INDEPENDENT SALES OR BUNDLING? DECISIONS UNDER DIFFERENT MARKET-DOMINANT POWERS

FENG WEI* AND HONG CHEN

School of Management and Economics
University of Electronic Science and Technology of China
Chengdu Sichuan 611731, China

(Communicated by Stefan Wolfgang Pickl)

Abstract. Enterprises are aware that bundling strategies can improve profitability in the highly competitive marketplace. This study evaluates an online to offline (O2O) supply chain system made up of a supplier and an e-retailer who can sell two products independently or bundled through online and offline channels, and discuss the influence of pricing strategy and channel choice on profit under different market-dominant powers. Based on a game theory model, we derive an optimal wholesale price for the supplier, an optimal sale price for the e-retailer, and their respective profit. We demonstrate that a Stackelberg leader is more profitable, irrespective of whether independent sales or bundling are chosen. Regardless of who the leader is, the whole supply chain receive equal profit. For a market leader, independent sales or bundling decisions should be made according to market size. Sensitivity analysis show that as the self-price sensitivity coefficient increases, the profit monotonically decreases for both independent sales and bundling; this occur for both the market dominated by the supplier and that dominated by the e-retailer. For independent sales, as the cross-price sensitivity coefficient increases, the profit monotonically increases; for bundled sales, the profit of the game players is not affected.

1. Introduction. Nowadays, Internet applications are very popular and customers are familiar with buying goods and services through the Internet. Online and offline bundle sales are a widespread phenomenon. Online to offline (O2O) bundling is valued and is being adopted by many e-businesses. The mobile Internet has created many O2O opportunities. Many traditional enterprises and e-commerce companies have invested in O2O, which makes the competition on e-commerce platforms increasingly fierce. In recent years, customers increasingly require diversification and individualization of products, and companies obtain a competitive advantage by adopting bundled strategies and differentiated products. Some scholars have discussed bundle pricing decisions with constrained capacity [27]. In 2011, the concept of O2O was proposed by Alex Rampell, who purported that this model would allow businesses to find consumers online and direct them to the physical store. Online marketing and purchasing drive offline consumption and business, linking

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2010 Mathematics Subject Classification. Primary: 58F15, 58F17; Secondary: 53C35.
Key words and phrases. Different market-dominant powers, bundling, multi-product pricing, O2O supply chain, game theory.
This research is supported by the National Natural Science Foundation of China(71472026).
* Corresponding author: Feng Wei.
offline business with the Internet. The O2O business model achieves integration of the online virtual economy (virtual world) and the offline real economy (real world). By providing discounts on group purchases and service bookings, the message from the offline store is pushed to Internet users, converting them into offline customers; the integration of online and offline resources promotes sales. With continual development of the O2O mode and logistics technologies, retail enterprises have become deeply integrated with the Internet in terms of internal operation, service, and product sales. An increasing number of enterprises have combined online and offline resources to achieve dual-channel operation. Examples include Alibaba Corporation, Wal-Mart, Uber, Woolworths, GoodRx, IKEA, Getaround, Zaarly, and Airbnb. These businesses have both online and offline channels that present a coordinated series of decision-making issues, which include the pricing system, channel conflict, inventory strategy, and consumer preferences. Further, in the era of the virtual economy, e-business enterprises can deepen their business scope by using O2O channels.

O2O bundling is an important strategy in supply chain management. Businesses use bundled sales to improve efficiency and promote sales. Differential pricing can reduce the search costs for consumers and can increase their consumption. For example, one software package strategy involves the purchase of electronic products at physical stores and the downloading of discounted software online by consumers. Manufacturing packages include a laptop being bundled with an operating system or other software. In online retailing, the Taobao shopping platform launched the “100 minus 30” activities in the “double eleven” global shopping carnival in 2018. Uniqlo’s O2O strategy is O2O diverting; code scanning services provided by the online application can only be scanned and used in physical stores, which achieves bundled sales and increases demand. This type of invisible bundling has expanded their market scale and reduced the search cost for consumers. The same types of strategies can be implemented with products such as consumer goods, e-journal insurance packages, and so on. In the actual market, bundle marketing results in different degrees of fluctuation to the retail price and demand, which in turn affects the performance of businesses. Consequently, some key research questions are whether game players should make bundle-pricing decisions in a multi-product sales market and how we can provide decision-making support to improve the performance for different dominant parties.

In the last few years, scholars have studied the bundle marketing decision-making problem from various perspectives. Researchers to date have studied the influence of the bundling-product correlation, the product bundle quantity, and quantity discounts on pricing and bundling. However, these studies have only examined the operational efficiency of retailers, without considering the impact of upstream wholesalers on game results. Yan et al. [38] examine the relationship between bundle sale decisions and advertising. They analyze three scenarios: bundled with advertising, bundled without advertising, and not bundled. The findings of their study can be used to help companies adopt reasonable and effective strategies to improve performance. Chakravarty et al. [7] evaluate a decentralized supply chain with three different bundling situations and investigate the influence on independent and bundled sales.

Different market-dominant powers can affect the pricing and performance of the supply chain participants. In a supplier-leading or retailer-leading market, one player is the dominant player and the other is the follower; each must make decisions
in a different order. To the best of our knowledge, most literature assumes that supply chain participants are completely rational and make independent decisions, and that game analysis is carried out under symmetric information to improve efficiency. In the market game, the player undoubtedly adopts a sales strategy that is beneficial to them, that expands their market scale and invades the opponents market. Business managers are concerned with the existence of market-dominant powers, and they pay attention to pricing and channel selection. For example, as a dominant power, a supplier firstly determines the wholesale prices; then, the platform vendor sets the retail prices based on the wholesale prices. Finally, there is an analysis of the cost-demand related variables and discount level to achieve a win-win for all players.

Given previous research, this study analyzes the equilibrium price, bundle strategy, channel selection, and supply chain profit. Specifically, the following fundamental research issues are addressed:

1. An e-retailer can sell commodities through offline physical stores and virtual online stores; this is a common trend in retail industries. Under the O2O business model, how can we establish a game decision model to maximize profit for the e-retailer? What is the equilibrium game result of multi-channel pricing and different decision behaviors for the whole O2O supply chain?

2. The dominant strategy of a market leader should be determined based on market size (independent sales or bundle sales). How does market size affect the suppliers and e-retailers channel sales strategies under different market leaders?

3. In market competition, a dominant player can affect the decisions of the participants. The supplier and e-retailer inevitably compete for market share. How should pricing decisions and channel sales under different market-dominant powers be made?

This study makes three contributions to the current knowledge of bundle sale strategies in O2O supply chain management. First, it focuses on examining the influence of different dominant powers on optimal pricing and performance. This expands the current literature on online and offline bundling strategies. Second, it includes a comprehensive study of the influence of related parameters (e.g. $a, \beta, \gamma$). Finally, it indicates that sales strategy is influenced by market size. These findings have implications for the coordination and cooperation of game players.

