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Return policies and O2O coordination in the e-tailing age

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ABSTRACT

Return policy is a strategic tool widely used by firms to build long-term relationship with their consumers. We develop a novel O2O (online to offline) competition model to address how the competitive return policies can be employed to coordinate the O2O distributions under the manufacturer – traditional retailer supply chain where the manufacturer opens an online channel to compete with the traditional retailer. Our results show that utilizing the revenue sharing plus profit sharing mechanisms, the manufacturer and the traditional retailer can employ different return policies for their respective channels to coordinate the O2O distributions and achieve a Pareto solution for all parties in a manufacturer - traditional retailer supply chain. Particularly when the product is becoming increasingly compatible with online sales, the value of the differential of return policies would further increase for both the manufacturer and the retailer.

1. Introduction

Return policy plays a significantly important role in the business market. Return policy is a strategic tool widely used by firms to build long-term relationship with their consumers. Allowing consumers to return the purchased products protects consumers who experience product misfit, a wrong order, and other problems. Having a well-thought-out return policy is the key to attracting and keeping consumers and an offered return policy potentially increases consumer's willingness to purchase the products (Bechwati and Siegal, 2005; Jeng, 2017; Zhang et al., 2017) and improves market demand, which in turn creates a competitive advantage for firms (Yan, 2009; Zhang et al., 2017). However, product returns also increase monetary costs for firms. For example, even if products are returned in an original condition, retailers (e.g., merchants in the apparel and consumer electronics industry) often cannot directly put the returned items back in shelves. The apparel may be out of season upon return and electronics may have become outdated. For such products, retailers have to discount the merchandise or liquidate it, which increases the return related costs (Brohan, 2005). According to the report of marketwatch.com on June 18, 2015, the value of products consumers returned to retailers worldwide exceeds $642.6 billion annually. In addition, the report of marketwatch.com on December 21, 2016 further shows that Americans return more than $260 billion in goods each year. Therefore, the return policy is a set of tradeoffs for a firm – a generous return policy can increase sales revenue by inducing more consumers to purchase, but also increases the quantity of product returns and leads to substantially higher costs. As a result, designing and employing an optimum return policy become critically important to firms.

In the business market, some firms are employing a generous return policy to refund a full amount of money to consumers (e.g., kohl's, Wal-Mart, Target, etc.) but others are employing a strict return policy to refund only a portion or percent of the paid price to consumers (e.g., Sears, EBay, etc.). A question therefore arises as to what types of return policies should be employed by business managers in the manufacturer – retailer O2O supply chain. In other words, our research addresses the value of return policy in the business-to-business (i.e., manufacturer to retailer) market. Specifically, in a manufacturer - traditional retailer supply chain where the manufacturer opens an online channel to sell product directly to consumers and this online channel could be potentially in conflict with the traditional retailer, should a strict or generous return policy be employed by the online channel and the traditional retailer, respectively? What is the important role the product compatibility with online sales (i.e., consumer acceptance of web-based product purchase) plays? If the return policy the online channel would like to employ is in conflict with the return policy the traditional retailer would like to employ, what effective mechanism(s) can be utilized to help the return policies coordinate the O2O (online to offline) distributions and achieve a Pareto result for both the manufacturer and the retailer? The results are not obvious and the strategies need rigorous analysis.

Prior studies (e.g., Chiang et al., 2003; Tsay and Agarwal, 2004; Mukhopadhyay et al., 2007; Yan and Pei, 2015; Pei and Yan, 2015; Yan et al., 2016) show that wholesale price discount, sales efforts, the value-

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added services, the supportive retail services, cooperative advertising, and information sharing can be utilized to coordinate the O2O distributions. However, all of prior studies in the extant literature ignored the strategic value of competitive return policies in the O2O distributions. In this paper, we develop a new O2O competition model to investigate how the competitive return policies can be utilized to coordinate the O2O distributions and influence the performances of supply chain players in the manufacturer – retailer O2O supply chain. This is a pioneer study in the extant literature. We first present a profit maximization model to obtain optimal strategies for each firm under the manufacturer – traditional retailer supply chain where the manufacturer opens an online channel to compete with the traditional retailer. We then analyze these and other strategies and show that utilizing the revenue sharing plus profit sharing mechanisms, the manufacturer and the traditional retailer can employ different return policies for their respective channels to coordinate the O2O distributions and achieve a higher profit for all parties in a manufacturer - traditional retailer supply chain. Particularly when the product is becoming increasingly compatible with online sales, the value of the differential of return policies would further increase for both the manufacturer and the retailer.

The paper is organized as follows. In Section 2, we report the relevant literature review and explain our contributions. In Section 3, we develop a new O2O competition model. In Section 4, we analyze a manufacturer - traditional retailer supply chain where the manufacturer opens an online channel to compete with the traditional retailer. Finally, Section 5 summarizes our research and proposes important managerial implications for business managers.

