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Cause-related marketing strategy in a supply chain: A theoretical analysis and a case study

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ABSTRACT

With the development of commodity market, corporate social responsibility (CSR) has become a topic of widespread concern for both enterprises and society. Cause-related marketing (CRM), as an effective marketing tool for enterprises to fulfill their social responsibility, is rapidly being applied to all stages of the supply chain. However, there is no conclusive evidence on the implementation strategy of CRM for supply chain members. In this paper, we study the decision and pricing strategies of CRM for the manufacturer and the retailer by constructing models for two scenarios: the manufacturer implements CRM, and the retailer implements CRM. We conclude that the donation percentage and the pro-sociality of consumers have a significant impact on the strategic and pricing decisions for supply chain members. The wholesale and selling prices will be higher when the manufacturer implements CRM. Our result also shows that the manufacturer and retailer are profitable in CRM only when the donation amount exceeds a certain percentage. In addition, to maximize profits, the manufacturer is more likely to allow a retailer to implement CRM, and the retailer is only optimally positioned to implement CRM when the pro-sociality of consumers is high or when the donation percentage is high.

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1. Introduction

In a market environment where the price and quality of goods are becoming more and more similar, the single provision of quality products or services can no longer meet the long-term stable development of enterprises [1, 2]. At the same time, with the pursuit of a higher quality experience, consumers are increasingly concerned about the ethical and sustainable conduct of companies [3-5]. Some scholars believe that the social, economic, and environmental behavior of a company is positively related to the profitability of the organization [6-7]. Therefore, the fulfilment of CSR has become one of the key factors indispensable for companies to gain greater competitiveness [8, 9]. As early as 1953, Bowen pointed out that companies should be socially responsible in their business activities and should make corporate decisions based on the goals and values of society. Smith *et al.* [10] considered corporate responsibility as something that goes beyond economics and law; enterprises also need to focus on politics, education, and welfare. In order to seek better survival and development, it has become a goal for companies to strive to find a marketing method that can balance the acquisition of profit and fulfill social responsibility [11, 12]. Cause-related marketing (CRM), as a combination of CSR and marketing,

which can not only help firms fulfil their social responsibility and enhance brand image, but also have a positive impact on consumers' willingness to purchase, gradually becomes an effective tool in the marketing area [13].

CSR was introduced in the 1980s and has become one of the major concerns of the business community [14], and CRM is one of the ways in which companies can fulfill their social responsibility. In 1981, American Express partnered with a non-profit organization to link consumers with donations by donating two pennies to the charity for every purchase made with an Express card. The campaign not only generated additional revenue for Express, but also supported the daily operations of the charity. Another example of CRM is the Chinese brand Nongfu Spring, which launched a campaign in 2001, stating that for every mineral water sold, one cent of the proceeds would be donated to support the Olympic bid matters. When a company chooses to engage in CSR, consumers' purchasing decisions may depend not only on the intrinsic value of the product, but also on its social impact. CRM not only builds brand dependence among consumers, and creates higher revenue for the company, but also contributes to society and the environment, creating a win-win situation [15]. It is because of the multiple positive impacts of CRM for businesses that it has become a successful initiative for all types of organizations [16-17]. CRM is also widely used in all stages of the supply chain, with upstream suppliers and downstream retailers participating [18]. Supply chain members practice CRM by partnering with non-profit organizations to donate a portion of the proceeds from the sales to the community. At the same time, they will advertise for charity events. A survey shows that most consumers learn about and participate in causes through advertising [19].

In this paper, we analyze the manufacturer's and retailer's decisions and pricing strategies for implementing CRM by constructing a model in the context of the supply chain and discuss the impact of donation percentage and pro-sociality of consumers on the manufacturer's and retailer's decisions. We pose and address the following questions:

- How should the price of the manufacturer and retailer price when they implement CRM and how does the donation percentage affect pricing?
- How does the donation percentage and the pro-sociality of consumers in the target market to CRM affect the manufacturer's and retailer's decisions?
- What kind of marketing strategy should the manufacturer and the retailer develop for the benefit of the supply chain as a whole?

We consider a supply chain system consisting of a manufacturer and a retailer who play a Stackelberg game with the goal of maximizing their respective profits. We solve and analyze the optimal and equilibrium solutions of the model by constructing two scenarios, one for the manufacturer and one for the retailer. Our work will provide a suggestion for the implementation of CRM and supply chain management.

The remainder of this paper is organized as follows: Section 2 summarizes the previous literature. Section 3 illustrates the notation in this paper and models for the manufacturer and the retailer. In Section 4, we analyze the pricing and CRM decisions, and discuss the effects of donation percentage and consumer’s pro-sociality. Section 5 uses arithmetic examples to validate the analysis in the previous sections. Finally, we draw conclusions in Section 6. All proofs of the paper are in the Appendix.

2. Literature review

This paper examines the CRM strategies of supply chain members who fulfill their CSR. Therefore, we build our study on supply chain CSR and CRM.

Many scholars have quantitatively analyzed supply chain CSR using empirical methods. Mani *et al.* [20] found that corporate engagement in CSR promotes mutual benefits among supply chain partners, increases trust to foster long-term trusting relationships. Maloni *et al.* [21] have studied CSR in the food industry and developed a comprehensive framework for supply chain CSR in this industry. Valdez-Juárez *et al.* [22] showed that CSR and SCM have a strong interdependence. Many scholars have analyzed the issue of supply chain CSR performance and influenc-

ing factors by building models. Arya *et al.* [23] analyzed the situation where the social benefits of a company's CSR strategy have nothing to do with product sales. Raza [24] demonstrated that it is feasible for manufacturers to undertake CSR investments to improve the profitability of their supply chain. Hsueh [8] analyzed the supply chain CSR and concluded that a new revenue-sharing contract with corporate social responsibility (RS-CSR) can achieve the goal of improving both performance and total supply chain profitability. Panda *et al.* [25] explored channel coordination and profit-sharing in socially responsible supply chains, concluding that CSR and its share are key determinants of channel members' net profits, and that supply chain members should pay attention to the CSR practices of other members. Liu *et al.* [26] concluded that a certain range of government subsidies can promote CSR among supply chain members and improve the overall performance and social welfare. Yan *et al.* [27] have shown that the retailer with CSR investment practices earns more profits than those without CSR investments. Most of the existing literature has studied CSR in terms of its performance and influencing factors, while little research has been done on the decision-making aspects of supply chain members. In contrast, we combine CRM and supply chain to study the pricing and strategic decisions of supply chain members in fulfilling social responsibility by building a model.

