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Quality-Contingent Pricing Decisions for Network Marketing Firms with Quality-Sensitive Demand

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Abstract: This study aiming at maximize the expected return per unit of time, to build a network marketing firm quality related pricing model, based on the definition of the market and the quality estimated probability of corporate distribution. According to the assumption of quality-sensitive demand, the study right the optimal model from two angles.

Key words: Quality-contingent pricing, quality-sensitive, network marketing, decision model

INTRODUCTION

In the transaction of electronic markets, the parties can bargain over long distances and know the quality of goods only after the contact while buyers must decide whether to buy it or not before they can know the quality of goods (Moorthy and Srinivasan, 1995; Li *et al*., 2004). Such information asymmetry between the parties of the transaction makes quality uncertainty pervasive. In addition,sellers provide many services associated with the transactions by a distribution network and the quality of service will be subjected to the third party service providers. Thus, the randomness in the transaction process will cause uncertainty of quality in electronic markets. It may lead to market failure in extreme cases (Akerlof, 1970). So it is an urgent problem that how signaling can reduce the quality uncertainty so as to increase the market demand.

The difference between the actual quality and quality promised by single fixed price may reduce consumers' satisfaction, so some companies provide offer associated with some level of quality and pay a certain discounts when the merchandise does not reach this level of quality. the pricing method was defined as quality-contingent pricing which provides a guarantee for the level of quality promised by sellers. For example, in the electronic store of Domino's Pizza, the delivery time is an important factor affecting the quality of Pizza, so the firm promise Pizza would be sent in 30 minutes after the customer's order in the same city, or the customer would have a 100% discount. Quality-contingent offer provided better reveals the information of quality of goods and reduce the uncertainty perceived by the quality of buyers (Song, 2004).

In fact, the quality of goods can usually be described from multiple dimensions. Here, we focus on an objective quantitative detection of quality dimensions and assume the minor uncertain interval between the firm and customers in the dimension. We discuss its optimality and analyze quality-contingent pricing strategy under the evaluation difference situation, as well as the effect of the cost of goods and the market demand rate on the optimal pricing strategy.

MODEL DESCRIPTIONS

Before describing quality-contingent pricing model, we first make the following assumptions:

- All the consumers have the same quality estimation distribution G(q)
- Network marketing companies have accurate information on quality estimation distribution F(q)
- Consumers are risk-neutral that is, consumers are quality-sensitive

To simplify the research of the problem, we only discuss:In the normalized interval [0,1], the market guarantees the quality level Q($Q\in[0, 1]$) and it is divided into two parts[0,Q]and [Q,1].Here, the interval [Q,1], how to determine the price P when the quality meets or exceeds Q and in the interval[0,Q], when the quality is less than Q, how to determine the discount R.

As consumers' expected prices are mainly affected by probability distribution of market quality estimation, whereby consumers can get the expected price P_C, where:

$$P_C = (P-R)(G_{(Q)}-G_{(0)})+P(G_{(1)}-G_{(Q)}) = P-RG_{(Q)} \quad (1)$$

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Firms'expected sales price depends on probability distribution of market quality estimation, where:

$$P_f = (P-R)(F_{(Q)}-F_{(0)})+P(F_{(1)}-F_{(P)}) = P-RF_{(P)} \quad (2)$$

We set the expected price of both consumers and firms under the quality-contingent pricing strategy in the firms. According to assumption, quality perception and also network marketing firms pricing strategy have an effect on the quality-sensitive demand. Therefore, we will discuss the relationship among price, discount and market demand.

Assuming consumers' demand is independent, where the demand rate (the whole demand per unit time) is λ, then we suppose the total utility obtained by consumers per unit time is $U(\lambda)$ and $U(\lambda)$ is continuously differentiable, monotonically increasing and strictly concave. For network marketing firms, since the short or medium term demand rate is limited, if the firm's maximum demand rate per unit time is $\alpha(\alpha>0)$,then according to the literature, we might assume that the consumer' total utility is:

$$U(\lambda) = 2\alpha\lambda-\lambda_2,\ \text{且}\ \lambda\epsilon[0, \alpha] \quad (3)$$

According to the Eq. 3, if $U'(\lambda)>0$, $U''(\lambda)<0$, then it meets the condition of the total utility function: Continuously differentiable, monotone increasing and strictly concave.

