

Analysis of the optimal profit strategy of network cargo based on game theory

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ABSTRACT

With the popularity of social media, the Internet celebrity economy has become a new economic phenomenon, driven by huge interests, more and more people enter the industry, one of the main ways to bring goods is targeted sales by celebrities relying on their huge fan base. However, the development of the network with the goods industry is also uneven, there are unqualified products, supervision is not in place and other problems, some carriers pay attention to the interests of blind selling goods at the expense of consumer interests, this behavior is not conducive to long-term development. Therefore, this paper analyzes the optimal profit of online goods by using Nash equilibrium on the basis of considering the interests of consumers. The key to improve profits is to reduce the return rate, and to reduce the return rate lies in whether the marketing subject can control the quality of the goods. On this basis, the probability of monitoring and non-monitoring of the marketing platform is set, and the income of the marketing platform under the strategy of product control and non-control, and consumers under the strategy of purchase and non-purchase is obtained by using repeated games. The optimal profit of online delivery and how to maintain long-term interests are analyzed. Finally, it is concluded that the long-term profit can be obtained when the control cost is low, the control profit is high, the marketing platform penalty and deduction are low and the discount rate is high.

KEYWORDS

Repeat the game; Online celebrity economy; Nash equilibrium; The optimal profit; Long-term profits.

1. RESEARCH BACKGROUND

With the continuous development of Internet economy, the model of grasping Internet economy benefit is diversified. Since 2016, the online celebrity economy has formed a trend of Internet marketing, and the online celebrity economic industry chain further has established along with the further development of MCN institutions [1]. The online celebrity economy, also called the internet celebrity economy, is growing rapidly in China. Celebrity retailers are usually demand sensitive and capital constrained [2]. To analyze network marketing from the Angle of "network economy", it is necessary to grasp the constituent elements of "network celebrity economy" [3]. Marketers' content generation efforts and interactions between marketers and consumers significantly affect e-commerce sales, the first-order effect of Web celebrity endorsement. In addition, interaction within the fan community has a second-order effect on sales performance from content marketing [4]. And the increase of product brand effect is conducive to improving the total demand and total profit of production and sales system [5].

With the popularity of social media and, recently, live streaming, internet celebrity endorsements have become a prevalent approach to content marketing for e-commerce sellers. Investigate whether and how internet celebrities, as content marketers, and fans, as seeding consumers, influence e-commerce sales performance, which provides insights into research on internet celebrity endorsement and MGC. A cross-sectional regression is conducted to evaluate the economic value of internet celebrity endorsement, and a PVAR model is employed to examine the relationship between celebrities' and consumers' content marketing behaviors and e-commerce sales performance. This paper provides new insights for e-commerce retailers to evaluate the economic values of internet celebrity endorsement, a new content marketing practice in e-commerce platform [4]. And, under the circumstances of anchor signing and not signing, the optimal service quality efforts of the streamer increase with the increase of the streamer commission proportion and decrease with the proportion of the live streaming service platform. But the optimal service quality efforts of the live streaming service platform increase with the increase of the streamer commission proportion and the proportion of the live streaming service platform in the two cases [6].

“Live commerce” has been favored by many consumers since its launch. Many businesses and individuals have brought goods to sell through major live commerce platforms. However, the chaos of “live tape” is endless, and selling fake is common. Combining with the KMRW theory, through the analysis of a single game and multiple games between the seller and the regulator, this paper obtains the optimal choice of the seller in each stage: in a single game, the immoral sellers will choose to sell fake goods to obtain the maximum benefit; in multiple games, immoral sellers pretend to maintain their credibility as moral sellers until giving up maintaining their credibility for maximum benefit at last [7]. The interaction between trust-dependent preferences and reputation building in repeated trust mini-games [8].

Repeat-purchase relationships and third-party monitoring are required for high-quality credence goods to be available [9]. Evolutionary game theory combined with dynamic simulation modeling can provide a formal approach to understanding web celebrity brand eWOM marketing decision-making in social media, which can thus support the control of unhealthy web celebrity marketing environment. The results demonstrate that the reasonable control of social platform control costs may be more effective than the government policy on web celebrity fake brand eWOM marketing behaviors. The study enriches the research on the management and control of eWOM marketing as well as provides guidance for the sustainable development of the web celebrity economy in social media [10].

