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Original scientific paper

BALANCING SUPPLIER CHANNELS: AN INCENTIVE MODEL FOR ONLINE AND OFFLINE SALES CHANNELS

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Abstract
In this paper, we first propose online and offline channel incentive models (CIM) with consideration of the consumers' rational choices to solve and simulate the channel incentive problem (CIP) for supplier. We investigate whether the increase in demand along with channel incentive activities is enough to compensate for the decrease in the supplier's marginal revenue and retailers could benefit from the increase in market demand when retail channel information reference factor satisfies a certain threshold value. Our results show that decision preference of channel members is influenced by the reference factor and marginal revenue. Furthermore, the numerical achievements indicate that there is a unique optimal channel incentive coefficient related to the rational choices in benchmark channel incentive model (BCIM) for omnichannel. Both suppliers and retailers would benefit from the increased orders. Channel efficiency is improved from 72 % to 79 %. And the supplier profit function is a concave function of supplier's input in the offline channel incentive in the offline CIM.
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Key Words: Channel Incentive, Channel Conflict Level, Bounded Rationality, Reference Prices

1. INTRODUCTION

The channel incentive problem (CIP) (Agnihotri and Zhang [1], Sun and Ji [2], and Hsiao et al. [3]) reflects a rational interaction system between incentive subjects (i.e., consumers) and channel subjects (i.e., suppliers and retailers), such as advertisements and sales promotions. Channel incentive activities represent the most essential demands of consumers (e.g., low prices and less time required). Therefore, incentive factor analysis is the premise of CIP research. Middlemen form the channels of product and ownership transfer between suppliers and users, and provide upstream suppliers with services (Deligiannis et al. [4] and Yan et al. [5]), such as the organisation of market work, the construction of business outlets, the occupation of inventory funds, logistics distribution and so on.

Some real examples are used to illustrate the challenges of breaking into a channel and the costs involved in sourcing and vetting partners in the literature (Wu [6], Mohamed et al. [7], Xiao et al. [8], Ma et al. [9] and Choi et al. [10]). Service providers such as consulting firms or marketing agencies also need to build relationships with channel partners to grow their business. However, finding the right partner could be challenging, and vetting potential partners may be time-consuming and costly. For example, a marketing agency that specializes in social media may need to find a partner that can help them expand into email marketing. The agency would need to evaluate potential partners based on their expertise, track record, and pricing, and may need to hire a specialized service to conduct this evaluation. The conclusions and future research directions are presented in Section 6.

This study focuses on the design of channel incentive models (CIM), as shown in Fig. 1.

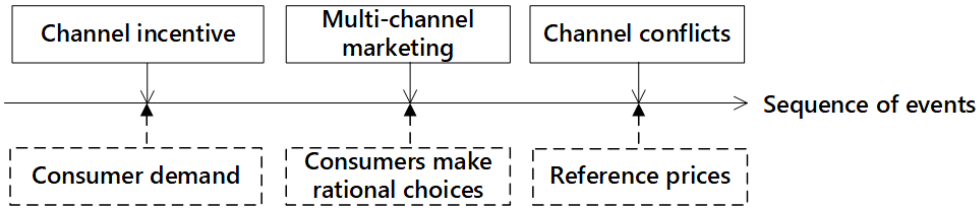


Figure 1: Sequence of events.

2. LITERATURE REVIEW

Channel incentive refers to all kinds of incentive or promotion measures taken by suppliers to promote channel members to achieve the company's designated distribution goals (Sun and Ji [2], Hsiao et al. [3]). Multichannel incentive is conducive to the interaction between online and offline channels and the development of omnichannel mode (Sun and Ji [2] and Ciric et al. [11]), but conflicts among members also arise because of the limitation of bounded rationality of the consumers. Simple feedback incentive cannot reconcile the conflict of interests between suppliers and channel members. Mittal and Sridhar [12] showed that consumers have a psychological upper limit on the retail price of goods, and the cost of channel conflict cannot be transferred to consumers through all the elevated prices. Consumers stimulate bounded rationality, such as price comparison and reference under the omnichannel mode of channel incentive. Therefore, the research on the CIP combined with the effect of rational choice behaviour can provide a favourable decision-making guarantee for multichannel robust design of suppliers and retailers in channel conflict environment, which has more theoretical and practical significance and has been widely studied by scholars. For example, based on Aseri et al. [13], the platform would allow for real-time bidding for the promotion of personalized advertising by mobile channel incentives to determine the number of advertising displays and obtain an approximate optimal strategy.

