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Influence of Greenwashing Strategy on Pricing: A Game-Theoretical Model for Quality Heterogeneous Enterprises

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Abstract. Greenwashing behaviors refer to the performance that enterprises claim environmental protection, but their words and actions are inconsistent. The greenwashing strategy has both short-term benefits and negative effects for corporations. In this paper, a model of competition between two companies with different product quality is constructed. This paper explores how the greenwashing strategy of brown enterprises with inferior quality affects the pricing and profits of traditional enterprises without greenwashing motivation. The results show that: (1) the price of greenwashing enterprises is unimodal. Greenwashing companies will improve product quality while reducing prices to ensure a growing market demand. (2) Traditional enterprises fail to regain the market by relying on price competition, and it is more important to reduce the success rate of greenwashing. (3) Only by reducing the success rate of greenwashing, will greenwashing companies lose their greenwashing benefits, and traditional enterprises can regain market shares.

Keywords. Greenwashing behavior, product quality, success rate, pricing decisions

1. Introduction

In recent years, corporate social responsibility (CSR) has become the focus of social attention. Many investors are not only concerned about the profitability of the enterprise, but also the fulfillment of the CSR behavior. However, the false sales of new energy vehicles defraud the government's environmental protection subsidies, the formaldehyde purification ability of the air purification industry deceptively advertise products, and China Resources Power Holdings Company Limited swindle the state of environmental subsidies of more than ¥ 10 million through "desulfurization" fraud [1]. These brown companies of poor environmental performance have used green marketing to gloss over their superficial environmental behaviors. Jay (1986) was the first to define this behavior as "greenwashing" [2]. Greenwashing behaviors (GWBs) refers to the fact that the company declares environmental protection, but its words and actions are inconsistent. Reasons such as lax government control and limited consumer identification ability provide the possibility of GWBs. In 2007, Terra Choice Environmental Marketing conducted a survey of so-called "green products" sold in North America. Subsequently,

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he published the "Seven Sins of Greenwashing", including environmental manifestations such as superficiality, undocumented, vague, misleading, unworthy of name, false statements, and false labels [3], which generated great social repercussions. The issue of GWBs has received considerable critical attention in China. In 2009, Southern Weekend (a Chinese magazine) published the "the List of Greenwashing", exposing the greenwashing scams of numerous companies. Coca-Cola, Nike and Disney have all appeared on the list.

There is no doubt that the reason why corporations take the greenwashing behavior remains for the potential profit demand. However, although companies may package themselves as low-carbon pioneers through "greenwashing", once the green lie is exposed, the company's brand image will be hit severely. Consumers will lose loyalty to the brand, and the financial performance of the company may be negatively affected [4]. For example, North China Pharmaceutical Group Co., Ltd., one of the largest pharmaceutical enterprises in China, actively responds to national policies in the establishment of green factories. On the other hand, some of the group's enterprises have been fined more than ¥ 2 million for improper use of pollution prevention and control facilities, failure to dispose of solid waste as required, discharge of sewage in excess of standards, etc. [5].

A considerable amount of literature has been published on greenwashing. Some empirical researches show that greenwashing will not only have a direct negative impact on consumers' word-of-mouth [6] and purchase intention [7], but also lead to a significant reduction in investors' valuation of "green companies" [8]. Other scholars explore the influence of greenwashing by establishing theoretical models. Sun and Zhang (2019) [9] conduct evolutionary game analysis on heterogeneous enterprises, and discuss the impact of government punishment mechanism and tax subsidy mechanism on enterprises' GWBs. Yenipazarli and Vakharia [10] make pricing decisions under different circumstances for green products in the brown-green product portfolio. Furthermore, they suggest that greening up incumbent brown products does not necessarily diminish the environmental impact of enterprises compared with designing a new environment-friendly product [11].

So far, however, there has been little discussion about the greenwashing behavior of firms combining with competitive pricing decisions among heterogeneous companies. As far as we know best, there are two articles closely related to our work. Wu [12] examine the game between profit-driven and socially responsible companies, revealing how information transparency leads to greenwashing, and proposing that green cleaning has a positive side. However, compared with our research, they do not discuss about the competitive pricing decisions between the two companies. In addition, Huang [13] propose a game theory model to explore the competitive pricing strategies of incumbent green firms when they face the competition from greenwash participants in emerging markets. Comparing with Huang [13], our research takes into account two types of firms: those that have dominate product quality without greenwashing motivation and those enterprises that have inferior product quality and greenwashing motivation. Then we investigate into how high-quality enterprises can make decisions on pricing and profit to resist the greenwashing behavior of low-quality enterprises.

