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STRATEGY OF E-COMMERCE MARKET ENTRY BASED ON VERTICAL COMPLEMENTARITY OF SERVICE SUPPLY CHAIN

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Abstract. *Aiming at the vertical complementary service supply chain composed of duopoly traditional enterprises and monopoly platform enterprises, this paper adopts the platform experience level and the complementary levels of compatible parties as decision variables and Cournot game and Stackelberg game as modeling methods to study the problem for two parties to make the optimal decision, in case that upstream and downstream markets are compatible with each other in order to improve competitiveness, while upstream markets may enter downstream markets through compatibility. This paper shows that the complementary compatibility between upstream and downstream supply chains is an effective strategy to improve competitiveness, achieve market share and profit growth. The higher the experience level of the incumbent platform is, the greater the complementarity between upstream and downstream will be, and the greater the profit improvement that compatible parties may obtain. For the entry threat of upstream compatible enterprises, the incumbent platform can choose three strategies: blocking compatibility, entering compatibility and rejecting compatibility. Blocking compatibility requires a high level of experience and a small complementarity. Entering compatibility requires higher experience level and smaller complementarity. When the level of experience is low or complementarity is large, the platform will choose to the rejecting compatibility strategy.*
Keywords: Service supply chain, Vertical complementarity, Compatibility, Platform experience, Market entry

1. **Introduction.** In many real markets, both monopoly and excess profits exist. So the new enterprises will always be introduced. For the incumbent enterprises that have gained monopoly power, these entry actions are bound to pose a threat. Therefore, how to deal with these entry threats is a key issue that every incumbent enterprise pays close attention to. In the past, a large number of studies on market entry have focused on those entrants who have direct substitution relationship with the products of incumbents. Therefore, the relationship between friend and foe is clear at the beginning of the decision-making [1]. However, in the era of platform economy, it is found that many entrants did not appear as direct substitutes at primary; on the contrary, they appeared as complementary through cooperation [2]. The complementarity between the two products means that the increase of consumption quantity of one product will lead to the increase of consumption quantity of another product, too. There are two types of complementarity. One is horizontal

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complementarity, that is, two similar products, the effect of bundling sell is better than single sell, such as the different color ink cartridges of color printer. The other is vertical complementarity, that is, two different products, the effect of bundling sell is better than single sell, such as the printer and the cartridge.

E-commerce platforms mostly play the role of production service providers. For example, B2C platform is mainly for enterprises of selling to customers, and the production and sales among enterprises are mainly serviced by B2B platform. These enterprises of production and operation constitute a production supply chain, and constitute a supporting service supply chain around their service providers. Take the takeaway market as an example. The so-called producers and operators are catering enterprises, customers are a large number of takeaway diners, catering enterprises and takeaway customers constitute a takeaway production supply chain. Around the production supply chain, there is also a service supply chain, that is, the service provider for food production and the service provider for food trade. The former has MRP, ERP of various catering enterprises and other management system providers, and the latter has takeaway e-commerce platform. Among these service providers, because of the matured technology and process, there are large homogeneous products in the market with fierce competition, and both market share and product price for single provider are low. For takeaway market, because the advantages of e-commerce services are increasingly obvious, more and more catering enterprises begin to adopt e-commerce platform to complete trade. However, only trading services are provided, the e-commerce market is huge, but the process is simple and the added value is low, so the customer stickiness is small and the stability is not high. Therefore, the two types of service providers have sufficient motivation to propose the following strategic objectives: system providers urgently need to achieve service differentiation in order to improve service effectiveness and expand production scale; e-commerce platform hopes to improve service value, increase customer stickiness, stabilize and then expand production scale. Because of the high entry threshold of e-commerce platform, the competition is relatively weaker. Comparatively speaking, the demand of system providers is more urgent. System providers and e-commerce platforms constitute the upstream and downstream of catering production service supply chain, and complement each other vertically. Therefore, a reasonable way of thinking is to integrate the upstream and downstream to have complementary effects, so that their data can be exchanged to improve service efficiency and user experience. Service providers can achieve their goals through the following strategies. Firstly, they can directly develop their own complementary operational systems. Secondly, they can indirectly achieve the goal of integration, through compatibility with complementary systems. Thirdly, on the basis of compatibility, they should develop and operate their own complementary system. For the first strategy, it is very difficult to develop and operate a new service system, because the e-commerce platform requires huge investment (money burning), especially to enter the relatively mature platform service market directly. Therefore, if service providers only want to achieve complementary effect, they should adopt the second strategy. If they want to enter the complementary service market at a low cost besides the complementary effect, the third strategy will be appropriate. However, this strategy will face resistance from complementary market incumbents. Compatibility may be beneficial to each other, but market entry is likely to undermine the benefit of incumbents and thus to be blocked. In the Chinese takeout service market, two-dimensional fire company (short for '2dfire') as a system provider and Mei Tuan company as an e-commerce platform are just in such kind of relationship. They are complementary and compatible with each other in order to enhance their competitiveness. They also enter each other's market because they covet temptation, after being blocked, and they slander each other and even go to court [3].

These problems bothered a lot to the incumbents in market to make decision. They need not only to identify the real purpose of partners, but also to make trade-offs between benefits of cooperation and the threat of entry. The innovation is summarized as follows. This paper is to adopt the theory of industrial organization and game, while considering the strategic interaction of market stakeholders and the balance between gains and losses of market incumbents, to solve two core issues for the selection of key decision variables and the modeling of vertical complementary relationship and to find the threshold of strategic conflict between cooperation benefit and entry threat.

The main theoretical contributions of this paper are shown as follows.

In terms of research perspective, this study mainly focuses on the trade-off between compatible cooperation and entry threat of complementary products, while previous studies mainly focused on the entry threat of substitutes.

In terms of research methods, this study mainly focuses on vertical complementarity and proposes their modeling methods, while previous studies mainly focused on horizontal complementarity for complementary products.

Based on the above theories, we found that this study can help Internet enterprises and the traditional enterprises who want to transfer to the Internet enterprises to make better profit improvement, market share expansion and pricing strategy, when they face challenges and opportunities of entry.

The structure of the article is as follows. Chapter 2 is literature review. Chapter 3 shows the study hypothesis and model. Chapter 4 is about model solving and comparative static analysis. Chapter 5 presents the management inspiration and conclusion.

2. **Literature Review.** This paper is mainly based on the platform compatible market entry, complementary products, multi-homing of platform users, envelope competition and entry deterrence. Therefore, the literature on these aspects is reviewed.

(1) Research on compatible entry of platform market. Researchers have been paying attention to the issues related to platform market entry through compatibility. In their seminal papers, Katz and Shapiro [4] studied system compatibility under one-way platforms and direct network effects. When competitive platforms are two-sided and have indirect network effects, Casadesus-Masanell and Zhu [5] found that the incumbents who pursue market position in two-sided platform markets would block compatibility requests of potential entrants. Adner et al. [1] found that when entrants and incumbents are complementary, but the main sources of profits are different, incumbents have incentives to be compatible with entrants through analyzing the competition behavior model between Apple and Amazon on the e-book platform. However, these studies pay less attention to the complementary and competitive relationship among vertical partners in supply chain due to compatibility.

(2) Research on multi-homing of platform users. Multi-homing of the platform users in the incumbents and entrants is often used to enter the platform market through compatibility and complementarity. Byung-Cheol et al. [6] studied the competition problem of asymmetric platforms under pure multi-homing. It was found that the level of differentiation among competitive platforms significantly affected user's multi-homing behavior. In two-sided markets, the side with significant platform differentiation would form single-homing, while the side with no difference would form multi-homing. Poolsombat and Vernasca [7] proposed the concept of 'Partial Multihoming' at the earliest, and found that there are two conditions for the existence of partial multi-homing equilibrium: one is that the network effect of users exceeds the cost of multi-homing and the other is that the proportion of multi-homing is small enough. From the perspective of user pricing, partial multi-homing makes the platform stronger to bargain with users compared with

single-homing, and this ability is more effective for those users with higher network preferences. Ji and Wang [8] analyzed the competitive equilibrium of asymmetric platforms under the condition of single-homing and partial multi-homing, and found that network effect and pricing timing have significant influence on competitive advantage. Most of the objects of existing research for multi-homing are single service platform, and there are few references to study multi-homing user behavior of multi-service platform.

