Analysis of Corporate Sales Strategies in the Presence of Resale Platforms

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Abstract. The existence of resale platforms may have a certain cannibalization effect on firms' profits. Using Xiaomi phones as a research object, a two-stage model is developed based on the heterogeneity of consumer preferences for new and old products, with resale platforms only appearing in stage 2. We compare and analyze the maximum profits of electronic durable goods enterprises with direct sales and monopoly on new products under three different forms of resale platforms, i.e., only third-party C2C resale platform, B2C resale platform under enterprise trade-in, and enterprise's own C2C resale platform, to decide whether and how to enter the resale platform and the optimal pricing of products. In the second stage of the study, it was found that in general, enterprises choose to enter the resale platform, and as the price of product 1 in the first stage, the unit cost of product 2 in the second stage and the degree of loss of Second-hand product 1 increase, the optimal entry mode of enterprises changes from the B2C resale platform under trade-in to the self-owned C2C resale platform.

Keywords: Resale Platform, Consumer Utility, Corporate Profit, Net Product Salvage value.

1. Introduction

Durable goods still have use value after being used and can therefore re-enter circulation and be traded twice through resale platforms. However, the existence of secondary transactions can cause consumers who originally intended to buy new products to turn to the secondary market (resale platform), thus affecting the profit of enterprises. Admittedly, companies can choose to operate their own resale platforms to attract this segment of consumers, creating a situation where the old and new markets coexist. However, if the business strategy is not appropriate, then the self-operated resale platform will bring losses to the enterprise. Therefore, what strategy should be used to deal with resale platforms needs further study.

To address this issue, a two-stage model is developed based on the heterogeneity of consumers' preferences for new and old products using Xiaomi cell phones as the research object. The model is then used to calculate the maximum profit of the company in the presence of different modes of resale platforms, i.e., third-party C2C resale platform, B2C resale platform under the company's trade-in, and the company's own C2C resale platform. Finally, this paper takes profit maximization as the starting point, takes into account factors such as product upgrade, old product wear and tear, and consumer utility, and provides suggestions for companies' sales strategies. This study addresses the following questions: 1) whether to enter the second-hand market; 2) which model to choose to enter the second-hand market

2. Problem description and model construction

2.1. Problem description and hypothesis

This paper takes Xiaomi cell phones as an example to explore the model choice and pricing strategy in the presence of a resale platform for a firm with a direct sales monopoly on new products at each stage, without a third-party downstream supply chain. In a two-stage model, at each stage Xiaomi sells only the latest new product in the current stage and has a complete monopoly over it. The resale platform exists only in the second stage, and this paper investigates the firm's sales strategy in the second stage in the presence of the resale platform.

This paper defines the latest products in both phases as products with similar functional attributes, but with some differences in production process, hardware configuration and after-sales service, e.g., Xiaomi 10 and Xiaomi 11. Therefore, this paper defines these two products as the first-generation products, product 1 (Xiaomi 10) and the second-generation products, product 2 (Xiaomi 11), representing the latest products in phases 1 and 2, respectively. Similar to the literature [1]. In the second stage, the firm no longer sells the new product1, and only some of the used products1 are circulated in the resale platform.

In the firm's product production and product upgrade decisions, the pricing of the newest product in each stage should be higher than the newest product in the previous stage, i.e.,$p_1 > p_0$. Considering the increase of R&D investment in new products and the reduction of manufacturing cost due to technological upgrading, the relationship between the unit variable cost c_0 and c_1 of the newest product at each stage cannot be directly judged. In the presence of resale platform, enterprises decide whether to participate in the resale platform according to their own interest maximization, and if they participate, whether to choose the B2C resale platform under trade-in or the C2C resale platform run by enterprises to enter the resale platform. In this paper, we discuss the sales strategies of enterprises under the above three resale platforms, and compare the profit functions of enterprises under different situations to determine the mode choice and optimal pricing strategies.

Model 1: Third-party-only C2C resale platform, in which Xiaomi chooses not to enter the resale platform and only participates in the sale of new products in each phase. Consumers of new product 1 in the first phase can choose to sell their Second-hand product 1 in the third-party C2C resale platform at the market clearing price in the second phase based on the principle of maximizing their utility.

Model 2: B2C resale platform under corporate trade-in, in which Xiaomi chooses to recycle Second-hand product 1 in the second stage from the holders of Second-hand product 1 who want to buy product 2 through the trade-in strategy and re-sell it to the consumers who want to buy Second-hand product 1 in the second stage to gain benefits. The company owns the pricing right of used product 1.

