Optimal pricing strategy for green products under salience theory

Zhiyi Meng, Na Zhao, Bin Shen & Chang Zhai

Published online: 06 Oct 2021.

Submit your article to this journal

Article views: 3162

View related articles

View Crossmark data

Citing articles: 2 View citing articles

Routledge
Taylor & Francis Group

Optimal pricing strategy for green products under salience theory

Zhiyi Meng[a], Na Zhao[b], Bin Shen[b] and Chang Zhai[c]

[a]Rural Revitalization Research Center, Business School, Sichuan University, Chengdu, China; [b]Basic Police Skills Teaching Department, Sichuan Police College, Luzhou, China; [c]Natural Science, Michigan State University, East Lansing, MI, USA

ABSTRACT

Environmental pressures and people's demands for green consumption have prompted manufacturers to engage in the research and development of green products. Manufacturers need to consider the price and greenness of products when making production decisions. This paper analyzes the level of greenness and price competition of duopoly manufacturers in the consumer market in which both green-sensitive consumers (salience to greenness) and price-sensitive consumers (salience to price) exist simultaneously according to salience theory. We find that the regular manufacturer will enter the green market when all consumers' average degree of price responsiveness is small or in a moderate part of the region. In addition, this paper also discusses the influence of salience on manufacturers' level of greenness and pricing strategy choice. We find that the degree of salient thinking of consumers influences optimal pricing, optimal greenness and profits under the uniform pricing and price discrimination mechanisms.

1. Introduction

Rapid economic development occurs at the expense of the consumption of numerous non-renewable resources and the environment. Currently, population, resources and environmental issues have become important bottlenecks and major problems that restrict the continued sustainable development of society, and environmental issues are increasingly prominent (Conrad, 2005; Goran et al., 2019; He et al., 2021; Murali et al., 2019). Nuryakin and Maryati (2020) used the competitiveness of green product and the success of green product as mediating variables to demonstrate the impact of the competitiveness and the success of green product on the innovation performance of green product. In order to handle the increasingly serious environmental problems, the concept of green was proposed. In this context, green products are increasingly

popular because they have more environmentally friendly characteristics than traditional products (Debabrata et al., 2018). However, in the research and development of green products, companies face a great risk that their input research and development costs will not be recognised by consumers and result in losses (Tsaur, 2015).

This may lead to higher prices for green products, leading to losing part of the demand of consumers who are more price-sensitive while manufacturers are committed to developing green products to attract consumers who are more sensitive to green products. The reason is that different types of consumers in the market have different preferences for different attributes of products, that is, they have different sensitivities to changes in different attributes. Some consumers prefer green products while others are more price sensitive. Consumers tend to pay more attention to certain attributes of products when making purchase decisions. For example, when buying air tickets, consumers who pay more attention to time will pay special attention to the punctuality of an aircraft, price-conscious consumers will pay special attention to the discount rate of air tickets, and quality-oriented consumers will be more concerned about the comfort and service levels of aircraft. As another example, when purchasing clothes, some consumers focus on the quality of the clothes while others are more concerned with price. Most consumers will give excessively distorted weights to lottery gains when buying lottery tickets. Therefore, consumers give greater weights to the attributes they care about before making purchasing decisions. Bordalo et al. (2012) refer to this phenomenon of consumers as a salience effect and proposed salience theory, that is, consumers assigned different weights to different attributes in different scenarios. Salience theory points out that consumers often pay more attention to certain attributes of products when making purchase decisions. Both salience theory and prospect theory can effectively explain the Alai paradox and people's risk attitudes. However, prospect theory requires different functions and constraints while salience theory uses a unified function model to judge people's choices of results. Salience theory is an effective tool to describe bounded rationality and can intuitively explain the preference reversal phenomenon, including the Alai paradox, using the salient difference of the attribute value.

Regarding green products, consumers pay more attention to the greenness and prices of the products. Therefore, we select these two attributes, consider that different types of consumers in the market have different sensitivities to greenness and prices, and study whether the firm should enter the green market in the context of its competitors producing green products in a duopoly environment. Based on salience theory, this paper analyzes the level of greenness and price competition of duopolistic manufacturers producing green products in the consumer market where both greenness-sensitive consumers (salience to greenness) and price-sensitive consumers (salience to price) exist simultaneously. We combine the classic Hotelling model and salience theory to construct the utility function of consumers; obtain the demand and profit functions of manufacturers; and give the optimal product decisions of the two manufacturers, including the greenness and price decisions of the products. We also discuss the impact of consumers' distinctive thinking on the greenness, pricing, and profits of a company's products.

The remainder of the paper proceeds as follows. Section 2 contains a literature review. Section 3 constructs and analyzes two models of regular manufacturers

entering and not entering the green market. Section 4 extends the previous sections by exploring the optimal decision-making problem when the two manufacturers both produce green products and implement price discrimination strategies for green-sensitive consumers and price-sensitive consumers. Section 5 conducts the numerical simulation analysis to provide relevant conclusions. Finally, Section 6 concludes the study.

2. Literature review

As global climate change issues receive increasingly more attention, the government has gradually increased the environmental awareness of consumers by promoting learning and accelerating the spread of green technologies. The greenness of products is becoming increasingly more important for consumers (Shamdasani et al., 1993). In addition to the price, the greenness of a product has also become an attribute that concerns consumers more. Green consumption is gradually surpassing tradition and becoming a new trend in international consumption (Jo & Shin, 2017). Liu et al. (2012) stated that for green supply chains, product greenness is an important factor affecting sales. Xia et al. (2020) analysed the issues of competition between the two manufacturers in terms of price and environmental quality under the situation where the products produced by duopoly manufacturers have horizontal differentiation. In addition, they also discussed the impact of horizontal product differentiation on the company's participation in environmental certification. Hong et al. (2018) investigated a green product pricing problem by considering consumer environmental awareness (CEA) and nongreen (regular) product references. Tripathi et al. (2018) evaluated the impact and application of nine-tail prices and round-tail prices on the purchase of green and nongreen products under different price levels and different buying motives. The best performance is that consumers care more about the green nature of products than performance or price; and as the concept of environmental protection is more deeply rooted in the hearts of the people, consumers are becoming increasingly more aware of the importance of environmental protection, which has led to a series of great changes in consumer thinking, consumer psychology and consumer behaviour (Strazzera et al., 2012).

The above studies all assume that consumers have the same preference for different attributes. In recent years, some scholars have considered that consumers have a higher degree of preference for the greenness of products when they are environmentally conscious in reality. Liu and Yi (2017) used game theory to analyse the trend of green product prices with greenness and target advertising input and discussed the pricing strategy in the context of big data. Rahmani and Yavari (2019) considered the pricing and greenness decision of a green dual-channel supply chain after joining interrupted demand. Zhang et al. (2020) studied the impact of consumers' environmental awareness on manufacturers' optimal product selection and channel strategy. Their research results show that the increase in consumers' environmental awareness will increase the motivation of manufacturers to produce green product. Sana (2020) studied the impact of word-of-mouth and CEA effects on the spread of newly

launched green products. However, the above research ignores that consumers may also be price-sensitive, that is, they have a preference for product price.

In reality, there are often different types of consumers at the same time. Zhao et al. (2014) indicated that consumer attitudes can be the most important predictor of their purchasing behaviour. Changing lifestyles and consumption patterns are the result of growth and urbanisation, putting pressure on the environment and sustainable development. Coibion et al. (2007) assumed that there were two types of consumers, high-income and low-income consumers; and the former was less price-sensitive than the latter. Syam and Kumar (2006) assumed that the market is composed of two types of consumers, high cost and low cost; and derived the needs of manufacturers based on the classical Hotelling model. Different types of consumers were characterised by preference positioning and different conversion costs. Consumers opt for insurance policies with small deductibles, even though the implied claim probabilities (in comparison with high deductible policies) are implausibly high (Liu & Serfes, 2005; Sydnor, 2010). Regarding the behaviour of consumers with different preferences, Taylor and Thompson (1982) proposed the salience theory, which pointed out that consumers' attention will be attracted by the distinctive part, and the information contained in this part will be disproportionately weighted in subsequent subjective judgments. For example, in the process of purchasing lottery tickets, consumers usually give excessively distorted weight to lottery revenue.

This theory points out that consumers' attention will be attracted by the distinctive part, and the information contained in this part will be disproportionately weighted in subsequent subjective judgments.

Bordalo et al. (2012) found that different types of consumers have different preferences for different attributes of products and proposed salience theory to describe this behaviour. Bordalo et al. (2013) applied this idea to understand decisions under risk and presented a model in which decision makers excessively weigh salient lottery states. They found that many abnormalities in choice under risk, such as frequent risk-seeking behaviour, can be obtained naturally. On their basis, Wu et al. (2014) applied salience theory to the field of project management to study the impact of individual cost salience and showed that teams with different levels of cost salience thinking performed better than similar teams. Zheng et al. (2019) studied the advantages of manufacturers in implementing probabilistic sales strategies under the significant thinking of consumers and proved that consumers' significant thinking behaviours will have an impact on the pricing strategies of manufacturers. Cosemans and Frehen (2021) provided empirical evidence for the impact of salience theory on asset pricing. It is argued that investors will overestimate significant past earnings when they form expectations for future returns. As a result, investors are attracted to stocks with significant upside potential that are overvalued and receive low returns.