If online channels are too strong, it will inevitably impact the offline business in price, distribution and channel of the system (Amrouche et al. [14] and Choi et al. [10]). Amrouche et al. [14] showed if the online prices are increased drastically, the manufacturer will follow this move by adjusting prices (the wholesale and retail price). Kahneman and Tversky [15] proposed prospect theory that most decision-makers' judgements on gains or losses are based on bounded rationality. Consumers are faced with the same brand and model of commodities in different channels, and there are different choice behaviours in different periods of time according to the research of Zhang and Chiang [16], Zhang et al. [17] and Uncu [18]. Consumers are affected by loss aversion in terms of price and commodity sales (Amaldoss and He [19], Sogn-Grundvåg and Zhang [20], Babai et al. [21] and Gracanin et al. [22]). Through technology investment and a replenishment strategy, the retailer's total profit can be maximized in a limited planning period (Mandal et al. [23], Li et al. [24] and Shen et al. [25]). The characteristics of rational choice behaviour are confirmed. For example, in the paper of Geng et al. [26] and in Amaldoss and He [19].

3. CHANNEL INCENTIVE AND CONFLICT PROBLEMS WITH CONSUMER RATIONAL CHOICE

Multichannel system is composed of supplier, retailer and consumer, as shown in Fig. 2. The supplier is the leader and the retailer is the follower. Multichannel retail emphasizes that multiple channels are used as ways of sale and order fulfilment at the same time, but it does not emphasize the connection between various channels and the possibility of switching between channels for customers.

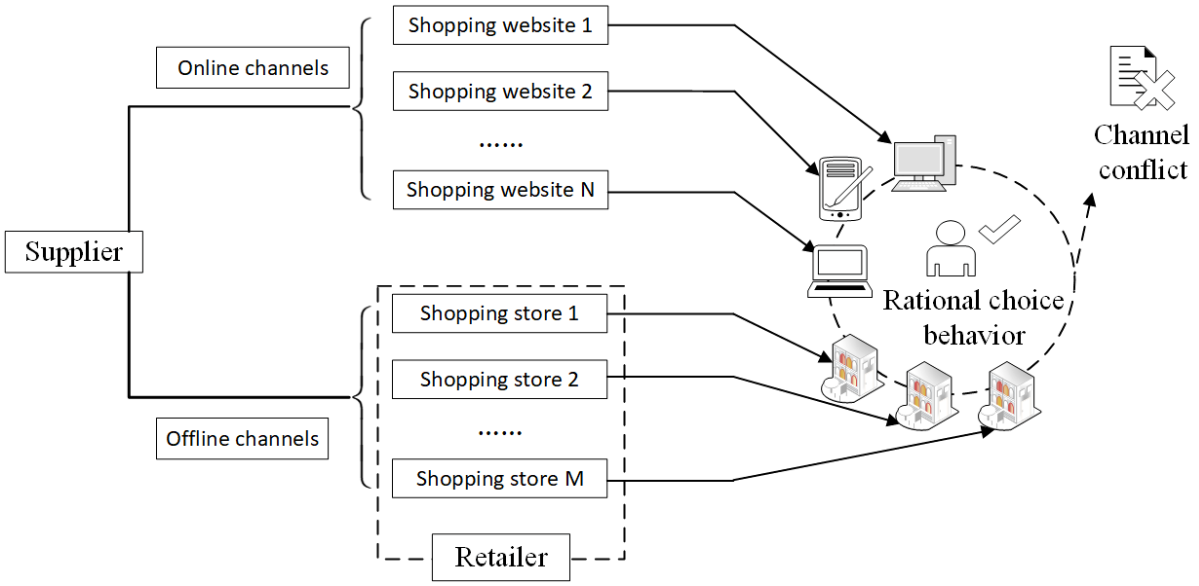


Figure 2: The CIP with multichannel conflict.