Model 3: Enterprise owned C2C resale platform. In this model, Xiaomi builds and operates its own C2C resale platform, where consumers can trade used product 1 as buyers and sellers at market-clearing prices, and Xiaomi profits from a proportional share of the total sales of used products in the resale platform. According to the reality, the percentage of commission is generally less than 30%, i.e., $0<f<0.3$. Consumers generally recognize the quality of goods purchased through this platform more than third-party C2C resale platforms, and this is reflected in the utility function of consumers for used products.

Assumptions: (i) firms and rational consumers make decisions according to their own interests or utility maximization; (ii) the price of used product 1 in the C2C resale platform is determined by the market clearing price at supply equilibrium; (iii) the demand for used product 1 in the second stage of model 2 is assumed to be no greater than the supply, and there is no oversupply; (iv) the total number of consumers in both stages remains the same, assuming that the total number of products is 1, and each consumer can only buy at most 1 Xiaomi product at each stage. (v) assuming that the utility of the old product to the consumer is negligible when the consumer holds the new product. As rational consumers, Stage 1 purchasers will choose not to hold the Second-hand product 1 when they consider buying the new product 2 in Stage 2; (vi) the transaction cost in the resale platform is neglected; (vii) the case that the Second-hand product 1 is completely damaged in Stage 2 is neglected.

2.2. Demand function model construction

Consumers decide whether to buy a product and which product to buy by the magnitude of the net consumer utility obtained from the different purchase choices. Similar to the literature [1], it is assumed that the customers' evaluated value of the new product at each stage is v, which follows a uniform distribution of [0, 1], and similarly, the number of customers is uniformly distributed over this interval with a density of 1. The residual value coefficient of the old product is $\delta, 0 < \delta < 1$, and

in modes 1 and 2, the customers' evaluated value of the Second-hand product1 at the second stage is δv, but since the customers' recognition of the product quality of the company's own C2C resale platform is generally However, since customers' recognition of the product quality of the company's own C2C resale platform is generally higher than that of other cases, the customer's evaluation value of the second stage used product 1 in model 3 is $(1+\alpha)\delta v, 0<\alpha<1$. In the first stage, when the only product available in the market is Product 1 sold through the official channel, the net utility for consumers to purchase the new Product 1 is $v-p_0$. When $v-p_0 \geq 0$, the customer chooses to buy the new product 1 in the first stage; when $v-p_0$ <0, the customer chooses not to buy it in the first stage. In the second stage, there is a new product2 sold in the official channel and a used product1 in the resale platform. Since the used product in the C2C resale platform is priced at the market clearing price, the buyer in the first stage can choose to continue to hold product1 in the second stage, resell used product1 but not buy product2 (except for mode 2), or resell used product1 and buy new product2. consumers who do not purchase Product 1 in Stage 1 can choose to purchase new Product 2, purchase used Product 1, or continue to not purchase any product in Stage 2, depending on net utility maximization. The utility functions of customers with different purchase choices in the first stage for each of the three different modes in the second stage are shown in Table 1.

Table 1. Utility functions under different models

Consumer Type	$v-p_0 \geq 0$	$v-p_0<0$
Model 1	$\max\{\delta v, p_2, v+p_2-p_1\}$	$\max\{0, v-p_1, \delta v-p_2\}$
Model 2	$\max\{\delta v, v+ap_0-p_1\}$	$\max\{0, v-p_1, \delta v-p_3\}$
Model 3	$\max\{\delta v, p_4, v+p_4-p_1\}$	$\max\{0, v-p_1, \delta(1+\alpha)v-p_4\}$

By comparing the utility functions of different consumption choices according to the principle of consumer utility maximization, we can obtain the proportion of customers with different consumption choices in the total group of consumers, and then obtain the proportion of each type of consumers who buy new product 2 or used product 1 in the second stage, as shown in Table 2. Because of $v-p_0<0$, consumers who do not buy new product 1 in the first stage will not choose to buy new product 2 in the second stage, and q_1 will be zero. Therefore, the demand functions for new product 2 and used product 1 are q_0 and q_2, respectively.