(3) Research on the envelope competition of platform market. Envelope competition based on common user installed is an important way for platform market entry. Chen et al. [9] studied the decision-making choices of dominant firms for product compatibility with other firms in a network effective market. It is found that the dominant firm tends to be compatible when the counterpart user installation base is small and prefers not to be when the installation base is large. The key point of strategic pricing is to prevent the difference of installation base between both compatible parties to expand beyond incompatibility. Its essence is to prevent the possibility to form envelope entry by counterpart. At present, there are few studies specializing in envelope competition. The representative work is the research of Eisenmann et al. [10]. They classified the envelope entry modes preliminarily and proposed an envelope entry analysis framework based on vertical bundling. The analysis found that the envelope entry is caused by the scale economy formed by huge network effects and low conversion costs. It is a unique market entry mode of platform economy. Three types' of results are: complete envelope, the dominant firms exit completely; partial envelope, the entrants share the market with the dominant firms; envelope failure, the entrants exit competition. Gawer and Cusumano [11] found that the dominant firms of platform market often have disadvantages when they are faced with envelope entry through case analysis. The main reason given by the study is that the dominants lack foresight of envelope competition and are slow to respond. Lauri [12] summarized two main envelope strategies of platform market: weak substitution envelope and irrelevant envelope by comparing and analyzing the envelope cases of Apple and Samsung from 2006 to 2011. Among them, the envelope of the iPad to the e-book market belongs to the irrelevant strategy, while the envelope of Galaxy Tab to the iPad belongs to the weak substitution.

(4) Research on market entry deterrence. One of the direct results of envelope entry is that blocking strategies may be adopted on the incumbent platforms, among which indirect exclusive and direct deterrence strategies are the most common. Armstrong [13] studied the platform's exclusive problem based on bottleneck resources. It was found that under certain conditions, users would accept exclusive contracts, user surplus would increase, but the total market surplus would decrease, and exclusive behavior would lead to inefficiency. Mantena et al. [14] analyzed problem of the exclusive constraints for competitive video game platforms to complementary suppliers. It is believed that exclusive strategy will bring more users, and exclusive behavior mainly occurs in the product entry and maturity stages but not in the intermediate stage. Direct deterrence strategies are very classical, such as transitional investment strategy, increasing conversion cost strategy, brand diffusion strategy and restrictive pricing strategy [15]. Under the condition of considering vertical complementary entry, how to choose the entry deterrence strategy has been less considered in previous studies.

In summary, we find that the existing studies have focused mainly on the compatibility of horizontal complementary products, and have not considered the relationship between entry and cooperation. The researches on user's multi-homing and envelope competition are mainly oriented to single service platform. There are few studies on vertical multi-service complementary cooperation and entry conflict in supply chain.

3. Hypothesis and Modeling.

3.1. Hypothesis.

(1) Market. In this paper, the total market size is standardized to 1. Suppose there is a single product B2C market with a total production of 1, that is, all enterprises operate only one homogeneous product, such as homogeneous takeaway. In the initial state, there are traditional duopoly service providers in the upstream market of service supply chain, and there is only one monopoly e-commerce platform in the downstream market.

(2) Market strategy. The service providers in the whole market adopt Cournot output decisions, and have made strategic objectives to integrate complementary services and enhance competitiveness. Strategic implementation chooses the third strategy mentioned above, that is, compatibility first and then low-cost entry to complementary services market. Therefore, there will be three stages in the implementation of the strategy. Stage 1, there is no compatible market at present. Stage 2, the downstream platform is compatible with one service provider in the upstream market. Stage 3, the upstream compatible service providers enter the downstream market, develop and operate their own platform, and achieve compatibility of their own upstream and downstream systems, and then turn off compatibility with incumbent platforms of downstream.

(3) Decision variables. The technological process of existing upstream and downstream service systems is stable, and neither incumbents nor entrants are willing to change the status. The experience effect of platform market is exogenous given s, $s \in [0, 1]$, and the traditional market does not consider it. The strength of complementary effect is γ, $\gamma \in [0, 1]$, and it remains unchanged throughout the strategy implementation process between upstream and downstream systems. The complementary effect is positively correlated with the complementary strength γ and the size q_c of the complementary party, set it γq_c. The upstream service providers gain the experience effect of the downstream market indirectly, and enter the downstream market through compatibly, which saves the huge cost of market development and cultivation, but the cost is that they only have the market experience effect γs. Considering that both upstream and downstream are information services, the marginal cost of services is set 0. Based on the above assumptions, under the condition of the existence of vertical complementary products in the market, when the market is monopolistic, there are the inverse demand function $p = 1 - q + \gamma q_c + s$ and the profit function $\pi = pq$. When the market is duopoly competition, there are the inverse demand function $p_i = 1 - q_i - q_j + \gamma q_c + s$ and the profit function $\pi_i = p_i q_i$. Specific models for different strategic stages are presented in Section 3.2.

(4) Superscript and subscript symbols. Upstream is abbreviated as u, downstream is abbreviated as d. Order $j = 1, 2, 3$ to represent the three stages of the implementation of the strategy. Let $i = 1, 2$ represent two oligarchy service providers in the upstream market. Incumbent platform is short for I and entrant platform is short for E. In the downstream market, the output, price and profit of the incumbent platform are q_{Ij}^d, p_{Ij}^d, π_{Ij}^d, and the output, price and profit of the entrant platform are q_{Ej}^d, p_{Ej}^d, π_{Ej}^d, respectively. Production changes q_{Ij}^d, q_{Ej}^d and q_{ij}^u of three stages in service supply chain as shown in Figure 1.

In Figure 1, there are two types of service providers, production-oriented and transaction-oriented, which constitute a two-stage service supply chain forming by upstream and downstream. The upstream and downstream face the same production enterprise market whose scale is 1. Stage 1 is the initial state of the market. The upstream and downstream are incompatible, and have no direct relationship with each other. Stage 2, the incumbent platform of downstream is compatible and complementary with upstream system provider 1. The experience effect of the platform has a potential impact on the upstream

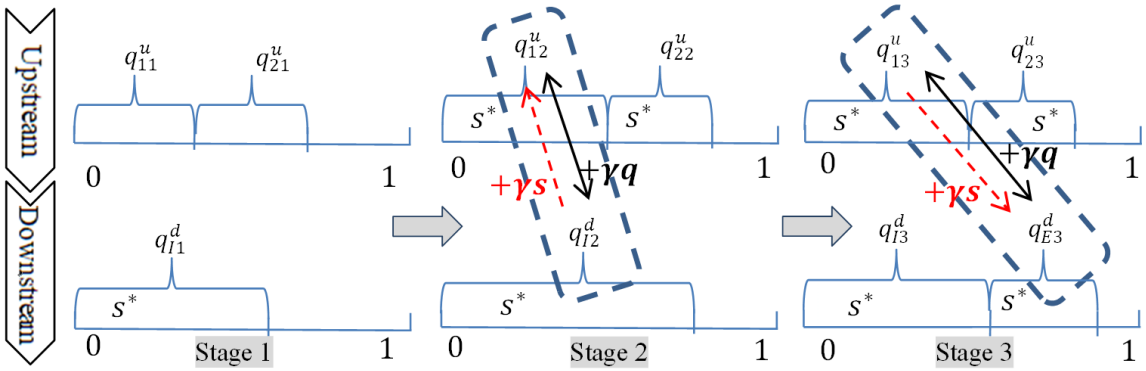

FIGURE 1. Three stages of upstream and downstream complementary compatibility and entry in service supply chain

compatible enterprise. Stage 3, upstream system provider 1 enters downstream market, establishes downstream entry platform, establishes compatibility relationship with each other, and turns off compatibility relationship with downstream incumbent platform. The entrant platform indirectly benefits from the experience effect of incumbent platform, and incumbent platform indirectly benefits from the complementary effect of upstream system providers.

