INFORMATION SHARING WHEN COMPETING MANUFACTURERS ADOPT ASYMMETRIC CHANNEL IN AN E-TAILER

GUOQIANG SHI
School of Economics and Business Administration
Chongqing University, Chongqing, China
School of Economics and Management
Chongqing University of Arts and Sciences, Chongqing, China

YONG WANG*, DEJIAN XIA AND YANFEI ZHAO
School of Economics and Business Administration
Chongqing University, Chongqing, China

(Communicated by Bertrand M.T. Lin)

Abstract. This paper investigates the incentive for information sharing when competing manufacturers sell substitute products through the marketplace channel and the reseller channel respectively. Our analysis shows that the e-tailer’s incentive to share information strongly depends on the platform fee, competition intensity, and different information sharing scenarios. If competition intensity is small, or competition intensity is large and the platform fee is enough large, the e-tailer has incentive to alone share information with the manufacturer who is from the marketplace channel; if competition intensity is moderate and the platform fee is small, or competition intensity is large but the platform fee is moderate, it has incentive to share information with both manufacturers; if competition intensity is large but the platform fee is small, it has no incentive to share information. The results also indicate that the double marginalization effect of information sharing is a promoting factor to share information under linear cost, which is different from previous literature. Additionally, we find that the main qualitative insights from the base model are robust even if one monopolist manufacturer employs both channels. And we also compare the incentive of information sharing under asymmetric channel with that under symmetric channel.

1. Introduction. With the increasing prevalence of online retailing, e-tailers can gather a growing volume of market data by various tools, such as “Web Forums”, “Product Tagging”, and “Similarity Web”, and so on [1]. Therefore, compared with upstream manufacturers, the e-tailers can collect more datum about market demand. Because firms usually have access to standard technology (e.g., through a third party data service provider) for converting data into information, for the purpose of this study, sharing data is equivalent to sharing information [21]. In

2020 Mathematics Subject Classification. Primary: 90B06, 91B44; Secondary: 90B50.
Key words and phrases. Supply chain management, information sharing, the marketplace channel, electronic commerce, game theory.
This work was supported by the National Natural Science Foundation of China (grant number 71672015).
*Corresponding author: Yong Wang.
addition, the benefits of information sharing are well documented [10, 15]. However, the incentive for e-tailers to share information are enough important for online retailing supply chain to ignore.

In online retailing industry, competing manufacturers who produce substitutable products are increasingly selling products through a common e-tailer [27]. In an e-tailer, such as JD.com and Amazon.com, competing manufacturers may adopt the reseller channel or the marketplace channel, which yields three alternative channel structures: both adopt the reseller channel (pure reseller channel); both employ the marketplace channel (pure marketplace channel); one uses the reseller channel, and its competitor uses the marketplace channel (asymmetric channel) [24, 30]. In particular, different from the traditional reseller channel, under the marketplace channel, manufacturers sell their products directly to online consumers by paying platform usage fee to the e-tailer [23].

Under the symmetric channel, i.e., pure reseller and marketplace channels, the incentive of information sharing is obvious. Under the pure marketplace channel, manufacturers compete with each other directly, and the e-tailer’s profit (the platform usage fee) is a proportion of manufacturers’ revenue. We can infer that the e-tailer generally prefers to share information but manufacturers’ competition may become a major obstacle. Because of the cooperation, i.e., manufacturers pay platform usage fee to the e-tailer, the e-tailer prefers to share information. However, compared with the case in which only one manufacturer is informed, sharing information with both manufacturers increases the correlation between the two manufacturers’ strategies, thereby further increasing competition and, in turn, reducing the platform usage fee. Under the pure reseller channel, competing manufacturers wholesale products to the e-tailer who then sells them to online consumers. There is no essence difference between online sales and offline sales. The previous researches, such as [6, 7], indicate that the double marginalization effect of information sharing is major obstacle to share information. Although competition exists, it is not the obstacle since the e-tailer prefers a high level of competition [24].

The asymmetric channel differs from the symmetric channel, which makes the incentive tangled. Therefore, firms need to rethink the incentive of information sharing. Under the asymmetric channel, the e-tailer purchases products from the manufacturer in the reseller channel. And then the e-tailer, and another manufacturer who is from the marketplace channel compete with each other in the end market. In addition, the manufacturer from the marketplace channel needs to pay a fraction of its revenue to the e-tailer as the platform usage fee. Therefore, the e-tailer faces not only the double marginalization effect of information sharing in the reseller channel, but also competition and cooperation in the marketplace channel. The incentive of information sharing seems to be of lack relatively. Is there only the case in which the manufacturer from the marketplace channel may acquire the information? However, the situation may be changed from a systematic point of view. In detail, although the double marginalization effect of information sharing hurts the reseller channel, it may benefit the marketplace channel. Moreover, when the profit in the reseller channel is sacrificed, the competition and cooperation from the marketplace channel cannot be ignored. Therefore, firms consider not only the double marginalization effect of information sharing, but also competition and cooperation. The combined effects will make the incentive complicated.
Based on the above-mentioned considerations, this paper intends to address the following research questions: firstly, how the incentive of information sharing depends on the platform fee, competition intensity and different information sharing scenarios? Secondly, what are the equilibrium information sharing decisions? How do the equilibrium decisions depend on the platform fee and competition intensity? Finally, how does the incentive-driven information sharing affect the profits of individual parties?

To capture the aforementioned issues, we consider a supply chain, in which one upstream manufacturer wholesales products to an e-tailer, and then the e-tailer sells them to online consumers, while another manufacturer directly sells partially substitutable products to online consumers through the marketplace channel by paying platform usage fee required by the e-tailer. Additionally, the e-tailer is endowed with private demand information. We use multistage game to study those problems. In the beginning, before the e-tailer observes the private demand signal, the manufacturers decide payments to buy information from the e-tailer and the e-tailer decides whether to accept the offer. Next, the e-tailer observes private demand signal and shares it with manufacturers if there is such an agreement. Then, the upstream manufacturer in the reseller channel determines a wholesale price. Finally, another manufacturer in the marketplace channel and the e-tailer set retail quantities, respectively. By a game-theoretic approach, we solve the above research problems.

The main contributions of this work are in the following three aspects. Firstly, different from the literature on incentive-based information sharing, we add two new elements in our investigation of information sharing: the platform fee and asymmetric channel. Secondly, we characterize the conditions under which the e-tailer has incentive to share information with none, one or both of manufacturers. In particular, the results show that the e-tailer has incentive to vertically share information under linear cost and no encroachment. Thirdly, under some conditions, the double marginalization effect of information sharing is no longer an obstacle but a promotor for information sharing, which is different from previous literature.

The remainder of this paper is structured as follows. Section 2 provides a brief review of related research. Section 3 presents the basic model in detail. Section 4 examines incentives for the e-tailer’s information sharing and gets the equilibrium information sharing decisions. Section 5 offers an extension and a comparison. Section 6 concludes.

2. Literature review. Our paper belongs to the literature on incentive-based information sharing. For example, Li and Zhang [18] examine the effect of different confidentiality level on information sharing, and find that all parties may have incentives to engage in information sharing; Ha et al. [7] study competing supply chains with production technologies that exhibit diseconomies of scale, and show that information sharing can benefit the supply chain due to the order uncertain effect when the production diseconomy is large; Shang et al. [21] also examine the effect of nonlinear cost on information sharing in a supply chain with two competing manufacturers selling substitute products through a common retailer, and they show that the incentive to share information depends on nonlinear production cost, competition intensity; considering a model of a retailer and a make-to-stock manufacturer, Li and Zhang [19] find that the retailer will be willing to share the imperfect demand information with the make-to-stock manufacturer if the magnitude
of demand uncertainty is intermediate; Zhang and Chen [32] study how different coordination mechanisms affect the information sharing in a supply chain, and show that the decisions of information sharing depend on the coordination mechanism and some parameters. Wang et al. [26] study information sharing when the incumbent retailer is endowed with a dominant position, and show that information sharing has opposite effects on different members; Jiang and Hao [14] consider four representative two-tier supply chains, and the results indicate that the supplier will acquire signals because of the differential payment offered to downstream firms or sufficiently correlated signals; Ha et al. [6] consider competing supply chains with production cost reduction, and show that information sharing can benefit the supply chain if the manufacturer is efficient in cost reduction; Huang et al. [9] point out that the retailer may voluntarily share the demand information in anticipation of supplier encroachment; Zhang and Zhang [35] consider an e-tailer’s information sharing incentives in the presence of both agency selling and reselling, and find that under agency selling or reselling, the e-tailer can strategically share or withhold the demand information to deter the supplier from offline entry; Sun et al. [22] study the interaction of quantity-based cost decline and supplier encroachment in a supply chain in which a supplier with encroachment capability and quantity-based cost decline sells through a retailer with demand information advantage, and obtain their impacts on the supply chain members; Wei et al. [28] investigate incentive of retailer information sharing on manufacturer volume flexibility choice, and obtain the equilibrium strategies regarding retailer’s information sharing and manufacturer’s volume flexibility choice; Zhang et al. [33] consider manufacturer encroachment with both endogenous quality decision and asymmetric demand information, and study the effects of encroachment and information structure on quality and profits for chain members; Zhang et al. [34] consider a dual-channel supply chain with asymmetric information, and get the conditions under which the manufacturer prefers to give up its wholesale pricing power, to avoid information leakage.

This paper is also related to the literature on horizontal information sharing. Clarke [2], Vives [25] and Gal-Or [5] mainly posits that firms will disclose private demand information under Bertrand competition, whereas none will do so under Cournot competition.

Different from the aforementioned literature in which scholars add different factors in the study of information sharing, (e.g., confidentiality, nonlinear cost, the correlation coefficient on successive demand, production mode, the presence of a dominant retailer, endogenous channel structure, collusion, signal correlation, cost reduction, encroachment and so on), this paper adds two new elements in our investigation of vertical information sharing: the platform fee and asymmetric channel. Specially, our work is also very different from Zhang and Zhang [35]. Our paper considers a supply chain consisting of two competing manufacturers selling substitute products through the reseller channel and the marketplace channel respectively, and shows that the platform fee in the marketplace channel and the double marginalization effect of information sharing can reduce the loss of information sharing value caused by fierce competition, which enables vertical information sharing to occur. Zhang and Zhang [35] consider a supply chain consisting of a supplier and an e-tailer. The supplier sells products through the marketplace channel or the reseller channel, and the e-tailer faces a threat of encroachment from the supplier who may build a direct channel. They compare the impacts of the threat on information sharing in the marketplace channel with that in the reseller channel, and find that
in the marketplace (reseller) channel, the e-tailer can strategically withhold (share) the demand information to deter the supplier from encroachment.

