development of the multinational green supply chain, especially in the competitive channel. However, the MNM's choice of the exclusive structure could result in more gains and a substantial loss of the local manufacturer's profits. By the two-tariff contracts to improve the contract, the MNM would prefer the competitive channel and achieve a win–win solution for both the manufacturers.

Based on the game analysis above, we derive the following managerial insights. (i) From the perspective of the MNMs, the competitive structure is profitable when the green R&D fees are high. Such a choice is valuable because we are currently witnessing fast manufacturing growth in emerging markets (e.g., automotive manufacturing in China and India). Especially in the case of high CSR objective, the MNMs perform better in terms of product greenness in competitive marketing. Conversely, the MNMs that prefer the exclusionary structure cannot achieve a higher green level but will gain more revenue. (ii) From the perspective of emerging economies, lowering tariffs will facilitate the MNM's choice of competitive marketing, which will be more conducive to the green economy. Furthermore, the government should subsidize the manufacturer's selection of the competitive channel, which is advantageous to both the multinational and the local manufacturers. (iii) From the part of the whole supply chain, overseas marketing channels (i.e., exclusive retailers and competitive manufacturers) can benefit from the high green level of the MNM's products, so they are obliged to cover some of the green R&D expenses. Moreover, the stakeholders require clarity through contracts on how to share the benefits of the green supply chains.

This paper examines marketing channel strategies for the manufacturer that develops the multinational green supply chain in a deterministic setting. We only discussed the two-level supply chain that includes the global manufacturer and the channel distributor in the emerging market and neglected the cost of marketing efforts in the retailing channels. The future research will discuss the multinational manufacturer's channel preferences under demand uncertainty when marketing effort investment varies. Besides, with the increase of the consumer green perception, we can further investigate the impact of multiple competing retailers or local manufacturers on the channel decisions and the green level of the global supply chain.

Appendix

We do not list the detailed mathematical solution process, because,

(a) The optimal solutions of the different scenarios in this paper can be obtained by first-order and second-order derivations

(b) Most of the propositions are obtained by parameter derivation or comparison of algebraic expressions

Proof of Proposition 1

(a) For $k > (1/2(1-\delta))$, then $4\delta k - 4k + 1 < 0$, $\delta k - 4k + 1 < 0$ and $2\delta k - 2k + 1 < 0$, there is $\theta^E - \theta^C = (\delta(2\delta k - 4k + 1)/(\delta k - 4k + 1)(4\delta k - 4k + 1)) < 0$, namely, $\theta^E < \theta^C$

(b) $(\partial\theta^E/\partial k) = -((2-\delta)(4-\delta)/2(4k - \delta k - 1)^2) < 0$; $(\partial\theta^C/\partial k) = -(4(1-\delta)^2/(4k - 4\delta k - 1)^2) < 0$.

$$\frac{\partial\theta^E}{\partial k} - \frac{\partial\theta^C}{\partial k} = -\frac{\delta\left(8\delta^3k^2 - 48\delta^2k^2 - 8\delta^2k + 72\delta k^2 + 40\delta k - 32k^2 - 7\delta - 32k + 10\right)}{2(4k - \delta k - 1)^2(4k - 4\delta k - 1)^2}. \tag{A.1}$$

We suppose $\Delta = 8\delta^3k^2 - 48\delta^2k^2 - 8\delta^2k + 72\delta k^2 + 40\delta k - 32k^2 - 7\delta - 32k + 10$,
then-
$\Delta = 8(\delta-4)(1-\delta)^2(k + (1/2(1-\delta)))^2 - 9\delta + 18$
due to $k > (1/2(1-\delta))$ and $\delta \in (0,1)$, hence $\Delta < 0$, namely, $(\partial\theta^C/\partial k) < (\partial\theta^E/\partial k) < 0$.