3.2. **Vertical complementary compatibility and market entry model.**

3.2.1. *Stage 1: Basic model – upstream and downstream are incompatible.* At this stage, the downstream is a monopoly platform market, and the platform d_{I1} adopts output decision-making. The upstream is a traditional duopoly market, and production service provider u_{i1} adopts duopoly Cournot game to make decisions. There is no correlation between upstream and downstream. The decision model is as follows.

(1) Downstream monopoly

Inverse demand function of platform d_{I1} is

$$p_{I1}^d = 1 - q_{I1}^d + s \tag{1}$$

Profit function is

$$\pi_{I1}^d = p_{I1}^d q_{I1}^d \tag{2}$$

(2) Upstream duopoly

Inverse demand function of service provider u_{i1} is

$$\begin{cases} p_{11}^u = 1 - q_{11}^u - q_{21}^u \\ p_{21}^u = 1 - q_{21}^u - q_{11}^u \end{cases} \tag{3}$$

Profit functions are

$$\pi_{11}^u = p_{11}^u q_{11}^u \tag{4}$$

$$\pi_{21}^u = p_{21}^u q_{21}^u \tag{5}$$

3.2.2. *Stage 2: Platform d_{I2} and production service provider u_{12} are compatible with each other.* At this stage, the downstream is a monopoly platform market, and the platform d_{I2} adopts output decision-making. The upstream market is a traditional duopoly market, and service provider u_{i2} adopts a duopoly Cournot game to make decisions. Upstream service provider u_{12} is compatible with downstream platform d_{I2} and gets complementary effect each other. The decision model is as follows.

(1) Downstream monopoly

Inverse demand function of platform d_{I2} is

$$p_{I2}^d = 1 - q_{I2}^d + s + \gamma q_{12}^u \tag{6}$$

Profit function is

$$\pi_{I2}^d = p_{I2}^d q_{I2}^d \tag{7}$$

(2) Upstream duopoly

Inverse demand function of service provider u_{i2} is

$$\begin{cases} p_{12}^u = 1 - q_{12}^u - q_{22}^u + \gamma q_{I2}^d \\ p_{22}^u = 1 - q_{22}^u - q_{12}^u \end{cases} \tag{8}$$

Profit functions are

$$\pi_{12}^u = p_{12}^u q_{12}^u \tag{9}$$

$$\pi_{22}^u = p_{22}^u q_{22}^u \tag{10}$$

3.2.3. *Stage 3: Service provider u_{13} enters the downstream platform through the platform d_{E3}. Service provider u_{13} is compatible with the platform d_{E3} and is no longer compatible with the platform d_{I3}.* At this stage, downstream is a duopoly platform market, the leader platform d_{I3} and the follower platform d_{E3} adopt the Stackelberg game to make decisions. The upstream market is a traditional duopoly market, and service provider u_{i3} adopts a duopoly Cournot game to make decisions. u_{13} is compatible with d_{E3}, and has mutual complementary effect each other, but no longer compatible with d_{I3}. The market experience effect of d_{E3} is γs. The decision model is as follows.

(1) Downstream monopoly

Inverse demand functions of platform d_{I3} and d_{E3} are

$$p_{E3}^d = 1 - q_{E3}^d - q_{I3}^d + \gamma s + \gamma q_{13}^u \tag{11}$$

$$p_{I3}^d = 1 - q_{I3}^d - q_{E3}^d(q_{I3}^d) + s \tag{12}$$

Profit functions are

$$\pi_{E3}^d = p_{E3}^d p_{E3}^d \tag{13}$$

$$\pi_{I3}^d = p_{I3}^d q_{I3}^d \tag{14}$$

(2) Upstream duopoly

Inverse demand function of service provider u_{i3} is

$$\begin{cases} p_{13}^u = 1 - q_{13}^u - q_{23}^u + \gamma q_{I3}^d \\ p_{23}^u = 1 - q_{23}^u - q_{13}^u \end{cases} \tag{15}$$

Profit functions are

$$\pi_{13}^d = p_{13}^d q_{13}^d \tag{16}$$

$$\pi_{23}^d = p_{23}^d p_{23}^d \tag{17}$$

4. **Model Solution and Comparative Analysis.**

4.1. **The model solution.**

4.1.1. *Stage 1.* At this stage, according to Formulas (1) and (2), the optimal output decision of downstream monopoly platform is $\frac{d\pi_{I1}^d}{dq_{I1}^d} = 1 - 2q_{I1}^d + s = 0 \Rightarrow {q_{I1}^d}^* = \frac{1+s}{2}$. According to Formulas (3)-(5), the response function of Cournot output game of upstream duopoly service providers is $\frac{\partial \pi_{i1}^u}{\partial q_{i1}^u} = 1 - 2q_{i1}^u - q_{-i1}^u = 0$, $i = 1, 2$, because of $q_{i1}^u = q_{-i1}^u$, there is $1 - 3q_{i1}^u = 0$, and we get ${q_{i1}^u}^* = \frac{1}{3}$. Take ${q_{I1}^d}^*$, ${q_{i1}^u}^*$ into Formulas (1)-(5), it is easy to get the following conclusion.

Lemma 4.1. *For a two-stage complementary service supply chain with a monopolistic e-commerce platform in the downstream and a duopoly service provider in the upstream, when the upstream and the downstream are incompatible, the optimal decision in the downstream is* $q_{I1}^{d\,*} = \frac{1+s}{2}$, $p_{I1}^{d\,*} = \frac{1+s}{2}$, *and the optimal profit is* $\pi_{I1}^{d\,*} = \frac{(1+s)^2}{4}$. *The upstream optimal decision is* $q_{i1}^{u\,*} = \frac{1}{3}$, $p_{i1}^{u\,*} = \frac{1}{3}$, *and the optimal profit is* $\pi_{i1}^{u\,*} = \frac{1}{9}$.

Comparing the decision and profit structure of the market for platform and traditional one, we can find that the output and price of platform market not only depend on the scale of the whole market, but also positively correlate with the experience level of platform. Therefore, it may obtain higher output price and profit, also that is more attractive.

From the perspective of market structure, platform market is a market that depends more on scale, so it has higher concentration and weaker competition. On the contrary, the traditional market has lower concentration, many participants and fierce competition. From the operator's perspective, although the cultivation investment for experience level of platform market is huge, and the entry threshold of platform market is higher and higher, but once entered, the income brought by platform market will be incomparable with the traditional market.

4.1.2. *Stage 2.* At this stage, according to Formulas (6) and (7), the optimal output decision of downstream monopoly platform is $\frac{d\pi_{I2}^d}{dq_{I2}^d} = 1 - 2q_{I2}^d + s + \gamma q_{12}^u = 0 \Rightarrow q_{I2}^d(q_{12}^u) = \frac{1+s+\gamma q_{12}^u}{2}$. According to Formulas (8)-(10), the response functions of Cournot output game of upstream duopoly service provider are $\frac{\partial \pi_{12}^u}{\partial q_{12}^u} = 1 - 2q_{12}^u - q_{22}^u + \gamma q_{I2}^d = 0$ and $\frac{\partial \pi_{22}^u}{\partial q_{22}^u} = 1 - 2q_{22}^u - q_{12}^u q_{22}^u = 0$, they are solved simultaneously and the results are $q_{12}^u(q_{I2}^d) = \frac{1+2\gamma q_{I2}^d}{3}$ and $q_{22}^u(q_{I2}^d) = \frac{1-\gamma q_{I2}^d}{3}$. The optimal output is obtained by solving $q_{I2}^d(q_{12}^u)$, $q_{12}^u(q_{I2}^d)$ and $q_{22}^u(q_{I2}^d)$ simultaneously. By substituting the results into Formulas (6)-(10), the following conclusions can be obtained.