The remainder of the article is organized as follows. First, we review the relevant literature in Section 2. In Section 3, we set the model assumptions. In Sections 4 and 5, pricing policies for independent and bundled sales channels are discussed. In Section 6, we focus on marketing decisions, pricing, and O2O supply chain profit, which can help game players develop effective management strategies. In Section 7, the validity of the model is verified using a numerical example. Finally, in Section 8, research conclusions and further research are proposed.

2. Literature review. To the best of our knowledge, few scholars have studied O2O supply chain bundling. Thus, there is a critical gap in the e-commerce research field. In particular, under the O2O business model, it is worth exploring consumer demand, bundle marketing modes, and supply chain profit. Further, there is little existing research on the online and offline bundling problem. In practice, the importance of bundling sale strategies and the pricing of O2O supply chains is of great significance. Young people who lack experience in traditional shopping channels like online shopping [24]. Under the O2O business model, the selection of the
environment for an enterprise ecosystem is more complicated than traditional business models. Different game players establish cooperative mechanisms to improve e-commerce and retailing, and form a symbiotic rather than a zero-sum relationship, constructing a win-win cooperative ecological circle.

The literature on bundling and channel selection has provided useful guidance. In reality, whether or not participants adopt a bundling strategy will have a different impact on selling price, pricing, and consumer demand. Thus, whether or not suppliers and platform vendors adopt a bundled sales approach is extremely important in multi-product pricing decisions. Hanson et al. [17] evaluate the pricing of a single firm and present the effectiveness and economic insights of this strategy. They then formulate an optimization model to improve the firm’s profit. Chiang et al. [10] analyze the indirect profit of direct marketing through the offline channel. Gurler et al. [16] study a retail enterprise that sells two types of products and find that the number of bundles influence the bundling cost. They report an approach to pricing and bundle formation under inventory constraints using a stochastic model. Yan et al. [39] focus on direct channel marketing using online technology to enhance market competitiveness. Prasad et al. [29, 30] study the effects of three types of bundling approaches: pure composition, pure bundling, and mixed bundling. In 2015, they also discussed mixed bundling or reserved product pricing for two products. The impact of the discount level and different types of consumers on optimal price, demand, and profit were also discussed for three specific cases.

A considerable amount of literature has investigated pricing tactics and channel selection. For example, Hua et al. [21] consider delivery lead time and pricing in an online direct channel. Other research indicates that complementary products require optimum bundling to maximize their profit [37]. Dan et al. [13] examine optimal pricing for retail services using a Stackelberg game. Another study evaluate quantifying costs when purchasing groceries online compared to offline [11]. Hu et al. [20] investigate price decisions and service levels with a dual-channel. Ryan et al. [32] study a manufacturer who sells a single commodity through a dual-channel. Sheikhzadeh et al. [34] examine a pure bundling policy compared to independent selling of products, i.e., a no-bundling policy. Balakrishnan et al. [1] analyze the influence of O2O pricing strategies under value uncertainty. Research suggests that consumers first visit a physical store to browse the goods, and then decide whether to purchase it in the store or online at a cheaper price. This behavior is known as “showrooming”. Channel switching behavior by consumers can reduce a company’s online and offline profit. Jiang et al. [23] propose the use of an instant coupon and appropriate bundle discount to increase revenue. Given a customer’s purchase preference, they design a model to handle the online pricing issue. Research suggests that bundling and coupons are appropriate tools for integrated marketing. Cao et al. [5] study a bundling decision under limited supply and find that limiting supply can affect the bundling strategy. If limited supply is appropriate, then bundled sales can create value and extract a higher margin for businesses. Gao et al. [14] study online payments and offline physical store pick-up. They built a stylized model with offline and online channels, based on the customer’s channel choice. Banciu et al. [2] study the pricing strategy problem for bundled products. They find that marginal costs are small, and the seller obtains more profit compared to their valuations. Recently, Ji et al. [22] focus on the low-carbon environment of the O2O retail supply chain. Mehra et al. [28] report that customers often select a “best-fit” product in a physical store but purchase it online at a cheaper retail price. They consider
two types of retailers, online retailers and brick-and-mortar stores, and analyzed
the issue of price matching. Xie et al. [36] explore the influence of advertising
investment on revenue. In particular, they determine wholesale prices and optimal
offline/online prices. Honhon et al. [19] consider vertically differentiated goods that
can be sold individually or in bundles and described optimal bundling strategies.
Sarkar et al. [33] apply the Stackelberg game policy to determine sales strategies
for two products. He et al. [18] examine how to impact consumer purchase behavior
in the O2O environment. They formulate an O2O business model with reference to
the quality effect. Prasad et al. [31] explore temporal bundling effectiveness with
strategic and myopic consumers.

Another stream of literature examines the influence of different market-dominant
powers on pricing and profit [7, 24, 12, 3]. Choi [12] analyze the impact of different
channel structures on profit. He studies three power structures (retailer Stackelberg,
manufacturer Stackelberg, and vertical Nash) with a demand function. Yao et
al. [40] discuss pricing strategies for both offline and online distribution channels
and design a retail price and e-tail price, respectively. Cao et al. [6] find that
manufacturers can distribute more goods using their own retail stores, whereas
independent retailers should be used if the manufacturer sells highly substitutable
products. Zhang et al. [41] analyze the impact of alternative products on profit
under different power structures. They discuss three game scenarios and find that a
vertical structure is beneficial to consumers. Bhargava [3] studies product bundling
of two component goods in different distribution structures. He demonstrate the
influence of bundling and pricing for two suppliers and one retailer and find that the
conflict between vertical and horizontal channels weaken the company’s bundling
incentives. Chen et al. [8] analyze a supply chain in which one side dominate the
sales market and the other side is the follower, while Chen et al. [9] study pricing
policies for a supplier and retailer, with the retailer selling goods through O2O
channels. The wholesale price is first formulated and the substitute product’s retail
price is decided by the retailer; an appropriate cooperation strategy is formulated
using the Nash equilibrium. Girju et al. [15] focus on channel interactions. They
analyze pricing and bundling using Stackelberg games. Cao et al. [4] consider
bundle sales in a single channel where the supplier first sets the wholesale price.
Wang et al. [35] discuss pricing and channel sales with O2O channels under different
decision makers. Luo et al. [25] investigate optimal pricing policies under different
power structures, considering both vertical and horizontal competition. Luo et al.
[26] examine how customer value affects pricing decisions and find that the pie split
is determined by the power structure. To facilitate comparison with the present
study, Table 1 shows the recently published works on bundling.

In summary, the existing literature focuses on pricing and bundling under a single
channel structure. There are very few studies of the bundling problem under both
online and offline channels. Moreover, few studies have considered the influence
of different dominant powers. To address this gap, our study takes “traditional think-
ing and Internet thinking integration” as the research perspective and explores the
problem of online and offline bundling decisions under an e-commerce environment.
And discuss the pricing and channel selections of a game player under different
market powers.

