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Marketplace, Reseller, or Hybrid: Strategic Analysis of an Emerging E-Commerce Model

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Traditionally, online retailers have acted as product resellers. Recently, these retailers have also started to serve as online marketplaces by providing a platform to directly connect sellers with buyers. Over and above re-shaping the traditional e-commerce market, conventional wisdom suggests that this new format will mitigate the double-marginalization effect and benefit both the intermediary and suppliers through a revenue sharing scheme. However, we find that upstream competition between suppliers critically moderates this possibility. We also find that the interaction of order-fulfillment costs and upstream competition intensity moderates the selection of an optimal mode for the intermediary. More specifically, when order-fulfillment costs are large and when the supplier product offerings are similar (i.e., competition intensity is high), the pure reseller mode is the preferred choice; when order-fulfillment costs are small and the supplier product offerings are highly differentiated (i.e., low competition intensity), the pure marketplace mode is the preferred choice. Finally, the hybrid mode is preferred when order-fulfillment costs are moderate and suppliers' products are somewhat similar (i.e., competition intensity is moderate). The intuition behind these results hinges on the trade-off between transfer of pricing rights and the responsibility for order fulfillment. Our findings not only complement the emerging online marketplace literature but also provide testable empirical questions concerning the relationship and magnitude of different factors steering the mode choice.

Key words: online marketplace; channel structure; upstream competition; order-fulfillment cost
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1. Introduction

Online retailers who have traditionally acted as resellers are starting to offer online markeplace services providing a direct connection between buyers and sellers. The success of online marketplaces is well documented. For example, direct sales from suppliers accounted for 45% of units sold on Amazon.com in the second quarter of 2015, and leading Chinese online retailer JD.com reports that sales through its online marketplace grew at a rate higher than its projection at 40%. Perhaps this is what has driven online retailers who were originally resellers to add an online marketplace (e.g., Amazon, JD.com, Gome) to expand their product offering options for the consumer. However, note that neither Amazon nor JD.com is moving forward to the pure marketplace mode. For example, Amazon and its marketplace sellers offered a total of 353,710,754 different products, and Amazon itself carried 12,231,203 in May 2016.[1] Further, some online retailers (e.g., BestBuy.com) are still working as pure resellers. More interestingly, there are also examples of retailers (such as Zappos.com) that started as online markeplaces, but have now switched completely to the reseller mode. The underlying motivation for these alternative modes is not always clear.

In the reselling mode, online retailers purchase products from suppliers for a wholesale price, then determine retail prices for consumers. In contrast, in the online marketplace mode, suppliers determine retail prices and share revenue with the online retailer. The online retailer does not incur any direct inventory or delivery costs, but it loses the flexibility

of setting market prices. Of course, it is also possible for the online retailer to adopt a hybrid configuration mode; that is, for some products they act as resellers and for others they serve as an online marketplace. Regardless of the chosen channel mode, online retailers often offer products from competing suppliers, which necessitates an integration of upstream competition in the chain. From an efficiency perspective, there is also a need to consider costs related to inventory, storage, and transportation; we refer to these as "order-fulfillment costs." According to a recent report in the *Wall Street Journal* (Kapner 2014), the cost of fulfillment operations can run as high as 25% of the sales revenue. The adopted channel mode also affects whether the online retailer bears these costs (reseller mode) or whether they are borne by the suppliers (online marketplace mode).

These observations motivate the research of this study which is to address the following general question: Should online retailers operate as resellers, online marketplaces, or adopt both modes of operation? Which mode would be preferred for suppliers? The focus of this study is to examine the desirability of these platform choices for the online intermediary. More specifically, we investigate the impact of upstream (supplier) competition and fulfillment (inventory and delivery) costs on intermediary and supplier profitability across three mutually exclusive platform modes: (a) Reseller Mode for both suppliers, (b) Hybrid Mode, where one supplier operates under the reseller format while the other operates as a direct seller through an online marketplace, and (c) Online Marketplace Mode for both suppliers. Our study helps to shed light on why different online platforms adopt different selling modes and determine the key drivers of different proportional fees based on product category.

There is an emerging stream of literature that discusses the importance of the strategic contract choices between resellers and online marketplaces with a focus on trade-offs between these two distinct pure modes. Prior research addressing this general question has focused on information asymmetry (Jiang et al. 2011), positive or negative cross-channel effects (Abhishek et al. 2016), complementary relationships between products and devices (Hao and Fan 2014), online product reviews (Young et al. 2014), control rights of marketing activity (Hagiu and Wright 2015), and downstream competition (Tan et al. 2016). Our focus is completely different, as we provide insights into how both upstream competition and order-fulfillment costs moderate the choice of channel mode for the online intermediary.

The key findings of our study can be summarized as follows. As opposed to the monopoly setting, where the marketplace mode will dominate the reseller mode, our analysis reveals that upstream competition intensity and order-fulfillment costs are two interacting forces steering the mode choice of the online retailer. Essentially, in the reseller mode, the intermediary can function as a moderator to alleviate the fierce price competition in the online marketplace. Specifically, when the order-fulfillment cost is relatively small and the competition intensity is low, the pure marketplace mode will become the preferred choice; when the order-fulfillment cost is relatively high or the competition is sufficiently intense, then the pure reseller mode is the preferred choice. The hybrid mode is the preferred choice when order-fulfillment costs and competition intensity are both at moderate levels. The intuition hinges on the trade-off between the intensity of the price competition due to the transfer of the pricing right and the responsibility of bearing the order-fulfillment cost accompanied by the mode change.

Our findings also suggest that the revenue-sharing scheme adopted by many online platforms (i.e., online marketplace mode) does not always outperform the traditional reseller model. This result holds when the upstream competition is very intense or the order-fulfillment cost is high. This implies that depending upon upstream competition intensity and magnitude of order fulfillment costs, online intermediaries should design different contract terms for distinct product categories. For example, instead of allowing the suppliers to sell on its website, Amazon can become the reseller in certain highly competitive product categories, such as electronics. On the other hand, it is more profitable for Amazon to serve as a marketplace for other less competitive product categories, such as fine art (i.e., long-tail product category). For print books (with high order-fulfillment costs), Amazon should serve as a reseller, while for e-books (with low order-fulfillment costs), Amazon should choose to operate as an online marketplace. Thus, the revenue sharing proportion (and associated bounds) are useful to encourage or discourage the adoption of the online marketplace mode by suppliers.

The remainder of this study is organized as follows. In the next section, we review and examine how our study relates to relevant literature. This is followed by a description of our model and analysis in sections 3 and 4, respectively. Section 5 presents the main insights of our results. Section 6 concludes the paper with a summary and possible avenues for future research. All proofs can be found in the Online Appendix.

2. Relevant Literature

This study contributes to the emerging research literature that focuses on the strategic mode choice

between suppliers and online retailers, and aims to reveal the trade-offs between the two distinct pure modes (i.e., reseller and online marketplace). One of the key aspects in this context is the cross-channel effect. This effect is a result of suppliers offering goods through multiple channels, potentially leading sales in one channel to impact sales in another channel. In the presence of spillovers between channels, different selling modes will elicit different reactions from suppliers, because the sales through new channels would impact suppliers' sales in the traditional channel (Brynjolfsson et al. 2009). Abhishek et al. (2016) study a setting with one supplier and two online intermediaries, and find that the online intermediary prefers to use the marketplace mode if the sales through the intermediary lead to a negative effect on demand of the supplier's traditional channel, and vice versa. They also show that such preferences are moderated by competition among intermediaries. In contrast, in our study, we examine competition between suppliers.

Hagiu and Wright (2015) focus on a single decision variable, the level of demand-enhancing marketing activity, which is controlled by suppliers in the pure marketplace mode but by the intermediary in the pure reseller mode. They assume information asymmetry such that each supplier has information on the impact of market activities on demand while the intermediary and other suppliers do not. Their results indicate that the pure marketplace mode is preferred if and only if the variance of the private information exceeds the squared value of spillovers from marketing activities across products. In their model, suppliers are only charged a fixed membership fee in the pure marketplace mode. However, in reality, there is usually a small fixed participation fee plus a large proportional revenue sharing fee. By contrast, we endogenize the revenue sharing fee, and examine how the online intermediary can manipulate this fee to encourage or discourage the adoption of the online marketplace mode for the suppliers.

Jiang et al. (2011) also consider the impacts of demand-enhancing marketing activities and information asymmetry. They focus on the strategic underselling behavior of sellers on platforms rather than the strategic mode choice we consider in this study. Other issues of interest have been explored in prior research on online marketplaces. Hao and Fan (2014) focus on the publishing industry and show that e-book prices are lower in the pure reseller mode due to the existence of a complementary market (i.e., e-book readers). Young et al. (2014) show that channel mode choice can be used as a strategic tool to benefit from third-party product reviews. More recently, Tan et al. (2016) and Tan and Carrillo (2017) illustrate that the mechanism of the online marketplace can benefit both the upstream supplier and the retailer in the digital publishing industry.