Lemma 4.2. *For a two-stage complementary service supply chain with a monopolistic e-commerce platform of B2C in the downstream and a duopoly service provider in the upstream, when the downstream platform is compatible with an upstream service provider, the optimal decisions of downstream platform are* $q_{I2}^{d\,*} = \frac{3(1+s)+\gamma}{2(3-\gamma^2)}$, $p_{I2}^{d\,*} = \frac{3(1+s)+\gamma}{2(3-\gamma^2)}$, *and the optimal profit is* $\pi_{I2}^{d\,*} = \frac{[3(1+s)+\gamma]^2}{4(3-\gamma^2)^2}$. *The optimal decisions of upstream compatible service providers are* $q_{12}^{u\,*} = \frac{1+(1+s)\gamma}{3-\gamma^2}$ *and* $p_{12}^{u\,*} = \frac{1+(1+s)\gamma}{3-\gamma^2}$, *and the optimal profit is* $\pi_{12}^{u\,*} = \frac{[1+(1+s)\gamma]^2}{(3-\gamma^2)^2}$. *The optimal decisions of upstream incompatible service providers are* $q_{22}^{u\,*} = \frac{2-(1+s)\gamma-\gamma^2}{2(3-\gamma^2)}$ *and* $p_{22}^{u\,*} = \frac{2-(1+s)\gamma-\gamma^2}{2(3-\gamma^2)}$, *and the optimal profit is* $\pi_{22}^{u\,*} = \frac{[2-(1+s)\gamma-\gamma^2]^2}{4(3-\gamma^2)^2}$.

By simple calculation, we can see that $q_{I2}^{d\,*}$, $p_{I2}^{d\,*}$, $\pi_{I2}^{d\,*}$, $q_{12}^{u\,*}$, $p_{12}^{u\,*}$ and $\pi_{12}^{u\,*}$ increase monotonously with the increase of γ and s, while $q_{22}^{u\,*}$, $p_{22}^{u\,*}$ and $\pi_{22}^{u\,*}$ decrease monotonously with the increase of γ and s. It can be seen that the stronger complementarity, the higher experience level will be more beneficial to compatible platform, and more disadvantageous to incompatible platform. The conclusion is intuitive and easy to understand through compatibility and complementarity to enhance the service value of compatible platform. At the same time, the output of compatible platforms is enlarged and the experience effect is contributed to output, price and profit indirectly through complementarity. However, the upstream market structure has also changed from homogeneous competition to differentiated competition and the market is differentiated, while compatible service providers occupy the high-end market. Although the competitiveness of the market is

weakened, incompatible service providers can only stay in the low-end market, the demand and price are reduced, and the profits are also damaged. This is called 'the enemy's friend is also the enemy'.

In addition, it shows that the contribution of complementarity effect to upstream compatibles is greater than downstream compatibles and reflects that complementarity effect improves the service level of both, and the improvement plays a significant role in more competitive market. However, the experience level is only an indirect improvement of upstream compatible service providers, which is limited by other factors, and its effect is less obvious than the direct effect of downstream platforms.

4.1.3. *Stage 3.* At this stage, the downstream duopoly platform carries out Stackelberg game. The incumbent first determines the output q_{I3}^d, and then the entrant makes output decision according to the output selected by the incumbent. According to backward induction to solve, by Formulas (11) and (13), the first step, we get $\frac{d\pi_{E3}^d}{dq_{E3}^d} = 1 - 2q_{E3}^d - q_{I3}^d + \gamma s + \gamma q_{13}^u = 0 \Rightarrow q_{E3}^d(q_{I3}^d, q_{13}^u) = \frac{1+\gamma s+\gamma q_{13}^u - q_{I3}^d}{2}$. The second step, $p_{I3}^d = 1 + s - q_{I3}^d - \frac{1+\gamma s+\gamma q_{13}^u - q_{I3}^d}{2} \Rightarrow \frac{d\pi_{I3}^d}{dq_{I3}^d} = \frac{1+(2-\gamma)s-\gamma q_{13}^u}{2} - q_{I3}^d = 0 \Rightarrow q_{I3}^d(q_{13}^u) = \frac{1+(2-\gamma)s-\gamma q_{13}^u}{2} \Rightarrow q_{E3}^d(q_{13}^u) = \frac{1-(2-3\gamma)s+3\gamma q_{13}^u}{4}$ is obtained by Formulas (12) and (14). The upstream duopoly service providers carry out Cournot output game, according to Formulas (15) and (17), there are $\frac{\partial \pi_{13}^u}{\partial q_{13}^u} = 1 - 2q_{13}^u - q_{23}^u + \gamma q_{E3}^d = 0$ and $\frac{\partial \pi_{23}^u}{\partial q_{23}^u} = 1 - 2q_{23}^u - q_{13}^u = 0$ simultaneously to solve, we can get $q_{13}^u(q_{E3}^d) = \frac{1+2\gamma q_{E3}^d}{3}$ and $q_{23}^u(q_{E3}^d) = \frac{1-\gamma q_{E3}^d}{3}$. The optimal output is obtained by solving $q_{I3}^d(q_{13}^u)$, $q_{E3}^d(q_{13}^u)$, $q_{13}^u(q_{E3}^d)$, and $q_{23}^u(q_{E3}^d)$ simultaneously. By substituting the results into Formulas (11)-(17), the following conclusions can be obtained.

Lemma 4.3. *For two-stage complementary service supply chain with B2C monopoly e-commerce platform in downstream and the duopoly operation service in upstream, when downstream platform is compatible with one upstream service provider, upstream service provider enters downstream market through compatibility. The optimal decisions of downstream incumbent platform are* $q_{I3}^{d\,*} = \frac{3-\gamma-2\gamma^2+(6-3\gamma-2\gamma^2)s}{3(2-\gamma^2)}$ *and* $p_{I3}^{d\,*} = \frac{3-\gamma-2\gamma^2+(6-3\gamma-2\gamma^2)s}{6(2-\gamma^2)}$, *and the optimal profit is* $\pi_{I3}^{d\,*} = \frac{[3-\gamma-2\gamma^2+(6-3\gamma-2\gamma^2)s]^2}{18(2-\gamma^2)^2}$. *The optimal decisions of downstream entry platform are* $q_{E3}^{d\,*} = \frac{1+\gamma-(2-3\gamma)s}{2(2-\gamma^2)}$ *and* $p_{E3}^{d\,*} = \frac{1+\gamma-(2-3\gamma)s}{2(2-\gamma^2)}$, *and the optimal profit is* $\pi_{E3}^{d\,*} = \frac{[1+\gamma-(2-3\gamma)s]^2}{4(2-\gamma^2)^2}$. *The optimal decisions of upstream compatible service providers are* $q_{13}^{u\,*} = \frac{2+\gamma-(2-3\gamma)\gamma s}{3(2-\gamma^2)}$ *and* $p_{13}^{u\,*} = \frac{2+\gamma-(2-3\gamma)\gamma s}{3(2-\gamma^2)}$, *and the optimal profit is* $\pi_{13}^{u\,*} = \frac{[2+\gamma-(2-3\gamma)\gamma s]^2}{9(2-\gamma^2)^2}$. *The optimal decisions of upstream incompatible service providers are* $q_{23}^{u\,*} = \frac{4-\gamma-\gamma^2+(2-3\gamma)\gamma s}{6(2-\gamma^2)}$ *and* $p_{23}^{u\,*} = \frac{4-\gamma-\gamma^2+(2-3\gamma)\gamma s}{6(2-\gamma^2)}$, *and the optimal profit is* $\pi_{23}^{u\,*} = \frac{[4-\gamma-\gamma^2+(2-3\gamma)\gamma s]^2}{36(2-\gamma^2)^2}$.

