Research Article

Impact of Consumer Strategic Behavior on the Supplier Channel Selection in a Retailing Platform

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Flourishing online retailing has spawned the agency selling channel, which motivates suppliers to choose among traditional reselling (R), agency selling (A), and hybrid channel strategies (H). In this paper, considering a supplier and a retail platform facing strategic consumers, we develop a Stackelberg game to examine the equilibrium pricing under three channel strategies and further analyze the impact of consumer strategic behavior on the supplier’s channel selection. Results indicate that consumer strategic behaviors induce the intertemporal competition, by reducing the price difference between the two periods. Meanwhile, channel competition can mitigate the effect of strategic behaviors. Furthermore, supply chain members also employ different pricing policies in accordance with channel strategies to respond to more strategic consumers. Specifically, prices would be raised to acquire high-valued consumers in Strategy H, while “small profits but quick turnover” would be taken in the pure channel strategies. Moreover, the supplier optimal channel strategy is a threshold strategies of commission rate, below which Strategy H is preferred, and Strategy R is preferred otherwise, noticing that Strategy A is never be selected. Interestingly, we find that the supplier, retail platform, and consumers could be better off at the same time only when the hybrid channel strategy is selected.

1. Introduction

The world’s e-commerce market keeps on expanding. Statista [1] assesses the worldwide retail e-commerce sales in 2022 surpassed 5.7 trillion dollars and will continue to grow. To capture a larger market share, e-commerce platforms constantly innovate and incorporate the agency selling service in an effort, like Platform Open Plan of JD.com. Suppliers can therefore offer products directly to consumers by paying commissions to platforms (agency selling channel), selling products to platforms (reselling channel), as well as combining both of the two channels (hybrid channel). Taking the fast fashion brands on JD.com as examples, MLB adopts the pure reselling channel strategy, GAP chooses the pure agency selling channel, and MUJI chooses the hybrid channel strategy.

One of the key challenges for businesses to increase their profitability is deciding which of the three channel strategies to use, as each channel strategy has its characteristics that must be taken into consideration. Existing literature [2, 3] discusses the three channel strategies deeply. It is demonstrated that the traditional reselling channel results in a double marginalization effect, as each company seeks to maximize its own profits. In the pure agency selling channel, suppliers may face challenges in ensuring market coverage and gathering information, which are functions that retailers typically excel at. The hybrid channel can offer greater market penetration, as it combines the strengths of both reselling and agency selling channel. However, it can also lead to issues such as price undercutting, channel conflict, and reduced trust between suppliers and platforms. Therefore, suppliers are faced with choosing among different channel strategies to get the optimal profits. There has been a lot of literature on channel selection and whether new channels should be introduced. Tsay and Agrawal [3], and Shi et al. [4] consider the trade-offs between the advantages of increased sales and the disadvantages of channel cannibalism. Moreover, recent studies have extensively discussed channel strategies with different emphasis, such as differentiated goods [5], information sharing [6], and operating cost [7].
Meanwhile, online retailing has witnessed the prevalence of strategic consumers. Consumers may openly access previous pricing information through platforms, which encourages waiting for promotions before making a purchase. This behavior can create fluctuations in demand and lead to losses for retailers, which are proved in early research Besanko and Winston [8]. Nowadays, a growing number of studies [9, 10] investigate how to resist the effect of strategic consumers. Recent studies have begun to examine the effect of strategic consumers in various scenarios, such as sharing economy [11], product returns [12], and channel selection [13]. To the best of our knowledge, the impact of strategic consumers on channel selection in the background of multiperiods in a retailing platform is not fully understood by existing research. On the one hand, strategic consumers intensify the channel competition, which may harm the supplier’s profit, but on the other hand, it may mitigate the double marginalization effect at the same time, which may make the supplier better off. Thus, understanding the strategic consumer behaviors is essential for suppliers to make informed channel selection.

Motivated by the above discussions, this paper examines the optimal channel selection in the presence of consumer strategic behavior, weighing the added benefits in agency selling channel and channel competition between agency selling and reselling channel. In specific, the study of this paper addresses the following questions: What are the equilibrium solutions of the supply chain members in reselling, agency selling and hybrid channel strategies? Which channel strategy would be optimal for suppliers? What effects do strategic behaviors have on the optimal channel strategy? In order to better understand how strategic consumers impact channel selection, we model supplier and retail platform interactions as a five-stage Stackelberg game. We examine the equilibrium prices and corresponding profits under each channel. Specifically, the supplier as the first-mover decides the channel strategy and sets the initial wholesale or retail prices, and the platform follows to establish the retail price. Then, they successively establish the final prices in the second selling period. On this basis, we further investigate how changes in strategic consumer patience level affect pricing, profit, and channel selection.

Our major findings are summarized as follows. Firstly, we explain the role of strategic consumer behaviors in optimal prices by solving and analyzing the equilibrium solutions. When the patience level of strategic consumers is limited, suppliers and platforms induce consumers to purchase by reducing prices in the first period and increasing them in the second period. Moreover, in response to consumers with high patience level, pure-channel merchants sell more products at lower margins, while hybrid-channel merchants react by raising prices in order to attract high-value consumers due to the coexistence of competition and collaboration. In addition, in line with Cachon and Swinney [10], we discover that intertemporal price difference reduces so that intertemporal competition rises as customers’ strategic level grows under normal conditions. The presence of channel competition also results in a special case where intertemporal competition initially rises and then falls within a given parameter range in Strategy H, demonstrating that channel competition diminishes the impact of strategic consumers.

Second, this study examines the optimal strategy for suppliers and the role of strategic consumers in selection. For suppliers, the hybrid channel always dominates the pure agency selling channel. Additionally, the optimal channel strategy is a threshold strategy of the commission rate, below which is the hybrid channel and otherwise the reselling channel. The results are consistent with Xie et al. [14]. Furthermore, we incorporate strategic consumers to investigate the selection threshold. With varied levels of patience, we discover that the threshold strategy is nonmonotonic. This provides a supplement to the literature on channel selection by studying strategic behaviors.

Third, we analyze how the supplier’s optimal strategy interacts with optimal strategies of platforms and consumers. The selection of the hybrid channel strategy can benefit both suppliers and platforms when the commission rate is reasonable. Additionally, when moderate commission rate and low strategic level are satisfied, consumers in the hybrid channel obtain the optimal surplus. Earlier literature [15, 16], points out that adding suppliers’ direct selling channels reduces retailers’ profits. In contrast, we come to the conclusion that hybrid channel is beneficial to both sides, since we take into account the competition and cooperation game in the background of retailing platform. It also shows that the hybrid channel can regulate supply chain participants’ profits to resolve their conflicts and create a win-win-win scenario.

The rest of this paper is structured as follows. We provide a brief review of the pertinent literature in Section 2. Section 3 has a description of our model. Section 4 analyzes the equilibrium results for three channel strategies. The optimal supplier strategy is presented in Section 5. The effects of strategic consumers on channel selection are revealed in Section 6. Additionally, Section 7 further discusses the role of optimal strategy on the platform and consumers. The paper is wrapped up in Section 8 with a summary.

2. Literature Review

Our paper is related to three streams of literature, including channel selection and competition, consumer strategic behavior, and retailing platform.

The first stream concentrates on the selection and competition generated by multiple channel formats. Multichannel manufacturers not only sell to consumers through the conventional reselling channel but also engage directly in the downstream market. Early research [15, 16] discussed whether suppliers should add direct selling channels, pointing out that such channels can decrease retailer profits and supply chain efficiency. Nonetheless, subsequent literature [2, 3, 17, 18] analyzes channel conflict impacted by consumer preference, supply chain control right, and offers insights into strategies to address it, such as dynamic pricing strategies and commission payments. These articles establish a theoretical foundation of coordinating dual channels, and thus, recent studies further consider detailed factors and scenarios that impact channel selection. Some research focuses on factors related to supply chain members, such as decision-making power [19, 20], information sharing [6, 21], and the operating objectives [22, 23]. Other research focuses emerging business scenarios, such as differentiated goods Tan and Carrillo [5]; Tao et al. [24];
Another crucial stream is the study of strategic consumers. This research can be traced back to Coase [27] who demonstrated that customers who strategically delay their purchases can force a monopolist to set prices at marginal cost. In addition, Besanko and Winston [8] pointed out that such behavior can result in significant losses for retailers. In follow-up research, pricing strategies were studied to resist strategic consumer behavior, including intertemporal pricing [28], pricing commitment [9], and quick response [10]. Besides, information asymmetry and disclosure are considered [29, 30]. Lin et al. [31] found that manufacturers and retailers earn higher profits in the presence of strategic consumers in the view of holistic supply chain. In terms of recent pricing research considering strategic consumers, it has begun to capture the characteristics of supply chains under complex consumption scenarios, for instance, segmented market such as sharing economy [11] and low-carbon products [32], two-echelon news vendor [33], purchase behaviors including repeat purchasing [34], defective product returns [12], and so forth. There are related articles exploring strategic consumers’ impact in channel selection. Yu et al. [13] focus on how strategic consumers impact offline and online reselling and agency selling formats; Huang et al. [35] introduce store brand and explore its competition with suppliers. In contrast, this article explores the interaction of strategic consumer and channel selection among reselling, agency selling, and hybrid selling in the retailing platform while taking into account competitive cooperative relationship in the hybrid channel.

Lastly, the retailing platform is the foundation for our research. The interplay between retailing platform and consumers gives transformative impact on the retailing environment. The emerging research issues of retailing platforms include pricing strategies, consumer behavior, channel integration, and strategies. Pricing strategies involve pricing policy such as online coupon [36, 37], bundling pricing [38], contract design [39, 40], and pricing policies in emerging new retailing, such as omni-channel Huang and Guo [41], ship-from-store [42]. Additionally, consumer behaviors are affected by purchase intentions [43], customer satisfaction [44, 45], and perceived value [38, 46]. More importantly, channel strategies, as the focus of this paper, involve channel introduction [47–50] and channel competition and selection [35, 51, 52]. Shi et al. [50] explore the interaction between the selection of agency selling or reselling formats and downstream retailers for suppliers, with introduction of third-party retailers as the emphasis. This paper examines the selling formats on platform by considering competition and cooperation between platforms and suppliers as well as the impact of strategic consumer behaviors in platforms. We add contribution to channel selection research by applying a two-period game-theoretic model to examine the pricing decisions of supply chain members under different channel strategies in the presence of strategic consumers.