We refer to the research of Bordalo et al. (2012) in stressing the interplay of attention and choice, extend the concept of salience to riskless choice among goods with different attributes, and apply salience theory to the scenario when consumers choose green products. We select two attributes of green products that have attracted more attention: greenness and price. The innovation of this paper is that it studies the level of greenness and pricing decisions of a company when the level of greenness and

price preference of a green product are heterogeneous. We innovatively apply salience theory to characterise consumer heterogeneity. The utility function of the consumer is constructed based on the classic Hotelling model. Greenness and price competition are analysed when the firm implements unified pricing and price discrimination.

This research will be divided into three scenarios. First, we consider that there are two manufacturers of the same type in the market: one produces green products and one produces regular products. Then, the two manufacturers compete on price. Second, we study a scenario in which a regular product firm can imitate a green product firm. Finally, we conduct an extended study in which both manufacturers implement personalised pricing in the face of different types of consumers.

3. Model

3.1. Salience theory and assumptions

According to Bordalo et al. (2012), a salient thinker will sort all the attributes of a product and distort their utility weights. Then, the utility formula for the salient thinker is:

$$
U^{LT}(q_k) = \begin{cases} \theta_1 \left(\dfrac{\delta}{\delta\theta_1 + \theta_2} \right) q_k - \theta_2 \left(\dfrac{1}{\delta\theta_1 + \theta_2} \right) p_k & price-sensitive \\[3mm] \theta_1 \left(\dfrac{1}{\theta_1 + \delta\theta_2} \right) q_k - \theta_2 \left(\dfrac{\delta}{\theta_1 + \delta\theta_2} \right) p_k & green-sensitive \end{cases} \tag{1}
$$

Following salience theory, we select two representative attributes of green products: the level of greenness q_k and price p_k. Since salience theory was introduced, for a given salience ranking, utility weights θ_1 and θ_2 ($\theta_1 + \theta_2 = 1$) are attached to level of greenness and price, respectively. If consumers prefer greenness, the relative weight of greenness increases as $\hat{\theta}_1^k = \theta_1(1/(\theta_1 + \delta\theta_2)) > \theta_1$ and the relative weight of price decreases as $\hat{\theta}_2^k = \theta_2(\delta/(\theta_1 + \delta\theta_2)) < \theta_2$ compared to the rational consumer's evaluation. However, if price is salient, its relative weight increases at the expense of that of greenness. The level of salient thinking of consumers is $\delta(0 < \delta < 1)$; and the smaller δ is, the greater the level of salient thinking of consumers. Thus, a consumer's evaluation of any green product k increases relative to the rational benchmark, $U^{LT}(q_k) > U(q_k)$, when its greenness is salient and decreases when its price is salient, in which case $U^{LT}(q_k) < U(q_k)$.

Consumer types are classified by greenness and price: green-sensitive consumers and price-sensitive consumers. Among them, green-sensitive consumers are more sensitive to the greenness of products when considering the overall experience brought by a product and will give greenness a higher weight. Price-sensitive consumers are more sensitive to product prices when considering the overall experience of a product and will give price a higher weight. Both types of consumers aim to maximise their utility. From the perspective of salience theory, we analyse the impact of corporate green product design strategy and pricing strategy.

The formula shows that compared to rational consumers, when greenness is salient (that is, consumers are green-sensitive), the corresponding weight of greenness is

increased, and the corresponding weight of price is reduced. When price is salient (that is, the consumer is price-sensitive), the situation is the opposite.

In the model proposed by Bordalo et al. (2012), consumers change their weights due to changes in different attributes in the market. However, in reality, more consumers are the established types. Environmentally friendly consumers always give a greater weight to the level of greenness of products, and price-sensitive consumers always give a greater weight to prices. Changes in the market will only affect the level of salient thinking of consumers, so we use the weighting method of salience theory. We first classify the types of consumers in the market and then test the optimal decision of the manufacturer in the presence of different types of consumers.

In order to facilitate the analysis, this paper proposes the following assumptions:

Assumption 1. Uniform pricing (price discrimination) means that manufacturers charge the same price (different prices) for different types of consumers. We assume there are two manufacturers producing and selling substitutable products.

Assumption 2. There are two manufacturers in the market: one produces and sells a regular (nongreen) product Q_r to consumers (hereafter, the regular manufacturer r), and one that produces and sells a green product Q_g to consumers (hereafter, the green manufacturer g). These two products are similar in terms of their functional attributes but are heterogeneous in terms of their greenness. The price and level of greenness of the two products are $Q_g = (p_g, q_g)$ and $Q_r = (p_r, q_r)$, respectively.

Assumption 3. There are also two types of consumers in the market. One type of consumer is more sensitive to price, and the weight given to price is higher than the weight given to greenness. The other type is more sensitive to level of greenness, and the weight given to price is higher than the weight given to greenness. Consumers make purchase decisions based on the principle of utility maximisation.

Assumption 4. Product demand is a function of price and the level of greenness, that is, the products of manufacturers have alternatives. Demand depends not only on the price and level of greenness of a manufacturer's products but also on other the prices and levels of greenness of similar products. The consumer's value of purchasing a product is v, assuming v is sufficiently large to ensure that the consumer purchases the product.

Assumption 5. In this part, we apply salience theory to the Hotelling model and reassign the weights of the greenness and price based on consumers' emphasis. In the Hotelling model, in order to obtain the product demand function, assume there is a 'linear market', and the length is 1 with a [0,1] segment representing the market.

Assumption 6. The two manufacturers are positioned at the two ends of the market, and the total number of consumers is normalised to 1 and uniformly distributed in the linear market. x represents the position of consumers and can be explained as the ideal point of consumer preferences. Consumers whose location of consumption is x face the utility loss t, which is also known as switching costs or transportation costs when choosing different manufacturers.

The description of the relevant parameters is given in Table 1.

Table 1. The description of the relevant parameters.

Parameter	Description
θ_1/θ_2	Utility weights attached to level of greenness/price, respectively.
δ	The degree of consumers' salient thinking, and it monotonically decreases
i	$i = g/r$, where g and r respectively represent green and regular
j	$j = u/d$, where u and d respectively represent uniform pricing and price discrimination
S	$S = GR/GG$, where GR and GG respectively indicate the G-R scenario and G-R scenario
q/p	Level of greenness/product price
U_{jip}^S	The utility that price-sensitive consumers obtain by purchasing the product in different scenarios
U_{jiq}^S	The utility that green-sensitive consumers obtain by purchasing the product in different scenarios
v	Base value of the product
d_{ji}^S	The total demand of product i in different scenarios
t	Switching costs
x	The position of consumers
η	The unit cost of improving the level of greenness
Π_{ji}^S	Manufacturer i's profits in different scenarios

Source: The authors.

3.2. The G-R scenario

In this section, we consider two manufacturers in the market: one producing green products and the other producing regular products. Therefore, we assume $q_g = q$ and $q_r = 0$, which represent the levels of greenness of green products and regular products, respectively.

Then, if consumers prefer the price of products, they are more sensitive to changes in price, and they are called price-sensitive consumers. At this time, the utility function is:

$$
U_{uip}^{GR} = \begin{cases} v + \theta_1\left(\dfrac{\delta}{\delta\theta_1 + \theta_2}\right)q - tx - \theta_2\left(\dfrac{1}{\delta\theta_1 + \theta_2}\right)p_{ug}^{GR} & i = g \\[2ex] v + 0 - t(1 - x) - \theta_2\left(\dfrac{1}{\delta\theta_1 + \theta_2}\right)p_{ur}^{GR} & i = r \end{cases} \tag{2}
$$

If consumers prefer the greenness of products, they are more sensitive to changes in the level of greenness, and they are called green-sensitive consumers. At this time, the utility function is:

$$
U_{uiq}^{GR} = \begin{cases} v + \theta_1\left(\dfrac{1}{\theta_1 + \delta\theta_2}\right)q - tx - \theta_2\left(\dfrac{\delta}{\theta_1 + \delta\theta_2}\right)p_{ug}^{GR} & i = g \\[2ex] v + 0 - t(1 - x) - \theta_2\left(\dfrac{\delta}{\theta_1 + \delta\theta_2}\right)p_{ur}^{GR} & i = r \end{cases} \tag{3}
$$

If there are only price-sensitive consumers in the market, the utility indifference preference can be described as:

$$
\tilde{x}_p = \frac{1}{2} + \frac{\theta_1\left(\frac{\delta}{\delta\theta_1 + \theta_2}\right)q - \theta_2\left(\frac{1}{\delta\theta_1 + \theta_2}\right)(p_{ug}^{GR} - p_{ur}^{GR})}{2t} \tag{4}
$$

$\alpha_p = \theta_2/(2t(\theta_1 + \delta\theta_2))$ and $\beta_p = (\theta_1\delta)/(2t(\theta_1 + \delta\theta_2))$ represent the degrees of demand responsiveness to price and greenness for price-sensitive consumers.