3. Notations and model assumptions. This research examine an O2O supply
chain consisting of a supplier and an e-retailer. The supplier and retailer sell two
Table 1. Recently published works on bundling

| Literature            | Selling price                      | Strategy                                       | Situation                                           |
|-----------------------|------------------------------------|------------------------------------------------|----------------------------------------------------|
| Gurler et al. [7]     | Independent and bundled sales price| Bundle pricing and inventory levels            | Inventory constraints and stochastic model         |
| Prasad et al. [9]     | Mixed bundling                     | Different bundling and network externality     | Technological products and network externality     |
| Sheikhzadeh et al. [17]| Bundled sales price               | Pure bundling and independent policy           | Product heterogeneity and risk considerations       |
| Jiang et al. [19]     | Online pricing with bundling       | Online pricing strategy Coupon discounts       | Customers purchase preference and coupon           |
| Prasad et al. [29]    | Inter-temporal pricing             | Pure components, pure bundling, and mixed bundling | Myopic and strategic consumers                     |
| This study            | Independent and bundled sales price| Channel selection, Online and offline sales    | E-commerce and different market-dominant powers     |

types of products independently or bundled. We examine price strategy and channel selection under different market powers.

The supplier’s unit wholesale prices are $w_1$ and $w_2$. The supplier sells two products to the e-retailer independently or in bundles, and the e-retailer sells those two products to customers through O2O channels. To ensure that the e-retailer is profitable, $w_i + c_i < p_i$ must be satisfied, where $i = 1, 2$. In addition, the unit sale cost must be satisfied: $c_i < w_i < p_i$. For notation and explanation, see Table 2.

Similar to previous research, the consumer’s demand function through the offline channel is $q_1(p_1, p_2) = \mu a - \beta p_1 + \gamma p_2$; the demand function through the online channel is $q_2(p_1, p_2) = (1 - \mu) a - \beta p_2 + \gamma p_1$, where $\mu \in [0, 1]$. Without loss of generality, assume $\beta > \gamma$ [8]. The consumer’s demand function for bundling products is $q_{12}(p_{12}) = a - \beta p_{12}$. To make the research more consistent with the actual market situation, we also assume that $c_{12} = c_1 + c_2$ and $p_{12} < p_1 + p_2$. This means that there is a specific discount on bundling. The cost of the bundled products is equal to the cost of selling the two products separately. The demand and cost information is symmetrical for the supplier and e-retailer; they are self-interested and rational and want to maximize their profit. Obviously, a different sales strategy exists for each player. Figure 1 describes the model, with Figure 1(a) showing the case of independent sales and Figure 1(b) showing the case of bundled sales.

4. Independent sales model.

4.1. Supplier-dominated Stackelberg model. In a scenario where the supplier is a Stackelberg leader and the e-retailer is the follower, the supplier has an advantage. First, the dominant supplier sets the wholesale prices $w_1$ and $w_2$. Second, the e-retailer maximizes profit by setting sales prices through online and offline channels
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Figure 1. Different sales strategies

Table 2. Notation and explanation

| Notation | Explanation |
|----------|-------------|
| $w_i$    | The supplier’s unit wholesale price, where $i = 1, 2$ |
| $p_1$    | Unit sale price through e-retailers offline channel |
| $p_2$    | Unit sale price through e-retailers online channel |
| $c_1$    | Unit sale cost through e-retailers offline channel |
| $c_2$    | Unit sale cost through e-retailers online channel |
| $a$      | Maximum market size |
| $\mu$    | The proportion of offline demand |
| $\beta$  | The self-price sensitivity coefficient |
| $\gamma$ | The cross-price sensitivity coefficient |
| $w_{12}$ | The wholesale price of two bundled products |
| $p_{12}$ | The sale price of two bundled products |
| $c_{12}$ | The sale cost of two bundled products |

based on the wholesale prices. Finally, the game players gain their respective profit according to consumer demand. The game order is shown in Figure 2.

Figure 2. Game order dominated by supplier in independent sales

The supplier’s profit $\pi_s(w_1, w_2)$ is expressed as:

$$\pi_s(w_1, w_2) = w_1 q_1(p_1, p_2) + w_2 q_2(p_1, p_2)$$

The former group is the profit from selling one product offline while the latter group is the profit from selling the other product online. So,

$$\pi_s(w_1, w_2) = w_1 (mua - \beta p_1 + \gamma p_2) + w_2 [(1 - \mu)a - \beta p_2 + \gamma p_1]$$

To simplify the calculation, we make the wholesale prices equal for the two products offered by the supplier, that is, $w_1 = w_2 = w$; this does not affect the results. It should be noted that this is the price that the supplier wholesales to the e-retailer, not the price that the e-retailer sells the product to the consumer (different retail
prices $p_1 \neq p_2$). The equilibrium equation is:

$$\pi_s(w) = w[a + (\gamma - \beta)(p_1 + p_2)] \tag{1}$$

The e-retailer’s goal is to obtain optimal profit from O2O channels and determine the retail price. The profit function is expressed as $\pi_r(p_1, p_2)$, so

$$\pi_r(p_1, p_2) = (p_1 - w_1 - c_1)q_1(p_1, p_2) + (p_2 - w_2 - c_2)q_2(p_1, p_2)$$

The former group is the profit from selling one product offline while the latter group is the profit from selling the other product online. So,

$$\pi_r(p_1, p_2) = (p_1 - w - c_1)(\mu a - \beta p_1 + \gamma p_2)$$

$$+ (p_2 - w - c_2)((1 - \mu)a - \beta p_2 + \gamma p_1) \tag{2}$$

We can determine the optimal pricing and summarize the important results as follows:

**Proposition 1.** Under the independent sales model, in a supplier-dominated market, the optimal retail prices $p_1^*$ and $p_2^*$ and the wholesale price of each product $w^*$ are:

$$w^* = a/(4\beta - 4\gamma) - (c_1 + c_2)/4$$

$$p_1^* = [(1 + 4\mu)\beta + (5 - 4\mu)\gamma]a/(8\beta^2 - 8\gamma^2) + (3c_1 - c_2)/8$$

$$p_2^* = [(5 - 4\mu)\beta + (1 + 4\mu)\gamma]a/(8\beta^2 - 8\gamma^2) + (-c_1 + 3c_2)/8$$

The proposition indicates that the wholesale price $w^*$ and $\beta$ are negatively correlated while $w^*$ is positively correlated to $a$ and $\gamma$. The values of the two parameters play an important role in the wholesale price. The retail price is directly proportional to market size $a$, which is consistent with the actual situation. The market size is a key factor that must be considered when setting wholesale and retail prices.