Through simple calculation, we can see that $q_{I3}^{d\,*}$, $p_{I3}^{d\,*}$ and $\pi_{I3}^{d\,*}$ decrease with the increase of γ and increase with the increase of s. This shows that the greater the complementarity between upstream and downstream, the greater the damage to incumbents is at this stage, and the experience level is still an important factor for incumbents to improve their competitiveness. $q_{E3}^{d\,*}$, $p_{E3}^{d\,*}$, $\pi_{E3}^{d\,*}$, $q_{13}^{u\,*}$, $p_{13}^{u\,*}$ and $\pi_{13}^{u\,*}$ increase with the increase of γ, but are uncertain about the relationship with s. They increase marginally, otherwise decrease marginally, when γ is large enough. It shows that complementarity has a positive impact on compatible parties because of compatibility, but experience utility needs indirect transmission of complementarity, therefore, it is a positive effect on compatible

parties, when complementarity is large enough, only. The relationship is uncertain between $q_{23}^{u\,*}$, $p_{23}^{u\,*}$, $\pi_{23}^{u\,*}$ and γ, s. When γ is large enough and s is small enough, $q_{23}^{u\,*}$, $p_{23}^{u\,*}$, $\pi_{23}^{u\,*}$ have a marginal decreasing relationship with gamma, and when γ is large enough, $q_{23}^{u\,*}$, $p_{23}^{u\,*}$, $\pi_{23}^{u\,*}$ have a marginal decreasing relationship with s, conversely, on the contrary. It shows that because the upstream compatibles enter the complementary market, the competition in the complementary market makes the output scale of the entrants lower than the monopoly state, which results in relative decrease of the complementary and experience benefits of the upstream compatibles, and relative decrease of the difference with the incompatibles, too. When γ is small enough and s is large enough, incompatibles of upstream even may benefit from this compatibility relationship, and then improve profits. It is a relationship of counter-balance.

In addition, according to $\frac{\partial \pi_{I3}^{d\,*}}{\partial s} > \frac{\partial \pi_{E3}^{d\,*}}{\partial s}$, it is same as stage 2, which shows that the direct effect of experience effect is stronger than the indirect effect. The relationship is uncertain between $\pi_{13}^{u\,*}$ and $\pi_{23}^{u\,*}$, when γ is small enough and s is large enough, there will be $\pi_{23}^{u\,*} \geq \pi_{13}^{u\,*}$, which indicates that the competition of the entrants in the downstream market leads to the weakening of its competitive advantage in the upstream market, and sometimes even reverse. This is also a portrayal of 'enemies of the enemy sometimes become friends'.

4.2. **Comparative analysis.** In this section, comparisons and calculations mostly involve multivariate high-order non-linear operations, and it is difficult to find analytical solutions. Therefore, numerical methods are adopted and solved by MATLAB. The application of the theoretical contribution takes a case of the compatible entry for '2dfire and Mei Tuan'.

4.2.1. *Profitability comparison.*

(1) Comparing the profit of upstream and downstream service providers, before and after the implementation of compatibility strategy.

In the feasible region $s \in [0,1]$, $\gamma \in [0,1]$, for the downstream incumbent platform, by Lemma 4.1, the profit before compatibility is $\pi_{I1}^{d\,*} = \frac{(1+s)^2}{4}$, the profit after compatibility is $\pi_{I2}^{d\,*} = \frac{[3(1+s)+\gamma]^2}{4(3-\gamma^2)^2}$, and the simple calculation shows $\pi_{I2}^{d\,*} - \pi_{I1}^{d\,*} \geq 0$. Similarly, for upstream compatible service providers, there is $\pi_{12}^{u\,*} - \pi_{11}^{u\,*} = \frac{[1+(1+s)\gamma]^2}{(3-\gamma^2)^2} - \frac{1}{9} \geq 0$. This means that in the whole decision-making space, both compatible parties have incentives compatible with each other, and the larger s and γ, the greater compatible incentives are. In addition, there are $q_{12}^{u\,*} - q_{22}^{u\,*} = \frac{3(1+s)+\gamma}{2(3-\gamma^2)} - \frac{2-(1+s)\gamma-\gamma^2}{2(3-\gamma^2)} \geq 0$ and $\pi_{11}^{u\,*} - \pi_{12}^{u\,*} = \frac{1}{9} - \frac{1}{9} = 0$. It shows that upstream compatible service providers break the competitive balance with their rivals and form an advantage on market share due to compatibility.

(2) Comparing the profit of upstream and downstream service providers, before and after the implementation of entry strategy.

In the feasible region $s \in [0,1]$ and $\gamma \in [0,1]$, before and after the implementation of the entry strategy, the profits of the downstream incumbent platform are $\pi_{I2}^{d\,*} = \frac{[3(1+s)+\gamma]^2}{4(3-\gamma^2)^2}$ and $\pi_{I3}^{d\,*} = \frac{[3-\gamma-2\gamma^2+(6-3\gamma-2\gamma^2)s]^2}{18(2-\gamma^2)^2}$, respectively. The total profits of platform market entrants are $\pi_{12}^{u\,*} = \frac{[1+(1+s)\gamma]^2}{(3-\gamma^2)^2}$ and $\pi_{E3}^{d\,*} + \pi_{13}^{u\,*} = \frac{[1+\gamma-(2-3\gamma)s]^2}{4(2-\gamma^2)^2} + \frac{[2+\gamma-(2-3\gamma)\gamma s]^2}{9(2-\gamma^2)^2}$.

Assuming that the solution of $\pi_{I2}^{d\,*} = \pi_{I3}^{d\,*}$ is $\gamma_I(s)$, the equation is solved by using MATLAB. As shown in Figure 2(a), the crossover point of $\gamma_I(s)$ and axis s is $(s_I, 0)$, and the crossover point of $\gamma_I(s)$ and $s = 1$ is $(1, \gamma_I)$. In the feasible area $s \in [0, s_I]$, $\gamma \in [0,1]$ and $s \in [s_I, 1]$, $\gamma \in (\gamma_I(s), 1]$, there are $\pi_{I3}^{d\,*} < \pi_{I2}^{d\,*}$, which means that the profit of the incumbent platform will be reduced by implementing the entry strategy in this area. In

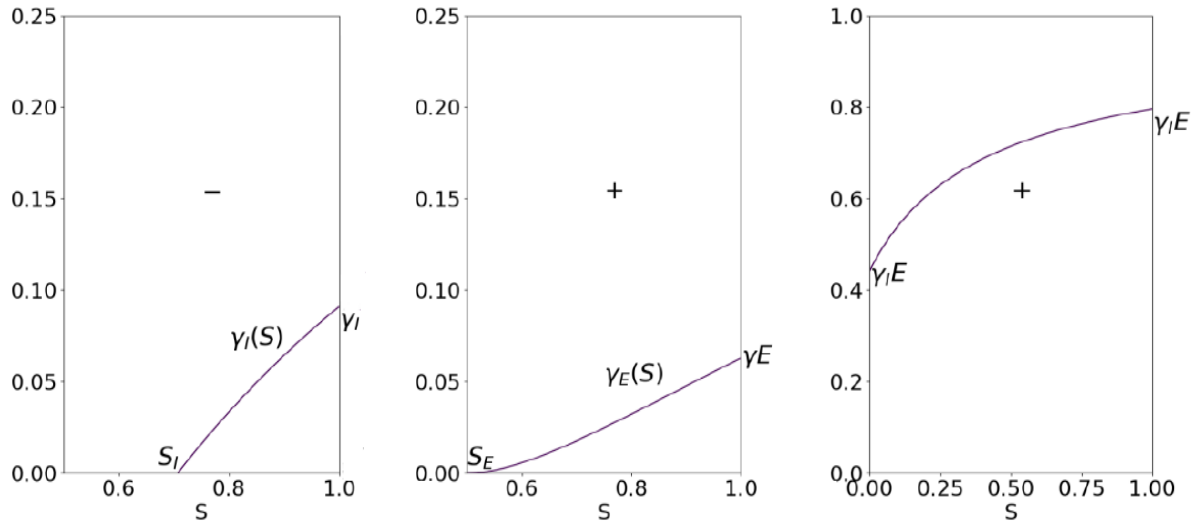

FIGURE 2. Comparisons of profit and market share before and after implementation of compatibility and entry strategy

the feasible area $s \in [s_I, 1]$, $\gamma \in [0, \gamma_I(s))$, there are ${\pi_{I3}^d}^* > {\pi_{I2}^d}^*$, which means that the profit of the incumbent platform will increase if the entry strategy is implemented in this area.