Table I: Notation description.

I_{online}	The input of the supplier in the online channel incentive (the input of the retailer is prohibited to avoid channel conflict and brand devaluation caused by online information symmetry).
I_s	The input of the supplier in the offline channel incentive.
I_r	The input of the retailer in the offline channel incentive.
I_{BCI}	The input of the benchmark channel incentive.
β	The multichannel conflict factor.
ρ	The channel efficiency.
λ	The channel information reference factor describing the multichannel information effects of consumer.
m_s	The marginal profit of the supplier without the channel incentive.
m_r	The marginal profit of the retailer without the channel incentive.
t_n	The end of the selling season.
t_1	The beginning of the selling season.
$Q(t)$	The demand function of the reference point with rational choice behaviour, $Q(t)=A-bp(t)-\lambda\left(p(t)-r(t)\right)$.
A	$A(A>b(m_s+m_r))$ represents the potential market demand.
$p(t)$	The retail price at time t.
$r(t)$	The psychological reference value.
$b\,(b>0)$	The information sensitivity factor.
$\prod_O^{BCI}\left(I_{BCI}\right)$	The profit of the integrated channel with the CIP.
$\prod_s^{CI}\left(I_{online},0\right)$	The profit of the supplier in the online CIM.
$\prod_r^{CI}\left(I_{online},0\right)$	The profit of the retailer in the online CIM.
$\prod_s^{CI}\left(I_s,I_r\right)$	The profit of the supplier in the offline CIM.
$\prod_r^{CI}\left(I_s,I_r\right)$	The profit of the retailer in the offline CIM.

The time interval of demand disturbance caused by channel incentives is recorded as $[t_1, t_1 + T]$ in the sales cycle. t_n is the end of the sales season. I_s is the input of the supplier in the offline channel incentive, and I_r is the input of the retailer in the offline channel incentive. I_s and I_r are the utility values in different channel incentives according to the input cost. The difference in information between the online channel and offline channel inevitably results in the interference of demand fluctuation within the system, such as different discount prices, after-sales services, and sales benefits. According to Fibich et al. [27], Mirzaei et al. [28], Sun et al. [29], Ali et al. [30], and Galal and El-Kilany [31], the linear demand function $Q(t) = A - bp(t) - \lambda(p(t) - r(t))$. A larger β value means a higher interference intensity of information conflict and the lower brand loyalty of consumers. The reference value is more dependent on long-term information, where $r(t_1)$ is recorded as the datum point at t_1, and $r(t_1) = m_s + m_r \cdot p(s)$ is the sales information at time s based on Fibich et al. [27] and Mirzaei et al. [28]. The notations are listed in Table I. In our research, we stand on the supplier's perspective so the input of brand supplier is noted as a comprehensive index I_{online} in the online channel incentive.

4. MODEL FRAMEWORK

4.1 Scenario 1: benchmark channel incentive model (BCIM)

The decision-maker determines the decision variables of the channel's comprehensive incentive coefficient to maximize the overall profit of the channel in Fig. 3.

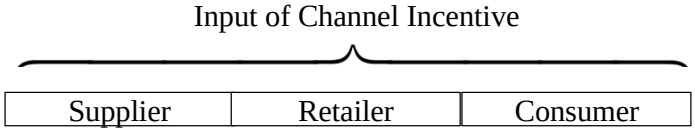


Figure 3: The omnichannel incentive of the benchmark model.

Proposition 1: In the BCIM, the optimal channel comprehensive incentive coefficient is $I_{BCI}^{*} = \frac{(m_s + m_r)b_1 - b_2}{-2a}$. The channel incentive will strictly benefit the omnichannel, i.e., $\prod_O^{BCI}(I_{BCI}^{*}) > \prod_O$, in which $a = -\frac{\lambda(1-e^{-\beta T}) + \beta bT}{\beta}$, $b_1 = -\frac{\left(\lambda e^{-\beta(t_n - T)}(1-e^{-\beta T}) + \beta bT\right)}{\beta}$, and $b_2 = (A - b(m_s + m_r))T$.