3. Model. Consider a supply chain with two competing manufacturers (indexed by 1 or 2) selling substitute products through an e-tailer. In detail, manufacturer 1 wholesales products to the e-tailer, and then the e-tailer sells them to online consumers (the reseller channel), while manufacturer 2 directly sells products to online consumers through a marketplace channel by paying platform usage fee required by the e-tailer (the marketplace channel). Consistent with practice, we assume that the platform usage fee is a proportion of the manufacturer’s revenue and the platform fee rate $\beta \in (0, 1)$ is an exogenous variable (e.g., JD.com, Amazon.com, and Taobao). The aforementioned assumptions are widely employed in studies on e-tailer, such as [23, 27, 29, 35]. For simplicity, we call the platform fee rate the platform fee in this paper. Figure 1 illustrates the supply chain structure.

![Figure 1. Supply chain structure. Note: The dashed line indicates that the retailing quantity in the marketplace channel is decided by manufacturer 2](image)

The e-tailer and manufacturer 2 are engaged in a Cournot competition. According to the literature on supplier encroachment (e.g. [9, 20]), the inverse demand functions in the reseller and marketplace channels are given as follows:

$$p_1 = M - q_1 - \gamma q_2 \quad \text{and} \quad p_2 = M - q_2 - \gamma q_1,$$

where subscripts 1 and 2 denote the reseller and marketplace channels, respectively, and $M$ represents the online market potential. In the given channel demand functions, $p_i$ and $q_i$ pertain to the market price and quantity of channel $i (i = 1, 2)$, respectively, and $\gamma \in (0, 1)$ is a measure of competition intensity.

The e-tailer is endowed with private information about an uncertain online demand [12, 35]. Although manufacturers can conduct market surveys and attain demand information from direct selling products, as mentioned in “Introduction”, the e-tailer has further access to obtain additional demand information.

To capture the uncertain demand, we follow [6, 17, 31] and replace $M$ with $\alpha + \theta$. Thus, the inverse demand functions are derived as follows:

$$p_1 = \alpha + \theta - q_1 - \gamma q_2 \quad \text{and} \quad p_2 = \alpha + \theta - q_2 - \gamma q_1,$$
where $\alpha$ is a constant, and the random variable $\theta$ with zero mean and variance $\sigma^2$ implies the demand uncertainty. The e-tailer observes a private signal $Y$ about $\theta$. According to the assumption of Li [16], we define $t = \frac{1}{E[\text{var}(Y|\theta)]}$ as the signal accuracy. The joint probability distribution of $(\theta, Y)$, which is common knowledge, satisfies the following conditions: (1) $Y$ is an unbiased estimator of $\theta$, i.e. $E[Y|\theta] = \theta$, and (2) the expectation of $\theta$ conditional on signal $Y$ is a linear function of the signal, i.e. $E[\theta|Y] = \frac{t\sigma^2}{1+t\sigma^2}Y$. On the basis of the given assumptions on information structure, we obtain $E \left[ (E[\theta|Y])^2 \right] = \frac{t\sigma^4}{1+t\sigma^2}$. Let $\delta = E \left[ (E[\theta|Y])^2 \right]$ for simplicity.

We assume that the decisions of the e-tailer to share or not to share information is made ex ante rather than ex post, that is, before obtaining the demand signal, and that information is shared truthfully.

Similar to [9, 10, 17], we normalise the two manufacturers’ production cost to zero without loss of generality. We have computed that with the assumption of zero selling cost of the e-tailer and manufacturer 2 still do not change the results even when the e-tailer is more (less) efficient in retail operations than manufacturer 2. This is consistent with [9, 35]. Because production cost and selling cost cannot affect the value of information sharing, we have these assumptions.

A multistage game is considered with the following sequence of events:

1. The manufacturers decide a payment to buy information from the e-tailer. The e-tailer decides whether to accept this payment and, if it does, to truthfully share information with manufacturers. After the e-tailer observes private demand signal, it will be disclosed with manufacturers if there is such an agreement.

2. Manufacturer 1 sets the wholesale price.

3. The e-tailer and manufacturer 2 set the sales volume simultaneously.

We assume that the information sharing is truthful. The assumption is in line with the existing literature, such as [6, 7, 9, 21]. In our model, the demand signal can be interpreted as the information about the potential demand, which is derived from the historical data collected by the e-tailer [21]. Compared with managers’ personal opinions, the information, i.e., the data, can be truthfully shared via data exchange platforms (e.g., EDI and Internet) [13]. Additionally, in order to attract manufacturers to participate in its online platform, the e-tailer cares about its reputation. Therefore, we study the truthful sharing of information. One example supporting truth-telling is that Joyoung (a household appliance company in China), obtains the demand information from Alibaba (an e-tailer in China), and thus its performance is raised\(^1\). Another example is that Amazon uses information technology to share the real-time data with its key suppliers, which delivers significant performance improvements [4].

In our model, we assume that the wholesale price in the reseller channel is not observable to the marketplace channel. We also assume that the e-tailer and manufacturer 2 set order quantities simultaneously so that neither of them can infer information by observing its competitor’s order quantity. As pointed out by [3], this is what we would expect in practice because, after the price or quantity commitments somehow becomes known to the rival channel, channel members may have incentive to secretly renegotiate and they cannot make credible commitment.

\(^1\)https://new.qq.com/omn/20201104/20201104A09E9M00.html.
not to do so. The assumption is in line with numerous studies on the incentive of information sharing, such as [6, 7, 14].

4. Game analysis. We will solve the game backward by first solving for the equilibrium wholesale prices and retail quantities. On the basis of the results, we compute the ex-ante payoffs of the firms for different information sharing scenarios. The ex-ante payoffs will then be used to solve for the equilibrium information sharing decisions in the first stage.

Subscripts \(e, m1\) and \(m2\) denote the e-tailer, manufacturer 1 and manufacturer 2, respectively. Let \(x_j\) be the information status of \(j\) \((j = m1 \text{ or } m2)\), where \(x_j = I\) if \(j\) is informed and \(x_j = N\) otherwise. Let \(V\) denote the payoffs of the supply chain. The Appendix presents the details of the process.

4.1. Equilibrium analysis under different information-sharing scenarios. Manufacturer 1, as an upstream supplier, sells products to the e-tailer, and the e-tailer sells these products to online consumers (the reseller channel). Manufacturer 2 does not sell products to the e-tailer but pays a platform usage fee and directly sells its products to online consumers through the e-tailer’s marketplace (the marketplace channel). Therefore, the e-tailer’s profit can be decomposed into two components: the first comes from the reseller channel, in which it procures products from manufacturer 1 and sells them to online consumers; the second is from the marketplace channel, in which it charges the platform usage fee from manufacturer 2.

The information statuses of manufacturers 1 and 2 \((x_{m1}, x_{m2})\) are \((N, N)\), \((I, I)\), \((N, I)\) and \((I, N)\), which indicate that both manufacturers are uninformed, both are informed, manufacturer 1 is uninformed but manufacturer 2 is informed and manufacturer 1 is informed but manufacturer 2 is uninformed, respectively. Therefore, we will consider four information-sharing scenarios in this supply chain.

In the third stage, the e-tailer and manufacturer 2 are engaged in quantity competition. Given the wholesale price \(w\) of manufacturer 1, the e-tailer selects \(q_1\) to maximize the profit function as follows:

\[
q_1 (\alpha + E [\theta | Y] - q_1 - \gamma E [q_2 | Y] - w) + E [q_2 | Y] (\alpha + E [\theta | Y] - E [q_2 | Y] - \gamma q_1) \beta, \tag{1}
\]

Simultaneously, manufacturer 2 selects \(q_2\) to maximize the profit function

\[
q_2 (\alpha + E [\theta | Y] - q_2 - \gamma E [q_1 | Y]) (1 - \beta), \tag{2}
\]

when manufacturer 2 is informed or manufacturer 2 chooses \(q_2\) to maximize

\[
q_2 (\alpha + E [\theta] - q_2 - \gamma E [q_1]) (1 - \beta), \tag{3}
\]

when manufacturer 2 is uninformed.

In the second stage, uninformed manufacturer 1 sets the wholesale price \(w\) in anticipation of the quantity decisions of the e-tailer and manufacturer 2 to maximize

\[
E [q_1] w. \tag{4}
\]

As an alternative, informed manufacturer 1 sets the wholesale price \(w\) to maximize

\[
E [q_1 | Y] w. \tag{5}
\]

Table 1 groups the equilibrium outcomes and corresponding expected ex-ante profits of the e-tailer and manufacturers across scenarios.
Information sharing with only manufacturer 1 will enable it to extract more profit by adjusting his wholesale price to respond positively\(^2\) to the demand information. This makes the wholesale price stronger\(^3\), which benefits the manufacturer but hurts the e-tailer and the supply chain. This is called the double marginalization effect of information sharing [18]. Therefore, the payoffs of the supply chain are larger under \((N, N)\) than under \((I, N)\), and we will not focus on the scenario \((I, I)\).

From Table 1, comparing the retailing quantity under \((N, I)\) with that under \((N, N)\), we have Lemma 4.1.

**Lemma 4.1.** Compared with no information sharing, information sharing with only manufacturer 2 makes the e-tailer’s retail quantity \(q_1\) less responsive to \(Y\), but it makes manufacturer 2’s retail quantity \(q_2\) more responsive to \(Y\). It makes the demand for the e-tailer less variable but the demand for manufacturer 2 more variable.

Since the e-tailer is endowed with the private demand information, \(q_1\) is responsive to \(Y\). When manufacturer 2 is informed, \(q_2\) is also responsive to \(Y\). Because manufacturer 2 and the e-tailer are engaged in quantity competition and retail quantities are strategic substitutes, a responsive \(q_2\) makes the responsiveness of \(q_1\) decreased. A less responsive \(q_1\) in turn further makes \(q_2\) more responsive. A more

\(^2\)Positive response means that the manufacturer raises his wholesale price when the information shows that demand is more likely to be high and lowers his wholesale price when it is more likely to be low.

\(^3\)It is stronger on average. For more details, see [21].
responsive $q_2$ makes the demand intercept facing the e-tailer, $\alpha + \theta - \gamma q_2$, less variable. And a less responsive $q_1$ makes the demand intercept facing manufacturer 2, $\alpha + \theta - \gamma q_1$, more variable.

Then, comparing the retailing quantity under $(I, I)$ with that under $(N, N)$, we have Lemma 4.2.

**Lemma 4.2.** Compared with no information sharing, information sharing with both manufacturers makes the e-tailer’s retail quantity $q_1$ less responsive to $Y$, but it makes manufacturer 2’s retail quantity $q_2$ more responsive to $Y$. It makes the demand for the e-tailer less variable but the demand for manufacturer 2 more variable.

