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COMPETITION STRATEGY OF RETAILERS IN DUAL-CHANNEL BASED ON THE HOTELLING MODEL

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Abstract. *In order to analyze the decisions of independent retailers in different channels, an improved hotelling model based on considering customers' channel psychological preferences is built. With different product categories, network externalities and transaction costs, an analysis is made for online and offline retailers in game equilibrium prices, market shares and profits. The result shows that product category plays a significant role for channel choice and business decisions, and the product with higher economic and experience value is more suitable for traditional channel. Due to the network externalities, a better market share does not translate into higher profits, consumers rather than retailers benefit from increasing network externalities. Channel with higher transaction cost will get smaller market share, so the retailers should adopt a lower game equilibrium price to attract more attention.*
Keywords: Dual-channel supply chain, Hotelling model, Competition strategy

1. **Introduction.** As consumer access to the Internet continues to grow, and in China online consumers in 2015 reaching ¥4.1 billion, it is becoming increasingly apparent to retailers that they cannot ignore the importance of selling products online. Shopping experience in different channels has different benefits, so customers are more and more used to buying the most appropriate product from different channels. How to solve the conflict and competition between network and traditional channels has been a hot problem in the study on dual channel supply chain.

Now, the study of dual channel retailers focuses mainly on the price competition and channel decisions. In [1], Balasubramanian discussed the strategic analysis of competition between direct marketers and conventional retailers; Friberg et al. [2] examined the relation between prices in conventional stores and on the Internet, and the main result is that retailers who only sell through Internet have lower on-line prices than retailers who also sell through conventional stores; Pan et al. [3] developed a game theoretic model of price competition between a pure play e-retailer and a bricks-and-clicks e-retailer, and they showed that in general the pure play e-retailer has a lower equilibrium price; Viswanathan [4] developed a stylized spatial differentiation model to examine the impact differences in channel-flexibility, network externalities and switching costs on competition between online, traditional and hybrid firms; Huang and Swaminathan [5] studied four prevalent pricing strategies which differ in the degree of autonomy for the Internet channel; Elie et al. [6] demonstrated that when differentiation among competing retailers is not too high, having an online channel can actually increase investment in store assistance levels and decrease profits; Zhang et al. [7] discussed retailers' dual channel strategies with price and service competition, and the result showed that when the differentiation among the competing retailers is not too high, having an online channel can increase service level and decrease profits; Gu et al. [8] analyzed the influence of the applicability of product in

online channel, and the result showed that with the increase of the applicability of product in online channel, difference of game equilibrium price and market share will decrease and the profits of offline retailer will decrease too; meanwhile the profits of online retailer will increase.

There is a growing body of research that studies competition between online and offline retailers. It is widely recognized that product category [9] and channel characteristics [10-12] such as quality of service, channels convenience, channel risk, and transaction costs play a significant role for channel decisions. Now in the 'new economy', as Viswanathan [4] and Gu et al. [8] note, other salient features such as network externalities, switching costs and the applicability of product in online channel are also crucial for the strategic analysis in e-markets. In this paper, we discussed the influence of product category, network externalities and transaction costs for dual channel retailers on game equilibrium prices, market shares and profits. The rest of the study is organized as follows. Section 2 elucidates the key technology-driven channel parameters and describes the basic analytical model of competition. Section 3 builds on the basic model in Section 2 to analyze the impact of differential parameters on the equilibrium outcomes in the two channels. The problem is formulated in Section 4. And we conclude the management inspiration and the prospects of the future research in Section 5.

2. **The Basic Model.** According to the approach of Hotelling, using the customers' channel psychological preferences instead of spatial location difference, we assume that customers are uniformly distributed on the interval $[0, 1]$, in which the end 0 means the customers only purchase products from traditional channel, and the end 1 means the customers only purchase products from network channel. Suppose customer demands are a unit linear market, and there is only one kind of product in the market, the cost of production is negligible to 0. Furthermore, for simplicity, we assume that only one traditional retailer and one pure network retailer compete in this market, they both seek to maximize their own profits. We give the parameters and assumptions as follows:

U is the value evaluation for the product, which is a relative value and high enough to guarantee that each consumer will buy one and just one unit from one channel;

The coefficient of experience effects in traditional channel is denoted by η_t $(0 < \eta_t < 1)$, which is linear with U;

The coefficient of network externalities in network channel is denoted by μ_e $(0 < \mu_e < 1)$, which is linear with the equilibrium market shares of network channel;

The coefficient of transaction costs in traditional channel is denoted by C_t $(0 < C_t < 1)$, which is related to transportation costs, time costs, opportunity costs and other factors $(C_t > \eta_t)$;

The coefficient of transaction costs in network channel is denoted by C_e $(0 < C_e < 1)$, which is related to the delivery logistics costs, information search costs and other factors $(C_e > \mu_e)$;

P_t is the price purchasing from traditional retailer, and P_e is the price purchasing from network retailer.