Let the solution of ${\pi_{12}^u}^* = {\pi_{E3}^d}^* + {\pi_{13}^u}^*$ is $\gamma_E(s)$, and the equation is solved by using MATLAB. As shown in Figure 2(b), the crossover point of $\gamma_E(s)$ and axis s is $(s_E, 0)$, and the crossover point of $\gamma_E(s)$ and line $s = 1$ is $(1, \gamma_E)$. Within the feasible area $s \in [0, s_E]$, $\gamma \in [0, 1]$ and $s \in [s_E, 1]$, $\gamma \in (\gamma_E(s), 1]$, there are ${\pi_{I3}^d}^* > {\pi_{I2}^d}^*$, which means that the profits of market entrants will increase if the entry strategy is implemented in this area. Within the feasible area $s \in [s_E, 1]$, $\gamma \in [0, \gamma_E(s))$, there is ${\pi_{I3}^d}^* < {\pi_{I2}^d}^*$, which means that the profits of market entrants will be reduced if the entry strategy is implemented in this area.

In addition, there is ${q_{I3}^d}^* - {q_{E3}^d}^* = \frac{3-\gamma-2\gamma^2+(6-3\gamma-2\gamma^2)s}{3(2-\gamma^2)} - \frac{1+\gamma-(2-3\gamma)s}{2(2-\gamma^2)}$, let the solution of ${q_{I3}^d}^* = {q_{E3}^d}^*$ be $\gamma_{IE}(s)$, and the equation is solved by using MATLAB. As shown in Figure 2(c), the crossover point of $\gamma_{IE}(s)$ and axis γ is $(0, \gamma_{IE})$, and the crossover point of $\gamma_{IE}(s)$ and line $\gamma = 1$ is $(s_{IE}, 1)$. Within the feasible area $s \in [0, s_{IE}]$, $\gamma \in (\gamma_{IE}(s), 1]$, there is ${q_{I3}^d}^* - {q_{E3}^d}^* < 0$, which shows that when the experience level is lower and the complementarity is larger, the incumbent platform lacks market share advantage compared with the entry platform.

After the implementation of compatibility strategy, both 2dfire and Mei Tuan gained profits and increased in market share. When the 2dfire tried to recommend its own takeaway platform, it affected the market share and profits of Mei Tuan. This is related to the lower experience level and the compatibility between them.

In summary, conclusions are as follows.

Proposition 4.1. *(1) When $s \in [0, 1]$ and $\gamma \in [0, 1]$, there is ${\pi_{I2}^d}^* - {\pi_{I1}^d}^* \geq 0$, ${\pi_{12}^u}^* - {\pi_{11}^u}^* \geq 0$ and ${q_{12}^u}^* - {q_{22}^u}^* \geq 0$. (2) When $s \in [0, s_I]$, $\gamma \in [0, 1]$ and $s \in [s_I, 1]$, $\gamma \in (\gamma_I(s), 1]$, there is ${\pi_{I3}^d}^* < {\pi_{I2}^d}^*$. When $s \in [s_I, 1]$ and $\gamma \in [0, \gamma_I(s))$, there is ${\pi_{I3}^d}^* > {\pi_{I2}^d}^*$. (3) When $s \in [0, s_E]$, $\gamma \in [0, 1]$ and $s \in [s_E, 1]$, $\gamma \in (\gamma_E(s), 1]$, there is ${\pi_{I3}^d}^* > {\pi_{I2}^d}^*$. When $s \in [s_E, 1]$ and $\gamma \in [0, \gamma_E(s))$, there is ${\pi_{I3}^d}^* < {\pi_{I2}^d}^*$. (4) When $s \in [0, s_{IE}]$ and $\gamma \in (\gamma_{IE}(s), 1]$, there*

is $q_{I3}^{d\,*} - q_{E3}^{d\,*} < 0$. *When* $s \in [0, s_{IE}]$, $\gamma \in (0, \gamma_{IE}(s))$ *and* $s \in [s_{IE}, 1]$, $\gamma \in [0, 1]$, *there is* $q_{I3}^{d\,*} - q_{E3}^{d\,*} > 0$.

4.2.2. *Pricing strategy analysis.* Pricing strategy is one of the key issues in platform operation. When the operating environment of the platform has change, the effective adjustment of pricing strategy is important particularly. In the context of this study, the incumbent platform faces two pricing adjustment problems, and the entry platform faces one reference pricing problem.

Simple calculation from Lemmas 4.1-4.3, it can be get that the price adjustment strategy of the incumbent platform in stage 2 is $p_{I2}^{d\,*} = p_{I1}^{d\,*} + \Delta p_{I2}^{d} = p_{I1}^{d\,*} + \left[\frac{\gamma+\gamma^2}{2(3-\gamma^2)} + \frac{\gamma^2 s}{2(3-\gamma^2)}\right]$, obviously, there is $\Delta p_{I2}^{d} = \frac{\gamma+\gamma^2}{2(3-\gamma^2)} + \frac{\gamma^2 s}{2(3-\gamma^2)} \geq 0$. At this time, the incumbent platform will adopt a price-raising strategy. Price growth consists of two parts: the price increase $\left(\frac{\gamma+\gamma^2}{2(3-\gamma^2)}\right)$ caused by vertical complementarity effect from compatibility and the price increase $\left(\frac{\gamma^2 s}{2(3-\gamma^2)}\right)$ caused by experience promotion. Within the feasible region $\gamma \in [0, 1]$ and $s \in [0, 1]$, the former is larger than the latter, it shows that the service value-added brought by complementarity is the main reason for the price increase.

In the third stage, the price adjustment strategy of the incumbent platform is $p_{I3}^{d\,*} = p_{I2}^{d\,*} + \Delta p_{I3}^{d} = p_{I2}^{d\,*} + \left[\frac{9-3\gamma-9\gamma^2+\gamma^3}{6(2-\gamma^2)(3-\gamma^2)} - \frac{(9+3\gamma-3\gamma^2-2\gamma^3)\gamma s}{6(2-\gamma^2)(3-\gamma^2)}\right]$. Set $\hat{\gamma}(s) \in [0, 1]$ becomes the solution of the implicit function $\Delta p_{I3}^{d} = \frac{9-3\gamma-9\gamma^2+\gamma^3}{6(2-\gamma^2)(3-\gamma^2)} - \frac{(9+3\gamma-3\gamma^2-2\gamma^3)\gamma s}{6(2-\gamma^2)(3-\gamma^2)} = 0$, and using MATLAB to solve this function, the solutions are shown in Figure 3(a). The crossover point of $\hat{\gamma}(s)$ and axis γ is $(0, \hat{\gamma}_2)$, and the crossover point with the line $s = 1$ is $(0, \hat{\gamma}_1)$, so there is $\hat{\gamma}_1 < \hat{\gamma}_2$. In feasible region $s \in [0, 1]$, $\gamma \in [0, \hat{\gamma}(s))$, there is $\Delta p_{I3}^{d} > 0$, which means that when the complementarity is lower, the competitive ability of entrant platform is weaker because of the complementarity, and the advantage of the incumbent platform is still obvious. At this time, we can consider the implementation of price-raising strategy, and the range of price increase is Δp_{I3}^{d}. Within the feasible area $s \in [0, 1]$, $\gamma \in (\hat{\gamma}(s), 1]$, there is $\Delta p_{I3}^{d} < 0$, which means that when the complementarity is higher, the entry platform has gained stronger competitiveness by relying on complementarity, and the weakness of the incumbent platform has become obvious. It is necessary to win customers through price reduction strategies, such as adopting subsidies policy, the range of subsidies price is Δp_{I3}^{d}.