Firstly, according to Lemma 4.1, information sharing with only manufacturer 2 makes the e-tailer’s retail quantity $q_1$ less responsive to $Y$. Secondly, when manufacturer 1 is informed, vertical information sharing brings about the double marginalization effect of information sharing. The double marginalization effect of information sharing brings about the wholesale price stronger, which also makes the e-tailer’s retail quantity $q_1$ less responsive to $Y$. Because manufacturer 2 and the e-tailer are engaged in quantity competition and retail quantities are strategic substitutes, a less responsive $q_1$ makes $q_2$ more responsive. The greater responsiveness of $q_2$ to $Y$ in turn further reduces the responsiveness of $q_1$ to $Y$. A more responsive $q_2$ makes the demand intercept facing the e-tailer, $\alpha + \theta - \gamma q_2$, less variable. And a less responsive $q_1$ makes the demand intercept facing manufacturer 2, $\alpha + \theta - \gamma q_1$, more variable.

In addition, comparing the retailing quantity under $(N, I)$ with that under $(I, I)$, we have Lemma 4.3.

**Lemma 4.3.** When manufacturer 2 is informed, information sharing with manufacturer 1 makes the e-tailer’s retail quantity $q_1$ less responsive to $Y$, but it makes manufacturer 2’s retail quantity $q_2$ more responsive to $Y$. It makes the demand for the e-tailer less variable but the demand for manufacturer 2 more variable.

Similar to Lemma 4.2, the double marginalization effect of information sharing also makes the e-tailer’s retail quantity $q_1$ less responsive to $Y$ when manufacturer 2 is informed. Due to strategic substitutes, a less responsive $q_1$ makes $q_2$ more responsive. The greater responsiveness of $q_2$ to $Y$ in turn further reduces the responsiveness of $q_1$ to $Y$. Therefore, it makes the demand for the e-tailer less variable but the demand for manufacturer 2 more variable.

**Lemma 4.4.** Under the scenarios $(N, I)$ and $(I, I)$, as the platform fee $\beta$ becomes more larger, the e-tailer’s retail quantity $q_1$ is less responsive to $Y$. However, manufacturer 2’s retail quantity $q_2$ is more responsive to $Y$. The demand for the e-tailer is less variable but the demand for manufacturer 2 is more variable.

Recall that the e-tailer’s profit can be decomposed into two components, i.e., the first from reselling products to consumers, and the second from the platform usage fee. As the platform fee $\beta$ becomes more larger, the e-tailer can get more platform usage fee which is a proportion of manufacturer 2’s revenue. Therefore, with a larger platform fee, the e-tailer is willing to restrain its signal utilization to be less flexible in ordering from manufacturer 1, which will make manufacturer 2’s retail quantity $q_2$ more responsive to $Y$. A more responsive $q_2$ makes $q_1$ less responsive. Similar to the above analysis, the demand for the e-tailer is less variable but the demand for manufacturer 2 is more variable.
Lemma 4.5. Under the scenarios \((N, I)\) and \((I, I)\), when competition intensity \(\gamma\) becomes more larger, the e-tailer’s retail quantity \(q_1\) is always less responsive to \(Y\). And, manufacturer 2’s retail quantity \(q_2\) is also less responsive to \(Y\) when \(\beta \in \left(0, \frac{(2-\gamma)^2}{(4-\gamma)\gamma}\right)\), but the opposite is true when \(\beta \in \left(\frac{(2-\gamma)^2}{(4-\gamma)\gamma}, 1\right)\). The demand for the e-tailer is always less variable. And the demand for manufacturer 2 is less variable when \(\beta \in \left(0, \frac{(2-\gamma)^2}{(4-\gamma)\gamma}\right)\), but more variable when \(\beta \in \left(\frac{(2-\gamma)^2}{(4-\gamma)\gamma}, 1\right)\).

As competition intensity increases, the variance of the retailing quantity of both e-tailer and manufacturer 2 will decrease. The reason is because retail quantities are strategic substitutes, and fierce competition brings about the reduction. Interestingly, when \(\beta \in \left(\frac{(2-\gamma)^2}{(4-\gamma)\gamma}, 1\right)\), the demand for manufacturer 2 is more variable as competition intensity becomes larger. When the platform fee is very large, the e-tailer can charge enough platform usage fee from manufacturer 2. In order to avoid the reduction caused by fierce competition, as competition intensity increases, it will restrain its signal utilization to be less flexible in ordering from manufacturer 1, which makes manufacturer 2’s retail quantity \(q_2\) more responsive to \(Y\). And the demand for manufacturer 2 is more variable.

4.2. Effects of information sharing. We first look at how information sharing in a channel impacts the other channel. In the reseller channel, the e-tailer purchases products from manufacturer 1, and then sells them to online consumers, while manufacturer 2 directly sells products to online consumers by paying platform usage fee required by the e-tailer in the marketplace channel. The e-tailer’s revenue comes from reselling products (the first part) and the platform usage fee (the second part).

Proposition 1. When manufacturer 1 is informed, information sharing with manufacturer 2 will hurt manufacturer 1 and the e-tailer’s first part; but when manufacturer 2 is informed, information sharing with manufacturer 1 will benefit manufacturer 2 and the e-tailer’s second part.

According to \([6, 7]\), greater demand variability generates more revenue. By Lemma 4.1, information sharing with manufacturer 2 makes the demand for the e-tailer less variable, which hurts the e-tailer’s first part. It implies that the e-tailer’s order from manufacturer 1 will be less variable. So, the informed manufacturer 1 is hurt. By Lemma 4.3, when manufacturer 2 is informed, information sharing with manufacturer 1 makes the demand for manufacturer 2 more variable. Therefore, manufacturer 2 benefits from information sharing. Because the e-tailer’s platform usage fee is a proportion of manufacturer 2’s revenue, it also benefits the second part.

Next, we demonstrate how information sharing impacts the payoffs of the e-tailer.

Proposition 2. Compared with no information sharing, information sharing with only manufacturer 2 will make the e-tailer better off when \(\beta \in \left(\frac{(2-\gamma)^2}{(4-\gamma)\gamma}, 1\right)\) and \(\gamma \in (0, 1)\), otherwise, the opposite is true.

Figure 2 illustrates the results in Proposition 2. It implies that the e-tailer voluntarily shares information with only manufacturer 2 when platform fee \(\beta\) is large but competition intensity \(\gamma\) is small, and vice versa. Recall that greater demand variability generates more revenue and the e-tailer acquires revenue from two parts. By Lemma 4.1, we can conclude that information sharing with only manufacturer
Figure 2. The impacts of information sharing with only manufacturer 2 on the e-tailer

2 brings hurt to the first part, but gain to the second part (because of the increased profit of manufacturer 2). Because fierce competition reduces the variability of sales volume of both e-tailer and manufacturer 2 (Lemma 4.5), the information sharing value of both them decreases. In other words, fierce competition results in the loss not only to the first part but also to the second part. Therefore, the gain cannot compensate the hurt. However, the e-tailer can restrain the variability of retailing quantity $q_1$ to raise the variability of retailing quantity $q_2$, which reduce the loss of information sharing value. The phenomenon becomes strong with competition intensity $\gamma$ when the platform fee is very large (Lemma 4.5), and always becomes strong with platform fee $\beta$ (Lemma 4.4). Therefore, the more the platform fee is, the less the loss from fierce competition is. We call it “platform fee effect”. In addition, the e-tailer can get more platform usage fee as the platform fee becomes larger. In summary, the gain will dominate the hurt when platform fee $\beta$ is large but competition intensity $\gamma$ is small, and the e-tailer is willing to share information with manufacturer 2 under this condition.

Proposition 3. Regardless of whether manufacturer 2 is informed, information sharing with manufacturer 1 hurts the e-tailer.

When manufacturer 2 is uninformed, information sharing with manufacturer 1 has no effect on manufacturer 2. It hurts the e-tailer due to the double marginalization effect of information sharing. When manufacturer 2 is informed, on the one hand, information sharing with manufacturer 1 benefits the second part of the e-tailer due to the increased profit of manufacturer 2; on the other hand, it hurts the first part because of the double marginalization effect of information sharing. Because the latter dominates the former, the e-tailer is hurt.

Now, we look at how information sharing impacts the payoffs of the supply chain under different scenarios. Because information sharing with only manufacturer 1 hurts the supply chain due to the double marginalization effect of information sharing, we just need to consider the three scenarios $(N, N)$, $(N, I)$ and $(I, I)$. First, we compare $(N, I)$ with $(N, N)$. 
Proposition 4. Compared with no information sharing, information sharing with only manufacturer 2 benefits the supply chain when $\gamma \in (0, 2\sqrt{2} - 2) \cap \beta \in (0, 1)$ or $\gamma \in (2\sqrt{2} - 2, 1) \cap \beta \in \left(\frac{\gamma^4 + 4\gamma - 4}{(2 - \gamma)^2}, 1\right)$. Otherwise, vice versa.

The results are illustrated in Figure 3(a). The results indicate that information sharing with only manufacturer 2 makes the supply chain better off if competition intensity is small or competition intensity is large and the platform fee is enough large. As manufacturer 1 is uninformed, information sharing with only manufacturer 2 does not affect manufacturer 1. We just need to explore the impacts of information sharing on both manufacturer 2 and the e-tailer. Information sharing with only manufacturer 2 brings about hurt to the e-tailer’s first part, but gain to manufacturer 2 and the e-tailer’s second part (Lemma 4.1). When competition intensity is small, the gain can compensate the hurt regardless of the level of the platform fee. As competition intensity becomes strong, the information sharing value of both e-tailer and manufacturer 2 will decrease, that is to say, fierce competition results in the loss of information sharing value. Therefore, with increased competition, the hurt increases and the gain decreases, and then the hurt will overcome the gain. However, due to the “platform fee effect”, the gain still compensates the hurt when competition intensity is large and the platform fee is enough large. Therefore, the gain dominates the hurt under such conditions.

Then, we compare $(I, I)$ with $(N, N)$. Proposition 5 summaries the results.

Proposition 5. Compared with no information sharing, information sharing with both manufacturer 1 and manufacturer 2 benefits the supply chain when $\gamma \in \left(0, \frac{2\sqrt{19} - 4}{5}\right) \cap \beta \in (0, 1)$ or $\gamma \in \left(2\sqrt{19} - 4, 1\right) \cap \beta \in \left(\frac{2\gamma^2 + 28\gamma - 5\gamma^2 - 24}{(4 - 8\gamma + 5\gamma^2)\gamma}, 1\right)$. Otherwise, vice versa.