(c) $(\partial\theta^E/\partial\delta) = -(2k - 1/2(4k - \delta k - 1)^2) < 0$; $(\partial\theta^C/\partial\delta) = (1/(4k - 4\delta k - 1)^2) > 0$. □

Proof of Proposition 2

(a) If $k > (1/2(1-\delta))$ and $0 < \delta < 1$, we suppose $k = (1 + \delta/2(1-\delta))$ then $p_1^E - p_1^C = -(\delta^2k - 7\delta k + \delta + 6k/2(\delta k - 4k + 1)) = -((\delta-1)(\delta^2 - 7\delta - 6)/2(\delta^2 - 5\delta - 2)) > 0$, namely $p_1^E < p_1^C$. $p_2^E - p_2^C = -(3k(\delta-1)^2/4\delta k - 4k + 1) > 0$, namely, $p_2^E < p_2^C$.

(b) Because $(\partial p_1^E/\partial k) = ((2-\delta)(\delta-6)/4(\delta k - 4k + 1)^2) < 0$, $(\partial p_1^C/\partial k) = -((2-\delta)\delta/4(\delta k - 4k + 1)^2) < 0$, and $(\partial p_1^E/\partial k) - (\partial p_1^C/\partial k) = (3(\delta - 2)/2(\delta k - 4k + 1)^2) < 0$, namely $(\partial p_1^C/\partial k) < (\partial p_1^E/\partial k) < 0$. $(\partial p_2^E/\partial k) = -(3(1-\delta)^2/(4\delta k - 4k + 1)^2) < 0$ and $(\partial p_2^C/\partial k) = 0$;

(c) $(\partial p_1^E/\partial\delta) = -(k(\delta^2k - 8\delta k + 2\delta + 20k - 8)/4(\delta k - 4k + 1)^2) = -((\delta^3 - 11\delta^2 + 32\delta + 4)(1+\delta)/4(\delta^2 - 5\delta - 2)^2) < 0$,
$(\partial p_1^C/\partial\delta) = ((\delta^4 - 10\delta^3 + 45\delta^2 + 28\delta +$

$4)/4(\delta^2 - 5\delta - 2)^2) > 0$ and
$(\partial p_2^E/\partial\delta) = -(8\delta^2k^2 - 16\delta k^2 + 4\delta k + 8k^2 - 4k - 1/2(4k - \delta k - 1)^2) = ((\delta^4 - 10\delta^3 + 45\delta^2 + 28\delta + 4)/4(\delta^2 - 5\delta - 2)^2) > 0,$
$(\partial p_2^C/\partial\delta) = (1/2)(\partial p_2^C/\partial\delta) - (\partial p_2^E/\partial\delta) = (6k(\delta - 1)(2\delta k - 2k + 1)/(4\delta k - 4k + 1)^2) > 0.$ □

Proof of Theorem 1

(a) $\pi_1^E - \pi_1^C = (k\delta(4\delta k - 3\delta - 4k + 4)/(\delta k - 4k + 1)(4\delta k - 4k + 1))$, when $0 < \delta < 1$ and $k > (1/2(1 - \delta))\pi_1^E < \pi_1^C$, if and only if $(1/2(1 - \delta)) < k < (4 - 3\delta/4(1 - \delta))$; $\pi_1^E \geq \pi_1^C$, if and only if $k \geq (4 - 3\delta/4(1 - \delta))$.

(b) Similar to (a), we get $\pi_2^E < \pi_2^C$, if and only if $k > (1/4(1 - \delta))$. □

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

Authors' Contributions

Maozeng Xu conceived and designed the framework of the paper, and Luqing Rong conducted the experimental analysis and wrote the paper. Xiaofeng Chen and Qian Wen facilitated the problem analysis through constructive discussion.

Acknowledgments

This research was mainly sponsored by the Basic and Frontier Research Projects of Chongqing (nos. cstc2020jsyj-zdxwtBX0003 and cstc2018jcyjAX0606), Chongqing Social Science Planning Priorities Project (no. 2020TBWT-ZD002), and the Promotion Project for Young and Middle-Aged Teachers' Basic Scientific Research Ability in Colleges and Universities of Guangxi (no. 2019KY0382).

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