2. Literature review

A number of works studied the manufacturer's return policy offered to the retailer. For example, Marvel and Peck (1995) incorporated the uncertainties of consumers' arrival and consumers' valuations to examine pricing strategy and return policy for firms and their result showed that offering return policy would raise retail price. Webster and Weng (2000) modeled a simple supply chain with one manufacturer and one single retailer and investigated the risk of return policy in the presence of demand uncertainty. Their results showed that both the manufacturer and the retailer would benefit from the risk-free return policy. Choi et al. (2004) studied an optimal return policy for a two-stage supply chain where the manufacturer could sell the returned products at a higher price on the e-market. Their results revealed that the returned product's selling price on the e-marketplace should be dynamic one with the consideration of the amount of stock on hand. Chang and Pao (2006) studied the relationship between the quantity discount strategies and the return policies and showed when the retailer asks for a higher buyback price, the manufacturer would charge a higher wholesale price. Their result also showed that the quantity discount could become negative if the manufacturer's buyback price is too high. Chesnokova (2007) examined the effect of return policies on market outcomes and consumer welfare and found that the decrease in product prices raises consumer welfare but the decrease in product reliability reduces it; however, the former dominates, thus aggregate consumer welfare always increases with the offered return policy. Lu et al. (2007) studied the channel coordination from firm's rebate, returns, and price protection policies and revealed that quantity discounts may never create a win-win situation; in order to achieve a win-win situation, the supplier may need to charge a higher wholesale price to the retailer for large orders. Ding and Chen (2008) studied how to coordinate a three level supply chain with the consideration of return policy offered from the manufacturer to the retailer and showed that the flexible return policies do help improve the profit of whole supply chain, which can be shared among supply chain players. Hsieh and Lu (2010) studied the manufacturer's return policy in a manufacturer - two risk-averse retailers supply chain and found that the offered unit return price from the manufacturer increases with the retailer's risk-averse; the offered unit return rice may reach the unit wholesale price if the retailers are highly averse to risk. Gümü et al. (2013) investigated channel returns policies for durable products and revealed that a higher consumer's valuation of used products would motivate the manufacturer to offer a returns policy to the retailer. However, the aforementioned papers addressed the return policy offered from business (the manufacturer) to business (its retailer(s)), while our research addresses a return policy offered from business (retailer/seller) to consumers. Furthermore, the aforementioned papers addressed the value of return policy only in the sole traditional offline channel, while we address the value of competitive return policies in the environment of O2O competition.

A few studies examined consumer's response to retailer's return policy in the business-to-consumer (B2C) market. For example, Davis et al. (1998) used an analytical model to identify potential causes for offering a low-hassle return policy. Their results revealed that a low-hassle return policy can be offered only if the product's benefits cannot be consumed in a short period of time, the product line offers cross-selling opportunities, and a high salvage value for returned products can be obtained. Sarvary and Padmanabhan (2001) showed that return policy is an efficient demand-learning tool for retailer to reduce demand uncertainty when accurate information about demand is not available. Yan (2009) studied the optimal price and return policy for product sold through online marketing and found that a return policy is beneficial for both the consumers and the retailer, particularly if the product is highly compatible with online marketing. Venkatesan and Kumar (2004) and Petersen and Kumar (2009) revealed that product returns could positively affect the consumer's future buying behavior and help increase consumer's future value to the firm. Bonifield et al. (2010) studied the relationship between the characteristics of return policy and the quality of the e-tailer and found that the positive relationship between the e-tailer' quality and its return policy leniency only holds for non-consumable products. Pei et al. (2014) empirically examined the effect of e-tailer's return policy on consumers' purchase behaviors and showed that e-tailer's return depth plays a positive role in influencing on the consumer's perceived fairness of the return policy and purchase intention. Jeng (2017) investigated how the return policy generosity influences the consumer-perceived value and purchase intention when retailer's brand familiarity and product category are considered. The results showed that the lesser-known retailer would benefit more from generous return policy than the well-known retailer when a product needs a high-level return effort, but the well-known retailer benefits from generous return policy only if the product requires a low-level return effort. However, the aforementioned research focused on a business-to-consumer (i.e., the retailer/seller to its consumers) market, while we focus on a business-to-business (i.e., the manufacturer to its retailer(s)) market. Furthermore, the aforementioned research focused solely on the effect of a single retailer's return policy on the firm performance in a single distribution channel, while we focus on the effect of competitive return policies on firm performance in the environment of O2O competition and how the competitive return policies can be employed to coordinate the O2O distributions.