Suppose manufacturer and retailers in different channels are independent, manufacturer gives each retailer the same product wholesale price, which is denoted by W. Then the total utility purchasing from traditional channel retailers is: $U_t = U + \eta_t U - P_t - C_t X$, and from network channel retailers is $U_e = U + \mu_e(1 - X) - P_e - C_e(1 - X)$. Consumers choose the channel which offers the higher utility. When $U_t = U_e$, consumer's utility for purchasing from the dual channels is equal, that is $U + \eta_t U - P_t - C_t X = U + \mu_e(1 - X) - P_e - C_e(1 - X)$. As the result of the above equation for X, we get the market shares expressions for retailers as follows:

$$X = \frac{P_e + C_e - P_t - \mu_e + \eta_t U}{C_t + C_e - \mu_e} \tag{1}$$

Therefore, in the interval $[0, X]$ customers will purchase products from traditional channels, and in the interval $[X, 1]$ customers will purchase from network channels, in the point X customers may purchase from anyone. So the market shares for traditional channel retailers is $X_t = \frac{P_e+C_e-P_t-\mu_e+\eta_t U}{C_t+C_e-\mu_e}$, and the market shares for network channel retailers is $X_e = 1 - X_t = \frac{P_t+C_t-P_e-\eta_t U}{C_t+C_e-\mu_e}$.

3. **Game Analysis.** The hypothesis is that the supply chain members are independent, then we get the profit function for traditional retailers is $\prod_t = (P_t - W)X$, the profit function for network retailers is $\prod_e = (P_e - W)(1 - X)$, and the profit function for manufacturer is $\prod_m = W$, so the Nash equilibrium profits exist where (2) is satisfied:

$$\begin{cases} \dfrac{\partial \prod_t}{\partial P_t} = \dfrac{W + P_e + C_e - 2P_t - \mu_e + \eta_t U}{C_t + C_e - \mu_e} = 0 \\ \dfrac{\partial \prod_e}{\partial P_e} = \dfrac{W + P_t + C_t - 2P_e - \eta_t U}{C_t + C_e - \mu_e} = 0 \end{cases} \tag{2}$$

From Equation (2), we get the equilibrium prices for dual channel retailers as follows:

$$P_t^* = W + \frac{C_t + 2C_e - 2\mu_e + \eta_t U}{3} \tag{3}$$

$$P_e^* = W + \frac{C_e + 2C_t - \mu_e - \eta_t U}{3} \tag{4}$$

Plugging (3) and (4) into Equation (1), we get the equilibrium market shares for dual channel retailers as follows:

$$X_t^* = \frac{C_t + 2C_e - 2\mu_e + \eta_t U}{3(C_t + C_e - \mu_e)} \tag{5}$$

$$X_e^* = \frac{C_e + 2C_t - \mu_e - \eta_t U}{3(C_t + C_e - \mu_e)} \tag{6}$$

Thus, in a Nash simultaneous decision game equilibrium, the profit functions of the dual channel retailers are:

$$\prod_t^* = \frac{(C_t + 2C_e - 2\mu_e + \eta_t U)^2}{9(C_t + C_e - \mu_e)} \tag{7}$$

$$\prod_e^* = \frac{(C_e + 2C_t - \mu_e - \eta_t U)^2}{9(C_t + C_e - \mu_e)} \tag{8}$$

Proposition 3.1. *With the increase of the value evaluation of the product, the game equilibrium price market shares and profits for traditional retailers will increase, just the opposite for network retailers.*