In terms of the effectiveness of CRM, Cheng *et al.* [28] found that consumers are more likely to buy brands that implement CRM. However, Furman *et al.* [29] argued that not all CRM campaigns are effective in influencing consumer decisions. Arya *et al.* [23] found by constructing a model that implementing CRM leads to an increase in the price of cause-related products. In contrast, Gao [18] argued that the implementation of CRM results in lower product pricing. There are also some scholars who have given conclusions on the relationship between CRM and consumers. Kraft *et al.* [30] thought that consumers in the segment have different pro-sociality. Silva *et al.* [31] concluded that consumers' cause-related identification has a positive impact on their perceived value. Vyravene *et al.* [32] demonstrated that the product-cause fit affects consumer attitudes toward the brand.

A subset of scholars has examined the role of the donation amount. Moosmayer *et al.* [33] believed that the higher the amount of giving, the better the consumer perception of the CRM campaign. Tsiros *et al.* [34] considered that both the total amount donated and the method of communication influence consumer response to CRM. Kerr *et al.* [35] concluded that for individuals with a high perceived need, purchase intentions for the exact donation form are greater when the product-cause fit is low, regardless of the donation form. Grolleau *et al.* [36] believed the crowding-out effect may be particularly strong if the cause-linked products are targeted at consumers who have provided direct donations.

In terms of CRM in the supply chain, Barone *et al.* [37] thought that consumer perceptions of retailers' motivation to engage in CRM, the affinity of CRM, and the interaction effects associated with the two moderators can have a significant impact on retailer-cause fit. Choi *et al.* [38] indicated that for the label to be able to convey information to consumers about the fulfillment of CSR, manufacturers should therefore make special designs for the packaging. Heydari *et al.* [39] proposed a cost-sharing contract and collaboration model when the manufacturer implements CRM and concluded that the collaboration model can increase the profits of channel members. Although Gao [18] explored that decentralized supply chains can generate more social value through CRM, he did not consider the promotional costs of CRM in his study.

In summary, previous research has been extremely fruitful, whether from the perspective of consumers or effects for supply chain, but little literature has considered the decision to implement CRM for supply chain members. In addition, while we examine the implementation strategy of CRM, we also consider the cost of promotion during CRM, which has not been addressed in the previous literature.

3. Model formulation and notation

In this paper, we consider a supply chain consisting of a manufacturer and a retailer, where both of them are risk-neutral and perfectly rational, making decisions to maximize their profits. The manufacturer is the leader, and the retailer is the follower in the Stackelberg game. The manu-

facturer has to decide whether to implement CRM himself or to delegate CRM to the retailer, as well as price strategies. The retailer reacts according to the manufacturer's strategy. The manufacturer produces the product at a production cost of c and distributes it to the retailer at a wholesale price of w. The retailer sells the product to the consumer at a selling price of p.

It is assumed that both the manufacturer and the retailer will advertise for their CRM campaign, and therefore incur promotional costs A. The cost of promotion will affect consumer utility. Since the utility does not increase indefinitely with the cost, we assume that the additional utility of CRM by the manufacturer or retailer is $\sqrt{A}$. Additionally, we denote v by the consumer's perceived value of the product, v serving a uniform distribution between 0 and 1, i.e., $v \sim U[0,1]$. Show that in a market of size 1, the price that consumers are willing to pay for this product is uniformly distributed between 0 and 1. At the same time, we use δ to denote consumer's prosociality, i.e., the degree of consumer sensitivity to CRM, and the degree to which the level of CRM donations stimulates consumer buying behavior. We use η to indicate the donation percentage of sales per unit of product, and in other words, it is the donation amount as a percentage of the sales price or wholesale price. Thus, the utility function is $U = v - p + \delta\eta\sqrt{A}$. And we assume that a consumer will buy the product only if the utility function is greater than zero, i.e., $v \geq p + \delta\eta\sqrt{A}$. The number of consumers in a market of size 1 is $1 - p + \delta\eta\sqrt{A}$, and the demand function can be obtained as $d = 1 - p + \delta\eta\sqrt{A}$.

The parameters and variables mentioned in the model and their meanings are listed in the table below:

Table 1 Model parameters and decision variables

Notation	Description
c	The unit production cost of the product
p	The unit sales price of the product
w	The unit wholesale price of the product
δ	Consumer sensitivity to cause-related marketing （$\delta \geq 0$）
η	The proportion of wholesale price or sales price per unit donation amount
A	Promotional costs arising from the implementation of CRM
π_m	The profit of the manufacturer
π_r	The profit of the manufacturer
π_s	Total social welfare
$\cdot^M$	The scenario of the manufacturer implementing CRM
$\cdot^R$	The scenario of the retailer implementing CRM

To avoid a meaningless discussion, we propose the following assumptions:

(1) We assume that $\eta < \frac{(2-\sqrt{1+3c})}{3}$ and $1 - c - \eta > 0$, the profit is guaranteed to be greater than zero when the supply chain members implement CRM and the amount donated is limited by the production cost, which is in line with the real meaning.

(2) We assume that $\delta < \frac{\sqrt{2(1-\eta)}}{\eta(1-\eta)}$, it suggests that consumers' sensitivity to CRM is influenced by the percentage of the donation, and that this sensitivity is bounded and does not increase indefinitely as the donation amount increases.

(3) Assuming that both the manufacturer and the retailer are equipped to implement CRM and are skilled in CRM techniques.