A substantial research studied the manufacturer - retailer O2O supply chain. For example, Rosenbloom (2007) illustrated that while O2O distributions has a major potential in the business-to-business market, managers have to create synergies across O2O channels and deal with channel conflict to coordinate O2O distributions. Yan and Ghose (2010) examined the competition of online vs. offline and showed that forecast precision has a different effect on the performances of both O2O retailers. Chen et al. (2016) invested the effect of power structure on the supplier-retailer O2O supply chain and showed that both the supplier and the retailer would benefit from their market powers; however, the whole supply chain only benefits from the balanced power between the supplier and the retailer. Kong et al. (2017) investigated the pricing and service decisions in an O2O closed-loop

supply chain and revealed that revenue-sharing contract helps both the manufacturer and the retailer achieve a Pareto result through lowering the wholesale price and raising the transfer payment coefficient. However, the aforementioned papers didn't address the important factor of product compatibility with online sales in the O2O competition, while we do.

While O2O competition is considered, the product compatibility with online sales significantly influences the demands of both O2O channels. The products which have a strong compatibility with online sales often sell well online (e.g., books, clothes, digital products, software, CDs, tickets, and computers). However, few vegetable, milk, beverages, autos, and real estates are sold online. An important question here is why some product categories do very well on the online sales but some others do not. The reason is that some products have characteristics that have synergies with the characteristics of the online sales, making it advantageous for consumers to buy these products from online. For instance, software does so well because the web allows consumers to download software from the online onto their computers. The digital nature of software is very compatible with the digital nature of the web. However, vegetable and milk are not compatible with online sales well because these products cannot be kept for fresh through FedEx, UPS, or USPS delivery and their returns almost are impossible. Some studies did address the O2O competition through considering the important factor of product compatibility with online sales. For example, Balasubramanian (1998) developed a model to report the strategic implications of information diffusion when the online channel competes with the traditional retailers. However, his model can only be used to address the parallel competition between the online and traditional retailers and cannot be used to address any vertical relationship involving in the manufacturer – retailer(s) supply chain. Furthermore, Balasubramanian (1998) also didn't consider any coordination mechanism for the O2O competition. Chiang et al. (2003) showed that the wholesale price discount can be utilized to coordinate the O2O distributions when the manufacturer opens an online channel to compete with its retailer. Pei and Yan (2015) demonstrated that the supportive retail services can be utilized to coordinate the O2O distributions and achieve a win-win result for both the manufacturer and the retailer. Yan et al. (2016) found that through the manufacturer's cooperative advertising and the supply chain players' information sharing, both the manufacturer and the retailer can improve their respective performances significantly in the O2O competition. However, the O2O competition models employed in Chiang et al. (2003), Pei and Yan (2015), and Yan et al. (2016) all showed that the manufacturer's online channel is to push the retailer to drop its retail price, but not to sell any products through it. In the business market, many products (e.g., clothes, shoes, cigarettes, CDs, tickets, computers, digital products, electronics, smartphones, etc.) are sold well through the online channel and zero online sales are not realistic. Our research develops a new model to address this deficiency – no matter how small for the product compatibility with online sales, there would always be some sales volume in an online channel, which reflects a common business in practice.

To the best of our knowledge, our research is the first one to develop a new O2O competition model to address how the return policies in an O2O competitive market can be utilized to coordinate the O2O distributions and involve in revenue sharing plus profit sharing mechanisms in the extant literature. Specifically, our research addresses the following main questions:

(a) In a manufacturer – traditional retailer supply chain, when the manufacturer opens an online channel to compete with the traditional retailer, how does the differential of return policies influence the performances of both the manufacturer and the traditional retailer? What types of return policies should be employed by the manufacturer and the traditional retailer, respectively?
(b) Given the consideration of product compatibility with online sales, if the optimal return policy the manufacturer would like to employ is in conflict with the optimal return policy the traditional retailer would like to employ, what coordinative mechanism(s) should be adopted to help coordinate the O2O distributions and thus a win-win result can be achieved?

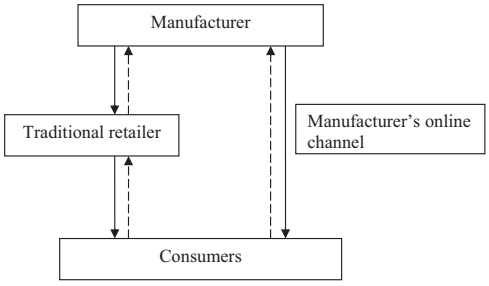

Fig. 1. The manufacturer - traditional retailer O2O supply chain.

Based on our results, we derive optimal marketing strategies for business managers to employ and thus they can benefit from our findings significantly.

