CHANNEL STRATEGY AND PRICING IN A DUAL-CHANNEL WITH COMPETITION

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ABSTRACT

This study deals with the impact of channel strategy and channel format selection on the manufacturer's, the retailer's, the e-tailer's, and the system-wide profits. We consider the problem of one manufacturer selling one product in the market through two competing channels: a physical channel (retailer) and an internet channel (e-tailer). We assume the manufacturer uses two commonly applied contracts in such a dual-channel structure: the wholesale-price-only (WPO) contract for the physical channel and the revenue-sharing contract for the internet channel. Under such a setting with heterogeneous and cross-channel competition, we model the decision-making of the dual-channel as a Stackelberg game and carry out equilibrium analysis. The strategic problem facing the manufacturer is to determine whether to take an integrated approach or a decentralized approach for its internet channel, that is to integrate the internet retailing into its operations or to let a third party e-tailer, e.g., Amazon.com or e-Bay.com, take over the virtual retailing. Numerical results show that the integrated strategy generates a lower e-tailing price and higher profit for the e-channel, while the cooperative decentralization generates a higher e-tailing price, lower revenue-sharing percentage, and higher system-wide profit.

Keywords: Revenue-sharing; Cross-channel Competition; Internet/Direct Marketing; Stackelberg Game

1. INTRODUCTION

Global competition and information technology (IT) advances have rapidly changed the marketing practices, especially the option of internet channel format [26]. By streamlining internet for providing goods and making it easier for customers to purchase, a growing e-channel directly competes with the traditional retailer [2]. According to research found in Forrester Research, the United Stated online retail industry will be worth of $279 billion in 2015 [21]. Customers have a choice to purchase through the internet retail stores, such as Yahoo!, Amazon, Best Value Bazaar and eBay, with internet-based firms. The internet channel is a powerful that allows the manufacturer to bypass the physical retailer to deliver its product directly to the end-customers. Most manufacturers add an internet channel to gain profits, while they face the problem of pricing competition between internet channel and existing physical channel [22].

This study deals with the impact of channel strategy and channel format selection on the supplier

(manufacturer), the retailer, the e-tailer, and the system-wide profits. We consider the problem of one manufacturer selling one product in the market through two competing channels: a physical channel (retailer) and an internet channel (e-tailer). We assume the manufacturer uses two commonly applied contracts in such a dual-channel structure: the wholesale-price-only (WPO) contract for the physical channel and the revenue-sharing contract for the internet channel. Under such a setting with heterogeneous and cross-channel competition, we model the decision-making of the channel as a Stackelberg game and carry out equilibrium analysis.

The critical problem facing the manufacturer is to determine whether to take an integrated strategy or a decentralized strategy for its internet channel, that is to integrate the internet retailing into its operations or to let a third party e-tailer, e.g., Amazon.com or e-Bay.com, take over the virtual retailing. After the strategic channel format was selected, the tactical problem becomes to determine the optimal prices and contract terms for both channels. Cattani et al. [6] considered a pricing strategy between a manufacturer's direct channel and traditional channel partner. Dumrongsiri et al. [11] analyzed a price-competition game between the manufacturer

and the retailer in a dual channel supply chain. Yao and Liu [27] and Cai [4] examined a game-theoretical model to determine the optimal direct channel price when the manufacturer competes with a traditional channel. Chiang et al. [8] studied a Stackelberg channel which the manufacturer becomes the leadership. It results in a higher price, lower sales volume and profits. Yoo and Lee[29] also used a game theoretic approach to study the impact of internet entry on manufacturer's distribution strategies. In this paper, the equilibrium pricing is carried out for different channel strategies under Stackelberg leader-follower game.

While inspired by the electronic commerce, revenue sharing has been applied in many industries like video rentals [3, 9, 20, 23] and mobile networks with independent content provides [13]. Under revenue-sharing contract, the manufacturer share a percentage of profit charges with retailer, when every sale was made. A review of the retailer-led game setting in revenue-sharing research has been performed [7, 14, 17, 18 , 25]. Yao et al., [28] presented a game-theoretical model based on the revenue-sharing contract for coordinating a supply chain comprising one manufacturer and two competing retailers. The internet content services with the revenue-sharing percentage model proposed by Chen et al., [7]. However, the aforementioned literature does not consider cross channel competition.