3.1 The manufacturer implements cause-related marketing

In this scenario, the manufacturer implements CRM by donating a percentage of the wholesale price to the charity for each unit of product sold incurring promotional costs for CRM. When the manufacturer implements CRM, the profit functions for the manufacturer and the retailer, as well as the social welfare, are as follows:

$$\pi_m^M = (w - \eta w - c)d - A \tag{1}$$

$$\pi_r^M = (p - w)d \tag{2}$$

$$\pi_s^M = \pi_m^M + \pi_r^M = (p - \eta w - c)d - A \tag{3}$$

Proposition 1: We obtain the optimal solutions when the manufacturer implements CRM as follows:

$$A^{M*} = \frac{(1-c-\eta)^2\delta^2\eta^2}{8+\delta^2\eta^3-\delta^2\eta^2} \tag{4}$$

$$w^{M*} = \frac{4(1-c-\eta)-c\delta^2(1-\eta)}{(1-\eta)(8+\delta^2\eta^3-\delta^2\eta^2)} \tag{5}$$

$$p^{M*} = \frac{2(3+c-3\eta)-c\delta^2(1-\eta)}{(1-\eta)(8+\delta^2\eta^3-\delta^2\eta^2)} \tag{6}$$

From Proposition 1 we can obtain Eqs. 7-9：

$$\pi_m^{M*} = \frac{(1-c-\eta)^2}{(1-\eta)(8+\delta^2\eta^3-\delta^2\eta^2)} \tag{7}$$

$$\pi_r^{M*} = \frac{4(1-c-\eta)^2}{(1-\eta)^2(8+\delta^2\eta^3-\delta^2\eta^2)^2} \tag{8}$$

$$\pi_s^{M*} = \frac{(1-c-\eta)^2(12-8\eta-\delta^2\eta^2(1-2\eta-\eta^2))}{(1-\eta)^2(8+\delta^2\eta^3-\delta^2\eta^2)^2} \tag{9}$$

We obtain Corollary 1 and Corollary 2 by finding the first-order derivatives of Eqs. 4-9 with respect to η.

Corollary 1: $\frac{dA^{M*}}{d\eta} > 0, \frac{dw^{M*}}{d\eta} > 0, \frac{dp^{M*}}{d\eta} > 0.$

Corollary 1 shows that when the manufacturer implements CRM, the pricing strategies are influenced by the donation percentage. Within the constraint, the cost of promotion, the manufacturer's wholesale price, and the retailer's selling price increase with the donation amount. This is because when the manufacturer makes a charitable donation, if the amount of donation is relatively higher, then the wholesale price will also increase, and therefore the retailer will also increase the sales price. At the same time, as the number of donations increases, the manufacturer will also spend more to publicize the behavior.

Corollary 2:

(i) If $0 < \delta < \delta_r^M$, then $\frac{d\pi_m^{M*}}{d\eta} < 0$ and $\frac{d\pi_r^{M*}}{d\eta} < 0$;

(ii) If $\delta_r^M < \delta < \delta_m^M$, then $\frac{d\pi_m^{M*}}{d\eta} < 0$ and $\frac{d\pi_r^{M*}}{d\eta} > 0$;

(iii) If $\delta_m^M < \delta < \frac{\sqrt{2(1-\eta)}}{\eta(1-\eta)}$, then $\frac{d\pi_m^{M*}}{d\eta} > 0$ and $\frac{d\pi_r^{M*}}{d\eta} > 0$.

Where $\delta_r^M = 2\sqrt{\frac{2c}{\eta(1-\eta)((3\eta+4c-5)\eta+2(1-c))}}$, $\delta_m^M = 2\sqrt{\frac{1-c-\eta}{\eta(1-\eta)((\eta+2c-2)\eta+1-c)}}$.

It is known from Corollary 2 that the profits of the manufacturer and the retailer are jointly affected by the proportion of donation and the pro-sociality of the consumer to CRM. From Corollary 2(i) we are able to obtain that when the pro-sociality of consumer to CRM is less than the threshold value δ_r^M, the profits of the manufacturer and the retailer decrease simultaneously with the donation amount; while when the pro-sociality of consumers to CRM is greater than δ_r^M and less than δ_m^M, the profits of the manufacturer still decrease, while the profits of the retailer increase with the donation ratio; finally, when the pro-sociality of consumer to CRM is greater than δ_m^M, the profits of the manufacturer and the retailer increase simultaneously.

The Corollary 1 and Corollary 2 show that the profits of the manufacturer and retailer decrease and then increase with the percentage of donations. However, both the manufacturer and the retailer are motivated to implement CRM only if their profits both increase under the influence of the donation amount. At the same time, the manufacturer and retailer's profits are governed by consumer sensitivity to CRM in the segment. When the manufacturer implements CRM,

if the segment consumers are relatively low pro-sociality, the donation will have a negative impact on the profits of the manufacturer and retailer, or even reduce the profits; while the target market consumer's pro-sociality is middle, the donation activities are beneficial for the retailer at this time, but not for the manufacturer; and when the consumer in the target market is more sensitive to public welfare behaviour, the implementation of CRM for the manufacturer can not only increase his own profits, the retailer can also be profitable.

3.2 The retailer implements cause-related marketing

In this case, the retailer implements CRM, donating a percentage of the selling price to the charity for each unit of product sold, as well as spending the advertising costs of the CRM. Then, when the retailer implements CRM, the profit functions of the manufacturer and the retailer as well as social welfare are as follows.

$$\pi_m^R = (w - c)d \tag{10}$$

$$\pi_r^R = (p - \eta p - w)d - A \tag{11}$$

$$\pi_s^R = \pi_m^R + \pi_r^R = (p - \eta p - c)d - A \tag{12}$$

Proposition 2: We obtain the optimal solutions when the retailer implements CRM as follows.

$$A^{R*} = \frac{(1 + c - \eta)^2 \delta^2 \eta^2}{4(4 + \delta^2\eta^3 - \delta^2\eta^2)^2} \tag{13}$$

$$w^{R*} = \frac{1 - c - \eta}{2} \tag{14}$$

$$p^{R*} = \frac{2(1 + 3c - 3\eta) - c\delta^2\eta^2(1 - \eta) - \delta^2\eta^2(1 + \eta^2 - 2\eta)}{2(1 - \eta)(4 + \delta^2\eta^3 - \delta^2\eta^2)} \tag{15}$$

From Proposition 2 we can obtain Eqs. 16-18：

$$\pi_m^{R*} = \frac{(1 - c - \eta)^2}{2(1 - \eta)(4 + \delta^2\eta^3 - \delta^2\eta^2)} \tag{16}$$

$$\pi_r^{R*} = \frac{(1 - c - \eta)^2}{4(1 - \eta)(4 + \delta^2\eta^3 - \delta^2\eta^2)} \tag{17}$$

$$\pi_s^{M*} = \frac{3(1 - c - \eta)^2}{4(1 - \eta)(4 + \delta^2\eta^3 - \delta^2\eta^2)} \tag{18}$$

We obtain Corollary 3 and Corollary 4 by finding the first order derivatives of Eqs. 13-18 with respect to η.