Actually, the sensitivity mentioned previously that the degrees of impact of the price and greenness vary based on consumer utility.

The demand function of the green product in the G-R scenario in which all consumers are price-sensitive is:

$$d_p^g = \tilde{x}_p = \frac{1}{2} - \alpha_p(p_{ug}^{GR} - p_{ur}^{GR}) + \beta_p q \tag{5}$$

The demand function of the regular product in the G-R scenario in which all consumers are price-sensitive is:

$$d_p^r = 1 - \tilde{x}_p = \frac{1}{2} + \alpha_p(p_{ug}^{GR} - p_{ur}^{GR}) - \beta_p q \tag{6}$$

Similarly, when there are only green-sensitive consumers in the market, the utility indifference preference can be described as:

$$\tilde{x}_q = \frac{1}{2} + \frac{\theta_1\left(\frac{1}{\theta_1 + \delta\theta_2}\right)q - \theta_2\left(\frac{\delta}{\theta_1 + \delta\theta_2}\right)(p_{ug}^{GR} - p_{ur}^{GR})}{2t} \tag{7}$$

$\alpha_q = (\theta_2\delta)/(2t(\theta_1 + \delta\theta))$ and $\beta_q = \theta_1/(2t(\theta_1 + \delta\theta_2))$ represent the degrees of demand responsiveness to price and the level of greenness for green-sensitive consumers.

The demand function of the green product in the G-R scenario in which all consumers are greenness-sensitive is:

$$d_q^g = \tilde{x}_q = \frac{1}{2} - \alpha_q(p_{ug}^{GR} - p_{ur}^{GR}) + \beta_q q \tag{8}$$

The demand function of the regular product in the G-R scenario in which all consumers are greenness-sensitive is:

$$d_q^r = 1 - \tilde{x}_q = \frac{1}{2} + \alpha_q(p_{ug}^{GR} - p_{ur}^{GR}) - \beta_q q \tag{9}$$

When there are green-sensitive and price-sensitive consumers in the market simultaneously, assume γ represents the proportion of price-sensitive consumers, and $1-\gamma$ represents the proportion of greenness-sensitive consumers. Then, the total demand for the green product in the G-R scenario is:

$$d_{ug}^{GR} = \gamma d_p^g + (1-\gamma)d_q^g \tag{10}$$

The total demand of the regular product in the G-R scenario is:

$$d_{ur}^{GR} = \gamma d_p^r + (1-\gamma)d_q^r \tag{11}$$

Table 2. Equilibrium in the G-R scenario (uniform pricing cases).

Classification	Green manufacturer	Regular manufacturer
Equilibrium price	$p_{ug}^{GR*} = \frac{3\eta}{6\eta\bar{\alpha}-\bar{\beta}^2}$	$p_{ur}^{GR*} = \frac{3\eta\bar{\alpha}-\bar{\beta}^2}{\bar{\alpha}(6\eta\bar{\alpha}-\bar{\beta}^2)}$
Equilibrium greenness	$q^* = \frac{3\bar{\beta}}{2(6\eta\bar{\alpha}-\bar{\beta}^2)}$	–
Equilibrium demand	$d_{ug}^{GR*} = \frac{3\eta\bar{\alpha}}{6\eta\bar{\alpha}-\bar{\beta}^2}$	$d_{ur}^{GR*} = \frac{3\eta\bar{\alpha}-\bar{\beta}^2}{6\eta\bar{\alpha}-\bar{\beta}^2}$
Equilibrium profits	$\Pi_{ug}^{GR*} = \frac{9\eta(4\eta\bar{\alpha}-\bar{\beta}^2)}{4(6\eta\bar{\alpha}-\bar{\beta}^2)^2}$	$\Pi_{ur}^{GR*} = \frac{(3\eta\bar{\alpha}-\bar{\beta}^2)^2}{\bar{\alpha}(6\eta\bar{\alpha}-\bar{\beta}^2)^2}$

Source: The authors.

$\bar{\alpha} = \gamma\alpha_p + (1-\gamma)\alpha_q$ and $\bar{\beta} = \gamma\beta_p + (1-\gamma)\beta_q$ represent the average degrees of price and greenness responsiveness, respectively, for the consumer in the entire market. Then:

$$d_{ug}^{GR} = \frac{1}{2} - \bar{\alpha}(p_{ug}^{GR}-p_{ur}^{GR}) + \bar{\beta}q \qquad (12)$$

$$d_{ur}^{GR} = \frac{1}{2} + \bar{\alpha}(p_{ug}^{GR}-p_{ur}^{GR}) - \bar{\beta}q \qquad (13)$$

As we can see from the above, when $\bar{\alpha}$ is sufficiently large, the demand will decrease when a manufacturer's own price decreases or the other manufacturer's price increases. Similarly, when $\bar{\beta}$ is sufficiently large, the demand will increase as a company's own greenness increases or the other company's greenness decreases.

This paper ignores the variable costs of the manufacturers, only considers the additional fixed costs of producing green products, and portrays the costs according to the level of greenness of the product. Assuming that the unit cost of improving the level of greenness is η, the quadratic function of fixed costs based on greenness is:

$$C_i(q) = \eta q_i^2 \qquad i = g, r \qquad (14)$$

The profits of the two manufacturers are as follows:

$$\Pi_{ug}^{GR} = d_{ug}^{GR} * p_{ug}^{GR} - \eta q^2 \qquad (15)$$

$$\Pi_{ur}^{GR} = d_{ur}^{GR} * p_{ur}^{GR} - 0 \qquad (16)$$

Proposition 1: *Assuming that there are green-sensitive and price-sensitive consumers in the duopoly market at the same time, and manufacturers also make price decisions to maximise their own profits. There is a unique pure strategy Nash equilibrium in the adoption of uniform pricing cases when $\bar{\alpha} > \bar{\beta}^2/(3\eta)$. The equilibrium price, greenness and balanced equilibrium profits are shown in Table 2.*

3.3. The G-G scenario

We assume that the regular manufacturer can imitate the green manufacturer g. In other words, the two manufacturers can change the level of greenness of the product.

Manufacturers set the same price for different types of consumers. Then, if the green product's price is more salient, the consumer's utility function can be defined as:

$$
U_{uip}^{GG} = \begin{cases} v + \theta_1\left(\dfrac{\delta}{\delta\theta_1 + \theta_2}\right)q_{ug}^{GG} - tx - \theta_2\left(\dfrac{1}{\delta\theta_1 + \theta_2}\right)p_{ug}^{GG} & i = g \\[3mm] v + \theta_1\left(\dfrac{\delta}{\delta\theta_1 + \theta_2}\right)q_{ur}^{GG} - t(1 - x) - \theta_2\left(\dfrac{1}{\delta\theta_1 + \theta_2}\right)p_{ur}^{GG} & i = r \end{cases}
\tag{17}
$$

If the product's greenness is more salient, a consumer's utility is:

$$
U_{uiq}^{GG} = \begin{cases} v + \theta_1\left(\dfrac{1}{\delta\theta_1 + \theta_2}\right)q_{ug}^{GG} - tx - \theta_2\left(\dfrac{\delta}{\delta\theta_1 + \theta_2}\right)p_{ug}^{GG} & i = g \\[3mm] v + \theta_1\left(\dfrac{1}{\delta\theta_1 + \theta_2}\right)q_{ur}^{GG} - t(1 - x) - \theta_2\left(\dfrac{\delta}{\delta\theta_1 + \theta_2}\right)p_{ur}^{GG} & i = r \end{cases}
\tag{18}
$$

If there are only price-sensitive consumers in the market, the utility indifference preference can be described as:

$$
\bar{x}_p = \frac{1}{2} + \frac{\theta_1\left(\frac{\delta}{\delta\theta_1+\theta_2}\right)(q_{ug}^{GG}-q_{ur}^{GG}) - \theta_2\left(\frac{1}{\delta\theta_1+\theta_2}\right)(p_{ug}^{GG}-p_{ur}^{GG})}{2t}
\tag{19}
$$

$\alpha_p = \theta_2/(2t(\theta_1 + \delta\theta_2))$ and $\beta_p = (\theta_1\delta)/(2t(\theta_1 + \delta\theta_2))$ represent the degrees of demand responsiveness to price and greenness for price-sensitive consumers, respectively. Actually, the sensitivity mentioned previously reflects that the degrees of impact of the price and greenness vary based on consumer utility. The demand function of the green product in the G-G scenario where all consumers are price-sensitive is:

$$
d_p^g = \bar{x}_p = \frac{1}{2} - \alpha_p(p_{ug}^{GG}-p_{ur}^{GG}) + \beta_p(q_{ug}^{GG}-q_{ur}^{GG})
\tag{20}
$$

The demand function of the regular product in the G-G scenario where all consumers are price-sensitive is:

$$
d_p^r = 1 - \bar{x}_p = \frac{1}{2} + \alpha_p(p_{ug}^{GG}-p_{ur}^{GG}) - \beta_p(q_{ug}^{GG}-q_{ur}^{GG})
\tag{21}
$$

Similarly, when there are only green-sensitive consumers in the market, the utility indifference preference can be described as:

$$
\bar{x}_q = \frac{1}{2} + \frac{\theta_1\left(\frac{1}{\theta_1+\delta\theta_2}\right)(q_{ug}^{GG}-q_{ur}^{GG}) - \theta_2\left(\frac{\delta}{\theta_1+\delta\theta_2}\right)(p_{ug}^{GG}-p_{ur}^{GG})}{2t}
\tag{22}
$$

$\alpha_q = (\theta_2\delta)/(2t(\theta_1 + \delta\theta_2))$ and $\beta_q = \theta_1/(2t(\theta_1 + \delta\theta_2))$ represent the degrees of demand responsiveness to price and the level of greenness for green-sensitive consumers, respectively.