We consider the Stackelberg competition in the dual-channel structure, where the e-tailer (i.e., market leader) moves first and provides a revenue-sharing contract to the manufacturer who also sells its product through a traditional retailer. This study analyzes to the problem of dual-channel competition under four channel structures/strategies: (1) non-cooperative decentralization, (2) vertically integrated channel, (3) partially integrated channel, and (4) cooperative decentralization. Our analysis is under a price-dependent, linear demand function. We examine the impact of channel selection on the individual and system-wide profits. We do not consider the effects of word-of-mouth [12] or brand royalty [19] in our dual channel setting. And the real-world cases involving with the three strategies are given by Cai [4], Cai, Zhang, and Zhang [5], and Dumrongsiri et al. [11]. Therefore, we refer the interesting readers to these papers for further details.

Our analysis shows that non-cooperative decentralization generates higher prices for both channels and leads to a less system-wide profit. In contrast, the integrated strategy generates the lower prices and higher system-wide profit. Furthermore, the partially integrated strategy, in comparison with the non-cooperative decentralization, generates a lower e-tailing price and higher profit for the e-channel, while the cooperative decentralization generates a higher e-tailing price, lower revenue-sharing percentage.

The remainder of this paper is organized as follows. Section 2 describes the problem. Section 3 develops mathematical models to represent the four channel strategies. Section 4 carries out numerical study. Conclusion is given in Section 5.

2. PROBLEM DESCRIPTION

In this section, we describe the context of the problem and summarize notations. We analyze four channel structures/strategies that are graphically illustrated Figure 1. Strategy 1 represents a non-cooperative decentralization (i.e., the base case) where the manufacturer sells its product through a retailer and a third-party e-tailer, who compete each other in the market. We use a game-theoretical approach and the sequence of moves in the Stackelberg game: The e-tailer is the Stackelberg leader who provides a revenue-sharing percentage to the manufacturer. The manufacturer determines the wholesale w and e-tailing price pe. Finally, the retailer determines the retail price pr. Strategy 2 represents a centralized supply chain who simultaneously determines the retailer price and e-tailing price by maximizing the system-wide profit. In strategy 3, the manufacturer integrated the internet retailing into its operations and to compete with its physical channel through a retailer. The manufacturer can directly attract customers such as Dell is reaping the benefits of internet channel. In strategy 4, the manufacturer decides to cooperate with a third party e-tailer and sells its products in a dual-channel.
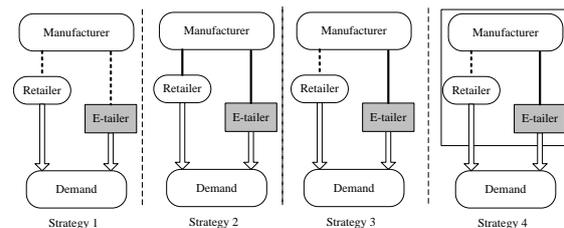

Figure 1: The supply chain configuration of strategy 1, 2, 3, and 4.

We consider the price competition with a linear demand function in the dual-channel supply chain where manufacturer sells product through e-tailer and traditional retailer distribution in parallel. The demand setup and assumptions are the same as those of Cai et al. [5] and Anderson and Bao [1] and Yao et al., [26] and Hua et al., [16]. We assume that the demand of each channel depends on its own product price and the price of the product through the other channel. Let $D_{i,r}$ and $D_{i,e}$ is the demand ($D_{i,r}$ is the retailer demand of the strategy i and $D_{i,e}$ is the e-tailer demand of the strategy i), which depends on

the prices. Specifically, the demand function is assumed to be:

$$D_{i,r} = \theta a - b_1 p_{i,r} + r(p_{i,e} - p_{i,r})$$
$$D_{i,e} = (1-\theta)a - b_2 p_{i,e} + r(p_{i,r} - p_{i,e}) .$$

where $a > 0$ is the scale parameter, which we refer to as a market base, and θ denotes the retailer's market size, and $(1-\theta)$ represents the e-tailer's market size, $0 < \theta < 1$, b_1 and b_2 are the coefficients of price sensitivity for the retail and the e-tailer, respectively. The parameter r is cross-price sensitivity that reflects the degree to which the product loyal customers of the two channels are differentiated. If the value of r is a smaller, the degree of product loyal customers differentiated between the dual-channel is the higher.