2. OPTIMAL PROFIT MODEL

2.1. Model formulation and assumptions

(1) In this paper, the network delivery service supply chain is composed of two sides: marketing main body and marketing platform.

Marketing subject: Network with goods of high traffic anchors and celebrities.

Marketing platform: TikTok, Taobao, Kuaishou, Xiaohongshu and other network marketing platforms.

(2) Consumer benefits are expressed by the return rate λ_r . When the satisfaction reaches 0.6 (the highest satisfaction is 1) or above, it meets the expectation that consumers will not return. The higher the return rate, the greater the loss, and the lower the return rate, the opposite.

(3) This paper is divided into two cases of platform supervision and non-supervision to discuss, construct the profit function of marketing subject and marketing platforms respectively, and use NASH equilibrium to obtain the optimal quality effort strategy and optimal profit of both parties under the two cases, and analyze the relationship between variables and marketing subject and

platforms. It also analyzes the strategies to optimize the profit and service quality of the two parties under the condition of ensuring the interests of consumers.

2.2. Parameter setting

(1) The potential total market demand is C , A is the fixed market demand, x represents the service effort of the marketing subject, θ is the sensitivity coefficient of the demand to the marketing subject's service quality efforts, y represents the marketing platform service efforts, φ is the sensitivity coefficient of the demand to the service quality efforts of the marketing service platform, and $\theta > 0, \varphi > 0$.

(2) If the marketing platform supervision, the impact of platform efforts on demand is G , The marketing platform supervision cost is G^2 , The sensitivity coefficient of the marketing platform regulatory efforts is η , Where $\eta > 0$, then $D = A + \theta x + \varphi y + \eta G$.

If the marketing platform does not supervise, the platform will try to reduce the impact on the demand (the network traffic loss caused by the deterioration of the platform due to adverse supervision will reduce the demand) is T , and $D = A + \theta x + \varphi y - T$.

(3) Service quality of the marketing subject, The cost of service quality of marketing platform is respectively: $D_1 = \rho x^2/2, D_2 = \mu y^2/2$.

(4) Set up marketing subject and marketing platform two sides of the similar status, independent decision-making.

2.3. Construction and solution of the optimal profit model

2.3.1. Marketing platform supervision

When the platform supervises, the profit of a single commodity sold by the marketing subject is z and the return rate of purchased goods is λ_i . If the return rate of the marketing receptor of the same batch of goods reaches more than 15%, it means that the quality of the products sold by the marketing receptor is not qualified, and then the marketing platform needs to fine the marketing subject and then play a restrictive role. Where q is the penalty coefficient, $q > 0$. And introduces the parameter Q . If $\lambda_i \leq 0.15, Q = \lambda_i$. If $\lambda_i \geq 0.15, Q = 0$.

The marketing subject will pay a certain service fee and take a cut to the marketing platform, and the proportion of the cost to the initial transaction amount of the marketing subject is σ_i . The profit of marketing subject and marketing platform is respectively:

The profit function of the marketing subject:

$$V_1^i = z(1 - \lambda_i - q\lambda_i + Qq + \sigma_i)(A + \theta x + \varphi y + \eta G) - \rho x^2/2 \quad (1)$$

Profit function of the marketing platform:

$$V_2^i = z(\sigma_i + q\lambda_i - Qq)(A + \theta x + \varphi y + \eta G) - \mu y^2/2 - G^2 \quad (2)$$

Using the x, y in formula (1) and (2), and solving the conduction equation in parallel, we can obtain the optimal strategy of Nash equilibrium. Get the optimal service quality of the marketing subject and marketing platform x^i, y^i, G^i , as follows:

$$\text{Marketing subject optimal service quality effort degree: } x^i = \frac{\theta z(1 - \lambda_i - q\lambda_i + Qq + \sigma_i)}{\rho}$$

$$\text{Marketing platform optimal service quality effort degree: } y^i = \frac{\varphi z(\sigma_i + q\lambda_i - Qq)}{\mu}$$

$$\text{Marketing platform optimal marketing efforts: } G^i = \frac{yz(\sigma_i + q\lambda_i - Qq)}{2}$$

Taking the optimal strategy x^i, y^i, G^i into (1) and (2) respectively, the optimal profit of the marketing platform and the subject can be obtained, as follows:

