Chapter 113
Pricing Strategy Research of Green Supply Chain Based on Products Substitution

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Abstract Green supply chain, as an emerging enterprise strategic management model, governments, enterprises and academic circles have attached more and more great importance to it, which is an essential way of realizing sustainable development of enterprises. Price strategy is helpful to improve the operation quality and benefit of the supply chain, and realize the coordination of green supply chain. On the current market, green products and general products coexist, the same as the basic functions of those two categories, but the green products can give consumers additional social responsibility. This article puts forward a social responsibility payment factor to represent the price interval that consumers willing to pay more for the green products because they have a preference for it. Get the optimal price of green products by discussion, and make the profits of green supply chain to maximize.

Keywords Green supply chain · Products · Pricing substitution

113.1 Introduction

Twentieth Century has witnessed the rapid development of human society, but this development has also posed several threats, such as resource exhaustion, environmental pollution and ecological imbalance, etc. Manufacturing—as a pillar industry of the national economy—has been creating abundant material wealth for the whole society; however, it has wasted large amounts of resources at the same

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time. Therefore, in order to minimize damages to the environment and make the manufacturing industry use resources efficiently, scholars both at home and abroad have dedicated to the research and application of green manufacturing (Melnyk and Smith 1996; Meng et al. 2009). Since Michigan State University has put forward the concept of green supply chain in 1996, different scholars have observed and researched green supply chain management from various angles. What they have researched mainly includes three aspects: the definition, elements and structures of green supply chain (Liu et al. 1998; Nagel 2000; Zsidisin and Siferd 2001); the operation of green supply chain (Dan and Liu 2000; Nagurney and Toyasaki 2003; Noci 1997; Sarkis 2003); and the relationship between green supply chain management and enterprise performance (Seuring 2001). In the fields of cooperative relationship, pricing and coordination research between members in the green supply chain, Luo, Li and Carter have studied the factors that would have influences on the cooperation between members in the green supply chain from the empirical perspective (Carter et al. 2000; Li et al. 2001; Luo and Zhao 2005; Zhu 2004). Wang (2003) thought of the pricing of green products from two cases—the action and inaction of ordinary product provider. Mu and Li (2005) established monopoly competitive model between two businesses from the angle of product differentiation, and proved that when the cost of environmental quality increased, and consumers have different preferences on the environmental impacts of products, manufacturers that produce clean products can gain more profits than those produce pollution products-adopting differentiation strategy to improve competitiveness; Zhang and Zhang (2005) established a cost and profit measuring model of green product in manufacturing industry, and put forward a goal programming model based on the opportunity cost, which can maximize the social benefits and economic benefits of green products, and the results can help manufacturing enterprises have an objective evaluation on whether bring green products into production or not. Zhang and Zhang (2005) researched the pricing and coordination mechanism of products and raw material in the green supply chain, all the studies are on the condition that green products and common products coexist and consumers have different preferences for these two different type of products, from this a conclusion can be drawn that the collaboration between manufacturers and suppliers not only can make consumers choose green products as the object of consumption, and both sides realize the Pareto improvement of profits, ensure the stable operation of the supply chain.

Under the present conditions, consumers have different preferences for green products and general products on the market. Therefore, how to let customers choose green products as the object of consumption from the utility maximization angle through reasonable pricing is essential for the effective operation of the green supply chain. This article considered from the perspective of social responsibility and introduced the social responsibility factor "θ", shows that consumers have the desire to pay more a certain price range for green products. Set down the optimal price of green products and maximize the whole profits of green supply chain. This article provides useful references for the pricing decision-making of green products on the market where these two categories of products coexist.

113.2 Problem Model

Considering a class of stable product marketing, products are in the mature period, its supply chain consists of a manufacturer, a retailer and a consumer groups that green consumers have homogeneous demands. The market price of its general product is P_N assuming that the general production cost is negligible, the green production cost is C_g, and the market price of green products is

$$P_g = (1 + \theta)P_N. \tag{113.1}$$

$$\theta = \frac{p_g}{p_N} - 1 = \frac{p_g - p_N}{p_N}$$

In this formula is the social responsibility payment factor, which refers to the money those consumers willing to pay more for green product. Assuming there is a consumer group that capacity of their markets is 1 on the current market. θ represents the social responsibility payment factor of green product that consumers want to buy. And assuming that the social responsibility payment.

Factor θ is uniform distribution between θ_1 and θ_2. When $P_N + \theta \bullet P_N > P_g$, that is to say, when the price of green product is lower than the money that consumers willing to pay, consumers are willing to buy green products, and buy general products on the contrary. That means, whether consumers buy green products is determined by θ. We define $1 - \theta$ as the degree consumers can accept, the social responsibility payment factor θ smaller, consumers' acceptability bigger, and consumers tend to buy green products, otherwise they choose to buy general products. Therefore, if you want consumers to buy green products, then the degree consumers can accept should meet:

$$1 - \theta \geq 0. \tag{113.2}$$

For enterprises, only when the social responsibility payment factor $\theta \geq 0$, enterprises can obtain the chance to gain more profits than ordinary products, and use it to encourage enterprises to further the development of green products and make enterprises the research and development leader in this product. From the above we can know $\theta \in [0, 1]$, so, the critical value of consumers' expectation of social responsibility payment factor $\theta*$ should meet:

$$P_N + \theta^* \bullet P_N = P_g\,(\theta^* \in [\theta_1, \theta_2]). \tag{113.3}$$