Our study differs from the aforementioned studies in four key aspects. First, we explicitly consider upstream supplier competition in identifying an equilibrium configuration mode for the online retailer. We believe this is a critical aspect since most online retailers simultaneously offer substitute products from competing suppliers. Second, since the configuration mode impacts the order-fulfillment costs borne by different supply chain members, we also integrate this critical aspect in our setting. As indicated earlier, these costs are a significant portion of the total channel costs. Third, practice indicates that some online retailers operate as both resellers and online marketplaces for the same product category. This drives us to explicitly include such a hybrid configuration mode in our comparisons. Fourth, we endogenize the equilibrium mode choice within the interactions between the suppliers and the online intermediary, and also the proportional fee for the suppliers under the online marketplace mode.

Our study also contributes to the research literature on channel structure. Early work on market channels concerned whether suppliers are better off using independent intermediaries instead of vertical integration (e.g., Choi 1991, Coughlan 1985, McGuire and Staelin 1983, Trivedi 1998). A common result is that the existence of independent intermediaries is able to mitigate the competition among suppliers. For example, McGuire and Staelin (1983) consider the partial substitutability between two products from two suppliers selling through exclusive retailers. They conclude that suppliers prefer to use independent intermediaries when the degree of substitutability is high, and prefer company-owned stores otherwise. Coughlan (1985) discusses the problem of choosing a vertical marketing channel in a product-differentiated duopoly market, and shows that integration of the marketing function results in greater price competition and lower prices than the use of independent marketing middlemen.

Another stream of research on channel structure examines the impact of introducing an online direct channel in addition to an existing retail channel. Chiang et al. (2003) have argued that the introduction of the direct channel may benefit the retailer through a reduction of the wholesale price. Tsay and Agrawal (2004a) have confirmed that result in a different setting by considering various sources of inefficiency. Cai (2010) and Cai et al. (2012) explore the impact of multiple channel structures and revenue sharing schemes to the supplier, the retailer, and the supply chain. Recent research has considered the rationale of selling through online platforms. For example, Ryan et al. (2012) consider a setting with a supplier who

sells goods through its own direct sale website and has the option of selling its goods through an online platform. They assume that selling through the platform system can attract more customers to the supplier's own website, but at some expense, e.g., a fixed participation fee or proportional fee charged by the online platform. Interested readers are referred to Cattani et al. (2004) and Tsay and Agrawal (2004b) for more comprehensive reviews.

Our study on strategic mode choice between suppliers and online retailers differs from the stream of market channel literature in three ways. First, in prior research, the online retailer/intermediary is assumed to function as a reseller. In our study, under the online marketplace mode, the intermediary acts as an agent, charging a proportional fee for each sale. Shy and Wang (2011) suggest that such a fee could be regarded as a revenue sharing mechanism that may mitigate double marginalization. Second, the focus of our study is identifying which selling mode is more beneficial for online intermediaries, rather than a comparison of direct/indirect selling activities. Third, we explicitly examine how the order-fulfillment cost and upstream competition, two significant but unexplored factors, determine the mode configuration choice.

Our research also complements the stream of literature on store-within-store in an offline setting (e.g., Jerath and Zhang 2010, Netemeyer et al. 2012), where retailers essentially rent out their retail space to suppliers and give them complete autonomy over retail decisions like pricing and in-store services. Our study of online marketplaces differs from this literature stream in two ways. First, in store-within-store contracts, suppliers typically manage all retail decisions, and the retailers charge them a fixed periodic rent (Jerath and Zhang 2010). Our work suggests that a proportional/revenue sharing fee could be a viable alternative in this setting. Through guidelines on proportional fees (α) (i.e., the revenue sharing proportion that the online retailers can keep), we show that online retailers can set the value of α to encourage or discourage the adoption of the online marketplace mode for the suppliers. As noted by Cachon and Lariviere (2005), revenue sharing contract is very difficult to implement in the offline setting. However, this is not the case for the online marketplace setting, which is analogous to the store-within-store model. Second, we show that order-fulfillment costs and upstream competition jointly determine the optimal mode configuration choice for online retailers. To the best of our knowledge, the literature on the store-within-store setting has largely neglected the impacts of these two significant but unexplored factors.

In summary, the key aspects of our paper (e.g., the proportional-fee/revenue-sharing fee, the order-fulfillment cost, and the upstream competition between suppliers) have not been thoroughly explored in the extant store-within-store literature. Thus, our findings regarding the online marketplace can also provide useful insights into store-within-store settings. In the next section, we turn to a description of our modeling framework.

3. Modeling Framework

We consider a stylized supply chain consisting of two competing suppliers (A and B) selling two substitutable products (A sells product a, B sells product b) through a common online intermediary (I). Given that the products are substitutable, we follow established norms in the marketing and operations literature (e.g., Birge et al. 1998, Choi 1991, Gal-Or et al. 2008, Garcia-Gallego and Georgantzis 2001, Li and Zhang 2008, McGuire and Staelin 1983) and our demand function is:[2]

$$d_a = \theta - p_a + \gamma(p_b - p_a) \tag{1}$$

$$d_b = \theta - p_b + \gamma(p_a - p_b) \tag{2}$$

where d_i and p_i refer to the realized demand and retail prices for product $i(=a, b)$, respectively, and θ denotes the market potential. $\gamma > 0$ is the measure of the intensity of price competition with higher values indicating a greater degree of product substitution and greater intensity of price competition.[3] Our entire analysis, without loss of generality, assumes that production costs for suppliers are normalized to be equal to zero. For ease of exposition, we use the pronoun "he" to represent the intermediary, and "she" to denote the suppliers in the remainder of the study.

Three alternative mode choices evaluated are as follows:

- Reseller Mode *RR*: Under mode *RR*, the intermediary acts as a reseller for both suppliers. Since many online intermediaries (e.g., Amazon and JD.com) were historically pure resellers, we set *RR* mode to be the benchmark (current) mode.
- Hybrid Mode *PR*: This mode represents a setting where the intermediary acts as a marketplace for one supplier (suppose Supplier A) by specifying a proportional fee α and acts as a reseller for the other supplier (Supplier B).
- Online Marketplace Mode *PP*: In direct contrast to mode *RR*, under this mode, the intermediary specifies a proportional fee α to both suppliers and acts as a marketplace for both suppliers.

Following industry practice, the intermediary acts as a Stackelberg leader in terms of whether she will

act as a reseller or marketplace for one or both suppliers. The suppliers, as followers, accept or reject the intermediary's offer. In determining the equilibrium outcomes, for each alternative mode, the conditions under which suppliers will accept the intermediary's mode choice are explicitly incorporated.

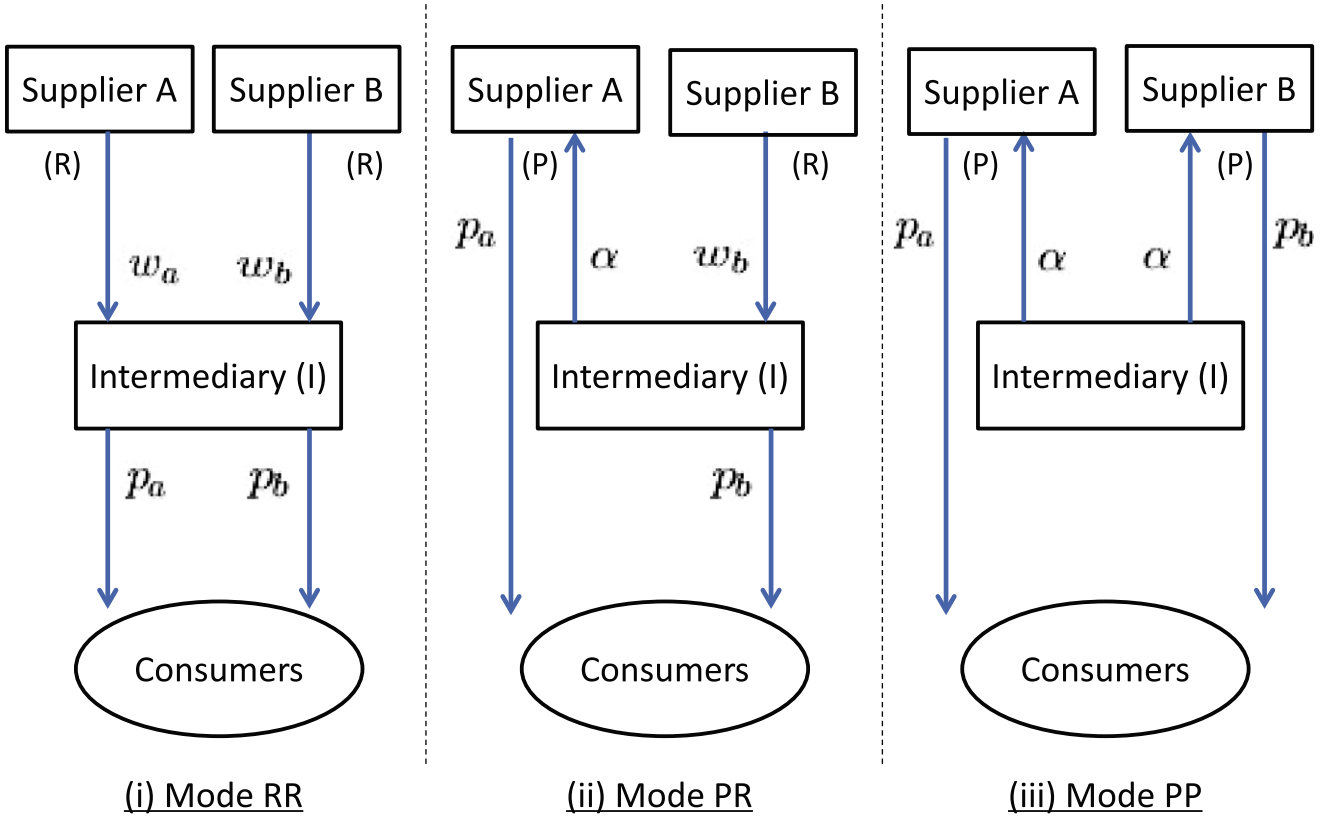
Based on this discussion, it is apparent that the possible existence of each mode of operation is driven by the intermediary's operational offering (e.g., the proportional fee α) and the suppliers' willingness to accept this offer. Assuming the existence of each mode, the interaction between the intermediary and suppliers is illustrated in Figure 1. The sequence of events for each mode of operation is as follows.