Corollary 3: $\frac{dA^{R*}}{d\eta} > 0, \frac{dw^{R*}}{d\eta} < 0, \frac{dp^{R*}}{d\eta} > 0.$

Through Corollary 3, the promotional costs, sales prices, and the manufacturers' wholesale prices are influenced by the proportion of donations in the retailer's donation behaviour. Within the constraint, the advertising cost required for CRM and the retailer's selling price increase with the percentage of donation. That is, when the retailer implements CRM, if he donates a higher amount, it should be equipped with more publicity. Also, to ensure profitability, the retailer's selling price will increase. In contrast, the manufacturer's wholesale price differs from the previous analysis in that it tends to decrease as the proportion of donations increases. In another words, as long as the retailer implements CRM, the cost he has to spend to obtain the product at the manufacturer will decrease.

Corollary 4:

(i) If $0 < \delta < \delta^R$, then $\frac{d\pi_m^{R*}}{d\eta} < 0$ and $\frac{d\pi_r^{R*}}{d\eta} < 0$;

(ii) If $\delta^R < \delta < \frac{\sqrt{2(1-\eta)}}{\eta(1-\eta)}$, then $\frac{d\pi_m^{R*}}{d\eta} > 0$ and $\frac{d\pi_r^{R*}}{d\eta} > 0$.

Where $\delta^R = 2\sqrt{\frac{2(1-c-\eta)}{\eta(1-\eta)((\eta+2c-2)\eta+1-c)}}$.

Corollary 4 suggests that when retailer practices CRM, profits are equally influenced by consumers' pro-sociality and the percentage of his donations. When consumer's pro-sociality is below than the threshold δ^R, the profits of both the manufacturer and the retailer decrease as the donation percentage increases; conversely, when consumer's pro-sociality is above the δ^R, the profits of both the manufacturer and the retailer increase as the donation ratio increases. In the case of a retailer implementing CRM, the benefits to both the manufacturer and the retailer are synchronized, with both tending to decrease and then increase as the percentage of donations increases. This means that when consumers in the target market are relatively less pro-social, the implementation of CRM by the retailer does not help to improve the profitability of both, and it is only when the social awareness of the consumer base is relatively higher that the retailer comes to implement CRM to the benefit of the supply chain.

4. Analysis

From the Corollary 1 and 3, pricing strategies as well as promotional cost is not influenced by the pro-sociality of consumers in the segment, but only by the percentage of donations made when they implement CRM.

Corollary 5: $A^{M*} < A^{R*}, w^{M*} > w^{R*}, p^{M*} > p^{R*}$.

Corollary 5 suggests that when the manufacturer implements CRM, the wholesale prices and sales prices will be relatively high but promotional costs will be less. That is the higher wholesale price will result in a corresponding increase in selling price. In terms of pricing alone, it makes sense for the manufacturer to implement CRM for supply chain members. This is because it costs less and generates more income.

Corollary 6:

(i) $\pi_m^{M*} < \pi_m^{R*}$;

(ii) When $0 < \eta < \frac{1}{9}$, if $0 < \delta < \delta'$, then $\pi_r^{M*} > \pi_r^{R*}$; if $\delta' < \delta < \frac{\sqrt{2(1-\eta)}}{\eta(1-\eta)}$, then $\pi_r^{M*} < \pi_r^{R*}$;

(iii) When $\eta > \frac{1}{9}$, then $\pi_r^{M*} > \pi_r^{R*}$.

Where $\delta' = \frac{\sqrt{8(\sqrt{\eta}-\eta)}}{\eta(1-\eta)}$.

Corollary 6(i) indicates that the manufacturer can make higher profits when the retailer implements CRM. Even at a lower cost and a higher price, the manufacturer is not more profitable. From Corollary 6(ii) and (iii), for the retailer, the percentage of donations affects the outcome of the decisions. For the retailer, Corollary 6(ii) suggests that it is more advantageous for the manufacturer to implement CRM when both the amount of donation and the pro-sociality of the consumer are lower. However, if the percentage of donations is small but the consumers are more aware of charity, it is more beneficial for the retailer to implement CRM. Conversely, CRM by the manufacturer is more beneficial to the retailer if a larger percentage of donations are made.

Since our discussion is focused on the manufacturer as the leader, the manufacturer will choose to maximize its profits by delegating the implementation of CRM to the retailer. It is not that the retailer does not profit from CRM at this point, but it is less profitable than when the manufacturer implements CRM.

Corollary 7:

If $0 < \delta < \delta_s$, then $\pi_s^{M*} > \pi_s^{R*}$; if $\delta_s < \delta < \frac{\sqrt{2(1-\eta)}}{\eta(1-\eta)}$, then $\pi_s^{M*} < \pi_s^{R*}$.

Where $\delta_s = \frac{2\sqrt{2(1-\sqrt{1-\eta+\eta^2})}}{\eta(1-\eta)}$.

Corollary 7 illustrates the effect of the pro-sociality of the segment on social welfare. When the pro-sociality of consumers is lower than the threshold δ_s, the social welfare of the manufacturer's implementation is higher, but when the sensitivity of the target market to CRM exceeds the threshold δ_s, the social welfare of the retailer's implementation of CRM is higher.

5. Numerical examples

In this section, we present numerical examples to illustrate the theoretical results. We let the manufacturing cost $c = 0.2$ and show the effect of the donation percentage on the decision variables, optimal profit, and the pro-sociality of the segment on social welfare in the form of figures.

5.1 Effect of donation percentage on decision variables

We plot the effect on the advertising costs, the optimal wholesale price and the optimal sales price of donation percentage η .