3. Model

We consider a supply chain which contains a supplier and a retail platform, facing strategic consumers. The supplier is motivated to select three channel strategies, which are reselling channel strategy (R), agency selling channel strategy (A), or hybrid channel strategy (H). Every channel strategy has its traits. In the reselling channel, retailing platforms can exert their advantages to improve consumer satisfaction and willingness to pay; the agency selling channel enables suppliers to sell directly to consumers, cutting out middlemen, and increasing their profits; the hybrid channel strategy can incorporate the benefits of the two channels, while pit platforms and suppliers in competition with each other, cannibalizing sales and profits. Thus, suppliers can choose suitable channel strategy in line with their operation and sales to improve profits. For example, MUJI, a fast fashion brand, sells products on JD.com through both self-owned stores and flagship stores. In the self-owned store, MUJI sells its products to JD.com for reselling; in contrast, MUJI sells directly to consumers in the flagship store, while JD.com provides the platform as an agent. The channel structures are depicted in Figure 1.

In the reselling channel strategy, the supplier sets the wholesale price, while the retail platform orders the product and decides the selling price to the consumers. In the agency selling channel strategy, the supplier sets the selling price and delivers its product directly to consumers via the platform, while the platform charges a commission rate $\phi$ for each unit of sales. We assume $0 < \phi < 0.5$, which is consistent with Geng et al. [53] and Xie et al. [14]. In practice, JD.com sets commission rate at 3%–20% for most product kinds, and Amazon sets the rate up to 45% for equipment accessories category. In the hybrid channel strategy, the supplier could use both the reselling and agency selling channel to deliver its product. In practice, self-run stores of platform tend to bring a better user experience due to thorough storage, logistics, and after-sales quality. Thus, this model introduces $\beta$ to describe the acceptance level of agency selling channel, where $\beta \in [0, 1]$.

Strategic consumers take into account the future opportunities and making their purchasing decisions within two selling period based on expected utility, where $i = 1, 2$ denotes the selling period. Assume that consumers’ valuation $\nu$ follows the uniform distribution of $[0, 1]$, which is consistent with existing literature [2, 54]. In practice, purchasing products immediately help consumers enjoy the maximum value. While as time goes on, the perceived value of a product decreases, which affects the consumer’s willingness to pay for it. Thus, we use $\alpha (0 < \alpha < 1)$ to measure this decline in value, which also reflects the patience level of strategic consumers. As Liu et al. [55] analyzed, a higher value of $\alpha$ implies that the consumer is more patient and is willing to wait longer for the product. In
Figure 1: Three channel structure.

contrasted, when $\alpha = 0$, consumers’ perceived value of the product $\alpha v$ can decrease to zero over time. As a result, they may be willing to pay a higher price for the product than if they had waited for its price to decrease. Besides, we assume $\beta > \alpha$, which means the consumers have limited strategic behaviors; otherwise, all consumers are waiting to purchase in the second period. And it is consistent with Liu and Zhang [56]. Specifically, in the first period, consumers choose whether or not to purchase and choose the channel from reselling or agency selling channels. When purchasing from the reselling channel in the first period, the consumer’s utility is $u_R^p = \nu - p_{r1}$ in the agency selling channel, consumer’s utility is $u_A^p = \beta \nu - p_{a1}$. If consumers are patient enough to wait and buy in the second period, consumers’ utilities in the reselling channel are $u_R^s = \alpha v - p_{r2}$, while utilities in agency selling channel are $u_A^s = \alpha \beta v - p_{a2}$. Taking Strategy H as example, when $u_R^p = u_A^p$, $v_1 = (p_{a1} - p_{r2})/(\alpha - \beta)$ and $v_2 = (p_{r2} - p_{a2})/(\alpha (1 - \beta))$ and $v_4 = (p_{a2}/\alpha \beta)$. The purchasing demand in Strategy $H$ in each period and channel can be depicted in Figure 2. Note that Strategy $R$ and $A$ are special cases of Strategy $H$. The strategy $R$ only has the demands in the first and second periods of the reselling channel, namely, $r_1$ and $r_2$ as shown in the figure while the strategy $A$ only shows $a_1$ and $a_2$. The detailed notation of decision variables, model parameters, and other symbols is shown in Table 1.

We model a five-stage Stackelberg game to illustrate the interactions of the supplier and the retailing platform. Figure 3 shows the sequence of events. In stage 1, the supplier decides the channel strategy from reselling, agency selling, and hybrid channels, given exogenous commission rate $\phi$. In stage 2, when selecting hybrid channel, the supplier decides the wholesale price $w_1$ in the reselling channel strategy and the retail price $p_{s1}$ in the agency selling. In stage 3, the platform decides the retail price $p_{r1}$ for reselling. In stage 4, the supplier sets the wholesale price $w_2$ and retail price $p_{a2}$. In stage 5, the platform sets the retail price $p_{r2}$.

The profit of both supplier and retail platform contains four parts. For suppliers, the profit comes from the wholesale profit and direct selling profit through platform in the first and second periods. For platforms, the profit comes from sales commission of supplier and sales profit in the first and second periods. Combining the demand mentioned above, the profit of supplier and platform are written as follows.

Supplier’s profit in the hybrid channel:

$$
\pi^H_s = (1 - \phi)p_{a1}\left(\frac{p_{r1} - p_{a1}}{1 - \beta} - \frac{p_{a1} - p_{c2}}{\beta - \alpha}\right) + w_1\left(1 - \frac{p_{r1} - p_{a1}}{1 - \beta}\right)

+ (1 - \phi)p_{a2}\left(\frac{p_{r2} - p_{a2}}{\alpha(1 - \beta)} - \frac{p_{a2}}{\alpha \beta}\right) + w_2\left(\frac{p_{a1} - p_{r2}}{\beta - \alpha} - \frac{p_{r2} - p_{a2}}{\alpha (1 - \beta)}\right).
$$

(1)

Platform’s profit in the hybrid channel:

$$
\pi^H_p = \phi p_{a1}\left(\frac{p_{r1} - p_{a1}}{1 - \beta} - \frac{p_{a1} - p_{c2}}{\beta - \alpha}\right) + (p_{r1} - w_1)\left(1 - \frac{p_{r1} - p_{a1}}{1 - \beta}\right)

+ \phi p_{a2}\left(\frac{p_{r2} - p_{a2}}{\alpha(1 - \beta)} - \frac{p_{a2}}{\alpha \beta}\right) + (p_{r2} - w_2)\left(\frac{p_{a1} - p_{r2}}{\beta - \alpha} - \frac{p_{r2} - p_{a2}}{\alpha (1 - \beta)}\right).
$$

(2)
Demands of Consumers

\[ \forall i, \quad \text{Supplier} \rightarrow \text{Platform} \rightarrow \text{Decide distribution channel} \]

\[ \forall i, \quad \text{Period} 1: \text{Agency selling (a)} \quad \text{Reselling (r)} \]

\[ \forall i, \quad \text{Period 2: Agency selling (a)} \quad \text{Reselling (r)} \]

Figure 2: Demands of consumers in the hybrid channel.

### Table 1: Notation

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<tr>
<th>Decision variables</th>
<th>Model parameters</th>
<th>Other symbols</th>
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**Figure 3:** The sequence of events strategy.

Similar to hybrid channel strategy, the profit functions in the reselling and agency selling channel are stated as follows. In the reselling channel, the profit of supplier is \( \pi^R_i = \omega_1 (1 - (p_{a1} - p_{r2})/(1 - \alpha)) + \omega_2 ((p_{r1} - p_{r2})/(1 - \alpha) - (p_{r2}/\alpha)) \). And the profit of platform is \( \pi^P_i = (p_{r1} - w_1) (1 - (p_{r1} - p_{r2})/(1 - \alpha)) + (p_{r2} - w_2) ((p_{a1} - p_{r2})/(1 - \alpha) - (p_{r2}/\alpha)) \). While in the agency selling channel, the profit of supplier is \( \pi^A_i = (1 - \phi) p_{a1} (1 - (p_{a1} - p_{a2})/((1 - \alpha)\beta)) + (1 - \phi) p_{a2} ((p_{a1} - p_{a2})/((1 - \alpha)\beta) - (p_{a2}/\alpha\beta)) \). And the profit of platform is \( \pi^P_i = \phi p_{a1} (1 - (p_{a1} - p_{a2})/((1 - \alpha)\beta)) + \phi p_{a2} ((p_{a1} - p_{a2})/((1 - \alpha)\beta) - (p_{a2}/\alpha\beta)) \).
4. Equilibrium Analysis

In this section, we characterize and analyze the equilibrium outcomes of reselling, agency selling, and hybrid channel strategies.