The results are illustrated in Figure 3(b). The results imply that information sharing with both manufacturers benefits the supply chain when competition intensity is small, or competition intensity is large and the platform fee is enough large. Information sharing with both manufacturers brings about hurt to the e-tailer’s first part (Lemma 4.2), but gain to the sum of profits for manufacturer 1, manufacturer 2 and the e-tailer’s second part because both manufacturers get information. When competition intensity is small, or competition intensity is large and the platform fee is enough large, the gain always dominates the hurt. There are two main reasons. The first reason is the “platform fee effect”. The second reason is that information sharing with manufacturer 1 in the reseller channel brings about the double marginalization effect of information sharing, which can also partly avoid the loss of information sharing value caused by fierce competition. In detail, because the double marginalization effect of information sharing makes the wholesale price stronger, which restrains the variability of retailing quantity $q_1$, the variability of retailing quantity $q_2$ becomes raised (Lemmas 4.2 and 4.3). We call it “vertical information sharing effect”, since vertical information sharing in the reseller channel brings about the double marginalization effect of information sharing.

In addition, we compare $(N, I)$ with $(I, I)$. We have Proposition 6.

Proposition 6. Compared with the case in which only manufacturer 2 is informed, information sharing with both manufacturers makes the supply chain better off when $\gamma \in (4 - 2\sqrt{3}, 1)$ and $\beta \in \left(0, \frac{\gamma^2 + 20\gamma - 10\gamma^2 - 8}{(12 - 8\gamma - 5\gamma^2)\gamma}\right)$. Otherwise, vice versa.
The results are illustrated in Figure 3(c). The results demonstrate that when manufacturer 2 is informed, information sharing with manufacturer 1 makes the supply chain better off if competition intensity is large but the platform fee is small. Under \((N,I)\) and \((I,I)\), the “platform fee effect” always works when competition intensity is large and the platform fee is enough large. But the “platform fee effect” becomes weak when competition intensity is large but the platform fee is small. However, except the “platform fee effect”, there is a “vertical information sharing effect” under \((I,I)\). Therefore, the “vertical information sharing effect” still works when competition intensity is large but the platform fee is small. Based on the above reasons, the payoffs of the supply chain under \((I,I)\) are larger than that under \((N,I)\) when competition intensity is large but the platform fee is small.

![Figure 3](image_url)

**Figure 3.** The impacts of information sharing on the supply chain payoffs. (a) Comparing \((N,I)\) with \((N,N)\); (b) Comparing \((I,I)\) with \((N,N)\); (c) Comparing \((I,I)\) with \((N,I)\)
4.3. Equilibrium information sharing decisions. In the first stage, the e-tailer voluntarily discloses information with manufacturers if information sharing benefits the e-tailer. If information sharing makes the e-tailer worse off, one natural arrangement is for manufacturers to pay the e-tailer for the information because of the benefits of information sharing [17]. Intuitively, the e-tailer will trade information only if the total supply chain profit increases with such information sharing [7]. If the increased profit of the supply chain is more under the first scenario than under the second scenario, it implies that manufacturers can pay the e-tailer more under the first scenario. And the e-tailer will choose the scenario in which it can get more payoffs. Therefore, we can compare the increased value of the supply chain under different scenarios, and then get the equilibrium information sharing decisions. Because information sharing with manufacturer 1 will hurt the supply chain due to the double marginalization effect of information sharing, the payoffs of the supply chain are larger under \((N,N)\) than under \((I,N)\). We just need to compare the three scenarios \((N,N)\), \((N,I)\) and \((I,I)\). \(m_{m1}\) and \(m_{m2}\) represent the payment offered by manufacturer 1 and manufacturer 2, respectively.

**Proposition 7.** The equilibrium information sharing decisions are as follows:

1. when \(\gamma \in (0, 4 - 2\sqrt{3})\) and \(\beta \in (0, 1)\), or \(\gamma \in (4 - 2\sqrt{3}, 1)\) and \(\beta \in \left(\frac{\gamma^3 + 20\gamma - 10\gamma^2 - 8}{(12 - 8\gamma - 7\gamma^2)^2}, 1\right)\), \((N,I)\) is the unique equilibrium;

2. when \(\gamma \in \left(4 - 2\sqrt{3}, \frac{2\sqrt{15} - 4}{5}\right)\) and \(\beta \in \left(0, \frac{\gamma^3 + 20\gamma - 10\gamma^2 - 8}{(12 - 8\gamma - 7\gamma^2)^2}\right)\) or \(\gamma \in \left(\frac{2\sqrt{15} - 4}{5}, 1\right)\) and \(\beta \in \left(\frac{2\gamma^2 + 28\gamma - 5\gamma^3 - 24}{(4 - 8\gamma + 5\gamma^2)^2}, \frac{\gamma^3 + 20\gamma - 10\gamma^2 - 8}{(12 - 8\gamma - 7\gamma^2)^2}\right)\), \((I,I)\) is the unique equilibrium;

3. when \(\gamma \in \left(\frac{2\sqrt{15} - 4}{5}, 1\right)\) and \(\beta \in \left(0, \frac{2\gamma^2 + 28\gamma - 5\gamma^3 - 24}{(4 - 8\gamma + 5\gamma^2)^2}\right)\), \((N,N)\) is the unique equilibrium.

![Figure 4. Equilibrium information sharing decisions. Note: The solid lines indicate the thresholds of Equilibrium information sharing decisions. The dashed line in \((N,I)\) area represents the threshold in which \(\pi_{e}^{NN} = \pi_{e}^{NI}\) and the dashed line in \((I,I)\) area represents the threshold in which \(V_{NI} = V_{NN}\).](image)
Figure 4 illustrates the results in Proposition 7. The results demonstrate that the e-tailer has incentives for information sharing under both $(N,I)$ and $(I,I)$ areas. Next, we explain it in detail.

In the $(N,I)$ area, only manufacturer 2 can obtain the information. If manufacturer 2 is informed, it can adjust the retail quantity in response to the demand signal to take advantage of demand fluctuation, which increases its profit, in turn, benefiting the second part (the profit which the e-tailer makes by charging the platform usage fee from manufacturer 2). But the e-tailer competes with manufacturer 2 in the end market. Sharing information with manufacturer 2 will result in a higher correlation between the e-tailer’s strategies and manufacturer 2’s strategies, which further intensifies competition. Therefore, the increased correlation will hurt both the e-tailer and manufacturer 2. In other words, not only the first part (the profit which the e-tailer makes by reselling manufacturer 1’s products), but also the second part and manufacturer 2 are hurt. At a whole, the second part and the profit of manufacturer 2 are increased, but the first is decreased. When the platform fee is enough large (above the dashed line in $(N,I)$ area), the increase of the second part overcomes the decrease of the first part. There are two reasons. On the one hand, the second part will be raised as the platform fee becomes stronger. On the other hand, as the platform fee becomes large, the e-tailer prefers to make profit by charging the platform usage fee. Therefore, it is willing to restrain its signal utilization to be less flexible in ordering from manufacturer 1, which will make manufacturer 2’s retail quantity more responsive to the information. The voluntary restriction reduces the correlation between the e-tailer’s strategies and manufacturer 2’s strategies. Therefore, above the dashed line in $(N,I)$ area, the e-tailer voluntarily shares information with manufacturer 2. Under the dashed line in $(N,I)$ area, regardless of competition intensity, the platform fee is relatively small. As a result, the efficiency of the two reasons decreases. Therefore, the decrease of the first part dominates the increase of the second part. However, the increase of manufacturer 2’s profit and the first part can overcomes the decrease of the first part. That is to say, the second reason still works. Therefore, manufacturer 2 can acquire the information by payment, and the minimum payment is $m_{m1} = \pi_e^{NN} - \pi_e^{NI} = \theta^2(\gamma-2)\left[(\beta+1)^2\gamma^2+(2-2\beta)^2\gamma^2-(8+4\beta)\gamma+8\beta\right] \frac{4(4-\beta^2)(\beta-4)\gamma^2-4\beta(1+\beta)\gamma^3-(36-28\beta^2+4\beta)\gamma^2+16(1+\beta)(\gamma-64\beta)}{16(4-\beta)(\beta-4)\gamma^2} \delta$.

In $(I,I)$ area, information sharing with both manufacturers makes the supply chain better off than other scenarios. Compared with the $(N,I)$ area, the platform fee is smaller and thus, it can only slightly reduce the correlation between the e-tailer’s strategies and manufacturer 2’s strategies. However, when manufacturer 1 is also informed, the double marginalization effect of information sharing occurs. Although the effect hurts the supply chain, it can compel the e-tailer to reduce the information utilization, and then increase the information utilization of manufacturer 2. The compulsion also reduces the correlation between the e-tailer’s strategies and manufacturer 2’s strategies. Therefore, in the $(I,I)$ area, sharing information with both manufacturers makes the supply chain better off than any other scenarios. The two manufacturers can jointly pay the e-tailer for the information. The minimum payments of both manufacturers are $m_{m1} + m_{m2} = \pi_e^{NN} - \pi_e^{II} = \theta^2 \left[8(1+\beta)(3\beta-4)\gamma^4-4(1+\beta)(36-28\beta^2+4\beta)\gamma^2+16(1+\beta)(\gamma-64\beta)\right] \frac{4(4-\beta^2)(\beta-4)\gamma^2-4\beta(1+\beta)\gamma^3-(36-28\beta^2+4\beta)\gamma^2+16(1+\beta)(\gamma-64\beta)}{16(4-\beta)(\beta-4)\gamma^2} \delta$. Because we focus on the incentive for information sharing, we don’t provide the payment quantity of each manufacturer. It depends on the bargaining power.

In the $(N,N)$ area, the competition between the e-tailer and manufacturer 2 becomes very fierce because competition intensity is very large. In addition, the
e-tailer’s voluntary restriction is dramatically weak since the platform fee is small. Even if the double marginalization effect of information sharing still exists, the hurt caused by fierce competition cannot be compensated. Therefore, the e-tailer has no incentive to share information.

5. Extension and discussion. In this section, we check the robustness when one manufacturer sells products through the reseller and marketplace channels simultaneously. In addition, we compare the incentive of information sharing under asymmetric channel with that under symmetric channel.

5.1. The robustness when one manufacturer adopts asymmetric channel. Except the case of the base model, one manufacturer may sell products through the reseller and marketplace channels simultaneously. For example, publishers simultaneously sell printed books and e-books through the reseller and marketplace channels, respectively [8, 23]. Many manufacturers, such as Adidas, simultaneously sell products through the reseller and marketplace channels in JD.com. Therefore, we consider another case in which a monopolist manufacturer simultaneously sells products through the reseller and marketplace channels in the e-tailer. We find that our main results keep robust.