From proposition 1, we can clearly establish the following lemma:

**Lemma 4.1.** The profit function $\pi_r(p_1, p_2)$ is a strictly concave function about $(p_1, p_2)$.

Further, under an independent Stackelberg market model, according to proposition 1 and equilibrium equation (1), we can obtain the suppliers maximum profit as follows:

$$\pi_s(w^*) = [a - (c_1 + c_2)(\beta - \gamma)]^2 / 16(\beta - \gamma) \tag{3}$$

In a supplier-dominated Stackelberg market, under an independent sales model, according to proposition 1 and function (2), we can obtain the e-retailer’s maximum profit as follows:

$$\pi_r(p_1^*, p_2^*) = 16\mu^2(\beta - \gamma) + 16\mu(\gamma - \beta) + 5\beta - 3\gamma a^2$$

$$+ c_1(3 - 8\mu) + c_2(8\mu - 5) a$$

$$+ (5c_1^2 - 6c_1c_2 + 5c_2^2) + (3c_1^2 - 10c_1c_2 + 3c_2^2)\gamma$$

$$+ 16(\beta - \gamma) \tag{4}$$

Thus, we can obtain the supply chain’s optimal profit in a Stackelberg market dominated by the supplier:

$$\pi(p_1^*, p_2^*, w^*) = \pi_s(w^*) + \pi_r(p_1^*, p_2^*) \tag{5}$$
4.2. e-retailer-dominated Stackelberg model. In a scenario where the e-retailer is the Stackelberg leader and the supplier is the follower, the e-retailer has an advantage over the supply chain members. The decision order is as follows. First, the dominant e-retailer decides the retail prices \( p_1 \) and \( p_2 \). Second, the supplier establishes the wholesale prices \( w_1 \) and \( w_2 \) based on \( p_1 \) and \( p_2 \) set by the e-retailer. The backward induction method is used to maximize profit. Finally, they gain respective profit according to the demand of market consumers. The game process is shown in Figure 3.

![Figure 3](image)

**Figure 3.** Game order dominated by the e-retailer in independent sales

The profit function of the supplier in the game, denoted as \( \pi_s(w_1, w_2) \), is as follows:

\[
\pi_s(w_1, w_2) = w_1q_1(p_1, p_2) + w_2q_2(p_1, p_2)
\]

The former group is the profit made by the supplier from the first product, considering the offline retail price; the latter group is the profit made by the supplier from the second product, considering the online retail price. That is,

\[
\pi_s(w_1, w_2) = w_1(\mu a - \beta p_1 + \gamma p_2) + w_2[(1 - \mu)a - \beta p_2 + \gamma p_1]
\]

The supplier sells two products; as in the above analysis, we make \( w_1 = w_2 = w \). Through the offline channel, if the marginal profit is \( k_1 \), then \( k_1 = p_1 - w \). Through the online channel, if the marginal profit is \( k_2 \), then \( k_2 = p_2 - w \). The supplier’s equilibrium equation is:

\[
\pi_s(w) = w[a + (\gamma - \beta)(k_1 + k_2 + 2w)]
\]

(6)

The goal of the e-retailer is to set retail prices to maximize profit. The profit function is expressed as \( \pi_r(p_1, p_2) \):

\[
\pi_r(p_1, p_2) = (p_1 - w_1 - c_1)q_1(p_1, p_2) + (p_2 - w_2 - c_2)q_2(p_1, p_2)
\]

Further, we get

\[
\pi_r(p_1, p_2) = (p_1 - w - c_1)(\mu a - \beta p_1 + \gamma p_2) + (p_2 - w - c_2)[(1 - \mu)a - \beta p_2 + \gamma p_1]
\]

(7)

Then, we can determine the optimal pricing and summarize the important results:

**Proposition 2.** Under the independent sales model, in an e-retailer dominated market, the optimal retail price \( p_1^r \) and \( p_2^r \) and the wholesale price of each product \( w^r \) are as follows:

\[
p_1^r = a\frac{(1 + 4\mu)\beta + (5 - 4\mu)\gamma}{(8\beta^2 - 8\gamma^2)} + (3c_1 - c_2)/8
\]

\[
p_2^r = a\frac{(5 - 4\mu)\beta + (1 + 4\mu)\gamma}{(8\beta^2 - 8\gamma^2)} + (-c_1 + 3c_2)/8
\]

\[
w^r = a\frac{1}{(8\beta - 8\gamma)} - (c_1 + c_2)/8
\]

The proposition demonstrates that the optimal online and offline prices and the wholesale price exist and are unique. The wholesale price \( w^r \) is inversely proportional to \( \beta \) and directly proportional to \( a \) and \( \gamma \). The retail price is directly
proportional to market size \( a \). Market size is a key factor that must be considered when setting wholesale and retail prices.

From proposition 2, we can directly obtain the following lemma:

**Lemma 4.2.** In an e-retailer-dominated Stackelberg market, the e-retailer’s optimal retail price \( p_1^r \) is a monotone increasing function of \( a \) and \( c_1 \), but a monotone decreasing function of \( c_2 \); \( p_2^r \) is a monotone increasing function of \( a \) and \( c_2 \), but a monotone decreasing function of \( c_1 \). The wholesale price \( w^r \) is a monotone increasing function of \( a \), but a monotone decreasing function of \( c_1 \) and \( c_2 \).

This lemma indicates that, if market size or the e-retailer’s offline unit cost is high, then the e-retailer must set a high price; if the online unit cost is high, the retailer must set a low offline price. Moreover, if the market size of the consumer is high or the e-retailer’s online unit cost is high, then the e-retailer must set a high online price; if the offline unit cost is high, the retailer must set a low online price. Moreover, if the market size of the consumer is high, the supplier must set a high wholesale price; if the unit cost is high, then the supplier can set a low wholesale price.

Furthermore, according to proposition 2 and function (1), under the independent sales model, the supplier’s profit can be obtained as follows:

\[
\pi_s(w^r) = \frac{a - (c_1 + c_2)((\beta - \gamma))^2}{32(\beta - \gamma)} 
\]  

Similarly, with the e-retailer as the dominant player in a Stackelberg market under the independent sales model, according to proposition 2 and function (2), the e-retailer’s maximum profit can be obtained as follows:

\[
\pi_r(p_1^r, p_2^r) = \frac{8(\beta - \gamma)\mu^2 + 8(\gamma - \beta)\mu + 3\beta - \gamma a^2}{16(\beta^2 - \gamma^2)} - c_1(1 - 4\mu) + c_2(4\mu - 3) + \frac{8}{a} + \frac{(3c_1^2 - 2c_1 c_2 + 3c_2^2)\beta + (c_1^2 - 6c_1 c_2 + c_2^2)\gamma}{16} 
\]

Therefore, in an e-retailer-dominated Stackelberg market, from (8) and (9), the supply chain’s optimal profit, denoted by \( \pi(p_1^r, p_2^r, w^r) \), is as follows:

\[
\pi(p_1^r, p_2^r, w^r) = \pi_s(w^r) + \pi_r(p_1^r, p_2^r) 
\]

5. **Bundle sales model.**

5.1. **Supplier-dominated Stackelberg model.** In a scenario with the supplier as a Stackelberg leader and the e-retailer as the follower, the supplier has an advantage. The dominant supplier first decides the wholesale price of two bundled products \( w_{12} \). Second, according to the wholesale price, the e-retailer maximizes profit by setting sales prices for bundled products in the O2O channel; the backward induction method is used to maximize more profit. Finally, the game players gain their respective profit according to consumer demand.