Proof: The objective function of the omnichannel is concave with I_{BCI}, thus, $\frac{\partial^2 \prod_O^{BCI}(I_{BCI})}{\partial I_{BCI}^2} = -2bT - 2\frac{\lambda(1-e^{-\beta T})}{\beta} < 0$. And we obtain the optimal channel comprehensive incentive coefficient $I_{BCI}^{*} = \frac{\left(\lambda e^{-\beta(t_n - T)}(1-e^{-\beta T}) + \beta bT\right)(m_s + m_r) + \beta(A - b(m_s + m_r))T}{-2\lambda(1-e^{-\beta T}) + \beta bT} = \frac{(m_s + m_r)b_1 - b_2}{-2a}$, in which $a = -\frac{\lambda(1-e^{-\beta T}) + \beta bT}{\beta}$, $b_1 = -\frac{\left(\lambda e^{-\beta(t_n - T)}(1-e^{-\beta T}) + \beta bT\right)}{\beta}$, and $b_2 = (A - b(m_s + m_r))T$.

4.2 Scenario 2: online channel incentive model (online CIM)

According to Amrouche et al. [14], suppliers could be interested to open an online channel to counter the threat of e-commerce, so offline retailers in the middle of the channel system do not avoid channel conflict in Fig. 4.

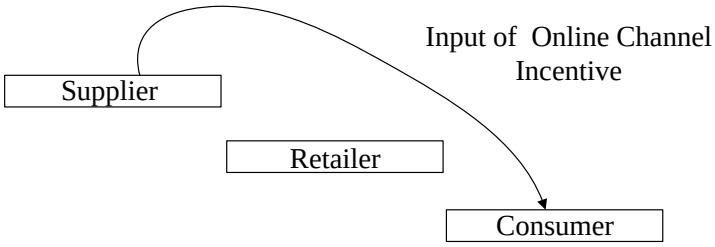


Figure 4: The online channel incentive of online CIM.

The online CIM will have a certain impact on offline retailers. The profits of the supplier and retailer are:

$$\prod_{\mathrm{s}}^{CI}\left(I_{online},0\right)=aI_{online}^{2}+\left(b_{1}m_{\mathrm{s}}-b_{2}\right)I_{online}+\prod_{\mathrm{s}} \tag{1}$$

$$\prod_{\mathrm{r}}^{CI}\left(I_{online},0\right)=m_{r}I_{online}b_{1}+\prod_{r} \tag{2}$$

where $\prod_{\mathrm{s}}=m_{s}\left(A-b\left(m_{\mathrm{s}}+m_{r}\right)\right)t_{n}$ and $\prod_{r}=m_{r}\left(A-b\left(m_{\mathrm{s}}+m_{r}\right)\right)t_{n}$. Accordingly, the following propositions are obtained.

Proposition 2: In the online CIM, the optimal channel incentive input is $I_{online}^{*}=\frac{m_{\mathrm{s}}b_{1}-b_{2}}{-2a}$. The order blowout of consumers is beneficial for suppliers, i.e., $\prod_{\mathrm{r}}^{CI}\left(I_{online}^{*},0\right)>\prod_{\mathrm{s}}$, and it is also beneficial for retailers, i.e., $\prod_{\mathrm{r}}^{CI}\left(I_{online}^{*},0\right)>\prod_{r}$.

Proof: From the supplier profit function in the online CIM, $\frac{\partial\prod_{\mathrm{s}}^{CI}\left(I_{online}^{*},0\right)}{\partial I_{s}^{2}}=2a<0$ and then, $I_{online}^{*}=\frac{m_{\mathrm{s}}b_{1}-b_{2}}{-2a}$ and $\prod_{\mathrm{s}}^{CI}\left(I_{online}^{*},0\right)=\prod_{\mathrm{s}}\frac{\left(b_{1}m_{\mathrm{s}}-b_{2}\right)^{2}}{-4a}$. When the supplier carries out channel incentive activities in the online CIM, $I_{online}^{*}>0$, and then, $\prod_{\mathrm{s}}^{CI}\left(I_{online}^{*},0\right)>\prod_{\mathrm{s}}$ and $\prod_{r}^{CI}\left(I_{online}^{*},0\right)>\prod_{r}$.