According to economic theory, only when the expected marginal utility of products is greater than or equal to the expected cost, risk-neutral consumers would buy them. For network marketing firms potential demand can be converted into actual demand. In this case, the minimum marginal utility of risk-neutral consumers is:

$$U'(\lambda) = Pc = P-RG_{(Q)} \quad (4)$$

According to Eq. 3-4 the demand rate can be obtained as follows:

$$\lambda = \alpha - \frac{1}{2}P + \frac{1}{2}RG_{(Q)} \quad (5)$$

By the Eq. 5, we see that the demand rate decreases with the price P and increase with the expected quality discount of consumers $RG_{(Q)}$ which meet the needs of quality-sensitive features.

In fact, in the electronic market, quality-contingent pricing in network marketing firms aims at maximizing their unexpected revenue. Since, the expected return of network marketing firms per unit time, the cost of product per unit is C and then the objective function is:

$$\begin{aligned}\pi &= \max \lambda(P_f - C)\\ &= \max[\alpha - \frac{1}{2}p + \frac{1}{2}RG_{(Q)} - C)\end{aligned} \quad (6)$$

$$\text{s. t. } 0\le R\le P \quad (7)$$

Equation 6 is the objective function which means that companies maximize the expected return per unit time, where P and R is the decision variable; Eq. 7 is the constraint that is, quality discount provided by firms should be non-negative and less than the minimum price.

OPTIMAL DECISION ANALYSES

Analysis model of optimality: The model is based on quality-sensitive needs and aim at maximizing the expected return per unit of time, to establish a quality-contingent pricing decision model for network marketing business. We assume that for a certain network marketing companies, price and discount level decision making won't change its guaranteed level of quality Q. And the model has two decision variables, the following were from two perspectives-the optimal level of discount R given price level P, the optimal price P given discount price R, investigate network marketing businesses optimal decision strategy.

By analyzing the Eq. 6-7, we can obtain the following proposition:

$$R = \frac{1}{2F(Q)G(Q)}[P(F_{(Q)} + G_{(Q)}) - CG_{(Q)} - 2\alpha F_{(P)}] \quad (8)$$

Proposition 1: For a given price P, unit time expected revenue function π of network marketing business is a concave function R on the discount and the optimal solution meet the following conditions for the optimal first derivative.

Proof: revenue function π is the first and second derivative of R, as follows:

$$\frac{\partial\pi}{\partial R} = -RF(Q)G(Q) + \frac{1}{2}P(F(Q)+G(Q)) - \frac{1}{2}CG(Q) - \alpha F(Q),$$

$$\frac{\partial^2\pi}{\partial R^2} = -1 < 0$$

This shows that the revenue function is concave function on R, therefore Proposition 1 is proved.

Proposition 2: For a given discount R, unit time expected revenue function π of network marketing business is a concave function R on the discount and the optimal solution meet the following conditions for the optimal first derivative:

$$P = \frac{1}{2}C + \frac{1}{2}CR(F(Q) + G(Q)) \quad (9)$$

Proof: Revenue function π about the first and second derivative of R, respectively, as follows:

$$\frac{\partial \pi}{\partial P} = -P + \alpha + \frac{1}{2}R(F(Q) + G(Q)),$$
$$\frac{\partial^2 \pi}{\partial P^2} = -1 < 0$$

This shows that the revenue function is concave function on P and therefore Proposition 2 is proved.

By Proposition 1 and 2, when maximum demand of unit time, unit product cost C, warranted quality level Q and distribution of estimation of quality of market and corporate about network marketing business is known, being given the price P can determine the optimal discount R or being given discounts R can determine the optimal price P.

Analysis the impact on decision of market quality estimated probability level.

Since, the existence of asymmetric information, the electronic market may overestimate or underestimate commodity quality of network marketing companies and therefore there is often a general difference between market and business of the quality estimated probability, estimation the network marketing business make for their commodity quality will maintain a certain stability (Viswanathan and Wang, 2003). This study only discusses impact which different market quality estimated levels have on the network marketing business of pricing decisions in a certain business quality estimated probability, at a given price or discount situation.

Impact market estimated probability have on decision at a given prices: Let $\alpha = 100$, $C = 60$, $F(Q) = 0.15$, $P = 110$, F(Q) is not reached probability of products firm estimated. G(Q) is not reached probability of products the market estimated. When G(Q) changes, according to quality-related pricing model, the optimal discounts, the expected price and the corresponding demand rate per unit time, expected returns about network marketing firm are shown as Table 1.