The demand function of the green product in the G-G scenario where all consumers are green-sensitive is:

$$d_q^g = \bar{x}_q = \frac{1}{2} - \alpha_q(p_{ug}^{GG} - p_{ur}^{GG}) + \beta_q(q_{ug}^{GG} - q_{ur}^{GG}) \tag{23}$$

The demand function of the regular product in the G-G scenario where all consumers are green-sensitive is:

$$d_q^r = 1 - \bar{x}_q = \frac{1}{2} + \alpha_q(p_{ug}^{GG} - p_{ur}^{GG}) - \beta_q(q_{ug}^{GG} - q_{ur}^{GG}) \tag{24}$$

We can see that demand is a linear function of the price and level of greenness. The demand for a product decreases as its own price and the other company's level of greenness increase and increases as its own level of greenness and the other company's price increase. The degree of demand responsiveness reflects the degree of impact of the changes in price and greenness on demand.

Then, the total demand for the green product is:

$$d_{ug}^{GG} = \gamma d_p^g + (1-\gamma) d_q^g \tag{25}$$

The total demand for the regular product is:

$$d_{ur}^{GG} = \gamma d_p^r + (1-\gamma) d_q^r \tag{26}$$

$\bar{\alpha} = \gamma\alpha_p + (1-\gamma)\alpha_q$ and $\bar{\beta} = \gamma\beta_p + (1-\gamma)\beta_q$ represent the average degrees of price and greenness responsiveness for a consumer in the entire market, respectively. Then:

$$d_{ug}^{GG} = \frac{1}{2} - \bar{\alpha}(p_{ug}^{GG} - p_{ur}^{GG}) + \bar{\beta}(q_{ug}^{GG} - q_{ur}^{GG}) \tag{27}$$

$$d_{ur}^{GG} = \frac{1}{2} + \bar{\alpha}(p_{ug}^{GG} - p_{ur}^{GG}) - \bar{\beta}(q_{ug}^{GG} - q_{ur}^{GG}) \tag{28}$$

The profits of the two manufacturers are as follows:

$$\Pi_{ug}^{GG} = d_{ug}^{GG} * p_{ug}^{GG} - \eta q_{ug}^{GG2} \tag{29}$$

$$\Pi_{ur}^{GG} = d_{ur}^{GG} * p_{ur}^{GG} - \eta q_{ur}^{GG2} \tag{30}$$

Assuming that the two manufacturers are conducting greenness-price joint decision making, they determine the greenness and price simultaneously to maximise their profits.

Proposition 2. *Assuming that there are green-sensitive and price-sensitive consumers in the duopoly market, manufacturers also make greenness-price joint decisions to maximise their own profits. There is a unique pure strategy Nash equilibrium in the*

Table 3. Equilibrium in the G-G scenario (uniform pricing cases).

Classification	Green manufacturer & regular manufacturer
Equilibrium price	$p_{ug}^{GG*} = p_{ur}^{GG*} = p_{u}^{GG*} = \frac{1}{2\bar{\alpha}}$
Equilibrium greenness	$q_{ug}^{GG*} = q_{ur}^{GG*} = q_{u}^{GG*} = \frac{\beta}{4\eta\bar{\alpha}}$
Equilibrium demand	$d_{ug}^{GG*} = d_{ur}^{GG*} = \frac{1}{2}$
Equilibrium profits	$\Pi_{ug}^{GG*} = \Pi_{ur}^{GG*} = \Pi_{U}^{GG*} = \frac{4\eta\bar{\alpha}-\beta^2}{16\eta\bar{\alpha}^2}$

Source: The authors.

adoption of uniform pricing cases. The equilibrium price, greenness and balanced equilibrium profits are shown in Table 3.

In order to ensure that the company's profits are nonnegative, $\Pi_{ug}^{GG*} = \Pi_{ur}^{GG*} = \Pi_{U}^{GG*} > 0$, it can be shown:

$$t = t_u = \frac{(\gamma\frac{\theta_1}{\theta_1+\delta\theta_2} + (1-\gamma)\frac{\delta\theta_1}{\delta\theta_1+\theta_2})^2}{8\eta(\gamma\frac{\delta\theta_2}{\theta_1+\delta\theta_2} + (1-\gamma)\frac{\theta_2}{\delta\theta_1+\theta_2})} = \frac{\bar{\theta}_q^2}{8\eta\bar{\theta}_p} \tag{31}$$

Then, the following conditions need to be met: $\eta > (\bar{\theta}_q^2)/(8t\bar{\theta}_p)$, $\bar{\theta}_p > (\bar{\theta}_q^2)/(8\eta t)$, and $\bar{\theta}_q^2 < 8\eta t\bar{\theta}_p$, where $\bar{\theta}_p$ and $\bar{\theta}_q$ represent the average degree of price sensitivity and the average degree of green sensitivity for all consumers, respectively.

If the switching costs of the consumers, the marginal costs of the company and the average price sensitivity of consumers are too low or the average green sensitivity of consumers is too high, it will lead to strong competition. Then, the profits will be negative, and there will not be an equilibrium.

Switching costs reflect the inherent consumer loyalty. Low switching costs make it easier for consumers to convert between manufacturers. Intensified price competition among manufacturers will result in too low of an 'equilibrium' price, and then corporate profits will be negative. Therefore, manufacturers should appropriately increase the barriers to conversion to prevent consumers from switching between the two manufacturers.

Lemma 1. $\gamma = 1$ *indicates that there are only price-sensitive consumers in the market. Then, $p_u^{GG*} = t + (t\theta_1)/(\delta\theta_2)$. The optimal price decreases as δ increases, and it increases as the degree of consumers' salient thinking increases.*

$\gamma = 0$ indicates that there are only green-sensitive consumers. Then, $p_u^{GG*} = t + (t\delta\theta_1)/\theta_2$. The optimal price increases as δ increases, and it decreases as the degree of consumers' salient thinking increases.

We continue to discuss the impact of levels of salience on optimal pricing when $\gamma \in (0, 1)$. We find that the effect of the degree of salient thinking of consumers on optimal pricing is also influenced by the proportion of consumers: t, θ_1 and θ_2. Therefore, in this part, we discuss the effects of average price salience and average greenness of all consumers on optimal pricing and the impact of profits.

Switching costs t reflects the inherent loyalty of consumers. Low switching costs makes it easier for consumers to switch between manufacturers and exacerbates price competition, leading to an excessively low 'equilibrium' price; then, corporate profits will be negative.

Since the equilibrium price is only related to the switching costs and average degree of responsiveness to price $\bar{\alpha}$, when the switching costs are too low, the degree of green competition among manufacturers will be intensified, and the increase in firm costs will make the profits negative.

When the average price sensitivity is too low, that is, when there are few price-sensitive customers and too many green-sensitive customers, manufacturers may increase the total costs by too much in order to meet the demands of too many green-preferring consumers, and they cannot obtain positive profits.

The above analysis shows that manufacturers should adopt a minimum differentiation strategy in a fully competitive market under the G-G scenario. The equilibrium price of products is determined by the average degree of price responsiveness and switching costs of the consumers. The higher the average degree of price responsiveness is, the more sensitive a consumer is to the price, and the optimal price of the manufacturers will be lower to attract the consumer. The higher the switching costs of consumers are, the more loyal consumers are, and the less likely they are to switch to competitors. In this case, a firm can charge a higher price to increase profits.

The equilibrium greenness of a green product is determined by the average perceived price sensitivity, the greenness sensitivity of consumers and the marginal production costs. The higher the average greenness sensitivity is, the more sensitive the greenness of consumers, and the higher the greenness of equilibrium. Higher average price sensitivity indicates that consumers are more sensitive to the price, and the company will provide relatively low greenness and low-priced green products to meet consumer demand. In addition, the higher the marginal production costs are, the lower the optimal greenness of the green product, which reduces costs and increases profits.

3.4. Comparative analysis

This section mainly analyzes the conditions under which the regular manufacturer also manufactures green products when there is a green manufacturer in the market and the impact of the significance level on the company's optimal profits under different conditions.

