A Study on Shopping Mall Coupon Strategies and Consumer Purchasing Decisions

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Abstract. Based on the perspective of game theory, this paper constructs a two-level game analysis framework for the coupon marketing strategy of shopping malls. The study adopts the Stackelberg game model to systematically examine the strategic interaction between shopping malls and consumers, as well as between shopping malls and competitors. In the vertical dimension, the influence mechanism of coupon issuance strategy on consumer purchase decision-making behavior is analyzed in detail; in the horizontal dimension, the dynamic impact of preferential competition among shopping malls on market share and operating income is deeply explored. Constructing theoretical models and numerical simulations reveals the formation conditions and action mechanisms of the optimal preferential strategy under different market environments. This study provides theoretical support for shopping malls to formulate differentiated coupon marketing plans in a complex competitive environment, which helps to achieve the dual goals of profit optimization and market position improvement and has important practical guiding value for the optimization of retail marketing strategies.

Keywords: Stackelberg game, coupon design, market competition.

1. Introduction

In today's highly competitive retail market environment, shopping malls have adopted various marketing methods to attract consumers and improve sales performance. Among them, coupons, as a common and effective marketing strategy, have received widespread attention. Coupons can not only stimulate consumers' desire to buy but also help shopping malls to expand their market share and increase profits to a certain extent [1]. However, in the actual market environment, shopping malls do not exist in isolation. Their coupon issuance strategies not only affect consumers' purchasing decisions but also trigger competition among shopping malls to attract consumers through coupon strategies.

Existing literature mainly focuses on the one-way impact of coupons on consumer behavior or the coupon pricing strategy of a single shopping mall. Although these studies have deeply analyzed the promotional effect of coupons, they generally ignore the important dimension of strategic interaction between shopping malls.

This paper constructs a Stackelberg game model to analyze the interactive behavior of shopping malls as leaders and consumers as followers, as well as the competitive strategies between shopping malls based on issuing coupons, and explores the impact of shopping malls' coupon issuance strategies on consumers' purchasing decisions, as well as the impact of competition between shopping malls on shopping malls' revenue and market share. This paper introduces the competition between two shopping malls, A and B, and simulates market competition factors, to provide a theoretical basis for shopping malls to formulate more effective coupon marketing strategies.

2. Literature Review

In the fiercely competitive retail market, coupons, as a common marketing tool, play an important role in promoting new products and attracting or rewarding new and old customers. Existing research mainly explores coupon strategies from three dimensions: consumer behavior impact, single mall decision model, and game analysis in a competitive environment.

First, from the perspective of consumer behavior, coupons are not only a voucher that allows consumers to deduct a certain amount of money or enjoy discounts when making purchases, but also a right to obtain a certain price discount, which can effectively stimulate consumption willingness, thereby increasing sales and promoting the growth of total profits [2, 3]. Consumers usually adjust their purchasing strategies based on information such as the face value, usage threshold, and validity period of the coupon, thereby affecting the effectiveness of the mall's marketing activities.

Secondly, at the decision-making level of a single shopping mall, the actual coupon strategy often involves the choice of variables such as whether to issue coupons, the number of coupons issued, and the denomination size. Such strategies need to consider not only the direct impact on sales volume, but also the goal of maximizing profits. In this context, the Stackelberg game model can be used to characterize the master-slave decision-making relationship between shopping malls and consumers. That is, shopping malls as "pioneers" issue coupon strategies, and consumers as "followers" make response strategies on whether to buy and the amount of purchases.

Third, considering that the real market does not exist in isolation, game analysis in a competitive environment becomes a key research direction. Ran Wenxue and other scholars constructed a Stackelberg game model for group buying marketing by retailers in a competitive market environment, pointing out that different marketing methods do not always lead to profit growth, and their effects are affected by factors such as market power and product substitution [4]. At the same time, Si Yinyuan and others studied the profit function modeling problem of competitive enterprises in the targeted delivery of electronic coupons based on consumer preferences, providing a theoretical basis for game modeling and strategy solving for this paper [5]. Viewing the two as a common exploration of game strategy research in a competitive environment will help expand the application boundaries and research depth of coupon strategies.