4.1. Reselling Channel Strategy. For suppliers, the profit comes from the wholesale profit; for platforms, the profit comes from sales profits. Combining the demand mentioned above, the profit of supplier and platform is written as follows. For the supplier, the objective function and constraints can be expressed as follows:

\[
\begin{align*}
\max \pi_s(w_1, w_2) &= \max \left( w_1 \left(1 - \frac{p_{r1} - p_{r2}}{1 - \alpha}\right) \right. \\
&\left. + w_2 \left(\frac{p_{r1} - p_{r2}}{1 - \alpha} - \frac{p_{r1} - p_{r2}}{\alpha}\right)\right),
\end{align*}
\]

s.t. \(0 < \frac{p_{r1} - p_{r2}}{1 - \alpha} \leq 1,\)

\(\frac{p_{r1} - p_{r2}}{1 - \alpha} - \frac{p_{r1} - p_{r2}}{\alpha} \geq 0,\)

\(w_1 < p_{r1},\)

\(w_2 < p_{r2},\)

\(w_1, w_2 > 0.\)

The profit of the platform is as follows:

\[
\begin{align*}
\max \pi_p(p_{r1}, p_{r2}) &= \max \left( (p_{r1} - w_1) \left(1 - \frac{p_{r1} - p_{r2}}{1 - \alpha}\right) \right. \\
&\left. + (p_{r2} - w_2) \left(\frac{p_{r1} - p_{r2}}{1 - \alpha} - \frac{p_{r1} - p_{r2}}{\alpha}\right)\right),
\end{align*}
\]

s.t. \(0 < \frac{p_{r1} - p_{r2}}{1 - \alpha} \leq 1,\)

\(\frac{p_{r1} - p_{r2}}{1 - \alpha} - \frac{p_{r1} - p_{r2}}{\alpha} \geq 0,\)

\(w_1 < p_{r1},\)

\(w_2 < p_{r2},\)

\(p_{r1}, p_{r2} > 0.\)

We firstly prove that the objective function is convex, then use the KKT condition to write the optimization problem with inequality constraints into an unconstrained optimization problem, and use backward induction to characterize the equilibrium prices. Please refer to the Appendix, which contains all proofs of the paper.

The equilibrium outcomes of the pure reselling channel strategy are stated in Theorem 1.

**Theorem 1.** The equilibrium outcomes in the reselling channel strategy are as follows:

\[
\begin{align*}
w_1^* &= (\alpha - 1)(79\alpha^2 - 200\alpha + 128) \\
2(4 - 3\alpha)(7\alpha - 8), \\
w_2^* &= (\alpha - 1)(19\alpha - 24) \\
2(3\alpha - 4)(7\alpha - 8), \\
\pi_p^* &= (8 - 5\alpha)^2(\alpha - 1) \\
4(4 - 3\alpha)^2(7\alpha - 8), \\
p_{r1}^* &= (\alpha - 1)(19\alpha - 24) \\
4(3\alpha - 4)(7\alpha - 8), \\
p_{r2}^* &= 3(\alpha - 1)(269\alpha^2 - 1376\alpha^2 + 2112\alpha - 1024) \\
16(8 - 7\alpha)^2(4 - 3\alpha)^2.
\end{align*}
\]

Theorem 1 shows that the optimal prices and profits of both the supplier and the platform only depend on the patience level of strategic consumers. Furthermore, we investigate how prices change as the patience level of strategic consumers changes.

**Lemma 2.** Optimal prices in the reselling channel strategy fluctuate with the patience level of consumers in ways as follows:

(i) \(w_1^* , p_{r1}^*\) decrease in \(\alpha\)

(ii) \(w_2^* , p_{r2}^*\) increase when \(\alpha\) in \([0, \alpha_s]\), decrease when \(\alpha\) in \([\alpha_s, 1]\)

(iii) \(p_{r1}^* - w_1^* , p_{r2}^* - p_{r2}^*\) decrease in \(\alpha\)

Lemma 2 describes the impact of strategic consumers on pricing, which is also depicted in Figure 4. We find that the responses of the supplier and platform to strategic behaviors are moderated by the patience level. In specific, wholesale price and retail price in the first period are monotonous, and
they decrease with the increment of the patience level; while wholesale price and retail price in the second period are nonmonotonic, they first increase and then decrease as patience level grows. It can be explained as follows. When patience level is limited, reducing the price differences between the two periods can mitigate strategic consumer effect. When patience level is large, merchants comply with consumers instead and lower the prices in the second period. They have to move their focus to the second period to achieve optimal result that is small profits but quick return.

Moreover, intertemporal competition increases as patience level increases, which refer to the gap between prices in the first period and the second period decreases continuously, consistent with Cachon and Swinney [10]. It can be explained by reducing the price gap between two periods lessens the strategic consumer effect, effectively inducing more consumers to purchase in the first period to obtain higher profit.

4.2. Agency Selling Channel Strategy. Moreover, we examine the equilibrium outcomes of the agency selling channel strategy. For the supplier, the objective function and constraints can be expressed as follows:

\[
\max \pi_s(p_{a1}, p_{a2}) = \max \left( (1 - \phi)p_{a1} \left( 1 - \frac{p_{a1} - p_{a2}}{(1 - \alpha)\beta} \right) \right.
\]

\[
+ (1 - \phi)p_{a2} \left( \frac{p_{a1} - p_{a2}}{(1 - \alpha)\beta} - \frac{p_{a2}}{\alpha\beta} \right) \right),
\]

s.t. \( 0 < \frac{p_{a1} - p_{a2}}{(1 - \alpha)\beta} \leq 1, \)

\[
p_{a1} - p_{a2} - \frac{p_{a2}}{(1 - \alpha)\beta} \geq 0, \]

\[
p_{a1}, p_{a2} > 0.
\]

The profit of the platform is as follows. And it shares the same constraints as the supplier.

\[
\max \pi_p = \max \left( \phi p_{a1} \left( 1 - \frac{p_{a1} - p_{a2}}{(1 - \alpha)\beta} \right) + \phi p_{a2} \left( \frac{p_{a1} - p_{a2}}{(1 - \alpha)\beta} - \frac{p_{a2}}{\alpha\beta} \right) \right).
\]

(7)

Through backward induction as above, we obtain the following theorem.

**Theorem 3.** The equilibrium outcomes in the agency selling channel strategy are as follows:

\[
p_{a1}^* = \frac{2(\alpha - 1)\beta}{3\alpha - 4},
\]

\[
p_{a2}^* = \frac{(\alpha - 1)\alpha\beta}{3\alpha - 4},
\]

\[
\pi_s^* = \frac{(\alpha - 1)\beta(\phi - 1)}{3\alpha - 4},
\]

\[
\pi_p^* = \frac{(\alpha - 1)\beta\phi}{3\alpha - 4}.
\]

(8)

Theorem 3 shows that the optimal prices and profits of both the supplier and the platform only depend on acceptance of agency selling channel by consumers and patience level of consumers. Therefore, we analyze how two factors affect the prices.

**Lemma 4.** Optimal prices in the agency selling channel strategy fluctuate with the patience level of consumers, and acceptance of agency selling channel is in ways as follows:

(i) \( p_{a1}^* \) decrease in \( \alpha \)

(ii) \( p_{a2}^* \) increase when \( \alpha \) in \([0, \alpha_a]\), decrease when \( \alpha \) in \([\alpha_a, 1]\)

(iii) \( p_{a1}^* - p_{a2}^* \) decrease in \( \alpha \)

(iv) \( p_{a1}^*, p_{a2}^* \) increase in \( \beta \)

As lemma proved, strategic consumer behavior reinforces intertemporal competition. Specifically, the price difference between the first and second periods decreases with the
increment of patience level. In addition, the impact of patience level on optimal pricing is depicted in Figure 5. The findings are consistent with which in the reselling channel strategy, the underlying reason can be explained similarly. Furthermore, we examine the impact of acceptance level of agency selling channel on pricing. Result shows that prices in each period increase with the increment of acceptance level of agency selling channel. This intuitional result can be explained by that higher channel acceptance makes consumers own higher utility, so that platform can set higher prices to maximize profits.

4.3. Hybrid Channel Strategy. Then, we investigate the equilibrium outcomes in the hybrid channel strategy.

Let the point of indifference between the first and second periods be $\theta_2$, and $\theta_2 = (p_{a1} - p_{a2})/(\beta - \alpha)$. For the supplier, the objective function and constraints can be expressed as follows:
The profit of the platform is as follows.

\[
\max \pi_p(p_{r1}, p_{r2}) = \max \bigg( (p_{r1} - w_1) \left( 1 - \frac{p_{r1} - p_{a1}}{1 - \beta} \right) + \phi p_{a1} \begin{pmatrix} p_{r1} - p_{a1} - \frac{p_{a1} - p_{r2}}{\beta - \alpha} \\ p_{r2} - p_{a2} - \frac{p_{a2} - p_{r2}}{\alpha (1 - \beta)} \end{pmatrix} \bigg),
\]

s.t. \(0 < \frac{p_{r1} - p_{a1}}{1 - \beta} \leq 1,\)
\[\theta_2 - \frac{p_{r2} - p_{a2}}{\alpha (1 - \beta)} \geq 0,\]
\[\frac{p_{r1} - p_{a1}}{1 - \beta} - \theta_2 \geq 0,\]
\[\frac{p_{r2} - p_{a2}}{\alpha (1 - \beta)} - \frac{p_{a2}}{\alpha \beta} \geq 0,\]
\[p_{r1}, p_{r2} > 0.\]

In the hybrid channel strategy, we decide \(pa, w\) simultaneously, so we examine convexity of the objective function through Hessian matrix firstly. Then, the constrained optimization problem is written as Lagrange function by KKT condition. Finally, through backward induction, we obtain the following theorem.
Theorem 5. The equilibrium outcomes in the hybrid channel strategy are as follows:

\[
\begin{align*}
 p_{o1}^* &= \frac{(\phi - 1)(\alpha \beta + \alpha - 4\beta)^2}{4(4\alpha \beta \phi - 3\alpha \beta + 2\alpha \phi - 3\alpha - 8\beta \phi + 8\beta)}, \\
p_{o2}^* &= \frac{\alpha \beta (\phi - 1)(\alpha \beta + \alpha - 4\beta)}{2(\alpha (4\phi - 3) + 2\phi - 3) - 8\beta (\phi - 1)}, \\
w_i^*, w_2^* &= \frac{-\alpha (\phi - 1)(\alpha \beta + \alpha - 4\beta)(\beta \phi - 1)}{2(\alpha (4\phi - 3) + 2\phi - 3) - 8\beta (\phi - 1)}, \\
p_{r1}^* &= \frac{-\alpha^2 (\beta + 1)^2 (\phi - 1) + \alpha (\beta^2 (1 - 4\phi) + 2\beta (7\phi - 4) + 6\phi - 9) + 8(\beta - 3)\beta (\phi - 1)}{4(\alpha (4\phi - 3) + 2\phi - 3) - 8\beta (\phi - 1)}, \\
p_{r2}^* &= \frac{-\alpha (\beta - 3)(\phi - 1)(\alpha \beta + \alpha - 4\beta)}{4(\alpha (4\phi - 3) + 2\phi - 3) - 8\beta (\phi - 1)}, \\
\pi_s^* &= \frac{1}{16} \left( \frac{(\phi - 1)^2 ((\alpha - 4)\beta + \alpha)^2}{2\phi (2\alpha - 2\beta + \alpha) - 3\alpha (\beta + 1) + 8\beta} + 4w_1 \right).
\end{align*}
\]
According to its own strength and competitive advantage. Based on our proposition, GAP is supposed to decide whether to introduce reselling channel or terminate the agency selling channels by comprehensively weighing the cost, manpower, and other factors.