We analyze the profit models from the viewpoints of the retailer, e-tailer and manufacturer, respectively. We assume that the manufacturer has set the wholesale price and e-tailer price and the retailer decides the retailer price and cm incurs variable cost of producing its product. The traditional retailer and e-tailer have cost per unit, cr and ce, respectively. The retailer's profit function of the strategy i is

$$\pi_{i,r} = (p_{i,r} - w - c_r)D_{i,r} \qquad (1)$$

and the e-tailer's profit function of the strategy i is

$$\pi_{i,e} = (\phi p_{i,e} - c_e)D_{i,e} \qquad (2)$$

The manufacturer's profit of the strategy i is

$$\pi_{i,m} = (w - c_m)D_{i,r} + [(1-\phi)p_{i,e} - c_m]D_{i,e} \qquad (3)$$

where the manufacturer's revenue have two part which is the wholesale-price-only contract for the retailer and other is the revenue-sharing contract for the e-tailer. ϕ is an revenue-share percentage and $1-\phi$ goes to percentage of the manufacturer's revenue when each unit of the product sold.

Before presenting the mathematical models for the four decision-making strategies, we define the notations used throughout the paper.

a : Sale parameter of demand function, $a > 0$;

θ : The market share of the physical channel;

b_1: Price elasticity of demand function of the retailer;

b_2: Price elasticity of demand of the e-tailer;

r: Cross-price sensitivity;

c_r: Unit variable cost of the retailer;

c_e: Unit variable cost of the e-tailer;

c_m: Unit variable cost of the manufacturer;

ϕ_i : Revenue-sharing percentage;

$p_{i,r}$: The selling price in the retailer under strategy i ;

$p_{i,e}$: The price of the e-tailer under strategy i ;

w_i: The wholesale price under strategy i ;

$\pi_{i,r}$: Total retailer's profit under strategy i;

$\pi_{i,e}$: Total e-tailer's profit under strategy i;

$\pi_{i,m}$: Total manufacturer's profit under strategy i;

$\pi_{i,pc}$: Total profit generated by the physical channel;

$\pi_{i,ec}$: Total profit generated by the internet channel;

Π_i: Total system-wide profit.

3. THE MODEL

3.1 Strategy 1-non-cooperative Decentralization

In the decentralized model (strategy 1), the base case is the benchmark against which we will measure the impact of price competition in dual-channel system. We consider the Stackelberg competition, where the e-tailer (market leader) moves first and sets its revenue-sharing percentage, independent of any competing channel. The second channel acts as the market follower which the manufacturer makes its wholesale price and e-tailing price to maximize individual profit based on the retailer's decisions. Based on this, the retailer price is given by

$$p_{1,r}(w_1, p_{1,e}) = \frac{a\theta + rp_{1,e} + (b_1 + r)w_1 + (b_1 + r)c_r}{2(b_1 + r)} \qquad (4)$$

Substituting (4) into (3) and simplifying, we get the manufacturer's profit that objective is to maximize profit for a given e-tailer's revenue-sharing contract. The wholesale price and e-tailer price of the manufacturer w1 and p1,e is given by

$$p_{1,e}(\phi_1) = \frac{4c_m A + 4B - \phi_3(rD - 4B)}{8A(1-\phi_3) - \phi_3^2 r} \qquad (5)$$

and

$$w_1(\phi_1) = \frac{\begin{array}{c}4(b_1 + r)(A(c_m - c_r) + \alpha\theta b_2 + \alpha r) + \phi_3 r(2B - r(D + c_m b_1)) \\ + \phi_3(r^2 D - 6rB) - A(4D + 8c_m b_1 + 2rc_m))\end{array}}{(b_1 + r)(8A(1-\phi_3) - \phi_3^2 r)} \qquad (6)$$

where

$$A = b_1 b_2 + rb_1 + rb_2$$
$$B = b_1 \alpha + r\alpha - \alpha\theta b_1$$
$$D = \alpha\theta - rc_r - b_1 c_r - b_1 c_m$$

Proposition 1. Given revenue-sharing contract, there exist optimal profit of the manufacturer and is concave in wholesale price and e-tailer price.