Marketing subject optimal profit:

$$V_1^{i*} = [zA + \frac{z^2(2\varphi^2 + \mu\eta^2)(\sigma_i + q\lambda_i - Qq)}{2\mu}](1 - \lambda_i - q\lambda_i + Qq + \sigma_i) + \frac{Q^2z^2(1 - \lambda_i - q\lambda_i + Qq + \sigma_i)^2}{2\rho} \quad (3)$$

Marketing platform for optimal profit:

$$V_2^{i*} = (\sigma_i + q\lambda_i - Qq)Az + \frac{Q^2z^2(\sigma_i + q\lambda_i - Qq)(1 - \lambda_i - q\lambda_i + Qq + \sigma_i)}{\rho} + (2\varphi^2z^2 + \eta^2z^2\mu) \frac{(\sigma_i + q\lambda_i - Qq)^2}{4\mu} \quad (4)$$

2.3.2. Marketing platform does not supervise

When the platform does not supervise, the profit of a single commodity sold by the marketing subject is z , The return rate of the goods is λ_j , The marketing subject will pay a certain service fee and a cut to the marketing platform, and the proportion of the cost in the initial transaction amount of the marketing subject is σ_j . The profit of marketing subject and marketing platform is respectively:

The profit function of the marketing subject:

$$V_1^j = z(1 - \lambda_j - \sigma_j)(A + \theta x + \varphi y - T) - \rho x^2/2 \quad (5)$$

The profit function of the marketing subject:

$$V_2^j = \sigma_j z(A + \theta x + \varphi y - T) - \mu y^2/2 \quad (6)$$

By taking the derivative of x, y in formula (3) (4) and solving the derivation equation in parallel, we can obtain the optimal strategy of Nash Equilibrium, the optimal service quality effort of marketing subject and marketing platform and marketing effort x^j, y^j . as follows:

Marketing subject optimal service quality effort degree:

$$x^j = \frac{z\theta(1 - \lambda_j - \sigma_j)}{\rho} \quad (7)$$

Marketing platform optimal service quality effort degree:

$$y^j = \frac{\sigma_j z \varphi}{\mu} \quad (8)$$

Taking the optimal strategy x^j, y^j into (3) and (4) respectively, the optimal profit of the marketing platform and the main body can be obtained, as follows:

Marketing subject optimal profit:

$$V_1^{j*} = z(A - T)(1 - \lambda_j - \sigma_j) + \frac{\theta^2 z^2 (1 - \lambda_j - \sigma_j)^2}{2\rho} + \frac{\varphi^2 z^2 \sigma_j}{\mu} \quad (9)$$

Marketing platform for optimal profit:

$$V_2^{j*} = \sigma_j z(A - T) + \frac{\sigma_j z^2 \theta^2 (1 - \lambda_j - \sigma_j)}{\rho} + \frac{\varphi^2 \sigma_j^2 z^2}{2\mu} \quad (10)$$

2.3.3. Relations analysis

The above optimal profit function model analyzes the influence of profit, penalty ratio and service fee ratio on the optimal profit. Such as form one:

It can be seen from the information in the above table 1 that the return rate during platform supervision is inversely proportional to the optimal profit of the marketing subject and the platform; The proportion of punishment is inversely proportional to the optimal profit of marketing subject and positively proportional to the optimal profit of marketing platform. The proportion of service fee is opposite to the optimal profit of marketing subject, and is proportional to the optimal profit of

marketing platform. When the platform does not supervise, the return rate is inversely proportional to the optimal profit of the marketing subject and the platform, the service fee ratio is inversely proportional to the optimal profit of the marketing subject, and is directly proportional to the optimal profit of the marketing platform. It shows that under the circumstances of platform supervision and no supervision, the reduction of return rate is conducive to the improvement of the interests of the marketing subject and the platform, the proportion of service fee is conducive to the increase of the profit of the marketing platform, is not conducive to the interests of the marketing subject, the improvement of the punishment coefficient is conducive to the interests of the marketing platform, but is not conducive to the profit of the marketing subject.

Table 1. Relations analysis

	Platform monitoring		The platform is not monitored	
	Marketing subject optimal profit	Marketing platform for optimal profit	Marketing subject optimal profit	Marketing platform for optimal profit
	-	-	-	-
	-	+		
	-	+	-	+

It shows that in order to improve the profits of marketing subject and marketing platforms, the return rate should be reduced, and appropriate penalty coefficient and service fee ratio should be established.