In the O2O bundling model, the consumer’s demand function is \( q_{12}(p_{12}) = a - \beta p_{12} \).

The supplier’s profit in the game, denoted by \( \pi_s(w_{12}) \), is: \( \pi_s(w_{12}) = w_{12} q_{12}(p_{12}) \)

The supplier decides the wholesale price of two bundled products; the right side of the equation is the profit of the supplier selling the two products through the
e-retailer’s O2O channel. The equilibrium equation is:

$$\pi_s(w_{12}) = w_{12}(a - \beta p_{12})$$

(11)

The e-retailer sets the O2O retail price of two bundled products based on the supplier’s wholesale price. The profit is expressed as $$\pi_r(p_{12})$$:

$$\pi_r(p_{12}) = (p_{12} - w_{12} - c_{12})q_{12}(p_{12})$$

The e-retailer’s equilibrium equation is:

$$\pi_r(p_{12}) = (p_{12} - w_{12} - c_{12})(a - \beta p_{12})$$

(12)

In terms of the e-retailer’s optimal bundle price for the O2O channel ($$p^*_s$$) based on the supplier’s bundle wholesale price ($$w^*_s$$), we can make the following proposition:

**Proposition 3.** In a supplier-dominated market, under the O2O bundling model, the optimal bundle price $$p^*_s$$ and the bundle wholesale price $$w^*_s$$ are:

$$p^*_s = (3a + \beta c_{12})/(4\beta)$$

$$w^*_s = (a - \beta c_{12})/(2\beta)$$

This proposition indicates that the optimal online and offline bundle prices and the bundle wholesale price for the O2O channel exist and are unique. In this scenario, $$p^*_s$$ is inversely proportional to $$\beta$$. And $$w^*_s$$, $$\beta$$ have the same relationship. $$p^*_s$$ and $$w^*_s$$ are directly proportional to $$a$$, which is consistent with the actual situation. Under an O2O bundling model, the cross-effect of two products disappears; thus, there is no relationship with $$\gamma$$. Both players in the game should consider all factors and set a reasonable equilibrium price.

Furthermore, according to proposition 3 and function (11), under an O2O bundling model in a supplier-dominated market, the supplier’s maximum profit can be obtained as follows:

$$\pi_s(w^*_s) = \frac{(a - \beta c_{12})^2}{8\beta}$$

(13)

From proposition 3 and function (12), the e-retailer’s maximum profit can be obtained as follows:

$$\pi_r(p^*_s) = \frac{(a - \beta c_{12})^2}{16\beta}$$

(14)

Therefore, in a supplier-dominated Stackelberg market, from (13) and (14), the supply chain’s optimal profit denoted by $$\pi(p^*_s, w^*_s)$$ is:

$$\pi(p^*_s, w^*_s) = \pi_s(w^*_s) + \pi_r(p^*_s)$$

(15)

From proposition 3, we can directly obtain the following lemma:

**Lemma 5.1.** In a supplier-dominated market, the e-retailer’s optimal bundle price $$p^*_s$$ is an increasing function of $$a$$ and $$c_{12}$$ while the supplier’s optimal bundle wholesale price $$w^*_s$$ is an increasing function of $$a$$ and a decreasing function of $$c_{12}$$.

This lemma indicates that, if the market size and the e-retailer’s unit cost of two bundled products are high, then the e-retailer must set a high sale price. In addition, if the market size is high, the supplier sets a high price. In an O2O channel, if the unit cost of two bundled products is high, the supplier sets a low bundle wholesale price.
5.2. **e-retailer-dominated Stackelberg model.** The e-retailer has an advantage over supply chain members. The order of decision making is as follows. First, the e-retailer, who dominates the market, decides the sale price of two bundled products. Second, the supplier sets the wholesale price using the backward induction method to solve the equilibrium solution and obtain maximum profit. Last, the game players gain their respective profit according to consumer demand.

The marginal profit of the two bundled products, denoted by $k_{12}$, is $k_{12} = p_{12} - w_{12}$.

The supplier’s profit in an e-retailer-dominated market is $\pi_s(w_{12}) = w_{12}q_{12}(p_{12})$.

On the right side of the equation is the supplier’s profit from selling two bundled products through the e-retailer’s O2O channel. The equilibrium equation is:

$$\pi_s(w_{12}) = w_{12}[a - \beta (k_{12} + w_{12})] \quad (16)$$

The e-retailer first sets the O2O sale price. The profit function is expressed as $\pi_r(p_{12})$:

$$\pi_r(p_{12}) = (p_{12} - w_{12} - c_{12})q_{12}(p_{12})$$

The latter is the profit from the two bundled products sold by the e-retailer through the O2O channel. The e-retailer’s profit is:

$$\pi_r(p_{12}) = (p_{12} - w_{12} - c_{12})(a - \beta p_{12}) \quad (17)$$

In terms of the e-retailer’s optimal bundle sale price for the O2O channel ($p_{12}^r$) and the supplier’s optimal bundle wholesale price ($w_{12}^r$), we have the following proposition:

**Proposition 4.** In an e-retailer-dominated market, under the O2O bundling model, the optimal bundle price $p_{12}^r$ and the bundle wholesale price $w_{12}^r$ are:

$$p_{12}^r = (3a + \beta c_{12})/(4\beta)$$

$$w_{12}^r = (a - \beta c_{12})/(4\beta)$$

The proposition indicates that in this scenario, both $p_{12}^r$ and $w_{12}^r$ are inversely proportional to $\beta$ and directly proportional to $a$. According to proposition 3, the sale price of bundled products is the same no matter who the market leader is; that is, the retail price of bundled products is not influenced by the market-dominant power.

Furthermore, under the O2O bundling model, according to the supplier’s profit function (16) and proposition 4, the supplier’s maximum profit is:

$$\pi_s(w_{12}^r) = (a - \beta c_{12})^2/16\beta \quad (18)$$

According to proposition 4 and function (17), the e-retailer’s maximum profit is:

$$\pi_r(p_{12}^r) = (a - \beta c_{12})^2/8\beta \quad (19)$$

Therefore, in an e-retailer-dominated Stackelberg market, according to (18) and (19), the supply chain’s optimal profit, denoted by $\pi(p_{12}^r, w_{12}^r)$, is:

$$\pi(p_{12}^r, w_{12}^r) = \pi_s(w_{12}^r) + \pi_r(p_{12}^r) \quad (20)$$

From proposition 4, we directly obtain the following lemma:
Lemma 5.2. In an e-retailer-dominated market, the e-retailer’s optimal bundled price $p^*_1$ is an increasing function of $a$ and $c_{12}$, while the supplier’s optimal bundle wholesale price $w^*_1$ is an increasing function of $a$ and a decreasing function of $c_{12}$.