Proof. Proof is provided in Appendix A

Proposition 2. The manufacturer's decision variable w_1 and $p_{1,e}$ decreases with decreasing and $p_{1,e}$ has a greater impact than w_1 on ϕ_1 , which is intuitively evident because increasing ϕ_1 may force the manufacturer increases e-tailing price in the internet channel.

Substituting (5) and (6) into (2) and simplifying terms, we get the e-tailer's profit. In this particular

case, it is difficult to find out the optimal revenue-sharing percentage explicitly. This result is that subject to the manufacturer's acceptance of the revenue-sharing contract. Likewise, a unique decision ϕ_1^* exists for the base model. In what follows, we present the optimal solutions of the e-tailer profit,

$$\pi_{1,e}^* = (\phi_1^* p_{1,e}^* - c_e)D_{1,e}^*)$$

We also find the profit of the manufacturer by

$$\pi_{1,m}^* = (w_1^* - c_m)D_{1,r}^* + [(1 - \phi_1^*)p_{1,e}^* - c_m]D_{1,e}^*$$

The retailer profit is given by

$$\pi_{1,r}^* = \frac{(\alpha\theta + rp_{1,e}^* - (b_1 + r)w_1^* - (b_1 + r)c_r)^2}{4(b_1 + r)}$$

We have the channel-wide optimal profit by

$$\Pi_1^* = \pi_{1,m}^* + \pi_{1,e}^* + \pi_{1,r}^* .$$

3.2. Strategy 2-vertically Integrated Channel

In this section, we analyze the optimal solution in the integrated system. If the channel is vertically integrated, optimal retailer price and e-tailing price should be chosen to maximize the system-wide profit. A single decision maker decides all relevant decision to maximize the joint profits. Let Π2 denote the profit of the integrated system,

$$\underset{p_{2,r}, p_{2,e}}{Max} \Pi_2 = \pi_{2,m} + \pi_{2,e} + \pi_{2,r} \qquad (7)$$

Substituting profit function (1), (2) and (3) into (7), the optimal price can be obtained by taking the first derivative of equation (7) with respect to p2,r, and p2,e. We have optimal prices ($p_{2,r}^*$, $p_{2,e}^*$) to maximize the system profit Π_2^* in a vertically integrated channel:

$$p_{2,r}^* = \frac{ar + (c_m + c_r)(b_1 b_2 + rb_1 + rb_2) + a\theta b_2}{2(b_1 b_2 + rb_1 + rb_2)}$$

$$p_{2,e}^* = \frac{ar + (c_m + c_e)(b_1 b_2 + rb_1 + rb_2) + a(1 - \theta)b_1}{2(b_1 b_2 + rb_1 + rb_2)}$$

Proposition 3. The strategy 2 profit Π_2^* is strictly jointly concave in $p_{2,r}^*$ and $p_{2,e}^*$.

Proof. Proof is provided in Appendix B

3.2. Strategy 3-partially Integrated Channel

Similar to the earlier case, we consider the partially integrated channel where the manufacturer integrated his internet channel to compete its retailer. Under the assumption strategy 3, the manufacturer becomes the leader and the retailer as the follower. In a Stackelberg game, the leader optimizes over the wholesale and e-tailing price based on the retailer's best response price function. The partially integrated channel profit is the sum of equations (1) and (2), the

objective of the strategy 3 is to derive the optimal decision variables to maximize the overall profit as shown below:

$$\underset{w_3, p_{3,e}}{Max} \pi_{3,m} + \pi_{3,e} = (w_3 - c_m)D_{3,r} + (p_{3,e} - c_m - c_e)D_{3,e}$$