To sum up, GWBs always exist in an immature green market in which the market management system is not complete, consumers need to spend a lot of time identifying green products and the awareness of businesses to consciously fulfill their social responsibilities. The impact of greenwashing on traditional businesses is complex and worth studying. Only by correctly recognizing the impact of greenwashing behavior, will

a level competition environment and the sustainable development of domestic product markets be built. This is also the main purpose of this article.

2. Model Formulation

In this research, we consider two companies that produce similar products with quality heterogeneity in the immature green market. We name them a traditional enterprise (Firm 1) and a greenwashing enterprise (Firm 2), denoted by subscript 1 and subscript 2, respectively. The product quality of traditional enterprise is superior to the one of greenwashing enterprise. We also assume that Firm 1 has no incentive to deceive consumers, and produces traditional products without any green element. Firm 2 may choose to make up for the lack of quality by exaggerating the greenness of its products, in order to attract the attention of environmentalists and make more profits. That is, Firm 2 adopts a greenwashing strategy. U_i i $(i = 1, 2)$ represents the level of utility that both products bring to consumers. Moreover, we suppose that consumers in the market have a certain awareness of green consumption and purchasing power. They are willing to pay an environmental premium for green products. p_i is the product price of the enterprises' products. However, as mentioned above, greenwashing behaviors (GWBs) may not be successful. For example, in 2011, Nippon Paint Co., Ltd. hyped up words such as "fully develop low-carbon environmental protection coatings" and "never change the color of the earth" in its corporate social responsibility report. But in 2015, it was punished by the Chengdu Municipal Environmental Protection Department and the Tianjin Municipal Environmental Protection Bureau for environmental violations of ¥ 100,000 (Guo, 2017) [14].

After weighing the benefits and risks of greenwashing behavior, will enterprises still adopt greenwashing strategies? This paper will investigate this problem by establishing two scenario models to explore how companies will choose greenwashing strategies and competitive pricing under the condition of different product quality.

Scenario 1: Firm 2 does not use GWBs

When the greenwashing enterprise recognizes that GWBs has greater risks, it may not choose to implement the greenwashing strategy. That is, Firm 2 competes fairly with Firm 1. Then, we can obtain a model of Firm 2 without GWBs, and the relevant parameters are represented by superscript *N*. The consumer utility of two of these products is: $U_1^N = V - p_1^N$; $U_2^N = \theta V - p_2^N$. V represents the basic utility obtained from the consumption of the above two products, and follows a uniform distribution on (0, 1). θ represents the different quality levels of the two products and is any constant on (0,1). Consumers will only make a purchase if the utility of the product is non-negative and they will choose the one with larger utility. Therefore, the demand functions of the two products are:

$$D_1^N = Pr(U_1^N \geq U_2^N, U_1^N \geq 0) = 1 - \frac{p_1^N - p_2^N}{1 - \theta}$$

$$D_2^N = P(U_1^N \leq U_2^N, U_2^N \geq 0) = \frac{p_1^N - p_2^N}{1 - \theta} - \frac{p_2^N}{\theta}$$

As mentioned above, the product quality of Firm 2 is lower than that of Firm 1, and therefore, its product cost will also be less than that of Firm 1. To simplify the calculation, we assume that the product cost of Firm 1 is c and the product cost of Firm 2 is 0, and

other operating costs are ignored. If we normalize the size of the potential market to 1, the profits that two companies receive from the product can be expressed as:

$$\Pi_1^N = (p_1^N - c)D_1^N;\ \Pi_2^N = p_2^N D_2^N$$

Lemma 1 The equilibrium prices of the two Firms p_1^{N*} and p_2^{N*}, the equilibrium demand D_1^{N*} and D_2^{N*}, and the equilibrium profits Π_1^{N*} and Π_2^{N*} are as follows.

$$p_1^{N*} = \frac{2(c-\theta+1)}{4-\theta};\ p_2^{N*} = \frac{\theta(c-\theta+1)}{4-\theta};\ D_1^{N*} = \frac{\theta c-2(1-\theta-c)}{(4-\theta)(1-\theta)};\ D_2^{N*} = \frac{1-\theta+c}{(4-\theta)(1-\theta)};$$

$$\Pi_1^{N*} = \frac{(2(\theta+c-1)-\theta c)^2}{(4-\theta)^2(1-\theta)};\ \Pi_2^{N*} = \frac{\theta(1-\theta+c)^2}{(4-\theta)^2(1-\theta)}.$$