Proposition 3. *Under the three scenarios, the comparison results of the price decisions of the two manufacturers are as follows:*

1. *Optimal price comparison of the two scenarios under uniform pricing: $p_{ug}^{GR*} > p_{ug}^{GG*}$ and $p_{ur}^{GR*} < p_{ur}^{GG*}$.*
2. *Optimal greenness comparison of the two scenarios under uniform pricing: $q_{ug}^{GR*} < q_{ug}^{GG*}$.*

Proposition 3 has two implications. If the regular manufacturer enters the green market (G-G scenario), compared to the nonentry scenario (G-R), the following will occur: (1) The pricing of the green manufacturer will decrease, and the pricing of the regular manufacturer will increase; and (2) The greenness of the green manufacturer will decrease. Comparing Proposition 1 and Proposition 2, the optimal profits of the two manufacturers in the two scenarios are shown in Figure 1 and Proposition 4.

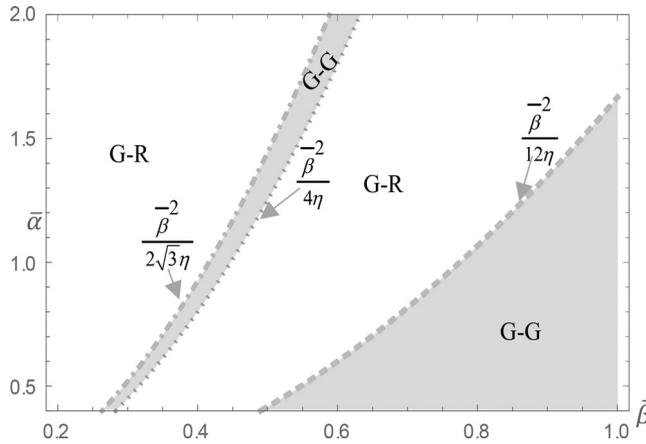**Figure 1.** Selection area of the G-G scenario and G-R scenario ($\eta = 0.05$).
Source: The authors.

Proposition 4.

1. When $0<\bar{\alpha}<\frac{\bar{\beta}^2}{2\sqrt{3}\eta}$, $\Pi_{ur}^{GG*}>\Pi_{ur}^{GR*}$; and when $\bar{\alpha}>\frac{\bar{\beta}^2}{2\sqrt{3}\eta}$, $\Pi_{ur}^{GG*}<\Pi_{ur}^{GR*}$.
2. When $0<\bar{\alpha}<\frac{\bar{\beta}^2}{12\eta}$ or $\bar{\alpha}>\frac{\bar{\beta}^2}{4\eta}$, $\Pi_{ug}^{GG*}>\Pi_{ug}^{GR*}$; and when $\frac{\bar{\beta}^2}{12\eta}<\bar{\alpha}<\frac{\bar{\beta}^2}{4\eta}$, $\Pi_{ug}^{GG*}<\Pi_{ug}^{GR*}$. When $0<\bar{\alpha}<\frac{\bar{\beta}^2}{12\eta}$ or $\frac{\bar{\beta}^2}{4\eta}<\bar{\alpha}<\frac{\bar{\beta}^2}{2\sqrt{3}\eta}$, the regular manufacturer enters the green market.

Figure 1 and Proposition 4 show that the regular manufacturer is more profitable when entering the green market under the condition of $0<\bar{\alpha}<\bar{\beta}^2/(2\sqrt{3}\eta)$. However, this may damage the profits of the green manufacturer. Only under the condition of $0<\bar{\alpha}<\bar{\beta}^2/(12\eta)$ or $\bar{\alpha}>\bar{\beta}^2/(4\eta)$ will the profits of the green manufacturer also increase. Otherwise, the green manufacturer may increase the barriers to entry to prevent the regular manufacturer from entering the green market. The result of the game is that the regular manufacturer enters the green market when $0<\bar{\alpha}<\bar{\beta}^2/(12\eta)$. Therefore, under the condition of $0<\bar{\alpha}<\bar{\beta}^2/(12\eta)$ or $\bar{\beta}^2/(4\eta)<\bar{\alpha}<\bar{\beta}^2/(2\sqrt{3}\eta)$, the G-G scenario is better; otherwise, the G-R scenario is better.

After understanding the conditions in different scenarios, we study the impact of the level of salient thinking of consumers on optimal profits. In the G-R scenario, the impact of consumers' green sensitivity and price sensitivity on the optimal profits of the two manufacturers is shown in Lemma 2.

Lemma 2. *Under the condition of $\frac{\bar{\beta}^2}{3\eta}<\bar{\alpha}$, the following holds:*

1. *The impact of the average degree of price responsiveness on the optimal profits is:*

$\frac{\partial \Pi_{ug}^{GR*}}{\partial \bar{\alpha}}<0$; *when* $\bar{\alpha}<\frac{(5+\sqrt{7})\bar{\beta}^2}{12\eta}$, $\frac{\partial \Pi_{ur}^{GR*}}{\partial \bar{\alpha}}<0$; *and when* $\bar{\alpha}>\frac{(5+\sqrt{7})\bar{\beta}^2}{12\eta}$, $\frac{\partial \Pi_{ur}^{GR*}}{\partial \bar{\alpha}}>0$.

2. *The impact of the average degree of greenness responsiveness on the optimal profits is:*

when $\bar{\alpha}<\frac{\bar{\beta}^2}{2\eta}$, $\frac{\partial \Pi_{ug}^{GR*}}{\partial \bar{\beta}}<0$; *when* $\bar{\alpha}>\frac{\bar{\beta}^2}{2\eta}$, $\frac{\partial \Pi_{ug}^{GR*}}{\partial \bar{\beta}}>0$; *and* $\frac{\partial \Pi_{ur}^{GR*}}{\partial \bar{\beta}}<0$.

From Lemma 2, the optimal profits of the green manufacturer decrease monotonically as the degree of price responsiveness of consumers ($\bar{\alpha}$) increases. That is, the more sensitive consumers in the market are to prices, the lower the optimal profits of the green manufacturer. For the regular manufacturer, when consumers are less sensitive to price on average, the impact of their optimal profits still monotonically decreases as consumers' price sensitivity increases; however, when consumers' price sensitivity exceeds a certain threshold, the regular manufacturer's optimal profits increase monotonically as consumers' price sensitivity increases. In addition, the optimal profits of the green manufacturer monotonically increase as consumers' degree of greenness responsiveness increases when $\bar{\alpha} > \bar{\beta}^2/(2\eta)$ while the optimal profits of the regular manufacturer monotonically decrease as consumers' degree of greenness responsiveness increases. In summary, in the G-R scenario, the green manufacturer should reduce the average degree of price responsiveness of consumers in the market while the regular manufacturer should reduce the average degree of greenness responsiveness of consumers.

In the G-G scenario, the impact of consumers' green sensitivity and price sensitivity on the optimal profits of the two manufacturers is shown in *Lemma 3*.

Lemma 3. *Under the condition of $\frac{\bar{\beta}^2}{12\eta} > \bar{\alpha}$, the following holds:*

1. *The impact of the average degree of price responsiveness on the optimal profits is:*

$$\frac{\partial \Pi_{ug}^{GG*}}{\partial \bar{\alpha}} = \frac{\partial \Pi_{ur}^{GG*}}{\partial \bar{\alpha}} > 0;$$

2. *The impact of the average degree of greenness responsiveness on the optimal profits is:*

$$\frac{\partial \Pi_{ug}^{GG*}}{\partial \bar{\beta}} = \frac{\partial \Pi_{ur}^{GG*}}{\partial \bar{\beta}} < 0.$$

From Lemma 3, we can find that, contrary to intuition, the higher the consumers' average degree of price responsiveness is, the lower the average degree of greenness responsiveness, and the higher the profits of the two manufacturers in the G-G scenario. The reason is that when consumers have a strong preference for green products in the G-G scenario, the two manufacturers will compete to increase the greenness of their products, which will lead to higher costs for the two manufacturers and decrease profits. Therefore, the two manufacturers should cultivate consumers' preferences for price and prevent consumers from paying too much attention to greenness in the G-G scenario.

4. Expansion—price discrimination

There are both price-sensitive consumers and green-sensitive consumers in the greenness and price competition markets. Different types of consumers have different sensitivities to price, and different price sensitivities allow manufacturers to segment consumers and set different prices for different types of consumers to maximise their profits.

In the greenness-price competition of price discrimination, if price is more salient, the utility of the consumer becomes:

$$U_{dip}^{GG} = \begin{cases} v + \theta_1 \left(\dfrac{\delta}{\delta\theta_1 + \theta_2} \right) q_{dg} - tx - \theta_2 \left(\dfrac{1}{\delta\theta_1 + \theta_2} \right) p_{pg} & i = g \\ v + \theta_1 \left(\dfrac{\delta}{\delta\theta_1 + \theta_2} \right) q_{dr} - t(1 - x) - \theta_2 \left(\dfrac{1}{\delta\theta_1 + \theta_2} \right) p_{pr} & i = r \end{cases} \tag{32}$$

If greenness is more salient, the utility of the consumer becomes

$$U_{diq}^{GG} = \begin{cases} v + \theta_1 \left(\dfrac{1}{\delta\theta_1 + \theta_2} \right) q_{dg} - tx - \theta_2 \left(\dfrac{\delta}{\delta\theta_1 + \theta_2} \right) p_{qg} & i = g \\ v + \theta_1 \left(\dfrac{1}{\delta\theta_1 + \theta_2} \right) q_{dr} - t(1 - x) - \theta_2 \left(\dfrac{\delta}{\delta\theta_1 + \theta_2} \right) p_{qr} & i = r \end{cases} \tag{33}$$

p_{qg} and p_{qg} represent the prices manufacturer g set for price-sensitive customers and green-sensitive customers, respectively.

p_{pr} and p_{qr} represent the prices manufacturer r set for price-sensitive customers and green-sensitive customers, respectively.