Table 2. Share of customers with different consumption choices in the total consumer group

Consumer Ratio	Model 1	Model 2	Model 3
q_0	$q_0=1+\frac{p_1-p_2}{\delta-1}$	$1-\frac{ap_0-p_1b}{\delta-1}$	$1+\frac{fp_4+p_1''-p_4}{\delta-1}$
q_1	0	0	0
q_2	$q_2=\frac{p_0-p_2}{\delta}$	$\frac{p_0-p_3}{\delta}$	$p_0-\frac{p_4}{\delta(1+\alpha)}$

3. Model building and solving

3.1. Third-party-only C2C resale platform

The demand functions for new product 2 and used product 1 in the second stage are:

$$q_0=1+\frac{p_1-p_2}{\delta-1} \tag{1}$$

$$q_2=\frac{p_0-p_2}{\delta} \tag{2}$$

The price of Second-hand product 1 in the C2C resale platform is determined by the market clearing price at supply equilibrium. In this model, Xiaomi does not enter the resale platform and

only participates in the sale of new products at each stage. It is easy to prove that under a third-party-only C2C resale platform, the firm has a unique optimal price for new product 2:

$$p_1^* = \frac{p_0\delta}{2} + \frac{c_1}{2} - \frac{\delta}{2} + \frac{1}{2} \tag{3}$$

The final maximum revenue available to the firm is:

$$\pi_1(p_1)^* = \frac{(p_0-1)^2\delta^2}{4} - \frac{(p_0-1)(c_1-1)\delta}{2} + p_0^2 - (c_0+1)p_0 - \frac{c_1^2}{4} + \frac{c_1}{2} + c_0 - \frac{1}{4} \tag{4}$$

The demand for new product 2 is

$$q_0^* = \frac{(p_0-1)\delta}{2} - \frac{c_1}{2} + \frac{1}{2} \tag{5}$$

3.2. B2C resale platform under enterprise trade-in

The demand functions for new product 2 and used product 1 in the second stage are

$$q_0' = 1 - \frac{ap_0 - p_1 b}{\delta - 1} \tag{6}$$

$$q_2' = \frac{p_0 - p_3}{\delta} \tag{7}$$

In the B2C resale platform under enterprise trade-in, Xiaomi Company gives the buyer of Product 1 in the first stage a discount on the purchase of Product 2 in the second stage at a ratio of the original price of Product 1, i.e., the buyer can buy the new Product 2 at a price $(p_1' - ap_0)$. The company resells the recycled used Product 1 to the consumer who wants to buy the used Product 1 in the second stage through the official channel and obtains the benefit. Under the B2C resale platform, the firm has the pricing power of the used product 1. Using the Lagrange multiplier method, the firm has a unique optimal price for new product 2 and used product 1 under the B2C resale platform of the firm's trade-in:

$$p_1'^* = \frac{1}{2} + ap_0 + \frac{c_1}{2} - \frac{\delta}{2} \tag{8}$$

$$p_3^* = \frac{\delta p_0}{2} \tag{9}$$

The final maximum revenue available to the firm is:

$$\pi_2(p_1', p_3, a) = \frac{1}{4\alpha - 4}((p_0^2 - 1)\delta^2 + (-5p_0^2 + p_0(4c_0 + 4) - 4c_0 - 2c_1 + 2)\delta + 4p_0^2 - p_0(4c_0 + 4) - c_1^2 + 4c_0 + 2c_1 - 1) \tag{10}$$

The demand for new product 2 and used product 1 are

$$q_0' = 1 - \frac{\delta - c_1 - 1}{2(\delta - 1)} \tag{11}$$

$$q_2' = \frac{p_0}{2} \tag{12}$$

3.3. Enterprise-owned C2C resale platform

The demand functions for new product 2 and used product 1 in the second stage are

$$q_0'' = 1 + \frac{fp_4 + p_1'' - p_4}{\delta - 1} \tag{13}$$

$$q_2'' = p_0 - \frac{p_4}{\delta(1+\alpha)} \tag{14}$$

In this model, Xiaomi builds and operates its own C2C resale platform, where consumers can trade used products1 as buyers and sellers at a market-clearing price p_4, and Xiaomi takes a proportional share *f* of the total sales of used products in the resale platform. The consumer's recognition of the quality of the product on the firm's own resale platform changes the utility of used product 1 to the consumer from δv to $(1+\alpha)\delta v$, where $0 < \alpha < 1$.

