Research on pricing problem based on consumer psychological account reference price

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Abstract

The theory of reference price and psychological account appeared earlier, but it is mostly applied in the scope of psychology. With the continuous development of economics and the expansion of the scope of application, it is gradually applied in the research of behavioral economics. In this paper, behavioral economics concepts such as consumer psychological account and reference price are introduced into the dynamic pricing model. The existence of psychological account influences people to treat different expenditure and income with different attitudes, thus making different decisions and behaviors. Referring to the three price strategies under the bargaining model built by Lin zhibing, the paper combines the psychological account with the reference price, introduces the psychological account reference price model, and discusses the optimal pricing strategy of consumers' psychological account under the lowest psychological account.

Keywords

Psychological account, reference price, pricing strategy.

1. Introduction

Reference price theory appeared earlier, but in the early days it was mainly concentrated in the fields of management and psychology. Kahneman and Tversky[1] have done research in the prospect theory, comparing the current price with the reference price. They pointed out that when the reference price was higher than the current price, consumers felt they gained the perceived benefits, and when the reference price was lower than the current price, consumers felt they suffered losses. However, this perception is asymmetric, and the perceived loss is greater than the perceived gain under the same price difference. The same price difference brings people very different transaction utility, people usually consider the price difference between the commodity and the reference price as the percentage of the reference price.

Literature related to reference price was sorted out: Green leaf[2] used the index mean of historical price as the reference price, analyzed how retailers improve revenue through repeated promotion, and pointed out that the reference price effect can make retailers get the maximum revenue, and the optimal price is the cycle change between high and low prices. Zhou Jidong[3] took the price of competitive products as the reference point, studied the market competition under the consumer reference dependence, and pointed out that the loss aversion of consumers would strengthen the price competition to some extent. The reference price is the price cognition formed by consumers based on the price of products in the past, which can easily affect consumers' purchasing behavior[4]. When purchasing a product, consumers will compare it with the historical price of the product or the price of other alternative products. When consumers have lower awareness or loyalty to a product, they will be more sensitive to the price. In the reference price model, Lin zhibing divided the pricing strategies of retailers into the lowest reference price strategy, the price maintaining strategy and the highest reference price strategy[5].

Psychological account is formally proposed by Thaler, a professor of behavioral science at the university of Chicago. As an important concept in behavioral economics, psychological account refers to the process of people's psychological classification, accounting, coding, evaluation and budgeting of results (especially economic results) [7]. People not only have the habit of categorizing various items, but also classify and treat money and wealth differently. People unconsciously attribute assets to different accounts for management, and different psychological accounts have different accounting methods and psychological operation rules. Assets cannot easily be transferred from one account to another. However, the way and operation rules of this psychological accounting are quite different from those of economics and mathematics. Therefore, decisions are often influenced in unexpected ways, making individual decisions violate the simplest rational economic laws.

Psychological accounts are often linked to reference prices. Thaler[6] believes that there is a dual process of comparison between psychological accounts. Consumers compare the reference price and the actual price to produce "transaction utility", and compare the actual price and product value to produce "acquired utility" when they consume products. Baucells and Hwang[8] put forward the MRAR model by considering the psychological account and reference price into the multi-stage purchase decision. This model effectively explains endowment effect, sunk cost effect, payment depreciation and fixed rate deviation. Therefore, it is necessary to consider both consumer psychological account and reference price in the dynamic pricing model.

This paper will examine the common influence of reference price and psychological account on consumers and retailers, and introduce behavioral economics concepts such as reference price and psychological account into the dynamic pricing model. The existence of psychological account influences people to treat different expenditures and incomes with different attitudes, so as to make different decisions and behaviors. Previous studies mostly focused on the fact that consumers purchase products based on current price, income level or market conditions, etc., with little consideration given to the reference price effect. Dynamic pricing strategy that considers consumer behavior would be more consistent with the actual decision-making behavior of consumers. Based on the three price strategies in the bargaining model built by Lin zhibing, this paper combines psychological account with reference price, introduces the psychological account reference price model, and discusses the pricing strategy of consumers' optimal psychological account.

2. Model assumptions

Taking a single consumer and a single retailer as the research object, we first determine the price f of the psychological account of consumers, assume that the minimum price (wholesale price) acceptable to retailers (w) determined by the bargaining model between retailers and consumers, and finally determine that the retail price is p. Taking a single consumer and a single retailer as the research object, we first determine the price f of the psychological account of consumers, assume that the minimum price (wholesale price) acceptable to retailers (w) determined by the bargaining model between retailers and consumers, and finally determine that the retail price is p. So the market demand function is $\mathrm{D} = \mathrm{N} - \mathrm{bp} + \alpha(f-p)^{+} - k\alpha(p-f)^{+}$, including$(x)^{+} = \max(x, 0)$, potential market demand is N, b said consumer price sensitivity, α for mental accounts anchoring effect coefficient, said retail prices and mental accounts with reference to the change of the price difference effect on demand. K is loss aversion. Subscripts c and r represent consumers and retailers respectively. And assuming$0 < \mathrm{w} < \mathrm{p}, \mathrm{w} \le \mathrm{f}, 0 \le \alpha < \mathrm{k}\alpha < \mathrm{b}, \mathrm{f} \le \frac{N}{b}, k > 1$.