In our research, the online channel is defined as the manufacturer's online channel. However, in the business market, traditional retailers (e.g., Wal-Mart, Target, BestBuy, etc.) also are using their online stores to complement the sales of their offline stores. Hence, in order to simplify the expression and eliminate any confusion, we define the traditional retailer's channel distribution, which includes the O2O stores, as one simple term – offline channel - in this paper.

3. Model framework

In this section, we study and analyze the supply chain structure as illustrated in Fig. 1.

Fig. 1 represents a supply chain where the manufacturer sells a product to a traditional retailer and in the meantime, also sells the identical product directly through its own online channel to consumers. In the business market, many manufacturers, such as Lenovo, Dell Computer, Sony, Clarks, Nike, Cisco System, and P&G, are opening their own online channels to compete with their retailers (Tsay and Agarwal, 2004; Amrouche and Yan, 2016). While analyzing this supply chain structure, we adopt a manufacturer-Stackelberg leader game. Cotterill and Putsis (2000) conducted an empirical study to show that the Stackelberg structure does reflect a strategic interaction between the manufacturer and the retailer(s).

3.1. Model development

Consumers can purchase products either from the offline channel with a price p_2 or directly from the online channel with a price p_1. In the meantime, the online and offline channels also offer a return policy to consumers respectively. The offered return policy from the offline channel is defined as r_2 and the offered return policy from the online channel is defined as r_1. The differential of two return policies between the online and offline channels is defined as r ($r = r_2 - r_1,\ 0 \le r < p_i,\ i = 1, 2$). If the return policy provided by the online channel is less generous, then more consumers will switch to the offline channel with a more generous return policy. Hence, following the similar assumption as in Caminal and Vives (1996), we assume that higher r helps increase the demand of offline channel, but decreases the demand of online channel. As a result, the demand functions are assumed to be linear in price, cross-price effect, and the differential of return policies. Specifically, the demand functions are given as

$$D_1 = \theta a - bp_1 + cp_2 - r \tag{1}$$

$$D_2 = (1 - \theta)a - bp_2 + cp_1 + r \tag{2}$$

Where, D_1 is demand in the online channel and D_2 is demand in the offline channel. The percentage of the primary demand a that goes to the online channel is $\theta(0 < \theta < 1)$ (when the value of θ is greater, the product compatibility with online sales is larger and more consumers would buy the product from the online channel), and $(1 - \theta)$ is the percentage of primary demand that goes to the offline channel. The direct-price effect b is normalized to 1, which is rather a standard assumption in economics (e.g., Cotterill and Putsis, 2001; Amrouche and Zaccour, 2007). $c(0 \le c \le b)$ represents cross-price effect and reflects the degree of channel competition between the online and offline channels (as c increases, the degree of channel competition between the online and offline channels increases).

Since θ is closely related to the product compatibility with online sales, we thus assume that $\theta = \frac{g}{2}(0 < g \le 1)$, where g represents the product compatibility with online sales. A managerial interpretation is that the higher the compatibility of the product with online sales, the more the consumers would like to buy from the online channel and thus the higher is the baseline demand in the online channel. The value $g = 0$ means that the product is not compatible with online sales at all. The value $g = 1$ signifies that the product is perfectly compatible with online sales and the baseline online demand is equal to the baseline demand in the offline channel. Kacen et al. (2013) showed empirically that the product compatibility with online sales is always less than 1 for many product categories. However, some products (e.g., digital music, airline tickets, CDs) are perfectly compatible with online sales. In other words, the product compatibility with online sales for these products would be equal to one. Furthermore, as product is more compatible with online sales, the channel competition between the online and offline channels would become more intense (Chiang et al., 2003). Thus including the product compatibility with online sales to the competition of online and offline channels (i.e., we assume that $c = g$), we can re-write the demand functions (1) and (2) as follows:

$$D_1 = \frac{g}{2}a - p_1 + gp_2 - r \tag{3}$$

$$D_2 = \left(1 - \frac{g}{2}\right)a - p_2 + gp_1 + r \tag{4}$$

4. Analysis

We here consider a supply chain where the manufacturer opens an online channel to sell its product directly to consumers and in the meantime, sells the identical product to consumers through a traditional retailer. In the Stackelberg game, the manufacturer announces a wholesale price w and an online price p_1 first to maximize its profit. In response to w and p_1, the traditional retailer offers a retail price p_2 to maximize its own profit. In order to prevent the traditional retailer from buying through the online channel with a lower price, we assume that the wholesale price should not be higher than the online price (i.e., $p_1 \ge w$). The product has a unit cost of production s. To simplify exposition and maintain analytical tractability, we assume $s = 0$ without affecting the basic results. Thus the profit function for the manufacturer is given as

$$M = p_1 D_1 + wD_2 \tag{5}$$

The profit function for the traditional retailer is given as

$$R = (p_2 - w)D_2 \tag{6}$$

Given the above structure, we obtain the corresponding proposition as follows. Proofs are shown in Appendix A.