Scenario 2: Firm 2 adopts GWBs

In this scenario, Firm 2 pursues profits more aggressively and takes risk to adopt a greenwashing strategy. Although the quality of its products is not as good as that of the traditional enterprise, the greenwashing enterprise achieves the purpose of "greening up products" after the packaging of green marketing and the use of environmentally-related professional words, such as "green homeland", "low-carbon life", etc. Moreover, in the immature green market, consumers have limited ability to identify green products. Thus, we model the utility functions of consumers as $U_1 = V - p_1$,$U_2 = \theta[V + \varphi(r+\delta) + (1-\varphi)(-\delta)] - p_2$. Since $V \geq 0$,we can obtain that $p_2 \geq \theta k$, where $k = \varphi(r+\delta) + (1-\varphi)(-\delta)$. φ indicates the success rate of greenwashing of Firm 2, which is an arbitrary constant on $(0,1)$. In addition, environmentally conscious consumers are willing to pay an environmental premium for green products. The environmental premium is the portion of the environmental value that consumers pay when they purchase a green product that exceeds its true usage value. So, we suppose r is the willingness to pay for the consumer's environmental premium. As described above, greenwashing is very risky. We assume that if the company successfully greenwash, it can gain greenwashing benefits δ. If the GWBs fail, the company will suffer $(-\delta)$ losses. Therefore, the overall expected greenwashing benefit is $[\varphi(r+\delta) + (1-\varphi)(-\delta)]$.

In this case, we obtain the demand function for Firm 1 and Firm 2:

$$D_1 = 1 - \frac{p_1 - p_2 + \theta[\varphi(r+\delta)+(1-\varphi)(-\delta)]}{1-\theta};\ D_2 = \frac{p_1 - p_2 + [\varphi(r+\delta)+(1-\varphi)(-\delta)]}{(1-\theta)} - \frac{p_2}{\theta}$$

Thus, we can derive the profit function of Firm 1 and Firm 2 as follows:

$$\Pi_1 = (p_1 - c)D_1;\ \Pi_2 = p_2 D_2.$$

Lemma 2 In the greenwashing scenario, the equilibrium strategies of Firm 1 and Firm 2 are:

$$p_1^* = \frac{2(1-\theta+c)-\theta[\mu(r+\delta)+(1-\mu)(-\delta)]}{4-\theta},\ p_2^* = \frac{\theta\{(1-\theta+c)+(2-\theta)[\mu(r+\delta)+(1-\mu)(-\delta)]\}}{4-\theta};$$

$$D_1^* = \frac{2(1-\theta-c)-\theta[\mu(r+\delta)+(1-\mu)(-\delta)-c]}{(4-\theta)(1-\theta)},\ D_2^* = \frac{(1-\theta+c)+(2-\theta)[\mu(r+\delta)+(1-\mu)(-\delta)]}{(4-\theta)(1-\theta)};$$

$$\Pi_1^* = \frac{(2\theta + 2c - \theta c - \theta\delta + \theta\varphi r + 2\theta\varphi\delta - 2)^2}{(1-\theta)(4-\theta)^2},$$

$$\Pi_2^* \frac{\theta(\mathrm{c} - \theta - 2\delta + 2\varphi\mathrm{r} + \theta\delta + 4\varphi\delta - \theta\varphi\mathrm{r} - 2\theta\varphi\delta + 1)^2}{(1-\theta)(4-\theta)^2}.$$

3. Structural Analysis

In this section, we mainly analyze three factors to explore how the greenwashing strategy impacts the pricing and profit of firms, including (1) the success rate of greenwashing φ; (2) the product quality θ; (3) the greenwashing benefit δ.

3.1. Impact of the Success Rate of Greenwashing φ

After obtaining the corresponding balanced decisions for Firm 1 and Firm 2, we consider the boundary conditions of the φ. From $p_1^* > c, p_2^* > 0, p_2^* > \theta k, D_1^* > 0, D_2^* > 0$, we can obtain that when $\theta + c < 1$, $\varphi \in (-\frac{c - \theta - 2\delta + \theta\delta + 1}{2r + 4\delta - \theta r - 2\theta\delta}, \frac{c - \theta + 2\delta + 1}{2r + 4\delta})$; when $\theta + c > 1$, $\varphi \in (-\frac{c - \theta - 2\delta + \theta\delta + 1}{2r + 4\delta - \theta r - 2\theta\delta}, \frac{\theta c - 2c - 2\theta + \theta\delta + 2}{\theta r + 2\theta\delta})$. Both cases are analyzed.