- Mode *RR*: In this benchmark (current) mode, the intermediary has decided not to offer the online marketplace service and acts as a reseller for both suppliers. Suppliers start by simultaneously offering wholesale prices w_a and w_b to the intermediary who in turn simultaneously sets retail prices p_a and p_b for the consumers.
- Mode *PR*: In this mode, the intermediary has offered to act as a marketplace for Supplier *A* by specifying a proportional fee α, and still acts as a reseller for Supplier *B*. Assuming Supplier *A* accepts the online marketplace offer and Supplier *B* chooses to continue participating under the reseller format, then based on the quoted wholesale price w_b from Supplier *B*, both Supplier *A* and the intermediary simultaneously set the retail prices p_a and p_b, respectively.
- Mode *PP*: In this mode, the intermediary has offered the online marketplace service to both suppliers by specifying the proportional fee α. Assuming both suppliers accept the offer, then both of them determine the retail prices p_a and p_b simultaneously.

Note that, under the marketplace service, the intermediary yields the pricing power to the supplier. The intermediary receives a commission in proportion to the supplier's revenue at a rate of α, which is determined by the intermediary. All three modes are analyzed under a complete information setting.

The proportion α is specified as a referral fee by some online intermediaries (Geng et al. 2018). This proportional fee, although different across product categories, is the same for all products within a certain category. Empirical data indicates that common α values range from 6% to 25% of the sale price depending on the product category on Amazon, while for JD.com, the fee for most product categories ranges from 5% to 12%. In addition to this proportional fee, some intermediaries also charge a fixed subscription

Figure 1 Channel Modes: *RR*, *PR* and *PP* [Color figure can be viewed at wileyonlinelibrary.com]



fee. For example, Amazon Marketplace charges a $39.99 monthly subscription fee for sellers who plan to sell more than 40 items a month. Sears.com also charges a $39.99 fee to suppliers whose sales are over $400 during one month. Because this fee is relatively small compared with the suppliers' sales volume, without loss of generality, we normalize this fixed fee part to zero. Previous literature has also adopted this assumption (Abhishek et al. 2016).

Order fulfillment, that is, delivering physical goods to the customer, is commonly cited as one of the most expensive and critical operations of online sellers (Agatz et al. 2008). The cost of order fulfillment can run as high as 25% of sales (Kapner 2014). To fulfill an order, firms take on costs such as warehouse building/renting costs, hiring staff to handle packages, and delivering the products to customers. The costs of storage and hiring staff are quite significant and can be viewed as fixed cost. Meanwhile, the delivery cost for online shopping is usually undertaken by the customers. For ease of exposition, we assume that order-fulfillment costs are fixed, since we find that the key insights stemming from our analysis are similar even if these costs are a function of the number of orders received.[4] Essentially, if the intermediary functions as a reseller, he will incur a fixed cost $F_I > 0$ to fulfill the order for per product category (product a or b); if the intermediary functions as an online marketplace, each supplier must be responsible for a fixed cost $F_S > 0$ to fulfill orders. Through analysis, we find that if the intermediary's order-fulfillment cost is lower than the supplier's order-fulfillment cost (i.e., $F_I < F_S$), the equilibrium mode is more likely to be the pure reseller mode, and vice versa. To eliminate the possibility that the equilibrium mode is driven by the asymmetric cost structure, we assume $F_I = F_S = F$ in our base model. More specifically, in mode *RR*, the intermediary bears order-fulfillment costs for both product categories (i.e., $2F$); in mode *PR*, Supplier *A* bears the order-fulfillment cost (F) for its product and the intermediary bears the order-fulfillment cost (F) for reselling Supplier *B*'s product; in mode *PP*, both Supplier *A* and Supplier *B* bear the order-fulfillment cost (F) of their own product category.[5] Recently, some online intermediaries (e.g., Amazon, Sears, JD, etc.) and 3rd party online order fulfillment service providers have offered an option to suppliers that allows them to outsource their order fulfillment. In this case, the supplier will pay some fees for order fulfillment; that is, even if the supplier outsources the order fulfillment, he still needs to bear the related costs. For ease of exposition and without loss of generality, we focus on the case that suppliers will fulfill the order in-house in our base model.[6]

In the next section, the equilibrium outcomes of each channel mode are structurally characterized.

4. Equilibrium Analysis

The first set of results described below is our benchmark (current) setting where the intermediary acts as a reseller for both suppliers (mode *RR*). Next, we consider the setting where one supplier switches to the online marketplace mode while the other supplier still adopts the reseller mode (model *PR*). Finally, we focus on the case in which both suppliers choose to accept the intermediary terms and switch to the online marketplace mode (mode *PP*). In deriving these results, the necessary conditions for the existence of each operating mode (i.e., *RR*, *PR*, and *PP*) are that the equilibrium profits for each supplier are at least as large as the profits each supplier could realize through exercising an outside option (denoted by π^O).

4.1. Mode *RR*

Under this setting, the suppliers simultaneously quote wholesale prices (w_a and w_b) and then the intermediary (who bears the order-fulfillment costs for both products) determines the retail prices p_a and p_b. The profits for the suppliers and the intermediary are as follows:

$$\begin{aligned}\pi_A(RR) &= w_a[\theta - p_a + \gamma(p_b - p_a)],\\ \pi_B(RR) &= w_b[\theta - p_b + \gamma(p_a - p_b)],\\ \pi_I(RR) &= (p_a - w_a)[\theta - p_a + \gamma(p_b - p_a)]\\ &\quad + (p_b - w_b)[\theta - p_b + \gamma(p_a - p_b)] - 2F.\end{aligned}$$

We solve this game by backward induction. For any given wholesale prices w_a and w_b, we first characterize the equilibrium retail prices that would maximize $\pi_I(RR)$. We then determine the wholesale prices for the suppliers by simultaneously maximizing their individual profit functions.

Lemma 1. *There exists a unique equilibrium for mode RR. The equilibrium prices and demands are as follows:*

$$\begin{aligned}w_a^{RR} &= w_b^{RR} = \frac{1}{2+\gamma}\theta,\\ p_a^{RR} &= p_b^{RR} = \frac{3+\gamma}{2(2+\gamma)}\theta,\\ d_a^{RR} &= d_b^{RR} = \frac{1+\gamma}{2(2+\gamma)}\theta,\end{aligned}$$

and the corresponding optimal profits are given by:

$$\begin{aligned}\pi_A^{RR} &= \pi_B^{RR} = \frac{1+\gamma}{2(2+\gamma)^2}\theta^2,\\ \pi_I^{RR} &= \frac{(1+\gamma)^2}{2(2+\gamma)^2}\theta^2 - 2F.\end{aligned}$$

It is straightforward to note that an increase in competition intensity (γ) would lead to an increase in the intermediary's profit and a simultaneous decrease in supplier profits, since an increase in γ reduces the suppliers' pricing power relative to that of the intermediary. The profit for each supplier under this *RR* benchmark mode serves as a base for evaluating whether a supplier would choose the online marketplace if it was offered by the intermediary.

The technical condition for the existence of the *RR* mode and its corresponding equilibrium is that the supplier's profit under this mode is at least as large as the profit that each supplier could realize by exercising the outside option, that is, $\pi^O \le \pi_A^{RR} = \pi_B^{RR} = \frac{1+\gamma}{2(2+\gamma)^2}\theta^2$. Given that the reseller mode is adopted by a large number of suppliers selling through online intermediaries, this existence condition is assumed to hold for the remainder of this study.