The lemma indicates that, if the market size and the e-retailer’s unit cost of two bundled products are high, then the e-retailer should set a lower sale price. In addition, if the market size is high, the supplier sets a high price; if the cost of two bundled products is high in the O2O channel, then the supplier should set a lower bundle wholesale price.

6. Pricing decisions and marketing strategies for the O2O supply chain.

In this section, we discuss the decisions and performance of supply chain members. Through the above analysis, in terms of the impact of different market-dominant powers on the supply chain’s optimal pricing, we can obtain the following important proposition:

Proposition 5. $p^*_1 = p^*_1$, $w^*_1 = p^*_1$, $w^*_2 = p^*_2$, $p^*_1 + p^*_2 = p^*_1 + p^*_2$, $w^*_1 > w^*_1$, $w^*_2 > w^*_1$, $w^*_1 < w^*_1 < w^*_2 = 2w^*_1$.

The proposition indicates that an e-retailer’s online and offline sale price led by a supplier are equal to those led by an e-retailer; there is no effect on an e-retailer’s sale price. From our calculations, the wholesale price of two bundled products is lower than the sum of those two products sold separately; the same is true for the retail price. Furthermore, it is advantageous to be a Stackelberg leader, whether the products are bundled or not. For example, the wholesale price led by a supplier is higher than the wholesale price led by an e-retailer. As long as the supplier gets more dominance, it will set a higher wholesale price.

Proposition 6. Compare supplier’s profit: $\pi_s(w^*_1) > \pi_s(w^*_1), \pi_s(w^*_1) > \pi_s(w^*_1)$.

Compare e-retailer’s profit: $\pi_r(p^*_1, p^*_2) < \pi_r(p^*_1, p^*_2), \pi_r(p^*_1, p^*_2) < \pi_r(p^*_1, p^*_2)$. Profit comparison of O2O supply chain: $\pi(p^*_1, p^*_2, w^*_1) = \pi(p^*_1, p^*_2, w^*_2) = \pi(p^*_1, p^*_2, w^*_2)$.

The market size $a$ is satisfied when $\max \left\{0, -\frac{B + \sqrt{B^2 - 4AC}}{2A} \right\} < a < -\frac{B + \sqrt{B^2 - 4AC}}{2A}$, bundling by all game players is the dominant strategy; when $a > -\frac{B + \sqrt{B^2 - 4AC}}{2A}$, independent sales by all game players is the dominant strategy, where

$$A = \beta^2 - \beta \gamma + 6\gamma^2 - 16\beta^2 \mu + 16\beta \gamma \mu + 16\beta^2 \mu^2 - 16\beta \gamma \mu^2$$

$$B = 14\beta^3 c_1 - 2\beta^3 c_2 - 14\beta c_1 \gamma^2 + 2\beta c_2 \gamma^2 - 16\beta^3 c_1 \mu + 16\beta^3 c_2 \mu + 16\beta c_1 \gamma \mu - 16\beta c_1 \gamma \mu^2$$

$$C = \beta^4 c_1^2 - 14\beta^4 c_2 c_1 + \beta^4 c_2^2 + \beta^3 c_1 \gamma^2 + 14\beta^3 c_1 c_2 \gamma + \beta^3 c_1 \gamma^2 - \beta^2 c_1^2 \gamma^2 + 14\beta^2 c_1 c_2 \gamma^2 - \beta^2 c_1^2 \gamma^2 - \beta \gamma^3 + 14\beta c_1 \gamma^3 - \beta c_2 \gamma^3$$

This proposition indicates that it is favorable for game players to be the Stackelberg leader because they can make more profit. Different market-dominant powers have a significant influence on the profit of game players; thus, the market-dominant power is a critical factor. In the case of independent sales and bundling, the total profit is equal: a higher profit for one member will necessarily lead to lower profit for the other.

Based on the market size, game players set reasonable sales strategies. If the market size is small, bundling can bring more profit; if the market size is beyond a certain range, independent sale is more advantageous. A Stackelberg leader must evaluate the market size and determine the corresponding favorable marketing mode. Different market-dominant powers can affect the profit distribution. By investigating market demand scale and adopting effective promotion methods, we can meet the
demand of customers, improve customer satisfaction, reduce transaction costs, and enhance market competitiveness. Thus, we can provide a decision reference for game players who must make decisions related to sales channels and pricing strategies.

**Proposition 7.** For a supplier, no matter who is the dominant power, the market size is satisfied: when \( \max \left\{ 0, -E - \sqrt{\frac{E^2 - 4DF}{2D}} \right\} < a < -E + \sqrt{\frac{E^2 - 4DF}{2D}} \), bundling is beneficial to herself / himself; otherwise, independent sales is beneficial to herself / himself, where

\[
D = 2 \left( \frac{c}{\beta} - \gamma \right) \\
E = -\beta^2 (c_1 + c_2) + \beta \gamma (c_1 + c_2) \\
F = \frac{\beta (c_1 + c_2) \beta (\beta - \gamma) (2 - \gamma)}{2(\beta - 2\gamma)}.
\]

This proposition indicates that the market-dominant power does not affect a supplier’s sales strategy; deciding whether to bundle sales depends on market size. For Proposition 6, if the market size is within a certain range and is not too large, bundling is beneficial to suppliers; if the market size increases to a certain extent, the independent sales mode is more favorable. A Stackelberg leader should assess their sales strategy based on market size, especially in the fierce competition of a game market, to increase her/his revenue. Market share is an important aspect of the decision-making process. Highlighting the characteristics of a commodity to expand market share and manage brand is a common strategy in marketing.