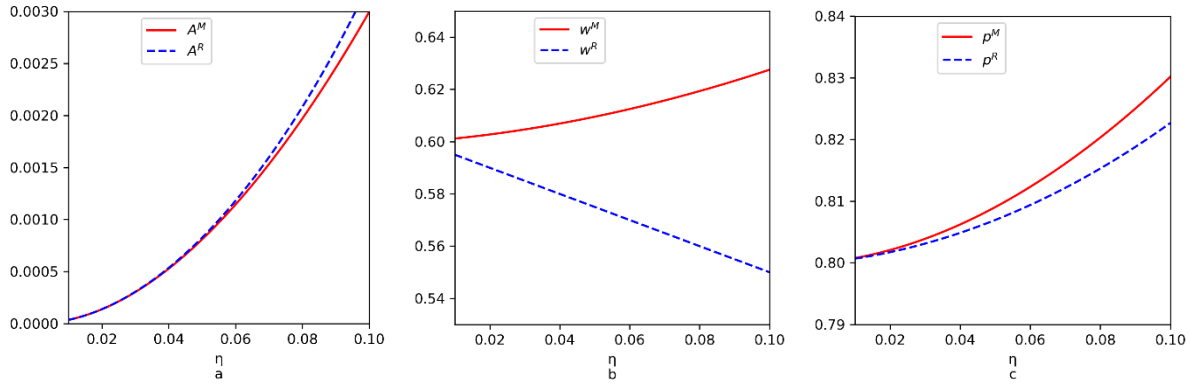

Fig. 1 Effect of donation percentage on decision variables ($\delta = 6$)

Fig. 1 reflects the effect of the proportion of CRM donations on the decision variables in Corollary 1 and Corollary 3. Fig 1(a) shows that as the donation percentage increases for both the manufacturer and the retailer, the promotional costs and selling price become larger. Further, the retailer's promotional costs are higher when CRM is implemented. As shown in fig. 1(b), for the wholesale price, it decreases with the increase of the donation percentage when the retailer implements the CRM, while the opposite is true when the manufacturer implements the CRM. And when the manufacturer implements CRM, the wholesale price is higher. From Fig. 1(c), we can conclude that the product price increases after the implementation of CRM, and the price increases faster when the manufacturer implements donations.

5.2 Effect of donation percentage on optimal profits

We show the effect of the donation percentage on the implementation of CRM strategies by the manufacturer and the retailer at different levels of consumer pro-sociality in the form of arithmetic examples. Through the previous analysis of optimal profit, when the manufacturer implements CRM, we can classify the degree of pro-sociality of the market segment into low, medium and high levels.

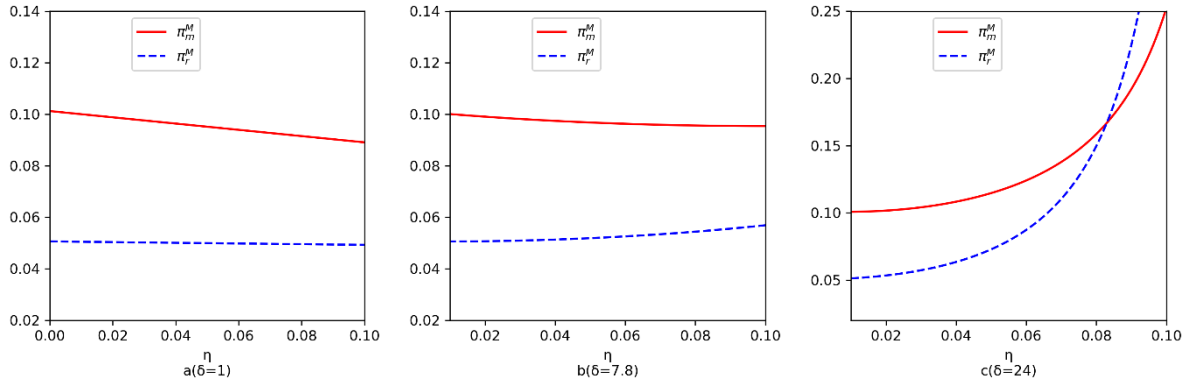

Fig. 2 Effect of donation parentage on profit when the manufacturer implements CRM

The three images in Fig. 2 represent how the percentage of donations affects the profits of the manufacturer and the retailer when the manufacturer implements CRM for three different magnitudes of consumer's pro-sociality. As shown in the previous analysis, when the pro-social awareness of consumers is weak, as in Fig. 2(a), these consumers do not care about the public welfare behavior of companies, therefore, they will not be motivated to make purchases by the welfare activities of companies. In this case, the manufacturer only invests the donation amount and the promotion cost but does not obtain the desired effect of revenue. While the wholesale price increases due to the increase of the donation amount, so the profit of the manufacturer and the retailer is in a simultaneous decline in this case.

Fig. 2(b) shows the profitability when the manufacturer implements CRM when the consumer's sensitivity to CRM is at a medium level. As shown in the figure, the manufacturer's profit is still decreasing, but the decreasing trend is slowing down, which means that as the amount of donation increases, the impact of its change on the company's maximum profit is gradually becoming weaker; at the same time, the optimal profit of the retailer increases with the donation percentage, because of higher pro-sociality, the benefits of CRM can already offset the costs and bring additional benefits for the retailer.

Fig. 2(c) shows a situation where the consumer base has a high awareness of public goods, and consumers are influenced by CRM to make purchases. At this point, if the manufacturer carries out donation activities, it will benefit both itself and the retailer, and the benefits of both will increase as the donation amount increases.

We have used the images above to verify the effect of consumer pro-sociality and donation percentage on the optimal profits when the manufacturer implements CRM, and we will now look at the scenario when the retailer implements CRM. When the retailer implements CRM, we classify the pro-sociality of consumers into two levels.

Fig. 3 represents the trend of profitability when the retailer implements CRM. Like the manufacturer's implementation, the optimal profit of the retailer and the manufacturer is affected by the strength of the pro-sociality of the consumers. When this sensitivity is weak, the donation of the retailer will result in losses for both manufacturer and retailer. Conversely, in more pro-social consumer markets, a cause campaign can generate higher returns for both the manufacturer and the retailer, and the higher the amount donated, the greater the return.

Below we validate the strategic decisions of the manufacturer and retailer to CRM. In the figure, we show the impact of consumer's pro-sociality on the CRM decisions of the manufacturer and the retailer in terms of low and high donation percentages. We use $\Delta\pi_m$ to denote π_m^R-π_m^M and $\Delta\pi_m$ to denote π_r^R-π_r^M . From Fig. 4, we can conclude that the donation strategies are not the same for different donation percentages.