The optimal wholesale price and the e-tailing price solves,

$$p_{3,e}^* = \frac{ar + (c_m + c_e)(b_1 b_2 + rb_1 + rb_2) + a(1 - \theta)b_1}{2(b_1 b_2 + rb_1 + rb_2)}$$

$$w_3^* = \frac{a + (c_m - c_r)(b_1 b_2 + rb_1 + rb_2) + a\theta b_2}{2(b_1 b_2 + rb_1 + rb_2)}$$

Proposition 4. The partially integrated channel profit is strictly concave in w_2^* and $p_{3,e}^*$.

Proof. Proof is provided in Appendix C.

Proposition 5. The optimal decisions generated by the strategy 2 and 3 persist in the following sequence: $p_{3,r}^* > p_{2,r}^* > p_{2,e}^* = p_{3,e}^*$ and $D_{3,r}^* < D_{2,r}^* < D_{2,e}^* < D_{3,e}^*$ and strategy 2 profit is higher than overall profit in the strategy 3, $\Pi_2^* > \Pi_3^*$.

Our equilibrium solution shows that the retailer prices always are higher than e-tailing price. We compare the channel-wide profit under different market structures. Our equilibrium solution shows that the channel-wide profit under the strategy 2 always is higher than the strategy 3.

3.4. Strategy 4-cooperative Decentralization

In contrast to the non-cooperative, the cooperative decentralization strategy determines the total system profit is maximized for all entities involved in the supply chain. In this strategy, individual profit is determined separately by the channel members. Let $\Pi_4(\phi_4)$ denote the joint total profit of strategy 4, i.e., the sum of all profits of channel partners for the cooperative strategy in the supply chain:

$$\Pi_4(\phi_4) = \pi_{4,m}(\phi_4) + \pi_{4,e}(\phi_4) + \pi_{4,r}(\phi_4) \qquad (8)$$

We first differentiate (8) with respect to ϕ_4 , and let the results be zero. We find the equilibrium revenue-sharing fraction by using numerical methods. The objective of the channel-wide decision is to determine the optimal values of ϕ_4^* such that the profit function Π_4^* is maximized. Substituting the equilibrium revenue-sharing fraction into (1), (2), (3), we get the equilibrium prices $\pi_{4,m}^*$, $\pi_{4,e}^*$, $\pi_{4,r}^*$ for the three players.

4. NUMERICAL STUDY

The four strategies incorporated with several numerical studies were conducted to uncover qualitative insights on price competition, with an emphasis on investigating how optimal revenue-sharing contract influence channel performance. We also examine the effect of the strategy on the channel-wide, the internet channel profit with respect to major parameters and how to choice the channel strategy for the manufacture.

4.1 The Base Case

In the underlying base case, we assume the values of major parameters as follows: the demand parameters a=20 and θ=0.5, let b=b1=b2=1 is the product of underlying market share, denoting consumer's price sensitivity, r=1, denoting the competing power, the cost parameters cm=2.5, cr =1 and ce =0.5. The numerical resulting for various channel structures summarized in Table 1. The results revealed that strategy 2 produces the highest channel efficiency at 22.875 and strategy 1 is the lowest at 21.038. The inefficiency is due to the decision bias by receiving a lower revenue-sharing percentage (ϕ_1=0.437) by the e-tailer and choosing a higher e-tailing price ($p_{1,e}^*$=7.504). If the strategy 4 is employed, such decision bias can be rectified significantly (ϕ_4^*=0.249 and $p_{4,e}^*$=6.734) which leads to a much higher channel-wide profit from 21.038 to 22.046. It also suggests that the channel-wide profit for strategy 3 was always smaller that that for strategy 4 which in turn was smaller than that for strategy 2. Furthermore, the profit of an internet channel profit under the strategy 3 is higher than under the strategy 4. It is obvious that the manufacturer would prefer integrate the internet retailing into its operations to its direct market.