4.2. Mode *PR*

In this setting, only one supplier will be offered the option of the online marketplace mode from the intermediary. Hence, one supplier adopts the online marketplace mode if accepted, while the other retains the reseller mode. Without loss of generality, we assume that the online marketplace option is accepted by Supplier *A*, and the intermediary operates as a reseller for Supplier *B*. For a given proportion α, the suppliers' and intermediary's profits are:

$$\begin{aligned}\pi_A(PR) &= (1-\alpha)p_a[\theta - p_a + \gamma(p_b - p_a)] - F,\\ \pi_B(PR) &= w_b[\theta - p_b + \gamma(p_a - p_b)],\\ \pi_I(PR) &= \alpha p_a[\theta - p_a + \gamma(p_b - p_a)]\\ &\quad + (p_b - w_b)[\theta - p_b + \gamma(p_a - p_b)] - F.\end{aligned}$$

We solve this game by backward induction as follows. For any given w_b, we first characterize the simultaneous pricing decision where Supplier *A* decides the retail price of product *a* (i.e., p_a) to maximize $\pi_A(PR)$, and the intermediary decides the retail price of product *b* (i.e., p_b) to maximize $\pi_I(PR)$. Next we determine Supplier *B*'s wholesale price w_b to maximize $\pi_B(PR)$. Finally, using this wholesale price w_b, the optimal retail prices p_a and p_b can be set. The results of this analysis are presented in the lemma below.

Lemma 2. *Given a proportion α and Supplier A accepting the offer of an online marketplace while the intermediary serves as a reseller for Supplier B, there exists a unique equilibrium with prices and demands are as follows:*

$$\begin{aligned}w_b^{PR} &= \frac{(1+\gamma)(2+3\gamma)-\alpha(1+2\gamma)\gamma}{2(1+\gamma)(2+4\gamma+\gamma^2)}\theta,\\ p_a^{PR} &= \frac{(4+9\gamma+3\gamma^2)(2+3\gamma)-\alpha(1+2\gamma)\gamma^2}{[4(1+\gamma)^2-(1+\alpha)\gamma^2](4+8\gamma+2\gamma^2)}\theta,\\ p_b^{PR} &= \frac{(3+6\gamma+2\gamma^2)(2+3\gamma)+\alpha(1+\gamma-\gamma^2)\gamma}{[4(1+\gamma)^2-(1+\alpha)\gamma^2](2+4\gamma+\gamma^2)}\theta,\\ d_a^{PR} &= \frac{(4+9\gamma+3\gamma^2)(1+\gamma)(2+3\gamma)-\alpha(1+\gamma)(1+2\gamma)\gamma^2}{[4(1+\gamma)^2-(1+\alpha)\gamma^2](4+8\gamma+2\gamma^2)}\theta,\\ d_b^{PR} &= \frac{(1+\gamma)(2+3\gamma)-\alpha(1+2\gamma)\gamma}{2[4(1+\gamma)^2-(1+\alpha)\gamma^2]}\theta,\end{aligned}$$

and the corresponding equilibrium profits are:

$$\begin{aligned}\pi_A^{PR} &= \\ &(1-\alpha)\frac{(1+\gamma)[(4+9\gamma+3\gamma^2)(2+3\gamma)-\alpha(1+2\gamma)\gamma^2]^2}{[4(1+\gamma)^2-(1+\alpha)\gamma^2]^2(4+8\gamma+2\gamma^2)^2}\theta^2 - F,\\ \pi_B^{PR} &= \frac{[(1+\gamma)(2+3\gamma)-\alpha(1+2\gamma)\gamma]^2}{2(1+\gamma)[4(1+\gamma)^2-(1+\alpha)\gamma^2](4+8\gamma+2\gamma^2)}\theta^2,\\ \pi_I^{PR} &= \alpha\frac{(1+\gamma)[(4+9\gamma+3\gamma^2)(2+3\gamma)-\alpha(1+2\gamma)\gamma^2]^2}{[4(1+\gamma)^2-(1+\alpha)\gamma^2]^2(4+8\gamma+2\gamma^2)^2}\theta^2\\ &\quad + \left[\frac{[(1+\gamma)(2+3\gamma)-\alpha(1+2\gamma)\gamma]}{2(1+\gamma)[4(1+\gamma)^2-(1+\alpha)\gamma^2]^2(4+8\gamma+2\gamma^2)}\right]\\ &\quad M\theta^2 - F,\end{aligned}$$

where:

$$\begin{aligned}M = [&(1+\gamma)(2+3\gamma)(2+4\gamma+\gamma^2)+\alpha(1+\gamma)(2+3\gamma)\gamma^2\\ &+\alpha(3+4\gamma)(2+4\gamma+\gamma^2)\gamma-\alpha^2(1+2\gamma)\gamma^3].\end{aligned}$$

For the equilibrium in Lemma 2 to exist, the following proposition characterizes the sufficient conditions under which Supplier *A* will accept the intermediary's marketplace offer and Supplier *B* will continue to participate under the reseller mode.

Proposition 1. *Supplier A will accept the intermediary's offer of an online marketplace provided $\pi_A^{PR} \ge \pi_A^{RR}$, and Supplier B will continue to participate under the reseller mode provided $\pi_B^{PR} \ge \pi^O$. This leads to the following sufficient conditions for the existence of the PR mode:*

- $F \le F^{PR}$; *where* $F^{PR} = \frac{(4+9\gamma+3\gamma^2)^2(1+\gamma)}{(2+\gamma)^2(4+8\gamma+2\gamma^2)^2}\theta^2 - \frac{1+\gamma}{2(2+\gamma)^2}\theta^2$; *and*
- $\alpha \le \alpha^{PR} = \min[\alpha_A^{PR}, \alpha_B^{PR}]$, *where* α_A^{PR} *is the unique solution of* $(1-\alpha_A^{PR})\frac{(1+\gamma)[(4+9\gamma+3\gamma^2)(2+3\gamma)-\alpha_A^{PR}(1+2\gamma)\gamma^2]^2}{[4(1+\gamma)^2-(1+\alpha_A^{PR})\gamma^2]^2(4+8\gamma+2\gamma^2)^2}\theta^2 - F = \frac{1+\gamma}{2(2+\gamma)^2}\theta^2$ *and* α_B^{PR} *is the unique solution of* $\frac{[(1+\gamma)(2+3\gamma)-\alpha_B^{PR}(1+2\gamma)\gamma]^2}{2(1+\gamma)[4(1+\gamma)^2-(1+\alpha_B^{PR})\gamma^2](4+8\gamma+2\gamma^2)}\theta^2 = \pi^O$.

Proposition 1 characterizes the conditions under which Supplier A will accept the intermediary's marketplace offer, and Supplier B will not pursue the outside option but continue to participate under the reseller mode. The first condition relates to the order-fulfillment cost, which should not exceed a certain threshold. Recall that by choosing the online marketplace service, the supplier gains pricing power but bears the order-fulfillment cost at the same time. Thus, this threshold value of the fulfillment cost reflects the trade-off between gains from the pricing power and the costs (in terms of order fulfillment) of realizing such gains.

Assuming the first condition is satisfied, the proposition then specifies a second condition related to the maximum proportion α, which can be charged to the supplier by the intermediary. Interesting insights regarding this proportion α are shown in Lemma 3.

LEMMA 3. *(i) π_I^{PR} increases in α whereas both π_A^{PR} and π_B^{PR} decrease in α; (ii) α^{PR} decreases in F.*

Lemma 3(i) indicates that an increase in α will increase the intermediary's profit π_I^{PR} and simultaneously decrease Supplier A's profit π_A^{PR}. Hence α should be small (i.e., $\alpha \le \alpha_A^{PR}$) to ensure $\pi_A^{PR} \ge \pi_A^{RR}$ so that Supplier A will accept the intermediary's marketplace offer. Meanwhile, a counterintuitive result is that an increase in α would also lead to a reduction in the profit of the other supplier (B), who has not been offered the online marketplace service. The reason for this negative spillover effect is that when α is increased, the supplier (A) tends to increase the price, as the intermediary will keep a higher proportion of the revenue. More specifically, when the intermediary raises the proportion α she can keep, Supplier A responds by charging higher retail prices. In response, the intermediary sets a higher retail price for Supplier B's product, leading to lower demand for the same product. The net result is lower profit for Supplier B. Thus α needs to be small enough ($\alpha \le \alpha_B^{PR}$) so that Supplier B will not pursue the outside option but continue to participate under the reseller mode or $\pi_B^{PR} \ge \pi^O$.[7] In equilibrium, assuming the condition related to the order-fulfillment cost is met (i.e., $F \le F^{PR}$), then the intermediary will set $\alpha = \alpha^{PR} = \min[\alpha_A^{PR}, \alpha_B^{PR}]$ since this will allow the intermediary to extract the maximum profits from the supplier. Further, Lemma 3(ii) shows that this threshold value of the proportional fee (i.e., α^{PR}) is decreasing in the order-fulfillment cost (F).