Under the firm's own C2C resale platform, there is a unique optimal pricing for the firm's new product 2:

$$\begin{aligned} p_1''^{*} = \frac{\alpha\delta + 1}{2}(&-\alpha^2\delta^2 f p_0 + \alpha^2\delta^2 p_0 - \alpha\delta f c_1 - \alpha\delta^2 f + \alpha\delta^2 p_0 - 2\alpha\delta f p_0 + \delta^2 f p_0 \\ &+ \alpha\delta c_1 - \alpha\delta^2 + \alpha\delta f + \alpha\delta p_0 - \delta f c_1 - \delta^2 f - 2\delta f p_0 + \alpha\delta + \delta f + \delta p_0 \\ &+ c_1 - \delta + 1) \end{aligned} \tag{15}$$

The final maximum revenue available to the firm is:

$$\begin{aligned} \pi_3(p_1'') = \frac{1}{4\alpha\delta + 4}(&((1+\alpha)p_0 - 1)^2\delta^2 + (-4\alpha p_0^2 + (4c_0 - 2c_1 + 6)\alpha - 2c_1 + 2)p_0 \\ &- 4c_0\alpha + 2c_1 - 2)\delta - 4p_0^2 + (4c_0 + 4)p_0 + c_1^2 - 2c_1 - 4c_0 + 1) \end{aligned} \tag{16}$$

The demand for new product 2 is

$$q_0'' = \frac{(\alpha p_0 + p_0 - 1)\delta - c_1 + 1}{2\alpha\delta + 2} \tag{17}$$

4. Comparative Analysis of Different Resale Platform Models

In this section, we focus on the optimal resale model for different situations and the impact of different influencing factors on the pricing of new and used products under different resale platform models. Easy to prove to obtain that $\delta - \delta p_0 + c_1 - 1 > 0$ holds.

4.1. Analysis of the relationship between the total profit function and the unit cost of product 2

First, we compare and analyze the impact of product2 unit cost c_1 on the total profit function under different resale platform models.

The first-order derivatives of the profit function with respect to δ, c_1 are obtained for each of the three cases:

$$\frac{\partial \pi_1}{\partial c_1} = \delta - \delta p_0 + c_1 - 1 \tag{18}$$

$$\frac{\partial \pi_2}{\partial c_1} = \delta + c_1 - 1 \tag{19}$$

$$\frac{\partial \pi_3}{\partial c_1} = (\alpha p_0 - p_0 + 1)\delta + c_1 - 1 \tag{20}$$

Because $\delta - \delta p_0 + c_1 - 1 > 0$ is constant, π_1 always increases as δ or c_1 increases. Since $\delta + c_1 - 1 > \delta - \delta p_0 + c_1 - 1, (\alpha p_0 - p_0 + 1)\delta + c_1 - 1 > \delta - \delta p_0 + c_1 - 1$, $\frac{\partial \pi_2}{\partial c_1} > 0$ and $\frac{\partial \pi_3}{\partial c_1} > 0$ are also constant, π_1 and π_3 always increase as δ or c_1 increases.

Therefore, in all three models, the total profit always decreases with the increase of the unit cost of product 2: the decrease of the unit cost of new products can bring more revenue to the enterprise, so the enterprise should pay attention to scientific research, increase the investment in scientific research, and actively promote product upgrading, so as to reduce the unit cost of new products.

4.2. Mode choice of enterprise participation in resale platform

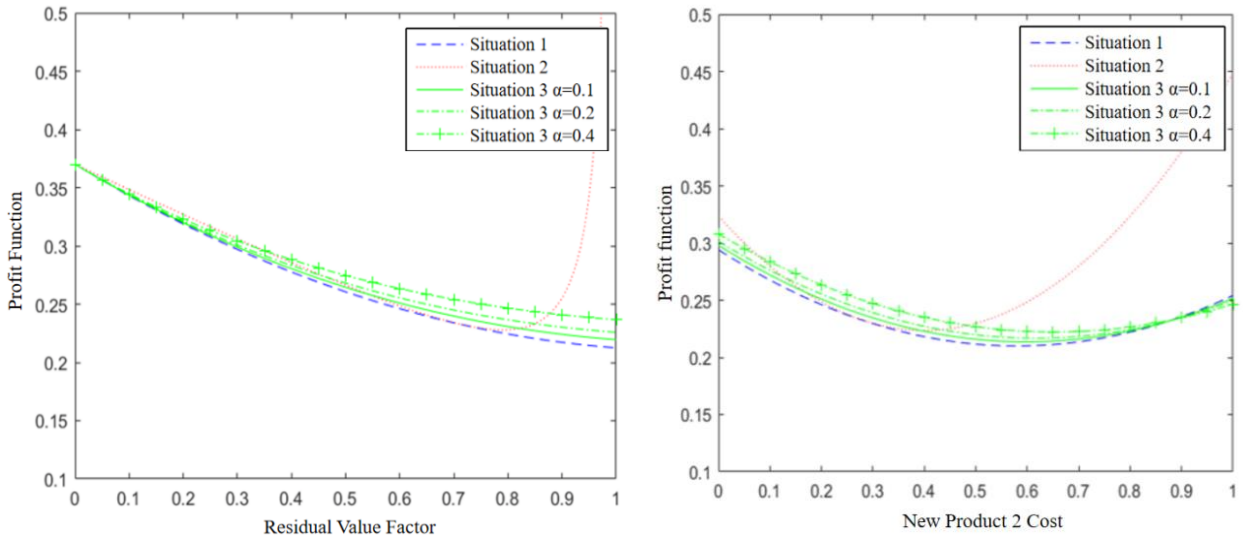
The choice of whether a firm will enter the resale platform or not, except for the special case where the degree of loss of the Second-hand product1 and the unit cost of the new product2 are extremely high, the profit of a firm entering the resale platform is generally better than that of a firm not entering, so the firm will choose to enter the resale platform.