Table 1(a). Decisions of the base case

Str.	ϕ_i	w_i	$p_{i,r}$	$p_{i,e}$
1	0.437	5.557	7.655	7.504
2			6.75	6.5
3		5.75	7.5	6.5
4	0.249	5.59	7.484	6.734

Table 1(b). Profits of the base case

Str.	$\pi_{i,m}$	$\pi_{i,e}$	$\pi_{i,r}$	$\pi_{i,pc}$	$\pi_{i,ec}$	Π_i
1	11.275	7.355	2.409	9.119	11.919	21.038
2				9.750	13.125	22.875
3	20.625		1.125	6.000	15.750	21.75
4	15.748	4.685	1.613	7.155	14.891	22.046

4.2 Sensitivity Analysis

In this section we report the observations obtained from the numerical experiments to examine the relationships between the revenue-sharing contract, e-tailing price, channel-wide and internet channel profit in the strategy 1, and compare the channel efficiencies with respect to major parameters such as the demand parameters. The results of them are summarized, where b $\in$ [0.5, 1.5], r $\in$ [0.5, 1.5], cr $\in$ [0.5, 1.5] and ce $\in$ [0, 1] in the Table 2. We observed that the channel-wide profit increases, revenue-sharing percentage decreases, e-tailing price decreases when the price elasticity or the degree of product difference increases. Furthermore, table 2 shows that the internet channel profit can be better (worse), when the price elasticity is small (larger) for the given example with r=0.5.

Table 2(a). Optimal solution of revenue-sharing contract generated by strategy 1

Strategy 1					
b	r	ϕ_1	w_i	$p_{i,r}$	$p_{i,e}$
0.5	0.5	0.531	10.171	14.020	13.741
	1.0	0.444	10.148	13.340	13.299
	1.5	0.386	10.179	12.964	12.997
1.0	0.5	0.483	5.600	7.908	7.647
	1.0	0.437	5.560	7.655	7.504
	1.5	0.404	5.540	7.491	7.400
1.5	0.5	0.408	4.033	5.705	5.507
	1.0	0.383	4.011	5.595	5.446
	1.5	0.364	3.999	5.516	5.397

Table 2(b). Optimal profit of revenue-sharing contract generated by strategy 1

Strategy 1			
b	$\pi_{i,pc}$	$\pi_{i,ec}$	Π_i
0.5	29.979	35.119	65.10
	32.360	34.933	67.29
	33.774	34.497	68.27
1.0	8.647	11.541	20.19
	9.119	11.919	21.04
	9.462	12.051	21.51
1.5	2.962	4.611	7.57
	3.056	4.844	7.90
	3.123	4.990	8.12

Figure 2 depicts the internet channel profit improvement versus the four parameters under different strategies. We compare the internet channel profit improvement for the strategy 1 and 3 is better than others. The comparison of internet channel profit between strategy 1 and 3 as following: the percentages of profit improvement are from 40.93% to 29.62% as b increases; from 33.67% to 31.15% as ce increases and from 33.54% to 31.07% as cr increases; the percentages of profit improvement increase from 24.02% to 37.6% as r increases. For the manufacturer decision, the benefit of strategy 3 is higher than strategy 4, especially when the degree of product difference is large. If the manufacturer cooperated with third party, the manufacturer will obtain lower profit than integrated his internet channel, although channel-wide performance, as a whole, is worse.