Similar to the base model, subscripts 1 and 2 denote the reseller and marketplace channels, respectively. Subscripts $e$ and $m$ denote the e-tailer and manufacturer, respectively. The information status of manufacturer $x_m$ can only be $N$ or $I$, which indicates that the e-tailer conceals or gives information, respectively.

In the third stage, the e-tailer and the manufacturer are engaged in quantity competition in the end market. If the manufacturer is informed given the wholesale price $w$ of the manufacturer, then the e-tailer chooses $q_1$ to maximize

$$q_1 (\alpha + E[\theta|Y] - q_1 - \gamma E[q_2|Y] - w) + E[q_2|Y] (\alpha + E[\theta|Y] - E[q_2|Y] - \gamma q_1) \beta.$$  

(6)

Simultaneously, the informed manufacturer chooses $q_2$ to maximize

$$wE[q_1|Y] + q_2 (\alpha + E[\theta|Y] - q_2 - \gamma E[q_1|Y]) (1 - \beta).$$  

(7)

If the manufacturer is uninformed, then the e-tailer chooses $q_1$ to maximize the profit function (6). Simultaneously, the uninformed manufacturer chooses $q_2$ to maximize

$$wE[q_1] + q_2 (\alpha + E[\theta] - q_2 - \gamma E[q_1]) (1 - \beta).$$  

(8)

In the second stage and in anticipation of the abovementioned quantity decisions, the manufacturer sets the optimal wholesale price. If the e-tailer shares information with the manufacturer, then the informed manufacturer sets wholesale price $w$ to maximize the profit function (7). If the e-tailer conceals information from the manufacturer, then the uninformed manufacturer sets wholesale price $w$ to maximize the profit function (8).

In the first stage, we solve for the equilibrium information sharing decisions. Comparing the ex-ante payoffs under the two scenarios, we can get the following results. The Appendix presents the details of the process.

**Proposition 8.** When one manufacturer sells products through the reseller and marketplace channels respectively, information sharing always improves the payoffs of the supply chain. If $\beta \in (\beta^{\Delta}, 1)$ and $\gamma \in (0, 1)$, the e-tailer voluntarily shares
information with the manufacturer; if $\beta \in (0, \beta^\Delta)$ and $\gamma \in (0, 1)$, the manufacturer can induce the e-tailer to share the information with it by payment$^4$.

![Figure 5](image)

**Figure 5.** Information sharing in a monopolist model. (a) Information sharing voluntarily; (b) Equilibrium information sharing decisions

Figure 5 illustrates the results in Proposition 8. It shows the robustness of our results under such a monopolist case. In order to present the robustness vividly, we make the following definition. If the manufacturer adopts the information to set the retailing quantity $q_2$, we say that information is shared in the marketplace channel and, we call it the scenario $(N, I)$. If the manufacturer adopts the information to set the wholesale price $w$, we say that information is shared in the reseller channel and, we call it the scenario $(I, N)$. If the manufacturer adopts the information to set both the wholesale price $w$ and the retailing quantity $q_2$, we say that information is shared in the two channels and, we call it the scenario $(I, I)$. Due to the double marginalization effect of information sharing, the scenario $(I, N)$ always makes the supply chain worse off. In addition, because information sharing always improves the payoffs of the supply chain, we just need to consider the two scenarios $(N, I)$ and $(I, I)$. We can get the ex-ante payoffs of the supply chain under the scenarios $(N, I)$ and $(I, I)$. Comparing the two ex-ante payoffs, the scenario $(I, I)$ makes the supply chain better off when $\gamma \in (0.728, 1)$ and $\beta \in \left(0, \frac{16 - 16\gamma + \gamma^4 + 2\gamma^3 - 2\sqrt{\gamma^8 - 5\gamma^7 + 19\gamma^6 - 26\gamma^5 - 36\gamma^4 + 112\gamma^3 - 32\gamma^2 - 96\gamma + 64}}{(4 + \gamma^2 - 4\gamma)^3} \right)$ (similar to Proposition 6). The result shows that information sharing in both channels makes the supply chain better off when competition intensity is large but the platform fee is small; information sharing in only the marketplace channel makes the supply chain better off when competition intensity is small or competition intensity is large and

---

$^4$In Proposition 8, as the threshold $(5\beta^2 + \beta^3 - \beta - 9) \gamma^4 + 8\beta^3 \gamma^3 + (64 - 16\beta^2 - 36\beta) \gamma^2 - 32\gamma + 64\beta - 48 = 0$ is a complex implicit function, we use $\beta^\Delta$ instead of the threshold. The details of the process are in the Appendix.
the platform fee is enough large. In addition, Proposition 8 indicates that the e-tailer is willing to share information with the manufacturer when \( \beta \in (\beta^a, 1) \) and \( \gamma \in (0, 1) \). Therefore, we can demonstrate the equilibrium results in Figure 5(b). Above the dashed line in the \((N, I)\) area, the e-tailer is willing to share information with the manufacturer and, under the dashed line in this area, information sharing with payment happens in the marketplace channel. In \((I, I)\) area, information sharing with payment happens in both channels. Figure 5(b) proves that our results of the base model are robust.

5.2. **Comparison between asymmetric channel and symmetric channel.** In the base model, we investigate the incentive of information sharing when competing manufacturers adopt asymmetric channel. However, competing manufacturers in an e-tailer may also adopt symmetric channel. There are two cases: the pure reseller channel, and the pure marketplace channel. In this section, we firstly present the results under symmetric channel. And then, we compare the results under asymmetric channel with that under symmetric channel, and show why the results obtained under the asymmetric channel cannot be extended to the case of symmetric channel. The Appendix provides the details of the process.

When both manufacturers adopt the reseller channel in an e-tailer (pure reseller channel), they sell substitute products to the e-tailer at wholesale prices \( w_1 \) and \( w_2 \), respectively, and then the e-tailer sets the retailing quantity \( q_1 \) and \( q_2 \). The information statuses of manufacturers 1 and 2 \((x_{m1}, x_{m2})\) are \((N, N)\), \((I, I)\), \((N, I)\) and \((I, N)\). Because of symmetric channel, we just need to consider one of \((N, I)\) and \((I, N)\). Without loss of generality, we only consider the scenario \((N, I)\). Therefore, there are three scenarios: \((N, N)\), \((I, I)\) and \((N, I)\). Similar with the base model, we can obtain the results: \( \pi_{NN} > \pi_{NI} > \pi_{II} \); \( V_{NN} > V_{II} \) and \( V_{NN} > V_{NI} \); \( V_{NI} > V_{II} \) if \( \gamma \in (0, 2\sqrt{2} - 2) \), otherwise, the opposite is true. The results imply that the e-tailer is not willing to share information with any manufacturer, and no information sharing makes the supply chain better off than other scenarios.

When competing manufacturers use the marketplace channel in an e-tailer (pure marketplace channel), they determine the retailing quantity \( q_1 \) and \( q_2 \), respectively. And they need to pay the platform usage fee to the e-tailer. In this case, we also just need to consider the three scenarios: \((N, N)\), \((I, I)\) and \((N, I)\). Proposition 9 summarizes the results regarding information sharing.

**Proposition 9.** When competing manufacturers sell products by adopting the marketplace channel in an e-tailer: if \( \gamma \in (0, 2\sqrt{2} - 2) \), the e-tailer will voluntarily share information with both manufacturers, and this information-sharing scenario makes the supply chain better off than others; if \( \gamma \in (2\sqrt{2} - 2, 1) \), the e-tailer will voluntarily share information with any one manufacturer, and this information-sharing scenario makes the supply chain better off than others.

Next, we focus on the comparison. Firstly, under the pure marketplace channel, the e-tailer is willing to share information with both manufacturers if competition intensity is small. However, when competition intensity becomes large, the e-tailer will voluntarily share information with any one of the manufacturers. Similarly, if competition intensity is small, sharing information with both manufacturers makes the supply chain better off than other scenarios; if competition intensity is large,
sharing information with any one manufacturer makes the supply chain better off. Under the pure marketplace channel, the two manufacturers compete with each other directly, and the e-tailer’s profit (the platform usage fee) is a proportion of manufacturers’ revenue. Generally, due to the cooperation, i.e., manufacturers pay the platform usage fee to the e-tailer, the e-tailer prefers to share information. However, compared with sharing information with only one manufacturer, sharing information with both manufacturers results in a higher correlation between the two manufacturers’ strategies, which further intensifies the competition. Therefore, if competition intensity $\gamma$ is large, the profits of both manufacturers will decrease, which reduces the e-tailer’s profit. Accordingly, the e-tailer will share information with any one manufacturer. Obviously, fierce competition is the obstacle for information sharing under the pure reseller channel. Different from the asymmetric channel, the double marginalization effect of information sharing doesn’t exist here. Next, we focus on the difference between the pure reseller channel and the asymmetric channel.

Under the pure reseller channel, the e-tailer doesn’t disclose information with any manufacturer, and no information sharing makes the supply chain better off than other scenarios. The double marginalization effect of information sharing is a major obstacle to share information, which is well studied in the literature [7, 17]. Here, we mainly analyse why $V_{NI} > V_{II}$ if $\gamma \in (0, 2\sqrt{2} - 2)$, otherwise, the opposite is true. This reason can make the difference between the pure reseller channel and the asymmetric channel clear. In detail, the two manufacturers compete with each other. When one manufacturer is informed, sharing information with another manufacturer results in a higher correlation between their strategies, which further intensifies upstream competition. Accordingly, the double marginalization effect of information sharing becomes weak, which will benefit the e-tailer. In particular, the larger competition intensity $\gamma$ is, the more the e-tailer can benefit. As a result, $V_{NI} < V_{II}$ if $\gamma \in (2\sqrt{2} - 2, 1)$. That is to say, the e-tailer prefers a high level of competition. Different from the pure reseller channel, the e-tailer, and manufacturer 2 (the manufacturer from the marketplace channel) compete under the asymmetric channel. When manufacturer 2 is informed, fierce competition results in the loss of information sharing value. Although the platform fee rate can alleviate competition, this mitigation effect becomes weak when competition intensity is large but the platform fee is small. However, when manufacturer 1 (the manufacturer from the reseller channel) is also informed, the double marginalization effect of information sharing can also alleviate competition. Accordingly, $V_{NI} < V_{II}$ if competition intensity is large but the platform fee is small.

In summary, the the results obtained under the asymmetric channel cannot be extended to the case of symmetric channel. The reason can be summarized as follows. Under the asymmetric channel, we obtain the findings because, for the incentive of information sharing, competition is a negative effect but the double marginalization effect of information sharing is a positive effect. However, under the pure marketplace channel, the double marginalization effect of information sharing doesn’t exist, and competition is a negative effect; under the pure reseller channel, competition is a positive effect but the double marginalization effect of information sharing is a negative effect.