In summary, existing research provides an important theoretical basis for the analysis of coupon strategies, but there are still the following research gaps: (1) There is a lack of research that systematically models and solves coupon strategies in competitive markets; (2) The description of consumer response mechanisms is still relatively simplified and has not fully reflected diversified behavioral preferences; (3) Existing models are mostly based on theoretical deductions and lack a verification mechanism that combines real data or empirical environments. Therefore, based on existing research, this paper will combine competitive games with consumer behavior response mechanisms to construct a more realistic coupon placement decision model, to provide theoretical support for shopping malls to formulate more effective marketing strategies.

3. Research

3.1. Model Building

A Stockberg game model is constructed, with the mall as the leader and the consumer as the follower. The mall's strategy is whether to issue coupons and, if so, the quantity and denomination of the coupons. The consumer's strategy includes buying or not buying, which can be further transformed into Q consumers buying goods out of N potential consumers. Then the Stockberg game model is solved.

On this basis, the competition between shopping malls can be further expanded. Assume that shopping mall A and shopping mall B are two major competitors, shopping mall A is the leader, and shopping mall B is the follower. Shopping mall A first determines its coupon distribution strategy, and shopping mall B adjusts its coupon distribution strategy according to shopping mall A's strategy. The specific model is as follows.

3.1.1 Stockberg game between a single mall and consumers

(1) Assumptions

Table 1 shows the variable settings. The model assumptions are described below.

1) Consumers are rational and will decide whether to purchase a product based on the difference between the product's original price P and the coupon's face value V (i.e., the actual price paid P − V).

2) Consumers are price sensitive. The price sensitivity of all consumers is set to be the same in the model. The purchase quantity Q is linearly related to the coupon value V: Q = a + bV (a, b>0)

3) The mall is a rational profit-maximizing entity. It decides whether to issue coupons and the face value of the coupons based on the predicted purchase quantity.

4) The mall's coupons are only distributed to potential consumers N, and the total market capacity is known and fixed.

(2) Variable settings

Table 1. Model variable definition

variable	description
P	The original price of the product
V	The face value of the coupon
Q	Number of consumers, $Q1$ is the number of consumers when coupons are issued, and $Q2$ is the number of consumers when no coupons are issued
N	The total number of potential consumers
C	Unit cost of goods
a, b	A constant representing the consumer's sensitivity to price

(3) Model building and solving

1) If coupons are issued

Profit function:

$$\pi_1(V) = (P - V - C)Q_1,\ Q1 = a + bV \tag{1}$$

Substituting in:

$$\pi_1(V) = (P - C)a + (P - C)bV - aV - bV^2 \tag{2}$$

Let $\frac{d\pi_1}{dV} = 0$, find the preferential denomination corresponding to the maximum value:

$$V^* = \frac{(P - C - \frac{a}{b})}{2} \tag{3}$$

Substituting into the optimal V^* value $Q_1 = a + bV$, it can get:

$$Q_1^* = a + bV^* = \frac{a}{2} + \frac{b(P-C)}{2} \tag{4}$$

Thus, get $\pi_1(V^*)$.

2) If no coupons are issued:

$$\pi_2(V) = (P - C)Q_2 \tag{5}$$

Mall decision: If $\pi_1(V^*) > \pi_2(V)$, then issue Q1∗ coupons with a face value of V∗; if $\pi_1(V^*) < \pi_2(V)$, no coupons will be issued; if $\pi_1(V^*) = \pi_2(V)$, considering the cost of printing and promoting coupons, this paper will also choose not to issue coupons.

3.1.2 Stockberg game and repeated game between two shopping malls and consumers

(1) Model explanation

In a real environment, malls A and B will continuously adjust their coupon strategies to obtain higher profits and a larger market share in the long-term competition. When two malls are in a state of long-term competition, their discount strategies are not determined at a fixed time point, but are repeatedly played over multiple periods and dynamically adjusted according to market feedback and the actions of their opponents [6]. Therefore, it is necessary to regard the coupon strategies of malls A and B as a multi-period Stockberg game (which can also be understood as a leader-follower model

in repeated games) and study how A, as a leader, and B, as a follower, decide on the face value and quantity of coupons in each period under multi-period conditions to maximize profits. Consumers, as buyers, will also provide different feedback and actions on the different discount strengths of each mall, forming dynamic purchasing behavior.

Unlike the single-period Stockberg game, the multi-period model needs to consider the mutual influence of inter-period strategies. The coupon face value decision of Mall A in each period not only affects the current profit, but also affects the response of Mall B in the current period and future periods, which in turn affects Mall A's profit in subsequent periods. If both A and B want to maximize their long-term discounted profits, they need to balance the relationship between "maximizing short-term profits" and "maintaining a better competitive environment" in each period.