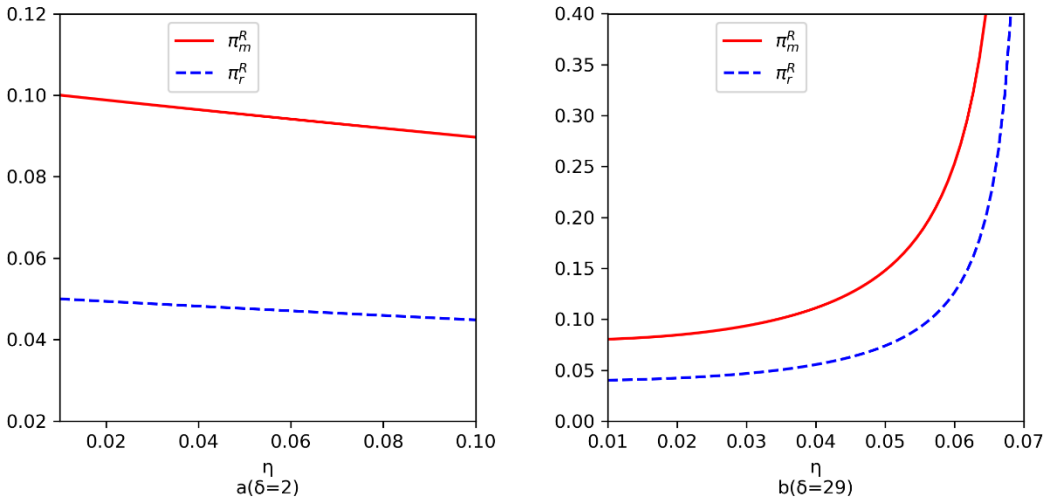

Fig. 3 Effect of donation parentage on profit when the retailer implements CRM

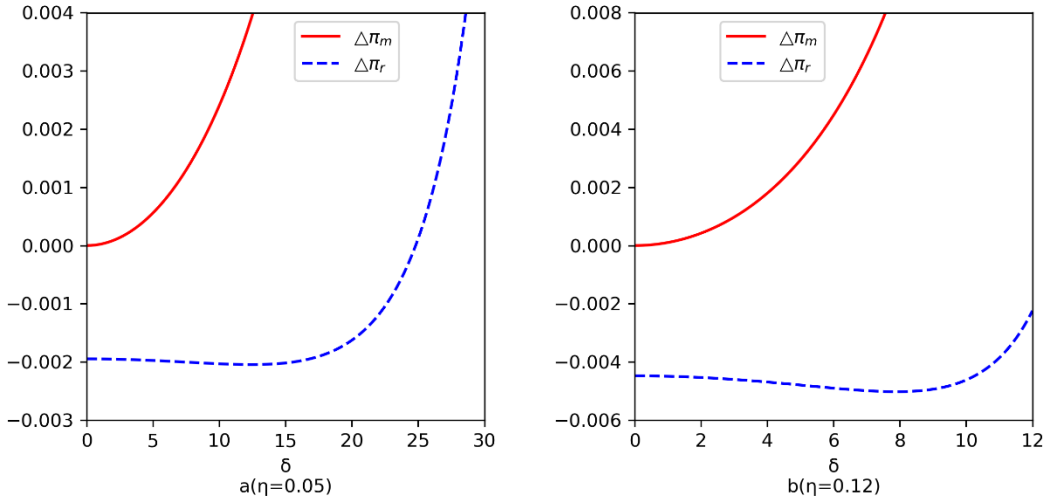

Fig. 4 Effect of consumer's pro-sociality on optimal profit with different donation percentage

As can be seen from the two graphs in Fig. 4, the manufacturer's decision is not influenced by the donation percentage and consumer sensitivity to CRM. Further, the manufacturer receives higher profits whenever the retailer implements CRM, so the manufacturer with the retailer should implement CRM. Differently, the retailer's decision is influenced by both the donation percentage and the consumer's sensitivity. Fig. 4(a) shows that if the donation percentage chosen by the donor is small and the consumer's pro-social awareness is weak, the retailer will not choose to implement CRM; if the consumer's sensitivity is high relatively, it is profitable for the retailer to implement CRM. Fig. 4(b) illustrates that it is more beneficial for the retailer when the manufacturer to implements CRM with a higher donation amount.

5.3 Impact of consumer's pro-sociality on social welfare

In the previous analysis, we obtained that the pro-sociality of consumers in the segment affects the retailer's decision, while the manufacturer's decision is independent of it. In this section, we use images to represent the impact of consumer pro-sociality on the overall profitability of the supply chain, also known as social welfare. We let $\eta = 0.05$.

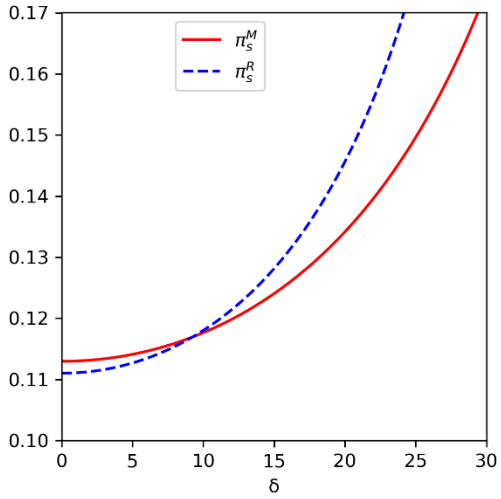

Fig. 5 Impact of consumer's pro-sociality on social welfare

Fig. 5 analyses the social welfare of the whole supply chain from the point of view of consumer's pro-sociality. As can be seen from the figure, the sensitivity of consumers to CRM affects the subject of implementing CRM. If the overall pro-social awareness of the consumer group in the market is low, the manufacturer's implementation of CRM is more beneficial to the supply chain as a whole; if the pro-social awareness of the consumer in the target market is high, then the retailer's implementation of CRM is beneficial to the whole supply chain.

6. Conclusion

In this paper, we examine the pricing and decision-making issues of implementing CRM by socially responsible supply chain members. We analyze two scenarios of the manufacturer and the retailer's implementation of CRM and conclude that donation amount and the pro-sociality of consumer groups in the segment are important. We make recommendations for the decisions of the manufacturer and the retailer in CRM and analyze the impact of donation amount and consumer's pro-sociality on pricing and strategy decisions.