Proposition 1

- p_1^* decreases in φ. p_2^* increases in φ.
- D_1^* decreases in φ. D_2^* increases in φ.
- Π_1^* decreases in φ. Π_2^* increases in φ.

In the green market, a high success rate of greenwashing can mask the problem of poor product quality. Firms vigorously promote the slogan of "consumption is green", so that consumers will shift their focus to the environmental functions of products, ignoring the comparison of quality. Therefore, the GWBs can bring more market share to brown companies. Moreover, customers with environmental awareness are more willing to pay an environmental premium. This makes the price of greenwashing products continue to grow, even exceeding the price of traditional high-quality products. When the success rate of greenwashing is larger than a threshold, the greenwashing company is more profitable than that of the traditional firm. Obviously, the increasing competition poses a threat to traditional firms. They want to regain their share of market demand by cutting prices. However, consumers are more inclined to purchase so-called "green products" to satisfy their own environmental preferences than cheap commodities.

Price competition is not an effective way for traditional firms to combat GWBs. The most important matter is to reduce the success rate of greenwashing in the green market. From the numerical experiment (Figure 1), it can be shown that when $\varphi < 0.4$, brown companies will not adopt a greenwashing strategy. Therefore, for the purpose of reducing the GWBs and protecting the interests of traditional firms from penetration, we can use the following two aspects to achieve its greenwashing success rate. On the one hand, the risk of GWBs is increased by reinforcing the authorities' supervision of the green market and cracking down on greenwashing speculation. On the other hand, improving consumers' ability to identify green products, popularize environmental protection labels and knowledge of organic products, making consumers less susceptible to deception by brown companies.

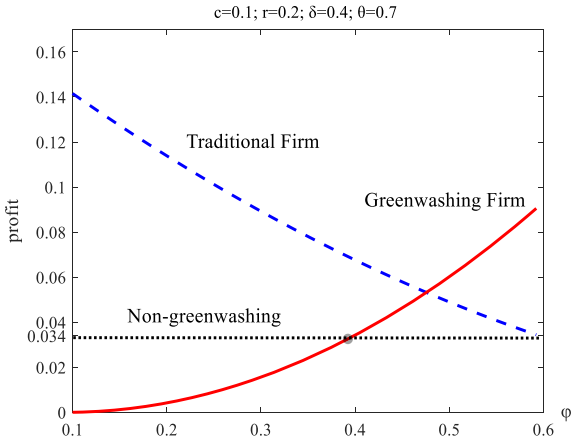

Figure 1. Impact of φ on the profit of firms.

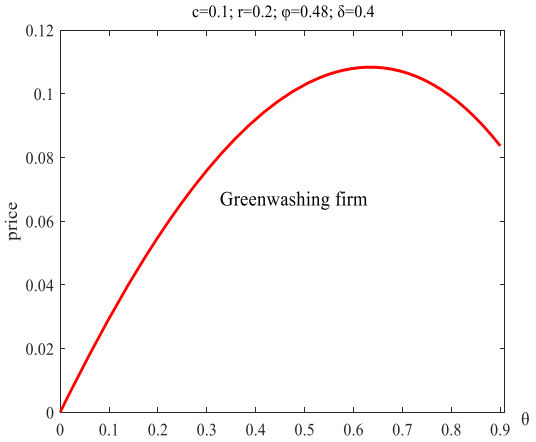

Figure 2. Impact of θ on the profit of firms.

3.2. Impact of the Product Quality θ

When studying how product quality affects corporate greening decisions, it is reasonable to assume $k = \varphi\,(r + \delta) + (1-\varphi)(-\delta) > 0$. If $k < 0$, the profit of the Firm 2 will be lost, so it will not adopt a greenwashing strategy. Similarly, we can work out the boundary conditions of θ. When $k > c$, $\theta \in (0, c + 2\delta - 2\varphi r - 4\varphi\delta + 1)$; when $0 < k < c$, $\theta \in (0, \frac{2-2c}{\varphi r - \delta - c + 2\varphi\delta + 2})$. Again, both cases are analyzed.

Proposition 2

- p_1^* decreases in θ. p_2^* is unimodal in θ.
- D_1^* is unimodal in θ. D_2^* increases in θ.
- Π_1^* decreases in θ. Π_2^* increases in θ.