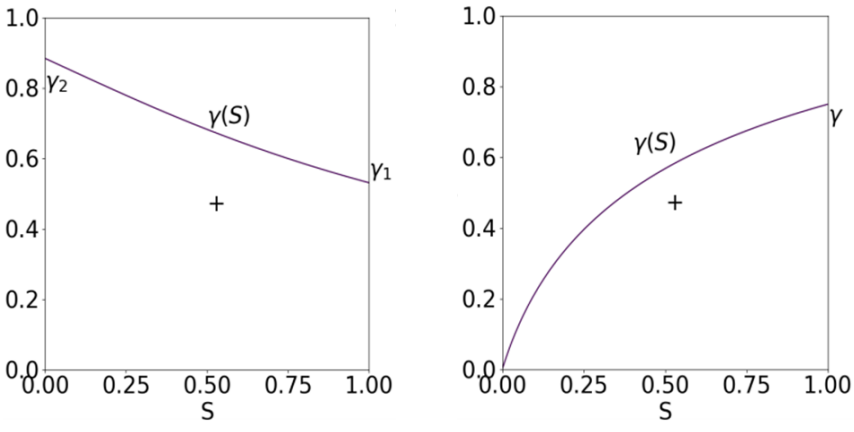

FIGURE 3. Pricing strategies after the implementation of the entry strategy

In the third stage, the entry platform will be priced according to the price strategy of the incumbent platform, which is $p_{E3}^{d\,*} = p_{I3}^{d\,*} + \Delta p_{E3}^{d} = p_{I3}^{d\,*} + \left[\frac{2\gamma+\gamma^2}{3(2-\gamma^2)} - \frac{(6-6\gamma+\gamma^2)s}{3(2-\gamma^2)}\right]$. Set $\bar{\gamma}(s) \in [0,1]$ becomes the solution of the implicit function $\Delta p_{E3}^{d} = \frac{2\gamma+\gamma^2}{3(2-\gamma^2)} - \frac{(6-6\gamma+\gamma^2)s}{3(2-\gamma^2)} = 0$, and using MATLAB to solve this function, the solutions are shown in Figure 3(b). The crossover point of $\bar{\gamma}(s)$ and axis s is $(0,0)$, and the crossover point with the line $s=1$ is $(1,\bar{\gamma})$. In feasible region $s \in [0,1]$, $\gamma \in [0,\bar{\gamma}(s))$, there is $\Delta p_{E3}^{d} < 0$, which means that when complementarity is weaker, the value-added of compatible-driven market entry services is smaller, and the price reduction strategy should be adopted. Such as adopting subsidies policy, the range of subsidies price is Δp_{E3}^{d}. Within feasible region $s \in [0,1]$, $\gamma \in (\bar{\gamma}(s),1]$, there is $\Delta p_{E3}^{d} > 0$, which means that the value-added service is larger, and the price can be increased appropriately, the range of price increase is Δp_{E3}^{d}.

In summary, conclusions are as follows.

Proposition 4.2. *(1) When $\gamma \in [0,1]$ and $s \in [0,1]$, there is $\Delta p_{I2}^{d} \geq 0$. (2) When $s \in [0,1]$, $\gamma \in [0,\hat{\gamma}(s))$, there is $\Delta p_{I3}^{d} > 0$. When $s \in [0,1]$, $\gamma \in (\hat{\gamma}(s),1]$, there is $\Delta p_{I3}^{d} < 0$. (3) When $s \in [0,1]$, $\gamma \in [0,\bar{\gamma}(s))$, there is $\Delta p_{E3}^{d} < 0$. When $s \in [0,1]$, $\gamma \in (\bar{\gamma}(s),1]$, there is $\Delta p_{E3}^{d} > 0$.*

4.2.3. *Entry threat and countermeasure analysis.* According to Proposition 4.1, as shown in Figure 4(a), within feasible region $s \in [0,s_I]$, $\gamma \in [0,1]$ and $s \in [s_I,1]$, $\gamma \in (\gamma_I(s),1]$, there is $\pi_{I3}^{d\,*} < \pi_{I2}^{d\,*}$, which means that entry platform brings a great threat to the incumbent platform. It is necessary for the incumbent platform to adopt strategies to deal with this threat.

As shown in Figure 4(b), when $s \in [s_E,1]$, $\gamma \in [0,\gamma_E(s))$, it means that the entry strategy does not necessarily increase the profits for the entrants. When the experience level is higher and the complementarity is lower, the market entry will lead to the decrease of profits.

The possibility of combining these two aspects, as shown in Figure 4(c), this paper finds that with the change of strategy space 1, the incumbent platform will adopt different strategies to deal with market entry threats. Let point (s^*,γ^*) be the crossover point of $\gamma_I(s)$ and $\gamma_E(s)$. Among them, region 1 consists of two parts: $s \in [s_I,s^*]$, $\gamma \in [0,\gamma_I(s))$

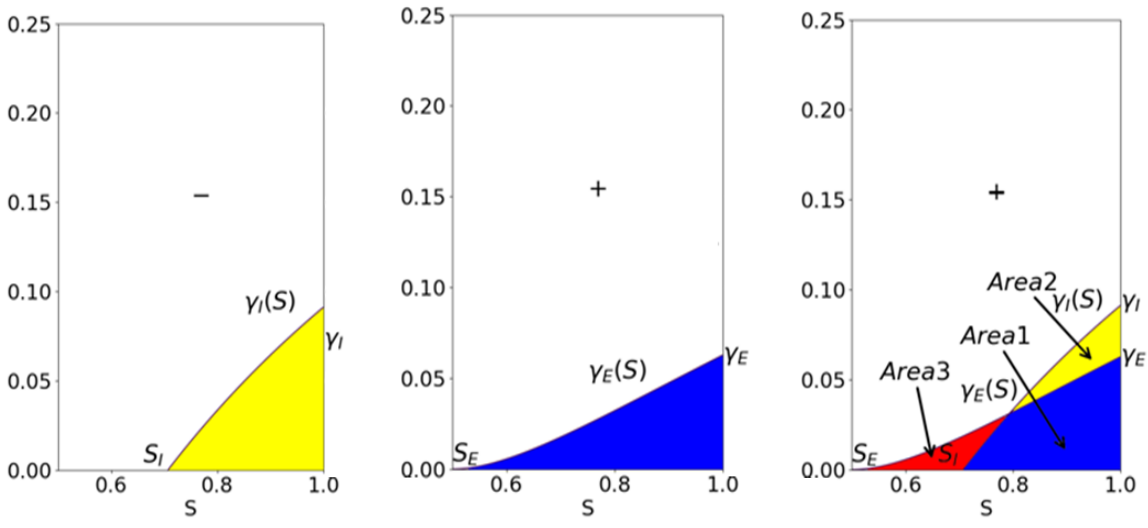

FIGURE 4. Entry threats and countermeasures of incumbents

and $s \in [s^*, 1]$, $\gamma \in [0, \gamma_E(s))$, there are ${\pi_{I3}^d}^* - {\pi_{I2}^d}^* > 0$ and $({\pi_{E3}^d}^* + {\pi_{13}^u}^*) - {\pi_{12}^u}^* < 0$, in this region, the strategy of the incumbent platform is to block compatibility, and the upstream compatible service providers will not enter the platform market. Region 2 is $s \in [s^*, 1]$ and $\gamma \in (\gamma_E(s), \gamma_I(s))$, there are ${\pi_{I3}^d}^* - {\pi_{I2}^d}^* > 0$ and $({\pi_{E3}^d}^* + {\pi_{13}^u}^*) - {\pi_{12}^u}^* > 0$, in this region, the incumbent platform will adopt a compatibility strategy, and the upstream compatible service providers will enter the platform market. When $s \in [0, s_I]$, $\gamma \in [0, 1]$ and $s \in [s_I, 1]$, $\gamma \in (\gamma_I(s), 1]$, there is ${\pi_{I3}^d}^* - {\pi_{I2}^d}^* < 0$, the incumbent platform will not adopt the compatible strategy, this is, it will adopt the rejection compatibility strategy, and compatible service providers are also not possible to enter the platform market. Here, the most noteworthy is region 3: $s \in [s_E, s_I]$, $\gamma \in [0, \gamma_E(s)]$ and $s \in [s_I, s^*]$, $\gamma \in (\gamma_I(s), \gamma_E(s)]$. In this region, s is larger, which belongs to the strategy factor of larger income for incumbent platform in stage 2, although the profit growth of entrant platform is negative. The incumbent platform can easily regard it as a blocking compatibility strategy area. Therefore, this region can be regarded as a dangerous area, and the incumbent platform must remember not to make mistakes.

In the case of 2dfire and Mei Tuan, the strategy of 'compatibility-reject compatibility' was adopted by Mei Tuan, which showed that Mei Tuan as the incumbent platform lacked a comprehensive strategic perspective. In the second stage, it only considered the benefits of compatibility and ignored the threat of complementary entry. Therefore, it adopted a higher degree of compatibility and complementarity, that led its loss own profits and market share when 2dfire adopted the entry strategy. According to the analysis in this paper, a better long-term consistent strategy can be set by Mei Tuan by setting the experience level and compatibility complementarity, such as blocking compatibility or compatible entry. In fact, a simply reject compatibility strategy may be better than the current strategy.