Comparing optimal profits of the supplier in the hybrid channel and reselling channel strategies, there exists $\phi_0$ satisfying

$$\pi_s^R > \pi_s^H, \quad 0 < \phi < \phi_0,$$

$$\pi_s^R < \pi_s^H, \quad \phi_0 < \phi < 0.$$ (13)

Therefore, we get Proposition 8.

**Proposition 8.** The optimal channel strategy for the supplier is a threshold strategy of commission rate, below which is the hybrid channel strategy and the reselling channel strategy otherwise.

Proposition 8 shows that when the commission rate is low, the hybrid channel is optimal, while when the commission is high, pure reselling channel is more profitable.

When the commission rate is low, the extra profit from the agency selling channel in the hybrid channel strategy dominates profit loss brought by the competition in the hybrid channel strategy for the supplier. When the commission rate is high, the extra profit that the supplier obtains from the agency selling channel becomes small and is dominated by profit loss in channel competition.

6. The Strategic Role of Consumer Behavior

In this section, we analyze the strategic role of consumer behaviors.

**Proposition 9.** The impact of consumer strategic behaviors on the threshold of optimal channel strategy is nonmonotonic.

Proposition 9 shows that the threshold commission rate of the optimal channel strategy changes with the change of patience. Figure 7 depicts how threshold commission rate changes with patience level. In specific, the threshold commission rate to select pure reselling channel strategy decreases first and then increases with the increment of patience level.

In order to explain the underlying reasons, we analyze the impact of strategic consumers on profits. Profit in the Strategy H predominates over that in the Strategy R when the strategic consumer is not taken into account due to the additional profit in the added agency selling channel. Considering strategic behaviors, there are two main effects on profits as Figure 8 shows. Strategic consumer behaviors enhance channel competition, which lowers profitability in Strategy H, and at the same time, they mitigate the double marginalization effect, which would benefit suppliers in reselling channel. As a result, when the strategic level is modest, profit in Strategy H declines, and that in Strategy R increases, which lowers the range of $\phi$ to select Strategy H. As the patience level continues to rise, earnings in the Strategy H rise, whereas profits in the Strategy R decline, due to the different pricing policies stated in the aforementioned sections playing major roles. Thus, the threshold $\phi$ for selecting the Strategy H rises.

Interestingly, Strategy H becomes the optimal approach and is unaffected by the commission rate when consumers are sufficiently strategic. It also gives a partial explanation of the practice. For example, the mentioned fast-fashion brands, MLB and MUJI, they have similar commission rates because of the same product category but different channel selections. It is explained that consumers have different patience levels with brands. Due to the branding effect, consumers are willing to wait patiently for a particular brand until the price drops to the expected level in the second period and are less loyal to other brands in contrast. Therefore, MUJI is willing to choose hybrid channel because its target consumers have higher loyalty towards it. For MLB, it appeals to fashion-conscious young people, who tend to prefer variety and thus have more substitute brands.

7. Discussion

In this section, we further consider platform profits and consumer surplus under the optimal channel selection strategy of the supplier.
7.1. Optimal Channel Strategy of the Supplier and the Platform. Firstly, we analyze the equilibrium strategies of supplier and retailing platform as depicted in Figure 9, where “Win-Win,” “Win-Lose,” “Lose-Lose” are equilibrium results for both parties. The former refers to the supplier, while the latter refers to the platform. For example, “Win-Lose” represents the supplier owns the optimal profits but the platform not.

For platform, it earns in direct proportion to consumer demands and takes an extra commission from the supplier. As a result, the optimal channel strategy for the platform is opposite to the supplier. In specific, the optimal strategy for platform is a commission rate threshold strategy, and below the threshold, the reselling channel is selected; otherwise, the hybrid channel is selected. Moreover, the threshold commission rate to select pure reselling channel strategy increases first and then decreases, which is caused by strategic consumer’ effect to channel competition and double marginalization effect as discussed previously.

Combining the optimal channel strategy of the supplier, the supplier and platform can achieve equilibrium results through the hybrid channel strategy under the moderate commission rate level. Meanwhile, the range of commission rates to achieve win-win situations first drops and then increases as consumer patience levels rise. It demonstrates the profit conflict between the supplier and the platform. When consumers are strategic, the unpredictable behaviors of consumers lead to the difficulty of dynamic pricing in the upstream supply chain. In contrast, the upstream supply chain participants will have more effective pricing countermeasures if consumers are myopic or overly strategic.

As the agency selling channel is accepted more widely, the scope of win-win strategy grows. When consumers have more favorable sentiments toward the agency selling channel, the supplier has a better status and more negotiating power, which compels the platform to embrace the supplier’s optimal channel strategy to a greater extent.

Additionally, we discover that win-win strategies are always under hybrid channel, regardless of the patience level and acceptance levels of the agency selling channel. It demonstrates the hybrid channel strategy can regulate the profit of supply chain members to alleviate their relationship. Comparing with earlier literature [15, 16], they prove that adding direct selling channels for supplier reduces retailers’ profits. The difference derives from the competition and cooperation game in the background of retailing platform.
7.2. Optimal Channel Strategy of Upstream Supply Chain and Consumer Surplus. Moreover, we further consider the consumer surplus. The consumer surplus in three channel strategies is calculated as follows:

\[
\begin{align*}
C_r &= \int_{p_{11}}^{1} (\theta - p_{11}) d\theta + \int_{p_{21}/\alpha}^{p_{11}/\alpha} (a\theta - p_{21}) d\theta, \\
C_a &= \int_{p_{11}}^{1} (\theta - p_{11}) d\theta + \int_{p_{21}/\alpha}^{p_{11}/\alpha} (a\beta - p_{22}) d\theta, \\
C_h &= \int_{p_{21}/\alpha(1-\beta)}^{p_{11}/\alpha(1-\beta)} (\theta - p_{11}) d\theta + \int_{p_{21}/\alpha(1-\beta)}^{1} (\theta - p_{11}) d\theta + \int_{p_{21}/\alpha(1-\beta)}^{p_{11}/\alpha(1-\beta)} (a\beta - p_{22}) d\theta.
\end{align*}
\]

Figure 10 shows the win-win-win strategy for consumers and supply chain members. Captions are respectively: the former refers to the supplier, the middle refers to the platform, and the latter refers to consumers.

For optimal channel selection of consumers, the reselling channel strategy is dominated by the hybrid channel strategy, which is in contrast to the findings of suppliers. This is due to the double marginalization effect in the reselling channel, which greatly harms consumers’ utility while maximizing the profit of suppliers. Moreover, the hybrid channel is optimal when consumers’ patience level is low, whereas the agency selling channel is selected when the patience level is high. It can be explained through the pricing strategies in different channel structures discussed in Part 4. Consumers favor the hybrid channels when consumer strategic level is low because the channel competition in hybrid channel strategy results in a low overall price level. However, with the strategic enhancement, the hybrid channel turns to targeting higher-valued consumers and raising prices, while agency selling channel enables consumers to achieve maximum utility.

In combination with supplier and platform’s optimal channel selection, it reveals two conditions under which the hybrid channel strategy is win-win-win: the commission rate at a moderate level and the patience level of consumers cannot be too large. The range of win-win-win scenarios decreases as consumers become more discerning or agency selling’s popularity increases, where consumers are encouraged to choose agency selling channel. This shows the managerial implication for the platform, which is that the upstream supply chain should alleviate positively the detrimental impact of strategic consumers’ patience level on the overall profit through various business ways, such as dynamic pricing strategy. Meanwhile, continuously strengthening on store construction makes consumers prefer to shop through the platform, so as to promote a win-win-win situation of three parties.

In addition, the hybrid channel strategy is the only way to implement the win-win-win situation, further demonstrating the effectiveness of hybrid channels to resolve interest conflicts.
7.3. The Impact of Strategic Consumer on Supply Chain and Social Welfare. Finally, we analyze the effect of strategic consumers on supply chain members and overall social welfare. We further examine how the profit of each stakeholder in the hybrid channel is impacted by strategic consumers, as Strategy H is proved to produce a win-win outcome in the previous section.

Figure 11 depicts the profits of strategic consumers at different patience levels under the hybrid channel. The revenues of platforms and suppliers decline initially and then increase when the level of patience rises; this is consistent with Section 6’s analysis. For both suppliers and platforms, complete strategic and shortsighted support their pricing decisions and maximum profitability. However, consumer surplus has the exact opposite pattern. Consumer surplus and social welfare are both maximized when consumers are moderately strategic, while they exhibit a declining tendency as strategic levels rise or fall. This result highlights both the conflicting interests between consumers and merchants as well as the general consistency of interests upstream in the supply chain.