In summary, from a managerial perspective, our results indicate that the intermediary requires a strategic focus in choosing the parameters for offering the online marketplace service. This service will only be attractive to suppliers provided the order-fulfillment cost is not significantly high. If this is the case, then the intermediary should set the proportion α equal to its upper bound in order to realize the maximum profits. From a supplier perspective, the online marketplace offering is preferred over the reseller setting when the flexibility gains due to price setting outweigh the explicit costs of order fulfillment.

4.3. Mode *PP*

In this setting, both suppliers will be offered the option of online marketplace from the intermediary. If both suppliers choose the online marketplace service, they will take into consideration the proportion α which they need to share with the intermediary. For a given proportion α, the profits for each supplier and the intermediary under this mode (i.e., both suppliers choose the online marketplace service) are as follows:

$$\begin{aligned}\pi_A(PP) &= (1-\alpha)p_a[\theta - p_a + \gamma(p_b - p_a)] - F,\\ \pi_B(PP) &= (1-\alpha)p_b[\theta - p_b + \gamma(p_a - p_b)] - F,\\ \pi_I(PP) &= \alpha p_a[\theta - p_a + \gamma(p_b - p_a)]\\ &\quad + \alpha p_b[\theta - p_b + \gamma(p_a - p_b)].\end{aligned}$$

We solve this game by simultaneously determining the retail prices p_a and p_b which maximize $\pi_A(PP)$ and $\pi_B(PP)$. The results are shown in the lemma below.

LEMMA 4. *Assuming both suppliers accept the proportion α, there exists a unique equilibrium with retail prices and demands are as follows:*

$$p_a^{PP} = p_b^{PP} = \frac{1}{2+\gamma}\theta,$$
$$d_a^{PP} = d_b^{PP} = \frac{1+\gamma}{2+\gamma}\theta.$$

The corresponding equilibrium profits are given by

$$\pi_A^{PP} = \pi_B^{PP} = (1-\alpha)\frac{1+\gamma}{(2+\gamma)^2}\theta^2 - F,$$
$$\pi_I^{PP} = 2\alpha\frac{1+\gamma}{(2+\gamma)^2}\theta^2.$$

When is this mode a possible outcome? This can be framed using the decision matrix in Table 1 where we are interested in the equilibrium when both suppliers will accept the online marketplace offer. This equilibrium will arise when *both* of the following conditions hold: Given that Supplier B (A) adopts the reseller model, Supplier A's (B's) profit should be higher under the condition of acceptance than refusal of the intermediary's marketplace offer, which is $\pi_A^{PR} \ge \pi_A^{RR}$ ($\pi_B^{RP} \ge \pi_B^{RR}$); given that Supplier B (A) adopts the online marketplace, Supplier A's (B's) profit should

Table 1 Decision Matrix with Resulting Profits

	Supplier *B* option	
Supplier *A* option	Online marketplace	Reseller
Online marketplace	$\underline{\pi_A^{PP}}, \underline{\pi_B^{PP}}$	π_A^{PR}, π_B^{PR}
Reseller	π_A^{RP}, π_B^{RP}	π_A^{RR}, π_B^{RR}

Note: Due to symmetry, we know that $\pi_A^{PR} = \pi_B^{RP}$, and $\pi_B^{PR} = \pi_A^{RP}$

also be higher when it accepts rather than refuses the intermediary's marketplace offer, which is $\pi_A^{PP} \geq \pi_A^{RP}$ ($\pi_B^{PP} \geq \pi_B^{PR}$). In addition, to ensure this equilibrium is stable, both suppliers' profits under the *PP* mode should not be lower than the profit under the outside option, which is $\pi_A^{PP} \geq \pi^O$ ($\pi_B^{PP} \geq \pi^O$). Based on the results in Lemma 4, the following proposition identifies the conditions under which both suppliers will not pursue the outside option but choose the online marketplace service offering.

PROPOSITION 2. *Both suppliers will choose the online marketplace service provided* $\pi_A^{PR} \geq \pi_A^{RR}$, $\pi_A^{PP} \geq \pi_A^{RP}$, *and* $\pi_A^{PP} \geq \pi^O$. *This leads to the following sufficient conditions for the existence of the PP mode:*

- $F \leq F^{PP}$; *where* $F^{PP} = \frac{1+\gamma}{(2+\gamma)^2}\theta^2 - \frac{(1+\gamma)(2+3\gamma)}{2(2+\gamma)(4+8\gamma+2\gamma^2)}\theta^2$; *and*
- $\alpha \leq \alpha^{PP} = \min\{\alpha_A^{PR}, \alpha_A^{PP}, \alpha_B^{PP}\}$; *where* α_A^{PP} *is the unique solution of* $(1-\alpha_A^{PP})\frac{1+\gamma}{(2+\gamma)^2}\theta^2 - F = \frac{[(1+\gamma)(2+3\gamma)-\alpha_A^{PP}(1+2\gamma)\gamma]^2}{2(1+\gamma)[4(1+\gamma)^2-(1+\alpha_A^{PP})\gamma^2](4+8\gamma+2\gamma^2)}\theta^2$ *and* α_B^{PP} *is the unique solution of* $(1-\alpha_B^{PP})\frac{1+\gamma}{(2+\gamma)^2}\theta^2 - F = \pi^O$.

Similar to the hybrid mode, both suppliers will accept the intermediary's online marketplace offer when the order-fulfillment cost and the proportional fee that the intermediary charges are all below a certain threshold. It is worth noting that the threshold in order-fulfillment cost is more stringent than that stated in Proposition 1, since $F^{PP} < F^{PR}$. As before, the intermediary's profit π_I^{PP} increases in α, while both π_A^{PP} and π_B^{PP} decrease in α. In equilibrium, the intermediary is once again incentivized to set $\alpha = \alpha^{PP}$, which decreases in the order-fulfillment cost (F). We also note that suppliers' profits will decrease as the upstream competition intensifies (i.e., a higher value of γ).

In the next section, we compare the equilibrium solutions for the three modes with a view to providing managerial insights.

5. Insights

5.1. Pricing and Demand

From a pricing and demand perspective, the proposition below provides a comparison across the three channel modes.

PROPOSITION 3. *Comparing the equilibrium results of retail prices and demand, we have* (*i*) $p_a^{RR} = p_b^{RR} > p_b^{PR} > p_a^{PR} > p_a^{PP} = p_b^{PP}$; (*ii*) $d_a^{PR} > d_a^{PP} = d_b^{PP} > d_a^{RR} = d_b^{RR} > d_b^{PR}$.

Interestingly, the results of Proposition 3 are *independent* of the proportional fee rate α and hold regardless of the parameter settings for competition intensity (γ) and maximum market size (θ). Essentially, market prices are highest in the pure reseller mode since they are set by the intermediary who attempts to moderate the competition between the suppliers. On the other hand, when the suppliers set the retail prices by operating in the online marketplace mode, they compete with each other directly, leading to lower retail prices. Because of double marginalization, in mode *PR*, the retail price of the product that does not join the online marketplace is higher than the price for which the supplier who chooses to do so. Corresponding to these pricing structures, demand coverage is higher in the online marketplace mode (*PP*) as compared to the reseller mode (*RR*).

5.2. Intermediary Profits

We now proceed to examine how intermediary profitability across the three modes is affected by two key parameters: competition intensity (γ) and order-fulfillment cost (F).[8] To assess how these parameters affect profitability of all supply chain members across the three modes, we start by making the following assumptions. First, we assume that the order-fulfillment cost is small enough to ensure that both mode *PR* and *PP* are feasible. Analytically, the potential values of F under this assumption are that $F < F^{PP} (< F^{PR})$. Note that the value of F which satisfies the first assumption also leads both α^{PR} and α^{PP} to be positive. Our second and final assumption is that the intermediary chooses to set $\alpha = \alpha^{PR}$ for mode *PR* and $\alpha = \alpha^{PP}$ for mode *PP*, which represent equilibrium outcomes.

Proposition 4 structurally characterizes which mode choice would be preferred by the intermediary, as moderated by the competition intensity parameter γ.