According to the steps of the unified pricing strategy, when consumers maximise their utility, the demand functions of the two manufacturers are:

$$d_p^g = \frac{1}{2} - \alpha_p(p_{pg} - p_{pr}) + \beta_p(q_{dg} - q_{dr}) \tag{34}$$

$$d_p^r = \frac{1}{2} + \alpha_p(p_{pg} - p_{pr}) - \beta_p(q_{dg} - q_{dr}) \tag{35}$$

$$d_q^g = \frac{1}{2} - \alpha_q(p_{qg} - p_{qr}) + \beta_q(q_{dg} - q_{dr}) \tag{36}$$

$$d_q^r = \frac{1}{2} + \alpha_q(p_{qg} - p_{qr}) - \beta_q(q_{dg} - q_{dr}) \tag{37}$$

According to the proportion of the market with the two different types of consumers, the profit functions of the two manufacturers are:

$$\Pi_{dg}^{GG} = \gamma d_p^g p_{pg} + (1 - \gamma) d_q^h p_{qg} - \eta q_{dg}^2 \tag{38}$$

$$\Pi_{dr}^{GG} = \gamma d_p^r p_{pr} + (1 - \gamma) d_q^l p_{qr} - \eta q_{dr}^2 \tag{39}$$

Proposition 5. *Assuming that there are green-sensitive and price-sensitive consumers in the duopoly market simultaneously, manufacturers establish a price discrimination policy to maximise their own profits. There is a unique pure strategy Nash equilibrium*

Table 4. Equilibrium in the G-G scenario (price discrimination cases).

Classification	Green manufacturer & regular manufacturer
Equilibrium price	$p_{pg}^{GG*} = p_{pr}^{GG*} = p_{dp}^{GG*} = \frac{1}{2\alpha_p} = \frac{t(\delta\theta_1+\theta_2)}{\theta_2}$
	$p_{qg}^{GG*} = p_{qr}^{GG*} = p_{dq}^{GG*} = \frac{1}{2\alpha_q} = \frac{t(\theta_1+\delta\theta_2)}{\delta\theta_2}$
Equilibrium greenness	$q_{dg}^{GG*} = q_{dr}^{GG*} = q_d^{GG*} = \frac{1}{4\eta}(\frac{\gamma\delta\theta_1}{\theta_2} + (1-\gamma)\frac{\theta_1}{\delta\theta_2})$
Equilibrium demand	$d_d^{g*} = d_d^{r*} = \frac{1}{2}$
Equilibrium profits	$\Pi_{dg}^{GG*} = \Pi_{dr}^{GG*} = \Pi_D^{GG*} = \frac{t}{2}(\gamma\frac{\delta\theta_1+\theta_2}{\theta_2} + (1-\gamma)\frac{\theta_1+\delta\theta_2}{\delta\theta_2}) - \frac{1}{16\eta}(\frac{\gamma\delta\theta_1}{\theta_2} + (1-\gamma)\frac{\theta_1}{\delta\theta_2})^2$

Source: The authors.

in the adoption of uniform pricing cases. The equilibrium price, greenness and balanced equilibrium profits are shown in Table 4.

The above analysis shows that in a fully competitive market, when manufacturers adopt price discrimination, the 'minimum differentiation strategy is still followed'. The balanced game is that greenness and price tend to be the same.

Lemma 4. *The equilibrium price of the green product is a decreasing function of the degree of salient thinking of consumers when price is salient, and it decreases as the degree of salient thinking of consumers increases. The equilibrium price of the green product decreases as the price utility coefficient increases and increases as the mass utility coefficient increases.*

Lemma 5. *The equilibrium price of the green product is an increasing function of the level of salience when greenness is salient, and it increases as the degree of salient thinking of consumers increases. The equilibrium price of the green product decreases as the price utility coefficient increases and increases as the mass utility coefficient increases.*

Proposition 6. *Under the price discrimination mechanism and the unified pricing mechanism, the manufacturer's optimal greenness and pricing comparison are as follows:* $q_d^{GG*} > q_U^{GG*}$ *and* $p_{dq}^{GG*} > p_u^{GG*} > p_{dp}^{GG*}$, *respectively.*

Proposition 6 shows that the optimal pricing of the two companies under the unified pricing mechanism is greater than the pricing for price-sensitive consumers under price discrimination and less than the pricing for quality-sensitive consumers, that is, manufacturers charge higher prices for quality-sensitive consumers under the price discrimination mechanism. Furthermore, if manufacturers want to adopt discrimination pricing, they also need to improve the greenness of their products.

It is worth noting that, in all cases, the optimal pricing strategy is never affected by the proportion of consumer types. The higher the conversion cost is, the more loyalty the consumer is, and the less likely it is for customers to move to a competitor. In this case, the price and profit are increased.

5. Numerical analysis

5.1. The impact of δ on the optimal profits

We assume that $\theta_1 = 0.5$, $\theta_2 = 0.5$, $\eta = 0.5$, and $t = 2$; then, we perform numerical simulations of the optimal pricing, optimal greenness, and profits in the case of a uniform pricing (UP) strategy and a price discrimination (DP) strategy.
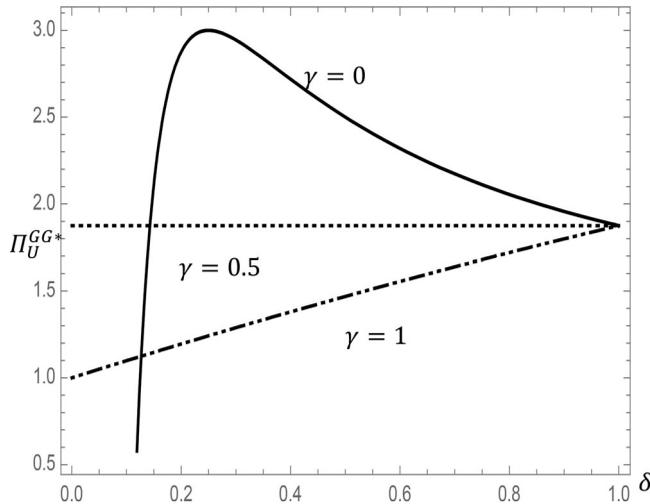
Figure 2. The influence of salience on optimal profits in the G-G scenario (UP).
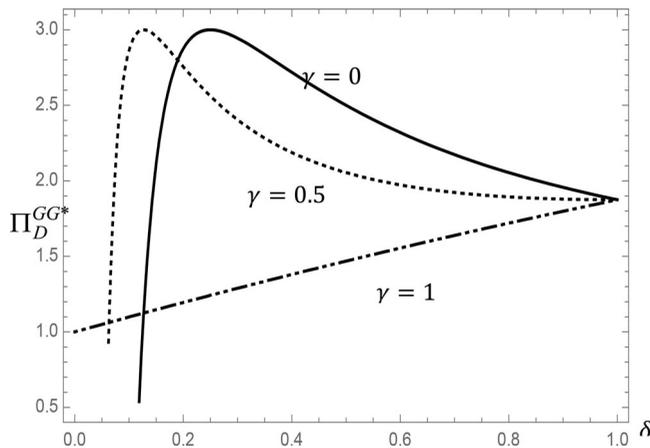Source: The authors.

Figure 3. The influence of salience on optimal profits in the G-G scenario (DP).
Source: The authors.

First, we analyse the impact of the proportion of consumer types on the optimal pricing when the level of salience of consumers in the market is fixed. Figure 2 shows the scenario of uniform pricing. When $\gamma = 0$, there are only green-sensitive consumers in the market. At this time, the effect of salience on the optimal profits of the manufacturers is concave. The optimal profits increase as the level of salience increases (the level of salience decreases as δ increases) and decrease when the level of consumer salience increases. When δ increases to a certain extent, the optimal profits will decrease. When $\gamma = 0.5$, the manufacturers' optimal profits are not affected by the level of salience. When $\gamma = 1$, there are only price-sensitive consumers in the market. The more rational consumers tend to be, the higher the profits.