Table 1 Effect of market estimated probability G(Q) changes on the best discounts, expected price, the demand rate and the expected benefits of the network marketing business.

In Table 1, |G(Q)-F(Q)| is absolute value of difference of quality estimated probability between market and firm, on behalf of the degree of difference of quality estimation between market and firm, also reflects the degree of information asymmetry. Note that, when the Eq. 8 to determine the optimal discount R>P, according to the constrained Eq. 7 taking R = P = 110. By analyzing Table 1, we can make the following conclusions 1 and 2.

Conclusions 1: When market underestimate quality and the degree of information asymmetry is higher, the network marketing business should apply the higher quality guarantee discount, reduce expected prices, increase demand rate, increase expected revenue.

From Table 1 can be seen, the larger G(Q) is, market suggest that the greater probability of product in order to get Q that is, the greater degree market underestimated, the higher the degree of information asymmetry, the higher discount adopted. When |G(Q)-F(Q)| = 0.65, the entirely discount R = P should be used. In general, when higher the market underestimate the quality and degree of information asymmetry, the higher the quality of corporate guarantees discounts to attract more consumer who expected the gains also higher.

Conclusion 2: The lower degree of information asymmetry, the lower of quality guarantee discount network marketing companies should adopt, expected price rise, the demand rate reduce, the expected return reduce and stabilize. In particular, when the market |G(Q)-F(Q)| = 0.05 or market overestimate quality, without applying quality discount demand rate and expected return remained stable.

From Table 1 can be seen, the smaller G(Q) is, the closer relation of market estimation and the actual quality of the goods, companies should adopt a lower discount, when |G(Q)-F(Q)| = 0.05, then do not need to use quality discount and this time the gains corporate expected is low and stable. Since, this study assume risk-neutral consumers and thus in a lower degree of information

Table 1: Market estimate probability G(Q) impact on optimal discount, expected price, demand rate, expected return

G(Q)	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
|G(Q)-F(Q)|	0.85	0.75	0.65	0.55	0.45	0.35	0.250	0.15	0.05	0.05
optimal discount R	110	110.00	110.00	102.38	91.67	76.67	54.177	16.67	0	0
Expected price p_j	93.5	93.50	93.50	94.64	96.25	98.50	101.870	107.50	110	110
Demand rate λ	100	94.50	89.00	80.83	72.50	64.17	55.830	47.50	45	45
Expected return π	3350	3165.75	2981.50	2800.30	2630.30	2470.42	2363.170	2256.25	2250	2250

Table 2: Market estimate probability G (Q) of Fail to Q impact on optimal price, Expected price, demand rate, Expected return

G(Q)	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
|G(Q)-F(Q)|	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05	0.05
optimal price P	141.50	140.50	139.50	138.50	137.50	136.50	135.50	134.50	133.50	132.50
Expected price p_j	138.50	137.50	136.50	135.50	134.50	133.50	132.50	131.50	130.50	129.50
demand rate λ	39.25	38.75	38.25	37.75	37.25	36.75	35.75	35.25	35.25	34.75
Expected return π	3081.13	3003.13	2926.13	2850.13	2775.13	2701.13	2628.13	2556.13	2485.13	2415.13

Table 3: Unit product cost impact on optimal discount, expected price, demand rate, expected return

C	40	45	50	55	60	65	70	75	80
Optimal discount R	110.0	104.17	87.50	70.83	54.17	37.50	20.83	4.17	0
Expected price p_j	93.5	94.37	96.88	99.38	101.87	104.38	106.88	109.37	110
demand rate λ	67.0	65.83	62.50	59.17	55.83	52.50	49.17	45.83	45
Expected return π	3584.5	3250.03	2930.00	2625.96	2363.17	2067.45	1813.39	1575.18	1350

asymmetry and the companies do not use quality discount circumstances, firms in the market is based entirely on the quality to determine the effectiveness of risk-neutral consumers. When information asymmetry is low, the quality of products have been understand by consumers, you do not need to show off the quality information of products through quality discount, will only attract some characteristics with a certain group of consumers prefer quality, as a result of model analysis, demand rate and expected return will remain relatively stable.