6. Conclusions. As asymmetric channel prevails in online retailing industry, the incentive of information sharing is tangled when competing manufacturers adopt
asymmetric channel. This paper mainly explores the incentive of information sharing, and how the incentive depends on competition intensity, the platform fee and different information sharing scenarios.

The results show that the double marginalization effect of information sharing may be a prevailing factor to share information under linear cost, which is different from previous literature. Accordingly, one manufacturer in the reseller channel may obtain the information if its competitor adopts the marketplace channel. We also find that the e-tailer’s incentive to share information strongly depends on competition intensity, the platform fee, and different information sharing scenarios.

Therefore, if competition intensity is small, or competition intensity is large and the platform fee is enough large, one manufacturer in the marketplace channel can obtain the information alone; if competition intensity is moderate and the platform fee is small, or competition intensity is large but the platform fee is moderate, the manufacturer should ally itself with its competitor to purchase the information.

We investigate the incentive of vertical information sharing when competing manufacturers adopt asymmetric channel and propose that future studies examine interactions between information sharing and the choice of channel. This study only considers demand information. Thus, other information may be worth examining in this background, such as cost or quality information.

Appendixes.

Derivation of Table 1. Under the scenario \((N,N)\), only the e-tailer’s estimate of \(\theta\) is \(E[\theta|Y]\), since the e-tailer conceals demand information from both manufacturers.

By the first conditions of Eqs. (1) and (3), and solving a Bayesian Nash equilibrium, we get \(q_{1N}(w) = \frac{1}{2}E[\theta|Y] + \frac{2\gamma(1 + \beta) - 4\alpha + 4\theta}{8 - 2(2 + 2\gamma)\gamma}\) and \(q_{2N}(w) = \frac{\alpha - \gamma - 2\alpha - \gamma w}{8 - 4(1 + \beta)\gamma^2}\).

Due to no information sharing, we have \(w_{NN} = \frac{\theta}{8 - 2(2 + 2\gamma)\gamma} + \frac{2}{2}(2 - \gamma - \beta\gamma)\) by solving the first conditions of Eq. (4). Therefore, \(q_{1N} = \frac{2 - (1 + \beta)\gamma}{8 - (2 + 2\gamma)\gamma^2} + \frac{1}{2}E[\theta|Y]\) and \(q_{2N} = \frac{8 - (1 + \beta)\gamma^2 - 2\gamma}{8 - 4(1 + \beta)\gamma^2} + \alpha\). The corresponding expected ex-ante profit of the e-tailer is:

\[
E \{ q_{1N}^N (\alpha + E[\theta]|Y) - q_{1N}^N - \gamma q_{1NN}^N - w_{NN}^N \} + q_{2N}^N (\alpha + E[\theta]|Y) - q_{2N}^N - \gamma q_{1NN}^N \beta = \frac{3(1 + \beta)^2\gamma^4 + 4(1 + \beta)\gamma^3 + 4(28\beta - 28\beta)^2 - 16(1 + \beta)\gamma + 64\delta + 16}{16(4 - (1 + \beta)\gamma^2)} \}
\]

Similarly, \(w_{NN}^N = \frac{\theta}{8 - (2 + 2\gamma)\gamma^2} + \alpha\), and \(\delta = E \left[ (E[\theta|Y])^2 \right] \) for simplicity. Therefore, under the scenario \((N,N)\), we have \(w_{NN}^N = A\alpha, \quad q_{1N}^N = 2\alpha, \quad q_{2N}^N = C\alpha, \quad \pi_{e1}^N = E\alpha, \quad \pi_{m1}^N = f\alpha, \quad \pi_{m2}^N = \pi_{m2}^N\).

Under the scenario \((I,N)\), both manufacturer 1’s and the e-tailer’s estimate of \(\theta\) are \(E[\theta|Y]\), since the e-tailer disclose demand information with only manufacturer 1. Because manufacturer 2 is uninformed and cannot observe the wholesale price of manufacturer 1 [21], manufacturer 2’s estimate of \(\theta\) is \(E[\theta] = 0\). By the first conditions of Eqs. (1) and (3), and solving a Bayesian Nash equilibrium, we get \(q_{1I}^N (w) = \frac{1}{2}E[\theta|Y] + \frac{2\gamma(1 + \beta) - 4\alpha + 4\theta}{8 + 2(2 + 2\gamma)\gamma}\) and \(q_{2I}^N (w) = \frac{\alpha - \gamma - 2\alpha - \gamma w}{4 + (1 + \beta)\gamma^2}\). Given \(q_{1I}^N (w),\)
the informed manufacturer 1 sets \(w^{1I} = \frac{\theta}{8 - (2 + 2\gamma)\gamma} + \frac{2}{2}(2 - \gamma - \beta\gamma)\)}
by solving the first conditions of Eq. (5). Therefore, \( q_1^{IN} = B\alpha + \frac{1}{4}E[\theta|Y] \), \( q_2^{IN} = C\alpha \) and \( \pi^{IN} = AO + \frac{4-(1+\beta)^2}{4-(1+\beta)^2}AE[\theta|Y] \). The corresponding expected ex-ante profit are: \( \pi_{e}^{IN} = \bar{\pi}_e + \frac{4-(1+\beta)^2}{64}\delta \), \( \pi_{m1}^{IN} = \bar{\pi}_{m1} + \frac{4-(1+\beta)^2}{32}\delta \), and \( \pi_{m2}^{IN} = \bar{\pi}_{m2} \).

We can follow similar procedures to establish the equilibrium outcomes and corresponding ex-ante profits for the other two scenarios.

**Proof of Lemma 4.5.** Similar to Lemma 4.4, we obtain

\[
\frac{\partial \pi_e^{IN}}{\partial \gamma} = \frac{4-(1+\beta)^2}{4-(1+\beta)^2}\gamma^2, \quad \frac{\partial \pi_{m1}^{IN}}{\partial \gamma} = \frac{4-(1+\beta)^2}{4-(1+\beta)^2}\gamma^2, \quad \frac{\partial \pi_{m2}^{IN}}{\partial \gamma} = \frac{4-(1+\beta)^2}{[4-(1+\beta)^2]^2}.
\]

When \( \beta > 0 \), we acquire Lemma 4.1 was obtained due to

\[
\frac{\partial \pi_e^{IN}}{\partial \gamma} < 0 \quad \text{and} \quad \frac{\partial \pi_{m1}^{IN}}{\partial \gamma} > 0.
\]

**Proof of Lemma 4.2.** Comparing \( q_1^{NN} \) with \( q_1^{IN} \), we obtain

\[
q_1^{NN} - q_1^{IN} = \frac{8-4\gamma}{8-(2+2\beta)\gamma^2} \quad \text{and} \quad q_2^{NN} - q_2^{IN} = -CE[\theta|Y].
\]

Because of \( 2-(1+\beta)^2(1+\beta)^2 \), we acquire Lemma 4.2.

**Proof of Lemma 4.3.** Comparing \( q_1^{NN} \) with \( q_1^{IN} \), we obtain

\[
q_1^{NN} - q_1^{IN} = \frac{8-4\gamma}{8-(2+2\beta)\gamma^2} \quad \text{and} \quad q_2^{NN} - q_2^{IN} = -CE[\theta|Y].
\]

Because of \( 2-(1+\beta)^2(1+\beta)^2 \), we acquire Lemma 4.3.

**Proof of Lemma 4.4.** As \( q_1^{NN} = B\alpha + 2BE[\theta|Y] \), \( q_2^{NN} = C\alpha \), and

\[
q_1^{IN} = B\alpha + BE[\theta|Y] \quad \text{and} \quad q_2^{IN} = C\alpha + CE[\theta|Y],
\]

we just need to solve

\[
\frac{\partial B}{\partial \gamma} = \frac{8-4\gamma}{8-(2+2\beta)\gamma^2}, \quad \frac{\partial C}{\partial \gamma} = \frac{8-4\gamma}{8-(2+2\beta)\gamma^2}.
\]

Because of \( \frac{\partial B}{\partial \gamma} = \frac{8-4\gamma}{[4-(1+\beta)^2\gamma^2]} < 0 \) and \( \frac{\partial C}{\partial \gamma} = \frac{8-4\gamma}{[4-(1+\beta)^2\gamma^2]} > 0 \), we have Lemma 4.4.

**Proof of Lemma 4.5.** Similar to Lemma 4.4, we obtain

\[
\frac{\partial \pi_e^{IN}}{\partial \gamma} = \frac{4-(1+\beta)^2}{4-(1+\beta)^2}\gamma^2, \quad \frac{\partial \pi_{m1}^{IN}}{\partial \gamma} = \frac{4-(1+\beta)^2}{[4-(1+\beta)^2]^2}\gamma^2.
\]
\[
\frac{(2-\gamma)^2}{(4-\gamma)^2}, \quad -4 - (1 + \beta) \gamma^2 + 4 (1 + \beta) \gamma > 0. \quad \text{Furthermore, we get } \frac{\partial C}{\partial \gamma} < 0 \text{ and } \frac{\partial B}{\partial \gamma} < 0 \text{ when } \beta \in \left(0, \frac{(2-\gamma)^2}{(4-\gamma)^2}\right), \text{ otherwise, the opposite is true. And } \frac{\partial B}{\partial \gamma} = -\frac{1}{2} \frac{(1+\beta)[4(1+\beta)\gamma^2 - 4\gamma]}{[4(1+\beta)\gamma]^2} < 0. \text{ Therefore, Lemma 4.5 was obtained.} \]