PROPOSITION 4. *There exist competition intensity thresholds* $\gamma^* > 0$ *and* $\gamma^{**} (> \gamma^*)$ *such that:*

- *If* $\gamma < \gamma^*$, *the optimal mode is PP;*
- *If* $\gamma > \gamma^{**}$, *the optimal mode is RR; and*
- *If* $\gamma^* \leq \gamma \leq \gamma^{**}$ *mode PR can be the optimal mode.*

Proposition 4 indicates that when competition intensity is low, the optimal mode is *PP*; when competition intensity is high, the optimal mode is *RR*. In addition, we observe that when competition intensity is medium, the optimal mode is *PR*. The rationale

behind these results hinges on the *moderating* role of the intermediary. Previous literature has shown that the intermediary prefers high levels of upstream competition, as it strengthens its channel power (Wang and Shin 2015). From a mode perspective, suppliers compete more fiercely in the online marketplace mode compared with the reseller mode as they set the prices directly and alternative modes allow the intermediary to moderate this competitive effect. To elaborate, when both suppliers are very competitive, the intermediary would prefer to operate as a reseller, since any other mode will lead to increased price competition which in turn negatively impacts the intermediary. This result validates the conjecture of Hagiu (2007) that strong substitutability between suppliers' products would lead to a greater preference for the pure reseller mode. When the competition intensity between suppliers is low, the intermediary's moderating role is not as important. Note that in mode *PP* the proportional fee could be considered a form of revenue sharing, which would mitigate the impact of double-marginalization (Geng et al. 2018, Shy and Wang 2011, Tan and Carrillo 2017). Hence, the intermediary prefers mode *PP* when competition intensity is low. When the competition intensity between suppliers is in the intermediate range, the intermediary's moderating role is important but not significant enough to alleviate double-marginalization effects, leading to a preference for the hybrid mode *PR*.

Anecdotal observations provide face validity for our results. For the household appliance market in China, the similarity between branded products leads to strong substitutability (or high competition intensity). Hence, most online retailers (e.g., JD.com) prefer to act as resellers for products in this category. On the other hand, the media content industry (publishing, video games) is characterized by low levels of product substitutability (or low competition intensity). This has motivated online retailers to set the terms for the online marketplace mode in such a way that suppliers have chosen that mode of operation. Etsy.com, the largest e-commerce website in handmade or vintage items, serves as a pure online marketplace because of low product substitutability. Further, Amazon serves as the reseller in certain high competitive product categories, such as electronics, but serves as a marketplace for other less competitive product categories, such as fine art (i.e., long-tail product category).

Next, we consider the impact of the order-fulfillment cost on the choice of equilibrium mode for the intermediary. Note that Proposition 4 shows that when the market competition intensity is above a certain threshold, the intermediary will always prefer to act as a reseller. To investigate the impact of the order-fulfillment cost, next we focus on the case that the market competition intensity is not too high. The proposition below characterizes the mode preferred by the intermediary depending on the magnitude of the order-fulfillment cost.

PROPOSITION 5. *When the market competition intensity is relatively small (i.e., $\gamma < \gamma^*|_{F=0}$), there exists two thresholds $F^* > 0$ and $F^{**}(\geq F^*)$ such that:*

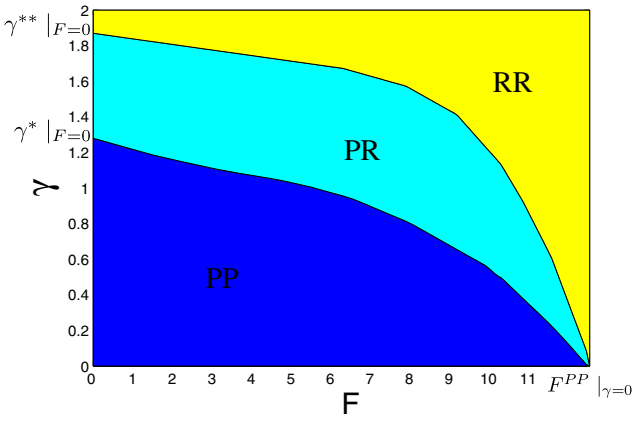
- *when $F \leq F^*$, the preferred mode is PP; and*
- *when $F^* < F \leq F^{**}$, the preferred mode is PR; and*
- *when $F > F^{**}$, the preferred mode is RR.*

Proposition 5 shows that the magnitude of the order-fulfillment cost will alter the mode choices. When the market competition intensity is relatively low ($\gamma < \gamma^*|_{F=0}$), as the order-fulfillment cost increases, the equilibrium mode will evolve from a pure marketplace mode to a hybrid mode then to a pure reseller mode. The intuition of this result lies in the fact that the higher the order-fulfillment cost becomes, the more difficult it becomes for the intermediary to convince the suppliers to adopt the marketplace mode and endure the order-fulfillment cost. Recall that both α^{PR} and α^{PP} decrease in F. That is, as the order-fulfillment cost increases, the intermediary has to set a much lower proportional fee to ensure that the suppliers will accept the marketplace offer. This becomes increasingly expensive as the order-fulfillment cost increases. As a result, the intermediary prefers the marketplace mode for both suppliers when the order-fulfillment cost is low and favors the reseller mode when the order-fulfillment cost is significant.

From a practical perspective, we observe that most hotel and airline companies use the *PP* mode on travel sites such as Expedia, Travelocity, Ctrip, and Qunar (Ctrip and Qunar are leading travel sites in China). This is partially driven by the low (almost negligible) order-fulfillment cost for electronic tickets/bookings. In the publishing industry, a transition to the *PP* mode from the *RR* mode is evident for e-books while the *RR* mode is still preferred for print books. This could be due in part to the fact that order-fulfillment costs are greater for printed books as compared to e-books.

Having analytically examined the impacts of the competition intensity and order-fulfillment cost individually, we next numerically illustrate how the interactions between these two parameters affect the mode choice for the intermediary. Figure 2 was generated by setting $\theta = 10$ (i.e., the market potential equals to 10) and $\pi^O = 0$ (i.e., the outside option facing the supplier is 0). Then we simultaneously vary F ($F \in (0, F^{PP}|_{\gamma=0})$, where $F^{PP}|_{\gamma=0} = 12.5$) and γ ($\gamma \in (0, 2)$). Note that our results are robust to the parameter changes.

Figure 2 Preferred Mode: Interaction of F and γ ($\theta = 10$, $\pi^O = 0$) [Color figure can be viewed at wileyonlinelibrary.com]



From Figure 2, we first observe that for any given order-fulfillment cost, increasing levels of competition intensity (i.e., γ) results in a transition from mode *PP* to mode *PR* and then to mode *RR* as intermediary's preferred mode choice. Second, when the market competition intensity is relatively low (i.e., $\gamma \leq \gamma^*|_{F=0}$), as the order-fulfillment cost increases, the equilibrium mode will evolve from mode *PP* to mode *PR* and then mode *RR*. Third, when the market competition intensity is in a medium range (i.e., $\gamma^*|_{F=0} < \gamma < \gamma^{**}|_{F=0}$), the preferred transition is between modes *PR* and *RR* as the order-fulfillment cost increases. In addition, when the market competition intensity is relatively high (i.e., $\gamma \geq \gamma^{**}|_{F=0}$), then the reseller mode *RR* will dominate as the preferred mode choice. The intuition behind these results hinges on the trade-off between the transfer of control rights for product pricing and the responsibility for order fulfillment. The results here provide executable managerial insights to the online platforms. Specifically, if competition intensity is low and the order-fulfillment cost is not too high, then the intermediary should specify a relatively low proportional fee α to induce suppliers to switch to mode *PP*. As both competition intensity and order-fulfillment costs increase, the intermediary should increase the proportional fee α to motivate some supplier switching. Finally, when both competition intensity and order-fulfillment cost are high, then the proportional fee α should be set to a large value to discourage the suppliers from switching to the online marketplace mode.

5.3. Supplier Profitability

It is straightforward to show that if the intermediary sets the referral proportion α such that $\alpha \geq \frac{1}{2}$, then for both suppliers, mode *RR* always optimizes their own profitability. It is only when $\alpha < \frac{1}{2}$ that supplier choices are moderated by the order-fulfillment cost F, the referral proportion α, and the level of competition intensity γ.

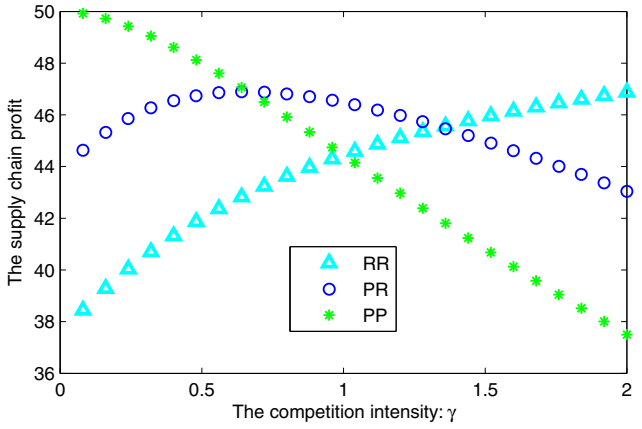
More specifically, assume that the supplier terms are such that $F \leq F^{PP}$ and $\alpha = \alpha^{PP}$ so that mode *PP* is now a feasible alternative. In this case, the choice of both suppliers to move to the online marketplace mode *PP* from the reseller mode *RR* is dependent upon the level of competition intensity such that: (a) under low levels of competition intensity, both suppliers' profits are larger under mode *RR*, and (b) under high levels of competition intensity, the reverse is true. These results indicate that regardless of the terms offered by the intermediary through the referral proportion α, the exogenous market parameter γ will affect whether suppliers are better or worse off under mode *PP* or mode *RR*. Hence, from a managerial perspective, it is relevant to not only evaluate the intermediary's terms for the online marketplace mode but also to examine the intensity of competition within a product category.