Proposition 1. *In an O2O supply chain where the manufacturer opens an online channel to compete with the traditional retailer, the optimal pricing strategies and profits for the manufacturer and the traditional retailer are summarized in* Table 1.

Table 1
Equilibrium results in a manufacturer – traditional retailer supply chain.

Wholesale price, w	$\frac{a(2 + g(3 - g)) - 2r(1 - g)}{4(1 - g)(3 + g)}$
Online price, p_1	$\frac{a(2 + g(3 - g)) - 2r(1 - g)}{4(1 - g)(3 + g)}$
Traditional retail price, p_2	$\frac{a(14 - 9g + 2g^2 + g^3) + 2r(5 - 4g - g^2)}{8(1 - g)(3 + g)}$
Manufacturer's profit, M	$\frac{(a(2 + g(3 - g) - 2r(1 - g))^2}{32(1 - g)(3 + g)}$
Traditional retailer's profit, R	$\frac{(a(g(5 + g) - 10) - 2r(7 + g))^2}{64(3 + g)^2}$

The results in Table 1 show that when the manufacturer opens an online channel to compete with the traditional retailer, the optimal decisions for both the manufacturer and the traditional retailer are influenced by the differential of return policies.

4.1. The differential of return policies

First, we examine how the differential of return policies impacts on the profits of both the manufacturer and the traditional retailer. Based on our analysis, we obtain the corresponding proposition as follows. Proofs are shown in Appendix B.

Proposition 2. In an O2O supply chain where the manufacturer opens an online channel to compete with the traditional retailer, the differential of return policies has a positive influence on the traditional retailer's profit but has a negative influence on the manufacturer's profit.

Proposition 2 shows some fresh findings. When the manufacturer opens an online channel to compete with the traditional retailer, the negative effect of the differential of return policies on the manufacturer's profit motivates the manufacturer to employ a generous return policy for its online channel in order to minimize the value of r. Furthermore, the positive effect of the differential of return policies shows that the traditional retailer benefits from the differential of return policies. Thus, in order to maximize the value of r, the traditional retailer also likes to offer a generous return policy to consumers. Consequently, both the manufacturer's online channel and the traditional retailer would like to employ a generous return policy for their respective channels.

4.2. The importance of product compatibility with online sales

Next, we examine if the product compatibility with online sales plays an important role on the effect of the differential of return policies on the profits of both the manufacturer and the traditional retailer. Thus we can see how the product compatibility with online sales influences the decision-makings of return policies. Based on our results, we have the corresponding proposition as follows. Proofs are shown in Appendix C.

Proposition 3. *In an O2O supply chain where the manufacturer opens an online channel to compete with the traditional retailer, the negative effect of the differential of return policies on the manufacturer's profit increases for the manufacturer but the positive effect of the differential of return policies decreases for the traditional retailer as the product compatibility with online sales increases.*

Proposition 3 indicates that any increase in the product compatibility with online sales makes both the manufacturer and the traditional retailer benefit less from the differential of return policies. Since the differential of return policies has a greater negative impact on the manufacturer's profit as the product compatibility with online sales increases, the manufacturer would like to employ a generous return policy for its online channel. To the traditional retailer, the differential of return policies contributes less profit to the traditional retailer as the product compatibility with online sales increases. Hence, the traditional retailer would like to employ a generous return policy as its optimum return policy to counter the threat of online channel. In general, given the consideration of the product compatibility with online sales, both the manufacturer and the traditional retailer would like to employ a generous return policy for their respective channels.

However, if the offered return policies from the manufacturer's online channel and traditional retailer are the same, the channel competition will become more intense and thus leads to serious channel conflict (particularly when the product is highly compatible with online sales), which may have an effect of lowering the profits of all parties. It is, therefore, to the manufacturer's benefit to decrease channel conflict. Hence, the important question is if the manufacturer can employs a strict return policy for its online channel and the traditional retailer can employ a generous return policy for the offline channel, so that the channel competition between the manufacturer's online channel and the traditional retailer can be alleviated. However, the most important question is that when the different return policies are employed, can both the manufacturer and the traditional retailer achieve a higher profit respectively? Only if both the manufacturer and the traditional retailer have an opportunity to achieve a higher profit individually, would they like to employ different return policies for their respective channels. Since the manufacturer and the traditional retailer cannot achieve higher individual profits directly through employing different return policies, we then need to investigate how the differential of return policies impacts the performance of whole supply chain, given the consideration of product compatibility with online sales. If the whole supply chain does benefit from the differential of return policies, then both the manufacturer and the traditional retailer do have an opportunity to achieve a higher profit individually. Based on our results, we have the proposition as follows. Proofs are shown in Appendix D.