And we can gain:

$$\theta^* = \frac{p_g}{p_N} - 1 = \frac{p_g - p_N}{p_N}. \tag{113.4}$$

Then the green products' needs of market are:

$$\begin{aligned} Q &= 1 \cdot \int_{\theta}^{\theta_2} \frac{1}{\theta_2 - \theta_1} d_\theta = \frac{\theta}{\theta_2 - \theta_1} \Big|_{\theta}^{\theta_2} = \frac{\theta_2 - \theta}{\theta_2 - \theta_1} \\ &= \frac{\frac{p_{g_2} - p_N}{p_N} - \frac{p_g - p_N}{p_N}}{\frac{p_{g_2} - p_N}{p_N} - \frac{p_{g_1} - p_N}{p_N}} \\ &= \frac{p_{g_2} - p_g}{p_{g_2} - p_{g_1}}. \end{aligned} \tag{113.5}$$

Then the expected profits for green supply chain are:

$$T_g = \int_0^Q (p_g - c_g) d_Q = (p_g - c_g) Q|_0^Q \tag{113.6}$$

$$T_g = (p_g - c_g) \frac{p_{g_2} - p_g}{p_{g_2} - p_{g_1}}. \tag{113.7}$$

Let $\frac{\partial T_g}{\partial P_g} = 0$,
we can gain:

$$p_g^* = \frac{p_{g_2} + c_g}{2} \tag{113.8}$$

$$\therefore T_g = \left(\frac{p_{g_2} - c_g}{2}\right)^2 \times \frac{1}{p_{g_2} - p_{g_1}} \tag{113.9}$$

$$p_{g_2} = (1 + \theta_2) p_N \tag{113.10}$$

$$p_{g_1} = (1 + \theta_1) p_N \text{ (we already know } \theta_1, \theta_2) \tag{113.11}$$

$$T_g = \left(\frac{(1 + \theta_2) p_N - c_g}{2}\right)^2 \times \frac{1}{(\theta_2 - \theta_1) p_N}. \tag{113.12}$$

We substitute (113.8) into (113.6) and know:

$$p_g^* = \frac{(1 + \theta_2) p_N + c_g}{2}. \tag{113.13}$$

In order to ensure the optimal price we ask for p_g^* is in the section $\left(p_{g_1}, p_{g_2}\right)$, hereby verify it:

We can gain from (113.1):

$$\begin{cases} P_{g_2} - P_{g^*} = (1 + \theta_2) P_N - (1 + \theta^*) P_N = (\theta_2 - \theta^*) P_N \geq 0 \\ P_{g^*} - P_{g_1} = (1 + \theta^*) P_N - (1 + \theta_1) P_N = (\theta^* - \theta_1) P_N \geq 0 \end{cases}.$$

Table 113.1 A green pork market relevant data

Variable	θ_1	θ_2	P_N	C_g	C_N
Values	0.20	0.80	18 .00	24 .00	14.00

So, p_g^* is in the extent of $\left(p_{g_1}, p_{g_2}\right)$, then p_g^* is the optimal price. So we can know the optimal price of a green product is $p_g^* = \frac{(1+\theta_2)p_N + c_g}{2}$, at this point, the profits of this whole supply chain is the biggest.

113.3 Example Analysis

Hypothesis that, after the research to one market, we found that customers have potential requirements to organic meat. Therefore, a green supply chain alliance supply for green pork, the related data are shown below:

113.3.1 References

Then we can get the optimal price P_{g^*} of 28.20,at this time the price change factor $\theta^* \approx 0.567$, the degree consumers can accept is about 0.433, the demand $Q = 0.3889$. This suggests that green pork pricing in a rational scope and consumer can accept. If the market has the total demand for thirty thousand kilograms of pork, so the total demand for green pork is about 11667 kg, and its biggest profits at about $49000, and the total demand for not green pork is about 18333 kg, the total profit about 73300 yuan. Compared the total demand and total profit of pork with the green pork respectively, it is concluded that the profit of per green pork was higher than the not green pork. Thus, as long as the enterprise can pricing the green product reasonably, it will stimulate the consumption, then obtain more profits for the enterprises, and also protect the environment, make the whole supply chain for the biggest profit (Table 113.1).

With the progress of the times, the public awareness of environment protecting will also growing, and green products will get the public's favorite more and more. We believe that the development of green products will be a new business opportunity and challenge.

113.4 Conclusion

This study shows that in the situation of the collaboration of suppliers, the manufacturers and sellers, concentrated pricing can make green supply chain system profit maximization. The basic function of green products and ordinary products is

the same; differences exist in social responsibility, so consumers are willing to pay extra for this part of the price to buy green products. If it is priced higher than the consumer's willingness to pay, which will greatly reduce the consumers' willingness to buy, making the profit of the whole of green supply chain low and even a loss, so as to the failure of the optimal pricing strategy of green supply chain. This article mainly do researches on how price influence the alternative of green product related to common products, and in the market, green products and common product has some of the alternative, and in the market of different preferences conditions, social obligation payment factor change in a reasonable scope. When $\theta = \theta^*$, the price P is the best price and the entire green supply chain get the max profit. In fact, when consumers are choosing to buy green products whether to buy the green products still depends on the strength of the environmental protection consciousness and the propaganda on green products of government departments, social public opinion, and all kinds of incentive mechanism, project fund for the support for green products project. But as the present situation of economic development and the Chinese laws and regulations are not perfect, it makes the government's support to green product enterprise cannot achieve the best. This will be our next step in the direction of the study, so as to provide scientific basis for government departments, and making the best scheme to encourage enterprise of green product development, providing effective incentive and policy support to the feasible green supply chain.

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