4.3 Scenario 3: offline channel incentive model (offline CIM)

After the supplier begins the online CIM, the retailer follows in the offline CIP game, recorded as the offline CIM in Fig. 5.

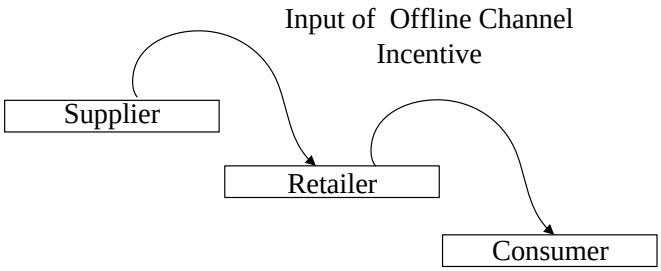


Figure 5: The offline channel incentive of the offline CIM.

Assuming that the supplier is the leader of the Stackelberg game and that the retailer is the follower, the profit function of the retailer is obtained by the following reverse solution:

$$\prod_{r}^{CI}\left(I_{s},I_{r}\right)=aI_{s}^{2}+b_{1}m_{r}I_{s}+\left(b_{1}m_{r}+aI_{s}-b_{2}\right)I_{r}+\prod_{r} \tag{3}$$

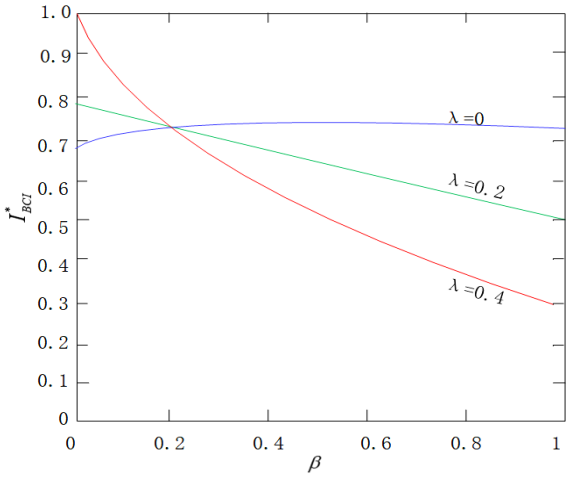
It can be seen from the derivation that the retailer's profit function is concave, and the optimal channel incentive input function of the retailer is:

$$I_r^*(I_s) = \frac{b_1 m_r - b_2}{-2a} - \frac{I_s}{2} \tag{4}$$

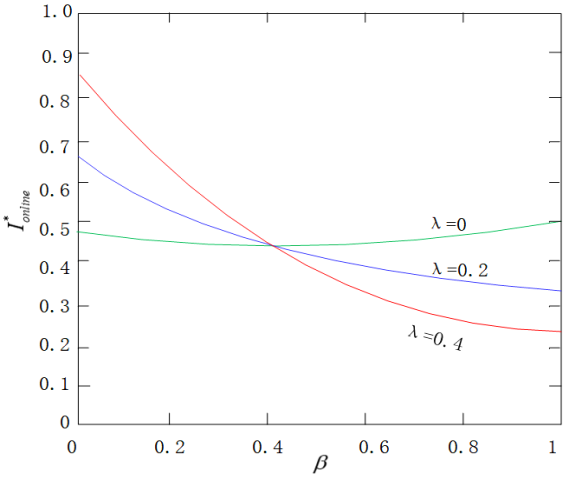
$$\prod_s^{CI}\left(I_s, I_r^*(I_s)\right) = \frac{1}{2}\left(aI_s^2 + (b_1 m_s - b_2 - b_1 m_r) I_s - b_1 m_s \left(\frac{b_1 m_r - b_2}{a}\right)\right) + \prod_s \tag{5}$$