(2) Assumptions

1) Consumers are rational and will decide whether to purchase a product based on the face value V of the coupon.

2) Consumers are sensitive to prices, and all consumers have the same sensitivity to prices. The purchase quantity Q after the consumer's decision is linearly related to the face value V of the coupon, that is, $Q = a + bV$, where a and b are positive constants that represent the consumer's sensitivity to prices.

3) There are only two major competing malls in the market: A (the leader) and B (the follower), both of which have been operating continuously for a long time.

4) The game is played in multiple discrete periods t=1, 2, …, T, and $T\to\infty$ can also be regarded as an infinite game. In each period, Mall A first decides on the coupon distribution strategy, and Mall B observes A's decision and then formulates its coupon strategy.

5) When both A and B offer coupons, consumers will compare the actual prices paid and make a choice; if the two offer the same discount, they may share the market equally or in other proportions.

(3) Variable settings

Table 2 shows the variable settings.

Table 2. Model variable definition

variable	describe
P	The original price of the product
V	The face value of the coupon (the actual price paid by the consumer is $P - V$)
Q	Number of consumers, Q_1 is the number of consumers when the coupon is issued, Q_2 is the number of consumers without coupons
N	The total number of potential consumers
C	Unit cost of goods
b	A constant representing the consumer's sensitivity to price
δ	Use $\delta(0<\delta<1)$ indicates the importance that the market attaches to future profits

(4) Model building and solving

The entire game is divided into T stages (when $T\to\infty$, it can be regarded as infinite). In the third stage:

Mall A first decides the coupon value $V_{A,t}$; Mall B observes $V_{A,t}$ and then makes a decision $V_{B,t}$; purchase allocations for A and B are based on the difference between $V_{A,t}$ and $V_{B,t}$; A, B obtains current profits respectively $\pi_{A,t}$ and $\pi_{B,t}$.

Both parties have complete information, B Mall is fully aware of A's decision, and A can also predict B's reaction function. Moreover, historical information can be memorized, and A and B can review each other's and their coupon strategies in the past periods and adjust the next period's strategy accordingly.

Assume that the two shopping malls adopt the coupon face value strategy in period t $V_{A,t}$ and $V_{B,t}$ the corresponding consumer purchase volume can be expressed as:

$$Q_{i,t} = a + bV_{i,t}, i = A, B \tag{6}$$

The single-period profit function is:

$$\pi_{i,t} = (p - V_{i,t} - C)Q_{i,t},\ i = A, B \tag{7}$$

The backward induction method is used to solve the game equilibrium. Given the preferential strategy of the leader mall A V_A, the profit maximization decision of mall B is:

If Mall B wants to attract all consumers, it must offer slightly better discounts than Mall A:

$$V_B^* = V_A^* + \epsilon, (\epsilon \to 0^+) \tag{8}$$

However, if the profit from doing so is lower than the profit from not issuing coupons, then B Mall may give up the competition. Therefore, B's total profit can be regarded as a function of the face value of A's coupons, recorded as $\pi_B(V_A)$

Then the optimal response function of B is:

Like $\pi_B(V_A + \varepsilon) > \pi_B(0), V_{B^*} = V_A + \varepsilon$

Like $\pi_B(V_A + \varepsilon) \leq \pi_B(0), V_{B^*} = 0$

For A, the single-period strategy is the same as the single-mall model, and the optimal coupon face value is determined by solving the derivative of the profit function to zero V_A^*.

(5) Repeated game objectives

Based on the results of the above single-period game, both parties AB will continue to increase the coupon denomination to seize market share, thus falling into fierce vicious competition. To maximize profits, the ideal situation is to adopt a cooperative approach to unify the coupon denomination at V=V_A^*, so that both parties can obtain greater profits. At this time, if one party's coupon deviates from this denomination, that is, increases the discount, it will occupy a larger market share in the short term, thereby exceeding the other party's profit. Based on the background of repeated games, a punishment strategy can be introduced to sanction behaviors that undermine cooperation, forcing the other party to adjust the discount amount to an equilibrium value, thereby achieving stability.