8. Conclusion

This paper studied channel selection of supplier in the background of online retailing in the presence of strategic consumers. We first propose a game-theoretic model to investigate the equilibrium decisions of the interactions of the supplier and the retail platform when facing the strategic consumers and address the optimal channel strategy. Moreover, we identify the impact of strategic consumers on optimal strategy. Finally, we further discuss whether or when the platform and consumer is better off in supplier’s optimal strategy and the strategic consumers’ role in social welfare.
This paper first solves the equilibrium price solutions. The results indicate the upstream supply chain would lessen the gap between the two periods of price when patience is limited in order to fend off the detrimental effects of strategic consumers. Meanwhile, channel competition is intensifying with the increasing of strategic level, which mitigates the intertemporal competition. Additionally, when consumers are sufficiently savvy, the bulk-cheap technique leads to maximum profits in the pure channel strategies. In the hybrid channel, platforms and merchants collaborate to extract value from high-value consumers due to their cooperative-competitive connection. The distinction between pure channels and the hybrid channel gives practical implications for firms that they should pay attention to the heterogeneity of consumers and implement corresponding pricing strategies under different channel strategies.

The supplier’s optimal channel strategy is then revealed. It is a nonmonotonic threshold strategy of commission rate; below which, Strategy H is selected, and otherwise, Strategy R. Compared with Strategy A, the hybrid channel strategy is more profitable. Additionally, the optimal channel strategy is unaffected by commission rates when consumers are patient enough. These research results emphasize the management decisions on channel selection considering strategic consumer. In detail, brands with more patient target consumers, namely high consumer loyalty, are supposed to give priority to the hybrid channel, whereas brands with low levels of patience prioritize the pure reselling channel, which explains why MLB and MUJI choose different channels.

Finally, we demonstrate that a moderate commission rate can be advantageous for both supplier and platform when the hybrid channel strategy is selected. Additionally, taking consumer surplus into consideration, low patience level and a reasonable commission rate can result in a win-win situation. It gives implications for how suppliers and platforms should collaborate through hybrid channels. Furthermore, the upstream supply chain should also take the patience of consumers into account to maximize profit.

Our study has several limitations, which can be extended in future studies. Firstly, this paper examines optimal pricing and channel strategies considering competitive partnership between the supplier and a single platform. For further research direction, scholars can study how suppliers make channel selection in the multi-platform competition environment, such as live streaming platform. Secondly, the focus of this article is on the demand side of consumers, and more factors can be integrated on the supply side in the future, such as limited capacity, product line competitions, and so forth.

Appendix

A. Proof of Theorem 1

For the supplier, the objective function and constraints can be expressed as follows:

\[
\max \pi_s(w_1, w_2) = \max \left( w_1 \left( 1 - \frac{p_{r1} - p_{r2}}{1 - \alpha} \right) + w_2 \left( \frac{p_{r1} - p_{r2}}{1 - \alpha} \alpha \right) \right),
\]

s.t. \(0 < \frac{p_{r1} - p_{r2}}{1 - \alpha} \leq 1,\)

\[
\frac{p_{r1} - p_{r2}}{1 - \alpha} - \frac{p_{r2}}{\alpha} \geq 0,
\]

\[w_1 < p_{r1},\]

\[w_2 < p_{r2},\]

\[w_1, w_2 > 0.\]

The profit of the platform is as follows:

\[
\max \pi_p(p_{r1}, p_{r2}) = \max \left( (p_{r1} - w_1) \left( 1 - \frac{p_{r1} - p_{r2}}{1 - \alpha} \right) \right. + \left. (p_{r2} - w_2) \left( \frac{p_{r1} - p_{r2}}{1 - \alpha} \right) \right),
\]

s.t. \(0 < \frac{p_{r1} - p_{r2}}{1 - \alpha} \leq 1,\)

\[
\frac{p_{r1} - p_{r2}}{1 - \alpha} - \frac{p_{r2}}{\alpha} \geq 0,
\]

\[w_1 < p_{r1},\]

\[w_2 < p_{r2},\]

\[p_{r1}, p_{r2} > 0.\]

(\text{A.1})

Firstly, the supplier selects pure reselling channel and announces wholesale prices. Then, the platform formulates the pricing strategy according to wholesale prices. In the second period, the supplier adjusts wholesale price due to strategic behaviors, and then, platform adjusts prices subsequently.

The constrained optimization problem is transformed into an unconstrained optimization problem by using the KKT condition and Lagrange multiplier method.

Step 4: Deciding retailing price in the second period

\[
\max \pi_p(p_{r2}) = \max \left( \left( p_{r2} - w_2 \right) \left( \frac{p_{r1} - p_{r2}}{1 - \alpha} - \frac{p_{r2}}{\alpha} \right) \right),
\]

s.t. \(\alpha + p_{r1} - 1 \leq p_{r2} \leq \alpha p_{r1},\)

\[p_{r2} > 0.\]

(\text{A.2})

The second-order derivative of profit function in the second period is calculated as follows:
Since (A.4) is always negative, the profit function of platform is strictly convex. The Lagrangian function (A.3) is as follows:

\[
\frac{\partial^2 \pi_p}{\partial w_2^2} = \frac{1}{(\alpha - 1)\alpha} < 0.
\]  

(A.8)

The second-order derivative is calculated as follows:

\[
L = (p_{r2} - w_2)\left(\frac{p_{r1} - p_{r2}}{1 - \alpha} - \frac{p_{r2}}{\alpha}\right) + \lambda_1 (p_{r2} - (\alpha + p_{r1} - 1)) + \lambda_2 (\alpha p_{r1} - p_{r2}),
\]

(A.5)

where \(\lambda_1\) and \(\lambda_2\) are the Lagrangian multipliers. Applying KKT conditions, the optimal price

\[
p_{r2}^* = \frac{1}{2} (\alpha p_{r1} + w_2).
\]

(A.6)

Step 3: Deciding wholesale price in the second period

Substituting (A.6) into (A.8), the profit function of supplier in the second period is as follows:

\[
\max \pi_s (w_2) = \max \left(\frac{w_2 (w_2 - \alpha p_{r1})}{2(\alpha - 1)\alpha}\right),
\]

(A.7)

\[
s.t. \ 2\alpha + \alpha (-p_{r1}) + 2p_{r1} - 2 \leq w_2 \leq \alpha p_{r1}.
\]

Step 2: Deciding retailing price in the first period

Substituting (A.6) and (A.10) into (A.2), the profit function of platform in the first period is as follows:

\[
L = \frac{w_2 (w_2 - \alpha p_{r1})}{2(\alpha - 1)\alpha} + \mu_1 (w_2 - (2\alpha + \alpha (-p_{r1}) + 2p_{r1} - 2)) + \mu_2 (\alpha p_{r1} - w_2),
\]

(A.9)

where \(\mu_1\) and \(\mu_2\) are the Lagrangian multipliers. Applying KKT conditions, the optimal price

\[
w_2^* = \frac{\alpha p_{r1}}{2}.
\]

(A.10)

The second-order derivative is calculated as follows:

\[
\frac{\partial^2 \pi_p}{\partial p_{r1}^2} = \frac{16 - 13\alpha}{8(\alpha - 1)} < 0.
\]

(A.12)

Since (A.12) is always negative, the profit function of platform is strictly convex. The Lagrangian function (A.11) is as follows:

\[
L = \frac{(16 - 13\alpha) p_{r1}^2 + 4p_{r1} (4(\alpha - 1) + (3\alpha - 4)w_1) - 16(\alpha - 1)w_1}{16(\alpha - 1)} + \lambda_3 \left(\frac{4\alpha - 4}{3\alpha - 4} - p_{r1}\right),
\]

(A.13)

where \(\lambda_3\) is the Lagrangian multipliers. Applying KKT conditions, the optimal price:

\[
p_{r1}^* = \frac{2(4\alpha + 3aw_1 - 4w_1 - 4)}{13\alpha - 16}.
\]

(A.14)
Step 1: Deciding wholesale price in the first period by substituting (A.6), (A.10), and (A.14) into (A.8), the profit function of supplier in the first period is as follows:

$$\max \pi_s(w_1) = \max \left( \frac{-8\alpha (\alpha - 1)^2 + (79\alpha^3 - 279\alpha^2 + 328\alpha - 128)w_1 - (4 - 3\alpha)^2 (7\alpha - 8)w_1^2}{(16 - 13\alpha)^2 (\alpha - 1)} \right),$$

(A.15)

subject to

$$\frac{4 - 4\alpha}{3\alpha - 4} < w_1 \leq \frac{14\alpha^2 - 30\alpha + 16}{9\alpha^2 - 24\alpha + 16}.$$  

Since (A.16) is always negative, the profit function of supplier is strictly convex. The Lagrangian function (A.15) is as follows:

$$L = \frac{-8\alpha (\alpha - 1)^2 + (79\alpha^3 - 279\alpha^2 + 328\alpha - 128)w_1 - (4 - 3\alpha)^2 (7\alpha - 8)w_1^2}{(16 - 13\alpha)^2 (\alpha - 1)}$$

$$+ \mu_3 \left( w_1 - \frac{4 - 4\alpha}{3\alpha - 4} \right) + \mu_4 \left( \frac{14\alpha^2 - 30\alpha + 16}{9\alpha^2 - 24\alpha + 16} - w_1 \right),$$

(A.17)

where $\mu_3$ and $\mu_4$ is the Lagrangian multipliers. Applying KKT conditions, the optimal price

$$w_1^* = \frac{(\alpha - 1)(79\alpha^2 - 200\alpha + 128)}{2(4 - 3\alpha)^2 (7\alpha - 8)}.$$  

(B.18)

B. Proof of Theorem 3

For the supplier, the objective function and constraints can be expressed as follows:

$$\max \pi_s(p_{a1}, p_{a2}) = \max \left( (1 - \phi)p_{a1} \left( 1 - \frac{p_{a1} - p_{a2}}{(1 - \alpha)\beta} \right) ight.$$  

$$+ (1 - \phi)p_{a2} \left( \frac{p_{a1} - p_{a2}}{(1 - \alpha)\beta} - \frac{p_{a2}}{\alpha\beta} \right) \right),$$

(B.1)

subject to

$$0 < \frac{p_{a1} - p_{a2}}{(1 - \alpha)\beta} \leq 1,$$

$$\frac{p_{a1} - p_{a2}}{(1 - \alpha)\beta} - \frac{p_{a2}}{\alpha\beta} \geq 0,$$

$$p_{a1}, p_{a2} > 0.$$
Firstly, the supplier selects the pure agency selling channel and decides prices in two periods sequently. As above, we use the KKT condition.