Proof: For $0 < \eta_t < 1$, according to Equations (3) and (4), we get $\frac{\partial P_t^*}{\partial U} = \frac{\eta_t}{3} > 0$ and $\frac{\partial P_e^*}{\partial U} = -\frac{\eta_t}{3} < 0$, it shows that with the increase of value evaluation of the product, the game equilibrium price for traditional retailers will increase, and the game equilibrium price for network retailers will decrease. In the same way, for $C_e > \mu_e$, $C_t + C_e - \mu_e > 0$, according to Equations (5) and (6), we get $\frac{\partial X_t^*}{\partial U} = \frac{\eta_t}{3(C_t+C_e-\mu_e)} > 0$ and $\frac{\partial X_e^*}{\partial U} = -\frac{\eta_t}{3(C_t+C_e-\mu_e)} < 0$, it shows that with the increase of value evaluation of the product, the game equilibrium market shares for traditional retailers will increase, and the game equilibrium market shares for network retailers will decrease. For (5) and (6), we get $C_t + 2C_e - 2\mu_e + \eta_t U > 0$ and $C_e + 2C_t - \mu_e - \eta_t U > 0$, according to Equations (7) and (8), we get $\frac{\partial \pi_t^*}{\partial U} = \frac{2\eta_t(C_t+2C_e-2\mu_e+\eta_t U)}{9(C_t+C_e-\mu_e)} > 0$, $\frac{\partial \pi_e^*}{\partial U} = -\frac{2\eta_t(C_e+2C_t-\mu_e-\eta_t U)}{9(C_t+C_e-\mu_e)} < 0$, it shows that with the increase of value evaluation of the product, the game equilibrium profits for traditional retailers will increase, and the game equilibrium profits for network retailers will decrease.

Proposition 3.2. *With the increase of the experience effects of the product, the game equilibrium price market shares and profits for traditional retailers will increase, just the opposite for network retailers.*

Proof: Similar to Proposition 3.1.

Proposition 3.1 and Proposition 3.2 showed that product category plays a significant role for channel choice and business decisions. It reflects the reality that the product with high economic value or when consumers need to "touch and feel" the product in order to determine how well it is their tastes and needs, they usually choose the traditional channel for security and reliable, such as fashion apparel, jewelry, sporting goods, and artwork. This reality also indicated that traditional retailers have powerful competitiveness for selling high economic and high experience value product, so the traditional retail enterprises must enhance the level of its service and customer experience to cope with the strong impact of electronic commerce.

Proposition 3.3. *With the increase of the network externalities, the game equilibrium price and profits for both dual channel retailers will decrease.*

Proof: According to Equations (3) and (4), we get $\frac{\partial P_t^*}{\partial \mu_e} = -\frac{2}{3} < 0$, $\frac{\partial P_e^*}{\partial \mu_e} = -\frac{1}{3} < 0$, and it shows that with the increase of the network externalities, the game equilibrium price for traditional channel retailers will decrease. When $\eta_t U > C_t$, according to Equations (5) and (6), we get $\frac{\partial X_t^*}{\partial \mu_e} = \frac{\eta_t U - C_t}{3(C_t + C_e - \mu_e)^2} > 0$, $\frac{\partial X_e^*}{\partial \mu_e} = -\frac{\eta_t U - C_t}{3(C_t + C_e - \mu_e)^2} < 0$, it shows that with the increase of the network externalities, the game equilibrium market shares for traditional channel retailers will increase, and the game equilibrium market shares for network channel retailers will decrease, just the opposite for $\eta_t U < C_t$. In the same way, for $C_e > \mu_e$ and Equations (5) and (6), $C_t + 2C_e - 2\mu_e + \eta_t U > 0$, $2C_t + 2C_e - \mu_e > 0$, $C_e + 2C_t - \mu_e - \eta_t U > 0$, $C_e - \mu_e + \eta_t U > 0$, so according to Equations (7) and (8), we get $\frac{\partial \pi_t^*}{\partial \mu_e} = -\frac{2(C_t + 2C_e - 2\mu_e + \eta_t U)(2C_t + 2C_e - \mu_e)}{9(C_t + C_e - \mu_e)^2} < 0$, $\frac{\partial \pi_e^*}{\partial \mu_e} = -\frac{(2C_t + C_e - \mu_e - \eta_t U)(C_e - \mu_e + \eta_t U)}{9(C_t + C_e - \mu_e)^2} < 0$, and it shows that with the increase of the network externalities, the game equilibrium market shares for dual channel retailers will decrease.

Proposition 3.3 illustrates the influence of the network externalities on the game equilibrium price and profits. It reflects the reality that the network externalities enhance the channel price competition, so with the increase of the network externalities, the game equilibrium price and profits for both dual channel retailers will decrease. Contrary to the conventional wisdom of the winning, we find that in a static market, a better market share does not translate into higher profits, consumers rather than retailers benefit from increasing network externalities. It told us that in the network economic age, as a result of network externalities and bandwagon effect, network retailers should pay more attention to the alternative revenues streams.