3. Standard model

If there is no reference effect ($\alpha = 0$) on the psychological account, the model is a simple standard model. Analyze the standard model.

The retailer's revenue function is: $\pi_r = (p-w)(N-bp)$

Available conclusion is: $\mathrm{p} = \frac{N+bw}{2b}$

If the negotiation between the consumer and the retailer fails, both the income of the retailer and the psychological account income of the consumer are 0, the bargaining model can be obtained as follows: $\max Z = (\pi_c)^{\theta}(\pi_r)^{1-\theta} = w^{\theta}\left(\frac{N+bw}{2b} - w\right)^{1-\theta}\left(N - \frac{N+bw}{2}\right)$, In which, θ $(0 \le \theta \le 1)$ represents the bargaining power of consumers, and $1-\theta$ represents the bargaining power of retailers.

So The lowest price (wholesale price) acceptable to the retailer after bargaining is $w = \frac{\theta N}{2b}$, The optimal retail price is $p = \frac{(2+\theta)N}{4b}$. Consumer psychological account earnings and retailer earnings are respectively $\pi_c = \frac{N^2\theta(2-\theta)}{8b}, \pi_r = \frac{N^2(2-\theta)^2}{16b}$.

Property 1: in the standard model, we take the partial derivative of the gains of consumers and retailers respectively, and obtain that the perceived gains of consumers' psychological accounts increase as their own costs increase, while the gains of retailers decrease as their own costs increase.

According to properties of 1: (1) when $\theta = 0$, the consumers' mental accounts yield minimum $\pi_c = 0$, and the retailer's revenue maximum $\pi_r = \frac{N^2}{4b}$; (2) when the $\theta = 1$, consumers' mental accounts yield maximum $\pi_c = \frac{N^2}{8b}$, the retailer's minimum income as $\pi_r = \frac{N^2}{16b}$.

4. Psychological account reference price model

In real life, consumers have different psychological accounts for different commodities. Due to the existence of psychological accounts, consumers will make irrational consumption behaviors. There are hidden accounts in people's minds: where to spend money, how much money to spend, in general, always have a balanced plan in mind. And the retail price will be compared with the psychological account reference price, which to a certain extent shows that the psychological account reference price has some influence on the retailer's decision-making and revenue.

The retailer's revenue function is: $\pi_r = (p-w)[N - bp + \alpha(f-p)^+ - k\alpha(p-f)^+]$

When given the psychological account reference price and wholesale price, the retailer's revenue function is transformed into the following two nonlinear programming problems:

H1: $\max \pi_{r1} = (p-w)(N - bp + \alpha(f-p))$

s.t. $\frac{N}{b} \ge f \ge p \ge w > 0$

H2: $\max \pi_{r2} = (p-w)(N - bp - k\alpha(p-f))$

s.t. $p \ge f \ge w > 0$

The corresponding H1 equation can be obtained:

$$p = \begin{cases} \frac{\alpha f + N}{2(b+\alpha)} + \frac{w}{2}, \frac{N}{b} \ge f \ge \frac{N+w(b+\alpha)}{2b+\alpha} \\ f, w \le f < \frac{N+w(b+\alpha)}{2b+\alpha} \end{cases}$$

The retailer's revenue is: $\pi_{r1} = \begin{cases} \frac{(N+\alpha f - w(b+\alpha))^2}{4(b+\alpha)}, \frac{N}{b} \ge f \ge \frac{N+w(b+\alpha)}{2b+\alpha} \\ (f-w)(N-fb), w \le f < \frac{N+w(b+\alpha)}{2b+\alpha} \end{cases}$

The corresponding H2 equation can be obtained:

$$p = \begin{cases} f, \frac{N}{b} \ge f > \frac{N + w(b+k\alpha)}{2b+k\alpha} \\ \frac{k\alpha f + N}{2(b+k\alpha)} + \frac{w}{2}, w \le f \le \frac{N + w(b+k\alpha)}{2b+k\alpha} \end{cases}$$

The retailer's revenue is: $\pi_{r2} = \begin{cases} (f-w)(N-fb), \frac{N}{b} \geq f > \frac{N+w(b+k\alpha)}{2b+k\alpha} \\ \frac{(N+k\alpha f-w(b+k\alpha))^2}{4(b+k\alpha)}, w \leq f \leq \frac{N+w(b+k\alpha)}{2b+k\alpha} \end{cases}$