Effect of market estimated probability on decision when given discounts: This situation also exists in the market. For some consumer durables market, similar products use substantially the same quality discounts. When companies sell such products, they mostly use a consistent quality with the market level of discount, in this case, companies will need according to different market quality estimated probability level to determine product sales prices. Let α = 100, C = 60, F (Q) = 0. 15, R = 20, then when the market estimated the that the product does not reach G (Q), the level of probability Q, the best price, the expected price per unit time and the corresponding demand rate, the expected return of the network marketing business are shown in Table 2.

As can be seen from Table 2, the optimal price, expected price and demand rate reduce as the linearly educe of market estimated product does not reach G(Q), the level of probability Q and reduce to a lesser extent. G(Q) each lower 0. 1, the best price and the expected prices are reduced by 1, the demand rate decreased 0.5; expected benefits of network marketing companies but also decreased and the degree of the reduction is small, G(Q) each lower 0 1, the expected return was reduced by approximately70. These results suggest that:

Conclusion 3: When in market all apply quality discount, the network marketing business use quality discount does not produce significant benefits.

Influence analysis of parameters on the decision: The parameters involved in the decision model are the unit cost of the product C and the biggest market demand rate α per unit time. In general, for the same network marketing companies, the unit cost C remained basically unchanged in the short term, but in the long term, or for a different network marketing businesses, this parameter may change, empathy, for a certain electronic market, the largest market demand rate per unit time in short term will remain stable while in the long term, or in different electronic markets will change. Thus, the following we fix market estimated probability of level, then discuss effect of these two parameters changing on optimal discount decisions for a given price.

Effect of a unit cost on decision-making: Let α = 100, P = 110, F (Q) = 0. 15, G (Q) = 0. 4. In general, the unit cost of the product meet $0<C<P$, then the effect of C changes on the best discounts and others of the network marketing business are shown in Table 3. Wherein, when the Eq. 8 to determine the optimal discount $R>P$, then according to the constrained Eq. 7 taking R = P = 110; Similarly, when $R<0$, take R = 0. Thus obtained, when $C<40$, R are 110, when $C>80$, R are 0, the table is no longer displayed instructions.

By analyzing Table 3, we can get the following conclusions 4: With the growth of unit product cost level, network marketing companies should apply lower the quality guarantee of discount, the expected price rise, the demand rate decrease correspondingly, eventually leading to the expected corporate earnings decline.

This conclusion shows that the lower unit product cost of network marketing company, in the electronic market they will have higher competitiveness and can apply higher discounts to increase market demand and increase revenue.

Unit time the largest market demand rate impact on decision-making: Let C = 60, P = 110, F(Q) = 0. 15, G(Q) = 0. 4, in general, the largest market demand rate per

Table 4: Largest market demand rate per unit of time impact on optimal discount, Expected price, demand rate, Expected return

	60	70	80	90	100	110	120	130	140
Optimal discount R	110.0	110.0	104.17	79.17	54.17	29.17	4.17	0	0
Expected price	93.5	93.5	94.37	98.12	101.87	105.62	109.37	110	110
demand rate	27.0	37.0	45.87	50.83	55.83	60.83	65.83	75	85
Expected return	904.5	1239.5	1576.55	1937.64	2337.60	2775.06	3250.03	3750	4250

unit time $\alpha \geq 0$. Effect of Changes on the best discounts and others of the network marketing business are shown in Table 4. Wherein when R>P, take R = P = 110; Similarly, when R<0, take R = 0.

According to Table 4, we get the trend of demand rate, the expected price, the best discounts and expected return over the changes of maximum market demand rate per unit time.

By analyzing Table 4, we can get the following conclusions 5: The larger of Electronic market demand, network marketing companies need use lower quality guarantee discount, the expected price increase, demand rate increases, expected revenue increases.

Conclusion 5: Only electronics market demand is low, the network marketing companies need to use more discounts to display its quality information to increase market demand and increase expected returns.

CONCLUSION

Analysis results show that, when the market underestimated the quality and degree of information asymmetry is high, the quality of network marketing companies guarantee discount is higher, more consumers can be attracted; when degree of asymmetric information is low, the network marketing business needn't to show off the product quality information by quality discount, then network marketing corporate earnings will remain relatively stable. In addition, Analysis results indicate that the lower cost network marketing companies have, in the electronics market they will have higher competitiveness, higher discounts can be used to increase market demand and increase revenue; when the electronic market demand is low, Internet marketing companies need to use a higher discount level to display its quality information to increase market demand and increase revenue.

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