4.3 Effect of Demand Parameters

Consider now the relationship between channel strategy and demand size, the major findings were the demand size increased in the strategy 4, along with its growing professionalism, and that the third party were more active in the dual-channel competition. We observed the demand under the strategy 3(D3,e) is higher than the strategy 4(D4,e). We assume effect of demand change between the strategy 3 and 4, D4,e= ΔD3,e, D4,e increases as Δ increases. If Δ exceeds 0.93, the internet channel profit under the strategy 3 will smaller than that of strategy 4. Therefore, it is importance for decision makers to understand how effect of internet channel profit with demand change so that they can make better-informed decisions. First, the third parties such as e-Bay, Yahoo! have a powerful new tool to interact with their consumers through Web advertising and provide product information and online help. At the end of third quarter 2009, there are more than 89.2 million active users on eBay. At the second quarter 2011, eBay have more than 100.3 million active registered accounts and the marketplace generating 11.3 to 11.6 billion net revenues full year 2010. For example, eBay has a great potential of market for selling products Second, IT-based firms also have good customer royalty. Amazon.com can effectively promote and sell their products to their customer easier than a retailer store [10].
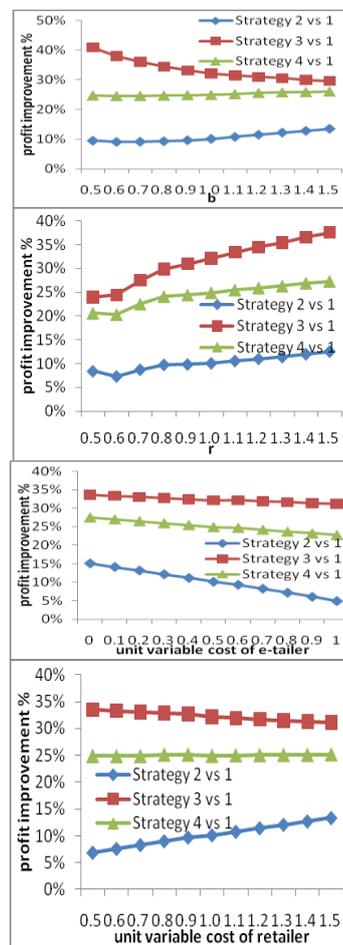

Figure 2: Profit improvement of e-channel: strategies 2, 3, and 4 versus strategy 1.

5. CONCLUSION

In this paper we analyze channel strategy and a price competition in dual-channel. We proposed four channel structures to determine optimal pricing strategies in a dual-channel. Under the strategy 1, we consider the powerful e-tailer as the Stackelberg leader, offered revenue-sharing contract for the manufacturer and examine the effect of revenue-sharing contract of channel-wide profit on supply chain and internet channel performance. Furthermore, this paper investigated how to choice the channel strategies for the manufacture in the dual-channel supply chain.

Our analysis showed that a substantial contribution to the research of revenue-sharing contract, channel strategy and pricing in a dual-channel supply chain with competition. First, the result revealed that channel-wide profit under the strategy 1 is inefficient when the e-tailer entered and offered revenue-sharing contract to the manufacturer. It can be shown that revenue-sharing contract has a negative impact on demand parameters, especially the price elasticity or the degree of product difference increases. The internet channel profit can be better when the degree of product difference and the price elasticity both are small. Second, the channel-wide profit for strategy 3 is always smaller than that for strategy 4. Both strategies 3 and 4 are smaller than 2. Third, we observed internet channel profit improvement under the strategy 3 is higher than the strategy 4. It is obvious that the manufacturer will obtain higher profit when he integrated the internet retailing into its operations, although channel-wide performance, as a whole, is worse.

Future extensions of this approach can offer further insights for this research stream. For example, uncertain demand can be considered by allowing the demand function to be driven by probability. We assumed that the e-tailer is more powerful than the others. If the e-tailer and retailer are equally powerful, we may develop a model that captures different game across various types of channels for a future research.

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APPENDIX

Appendix A.

  Taking the second-order partial derivatives of $\pi_{1,m}$ with respect to w_1, and $p_{1,e}$. We have the Hessian matrix.

$$H = \begin{bmatrix} \dfrac{\partial^2 \pi_{1,m}}{\partial w_1^2} & \dfrac{\partial^2 \pi_{1,m}}{\partial w_1 \partial p_{1,e}} \\ \dfrac{\partial^2 \pi_{1,m}}{\partial p_{1,e} \partial w_1} & \dfrac{\partial^2 \pi_{1,m}}{\partial p_{1,e}^2} \end{bmatrix} = \begin{bmatrix} -b_1 - r & -\dfrac{b_1 r}{2(b_1+r)} + r(1 - \dfrac{r}{2(b_1+r)}) + \dfrac{(1-\phi)r}{2} \\ -\dfrac{b_1 r}{2(b_1+r)} + r(1 - \dfrac{r}{2(b_1+r)}) + \dfrac{(1-\phi)r}{2} & 2(1-\phi)(-2b_2 + 2r(\dfrac{r}{2(b_1+r)} - 1)) \end{bmatrix}$$