In conclusion, property 2: given the minimum price acceptable to the retailer and the reference price of the consumer's psychological account, the optimal response function of the retailer is p = $\begin{cases} \frac{N+k\alpha f}{2(b+k\alpha)} + \frac{w}{2}, w \leq f \leq \frac{N+w(b+k\alpha)}{2b+k\alpha} \\ f, \frac{N+w(b+k\alpha)}{2b+k\alpha} < f \leq \frac{N+w(b+\alpha)}{2b+a} \\ \frac{N+\alpha f}{2(b+\alpha)} + \frac{w}{2}, \frac{N+w(b+\alpha)}{2b+\alpha} < f \leq \frac{N}{b} \end{cases}$

According to property two: (1) when $w \leq f \leq \frac{N+w(b+k\alpha)}{2b+k\alpha}$, f ≤ p ,this strategy called the minimum psychological account reference price strategy: that is, the consumer psychological account reference price is less than or equal to the retail price; (2) when$\frac{N+w(b+k\alpha)}{2b+k\alpha} < f \leq \frac{N+w(b+\alpha)}{2b+a}$, the strategy is called the mental accounts prices remain strategy: the retail price is equal to the mental accounts reference price; (3) when$\frac{N+w(b+\alpha)}{2b+\alpha} < f \leq \frac{N}{b}$, f > p ,this strategy is called the maximum psychological account reference price strategy: that is, the consumer psychological account reference price is greater than the retail price. (4) no matter what pricing method the retailer chooses, the retail price will increase with the increase of the reference price of the consumer psychological account. (5) by analyzing the impact of wholesale price change on retail price, it can be seen that when the wholesale price is equal to the psychological price of consumers, the change of wholesale price has no impact on retail price, while in the other two cases, half of the change of wholesale price will affect the retail price.

5. The lowest psychological account reference price

When the retailer adopts the minimum psychological account reference price strategy, according to the result of property 2, the wholesale price and the psychological account reference price meet the condition $w \leq f \leq \frac{N+w(b+k\alpha)}{2b+k\alpha}$. Convert this constraint to f ≥ w ≥ $\frac{f(2b+k\alpha)-N}{b+k\alpha}$.

Through the bargaining model, the following nonlinear programming problems can be obtained:max$Z_1 = (\pi_c)^{\theta}(\pi_r)^{1-\theta} = w^{\theta}(\frac{N+k\alpha f}{2(b+k\alpha)} - \frac{w}{2})^{1-\theta}\frac{N+k\alpha f-w(b+k\alpha)}{2}$, s.t. f ≥ w ≥ $\frac{(2b+k\alpha)f-N}{(b+k\alpha)}$

The conclusion is： w = $\begin{cases} \frac{f(2b+k\alpha)-N}{b+k\alpha}, \frac{(2+\theta)N}{4b+(2-\theta)k\alpha} < f \leq \frac{N}{b} \\ \frac{\theta(N+k\alpha f)}{2(b+k\alpha)}, \frac{\theta N}{2b+(2-\theta)k\alpha} < f \leq \frac{(2+\theta)N}{4b+(2-\theta)k\alpha} \\ f \quad , \ 0 < f \leq \frac{\theta N}{2b+(2-\theta)k\alpha} \end{cases}$

From the above equation, it can be seen that :(1) no matter what the psychological account reference price is, the minimum price acceptable to the retailer will increase with the increase of the psychological account reference price. (2) as the reference price of the consumer's psychological account is determined, when the reference price of the psychological account meets the requirement of being $\frac{\theta N}{2b+(2-\theta)k\alpha} < f \leq \frac{(2+\theta)N}{4b+(2-\theta)k\alpha}$, The lowest price a retailer can accept is affected by bargaining power， The higher the bargaining power, the higher the lowest price the retailer can accept. In other cases, the minimum price a retailer can accept has nothing to do with bargaining power.