In product pricing, we conclude that the retailer incurs higher advertising costs when implementing CRM, while the manufacturer has higher wholesale and selling prices when implementing CRM. In addition, if the retailer implements CRM, the higher the donation amount, the lower the wholesale price required; in other cases, regardless of who implements CRM, an increase in the donation amount will result in higher wholesale and product prices. However, it is not always advantageous for the manufacturer and the retailer to implement CRM. CRM decisions are influenced by a combination of donation amount and consumer's pro-sociality. Only when the pro-sociality of the segment market exceeds a critical threshold is the implementation of CRM profitable. From the manufacturer's point of view, it is always optimal to entrust the retailer to implement CRM; for the retailer, if the donation amount is small, it is also necessary to consider the pro-sociality of the consumer group: the retailer is willing to implement CRM only when the pro-sociality of the consumer is strong. If the donation percentage is larger, the retailer is the best choice to implement CRM.

We also analyzed the problem of the manufacturer and retailer's decision from social welfare perspective. The implementation of CRM is beneficial for maximizing social welfare for both the manufacturer and the retailer. Again, the pro-sociality of consumers remains an influential factor; if the pro-sociality of the consumer group is low, the manufacturer's implementation of CRM maximizes social welfare; if the pro-sociality of the consumer group is high, the retailer's implementation of public good marketing is optimal.

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Appendix A

Proof of proposition 1: It is easy to obtain Eq. 2 as a concave function with respect to p. Making the first order derivative of Eq. 2 with respect to equal to zero yields the reaction function of the selling price as $p = \frac{(\delta\eta\sqrt{A}+w+1)}{2}$. Substituting it into Eq. 1, the Hesse matrix of Eq. 1 is obtained as:

$$\begin{pmatrix} -(1-\eta) & \frac{(1-\eta)\delta\eta}{4\sqrt{A}} \\ \frac{(1-\eta)\delta\eta}{4\sqrt{A}} & -\frac{(w-\eta w-c)\delta\eta}{A^{3/2}} \end{pmatrix} \tag{A1}$$

The principal sub formulas of the Hesse matrix are $-(1-\eta) < 0$, $\frac{\delta\eta(1-\eta)(\delta\eta\sqrt{A}(\eta-1)-2(\eta w+c-w))}{16A^{3/2}} > 0$, it can be obtained that (A1) is a negative definite matrix. Since Eq. 1 is a concave function with respect to w and A, respectively.

Find the first-order derivatives of Eq. 1 to w and A, respectively, and make them equal to zero. Then we give Eqs. 4, 5 and 6. Substituting them into Eqs. 1-3 and simplifying them gives Eqs. 7-9.

Proof of Corollary 1: Taking the first order derivative of A^{M*} to η. We have

$$\frac{dA^{M*}}{d\eta} = \frac{2\delta^2\eta(1-c-\eta)(\delta^2\eta^2(\eta^2-2\eta+2c\eta-c+1)+8(1-2\eta-c))}{(8+\delta^2\eta^3-\delta^2\eta^2)^3} \tag{A2}$$

Similarly, we can obtain (A2) and (A3) as follows:

$$\frac{dw^{M*}}{d\eta} = \frac{c\delta^4\eta^4(1-\eta)^2 + 4\eta\delta^2(1-\eta)(-3\eta^2+5\eta+2c-2)+32c}{(1-\eta)^2(8+\delta^2\eta^3-\delta^2\eta^2)^2} \tag{A3}$$

$$\frac{dp^{M*}}{d\eta} = \frac{c\delta^4\eta^4(1-\eta)^2 + 2\eta\delta^2(1-\eta)(9\eta^2-15\eta+2c\eta-6c+6)+16c}{(1-\eta)^2(8+\delta^2\eta^3-\delta^2\eta^2)^2} \tag{A4}$$

It is easy to determine (A1), (A2) and (A3) > 0.

Proof of Corollary 2: Taking the first order derivative of π_m^{M*} with respect to η. We obtain (A5):

$$\frac{d\pi_m^{M*}}{d\eta} = \frac{2(1-c-\eta)(\eta(1-\eta)(\eta^2-2\eta+2c\eta-c+1)\delta^2-4(1-\eta+c))}{(1-\eta)^2(8+\delta^2\eta^3-\delta^2\eta^2)^2} \tag{A5}$$

because of $\frac{2(1-c-\eta)}{(1-\eta)^2(8+\delta^2\eta^3-\delta^2\eta^2)^2} > 0$, we only need to determine the positive and negative of $\eta(1-\eta)(\eta^2-2\eta+2c\eta-c+1)\delta^2-4(1-\eta+c)$. We obtain that if $0<\delta<\delta_m^M$, then $\frac{d\pi_m^{M*}}{d\eta}<0$; if $\delta_m^M<\delta<\frac{\sqrt{2(1-\eta)}}{\eta(1-\eta)}$, then $\frac{d\pi_m^{M*}}{d\eta}>0$.

Taking the first order derivative of π_r^{M*} to η. We obtain (A6)

$$\frac{d\pi_m^{M*}}{d\eta} = \frac{8(1-c-\eta)(\eta(1-\eta)(3\eta^2-5\eta+4c\eta-2c+2)\delta^2-8c)}{(1-\eta)^3(8+\delta^2\eta^3-\delta^2\eta^2)^3} \tag{A6}$$

Similarly, we can obtain that if $0<\delta<\delta_r^M$, then $\frac{d\pi_m^{M*}}{d\eta}<0$; if $\delta_r^M<\delta<\frac{\sqrt{2(1-\eta)}}{\eta(1-\eta)}$, then $\frac{d\pi_r^{M*}}{d\eta}>0$. Since $\delta_r^M<\delta_m^M$, we can proof Corollary 2.