Improving the quality of a product leads to a rise in prices. However, $\frac{\mathrm{d}^2 p_2^*}{\mathrm{d}\theta^2} < 0$. That is, θ is not monotonous. When θ increases to a threshold ($\theta \approx 0.63$), the price of the

product falls. The result is shown in Figure 2. This counterintuitive phenomenon is caused by fierce price competition between businesses. As product quality improved, Firm 2 attracts more consumers to buy its "green products". Thus, it's product demands increase. Consumers are also willing to pay higher prices for "green products", so the price of Firm 2 products is gradually rising. However, due to the improvement of the product quality of the competitors and the "green" marketing campaigns, the Firm 1 is forced to reduce the price. At first, when the product quality is low, the traditional company's price reduction practice can indeed boost some of its market demand. However, as the quality level of greenwashing products improve, the price reduction measures are ineffective. As a result, demand and profits for traditional businesses are declining. Then, fierce price competition has led to a slowdown in price growth for greenwashing enterprises. Furthermore, Firm 2 has reduced the price while improving the quality in order to grab a more substantial market share. Compared with traditional firms, the product cost of greenwashing firms is relatively low and the profit margin is large. Therefore, even if the price of greenwashing products falls, greenwashing firms is still more profitable than traditional firms.

3.3. Impact of the Greenwashing Benefits δ

Supposing $\theta + c < 1$, the boundary conditions for δ are as follows: When $\varphi > 0.5$, $\delta \in \left(0, \frac{2\theta + 2c - \theta c + \theta\varphi r - 2}{\theta - 2\theta\varphi}\right)$; when $\varphi < 0.5$, $\delta \in \left(\frac{2\theta + 2c - \theta c + \theta\varphi r - 2}{\theta - 2\theta\varphi}, 1\right)$.

Proposition 3

- When$\varphi < 0.5$, $\frac{dp_1^*}{d\delta} > 0$, $\frac{dD_1^*}{d\delta} > 0$, $\frac{dp_2^*}{d\delta} < 0$, $\frac{dD_2^*}{d\delta} < 0$, and $\frac{d\Pi_2^*}{d\delta} < 0$.
- When $\varphi > 0.5$, $\frac{dp_1^*}{d\delta} < 0$, $\frac{dD_1^*}{d\delta} < 0$, $\frac{dp_2^*}{d\delta} > 0$, $\frac{dD_2^*}{d\delta} > 0$ and $\frac{d\Pi_2^*}{d\delta} > 0$.
- When $\varphi < 0.5$, $\frac{d\Pi_1^*}{d\delta} > 0$. When $0.5 < \varphi < -\frac{2\theta + 2c - \theta c - 2}{\theta r}$, $\frac{d\Pi_1^*}{d\delta} < 0$.

When exploring the impact of greenwashing benefits on the price, demand and profit of the two firms, the impact of the success rate of greenwashing φ should not be overlooked. When the success rate of greenwashing is small $(\varphi < 0.5)$, the implementation of GWBs of enterprises is easier to be exposed. It means that the Firm 2's GWBs may suffer δ times the loss, so its product price, demand and profit will decrease in greenwashing revenue. As competitors, traditional enterprises will be more likely to dominate because brown companies are penalized or do not choose GWBs. Consumers may be more inclined to purchase products from Firm 1 due to loss of trust or superior quality. Thus, it has more demands and profits. Conversely, when the success rate of greenwashing is large $(\varphi > 0.5)$, the product price, demand and profit of greenwashing firms will increase in δ. But that of traditional Firms will be taken away and even be forced to withdraw from the market because the product has no market demand.

4. Conclusion Remarks and Future Research

This paper constructs a model in which two competitive enterprises with different product quality. The firm with dominating quality has no incentive to greenwashing, while the other firm with inferior quality may seek more profits through greenwashing

strategy. We explore how the greenwashing strategy affects the pricing and profits of traditional enterprises from three aspects, including the success rate of greenwashing, the product quality and the benefits of greenwashing. We show that it is essential to control the success rate of greenwashing in the market and reduce the market's tolerance for GWBs. Interestingly, the price of greenwashing firms is unimodal. The green marketing of greenwashing firms initially attracts some consumers, but as the price competition becomes intense, they had to reduce prices with improving product quality to maintain a sustained growth in market demand. Only when the success rate of greenwashing is large, will the profits of greenwashing companies increase with the income of greenwashing. For traditional businesses, only by reducing the success rate of greenwashing, will brown companies lose their interests in the GWBs, and traditional corporations can regain the market.

Our research provides a theoretical basis and practical reference value for supply chain decision-making in markets with greenwashing behaviors. However, we only consider deterministic needs, and it is possible to further study this problem with random demands.

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