Step 1: Deciding retailing price in the first period

Substituting 24 into 19, the profit function of supplier in the first period is as follows:

\[ \max \pi_s(p_{a1}) = \max \left( \phi p_{a1} \left( 1 - \frac{p_{a1} - p_{a2}}{(1 - \alpha)\beta} \right) + \phi p_{a2} \left( \frac{p_{a1} - p_{a2}}{(1 - \alpha)\beta} - \frac{p_{a2}}{\alpha\beta} \right) \right). \]  

(B.7)

The second-order derivative of profit function in the second period is calculated as follows:

\[ \frac{\partial^2 \pi_s}{\partial p_{a2}^2} = 2(1 - \phi) \left( \frac{1}{\alpha\beta} - \frac{1}{(1 - \alpha)\beta} \right) < 0. \]  

(B.8)

Step 2: Deciding retailing price in the second period

Since (B.4) is always negative, the profit function of platform is strictly convex. The Lagrangian function (B.3) is as follows:

\[ L = (1 - \phi)p_{a2} \left( \frac{p_{a1} - p_{a2} - p_{a2}}{(1 - \alpha)\beta} - \frac{p_{a2}}{\alpha\beta} \right) + \lambda_1 (p_{a2} - (\alpha\beta + p_{a1} - \beta)) + \lambda_2 (\alpha p_{a1} - p_{a2}). \]  

(B.9)
where $\lambda_1$ and $\lambda_2$ are the Lagrangian multipliers. Applying KKT conditions, the optimal price
\[
\hat{p}_{a1} = \frac{2(\alpha - 1)\beta}{3\alpha - 4}. \tag{B.10}
\]

C. Proof of Theorem 5

Then, we investigate the equilibrium outcomes in the hybrid channel strategy. Let the point of indifference between the first and second periods be $\theta_2$ and $\theta_2 = (p_{a1} - p_{r2})/(\beta - \alpha)$.

For the supplier, the objective function and constraints can be expressed as follows:

\[
\text{max} \pi_s (w_1, w_2, p_{a1}, p_{a2}) = \max \left( w_1 \left( 1 - \frac{p_{a1} - p_{r1}}{1 - \beta} \right) + (1 - \phi)p_{a1} \left( \frac{p_{r1} - p_{a1} - p_{a2}}{\beta - \alpha} \right) \right) \\
+ w_2 \left( \frac{p_{a1} - p_{r2} - p_{a2}}{\beta - \alpha} \right) + (1 - \phi)p_{a2} \left( \frac{p_{r2} - p_{a2}}{\alpha(1 - \beta)} \right).
\]

s.t. $0 < \frac{p_{a1} - p_{r1}}{1 - \beta} \leq 1$,

$\theta_2 - \frac{p_{r2} - p_{a2}}{\alpha(1 - \beta)} \geq 0$,

$\frac{p_{r1} - p_{a1}}{1 - \beta} - \theta_2 \geq 0$,

$\frac{p_{r2} - p_{a2}}{\alpha(1 - \beta)} - \frac{p_{a2}}{\alpha \beta} \geq 0$,

$w_1 < p_{r1}$,

$w_2 < p_{r2}$,

$w_1, w_2 > 0$,

$p_{a1}, p_{a2}$

The profit of the platform is as follows. And it shares the same constraints as the supplier.

\[
\text{max} \pi_p (p_{r1}, p_{r2}) = \max \left( (p_{r1} - w_1) \left( 1 - \frac{p_{r1} - p_{a1}}{1 - \beta} \right) + \phi p_{a1} \left( \frac{p_{r1} - p_{a1} - p_{a2}}{\beta - \alpha} \right) \right) \\
+ (p_{r2} - w_2) \left( \frac{p_{a1} - p_{r2} - p_{a2}}{\beta - \alpha} \right) + \phi p_{a2} \left( \frac{p_{r2} - p_{a2}}{\alpha(1 - \beta)} \right).
\]

s.t. $0 < \frac{p_{r1} - p_{a1}}{1 - \beta} \leq 1$,

$\theta_2 - \frac{p_{r2} - p_{a2}}{\alpha(1 - \beta)} \geq 0$,

$\frac{p_{r1} - p_{a1}}{1 - \beta} - \theta_2 \geq 0$,

$\frac{p_{r2} - p_{a2}}{\alpha(1 - \beta)} - \frac{p_{a2}}{\alpha \beta} \geq 0$,

$p_{r1}, p_{r2} > 0$.
Firstly, the supplier selects the hybrid channel and announces wholesale and retailing prices. Then, the platform formulates the pricing strategy. In the second period, the supplier adjusts wholesale price and retailing price due to strategic behaviors, and then, platform adjusts prices subsequently.

\[
\begin{align*}
\max_{\pi_p} & (p_{r2}) = \max \left( (p_{r2} - w_{a2}) \left( \theta_2 - \frac{p_{r2} - p_{a2}}{\alpha (1 - \beta)} \right) + \phi p_{a2} \left( \frac{p_{r2} - p_{a2}}{\alpha (1 - \beta)} - \frac{p_{a2}}{\alpha \beta} \right) \right). \\
\text{s.t.} & \quad \theta_2 \geq \frac{p_{a2}}{\alpha \beta}, \\
& \quad \frac{p_{a2}}{\beta} \leq p_{r2} - a \beta \theta_2 + a \theta_2 + p_{a2}.
\end{align*}
\]

Through backward induction, calculations are as follows:

Step 4: Deciding retailing price of the platform in the second period

\[
\begin{align*}
\max_{\pi_p} & (p_{r2}) = \max \left( (p_{r2} - w_{a2}) \left( \theta_2 - \frac{p_{r2} - p_{a2}}{\alpha (1 - \beta)} \right) + \phi p_{a2} \left( \frac{p_{r2} - p_{a2}}{\alpha (1 - \beta)} - \frac{p_{a2}}{\alpha \beta} \right) \right). \\
\text{s.t.} & \quad \theta_2 \geq \frac{p_{a2}}{\alpha \beta}, \\
& \quad \frac{p_{a2}}{\beta} \leq p_{r2} \leq - a \beta \theta_2 + a \theta_2 + p_{a2}.
\end{align*}
\]

The second-order derivative of profit function in the second period is calculated as follows:

\[
\frac{\partial^2 \pi_p}{\partial p_{r2}^2} = -\frac{2}{\alpha (1 - \beta)} < 0. 
\]

Since (C.4) is always negative, the profit function of platform is strictly convex. The Lagrangian function (C.3) is as follows:

\[
L = (p_{r2} - w_{a2}) \left( \theta_2 - \frac{p_{r2} - p_{a2}}{\alpha (1 - \beta)} \right) + \phi p_{a2} \left( \frac{p_{r2} - p_{a2}}{\alpha (1 - \beta)} - \frac{p_{a2}}{\alpha \beta} \right) \\
+ \lambda_1 \left( p_{r2} - \frac{p_{a2}}{\beta} \right) + \lambda_2 (-a \beta \theta_2 + a \theta_2 + p_{a2} - p_{r2}),
\]

where \( \lambda_1 \) and \( \lambda_2 \) are the Lagrangian multipliers. Applying KKT conditions, the optimal price

\[
p_{r2}^* = \frac{1}{2} (-a \beta \theta_2 + a \theta_2 + \phi p_{a2} + p_{a2} + w_{a2}).
\]

Step 3: Deciding wholesale price and retailing price of supplier in the second period

Substituting (C.6) into (C.2), the profit function of platform in the second period is as follows:

\[
\max_{\pi_s} (p_{a2}, w_{a2}) = \max \left( \frac{(\phi - 1) p_{a2}^2 (\beta \phi + \beta - 2) - \beta (\phi - 1) p_{a2} \alpha (\beta - 1) \theta_2 - 2w_{a2} + \beta w_{a2} \alpha (\beta - 1) \theta_2 + w_{a2})}{2 \alpha (\beta - 1) \beta} \right).
\]

The Hessian matrix of profit function in the second period is calculated as follows:

\[
\begin{align*}
\frac{\partial^2 \pi_s}{\partial p_{a2}^2} & = -\frac{a \beta^2 \theta_2 - a \beta \theta_2 - \beta \phi p_{a2} - \beta p_{a2} + 2 p_{a2}}{\beta} \leq w_{a2} \leq - a \beta \theta_2 + a \theta_2 - \phi p_{a2} + p_{a2}, \\
0 & \leq p_{a2} \leq a \beta \theta_2.
\end{align*}
\]
Applying KKT conditions, the optimal price can be obtained as follows:

$$L = \frac{(\phi - 1) \beta \phi \beta - \beta (\phi - 1) p_{a1} (\alpha (\beta - 1) \theta_1 - 2 w_2) \beta w_2 (\alpha (\beta - 1) \theta_2 + w_2)}{2 \alpha (\beta - 1) \beta} + \lambda_1 \left( w_2 - \frac{\alpha \beta \theta_2 - \alpha \beta \theta_2 - \beta \phi p_{a2} - \beta p_{a2} + 2 p_{a2}}{\beta} \right) + \lambda_2 (-\alpha \beta \theta_2 + a \theta_2 - \phi p_{a2} + p_{a2} - w_2) + \lambda_3 (\alpha \beta \theta_2 - p_{a2}),$$

where $\lambda_1$, $\lambda_2$, and $\lambda_3$ are the Lagrangian multipliers. Applying KKT conditions, the optimal price is:

$$p_{a2}^* = \frac{1}{2} \alpha \beta \theta_2, w_2^* = \frac{1}{2} (\alpha \theta_2 - \alpha \beta \theta_2 \phi).$$