**Proposition 8.** For an e-retailer: (1) in a supplier-dominant market, a is satisfied: when \( \max \left\{ 0, -M - \sqrt{\frac{M^2 - 4GN}{2G}} \right\} < a < -M + \sqrt{\frac{M^2 - 4GN}{2G}} \), the dominant strategy is bundle sales; otherwise, the dominant strategy is independent sales; (2) in an e-retailer-dominant market, a is satisfied: when \( \max \left\{ 0, -K - \sqrt{\frac{K^2 - 4LJ}{2L}} \right\} < a < -K + \sqrt{\frac{K^2 - 4LJ}{2L}} \), the dominant strategy is bundle sales; otherwise, the dominant strategy is independent sales, where

\[
G = 3\beta^2 - 3\beta \gamma + 2\gamma^2 - 16\beta^2 \mu + 16\beta \gamma \mu + 16\beta^2 \mu^2 - 16\beta \gamma \mu^2 \\
M = 10\beta^3 c_1 - 6\beta^3 c_2 - 10\beta c_1 \gamma^2 + 6\beta c_2 \gamma^2 - 16\beta^3 c_1 \mu + 16\beta^3 c_2 \mu + 16\beta c_1 \gamma \mu - 16\beta c_2 \gamma \mu \\
N = 3\beta^4 c_1^2 - 10\beta^4 c_1 c_2 + 3\beta^4 c_2^2 + 3\beta^3 c_1^2 \gamma - 10\beta^3 c_1 c_2 \gamma + 3\beta^3 c_2 \gamma^2 - 3\beta^2 c_1^2 \gamma^2 + 10\beta^2 c_1 c_2 \gamma^2 - 3\beta^2 c_2^2 \gamma^2 - 3\beta c_1^2 \gamma^3 + 10\beta c_1 c_2 \gamma^3 - 3\beta c_2^2 \gamma^3 \\
J = \beta^2 - \beta \gamma + 2\gamma^2 - 8\beta^2 \mu + 8\beta \gamma \mu + 8\beta^2 \mu^2 - 8\beta \gamma \mu^2 \\
K = 6\beta^3 c_1 - 2\beta^3 c_2 - 6\beta c_1 \gamma^2 + 2\beta c_2 \gamma^2 - 8\beta^3 c_1 \mu + 8\beta^3 c_2 \mu + 8\beta c_1 \gamma \mu - 8\beta c_2 \gamma \mu \\
L = \beta^4 c_1^2 - 6\beta^4 c_1 c_2 + 3\beta^4 c_2^2 + 3\beta^3 c_1^2 \gamma - 6\beta^3 c_1 c_2 \gamma + 3\beta^3 c_2 \gamma^2 - 3\beta c_1 \gamma \mu + 6\beta c_1 c_2 \gamma^2 - 3\beta^2 c_2 \gamma^2 - 3\beta \gamma \mu^2 + 3\beta c_1 \gamma^3 - 3\beta c_2 \gamma^3.
\]

This proposition indicates that different market-dominant powers significantly influence an e-retailer’s sales strategy and can even affect the overall efficiency of the O2O supply chain. We find that, when market size is within a certain range, an e-retailer should select the bundling mode. In addition, game players should consider the complementarity of products in e-commerce enterprises. Bundling of complementary products through the Internet has become very common, providing convenience to consumers who prefer online shopping.

Propositions 7 and 8 indicate that, for both suppliers and e-retailers, when the market is large enough, independent sales is the dominant strategy. Market size is a factor that cannot be ignored and should receive more attention.
7. **Numerical example.** Given the complexity of the game equilibrium solution, a numerical example is provided to verify the validity of the model with different market-dominant powers. By performing sensitivity analyzes, we can obtain the influence of different sales strategies on profit. In Section 3, we make the general assumption that \( \beta > \gamma \). We set \( \gamma = 0.4 \). \( \beta \in [0.5, 2] \) is an approximate scope for showing the trends in profit changes. Due to the e-commerce background, e-retailers primarily focus on the preferences of online consumers. The proportion of offline demand \( \mu \) should be relatively small, so let \( \mu = 0.3 \); the majority should be online consumers, thus, let the proportion of online demand \( 1 - \mu = 0.7 \). Set \( a = 100 \), \( c_1 = 3 \), and \( c_2 = 2 \). In a supplier-dominated market, by analyzing parameter \( \beta \), we obtain the profit \( \pi_r(p_{1r}^*, p_{2r}^*) \) and \( \pi_s(w^*) \) in an independent sales scenario, and we obtain the profit \( \pi_s(w_{1s}^* \rangle \) and \( \pi_r(p_{1r}^* \rangle \) in a bundled sales scenario, as shown in Figure 4.

Similarly, we can derive these profit in an e-retailer-dominated market, see Figure 5. Then, we discuss the influence of parameter \( \gamma \) on profit by setting \( a = 100 \), \( c_1 = 3 \), \( c_2 = 2 \), \( \beta = 1.2 \), \( \mu = 0.3 \), and \( \gamma \in [0, 1] \). Figures 6 and 7 show that when \( \gamma \) fluctuates at \([0, 1]\), the profit from the two sales strategies fluctuates.

Figure 4 shows that, in a supplier-dominated market, with an increase in \( \beta \), \( \pi_s(w^*) \) decreases faster than \( \pi_r(p_{1r}^*, p_{2r}^*) \); the curve reveals that in an independent sales channel, the impact of the value of \( \beta \) on the supplier’s profit is more significant than its impact on the e-retailer’s profit. The room for profit improvement becomes larger as \( \beta \) decreases in a supplier-dominated market. For the bundled channel, with an increase in \( \beta \), the decline in profit \( (\pi_s(w_{1s}^* \rangle \) and \( \pi_r(p_{1r}^* \rangle \) slows, indicating the influence of coefficient \( \beta \) is not large when the two products are sold in a bundle. The company should decide whether to adopt an independent or bundled sales strategy according to the value of \( \beta \). In addition, the supplier’s and e-retailer’s profit are decreasing functions of the self-price sensitivity coefficient \( \beta \) under different sales channels.

The curves in Figure 5 show the fluctuations in the supply chain members’ profit. When \( \beta \) decreases from 0.5 to 2, the rates of these profits slow. In an e-retailer-dominated market, with an increase in \( \beta \), \( \pi_r(p_{1r}^*, p_{2r}^*) \) decreases more quickly than \( \pi_s(w^*) \), implying that in an independent sales channel, the influence of the value of \( \beta \) on the e-retailer’s profit is more significant than its influence on the supplier’s profit. Similarly, for a bundled channel, with an increase of \( \beta \), the decline in profit \( (\pi_s(w_{1s}^* \rangle \) and \( \pi_r(p_{1r}^* \rangle \) slows and the e-retailer obtains more profit than the supplier. It can also be seen that the effect of coefficient \( \beta \) is not significant. Nevertheless, these profit functions are still a function of decreasing coefficient \( \beta \).

According to Figures 4 and 5, the profit curves go down as \( \beta \) increases, which is consistent with proposition 6. The supplier or e-retailer can make more profit as a Stackelberg leader in an independent sales channel; this trend is also observed in the bundled channel. It is clear why market-dominant power needs to be considered.