4.2.1. Influence of α on the choice of resale platform mode of enterprise participation

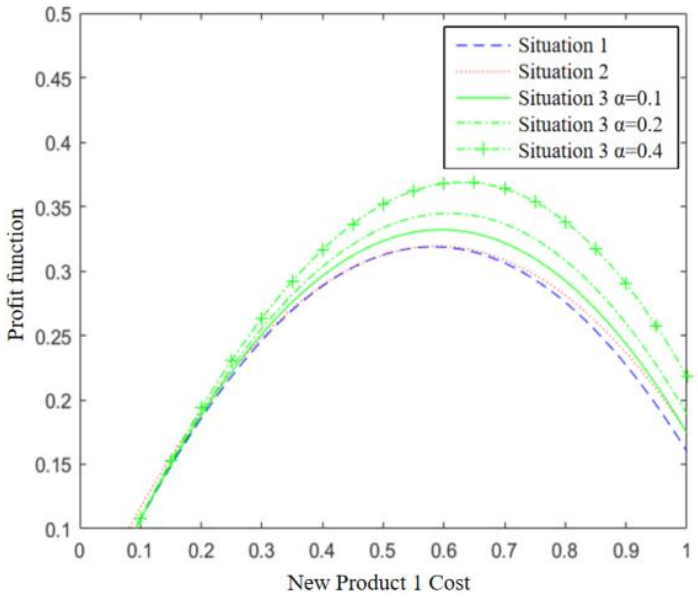
The profit of a firm's self-operated C2C platform increases incrementally with the increase of consumers' recognition of its quality, and the firm's optimal resale platform mode gradually changes from mode 2 to mode 3. Taking the first-order derivative of π_3 with respect to α, we obtain

$$\frac{\partial \pi_3}{\partial \alpha} = \frac{-\delta p0 + c1 + \delta - 1}{p0\delta} - \alpha \tag{21}$$

Simulations were performed using the software Matlab, taking the profit functions of three modes 3 with α=0. 1, 0. 2, and 0. 4, respectively. Without independent variables, p_0=0. 3, c_1=0. 2, c_0=0, δ=0. 6, f=0. 1, a =0. 2. The two-dimensional plots of the profit functions of the three modes with respect to δ, c_1, p_0, respectively, are obtained in Figure 1.



(a) Variation of enterprise profit with salvage value factor (b) Variation of enterprise profit with cost of new product2



(c) Variation of enterprise profit with the price of brand-new product1

Figure 1. Variation of enterprise profit with different quality recognition

In reality, α is smaller, in the interval [0, 0. 5], which basically satisfies $\alpha < \frac{-\delta p_0 + c_1 + \delta - 1}{p_0 \delta}$, and the profit function 3 increases monotonically. As can be seen from the figure, the optimal mode of the enterprise gradually changes from mode 2 to mode 3 as α increases. Therefore, when consumers recognize the quality of used products on the company's own C2C resale platform, the company prefers its own C2C resale platform; on the contrary, it chooses the B2C resale platform under trade-in.

4.2.2. The impact of δ, c_1, p_0 on the choice of resale platform models for business participation

Using Matlab simulation, we take the selling price of new product 1 p_0 = 0. 3, the degree of loss δ of Second-hand product 1, and the unit cost c_1 of new product 2 as independent variables, and make a projection diagram of the maximum profit function with respect to δ and c_1 in the three models.