The second-order is

$$\frac{\partial^2 \pi_p}{\partial p_{r1}^2} = \frac{2}{\beta - 1} < 0.$$
where $\lambda_1$, $\lambda_2$, and $\lambda_3$ are the Lagrangian multipliers. Applying KKT conditions, the optimal price

$$
pr_1^* = \frac{1}{2} (\beta - 1) \left( \frac{\phi p_{a1}}{\beta - 1} + \frac{p_{a1} - \beta_1}{\beta - 1} + \frac{1}{\beta - 1} + \frac{w_1}{\beta - 1} \right).
$$

(C.14)

Step 1: Deciding wholesale price and retail price of supplier in the first period

Substituting (C.14) into (C.15), the profit function of supplier in the first period is as follows:

$$
\begin{align*}
\max \pi_s & = \max \left( \frac{1}{2} \left( \frac{4\alpha p_{a1}^2 (-2\beta + \beta + 1) + w_1 ((\phi - 1)p_{a1} + \beta + w_1 - 1)}{\beta - 1} \right) \\
& - \frac{1}{2} \left( \frac{(1 - \phi)p_{a1} ((\alpha \beta + \alpha - 4\beta)((\phi - 1)p_{a1} - \beta + w_1 + 1) - 8(\beta - 1)p_{a1})}{(\beta - 1)(\alpha \beta + \alpha - 4\beta)} \right) \right) \\
\text{s.t.} & \quad \frac{\alpha \beta^2}{\alpha \beta + \alpha - 4\beta} + \frac{\alpha \beta p_{a1} + \alpha p_{a1} + 4\beta p_{a1} + 4\beta p_{a1} - 8p_{a1} - 4\beta^2 + 4\beta}{\alpha \beta + \alpha - 4\beta} \leq w_1 \leq - \phi p_{a1} + p_{a1} - \beta + 1 \\
& \quad 0 < p_{a1} < \frac{1}{4} (\alpha (-\beta) - \alpha + 4\beta).
\end{align*}
$$

(C.15)

The profit of the platform is as follows. And it shares the same constraints as the supplier.

$$
\begin{align*}
\max \pi_p & = \max \left( (pr_1 - w_1) \left( \frac{1 - pr_1 - p_{a1}}{1 - \beta} \right) + \phi p_{a1} \left( \frac{pr_1 - p_{a1}}{1 - \beta} - \frac{p_{a1} - pr_2}{\beta - \alpha} \right) \\
& + (pr_2 - w_2) \left( \frac{p_{a1} - pr_2}{\beta - \alpha} - \frac{pr_2 - p_{a2}}{\alpha (1 - \beta)} \right) + \phi p_{a2} \left( \frac{pr_2 - p_{a2}}{\alpha (1 - \beta)} - \frac{p_{a2}}{\alpha \beta} \right) \right).
\end{align*}
$$

(C.16)

The Hessian matrix of profit function in the second period is calculated as follows:
\[ H = \left( \begin{array}{c} \frac{\partial^2 \pi_1(p_{a1}, w_1)}{\partial p_{a1}^2} \frac{\partial^2 \pi_1(p_{a1}, w_1)}{\partial p_{a1} \partial w_1} \\ \frac{\partial^2 \pi_1(p_{a1}, w_1)}{\partial w_1 \partial p_{a1}} \frac{\partial^2 \pi_1(p_{a1}, w_1)}{\partial w_1^2} \end{array} \right) \]

\[ = \left( \begin{array}{c} \frac{4 \alpha (-2 \beta \phi + \beta + 1) + ((\phi - 1)((\alpha - 4) \beta + \alpha)(\alpha + \beta + 1)(\phi - 1) - 4(\beta \phi + \beta - 2))}{((\alpha - 4) \beta + \alpha)} \frac{\phi - 1}{\beta - 1} \\ \frac{\phi - 1}{\beta - 1} \end{array} \right). \]  

(C.17)

Since \( |H| = (4(\alpha(\beta(3 - 4\phi) - 2\phi + 3) + 8\beta(\phi - 1)))((\beta - 1)(\alpha - 4\beta + \alpha^2) > 0 \) and \( H_{11} < 0 \), Hessian matrix is negative definite.

The Lagrangian function of (C.3) is as follows:

\[ L = \frac{1}{2} \left( \frac{4 \alpha p_{a1}^2 (-2 \beta \phi + \beta + 1) + w_1 ((\phi - 1)p_{a1} + \beta + w_1 - 1)}{\alpha \beta + \alpha - 4 \beta} \right) - \frac{1}{2} \frac{(1 - \phi)p_{a1} ((\alpha + \beta - 4 \beta)(\phi - 1)p_{a1} - \beta + w_1 + 1) - 8(\beta - 1)p_{a1}}{(\beta - 1)(\alpha \beta + \alpha - 4 \beta)} + \lambda_1 \left( w_1 - \frac{\alpha \beta^2 - \alpha - \alpha \beta \phi p_{a1} + \alpha \beta p_{a1} - \alpha \phi p_{a1} + \alpha p_{a1} + 4 \beta \phi p_{a1} + 4 \beta p_{a1} - 8 p_{a1} - 4 \beta^2 + 4 \beta}{\alpha \beta + \alpha - 4 \beta} \right) + \lambda_2 (-\phi p_{a1} + p_{a1} - \beta - w_1 + 1) + \lambda_3 \left( \frac{1}{4} (\alpha (-\beta) - \alpha + 4 \beta) - p_{a1} \right), \]  

(C.18)

where \( \lambda_1, \lambda_2, \) and \( \lambda_3 \) are the Lagrangian multipliers. Applying KKT conditions, the optimal price

\[ p_{a1}^* = \frac{(\phi - 1)(\alpha \beta + \alpha - 4 \beta)^2}{4(4 \alpha \beta \phi - 3 \alpha \beta + 2 \alpha \phi - 3 \alpha - 8 \beta \phi + 8 \beta)} \]

\[ w_1^* = \frac{-\alpha^2 (-\beta^2) \phi^2 + 2 \alpha^2 \beta^3 \phi - 2 \alpha^2 \beta \phi^2 + 4 \alpha^2 \beta \phi - \alpha^2 \phi^2 + 8 \alpha \beta^2 \phi^2 - 8 \alpha \beta \phi^2 + 8 \beta \phi^2 - 16 \beta^2 \phi^2 + 16 \beta^2 \phi}{4(4 \alpha \beta \phi - 3 \alpha \beta + 2 \alpha \phi - 3 \alpha - 8 \beta \phi + 8 \beta)} \]  

(C.19)

\[ -\frac{-\alpha^2 (-\beta^2) - 2 \alpha^2 \beta + 2 \alpha^2 \phi - \alpha^2 + 2 \alpha^2 \beta^2 - 20 \alpha \beta \phi + 8 \alpha \beta - 4 \alpha + 6 \alpha + 16 \beta - 16 \beta}{4(4 \alpha \beta \phi - 3 \alpha \beta + 2 \alpha \phi - 3 \alpha - 8 \beta \phi + 8 \beta)}. \]

\[ \textbf{D. Proof of Lemma 2} \]

The partial derivatives of the optimal prices of the two periods are shown as follows:
acceptance of agency selling channel is in ways as follows: 

\[ \frac{\partial w_1}{\partial \alpha} = \frac{-461\alpha^3 + 1620\alpha^2 - 1920\alpha + 768}{2(8 - 7\alpha)^2(3\alpha - 4)^3} < 0, \]

\[ \frac{\partial p_{r1}}{\partial \alpha} = \frac{-85\alpha^2 + 208\alpha - 128}{(8 - 7\alpha)^2(4 - 3\alpha)^2} < 0, \]

\[ \frac{\partial w_3}{\partial \alpha} = \frac{399\alpha^4 - 1976\alpha^3 + 3556\alpha^2 - 2752\alpha + 768}{2(8 - 7\alpha)^2(4 - 3\alpha)^2}, \]

\[ \frac{\partial p_{r2}}{\partial \alpha} = \frac{3(399\alpha^4 - 1976\alpha^3 + 3556\alpha^2 - 2752\alpha + 768)}{4(8 - 7\alpha)^2(4 - 3\alpha)^2}, \]

\[ \frac{\partial (w_1 - w_2)}{\partial \alpha} = \frac{-1197\alpha^5 + 7524\alpha^4 - 19033\alpha^3 + 24100\alpha^2 - 15232\alpha + 3840}{2(8 - 7\alpha)^2(3\alpha - 4)^3} < 0, \]

\[ \frac{\partial (p_{r1} - p_{r2})}{\partial \alpha} = \frac{-133\alpha^2 + 304\alpha - 176}{4(8 - 7\alpha)^2} < 0. \]  

Let the partial derivatives \( \frac{\partial w_2}{\partial \alpha} \) and \( \frac{\partial p_{r1}}{\partial \alpha} \) be zero. And \( w_2 \) and \( p_{r1} \) have the same extreme point \( \alpha_e \), \( \alpha_e = 0.717 \). Thus, we have Lemma 2.

**Lemma 2.** Optimal prices in the reselling channel strategy fluctuate with the patience level of consumers in ways as follows:

(i) \( w_1, p_{r1} \) decrease in \( \alpha \)

(ii) \( w_2^*, p_{r2}^* \) increase when \( \alpha \) in \([0, \alpha_e]\), decrease when \( \alpha \) in \([\alpha_e, 1]\)

(iii) \( w_1^* - w_2^*, p_{r1}^* - p_{r2}^* \) decrease in \( \alpha \)

**E. Proof of Lemma 4**

The partial derivatives of the optimal prices of the two periods are shown as follows:

\[ \frac{\partial p_{a1}}{\partial \alpha} = \frac{2\beta}{(4 - 3\alpha)^2} < 0, \]

\[ \frac{\partial p_{a2}}{\partial \alpha} = \frac{(3\alpha^2 - 8\alpha + 4)\beta}{(4 - 3\alpha)^2}, \]

\[ \frac{\partial p_{a1} - p_{a2}}{\partial \alpha} = \frac{(-3\alpha^2 + 8\alpha - 6)\beta}{(4 - 3\alpha)^2} < 0, \]

\[ \frac{\partial p_{a1}}{\partial \alpha} = \frac{2(\alpha - 1)}{3\alpha - 4} > 0, \]

\[ \frac{\partial p_{a2}}{\partial \alpha} = \frac{(\alpha - 1)\alpha}{3\alpha - 4} > 0. \]  

Let the partial derivative \( \frac{\partial p_{a2}}{\partial \alpha} \) be zero. And \( p_{a2} \) have extreme point \( \alpha_0 \), \( \alpha_0 = 2/3 \). Thus, we have Lemma 4.