Proof of Proposition 1. Firstly, we present how information sharing with manufacturer 2 affects the parties of the reseller channel when manufacturer 1 is informed. From the corresponding expected ex-ante profits of manufacturer 1 and the e-tailer’s first part, we have \( \pi_{m1}^{II} - \pi_{m1}^{IN} = \pi_{e1}^{II} - \pi_{e1}^{IN} = \frac{1}{32} \left[\beta(1+\beta)^2 \gamma^4 + 2\beta(1+\beta)^2 \gamma^3 + (2 - 6\beta^2 - 4\beta) \gamma^2 + (4 - 12\beta^2 - 8\beta) \gamma + 16\beta - 16\right] (2-\gamma) \delta. \) Because \((1 + \beta) \gamma^2 + 2(1 + \beta) \gamma - 8 < 0, \pi_{m1}^{II} < \pi_{m1}^{IN}. \) Let \( f_1(\beta, \gamma) = \beta(1 + \beta)^2 \gamma^4 + 2\beta(1 + \beta)^2 \gamma^3 + (2 - 6\beta^2 - 4\beta) \gamma^2 + (4 - 12\beta^2 - 8\beta) \gamma + 16\beta - 16 \) for simplicity. Following the proof in [11, 29], and given that the threshold \( f_1(\beta, \gamma) = 0 \) has only two exogenous parameters, namely platform fee \( \beta \) and competition intensity \( \gamma \), we derive the threshold for every tuple \((\gamma, \beta)\) in Figure A1. By observing Figure A1, we obtain \( f_1(\beta, \gamma) > 0 \) when \( \beta \in (0, 1) \) and \( \gamma \in (0, 1) \). That is to say, \( \pi_{m1}^{II} < \pi_{m1}^{IN} \). Therefore, when manufacturer 1 is informed, information sharing with manufacturer 2 will hurt manufacturer 1 and the e-tailer’s first part.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure.png}
\caption{\( f_1(\beta, \gamma) > 0 \) when \( \beta \in (0, 1) \) and \( \gamma \in (0, 1) \)}
\end{figure}

In addition, we prove how information sharing with manufacturer 1 affects the marketplace channel when manufacturer 2 is informed. We have \( \pi_{m2}^{II} - \pi_{m2}^{NI} = \frac{\beta[16 - (1+\beta)^2 \gamma^2 - 6\gamma] - (2-\gamma) \delta}{[4(1+\beta)\gamma]^2} > 0 \) and \( \pi_{e2}^{II} - \pi_{e2}^{NI} = \frac{\beta[16 - (1+\beta)^2 \gamma^2 - 6\gamma] - (2-\gamma) \delta}{[4(1+\beta)\gamma]^2} > 0 \), i.e., \( \pi_{m2}^{II} > \pi_{m2}^{NI}, \pi_{e2}^{II} > \pi_{e2}^{NI} \). When manufacturer 2 is informed, information sharing with manufacturer 1 will benefit manufacturer 2 and the e-tailer’s second part.
Proof of Proposition 2. We obtain $\pi_e^{NI} - \pi_e^{NN} = \frac{(\beta+\delta)^3+(1-\beta^2-\beta)\gamma^2-4(1+\beta)\gamma+4\beta+4}{4(1+\beta)^2}\delta$ and let $g_1(\beta) = (1+\beta)^2\gamma^3 + (2-\beta)^2\gamma^2 - 4(1+\beta)\gamma + 8\beta$. We can get the threshold $\beta(1)$ in which $\pi_e^{NI} = \pi_e^{NN}$, that is, $g_1(\beta(1)) = 0$. From $g_1(\beta(1)) = 0$, we can obtain threshold $\beta(1) = \frac{4+\gamma^3-2\gamma-2\sqrt{2}\gamma^4+\gamma^2-4\gamma+4}{(2-\gamma)^2}$ [another solution is abandoned because $\beta \in (0, 1)$ and $\gamma \in (0, 1)$]. Therefore, when $\beta \in \left(\frac{4+\gamma^3-2\gamma-2\sqrt{2}\gamma^4+\gamma^2-4\gamma+4}{(2-\gamma)^2}, 1\right)$ and $\gamma \in (0, 1)$, then $\pi_e^{NI} > \pi_e^{NN}$, and vice versa.

Proof of Proposition 3. On the one hand, when manufacturer 2 is uninformed, $\pi_e^{NI} - \pi_e^{NN} = -\frac{12+\beta^2-8\gamma}{4(1+\beta)^2} \delta < 0$; on the other hand, when manufacturer 2 is informed, $\pi_e^{II} - \pi_e^{NN} = \frac{3(\beta^2-4)(2+1+\beta)^2\gamma^3}{64(1+\beta)^2} \delta < 0$. Therefore, regardless of whether manufacturer 2 is informed, information sharing with manufacturer 1 hurts the e-tailer.

Proof of Proposition 4. We compare the total supply chain profit under scenario $(N, I)$ with that under scenario $(N, N)$ and derive $\pi_e^{NI} = \pi_e^{NN}$ for $\gamma = \frac{2\sqrt{2}}{2}$ [another solution is abandoned because $\gamma \in (0, 1)$]. Therefore, when $\gamma \in (0, 2\sqrt{2} - 2)$ and $\beta \in (0, 1)$ or $\gamma \in (2\sqrt{2} - 2, 1)$ and $\beta \in \left(\frac{2^2+2\gamma-4}{(2-\gamma)^2}, 1\right)$, $V^{NI} > V^{NN}$, i.e., the illustrated results in Figure 3(a).

Proof of Proposition 5. We compare the total supply chain profit under scenario $(I, I)$ with that under scenario $(N, N)$ and derive $\pi_e^{II} = \pi_e^{NN}$ for $\gamma = \frac{2\sqrt{5}-4}{5}$ [other solutions are abandoned because $\gamma \in (0, 1)$]. Therefore, when $\gamma \in \left(0, \frac{2\sqrt{5}-4}{5}\right)$ and $\beta \in (0, 1)$ or $\gamma \in \left(\frac{2\sqrt{5}-4}{5}, 1\right)$ and $\beta \in \left(\frac{2\sqrt{2}+2\gamma-5\gamma^3-24}{(4-8\gamma+5\gamma^2)^2}, 1\right)$, $V^{II} > V^{NN}$, i.e., the illustrated results in Figure 3(b).

Proof of Proposition 6. We compare the total supply chain profit under scenario $(I, I)$ with that under scenario $(N, I)$ and derive $\pi_e^{II} = \pi_e^{NI}$ for $\gamma = \frac{2\sqrt{5}-4}{5}$ [other solutions are abandoned because $\gamma \in (0, 1)$]. Therefore, when $\gamma \in \left(4-2\sqrt{3}, 1\right)$ and $\beta \in \left(0, \frac{\gamma^3+2\sqrt{2}\gamma-10\gamma^2+8}{(1\sqrt{8\gamma+5\gamma^2})^2}\right)$, $V^{II} > V^{NI}$, i.e., the illustrated results in Figure 3(c).
Proof of Proposition 7. From Table 1, we can get the payoffs of the supply chain are larger under (N, N) than under (I, N), i.e., $V^{IN} - V^{NN} = -4 + 33\gamma^2 + 2\gamma - 3\delta < 0$. We just need to compare the three scenarios (N, N), (N, I) and (I, I). Compared with the total supply chain profit under different scenarios, we obtain the followings.

Firstly, we compare the total supply chain profit under scenario (N, N). From Proposition 4, we have $V^{NI} > V^{NN}$, when $\gamma \in (0, 2\sqrt{2} - 2)$ and $\beta \in (0, 1)$ or $\gamma \in (2\sqrt{2} - 2, 1)$ and $\beta > \beta^{(2)} = \frac{2^2 + 4\gamma - 4}{(2 - \gamma)^2}$. It reveals the threshold $\beta^{(2)} = \frac{2^2 + 4\gamma - 4}{(2 - \gamma)^2}$ in which $V^{NI} = V^{NN}$.

Secondly, compare the total supply chain profit when both manufacturers are informed with that when both manufacturers are uninformed. From Proposition 5, we get $V^{II} > V^{NN}$ when $\gamma \in (0, 2\sqrt{\frac{5}{9}} - 4)$ and $\beta \in (0, 1)$ or $\gamma \in (2\sqrt{\frac{5}{9}} - 4, 1)$ and $\beta > \beta^{(3)} = \frac{2^2 + 28\gamma - 5\gamma^3 - 24}{(4 - 8\gamma + 5\gamma^2)^2}$. It shows the threshold $\beta^{(3)} = \frac{2^2 + 28\gamma - 5\gamma^3 - 24}{(4 - 8\gamma + 5\gamma^2)^2}$ in which $V^{II} = V^{NN}$.

Thirdly, we compare the total supply chain profit under scenario (I, I) with that under scenario (N, I). From Proposition 6, we get $V^{II} > V^{NI}$ when $\gamma \in (4 - 2\sqrt{3}, 1)$ and $\beta < \beta^{(4)} = \frac{\gamma^3 + 20\gamma^2 - 10\gamma^3 - 8}{(12 - 8\gamma - 7\gamma^2)^2}$. It also shows the threshold $\beta^{(4)} = \frac{\gamma^3 + 20\gamma^2 - 10\gamma^3 - 8}{(12 - 8\gamma - 7\gamma^2)^2}$ in which $V^{II} = V^{NI}$.

Finally, to simplify the proof, we derive the thresholds $\beta^{(2)} = \frac{2^2 + 4\gamma - 4}{(2 - \gamma)^2}$, $\beta^{(3)} = \frac{2^2 + 28\gamma - 5\gamma^3 - 24}{(4 - 8\gamma + 5\gamma^2)^2}$ and $\beta^{(4)} = \frac{\gamma^3 + 20\gamma^2 - 10\gamma^3 - 8}{(12 - 8\gamma - 7\gamma^2)^2}$ in Figure A2. Following the proof in [11, 29], and given that the thresholds have only two exogenous parameters, namely platform fee $\beta$ and competition intensity $\gamma$. We derive the thresholds for every tuple $(\gamma, \beta)$ in Figure A2, which reveals that $\beta^{(4)} < \beta^{(3)} < \beta^{(2)}$. When $\beta^{(4)} = 0$, $\gamma = 4 - 2\sqrt{3}$, when $\beta^{(2)} = 0$, $\gamma = 2\sqrt{2} - 2$, and when $\beta^{(3)} = 0$, $\gamma = 2\sqrt{\frac{5}{9}} - 4$.

We have $2\sqrt{\frac{5}{9}} - 4 > 2\sqrt{2} - 2 > 4 - 2\sqrt{3}$. Therefore, in Figure A2, $\pi^{NI}_{m1} + \pi^{NI}_{m2} + \pi^{NI}_{e}$, $\pi^{II}_{m1} + \pi^{II}_{m2} + \pi^{II}_{e}$ and $\pi^{NN}_{m1} + \pi^{NN}_{m2} + \pi^{NN}_{e}$ are largest in (N, I), (I, I) and (N, N) areas, respectively. In other words, the area of $\beta \in (0, 1)$ and $\gamma \in (0, 1)$ is divided into three areas of equilibrium information sharing decisions by the two solid lines (i.e., the thresholds $\beta^{(3)}$ and $\beta^{(4)}$). By observing Figure A2, we can easily summaries Proposition 7 as follows: when $\gamma \in (0, 4 - 2\sqrt{3})$ and $\beta \in (0, 1)$ or $\gamma \in (4 - 2\sqrt{3}, 1)$ and $\beta \in \left(\frac{\gamma^3 + 20\gamma^2 - 10\gamma^3 - 8}{(12 - 8\gamma - 7\gamma^2)^2}, 1\right)$, (N, I) is the unique equilibrium; when $\gamma \in (4 - 2\sqrt{3}, 2\sqrt{\frac{5}{9}} - 4)$ and $\beta \in \left(0, \frac{\gamma^3 + 20\gamma^2 - 10\gamma^3 - 8}{(12 - 8\gamma - 7\gamma^2)^2}\right)$ or $\gamma \in \left(2\sqrt{\frac{5}{9}} - 4, 1\right)$ and $\beta \in \left(\frac{\gamma^3 + 20\gamma^2 - 10\gamma^3 - 8}{(12 - 8\gamma - 7\gamma^2)^2}, 1\right)$, (I, I) is the unique equilibrium; when $\gamma \in \left(2\sqrt{\frac{5}{9}} - 4, 1\right)$ and $\beta \in \left(0, \frac{2^2 + 28\gamma - 5\gamma^3 - 24}{(4 - 8\gamma + 5\gamma^2)^2}\right)$, (N, N) is the unique equilibrium.