  Since $\dfrac{\partial^2 \pi_{3,m}}{\partial w_3^2} = -b_1 - r < 0$, $\dfrac{\partial^2 \pi_{3,m}}{\partial p_{3,e}^2} = 2(1-\phi)(-2b_2 + 2r(\dfrac{r}{2(b_1+r)} - 1)) < 0$ and

  $|H| = 2(1-\phi)(b_1 b_2 + b_1 r + b_2 r) - \dfrac{\phi^2 r^2}{4} > 0$, $\pi_{1,m}$ is strictly jointly concave in w_1, and $p_{1,e}$.

Appendix B.

  Taking the second-order partial derivatives of Π_2 with respect to $p_{2,r}$, and $p_{2,e}$. We have the Hessian matrix.

$$H = \begin{bmatrix} \dfrac{\partial^2 \Pi_2}{\partial p_{2,r}^2} & \dfrac{\partial^2 \Pi_2}{\partial p_{2,r} \partial p_{2,e}} \\ \dfrac{\partial^2 \Pi_2}{\partial p_{2,e} \partial p_{2,r}} & \dfrac{\partial^2 \Pi_2}{\partial p_{2,e}^2} \end{bmatrix} = \begin{bmatrix} -2b_1 - 2r & 2r \\ 2r & -2b_2 - 2r \end{bmatrix}$$

Since $\dfrac{\partial^2 \Pi_2}{\partial p_{2,r}^2} = -2b_1 - 2r < 0$, $\dfrac{\partial^2 \Pi_2}{\partial p_{2,e}^2} = -2b_2 - 2r < 0$ and

  $|H| = 4(b_1 b_2 + b_1 r + b_2 r) > 0$, Π_2 is strictly jointly concave in $p_{2,r}$, and $p_{2,e}$.

Appendix C

  Taking the second-order partial derivatives, we have the Hessian matrix.

$$H = \begin{bmatrix} \dfrac{\partial^2 \pi_{3,m}}{\partial w_3^2} & \dfrac{\partial^2 \pi_{3,m}}{\partial w_3 \partial p_{3,e}} \\ \dfrac{\partial^2 \pi_{3,m}}{\partial p_{3,e} \partial w_3} & \dfrac{\partial^2 \pi_{3,m}}{\partial p_{3,e}^2} \end{bmatrix} = \begin{bmatrix} -b_1 - r & -\dfrac{b_1 r}{2(b_1+r)} + r(1 - \dfrac{r}{2(b_1+r)}) + \dfrac{r}{2} \\ -\dfrac{b_1 r}{2(b_1+r)} + r(1 - \dfrac{r}{2(b_1+r)}) + \dfrac{r}{2} & -2b_2 + 2r(\dfrac{r}{2(b_1+r)} - 1) \end{bmatrix}$$

Since $\dfrac{\partial^2 \pi_{3,m}}{\partial w_3^2} = -b_1 - r < 0$, $\dfrac{\partial^2 \pi_{3,m}}{\partial p_{3,e}^2} = -2b_2 + 2r(\dfrac{r}{2(b_1+r)} - 1) < 0$ and

$|H| = 2(b_1 b_2 + b_1 r + b_2 r) > 0$, $\pi_{3,m}$ is strictly jointly concave in w_3, and $p_{3,e}$.

競爭雙通路之策略與定價

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摘要

本研究處理通路策略之選項及定價對於製造商、零售商及供應鏈之利潤影響。本研究考慮一個製造商經由兩個競爭通路銷售單一產品：實體通路與虛擬通路，同時假設製造商使用兩種常用合約：批發價合約與營收分享合約，在此一設定下共產生四種組合的策略，本研究發展數學模式來分析相關決策：決定採用的通路形式與定價策略。數值分析結果顯示，整合通路策略產生較低的定價與較高的網路通路利潤，而合作的分散策略產生較高的定價、較低的營收分享比率及較高的全通路利潤。
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