In summary, conclusions are as follows.

Proposition 4.3. *The choices of the incumbent platform. (1) Compatible blocking strategy: When* $s \in [s_I, s^*]$, $\gamma \in [0, \gamma_I(s))$ *and* $s \in [s^*, 1]$, $\gamma \in [0, \gamma_E(s))$, *there are* ${\pi_{I3}^d}^* - {\pi_{I2}^d}^* > 0$ *and* $\left({\pi_{E3}^d}^* + {\pi_{13}^u}^*\right) - {\pi_{12}^u}^* < 0$. *(2) Entry compatibility strategy: When* $s \in [s^*, 1]$ *and* $\gamma \in (\gamma_E(s), \gamma_I(s))$, *there are* ${\pi_{I3}^d}^* - {\pi_{I2}^d}^* > 0$ *and* $\left({\pi_{E3}^d}^* + {\pi_{13}^u}^*\right) - {\pi_{12}^u}^* > 0$. *(3) Rejecting compatibility strategy: When* $s \in [0, s_I]$, $\gamma \in [0, 1]$ *and* $s \in [s_I, 1]$, $\gamma \in (\gamma_I(s), 1]$, *there is* ${\pi_{I3}^d}^* - {\pi_{I2}^d}^* < 0$.

5. **Inspirations and Conclusions.**

5.1. **Inspirations.**

After the previous analysis, we can get the following inspirations.

(1) Supply chain service complementarity is an effective way to achieve value added.

Relative to the development of complementary business by oneself, compatibility with upstream and downstream partner enterprises is a better way to achieve complementary operation between different links of supply chain, which is fast in process, low in cost and easy to achieve results.

(2) Vertical complementary compatibility is a better choice for upstream traditional enterprises to enter downstream platform market.

There are two necessary conditions for platform enterprises and traditional enterprises to achieve compatibility and complementarity: the experience level and the complementary level. Experience level plays a more significant role in platform enterprises, and complementary level contributes more to traditional enterprises. Compared with the traditional service market, the e-commerce platform market is a blue ocean, which is more attractive for the traditional enterprises that need to break the management dilemma and

realize the industrial transformation. It is a good choice for them to enter the platform market through complementary compatibility.

(3) Complementary compatibility is a double-edged sword of platform market.

Because complementary compatibility reduces the threshold of market entry, its possibility and threat of entry are greater than incompatible entry. If only considering the benefits of compatibility, the strategy choice of incumbent enterprises should be that the higher experience level and complementarity, the better will be. However, if we consider the possibility of entry threat brought by compatibility, this strategy will bring a disaster to incumbent enterprises.

(4) Incumbent platform strategy selection with the possibility of compatibility entry.

Considering the possibility of benefits and bad results of compatibility, the incumbent platform should choose the following strategies: when experience level is lower, it does not implement compatibility strategy. When experience level is higher, it can choose upstream enterprises with lower complementarity to be compatible, and the other side will not enter the platform market in the future. When the experience level is the highest, they can choose the upstream enterprises with relatively high complementarity to be compatible and the other side will enter the platform market in the future, but they will also have profit improvement.

(5) Entry compatible strategy is only a short-term strategy for incumbent platforms.

When the platform adopts the entry compatible strategy for tolerating the other side enters the market, its share may be at a disadvantage, although its profit has improved. At this time, the incumbent platform should choose and weigh carefully. If short-term benefits are emphasized, the incumbent platform can adopt an entry compatible strategy. However, traffic is king in platform economy. If we focus on long-term development, the incumbent platform should adopt the strategy of rejecting compatibility.

(6) Price strategy after adopting the decision-making of compatible entry.

In stage 2, after compatibility and before the platform market enters, the incumbent platform can implement the strategy of price increase. In stage 3, after compatibility entry, if the complementarity is lower, the price of the incumbent platform should be increased, and the price of the entry platform should be reduced; if the complementarity is higher, the incumbent platform should be reduced, and the price of the entry platform should be increased.

5.2. **Conclusions.** This paper shows that the complementary compatibility between upstream and downstream of supply chain is an effective strategy to enhance their competitiveness and achieve market share and profit growth. For complementary partners such as traditional enterprises and platform enterprises, the premise of implementing strategy is that platform enterprises have a higher experience level. The higher the experience level, the more compatible partner platform enterprises can choose; otherwise, they can only choose compatible partners with low complementarity. This paper shows that, different from the existing research conclusion 'either blocking or incompatible', there is also a win-win strategy of 'entry compatibility'. Whether blocking compatibility or entering compatibility, the higher the experience level of the incumbent platform, the larger the choice of strategy space for complementary compatibility will be, and the greater the profit improvement that compatible parties may obtain.

This study shows that on the one hand, most of the existing studies on alternative-based entry only considered the relevant strategic factors for 'entry' or not. On the other hand, the study of entry problems based on complementarity needs to consider the relevant strategic factors for 'compatibility-entry' or not at the same time. Therefore, compared with similar studies, this paper has expanded its research methods and conclusions.

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REFERENCES

[1] R. Adner, J. Chen and F. Zhu, Frenemies in platform markets: The case of Apple's iPad vs. Amazon's Kindle, *Harvard Business School Technology and Operations Management Unit Working Paper*, no.15-087, 2016.

[2] G. G. Parker, M. W. Van Alstyne and S. P. Choudary, *Platform Revolution: How Networked Markets Are Transforming the Economy – And How to Make Them Work for You*, W. W. Norton & Company Publishers, New York, 2016.

[3] M. Hong, *Two-Dimensional Fire Claimed to be Blocked by Mei Tuan? Mei Tuan: Prepared for Accountability!*, https://news.qudong.com/article/438259.shtml, 2017.

[4] M. L. Katz and C. Shapiro, Network externalities, competition, and compatibility, *American Economic Review*, vol.75, no.3, pp.424-440, 1985.

[5] R. Casadesus-Masanell and F. Zhu, Business model innovation and competitive imitation: The case of sponsor-based business models, *Strategic Management Journal*, vol.34, no.4, pp.464-482, 2013.

[6] K. Byung-Cheol, J. J. Lee and H. Park, Two-sided platform competition with multihoming agents: An empirical study on the daily deals market, *Information Economics and Policy*, vol.41, pp.36-53, 2017.

[7] R. Poolsombat and G. Vernasca, Partial multihoming in two-sided markets, *Discussion Papers from Department of Economics*, University of York, 2006.

[8] H.-L. Ji and X.-F. Wang, Competition model of two-sided markets with platform differentiation and users partially multihoming, *Systems Engineering – Theory & Practice*, vol.34, no.6, pp.1398-1406, 2014.

[9] J. Chen, U. Doraszelski and J. E. Harrington Jr, Avoiding market dominance: Product compatibility in markets with network effects, *The Rand Journal of Economics*, vol.40, no.3, pp.455-485, 2009.

[10] T. Eisenmann, G. Parker and M. V. Alstyne, Platform envelopment, *Strategic Management Journal*, vol.32, no.12, pp.1270-1285, 2011.

[11] A. Gawer and M. A. Cusumano, Industry platforms and ecosystem innovation, *Journal of Product Innovation Management*, vol.31, no.3, pp.417-433, 2013.

[12] H. Lauri, Taxonomy of platform envelopment: A case-study of Apple and Samsung, *The 5th IBA Bachelor Thesis Conference*, Enschede, Netherlands, 2015.

[13] M. Armstrong, Competition in two-sided markets, *The Rand Journal of Economics*, vol.37, no.3, pp.668-691, 2005.

[14] R. Mantena, R. Sankaranarayanan and S. Viswanathan, Platform-based information goods: The economics of exclusivity, *Decision Support Systems*, vol.50, no.1, pp.79-92, 2010.

[15] P. Belleflamme and M. Peitz, *Industrial Organization: Markets and Strategies*, 2nd Edition, Cambridge University Press, Belleflamme, 2015.