To facilitate comparison and provide a more intuitive interpretation, we provide graphs of \( \pi_s(w_{1s}^* \rangle \) and \( \pi_r(p_{1r}^* \rangle \). Figure 6 indicates that, in a supplier-dominated market, when \( \gamma \) changes, the profit from the two sales strategies fluctuate. Figure 6 illustrates that coefficient \( \gamma \) has no effect on profit for the bundled channel \( (\pi_s(w_{1s}^* \rangle \), \( \pi_r(p_{1r}^* \rangle \). This is because the cross-elastic effect of a product’s demand is eliminated with bundling, and thus, profit is not affected. Compared to the e-retailer, the supplier obtains more profit in a bundled channel. When \( \gamma \) increases from 0 to 1, \( \pi_s(w^*) \) increases more quickly than \( \pi_r(p_{1r}^*, p_{2r}^*) \); this explains why, in contrast to the
e-retailer’s profit, an increase in the value of $\gamma$ is more favorable to the supplier. Meanwhile, profits ($\pi_s(w^s)$ and $\pi_r(p^s_1, p^s_2)$) are increasing functions of coefficient $\gamma$ in an independent sales channel.

Figure 7 depicts curve graphs that describe the trends in the profit of supply chain members. In a bundled channel, coefficient $\gamma$ has no effect on the profit of supply chain members ($\pi_s(w^r_1), \pi_r(p^r_1, p^r_2)$). However, with the e-retailer as the Stackelberg leader, her/his profit is higher than that of the supplier in a bundled channel. Similarly, the e-retailer’s profit is higher than that of the supplier in an independent sales channel. The e-retailer’s profit ($\pi_r(p^r_1, p^r_2)$) increases more quickly than the suppliers profit ($\pi_s(w^r)$), which illustrates that $\gamma$ has a more remarkable influence on the e-retailer than the supplier.

As shown in Figures 6 and 7, the profit curves increase quickly as $\gamma$ increases in the independent sales channel, which verifies proposition 6. The supplier or e-retailer can make more profit as a Stackelberg leader. Regardless of who is the dominant power, coefficient $\gamma$ has no impact on the profit of the supplier and the e-retailer in a bundled channel.

Combined with the analyzes in Figures 4–7, we can deduce the following managerial insights: (1) The market-dominant power has a remarkable influence on the maximum profit of O2O supply chain participants. It is more advantageous to be the Stackelberg leader. However, the market-dominant power cannot influence the optimal sales decisions of participants. (2) Market size is an important factor for consideration. For the supplier or e-retailer, an independent sales strategy is the optimal strategy when the market size is large enough. In addition, the profit of the supply chain members is inversely proportional to the self-price sensitivity coefficient $\beta$ under different sales channels, but positively proportional to the cross-price sensitivity coefficient $\gamma$ in an independent sales channel. (3) The advantages of complementary bundling can bring higher profit margins to the supply chain members. In the supply chain pricing game, the bundling pricing strategy provides reference for decision making of enterprise managers to achieve improved performance.

![Figure 4. Effect of $\beta$ in a supplier-dominated market](image)

8. Conclusion. The present study examined multi-product pricing policies in an O2O business model under different market-dominant powers. A multi-channel e-retailer has a larger market and this increases her/his economic efficiency compared to a single channel retailer. However, an e-retailer faces the challenge of exploring optimal price and distribution strategies for different products. A reasonable sales strategy will make e-sales more competitive, and thus will expand the sales scale.
We apply a linear demand function model to analyze the bundle sales strategy of an O2O business model comprising a supplier who sells two products, either independently or bundled. The results of this study show that market size plays a key role in the O2O business model. For supplier and e-retailer, an independent sales strategy is the optimal strategy when the market is large enough; otherwise, a bundled sales strategy is optimal.

Different market-dominant powers significantly influence the pricing decisions and performance of game players. In a supplier-dominated market, a higher wholesale price is set, regardless of whether a bundled sales or independent sales channel is selected. The wholesale price of two bundled products is less than the sum of
the wholesale prices sold independently. In an e-retailer-dominated market, the prices of the two products sold independently are the same as those in a supplier-dominated market. Further, we observe that independent sales and bundled prices are unchanged under different market leaders, i.e. the dominant power does not affect the wholesale price or sale price.

Our findings also reveal that different market-dominant powers influence the profit of individual companies. For supplier and e-retailer, it is better to be the Stackelberg leader, whether independent or bundling sales is used, because dominant companies have increased power to maximize profit. We also find that, in the case of bundled and independent sales, the total profits of the O2O supply chain are equal. For supply chain participants, this has important implications for game players to build a fair market competitive environment.

There are unique optimal wholesale prices, online prices, and offline prices for suppliers and e-retailers in both an independent channel and a bundled channel. Using a leader-follower game approach, game players can use our results to scientifically formulate price strategies and sales strategies to improve economic performance.

Our findings also show that there are diverse decisions under different market-dominant powers in an O2O supply chain. For example, we find that if the market size meets certain conditions, an e-retailer’s bundled channel is selected in a supplier-dominated market; by comparison, in an e-retailer-dominated market, an e-retailer’s independent channel is selected. Supply chain participants should develop reasonable channel selection strategies to improve benefits. Our research provides decision-making support for firms to improve operation efficiency in a dynamic external market environment.

O2O bundling is a late-model marketing approach that is cross-industry and cross-brand. It can reduce selling cost, expand market share, and improve service level and brand image. The advantages of a complementary bundling sales approach make both sides more competitive in the market, further optimize social resources, and achieve Pareto optimization. Bundled luxury goods tend to be purchased by high-income consumers; bundled goods of inferior quality are more likely to be purchased by low-income consumers. If bundled goods are at two different levels, it is difficult to coordinate. Therefore, it is crucial to develop a reasonable bundling marketing strategy; enterprises must investigate the actual operation of the market.

Our research shows that different market-dominant powers influence the pricing and channel selection strategies of the supply chain participants. Online shopping has become a popular trend; many traditional retailers divert online consumers to offline consumption through a series of preferential activities. Many e-retailers, including Alibaba Corporation, JD.com, Suning.com, Wal-Mart, and Airbnb, establish offline experience stores to guide offline customers to online shopping. O2O thinking integrates traditional thinking and Internet thinking, thereby establishing a win-win ecological circle.

This study provides several valuable management methods, but it has some limitations. We investigate the differences in sales channels and pricing under different market-dominant powers by studying game players who sell two products independently or bundled. A linear demand function is used to construct the O2O bundling model and we hypothesize that the information between the decision makers is completely symmetrical. However, demand is uncertain in the actual market; further studies should consider a pricing game model with stochastic demand. Further research should also examine the effect of market-dominant powers on bundle sales
strategies and channel selection strategies under information asymmetry. From an information perspective, game players retain beneficial information to maintain their economic benefit; therefore, demand information and other information for managers is actually asymmetrical, which will affect the operation and development of the whole O2O supply chain.

Acknowledgments. Support is provided by the National Natural Science Foundation of China (No. 71472026). The authors are grateful to the Institute of Logistics and Supply Chain Management for the articles framework.

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Received June 2019; revised September 2019.

E-mail address: weifenghaoyun@126.com
E-mail address: chenh@uestc.edu.cn