The goal of the two shopping malls is to maximize the long-term profit discount. If the master-slave game is regarded as an infinite game, the long-term profit discount and maximization goal can be expressed as:

$$\max \sum_{t=1}^{\infty} \delta^{t-1} \pi_{i,t}\ (i = A, B) \tag{9}$$

The two parties can achieve "cooperation" through repeated interactions, that is, both parties choose a moderate coupon value V∗, thereby avoiding fierce competition. Under the cooperative strategy, the two parties agree to adopt the predetermined strategy V∗ in each period, and each party obtains stable profits; once party deviates, the other party will initiate a punishment strategy in the subsequent period, so that the market returns to a low-profit equilibrium state of fierce competition.

(6) Equilibrium analysis of cooperation and deviation

The two parties reach a consensus in advance and select the coupon value V∗ in each period (which can be obtained by maximizing the single-period profits of both parties) so that consumers are evenly distributed (for example, 50% market share).

For each mall, the long-term benefits of the partnership are:

$$U_i^{coop} = \frac{\pi(V^*, V^*)}{1-\delta} \tag{10}$$

Suppose one party (for example, shopping mall A) deviates from the coupon face value VA′ in a single period (so that it gains a larger market share in that period and obtains a single-period deviation profit πA(VA′, V∗)), and after observing the deviation, shopping mall B starts a punishment strategy from the next period (for example, both parties switch to a non-cooperative equilibrium strategy V^{Nash}), resulting in reduced future profits and both parties falling into a fierce competitive equilibrium.

If shopping mall A deviates, its total profit after punishment is:

$$U_A^{dev} = \pi_A(V_A', V^*) + \delta \frac{\pi_A^{punish}}{1-\delta} \tag{11}$$

In order for the cooperative equilibrium to be maintained, the incentive constraint of non-deviation must be met:

$$\frac{\pi_A(V^*,V^*)}{1-\delta} \geq \pi_A(V_A', V^*) + \delta \frac{\pi_A^{punish}}{1-\delta} \tag{12}$$

Similarly, shopping mall B also needs to meet similar conditions.

When the discount factor δ is large enough, that is, the importance of future gains is high, the losses caused by short-term deviations (long-term low profit penalties) will offset the deviation gains in the short term, thereby allowing the cooperation strategy to continue.

Analyzing and finding the parameter range that makes the above incentive constraints hold, such as the conditions for a, b, P, C, and δ, can prove that repeated games can stabilize cooperation under certain market conditions. The following modeling and simulation section gives a set of parameter values that meet the corresponding conditions and can achieve a stable cooperation strategy.

3.2. Modeling and Simulation

Table 3 shows the simulation parameter settings.

Table 3. Simulation parameter settings

parameter	Value
Price and cost	P = 100, C = 50
Total number of consumers	N = 1000
Cooperation discount amount	Vcoop = 10
Deviation from the preferential amount of one party	Vdev = 15 (assuming A deviates in period Tdev)
Discount amount for penalty strategy	Vpunish = 20 (Both parties enter the punishment phase, and profits decrease compared to cooperation)
Total number of repeated games	T = 50
Deviation period	Tdev = 10
Length of penalty period	Tpunish = 5
Discount Factor	δ = 0.95

The results are as figure 1 and figure 2:

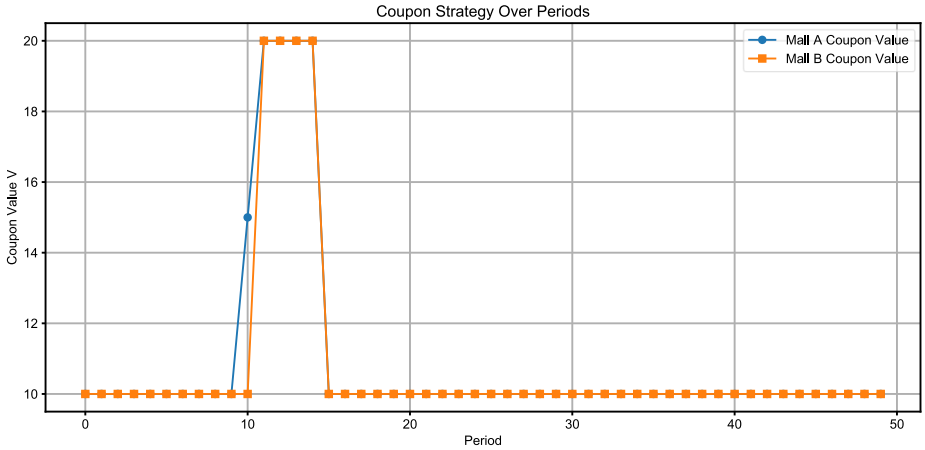

Figure 1. Simulation results - preferential denomination changes with the number of periods