**Lemma 4.** Optimal prices in the agency selling channel strategy fluctuate with the patience level of consumers, and acceptance of agency selling channel is in ways as follows:

(i) \( p_{a1}^* \) decrease in \( \alpha \)

(ii) \( p_{a2}^* \) increase when \( \alpha \) in \([0, \alpha_0]\), decrease when \( \alpha \) in \([\alpha_0, 1]\)

(iii) \( p_{a1}^* - p_{a2}^* \) decrease in \( \alpha \)

(iv) \( p_{a1}^*, p_{a2}^* \) increase in \( \beta \)

**F. Proof of Lemma 6**

The derivatives of the optimal prices of the two periods are shown as follows:

Prices in the first period:
Let the partial derivatives $\frac{\partial p_{r1}}{\partial \alpha}$, $\frac{\partial p_{al}}{\partial \alpha}$ and $\frac{\partial w_1}{\partial \alpha}$ be zero, then:

\[
\begin{cases}
\frac{\partial p_{r1}}{\partial \alpha} > 0, & (\alpha, \beta, \phi) \in \Omega_h1, \\
\frac{\partial p_{r1}}{\partial \alpha} = \frac{\partial p_{al}}{\partial \alpha} = \frac{\partial w_1}{\partial \alpha} < 0, & (\alpha, \beta, \phi) \in \Omega_h2,
\end{cases}
\]  

(F.2)

\[
\begin{align*}
\Omega_h1 &= \left\{ (\alpha, \beta, \phi): 0 < \alpha < \beta \leq \frac{1}{3}, 0 < \phi \leq \phi_h1 \right\} \cup \\
&\quad \left\{ (\alpha, \beta, \phi): 0 < \alpha \leq \alpha_h1, 0 < \beta \leq \frac{1}{3}, \phi_h1 < \phi < \frac{1}{2} \right\} \cup \\
&\quad \left\{ (\alpha, \beta, \phi): 0 < \alpha \leq \alpha_h1, \frac{1}{3} < \beta < 1, 0 < \phi < \frac{1}{2} \right\}, \\
\Omega_h2 &= \left\{ (\alpha, \beta, \phi): \alpha_h1 < \alpha < \beta \leq \frac{1}{3}, \phi_h1 < \phi < \frac{1}{2} \right\} \cup \\
&\quad \left\{ (\alpha, \beta, \phi): \alpha_h1 < \alpha < \beta, \frac{1}{3} < \beta < 1, 0 < \phi < \frac{1}{2} \right\}, \\
\alpha_h1 &= \frac{-4\beta^2 + 8\beta\phi - 4\beta}{4\beta^2 \phi - 3\beta^2 + 6\beta\phi - 6\beta + 2\phi - 3}, \\
\phi_h1 &= \frac{3\beta^2 + 2\beta - 1}{4\beta^2 + 6\beta - 6},
\end{align*}
\]  

(F.3)

and $\Omega_{h1} \cup \Omega_{h2} = D$, where $D = \left\{ (\alpha, \beta, \phi): 0 < \alpha < \beta < 1, 0 < \phi < (1/2) \right\}$

Prices in the second period:

\[
\begin{align*}
\frac{\partial p_{r2}}{\partial \alpha} &= \frac{(\beta - 3)(\phi - 1)\left(\alpha^2 (\beta + 1)(\beta(4\phi - 3) + 2\phi - 3) - 16\alpha\beta(\beta + 1)(\phi - 1) + 32\beta^2 (\phi - 1)\right)}{4(\alpha(\beta(4\phi - 3) + 2\phi - 3) - 8\beta(\phi - 1))^2} > 0, \\
\frac{\partial p_{al2}}{\partial \alpha} &= \frac{\beta(\phi - 1)(\alpha^2 (\beta + 1)(\beta(4\phi - 3) + 2\phi - 3) - 16\alpha\beta(\beta + 1)(\phi - 1) + 32\beta^2 (\phi - 1))}{2(\alpha(\beta(4\phi - 3) + 2\phi - 3) - 8\beta(\phi - 1))^2} > 0, \\
\frac{\partial w_1}{\partial \alpha} &= \frac{(\phi - 1)(\beta\phi - 1)(\alpha^2 (\beta + 1)(\beta(4\phi - 3) + 2\phi - 3) - 16\alpha\beta(\beta + 1)(\phi - 1) + 32\beta^2 (\phi - 1))}{2(\alpha(\beta(4\phi - 3) + 2\phi - 3) - 8\beta(\phi - 1))^2} > 0.
\end{align*}
\]  

(F.4)
\[
\frac{\partial (p_{a1} - p_{a2})}{\partial \alpha} = \frac{(\phi - 1)\left(\alpha^2 (\beta + 1)(\beta (4\phi - 3) + 2\phi - 3) - 16a\beta(\beta + 1)(\phi - 1) + 4\beta^2 (-2\beta + \beta + 8\phi - 7)\right)}{(a(\beta (4\phi - 3) + 2\phi - 3) - 8\phi(\phi - 1))^2} < 0,
\]
\[
\frac{\partial (p_{a1} - p_{a2})}{\partial \alpha} = \frac{(\phi - 1)(a\beta + \alpha - 4\beta)(\alpha(\beta + 1)(\beta (4\phi - 3) + 2\phi - 3) + 4\beta(\beta - 2\phi + 1))}{4(\alpha(\beta (4\phi - 3) + 2\phi - 3) - 8\phi(\phi - 1))^2} + \frac{\beta(\phi - 1)(\alpha^2 (\beta + 1)(\beta (4\phi - 3) + 2\phi - 3) - 16a\beta(\beta + 1)(\phi - 1) + 32\beta^2 (\phi - 1))}{2(\alpha(\beta (4\phi - 3) + 2\phi - 3) - 8\phi(\phi - 1))^2} < 0.
\]

Let the partial derivatives \(\frac{\partial (p_{a1} - p_{a2})}{\partial \alpha}\) be zero, where
then:
\[
\begin{cases}
\frac{\partial (p_{a1} - p_{a2})}{\partial \alpha} > 0, \quad (\alpha, \beta, \phi) \in \Omega_{h3}, \\
\frac{\partial (p_{a1} - p_{a2})}{\partial \alpha} < 0, \quad (\alpha, \beta, \phi) \in \Omega_{h4},
\end{cases}
\]
\[
\Omega_{h3} = \left\{ (\alpha, \beta, \phi): \alpha_{h2} < \alpha < \beta, 0 < \beta < 0.282, \phi_{h2} < \phi < \frac{1}{2} \right\},
\]
\[
\Omega_{h4} = \left\{ (\alpha, \beta, \phi): 0 < \alpha < \beta, 0.282 < \phi < \phi_{h2} \right\} \cup \left\{ (\alpha, \beta, \phi): 0 < \alpha < \alpha_{h2}, 0 < \beta < 0.282, \phi_{h2} < \phi < \frac{1}{2} \right\} \cup \left\{ (\alpha, \beta, \phi): 0 < \alpha < \beta, 0.282 < \beta < 1, 0 < \phi < \frac{1}{2} \right\},
\]
\[
\alpha_{h2} = \frac{8(\beta \phi - \beta)}{4\beta \phi - 3\beta + 2\phi - 3} - 4 \sqrt{\frac{4\beta^4 \phi^2 - 8\beta^4 \phi + 3\beta^4 + 2\beta^3 - \beta^2}{3(3\beta^2 + 4\beta + 1)(4\beta \phi - 3\beta + 2\phi - 3)^2}},
\]
\[
\phi_{h2} = \frac{9\beta^3 - 27\beta^2 + 31\beta + 3}{12\beta^3 - 26\beta^2 + 12\beta + 18}.
\]

and \(\Omega_{h3} \cup \Omega_{h4} = D\), where \(D = \left\{ (\alpha, \beta, \phi): 0 < \alpha < \beta < 1, 0 < \phi < \frac{1}{2} \right\}\)

Thus, we have Lemma 6.

**Lemma 6.** Optimal prices in the hybrid channel strategy fluctuate with the patience level of consumers, and acceptance of agency selling channel is in ways as follows:

(i) \(p^*_{a1}, p^*_{a2}, u^*_1\) increase in \(\Omega_{h1}\), decrease in \(\Omega_{h2}\)

(ii) \(p^*_{a1}, p^*_{a2}, u^*_2\) increase in \(\alpha\)

(iii) \(p^*_{a1} - p^*_{a2}\) and \(u^*_1 - u^*_2\) decrease in \(\alpha\)

(iv) \(p^*_{a1} - p^*_{a2}\) increase in \(\Omega_{h3}\), decrease in \(\Omega_{h4}\)

\[
\text{G. Proof of Proposition 7}
\]

Comparing optimal profits of the supplier in the agency selling strategy and hybrid channel strategy, we obtain the following result and proposition:
\[
\pi_s^H > \pi_s^A.
\]

Comparing the supplier’s optimal profits in the hybrid channel and pure reselling channel, we get
\[
\phi_0 = \frac{63a^3 (\beta + 1)^2 - a^4 \left(618\beta^2 + 947\beta + 253\right) + a^4 \left(2500\beta^2 + 2400\beta + 334\right) - 8a^4 \left(604\beta^2 + 317\beta + 18\right) + 192a\beta (23\beta + 5) - 1536\beta^2}{(4 - 3a)^2 (7a - 8) (a^2 + \alpha - 4\beta)}
\]

\[\text{(G.2)}\]

**Data Availability**

The data supporting the current study are available from the corresponding author upon request.

**Conflicts of Interest**

The authors declare that they have no conflicts of interest.

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