5. COMPUTATIONAL RESULTS

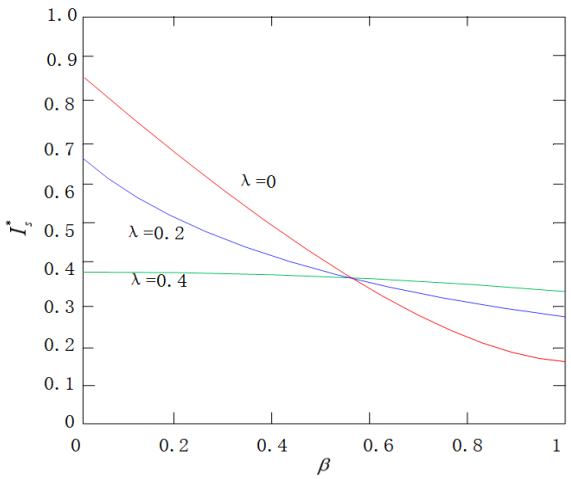
We can obtain the influence of the multichannel conflict factor on the optimal channel incentive input, channel profit increment and channel efficiency.



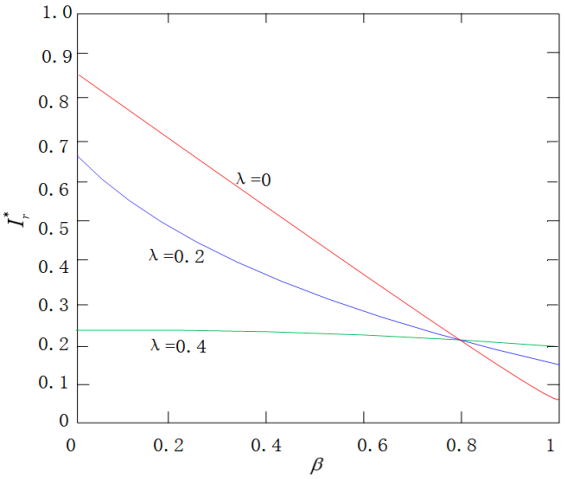
a) Impact of the channel conflict level on supplier's optimal channel incentive input in the BCIM



b) Impact of the channel conflict level on supplier's optimal channel incentive input in the online CIM



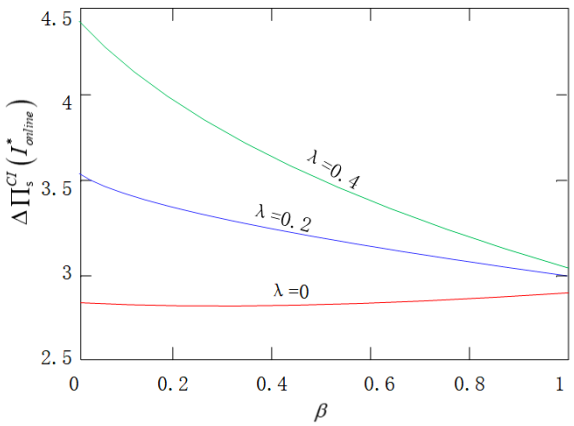
c) Impact of the channel conflict level on supplier's optimal channel incentive input in the offline CIM



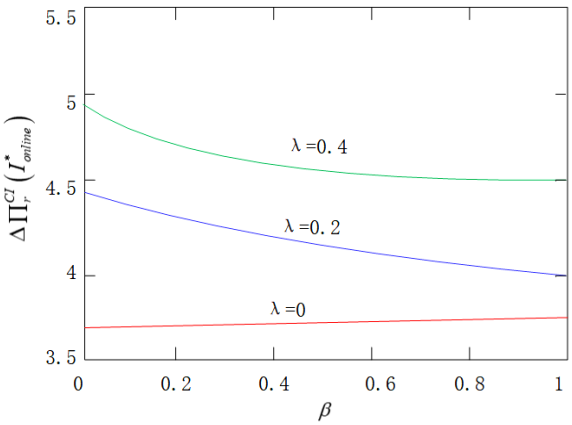
d) Impact of the channel conflict level on retailer's optimal channel incentive input in the offline CIM

Figure 6: The influence of the channel conflict level on the optimal channel incentive input.