The two main participants in online shopping are marketing subjects and consumers, and to ensure the interests of both, it is mainly necessary to reduce the return rate. The reduction of the return rate indicates that consumers are more satisfied with the purchased goods, the cost performance of the purchased goods is improved, and the interests of consumers are guaranteed. If the platform supervision, the reduction of the return rate will also reduce the fine of the platform for the marketing subject. Therefore, the key lies in the marketing subject's control of commodity quality.

3. LONG-TERM PROFIT MODEL

However, for the three parties, the process of buying and selling is not a one-time. Shopping online as a contemporary popular consumption mode brings huge benefits to the marketing body, and consumers have more selectivity. But due to the pursuit of maximum interests, some marketing subjects have false publicity in the process of carrying goods and sell substandard products. This phenomenon not only damages the rights and interests of consumers, but also damages the long-term interests of the network to carry goods, affecting the sustainable development of the network to carry goods. So how can we protect the interests of consumers so that online shopping can have long-term benefits?

In view of this phenomenon, repeated game knowledge is applied to present the return rate in the form of product control, which represents a low return rate. A long-term profit model is established to seek the profit maximization of consumers on the basis of ensuring the interests of consumers, providing new ideas for the sustainable and healthy development of online goods and promoting market regulation and governance.

Model hypothesis:

The participants in the game are the marketing subjects and the consumers, and both of them are rational people. Assuming that the marketing subjects have two types of quality control and non-quality control, and the consumers have two types of buy or don't buy. The marketing subject of the quality control will maximize the interests of consumers, while the non-quality control will sell fake goods or sell goods with poor quality in order to seek profits, which will damage the interests of consumers. If consumers buy non-quality control goods, they will terminate the transaction and will

not buy again. The dotted line represents the information set. The two dotted lines in the figure show that the marketing subject does not know that it will be monitored before selecting the quality control and non-quality control, and the dotted line at the bottom indicates that the consumer does not know whether the marketing subject will be monitored and whether they will select the quality control.

Introducing the probability of marketing platform monitoring into this model is conducive to providing governance countermeasures for online shopping credit system. The probability of marketing platform detection is p , and the undetection probability is $(1 - p)$. a is the profit when the marketing subject selects the quality control, and e is the fine when the non-quality control is detected. c is the income when consumers purchase the quality control products, and f is the income when consumers buy products without control. b is the product control cost of the marketing subject, among $c > 0, f < 0, 0 < p < 1$.

If it is a primary purchase, the optimal strategy of the marketing subject is not quality control when the marketing platform is not supervise. When the marketing subject opts quality control, whether the marketing platform detects has no impact on it, but consumers can achieve the optimal profit. But in real life, the marketing of marketing subjects is not a one-time but repeated, and hoping to achieve the long-term benefits. In order to find the marketing platform detection, and the marketing subject opts quality control, the participants can achieve the long-term optimal profit. Make hypothesis, and the discount rate is δ .