Proposition 3.4. *The game equilibrium price difference, market shares difference and profits difference are influenced by different transaction costs, and the channel with higher transaction cost will get lower game equilibrium price, market shares and profits.*

Proof: According to Equations (3)-(8), we get the equilibrium price difference, the equilibrium market shares difference, and the equilibrium profits difference as follows: $\Delta P^* = P_t^* - P_e^* = \frac{C_e - C_t - \mu_e + 2\eta_t U}{3}$, $\Delta X^* = X_t^* - X_e^* = \frac{C_e - C_t - \mu_e + 2\eta_t U}{3(C_t + C_e - \mu_e)}$, $\Delta \pi^* = \pi_t^* - \pi_e^* = \frac{C_e - C_t - \mu_e + 2\eta_t U}{3}$. When $\mu_e - 2\eta_t U$ is a fixed number, the game equilibrium price difference, market shares difference and profits difference will be influenced by the transaction costs difference. Especially, if $\mu_e = 2\eta_t U$, when transaction costs in traditional channel are higher than network channel, the game equilibrium price, market shares and profits in traditional channel are lower. In the same way, when transaction costs in network channel are higher than traditional channel, the game equilibrium price, market shares and profits

in traditional network are lower. When two equal channel cost, there is no difference in game equilibrium price, market shares and profits.

Proposition 3.4 illustrates that if the product category and network externalities are given, the difference of game equilibrium price, market shares and profits depend on the difference of transaction costs, the channel with higher transaction costs will get lower market share, so the retailers should adopt a lower game equilibrium price to attract more customers.

4. **Numerical Example.** To examine if the analytic results hold, we perform an empirical analysis of parameters at an online and offline retailers. Using the settings $W = 0$, $C_t = 0.6$, $C_e = 0.5$, $\eta_t = 0.4$, and $\mu_e = 0.2$, we get the range of U $(0 < U \leq 3.75)$. Figure 1 presents the tendency of the parameters increase with U.

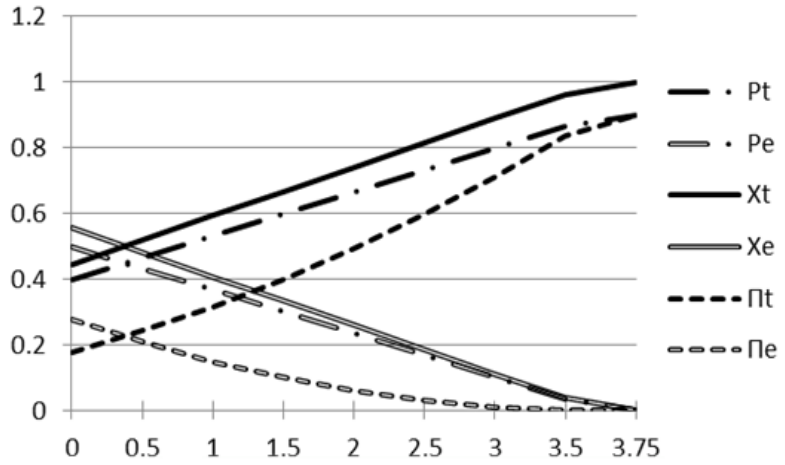

FIGURE 1. Sensitivity analysis of value evaluation for dual retailers

Using the settings $W = 0$, $C_t = 0.6$, $C_e = 0.5$, $\mu_e = 0.2$ and $U = 1$, Figure 2 presents the tendency of the parameters increase with η_t $(0 < \eta_t < 1)$.