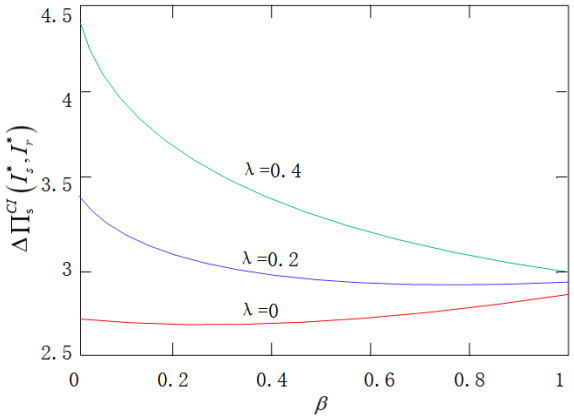
Fig. 6 shows that the channel incentive investment does not increase with the same level of rational choice behaviour of consumers when multichannel conflict factors β increase.



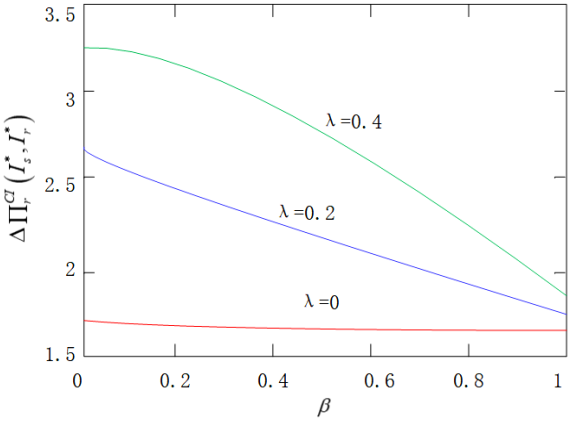
a) Impact of the channel conflict level on the increment of supplier profit in the online CIM



b) Impact of the channel conflict level on the increment of retailer profit in the online CIM



c) Impact of the channel conflict level on the increment of supplier profit in the offline CIM



d) Impact of the channel conflict level on the increment of retailer profit in the offline CIM

Figure 7: Impact of the channel conflict level on the profit increment.

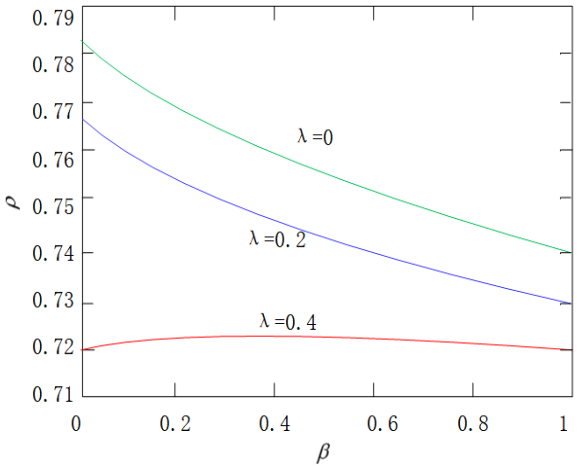
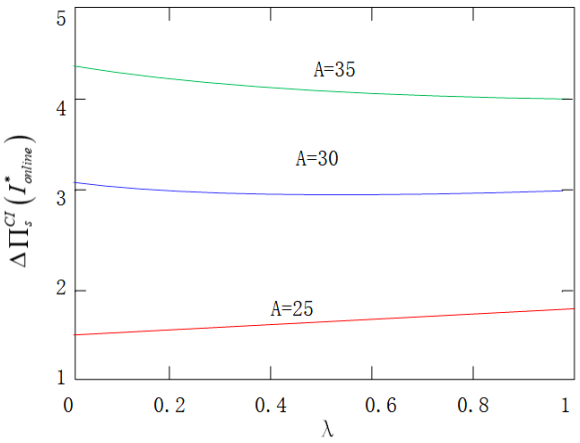
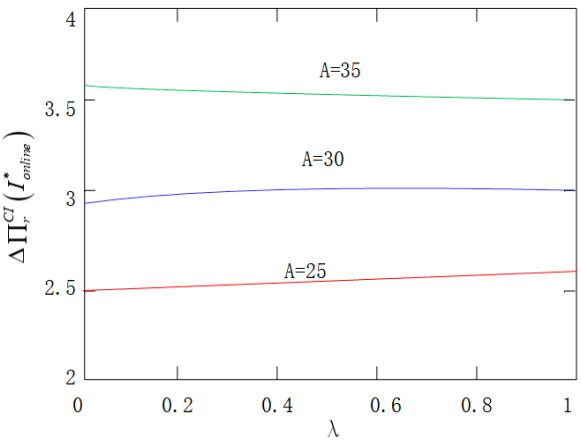


Figure 8: Impact of the channel conflict level on channel efficiency.