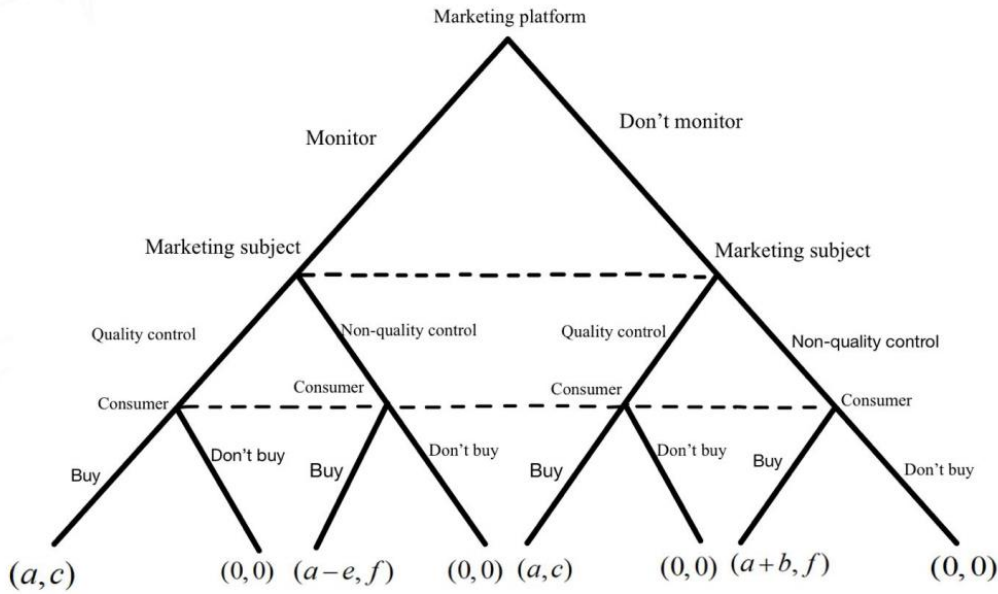


Figure 1. Model hypothesis

The long-term profit of the quality control is: $\frac{a}{1-\delta}$

The long-term profit of the marketing subject is: $p(a - e) + (1 - p)(a + b)$

The long-term profits of consumers when the marketing subject selects the quality control: $\frac{c}{1-\delta}$

The long-term profits of consumers when the marketing subject selects the non-quality control: f

Ensure that the long-term interests of the quality control of the marketing subject are greater than the profit of the non-quality control: $\frac{a}{1-\delta} > p(a - e) + (1 - p)(a + b)$

The profit of consumers when control is greater than the profit of the non-quality control: $\frac{c}{1-\delta} > f$

The interests of the marketing subject in the quality control are always greater than the interests of the non-quality control: $\frac{a}{1-\delta} \geq a - e$

Available by the above type: $1 \geq p > \frac{-a}{1-\delta+a+b} \geq 0, 1 - \frac{a}{a-e} \leq \delta < 1 - \frac{c}{f}$

Therefore, the probability must be between 0 and 1, and the minimum necessary monitoring level depends on the profit of the marketing subject selects the non-quality control, the cost of the product, the fine and discount rate. When the profit of the marketing subject controls the product is high, the probability of being monitored is small to maintain the balance. When the control cost of the marketing subject is high, it is often unwilling to consume the cost control increased, so it is necessary to increase the monitoring cost to maintain the balance. If the fine is increased when the marketing subject is monitored, the monitoring rate needs to be reduced to maintain the balance. Finally, if the discount rate is very low, the monitoring rate needs to be increased, because the marketing subject is willing to exchange future profits for current profits.

4. CONCLUSION SUMMARY

Through the analysis of the optimal profit of the marketing platform and the marketing subject, the relationship between the return rate, the penalty proportion and the service fee ratio and the optimal profit. Among them, the return rate is negatively correlated with the optimal profit of marketing subject, marketing platform and consumers. And the proportion of penalty and the percentage of service fee are negatively related with the optimal profit of marketing subject, but positively correlated with the optimal profit of marketing platform. Therefore, if you want to improve the optimal profit of the marketing subject and consumers, it is necessary to reduce the return rate of customers, reasonably formulate the penalty coefficient and service fee ratio, and finally achieve a win-win situation among the three parties. Consumers can buy high cost-effective and satisfactory goods, the marketing subject can get a higher pure profit, and the marketing platform can get a reasonable service fee and fine income. Lower return rate means to control the quality of products, through the long-term profit model, set the probability of monitoring and not monitoring of the marketing platform respectively. Using repeated game to obtain the revenue of the marketing platform under the quality control and non-quality control, and the revenue of consumers under the buying and not buying. Calculated the range of the discount rate and probability of monitoring when the profits are maximized under consumers buying indefinitely (quality control, buying, monitor). According to the obtained range, when the cost of quality control is low, the profit of quality control is higher, the fine is low and the discount factor is high, the probability of monitoring don't have to be high. At this time, the profits of marketing subject and consumers are relatively high, and they can achieve long-term interests. However, if any one of the above four factors shows the opposite state, the probability of monitoring needs to be increased to maintain the balance and achieve long-term profits. Finally, when the cost of the quality control is low, the profit of quality control is high, the fine and service fee ratio are low and the discount rate is high, means that the return rate is reduced under marketing subject controlling quality and consumers choose buying. The marketing platform, the marketing subject and the consumers can achieve the optimal profit.

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