Figure 3 shows the price discrimination scenario. When $\gamma = 0$ ($\gamma = 1$), there are only green-sensitive (price-sensitive) consumers in the market, and the conclusion is consistent with the uniform pricing strategy. However, when the proportion of the
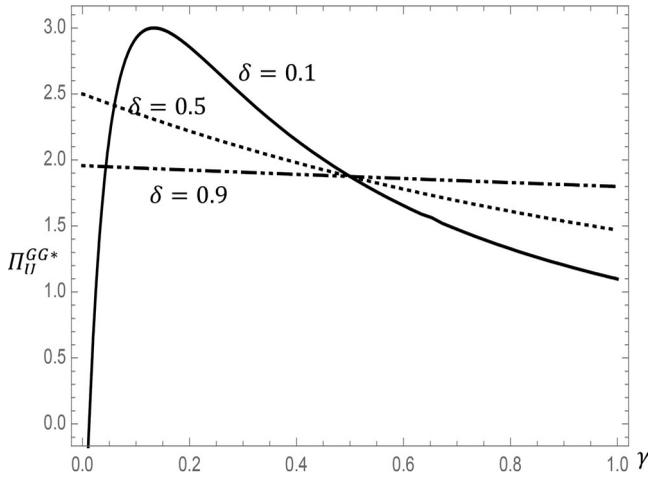
Figure 4. The influence of γ on the optimal profits in the G-G scenario (UP).
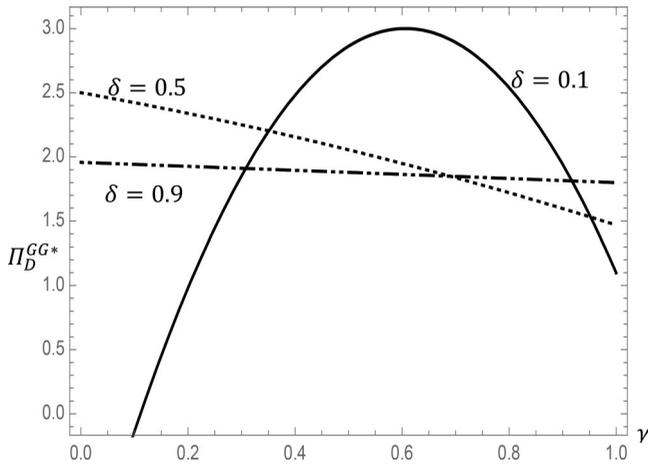Source: The authors.

Figure 5. The influence of γ on the optimal profits in the G-G scenario (DP).
Source: The authors.

two types of consumers in the market is $1/2$, the optimal profits of the price discrimination strategy first decrease as δ increases. The optimal profits of the price discrimination strategy present a concave function with δ.

5.2. The impact of γ on the optimal profits

In this section, we discuss the impact of consumer type ratios on optimal profits at different levels of salience. Analogously, we assume that $\theta_1 = 0.5$, $\theta_2 = 0.5$, $\eta = 0.5$, and $t = 2$; then, we conduct numerical simulations of the optimal pricing, optimal greenness, and profits in the case of a unified price strategy and price discrimination strategy.

Figures 4 and 5 show that different levels of salience will cause γ to have different effects on the optimal pricing. In the UP strategy and DP strategy, when the market consumer's salience is relatively high ($\delta = 0.1$; because δ cannot be 0 as the
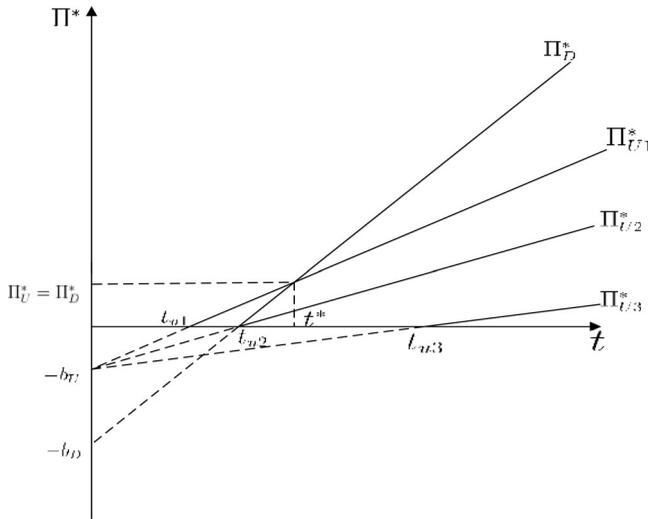
Figure 6. The impact of *t* on the optimal profits under the two strategies.
Source: The authors.

denominator, the value here is 0.1), the optimal profits first increase and then decrease as the proportion of price-sensitive consumers increases. When the ratio is low, the profits will be negative. When the level of consumer salience is at a medium level ($\delta = 0.5$), the optimal profits decrease as the proportion of price-sensitive consumers increases. As consumers become more rational, the impact of the proportion of consumer types on the optimal profits gradually disappears.

5.3. The impact of t on the optimal profits under the two strategies

In Figure 6, we study the differences between price discrimination and uniform pricing. Assuming that the other parameters are fixed except for the conversion costs in both strategies, the profit function is a linear function of *t*. Three scenarios can be obtained for the slope and intercept of the optimal profits under the two strategies.

In *Scenario 1*, when $t_{u1} < t < t^*$, the profits of the manufacturer adopting the price discrimination strategy are lower than the profits under uniform pricing. At this time, the producer should implement a uniform pricing strategy. When $t > t^*$, the producer should implement price discrimination.

In *Scenarios 2 and 3*, when $t < t_{u2}$ or $t < t_{u3}$, the profits under price discrimination are higher than the profits under uniform pricing, and manufacturers should adopt a price discrimination strategy.

In most cases, the profits under the price discrimination strategy are greater than the profits under unified pricing, which explains why increasingly more manufacturers prefer to price discriminate against consumers.

Proof.

$$\Pi_U^* = \frac{t(\theta_1 + \delta\theta_2)(\delta\theta_1 + \theta_2)}{2\theta_2((\gamma + \delta^2 - \gamma\delta^2)\theta_1 + \delta\theta_2)} - \frac{1}{16\eta}\left(\frac{\theta_1(\gamma\theta_2 + \delta\theta_1) + \delta^2\theta_1\theta_2(1-\gamma)}{\theta_2((\gamma + \delta^2 - \gamma\delta^2)\theta_1 + \delta\theta_2)}\right)^2,$$

$$\Pi_D^* = \frac{t}{2}\left(\gamma\frac{\delta\theta_1+\theta_2}{\theta_2}+(1-\gamma)\frac{\theta_1+\delta\theta_2}{\delta\theta_2}\right)-\frac{1}{16\eta}\left(\frac{\gamma\delta\theta_1}{\theta_2}+(1-\gamma)\frac{\theta_1}{\delta\theta_2}\right)^2,$$

Assuming $\Pi = kt-b$,

$$k_U = \frac{(\theta_1+\delta\theta_2)(\delta\theta_1+\theta_2)}{2\theta_2((\gamma+\delta^2-\gamma\delta^2)\theta_1+\delta\theta_2)}, \quad k_D = \frac{1}{2}\left(\gamma\frac{\delta\theta_1+\theta_2}{\theta_2}+(1-\gamma)\frac{\theta_1+\delta\theta_2}{\delta\theta_2}\right),$$

$$b_U = -\frac{1}{16\eta}\left(\frac{\theta_1(\gamma\theta_2+\delta\theta_1)+\delta^2\theta_1\theta_2(1-\gamma)}{\theta_2((\gamma+\delta^2-\gamma\delta^2)\theta_1+\delta\theta_2)}\right)^2, \quad b_D = -\frac{1}{16\eta}\left(\frac{\gamma\delta\theta_1}{\theta_2}+(1-\gamma)\frac{\theta_1}{\delta\theta_2}\right)^2,$$

Then, $\Delta k = k_D - k_U = \frac{t(1-\gamma)\gamma(1-\delta)^2\theta_1^2}{2\delta\theta_2(\gamma+(1-\gamma)\delta^2\theta_1+\delta\theta_2)}$, owing to $0 \le \gamma \le 1$, $0 \le \delta \le 1$, $\Delta k > 0$, then $\Delta b = b_D - b_U > 0$.

According to the absolute value of the slope and the intercept, the optimal profit difference under the two strategies will be pushed in three cases.

6. Conclusion

Due to the enhancement of consumers' awareness of environmental friendliness, the greenness of green products and product pricing have been widely considered in practice and academia. This paper considers that there are two types of consumers in the market, price-sensitive and green-sensitive, which prefer the price and greenness of products, respectively, and give higher weights to the corresponding attributes. On this basis, we analyse whether regular manufacturers should enter the green market when there is already a green manufacturer in the market and provide the conditions for regular manufacturers to enter the green market. In addition, this paper also explores the optimal decision-making problem under the price discrimination pricing implemented by two manufacturers for two types of consumers, which provides a reference for manufacturers' green decision making and pricing decision making.

Compared with the existing literature, this paper has three main innovations. First, this paper not only considers consumers' environmental awareness and preferences for green products but also considers that some consumers in the market pay more attention to the price of products and analyzes the influence of the coexistence of two types of consumers on a green manufacturer and a regular manufacturer. Second, salience theory is selected to describe the behaviour of different types of consumers with different sensitivities to a product's greenness and price, which is more comprehensive for describing the behaviour of consumers in the market. Third, considering the existence of two green manufacturers in the market at the same time, the optimal green decision and pricing decision are given under unified pricing and price discrimination for different types of consumers.