Assume that $F \leq F^{PR}$ and $\alpha = \alpha^{PR}$ so that mode *PR* is a feasible alternative. The supplier choosing the online marketplace service would realize higher profits under mode *PR* as compared to mode *RR*, while we *observe* that the supplier operating under the reseller mode (i.e., the supplier who is not offered the option of online marketplace by the intermediary) would realize lower profits in mode *PR* as compared to mode *RR*. Without the alleviation of the double-marginalization effect, Supplier *A* (who chooses the online marketplace mode) will decrease the retail price of its product to attract consumers, which leads to a reduction in the total demand for the other supplier (i.e., *B*). Although Supplier *B* attempts to alleviate this demand reduction with a relative price decrease to enhance profitability, the net impact does not result in a larger profit for this supplier as compared to when both suppliers operate as resellers (i.e., mode *RR*). Managerially, this reflects a "first mover" advantage for suppliers. As soon as the intermediary offers a reduction in the referral proportion α and sets $\alpha = \alpha^{PR}$, the first supplier to choose to switch to the online marketplace service would be the one who reaps the gains from this mode of operation. Note that the competition intensity parameter γ does not moderate this finding.

5.4. Supply Chain Profits

Our next focus is on total supply chain profits (i.e., the sum of both the suppliers' profits and the intermediary's profit) across the three modes. The fulfillment cost parameter is irrelevant in terms of this comparison and hence we set $F = 0$. Figure 3 illustrates the total supply chain profits as a function of the competition intensity parameter γ (the maximum market size $\theta = 10$ and the outside option profit $\pi^O = 0$). When

Figure 3 The Supply Chain Profit under Different Modes ($\theta = 10$, $\pi^O = 0$, $F = 0$) [Color figure can be viewed at wileyonlinelibrary.com]



competition intensity is low, total supply chain profits are at a maximum under mode *PP*; at the other extreme, when competition intensity is high, total supply chain profits are at a maximum under mode *RR*. It is only when competition intensity is the middle range that mode *PR* leads to maximum supply chain profits. The driver of these results is the trade-off between the alleviation of the double-marginalization effect and price competition.

5.5. Anecdotal Evidence

Since fulfillment costs (F) are related to inventory, storage, and transportation, it is reasonable to assume that "larger" products (in terms of weight and/or size) would lead to higher fulfillment costs. Given our results that higher fulfillment costs would lead to a stronger preference for the reseller mode (*RR*), we provide limited anecdotal evidence that these results hold in practice.

JD.com is one of the largest B2C online retailers in the world with annual sales around $23 billion. We focus our attention on a few product categories (e.g., cleaning products, household appliances, food, and digital products) sold on JD.com during March 2015. For each product category, the percentage of suppliers operating in a reseller mode (*RR*) is shown in Table 2. This Table shows that for each individual product, as product size/weight increases, the percentage of the reseller mode being adopted increases. Given that fulfillment costs would be higher for products with higher weight and/or larger size, this data provides validity to our results on the impact of order-fulfillment cost.

It is also interesting to note that there are significant differences in the percentage of suppliers who choose the reseller mode (*RR*) within and across product categories. For example, comparing the food/oil category to the household appliance category, we see that

Table 2 The Percentage of the Reseller Mode Used on JD.COM

Household appliance				
Electric kettle	*1.1 L and below*	*1.2–1.5*	*1.5 above*	
–	**17.7%**	**42.6%**	**48.1%**	
Multi-role pot	*2–4 L*	*4–6*	*6 above*	
–	**13.5%**	**22.6%**	**47.1%**	
Water heater	*60 L and below*	*60–79*	*80 and above*	
–	**10.4%**	**25.0%**	**31.3%**	
Egg boilers	*5 below*	*5–10*	*10 above*	
–	**19.0%**	**28.4%**	**35.3%**	
Yogurt maker	*500 ml*	*800–1000*	*1200 and above*	
–	**11.8%**	**14.5%**	**56.3%**	
Cleaning products				
Cloth cleaning	*0–1 kg*	*1–3*	*3 above*	
–	**29.2%**	**32.4%**	**41.2%**	
Home cleaning	*500 ml below*	*500–1000*	*1000 above*	
–	**3.5%**	**4.3%**	**6.9%**	
Skin care	*100 ml below*	*100–199*	*200–399*	*400 and above*
–	**4.4%**	**4.3%**	**6.7%**	**7.8%**
Food				
Rice grains	*1 kg and below*	*1–5*	*5 above*	
–	**5.8%**	**9.9%**	**12.7%**	
Digital products				
Student tablet	*8 inch below*	*8–10*	*10 above*	
–	**13.6%**	**41.8%**	**44.8%**	
Laptop computer	*13 inch below*	*13–15*	*15 above*	
–	**2.7%**	**10.5%**	**12.8%**	

Source: Data collected from JD.com during March 2015.

a significantly larger percentage of suppliers choose the reseller mode in the latter category as compared to the former. One explanation for this is that consumers might consider products within the household appliances category as being more homogeneous compared to products within the food/oil category. Since this would imply higher competition intensity for products in the household appliances category as compared to products in the food/oil category, it is preferable for suppliers to choose the reseller mode in the latter category and the online marketplace mode in the former category.

Finally, there are also differences for individual products within a product category. As product size and/or weight increases for both student tablets and laptop computers, a greater percentage of suppliers choose to operate under the reseller mode. These percentages are significantly different across the individual products. As we explored earlier, these differences could stem from differences in product differentiation (or competition intensity) for individual products within a product category; that is, lower fulfillment costs coupled with lower product differentiation (or higher competition intensity) leads to a higher percentage of suppliers choosing the reseller mode for student tablets as compared to lower fulfillment costs

coupled with higher product differentiation (or lower competition intensity) for laptop computers.

5.6. Variable vs. Fixed Order-Fulfillment Cost

Since customers are often responsible for delivery costs in online shopping, we normalize the variable cost of the order fulfillment to zero and focus on the fixed cost in our base model. It could be argued that variable order-fulfillment costs are proportional to market demand and hence, instead of fixed fulfillment costs, we should incorporate them into our analysis. When we do so, the results do not lead to any changes in our key insights. The primary reason for this is that variable order-fulfillment costs not only influence pricing decisions but also affect proportional fees in the equilibrium. Thus, they affect the results in a similar qualitative manner as fixed order-fulfillment costs. In particular, a higher (lower) variable order-fulfillment cost results in higher (lower) market prices. With a higher market price the supplier is less likely to accept the intermediary's marketplace offer with the same proportional fee rate, making the pure reseller mode more likely to emerge as an equilibrium choice. Since the focus of our study is on the strategic interactions between the online intermediary and the suppliers in mode choice, rather than on pricing strategy, a positive variable order-fulfillment cost only leads to more analytical complexity without yielding additional insights into our research questions. This is the rationale for choosing to incorporate fixed rather than variable fulfillment costs in our model.

5.7. Asymmetric Order-Fulfillment Costs or Market Potentials

Our analysis so far has assumed symmetric suppliers in terms of order fulfillments costs and market potentials. For the case of asymmetries in these parameters, we find that our key results and qualitative insights still hold. There are some interesting new insights that emerge from this investigation which are both related to the hybrid mode *PR* (details are provided in the Online Appendix).

First, the intermediary should offer the online marketplace option to the supplier with the lower relative order-fulfillment cost. This result is driven by the fact that the sufficient condition stated in Proposition 1 for the order-fulfillment cost is easier to achieve when the online marketplace offer is made to the supplier with the lower cost. Second, if the two suppliers have different market potentials, it is always optimal for the intermediary to provide and convince the supplier with higher market potential to accept the online marketplace offer. The proportional fee is a form of revenue sharing and hence, can mitigate double-marginalization effects (Geng et al. 2018, Tan and Carrillo 2017). A higher market potential induces a larger loss due to double-marginalization, and thus, by offering the online marketplace option to the supplier with a higher market potential, this loss can be reduced. This finding is consistent with industry practice. For example, Walmart Marketplace is invitation-only. They claim that "We are looking for relationships with reputable retailers and brands that provide first-class customer service, a compelling product assortment, competitive pricing and fast, reliable fulfillment."[9]

6. Conclusions and Discussions

A relatively new mode of operation for online intermediaries is the "online marketplace." Under this mode, the online intermediary offers an option to suppliers: The intermediary can act as a reseller of the suppliers' products, or let the suppliers to operate as independent suppliers on the intermediary platform; that is, the intermediary simply acts as an "online marketplace." In this study, we have provided insights into the key aspects that moderate the decision of an intermediary to operate as a reseller, operate as an online marketplace, or adopt a hybrid mode of operation.