Proposition 4. *In an O2O supply chain where the manufacturer opens an online channel to compete with the traditional retailer, the impact of the differential of return policies on the profit of whole supply chain increases as the product compatibility with online sales increases.*

Proposition 4 shows a valuable and important result. The whole supply chain does benefit from the differential of return policies and larger differential of return policies contributes more profit increase to the whole supply chain. Particularly when the product is more compatible with online sales, the whole supply chain would benefit more. The profit increase due to the differential of return policies does provide a valuable opportunity for the manufacturer to employ a strict return policy for its online channel and the traditional retailer to employ a generous return policy to alleviate the channel competition and achieve a higher profit for the whole supply chain. Since higher profit is achieved for the whole supply chain, the manufacturer and the traditional retailer can negotiate with each other to share the increased profit gain through profit sharing mechanism and achieve a higher profit individually when they are employing different return policies for their respective channels. The profit sharing scheme proposed by Yan and Pei (2015) can be used by the manufacturer and the traditional retailer to cooperatively share the increased profit gain that will be accumulated from implementing the different return policies for O2O channels.

4.3. The value of revenue sharing

Next, the important question is if there is any mechanism the manufacturer can utilize to further improve the performance of whole supply chain, thus both the manufacturer and the traditional retailer can benefit much more through sharing the increased profit gain. Here we propose that the manufacturer can utilize the revenue sharing as an effective mechanism to improve the performance of whole supply chain. When revenue sharing strategy is implemented, the traditional retailer pays the manufacturer a wholesale price for each unit purchased plus a percentage of the sales revenue that the traditional retailer generates. The revenue sharing has been popular in practice and theory. For example, Blockbuster Inc. (a video retailer) shares a percentage (estimated in the range of 30–45%) of its revenue with its suppliers in return for a sharp drop in the wholesale price from $65 to $8 per tape (Cachon and Lariviere, 2005). Another example is AT&T Wireless and Apple. The provider of the wireless iPhone AT&T shares a portion of its monthly rate with Apple for every purchased iPhone (Cai, 2010). As a result, the profit functions with revenue sharing can be written as follows:

$$M^r = p_1 D_1 + (kp_2 + w)D_2 \tag{7}$$

$$R^r = ((1-k)p_2 - w)D_2 \tag{8}$$

Where, M^r and R^r are the manufacturer's profit and the traditional

Table 2
Equilibrium results in a manufacturer – traditional retailer supply chain with revenue sharing.

Wholesale price, w^r	$\frac{(1-k)(2a(2-(1-g)g)+ak(4-(2-g)g(1+g))-2r(1-g)(2-k(2+g)))}{4(1-g^2)(2-k)}$
Online price, p_1^r	$\frac{ag(3-g)-2r(1-g)}{4(1-g^2)}$
Traditional retail price, p_2^r	$\frac{a(6+g^3(1-k)-4k+g^2k-g(3-2k))+2r(1-g)(3+g(1-k)-2k)}{4(1-g^2)(2-k)}$
Manufacturer's profit, M^r	$\frac{1}{16(1-g^2)(2-k)}(a^2(4-4g+g^2(15-9k)+g^4(1-k)-g^3(8-6k)) + 4ar(1-g)(2+g^2(1-k)-g(5-3k)+4r^2(1-g)(3-g(1-k)-k))$
Traditional retailer's profit, R^r	$\frac{(1-k)(a(2-g)+2r)^2}{16(2-k)^2}$

retailer's profit with revenue sharing, respectively. The parameter $k(0 < k < 1)$ represents the proportion of the traditional retailer's revenue that the manufacturer and the traditional retailer agree to share so that the manufacturer can apply its pricing incentive. Based on our analysis, we summarize the equilibrium results in Table 2. Proofs are shown in Appendix E.

Here we examine how the revenue sharing influences the performances of each supply chain player and whole supply chain, respectively. Based on our analysis, we obtain corresponding proposition as follows. Proofs are shown in Appendix F.

Proposition 5. (a) *While revenue sharing is applied to a manufacturer – traditional retailer supply chain where the manufacturer opens an online channel to compete with the traditional retailer, the manufacturer always benefits from revenue sharing* (*i.e.,*$M^r > M$*);* (b) *the traditional retailer does not profit from the revenue sharing* (*i.e.,*$R^r < R$); However, (c) the whole supply chain always benefits from revenue sharing (i.e., $M^r + R^r > M + R$).