Proof of proposition 2 The Hesse matrix of Eq. 10 is given by

$$\begin{pmatrix} -2(1-\eta) & \frac{(1-\eta)\delta\eta}{2\sqrt{A}} \\ \frac{(1-\eta)\delta\eta}{2\sqrt{A}} & -\frac{(p-\eta p+w)\delta\eta}{4A^{3/2}} \end{pmatrix} \tag{A7}$$

Its principal sub formulas are $-2(1-\eta)<0$, $\frac{\delta\eta(1-\eta)(\delta\eta\sqrt{A}(\eta-1)-2(\eta p+p-w))}{4A^{3/2}}>0$ respectively. From this we can obtain Eq. 10 as a concave function of A and w. We let the first-order derivative of Eq. 10 with respect to p and A be equal to zero to obtain the reaction function $p=\frac{w\delta^2\eta^2(\eta-1)-2(\eta-w-1)}{(1-\eta)(4+\delta^2\eta^3-\delta^2\eta^2)}$, $A=\frac{(\eta+w-1)^2\delta^2\eta^2}{(4+\delta^2\eta^3-\delta^2\eta^2)^2}$. Then we have Eqs. 13-15. Substituting them into Eqs. 10-12 and simplifying them gives Eqs. 16-18.

Proof of Corollary 3: Taking the first order derivative of A^{R*} to η. We have (A8):

$$\frac{dA^{R*}}{d\eta} = \frac{\delta^2\eta(1-\eta)(\delta^2\eta^2(\eta^2-2\eta+2c\eta-c+1)+4(1-2\eta-c))}{4(4+\delta^2\eta^3-\delta^2\eta^2)^3} \tag{A8}$$

Similarly, we can obtain (A9) and (A10) as follows:

$$\frac{dw^{R*}}{d\eta} = \frac{1}{2} \tag{A9}$$

$$\frac{dp^{R*}}{d\eta} = \frac{\delta^4\eta(1-\eta)(\delta^2\eta^3c(1-\eta)+6\eta^2+4c+10\eta-4)+8c}{2(1-\eta)^2(4+\delta^2\eta^3-\delta^2\eta^2)^2} \tag{A10}$$

It is easy to obtain (A8), (A9) > 0 and (A10) < 0.

Proof of Corollary 4: Taking the first order derivative of π_m^{R*} to η. We obtain (A11):

$$\frac{d\pi_m^{R*}}{d\eta}=\frac{(1-c-\eta)(\delta^2\eta(1-\eta)(\eta^2+2c\eta-c-2\eta+1)\delta^2-2(1-\eta+c))}{(1-\eta)^3(8+\delta^2\eta^3-\delta^2\eta^2)^3} \tag{A11}$$

We obtain that if $0<\delta<\delta^R$, then $\frac{d\pi_m^{R*}}{d\eta}<0$ and $\frac{d\pi_r^{R*}}{d\eta}<0$; if $\delta^R<\delta<\frac{\sqrt{2(1-\eta)}}{\eta(1-\eta)}$, then $\frac{d\pi_m^{R*}}{d\eta}>0$ and $\frac{d\pi_r^{R*}}{d\eta}>0$. We can proof Corollary 4.

Proof of Corollary 5: we can obtain

$$A^{M*}-A^{R*}=\frac{\delta^4\eta^4(1-\eta)(16+3\delta^2\eta^3-3\delta^2\eta^2)}{4(4+\delta^2\eta^3-\delta^2\eta^2)^2(8+\delta^2\eta^3-\delta^2\eta^2)^2} \tag{A12}$$

$$w^{M*}-w^{R*}=\frac{\eta(\eta(1-\eta)(\eta^2+2c\eta-c-2\eta+1)\delta^2+8(1-\eta+c))}{(1-\eta)(8+\delta^2\eta^3-\delta^2\eta^2)} \tag{A13}$$

$$p^{M*}-p^{R*}=\frac{\delta^2\eta^2(1-c-\eta)(2+\delta^2\eta^3-\delta^2\eta^2)}{2(4+\delta^2\eta^3-\delta^2\eta^2)(8+\delta^2\eta^3-\delta^2\eta^2)} \tag{A14}$$

It can be judged that (A12) < 0, (A13) > 0 and (A14) > 0.

Proof of Corollary 6: Since

$$\pi_m^{M*}-\pi_m^{R*}=\frac{\delta^2\eta^2(1-c-\eta)^2}{2(4+\delta^2\eta^3-\delta^2\eta^2)(8+\delta^2\eta^3-\delta^2\eta^2)} \tag{A15}$$

It is easy to get (A15)> 0.

$$\pi_r^{M*}-\pi_r^{R*}=-\frac{\eta(1-c-\eta)^2((1-\eta)^3\delta^4\eta^3+16(1-\eta)^3\delta^2\eta^3+64)}{4(1-\eta)^2(4+\delta^2\eta^3-\delta^2\eta^2)^2(8+\delta^2\eta^3-\delta^2\eta^2)} \tag{A16}$$

To determine the positive and negative of (A16). We need to determine the positive and negative of $(1-\eta)^3\delta^4\eta^3+16(1-\eta)\delta^2\eta^3+64$, we can solve when $0<\eta<\frac{1}{9}$, if $\delta'<\frac{\sqrt{2(1-\eta)}}{\eta(1-\eta)}$, then $\pi_r^{M*}<\pi_r^{R*}$; if $\delta'<\delta<\frac{\sqrt{2(1-\eta)}}{\eta(1-\eta)}$, there is $\pi_r^{M*}>\pi_r^{R*}$. When $\eta>\frac{1}{9}$, there is $\delta^{'}>\frac{\sqrt{2(1-\eta)}}{\eta(1-\eta)}$, then $\pi_r^{M*}>\pi_r^{R*}$.

Proof of Corollary 7: There is

$$\pi_s^{M*}-\pi_s^{R*}=\frac{\eta(1-c-\eta)^2(\delta^4\eta^3(1-\eta)^3-\delta^2\eta(1-\eta)+64)}{4(1-\eta)^2(4+\delta^2\eta^3-\delta^2\eta^2)(8+\delta^2\eta^3-\delta^2\eta^2)} \tag{A17}$$

since that when $\pi_s^{M*}>\pi_s^{R*}$, there is $\delta^4\eta^3(1-\eta)^3-\delta^2\eta(1-\eta)+64>0$, then $\pi_s^{M*}>\pi_s^{R*}$; when $\delta_s<\delta<\frac{\sqrt{2(1-\eta)}}{\eta(1-\eta)}$, there $\delta^4\eta^3(1-\eta)^3-\delta^2\eta(1-\eta)+64<0$, then $\pi_s^{M*}<\pi_s^{R*}$.