Property 3: the following three optimization problems can be obtained by taking the above formula into the income function of consumers' psychological accounts:

P1： max$\pi_{c1} = \frac{f(2b+k\alpha)-N}{b+k\alpha}(N-fb)$

s.t.$\frac{(2+\theta)N}{4b+(2-\theta)k\alpha} < f \leq \frac{N}{b}$

Optimal psychological account reference price: f = $\frac{(3b+k\alpha)N}{b(4b+2k\alpha)}$, The psychological account earnings of consumers: $\pi_{c1} = \frac{N^2(b+k\alpha)}{4b(2b+k\alpha)}$

P2:max$\pi_{c2} = \frac{\theta}{2}\frac{N+kf\alpha}{b+k\alpha}\frac{N+kf\alpha}{2}(1-\frac{\theta}{2})$

s.t.$\frac{\theta N}{2b+(2-\theta)k\alpha} < f \leq \frac{(2+\theta)N}{4b+(2-\theta)k\alpha}$

Optimal psychological account reference price: f = $\frac{(2+\theta)N}{4b+k\alpha(2-\theta)}$, The psychological account earnings of consumers: $\pi_{c2} = \frac{N^2\theta(4-2\theta)(b+k\alpha)}{(4b+2k\alpha-k\alpha\theta)^2}$

P3： max$\pi_{c3} = f(\frac{N+kf\alpha}{2} - \frac{b+k\alpha}{2}f)$

s.t.$0 < f \leq \frac{\theta N}{2b+k\alpha(2-\theta)}$

Optimal psychological account reference price: f = $\frac{\theta N}{2b+k\alpha(2-\theta)}$, The psychological account earnings of consumers: $\pi_{c3} = \frac{N^2\theta(2-\theta)(b+k\alpha)}{2(2b+2k\alpha-k\alpha\theta)^2}$

because$\pi_{c1} - \pi_{c2} > 0$ and $\pi_{c2} - \pi_{c3} > 0$, so $\pi_c = max\{\pi_{c1}, \pi_{c2}, \pi_{c3}\} = \pi_{c1}$, Then the reference price of the optimal psychological account selected by consumers is f = $\frac{(3b+k\alpha)N}{b(4b+2k\alpha)}$, at this time, consumers' psychological accounts get the best benefits.

Property 4: bring the consumer's psychological reference price into the lowest price is w = $\frac{N}{2b}$ that the retailer and the consumer can accept after bargaining. The retail price p = $\frac{N(3b+k\alpha)}{2b(2b+k\alpha)}$. This price is the lowest point of the consumer's psychological account's lowest reference price strategy. The benefits of consumers' mental accounts and retailers respectively are $\pi_c = \frac{N^2(b+k\alpha)}{4b(2b+k\alpha)} and\ \pi_r = \frac{N^2(b+k\alpha)}{4(2b+k\alpha)^2}$. The above analysis shows that under the minimum psychological account reference price strategy, the benefits of consumers' psychological account and retailers' benefits have nothing to do with their bargaining power.

Property 5: （1）$\frac{\partial\pi_c}{\partial k} < 0$, $\frac{\partial\pi_c}{\partial\alpha} < 0$；

（2）$\frac{\partial\pi_r}{\partial k} < 0$, $\frac{\partial\pi_r}{\partial\alpha} < 0$。

From property 5, it can be seen that the psychological account income of consumers decreases with the increase of loss aversion degree of consumers, and the income of retailers also decreases with the increase of loss aversion degree of consumers. Because, when the loss of consumer abhorrence degree is bigger, the effect of consumer psychology account cross-reference price is more apparent, the space that consumer USES cross-reference price of its psychology account and retailer bargain is bigger.

Property 6: $\pi_{c1} > \pi_c, \pi_{r1} < \pi_r$

According to property 6, no matter how bargaining power of consumers is, under the reference price strategy of the minimum psychological account, the benefits of consumers' psychological account are always greater than the benefits under the standard model, while the benefits of retailers are always less than the benefits under the standard model.

6. The concluding

Based on the single consumer and a single retailer sales model as the research object, to the introduction of the consumer mental accounts reference prices in the model as reference prices of consumers, consumers and retailers using bargaining model to determine the retailers can accept the lowest price, the consumer mental accounts on consumers can accept the highest price. This paper

first introduces the standard model without considering the reference price of psychological accounts and analyzes the income situation of consumer psychological accounts and retailers in this situation. Secondly, it introduces the reference price of consumer psychological account and constructs the reference price model. In this model, the retailer's pricing strategies are divided into the lowest psychological account reference price strategy, the psychological account reference price maintenance strategy, and the highest psychological account reference price strategy. This paper only analyzes the situation under the reference price strategy of the lowest psychological account. It can be concluded that under the reference price strategy of the minimum psychological account, the income of consumers' psychological account is higher than that under the standard model, while that of retailers is lower than that under the standard model. The minimum psychological account refers to the price strategy for the consumer's consumption decision, and provides reference to the best price acceptable for bargaining with the retailer.

The conclusion of this paper has certain reference significance for the allocation of psychological accounts of consumers. Consumers can bargain with retailers and determine an optimal transaction price by determining an optimal psychological account.

In this paper, some meaningful conclusions have been obtained through theoretical research, but the model is relatively simple. It only studies the situation under the reference price strategy of the consumer's minimum psychological account, and there are still research directions that can be expanded. In fact, consumers are influenced by many other factors when making decisions.