Proposition 5 reveals some valuable findings. First, proposition 5 (a) and (b) show that revenue sharing is beneficial to the manufacturer, but it is not beneficial to the traditional retailer. However, proposition 5 (c) shows that revenue sharing is beneficial to the whole supply chain. Thus a win-win opportunity does exist for both the manufacturer and the traditional retailer through employing revenue sharing as an effective incentive mechanism to improve the performance of whole supply chain. The rationale is that the increased profit for the manufacturer is much more than the traditional retailer's profit loss due to implementing a revenue sharing strategy. Hence, the manufacturer can induce the traditional retailer to implement a revenue sharing strategy through another coordination mechanism - profit sharing proposed by Yan and Pei (2015). As a result, a Pareto result through revenue sharing plus profit sharing mechanisms can be achieved for both the manufacturer and the traditional retailer. Hence, the important managerial implication is that when the manufacturer opens an online channel to compete with the traditional retailer, it needs to employ a strict return policy for its online channel but the traditional retailer needs to employ a generous return policy in the offline channel, and in the meantime, the manufacturer and the traditional retailer can utilize revenue sharing plus profit sharing as effective mechanisms to improve their respective profits.

5. Conclusions and managerial implications

Return policy is not only of interest to academics but also economically important in the business world. Our study provides marketing scholars and practitioners with a new perspective about how the competitive return policies can be utilized to coordinate the O2O distributions and help improve the performances of all supply chain players. We extended prior research on the value of return policy by taking into account both competitive return policies and coordination mechanisms in the manufacturer – retailer O2O supply chain. Our study has great theoretical and academic contributions. First, our study enriches the principle agent theory (Bergen et al., 1992). In this study, we consider a manufacturer - retailer supply chain in which the manufacturer (principal) opens an online channel to compete with its retailer (agent) and study how the competitive return policies can be utilized to alleviate the O2O competition and achieve the optimum profits for both the manufacturer and the retailer, which make the principle agent relationship become more efficient. Second, literature has been showing increasingly interest in return policy (Davis et al., 1998; Sarvary and Padmanabhan, 2001; Yan, 2009; Venkatesan and Kumar, 2004; Bonifield et al., 2010; Pei et al., 2014; Jeng, 2017; Venkatesan and Kumar, 2009). However, no prior study ever examines competitive return policies in the O2O distributions of manufacturer – retailer supply chain in the extant literature, particularly given the consideration of product compatibility with online sales. Our study addresses this gap and makes important contributions to the literature.

Nowadays e-commerce is becoming more and more popular in the business market, many manufacturers would like to open their own online channels to sell products directly to consumers, which leads to channel competition and conflict between the manufacturer and the retailer since retail partners are concerned that the orders placed through a manufacturer's online channel might reduce their own sales. As a result, the important questions is that when the manufacturer opens an online channel to compete with its retailer, what effective strategies can be utilized to alleviate the O2O competition and help improve the performances of all supply chain players? In this research, we first develop a new O2O competition model and then make game theoretical analysis to study the value of competitive return policies and their strategic influences on profits of supply chain players under the manufacturer – traditional retailer supply chain where the manufacturer opens an online channel to compete with the traditional retailer. Our results show that utilizing the revenue sharing plus profit sharing mechanisms, the manufacturer and the retailer can employ different return policies for their respective channels to coordinate the O2O distributions and achieve higher profits for all parties in a manufacturer – traditional retailer supply chain. Particularly when the product is becoming increasingly compatible with online sales, the value of the differential of return policies would further increase for both the manufacturer and the retailer.

Our research addresses important issues and our findings provide valuable managerial implications for business managers to make right decisions and improve their respective performances. The most significant contribution is that our paper contributes to the substantial and growing research about the value of return policies in an O2O competitive market using a new developed analytical model. When O2O distributions are becoming more and more popular in the business market, it is managerially important to develop some valuable and novel model to address channel competition and consider some effective coordination mechanisms to improve channel coordination. In our research, we use a game theoretic model to show that the competitive return policies can be utilized to coordinate the O2O distributions under the help of some other coordination mechanisms, such as revenue sharing and profit sharing, and create a Pareto result for all supply chain players. In the business world, business managers can use the managerial insights derived from our research to improve their decisions and thus enhance their respective profits.

This research also has some limitations. For instance, many factors such as manufacturer's brand reputation may affect the power structure, coordination, and price decisions. In the future research, we can consider the manufacturer's brand reputation in the model and examine how the manufacturer's brand reputation could influence the decision of return policies. Further, although the power structure is indirectly considered in the form of bargaining power, we can investigate how the power structure influences the design of return policies. In addition, this research focuses on analytical modeling and there is no empirical examination. In the future, we can collect data to test our propositions. For example, data about online-compatibility of products such as computers, digital products, shoes, toothpastes, and so forth, are available in the business market and can be collected through market research as Kacen et al. (2013) did. Furthermore, data about primary demand can be obtained from government's census. In addition, revenue sharing mechanism has been practiced in various industries, such as apparel, smartphones, movies, and so forth (Cachon and Lariviere, 2005; Cai, 2010; Blair and Lafontaine, 2015). Hence, empirical researchers can collect relevant data to test our analytical results and investigate whether the qualitative implications derived in our propositions can be generalized to empirical examinations.