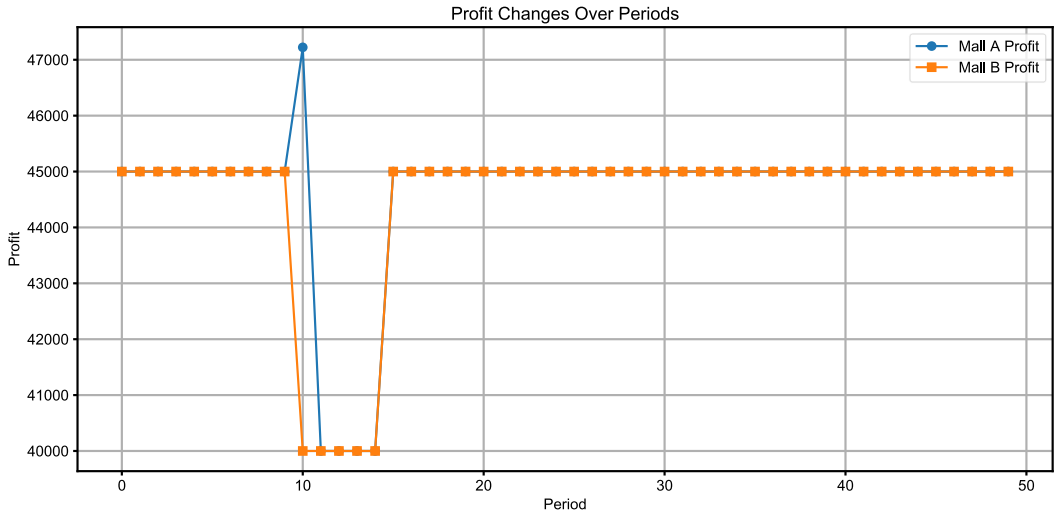

Figure 2. Simulation results - total profit changes with the number of periods

The simulation results show that:

(1) When both parties adopt a predetermined moderate coupon strategy, the cooperative equilibrium can achieve a long-term stable profit and market share distribution.

(2) The deviation and punishment mechanism can be used to maintain a stable equilibrium. When a single shopping mall attempts to gain short-term market share by increasing preferential treatment, although it can achieve a partial profit increase, the subsequent punishment phase will lead to a significant decline in future profits, thereby effectively preventing vicious competition and maintaining a cooperative equilibrium between the two parties.

The simulation in this part verifies the rationality of the theoretical model and proves that in a fiercely competitive environment; by rationally designing coupon strategies and penalty mechanisms, shopping malls can maximize profits and steadily increase market share while maintaining cooperation.

4. Conclusion

This paper analyzes the interactive relationship between shopping malls' coupon strategies and consumers' purchasing decisions by constructing a Stackelberg game model, and explores the coupon strategy adjustment mechanism between shopping malls in a competitive environment. The results show that in the context of a single shopping mall, the reasonable design of the face value and issuance strategy of coupons can effectively enhance consumers' willingness to buy, thereby increasing the profits of the shopping mall. In a competitive market, the coupon strategy competition between shopping malls may lead to fierce price wars, but through repeated games and appropriate punishment mechanisms, a stable cooperative equilibrium can be maintained in the long run, which benefits both parties.

The theoretical model and simulation experiment of this study verified the effectiveness of the coupon strategy in a competitive environment, and also provided a reference for shopping malls to formulate more scientific preferential policies in actual marketing. However, this study still has certain limitations. For example, the model assumes that consumers' sensitivity to price is evenly distributed and does not consider the heterogeneity of individual consumers. In addition, other factors in the actual market environment (such as brand loyalty, competition from non-price factors, etc.) may affect consumer decisions. Future research can further expand the model to be closer to the real market situation.

In summary, this study provides theoretical support for the formulation of coupon strategies in shopping malls in a complex market environment and also lays the foundation for subsequent research to explore more optimized marketing strategies. In the future, with the development of e-commerce

and data analysis technology, people can further combine big data analysis and machine learning methods to optimize coupon strategies and improve the market competitiveness of shopping malls.

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