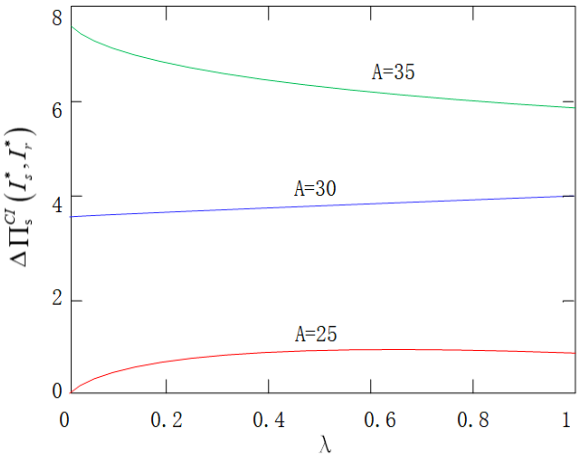
Fig. 7 shows the impact of multichannel conflict factors on the channel profit increment. The profit increment decreases with the increase in multichannel conflict factors. Fig. 8 shows that a low channel conflict level can improve channel efficiency. It can also be found from Fig. 8 that higher reference factors can improve channel efficiency.



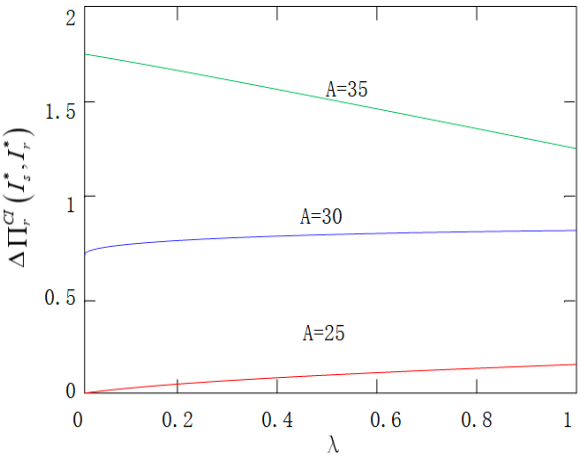
a) Impact of the channel information reference factor on the increment of supplier profit in the online CIM



b) Impact of the channel information reference factor on the increment of retailer profit increment in the online CIM



c) Impact of the channel information reference factor on the increment of supplier profit in the offline CIM



d) Impact of the channel information reference factor on the increment of retailer profit in the offline CIM

Figure 9: The influence of the reference point (λ) on the channel profit increment.

Fig. 9 shows that when the reference factor is given, the channel members in the online CIM and offline CIM obtain less incremental profit when the market demand is high.

6. CONCLUSIONS

Channel conflict is a common occurrence in the world of business (Krndzija and Pilav-Velic [32] and Agnihotri and Zhang [1]), particularly in the distribution of goods and services through multiple channels. It occurs when two or more channels that are supposed to work together to achieve a common goal end up competing against each other for the same customers or market share. This can lead to a variety of problems for the business, including reduced profits, damaged relationships, and overall decreased efficiency. To prevent or address channel conflict, businesses can adopt several strategies. Develop a clear channel strategy: A well-defined channel strategy can help prevent channel conflict by clearly outlining the roles and responsibilities of each channel partner. This includes defining the target market, identifying the products or services each partner will offer, and establishing guidelines for pricing, promotions, and distribution. Communication: Effective communication is critical in preventing and managing channel conflict. Regular communication and feedback between channel partners can help ensure everyone is on the

same page and working towards the same goals. Incentives: Offering incentives, such as commissions or bonuses, can help align the interests of different channel partners and reduce the likelihood of conflict.

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