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Appendix A

In the first stage, the manufacturer maximizes its profit, given in Eq. (5), subject to the retailer's best response function obtained by maximizing (6) with respect to p_2. Thus we get the retailer's response function as $p_2 = \frac{a(2-g)+2(gp_1+r+w)}{4}$
Substituting the above equation into M and maximizing, we obtain

$$w = \frac{a(2+g(3-g))-2r(1-g)}{4(1-g)(3+g)} \text{ and } p_1 = \frac{a(2+g(3-g))-2r(1-g)}{4(1-g)(3+g)}$$

Substituting the values of p_1 and w into retail price and profit functions, we obtain

$$p_2 = \frac{a(14-9g+2g^2+g^3)+2r(5-4g-g^2)}{8(1-g)(3+g)},\ M = \frac{(a(2+g(3-g)-2r(1-g))^2}{32(1-g)(3+g)},\ \text{and } R = \frac{(a(g(5+g)-10)-2r(7+g))^2}{64(3+g)^2}$$

Appendix B

Because $M = \frac{(a(2+g(3-g)-2r(1-g))^2}{32(1-g)(3+g)}$ and $R = \frac{(a(g(5+g)-10)-2r(7+g))^2}{64(3+g)^2}$, by the differential of M and R on r, respectively, we obtain

$$\partial M/\partial r = \frac{2r(1-g)+a(g^2-3g-2)}{8(3+g)} < 0 \partial R/\partial r = \frac{(7+g)(a(10-5g-g^2)+2r(7+g))}{16(3+g)^2} > 0$$

Thus, Proposition 2 is proved.

Appendix C

From Appendix B, we have $\partial M/\partial r = \frac{2r(1-g)+a(g^2-3g-2)}{8(3+g)} < 0$ and $\partial R/\partial r = \frac{(7+g)(a(10-5g-g^2)+2r(7+g))}{16(3+g)^2} > 0$
By the differential of $\partial M/\partial r$ and $\partial R/\partial r$ on g, respectively, we obtain

$$\partial(\partial M/\partial r)/\partial g = \frac{a(7-6g-g^2)-8r}{8(3+g)^2} < 0 \partial(\partial R/\partial r)/\partial g = -\frac{a(215+47g+9g^2+g^3)-16r(7+g)}{16(3+g)^3} < 0$$

Therefore, Proposition 3 is proved.

Appendix D

$$M = \frac{(a(2+g(3-g)-2r(1-g))^2}{32(1-g)(3+g)} \text{ and } R = \frac{(a(g(5+g)-10)-2r(7+g))^2}{64(3+g)^2}$$

Following the same proof procedures as in Appendices B and C, we obtain $\partial(\partial(M+R)/\partial r)/\partial g = \frac{55+1-g-g^2}{8(3+g)^2} > 0$. Thus, Proposition 4 is proved.

Appendix E

In the first stage, the manufacturer maximizes its profit, given in Eq. (7), subject to the retailer's best response function obtained by maximizing (8) with respect to p_2. Thus we get the retailer's response function as $p_2^r = \frac{a(2-g)+2(gp_1+r+\frac{w}{1-k})}{4}$
Substituting the above equation into M and maximizing, we obtain

$$w^r = \frac{(1-k)(2a(2-(1-g)g)+ak(4-(2-g)g(1+g))-2r(1-g)(2-k(2+g)))}{4(1-g^2)(2-k)} p_1^r = \frac{ag(3-g)-2r(1-g)}{4(1-g^2)}$$

Substituting the values of p_1^r and w^r into retail price and profit functions, we obtain

$$p_2^r = \frac{a(6+g^3(1-k)-4k+g^2k-g(3-2k))+2r(1-g)(3+g(1-k)-2k)}{4(1-g^2)(2-k)} R^r = \frac{(1-k)(a(2-g)+2r)^2}{16(2-k)^2} M^r$$

$$= \frac{1}{16(1-g^2)(2-k)}(a^2(4-4g+g^2(15-9k)+g^4(1-k)-g^3(8-6k))+4ar(1-g)(2+g^2(1-k)-g(5-3k)$$

$$+4r^2(1-g)(3-g(1-k)-k))$$

Appendix F

Through comparing M, R, and $M+R$ with M^r, R^r, and M^r+R^r, respectively, and after some computations, we can prove that $M^r > M$,$R^r < R$, and $M^r + R^r > M + R$. Thus, Proposition 5 is proved.

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