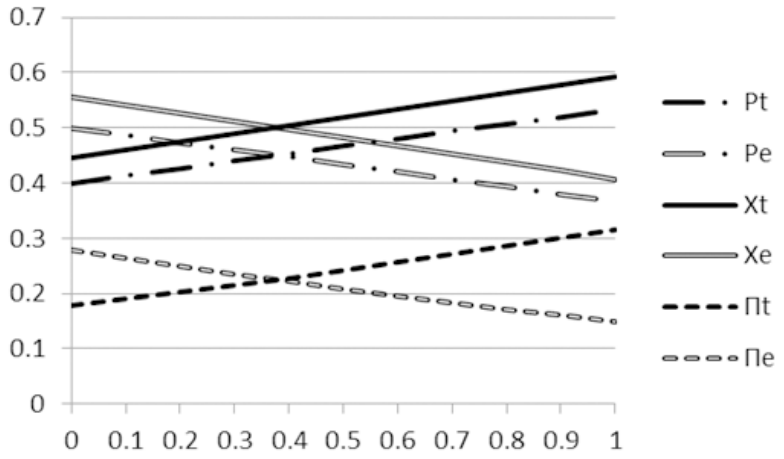

FIGURE 2. Sensitivity analysis of experience effects for dual retailers

Using the settings $W = 0$, $C_t = 0.6$, $C_e = 0.5$, and respectively suppose $\eta_t * U = 0.7$ $(\eta_t U > C_t)$ and $\eta_t * U = 0.4$ $(\eta_t U < C_t)$, the impacts of varying the unit network externalities on the equilibrium price market shares and profits are shown in Figure 3 and Figure 4.

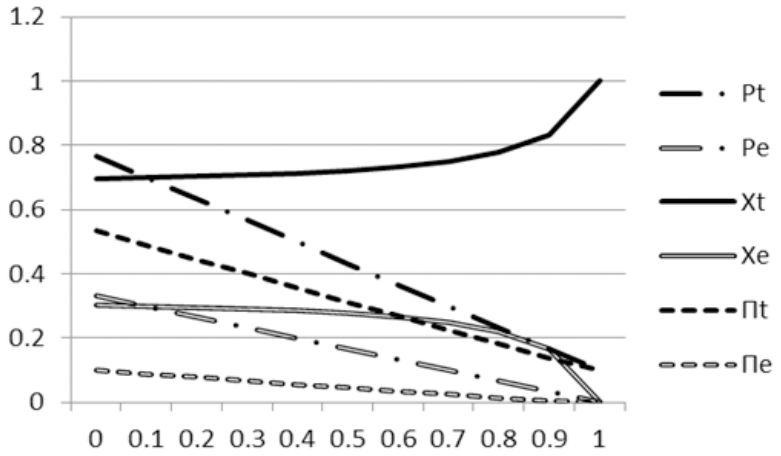

FIGURE 3. Sensitivity analysis of network externalities for dual retailers $(\eta_t * U > C)$

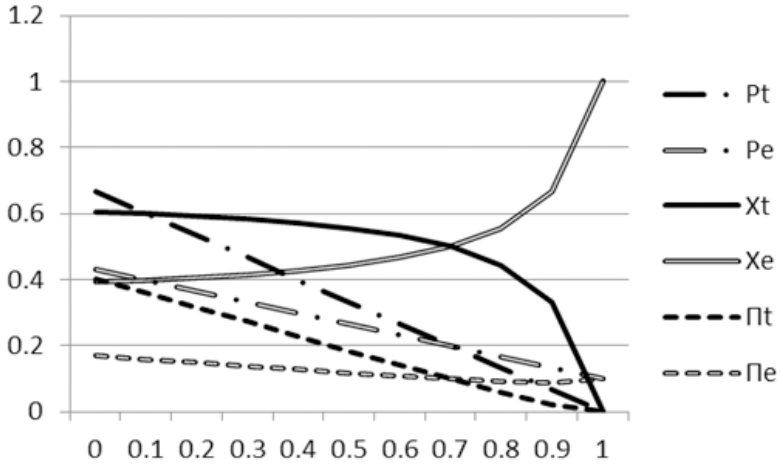

FIGURE 4. Sensitivity analysis of network externalities for dual retailers $(\eta_t * U < C)$

5. **Conclusions.** In this paper, we mainly make an analysis for dual-channel retailers in game equilibrium prices, market shares and profits, and it gives us some managerial implications. Firstly, product with higher economic and experience value is more suitable for traditional channel, so traditional retailers have powerful competitiveness for selling high economic and experience effects product, and they should enhance the level of its service and customer experience to cope with the strong impact of electronic commerce. Secondly, network externalities enhanced the channel competition, and consumers rather than retailers benefit from increasing network externalities. Contrary to the conventional wisdom of the winning, a better market share does not translate into higher profits, and network retailers should devote much attention to the alternative revenues streams. Furthermore, when other factors are fixed, channel with higher transaction cost will get smaller market share, so the retailers should adopt a lower game equilibrium price to attract more attention.

As for the future research direction, first this study does not consider hybrid firms, which is widespread under e-commerce environment. Second, we only consider the influence of product categories, network externalities and transaction costs of the retailers, and with the development of the real life, we should incorporate new factors into the model. Third, the formulation for line city could be extended for real urban scenarios.

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