The main management implications of this article are as follows:

(1) When a green manufacturer already exists in the market, if consumers' average degree of price responsiveness is small or in a moderate part of the region, the regular manufacturer entering the green market will have a win-win situation. Otherwise, the regular manufacturer should not enter the green market or the green manufacturer should increase the barriers to entry to green manufacturing to prevent the

regular manufacturer from entering. (2) When there is only one green manufacturer in the market, the green manufacturer should always increase the average degree of price responsiveness of all consumers, and the regular manufacturer only needs to increase this parameter after it exceeds a certain range. The regular manufacturer should always improve the average degree of green responsiveness of all consumers, and the green manufacturer needs to improve this parameter only after it exceeds a certain range. (3) If the regular manufacturer enters the green market, the original green manufacturer needs to reduce its price and the level of greenness. Finally, the two manufacturers should adopt the same green and pricing decisions. (4) When there are two green manufacturers in the market, under the uniform pricing mechanism, both manufacturers should increase the average degree of price responsiveness and reduce the average degree of greenness responsiveness. (5) Under the price discrimination mechanism, the price charged by the two manufacturers to green-sensitive consumers is higher than that charged to price-sensitive consumers, but if discrimination pricing is to be implemented, the greenness of products needs to be improved.

The relevant conclusions obtained in this paper provide certain referential value for manufacturers to make product greenness and pricing decisions. However, this paper also has certain limitations. First, this paper uses salience theory to describe consumers' behaviours with different preferences for different attributes of products and only analyzes them from a single-dimensional perspective. Future research can consider that consumers' preferences will change according to changes in enterprise strategies from a two-dimensional perspective. Second, in the extended model, we only analyse the problem that both manufacturers implement price discrimination for consumers, but in reality, different enterprises will adopt different pricing strategies. Future research can explore the problem that the two manufacturers adopt heterogeneous strategies. Third, the analysis and verification of the relevant conclusions only use the numerical simulation method, and future research can use the actual data of enterprises for fitting analysis.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

References

Bordalo, P., Gennaioli, N., & Shleifer, A. (2012). Salience in experimental tests of the endowment effect. *American Economic Review*, 102(3), 47–52. https://doi.org/10.1257/aer.102.3.47
Bordalo, P., Gennaioli, N., & Shleifer, A. (2013). Salience and consumer choice. *Journal of Political Economy*, 121(5), 803–843. https://doi.org/10.1086/673885

Coibion, O., Einav, L., & Hallak, J. C. (2007). Equilibrium demand elasticities across quality segments. *International Journal of Industrial Organization*, *25*(1), 13–30. https://doi.org/10.1016/j.ijindorg.2006.06.004

Conrad, K. (2005). Price competition and product differentiation when consumers care for the environment. *Environmental & Resource Economics*, *31*(1), 1–19. https://doi.org/10.1007/s10640-004-6977-8

Cosemans, M., & Frehen, R. (2021). Salience theory and stock prices: Empirical evidence. *Journal of Financial Economics*, *140*(2), 460–483. https://doi.org/10.1016/j.jfineco.2020.12.012

Debabrata, G., Janat, S., & Sanjeev, S. (2018). Product greening and pricing strategies of manufacturers under green sensitive consumer demand and environmental regulations. *Annals of Operations Research*, *24*(5), 1–30. https://doi.org/10.1007/s10479-018-2903-2

Goran, Đ., Gordana, T., Aleksandar, Đ., & Ankica, B. T. (2019). A new fuzzy risk management model for production supply chain economic and social sustainability. *Economic Research-Ekonomska Istraživanja*, *32*(1), 1697–1715. https://doi.org/10.1080/1331677X.2019.1638287

He, C., Ozturk, O. C., Gu, C., & Silva-Risso, J. M. (2021). The end of the express road for hybrid vehicles: Can governments green product incentives backfire? *Marketing Science*, *40*(1), 80–100. https://doi.org/10.1287/mksc.2020.1239

Hong, Z., Wang, H., & Yu, Y. (2018). Green product pricing with non-green product reference. *Transportation Research Part E: Logistics and Transportation Review*, *115*(1), 1–15. https://doi.org/10.1016/j.tre.2018.03.013

Jo, M., & Shin, J. (2017). Market strategy for promoting green consumption: Consumer preference and policy implications for laundry detergent. *International Journal of Consumer Studies*, *41*(3), 283–290. https://doi.org/10.1111/ijcs.12339

Liu, P., & Yi, S. P. (2017). Pricing policies of green supply chain considering targeted advertising and product green degree in the big data environment. *Journal of Cleaner Production*, *164*(10), 1614–1622. https://doi.org/10.1016/j.jclepro.2017.07.049

Liu, Q., & Serfes, K. (2005). Imperfect price discrimination in a vertical differentiation model. *International Journal of Industrial Organization*, *23*(5-6), 341–354. https://doi.org/10.1016/j.ijindorg.2005.01.005

Liu, Z., Anderson, T. D., & Cruz, J. M. (2012). Consumer environmental awareness and competition in two-stage supply chains. *European Journal of Operational Research*, *218*(3), 602–613. https://doi.org/10.1016/j.ejor.2011.11.027

Murali, K., Lim, M. K., & Petruzzi, N. C. (2019). The effects of ecolabels and environmental regulation on green product development. *Manufacturing & Service Operations Management*, *21*(3), 519–535. https://doi.org/10.1287/msom.2017.0703

Nuryakin, N., & Maryati, T. (2020). Green product competitiveness and green product success. Why and how does mediating affect green innovation performance? *Entrepreneurship and Sustainability Issues*, *7*(4), 3061–3077. https://doi.org/10.9770/jesi.2020.7.4(33)

Rahmani, K., & Yavari, M. (2019). Pricing policies for a dual-channel green supply chain under demand disruptions. *Computers & Industrial Engineering*, *127*(1), 493–510.

Sana, S. S. (2020). Price competition between green and nongreen products under corporate social responsible firm. *Journal of Retailing and Consumer Services*, *55*(7), 102118–102117. https://doi.org/10.1016/j.jretconser.2020.102118

Shamdasani, P., Chon-Lin, G., & Richmond, D. (1993). Exploring green consumers in an oriental culture: Role of personal and marketing mix factors. *ACR North American Advances*, *117*(117), 936–942. https://doi.org/10.1642/0004-8038(2000)117

Strazzera, E., Mura, M., & Statzu, V. (2012). Powering the change: A contingent valuation study on the determinants of demand for green vs. brown energy. *Journal of Environmental Economics and Policy*, *1*(2), 146–173. https://doi.org/10.1080/21606544.2012.692864

Syam, N. B., & Kumar, N. (2006). On customized goods, standard goods, and competition. *Marketing Science*, *25*(5), 525–537. https://doi.org/10.1287/mksc.1060.0199

Sydnor, J. (2010). (Over) insuring modest risks. *American Economic Journal: Applied Economics*, *2*(4), 177–199. https://doi.org/10.1024/0300-9831.75.4.251

Taylor, S. E., & Thompson, S. C. (1982). Stalking the elusive "vividness" effect. *Psychological Review*, *89*(2), 155–181. https://doi.org/10.1037/0033-295X.89.2.155

Tripathi, A., Pandey, N., & Norberg, P. (2018). Does impact of price endings differ for the non-green and green products? Role of product categories and price levels. *Journal of Consumer Marketing*, *35*(2), 143–156. https://doi.org/10.1108/JCM-06-2016-1838

Tsaur, R. C. (2015). Green product pricing decision analysis with application to personal computers. *International Journal of Production Research*, *53*(1), 307–320. https://doi.org/10.1080/00207543.2014.961202

Wu, Y., Ramachandran, K., & Krishnan, V. (2014). Managing cost salience and procrastination in projects: Compensation and team composition. *Production and Operations Management*, *23*(8), 1299–1311. https://doi.org/10.1111/poms.12095

Xia, H., Fan, T., & Lou, G. (2020). Environmental certification in a differentiated duopoly. *Economic Research-Ekonomska Istraživanja*, *33*(9), 1–20. https://doi.org/10.1080/1331677X.2020.1804424

Zhang, Q., Zhao, Q., Zhao, X., & Tang, L. (2020). On the introduction of green product to a market with environmentally conscious consumers. *Computers & Industrial Engineering*, *139*(1), 106190–106116. https://doi.org/10.1016/j.cie.2019.106190

Zhao, H., Gao, Q., Wu, Y., Wang, Y., & Zhu, X. (2014). What affects green consumer behavior in China? A case study from Qingdao. *Journal of Cleaner Production*, *63*(1), 143–151. https://doi.org/10.1016/j.jclepro.2013.05.021

Zheng, Q., Pan, X. A., & Carrillo, J. (2019). Probabilistic selling for vertically differentiated products with salient thinkers. *Marketing Science*, *38*(3), 442–446. https://doi.org/10.1287/mksc.2018.1145