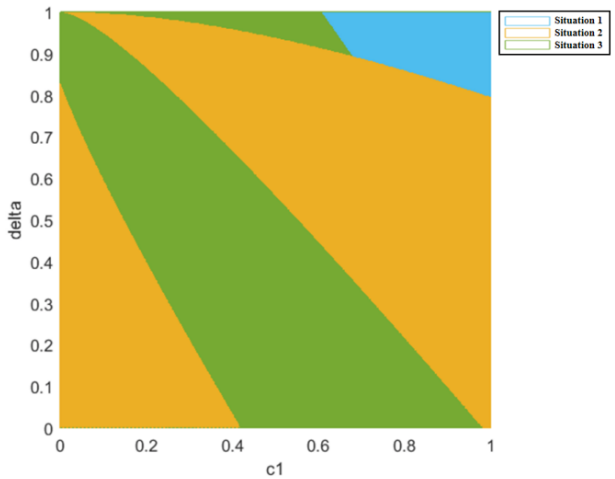


Figure 2. Projection diagram of the optimal model of the enterprise with respect to $\boldsymbol{\delta}$, $\boldsymbol{c_1}$

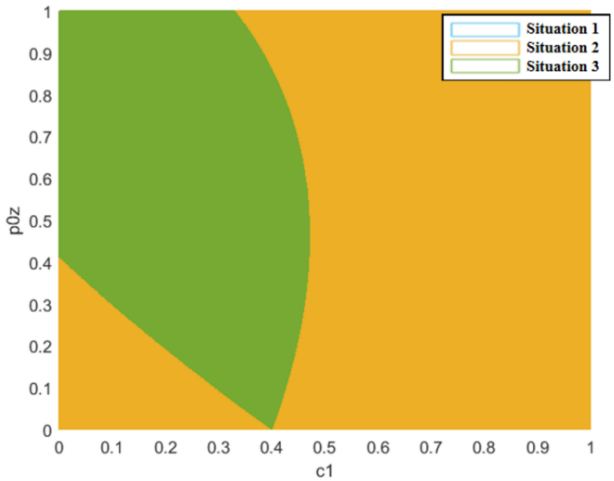


Figure 3. Projection diagram of the optimal model of the enterprise with respect to p_0, $\boldsymbol{c_1}$.

As shown in the Figure 2, except for the special cases where the loss of Second-hand product 1 δ and the unit cost of new product 2 c_1 are very large, companies usually choose to enter the resale platform, and as the price of product 1 in the first stage, the unit cost of product 2 in the second stage

and the loss of Second-hand product 1 increase, the optimal entry model for companies has changed from a B2C resale platform under trade-in to a self-operated C2C resale platform.

Using Matlab simulation, we take the loss degree $\delta = 0.6$ of Second-hand product 1, the price of new product 1 and the unit cost c_1 of new product 2 are the independent variables, and the projection diagrams of the maximum profit function in the three models are made with respect to p_0 and c_1.

The projection of the profit function with respect to p_0 and c_1 shows that when δ is certain, and c_1 is large, the optimal mode of the firm is always trade-in. When c_1 is small, as the selling price p_0 of the new product1 increases, the optimal model for the second stage firms changes from a B2C resale platform under trade-in to a self-operated C2C resale platform.

5. Conclusion

In this paper, we take Xiaomi cell phone of Xiaomi, an electronic durable goods company with a monopoly on new products, as the object of study. Based on the heterogeneity of consumers' preference for new and used products, a two-stage model is developed and a consumer utility function is constructed to analyze the market demand for new and used products at each stage. On this basis, we compare and analyze the maximum profits of enterprises under three different forms of resale platforms through Maple model optimization and Matlab simulation analysis, and decide whether and how to enter the resale platform.

The results show that in general, enterprises choose to enter the resale platform, and as the price of product 1 in stage 1, the unit cost of product 2 in stage 2 and the loss of Second-hand product 1 increase, the optimal entry mode of enterprises changes from a B2C resale platform under trade-in to a self-owned C2C resale platform;

Although this paper has studied the sales strategies of electronic durable goods firms with direct sales and monopoly on new products in the presence of resale platforms and obtained some valuable conclusions, there are still many issues that deserve further exploration, such as differential pricing of the same product, competition among multiple products, and competition in multi-channel sales. These issues will be the focus of subsequent research.

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