Previous research has indicated that the online marketplace is always the preferred option for supply chain members, since it reduces the double marginalization impact and thus increases profits for all members. We show that this is not necessarily the case. Instead, we note that the degree of competition intensity and magnitude of order-fulfillment cost moderate the preference regions within which distinct modes are preferred by the online intermediary. For given fulfillment costs: (a) high levels of competition intensity lead to the intermediary preferring the reseller mode, (b) moderate levels of competition intensity lead to a preference for the hybrid mode, and (c) at low levels of competition intensity, the preferred mode is the online marketplace. The key intuition behind this finding is the moderating role of the intermediary. Similarly, for a given level of competition intensity, we show that: (a) when order-fulfillment costs are low, the marketplace mode is the preferred choice, (b) moderate levels of order-fulfillment costs lead to the choice of the hybrid mode, and (c) the reseller mode is preferred when order-fulfillment costs are high.

We also find that a non-trivial interaction effect between the degree of competition intensity and the magnitude of fulfillment costs affects optimal mode choice for the intermediary. For example, the threshold order-fulfillment costs for the intermediary to switch from a marketplace to a hybrid mode or from a hybrid to a reseller mode decreases as competition intensity increases. Similarly, the threshold level of

competition intensity for the intermediary to switch from a marketplace to a hybrid mode or from a hybrid to a reseller mode decreases as fulfillment costs increase. Through data collected from one online intermediary, we also provide some face validity for our findings. Finally, these key insights hold regardless of whether the order fulfillments costs are fixed (as our analysis assumes) or are variable and demand dependent.

From a practical perspective, online retailers should consider providing the online marketplace option for product categories in which the competition among different suppliers is not intense, while adopting the traditional reseller mode for highly competitive products. An alternative is to discriminate between sellers across different product categories by using distinct revenue sharing proportions. For highly competitive product categories, the online intermediary can demand a higher proportional fee while charging a lower fee for the sellers in the long-tail product categories. Also, if the related order-fulfillment cost is very high, even when the competition is not intense, the online intermediary can still leverage the reseller mode to improve profitability.

We conclude the paper by pointing out a few caveats about our model and some directions for future research. First, we have assumed that the supplier's profit stemming from the outside option is not very high. If a supplier's profit under the outside option is very high, the supplier will choose to leave the intermediary and pursue the outside option. Consequently, the original operating modes will no longer exist and we will have a monopoly case. Existing literature (Hao and Fan 2014, Tan and Carrillo 2017) have studied the monopoly case and showed that the marketplace mode always dominates the reseller mode due to the revenue sharing structure in the marketplace mode. The focus of our paper is to illustrate how upstream competition and order-fulfillment cost can alter the existing results and provide unique managerial insights into the online intermediary managers. For this reason, the monopoly case is not as pertinent as the competitive case. In summary, to focus on the more relevant and realistic competitive case, we assume that the outside option is not the preferred choice for the suppliers.

Second, in practice, many major suppliers and brand owners introduce their own direct-sale websites in addition to selling through popular online retailing platforms. In such situations, the supplier's decision within its separate online store will interact with the selling mode (i.e., reseller or marketplace) and also the price in the online retailing platform. That is, there will be cross-channel effects. How will the two channels interact with each other? How will their interactions influence the suppliers' and the intermediary's preferences on selling modes and the corresponding pricing decisions? Ryan et al. (2012) and Abhishek et al. (2016) have provided some insights, but further studies are required. We leave it for future research to explicitly examine the effect of cross-channel effects on the mode choice for online intermediaries. Additionally, note that there are also a few large-scale suppliers/brand owners who do not sell through online retailing platforms. For example, Apple sells computers and accessories on Amazon, but it does not sell iPhones on Amazon. We find some anecdotal evidence regarding why certain companies (e.g., Apple) choose not to sell on the third-party online marketplaces.[10] Essentially it is due to competition, as Amazon itself also provides many competing products at the same time. Although our model cannot directly explain this rationale, we think this is also a promising research question for future scholars.

Third, our analysis and expositions have focused on the emerging online marketplace. In reality, there exists offline store-within-store models. The most typical and representative example is the consignment store, where the seller displays products in the store and shares the revenue with the product owners. Though our research resonates with such settings, there are some subtle but important differences with online marketplaces. To begin with, typically it is the consignment shop, not the product owner, who sets prices. Second, unlike the online marketplace, consignment shops typically sell second-hand and vintage products. Third, the revenue sharing contract is difficult to implement in the offline setting as pointed out by Cachon and Lariviere (2005). The marketplace idea is applicable to an offline setting, but it is not as popular as the online marketplace. Finally, a consignment store's reach is limited by consumer proximity. All these reasons might explain why consignment stores do not proliferate in practice.

Extensions of our work that may be of interest would be to capture other factors, such as complementary markets, asymmetric information and economies of scale of order-fulfillment cost, in addition to competition intensity and order-fulfillment cost. Another possible avenue would be to investigate the optimal mode choice not only in the case of supplier competition, but also integrating downstream competition where buyers might be in direct competition with one another. Finally, although we have confirmed that our findings are consistent with practical observations, our research poses some testable empirical questions. Our hope is that, as this body of literature expands in scope, many other related research issues will be investigated with a view to furthering our understanding of the efficacy of online marketplaces.

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Notes

[1]http://www.businesswire. com/news/home/20160614006063/en/Products-Amazon-Carry-Categories (accessed date May 10, 2016).

[2]Note that our linear demand functions can be derived from the maximization problem of a representative consumer with a quadratic and strictly concave utility function which is defined in Singh and Vives (1984): $U(d_a, d_b) = \theta d_a + \theta d_b - \frac{(\phi d_a^2 + 2\psi d_a d_b + \phi d_b^2)^2}{2}$, where $\phi = \frac{1+\gamma}{1+2\gamma}$, $\psi = \frac{\gamma}{1+2\gamma}$, and d_i is the amount of product i. In specific, the representative consumer maximizes $U(d_a, d_b) - p_a d_a - p_b d_b$, where p_i is the price of product i. Please refer to Singh and Vives (1984) for detailed clarifications and analysis.

[3]It is trivial to show that these demand functions satisfy the regularity properties for product substitutes. The ratio of price elasticity of demand for a supplier's own product offering is greater than the price elasticity of demand for the substitute product offering since $1 + \gamma > \gamma$. Note γ has an alternative interpretation, which is product differentiation. If consumers perceive that products are highly differentiated (i.e., low competition intensity), then the value of γ is low and vice versa.

[4]In our extension, we have illustrated that the impact of a variable cost for order fulfillment is very similar to the impact of a fixed order-fulfillment cost. When the marginal order-fulfillment cost is relatively small or moderate, our main results remain the same; when the marginal order-fulfillment cost becomes much higher, the results become similar to the case in which there is a very large fixed order-fulfillment cost.

[5]For mode *RR* (i.e., the intermediary choosing to act as a reseller for both suppliers), our entire analysis is based on assuming that there are no economies of scale in order fulfillment costs realized by the intermediary. If such economies do exist then these can be integrated by assuming total fulfillment costs under mode *RR* equal βF with $(1 \le \beta < 2)$. Since order fulfillment costs have no impact on the equilibrium wholesale and market prices (and hence, realized demands) for both suppliers, then the only impact would be on the corresponding optimal profits of the intermediary under mode *RR* which would increase by $(2 - \beta)F$. Hence, integrating economies of scale in order fulfillment costs would not change our insights substantively except that there would be changes in the preference regions for the three strategy choices with the preference regions for mode *RR* increasing and the preference regions for *PR* and *PP* would decline.

[6]Note that we have implicitly assumed that the two suppliers are symmetric for both order-fulfillment cost (e.g., F_S) and the market potential(e.g., θ). The analysis and results of asymmetric cases are discussed in section 5.7.

[7]Although one may argue that the condition $\pi_B^{PR} \ge \pi^O$ seems restrictive, it not only reflects real-world practice (i.e., for certain products, some suppliers choose to operate under the reseller mode while others choose the online marketplace option) but also market conditions. By selling through an intermediary, suppliers can ensure access to a larger customer base, and at the same time, offer their customers the benefit of an integrated shopping experience, using the intermediary platform. Thus, in a competitive setting, a supplier could choose to operate under the reseller mode even though its competitor chooses an alternative mode.

[8]The reason to focus on the intermediary's profit rather than suppliers' profits is that the intermediary can directly control the channel mode by structuring the terms of the online marketplace service. Suppliers, on the other hand, are assumed to make rational choices based on these terms and hence, play a passive role in the process.

[9]https://marketplace.walmart.com/FAQ (accessed date May 10, 2017).

[10]https://www.cnet.com/news/why-doesnt-amazon-sell-iphones (accessed date October 10, 2017).

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1: Proofs of Lemmas and Propositions.
Appendix S2: Analysis for Asymmetric Cases.