In addition, we add the threshold $\beta^{(1)} = \frac{4 + \gamma^3 - 2\gamma - 2\sqrt{2\gamma^2 + 2\gamma^2 + \gamma^2 - 4\gamma - 4}}{(2 - \gamma)^2}$ in which $\pi^{NN}_e = \pi^{NI}_e$ into Figure A2. In order to avoiding confusion, the thresholds $\beta^{(1)}$ and $\beta^{(2)}$ are demonstrated by the dashed line. Above the dashed line in (N, I) area, the e-tailer voluntarily shares information with manufacturer 2 and under the dashed line in this area, manufacturer 2 can acquire information by payment. Above the dashed line in (I, I) area, $V^{II} > V^{NI} > V^{NN}$, and under the dashed line in this area, $V^{II} > V^{NN} > V^{NI}$.

□
We can follow similar procedures to establish the equilibrium outcomes and corresponding ex-ante profits when one manufacturer may simultaneously sell products through the reseller and marketplace channels. Table A1 shows them.

| $x_m$ | Equilibrium outcome | Ex-ante profit |
|-------|---------------------|----------------|
| $N$   | $w^N = D\alpha$     | $\pi_{e}^N = \bar{\pi}_e + \frac{1}{2}\delta$ |
|       | $q_1^N = F\alpha + \frac{1}{2}E[\theta|Y]$ | $\pi_m^N = \bar{\pi}_m$ |
|       | $q_2^N = G\alpha$   | |
| $I$   | $w^I = D\alpha + DE[\theta|Y]$ | $\pi_e^I = \bar{\pi}_e (1 + \frac{2}{\alpha})$ |
|       | $q_1^I = F\alpha + FE[\theta|Y]$ | $\pi_m^I = \bar{\pi}_m (1 + \frac{\beta}{\alpha})$ |
|       | $q_2^I = G\alpha + GE[\theta|Y]$ | |

**Note:** $D = \frac{\alpha^2 (1+\beta)^2}{8 + (1+\beta)^2 \gamma^4 - 4 \gamma^2 - 8 \gamma}$, $F = \frac{2 (1-\gamma)}{8 - (3+\beta) \gamma^2}$, $G = \frac{8 - (1+\beta)^2 \gamma^2 - 2 \gamma}{2 (8 - (3+\beta) \gamma^2)}$, $\bar{\pi}_e = \frac{(5\beta + 6\beta^2 + \beta^3)^2 \gamma^4 + 8\beta^2 \gamma^3 + (16 - 16\beta^2 - 52\beta) \gamma^2 - 32 \gamma + 64\beta + 16}{32 - 12\gamma + 64\beta - 48}$, and $\bar{\pi}_m = \frac{(1+\beta)^2 \gamma^2 - 8\gamma - 8\beta + 12}{32 - 12\gamma + 64\beta - 48}$.

We let $\bar{\pi}_e$ and $\bar{\pi}_m$ be the deterministic payoffs (in the absence of uncertainty). Let $\delta = E[(E[\theta|Y])^2]$ for simplicity.

**Proof of Proposition 8.** We can follow similar procedures to establish the equilibrium outcomes and corresponding ex-ante profits when one manufacturer may simultaneously sell products through the reseller and marketplace channels. Table A1 shows them.

From Table A1, we obtain corresponding expected ex-ante profits of the e-tailer and manufacturer under two scenarios, which we will compare. Firstly, we obtain $\pi_e^N - \pi_e^I = \pi_e + \frac{1}{2} \delta - \left[\bar{\pi}_e \left(1 + \frac{\beta}{\alpha}\right)\right] = -\frac{(5\beta^2 + \beta^3 - \beta - 9) \gamma^4 + 8\beta \gamma^3 + (64 - 16\beta^2 - 36\beta) \gamma^2 - 32 \gamma + 64\beta - 48}{32 - 12\gamma + 64\beta - 48} \delta$. Let $g_5(\beta) = (5\beta^2 + \beta^3 - \beta - 9) \gamma^4 + 8\beta \gamma^3 + (64 - 16\beta^2 - 36\beta) \gamma^2 - 32 \gamma + 64\beta - 48$. The threshold $\beta(5)$ in which $\pi_e^N = \pi_e^I$, that is, $g_5(\beta(5)) = 0$, cannot easily be obtained because $g_5(\beta(5))$ is a high-degree equation. However, we can derive threshold $\beta(5)$ in Figure A3 following the proof in [11, 29]. By observing Figure A3, we obtain the following result: If $\beta \in (\beta(5), 1)$ and $\gamma \in (0, 1)$, then $\pi_e^N < \pi_e^I$, and vice versa. To avoid confusion, we replace $\beta(5)$ with $\beta^A$ in Proposition 8. That is,
if $\beta \in (\beta^\Delta, 1)$ and $\gamma \in (0, 1)$, then $\pi_e^N < \pi_e^I$, and vice versa. In addition, $\beta^\Delta$ is the solution of the expression $g_6(\beta^\Delta) = 0$ when $\beta \in (0, 1)$.

![Threshold $\beta^{(5)}$](image)

**Figure A3. Threshold $\beta^{(5)}$**

Secondly, we compare the total profit of the supply chain with and without information sharing: $\pi_e^N + \pi_m^N - (\pi_e^I + \pi_m^I) = \tilde{\pi}_e + \frac{1}{3} \delta + \tilde{\pi}_m - \left[ \tilde{\pi}_e \left( 1 + \frac{\Delta}{\pi_e} \right) + \tilde{\pi}_m \left( 1 + \frac{\Delta}{\pi_m} \right) \right] = \frac{2(1-\gamma)^2 \left[ (\beta + \frac{1}{2}) \gamma^2 - 6 \right]}{[8-(3+\beta)\gamma^2]^2} \delta < 0$. Therefore, $\pi_e^N + \pi_m^N > (\pi_e^I + \pi_m^I)$. Specifically, except the case in which the e-tailer voluntarily shares information with the manufacturer, the manufacturer can induce the e-tailer to share demand information with it by payment.

Based on the above analysis, we can obtain Proposition 8.

**Derivation of Figure 5(b).** If the manufacturer adopts the information to set the retailing quantity $q_2$, the ex-ante payoffs of the supply chain are $\frac{(1+\beta)\gamma^3 + (2-\beta^2-2\beta)\gamma^2 - 8\gamma + 8}{[4-(1+\beta)\gamma^2]^2} \cdot \delta + \frac{(\beta^2-2\beta-3)\gamma^3 + (24+16\beta)\gamma^2 - (12+24\beta)\gamma - 96\gamma + 112}{[8-(3+\beta)\gamma^2]^2} \cdot \gamma^4$. If the manufacturer adopts the information to set both the retailing quantity $q_2$ and the wholesale price $w$, the ex-ante payoffs of the supply chain are $\frac{(\beta^2-2\beta-3)\gamma^3 + (12-4\beta^2-4\beta)\gamma^2 - 8\beta \gamma + 8}{[4-(1+\beta)\gamma^2]^2} \cdot \delta + \frac{(\beta^2-2\beta-3)\gamma^3 + (12-4\beta^2-4\beta)\gamma^2 - 8\beta \gamma + 8}{[8-(3+\beta)\gamma^2]^2} \cdot \delta$.

We can get $(1+\beta)^2\gamma^3 - 4\gamma^2 - 8\beta \gamma + 8 > 0$, and let $g_6(\beta) = (\beta^2 - 2\beta - 3)\gamma^5 + (12 - 4\beta^2 - 4\beta)\gamma^4 + (4\beta^2 - 12)\gamma^3 + (32\beta - 24)\gamma^2 + (64 - 32\beta)\gamma - 32$. We can obtain the threshold $\beta^{(6)}$ in which the two payoffs are equal, that is to say, $g_6(\beta^{(6)}) = 0$. From $g_6(\beta^{(6)}) = 0$, we have $\beta^{(6)} = \frac{16-16\gamma^4+2\gamma^3-2\gamma^2-5\gamma^2+19\gamma^2-26\gamma^2-36\gamma^2+112\gamma^2-32\gamma^2-96\gamma+64}{(4+\gamma^2-4\gamma)\gamma^2}$. We can derive threshold $\beta^{(6)}$ in Figure A4. From the threshold, we have $\gamma = 0.728$ when $\beta = 0$. Other solutions are abandoned because $\gamma \in (0, 1)$ and $\beta \in (0, 1)$. The supply chain is better off under ($I, I$) than under ($N, I$) when $\gamma \in (0.728, 1)$ and $\beta \in \left( 0, \frac{16-16\gamma^4+2\gamma^3-2\gamma^2-5\gamma^2+19\gamma^2-26\gamma^2-36\gamma^2+112\gamma^2-32\gamma^2-96\gamma+64}{(4+\gamma^2-4\gamma)\gamma^2} \right)$. In addition, Proposition 8 indicates that the e-tailer is willing to share information with the
manufacturer when $\beta \in (\beta^\Delta, 1)$ and $\gamma \in (0, 1)$. Therefore, we can get Figure 5(b) in the paper.

$\square$

**Figure A4.** Threshold $\beta^{(6)}$

*Proof of the results under the pure reseller channel.* When competing manufacturers adopt the reseller channel in an e-tailer, competing manufacturers sell substitute products to the e-tailer at wholesale prices $w_1$ and $w_2$, respectively and simultaneously, and then the e-tailer sets the retailing quantity $q_1$ and $q_2$. Because two manufacturers are symmetric, we just need to consider three scenarios: $(N, N)$, $(I, I)$ and $(N, I)$. The sequence of events includes three stages. We solve the game by backward induction.

In the third stage, manufacturer 1 and manufacturer 2 are engaged in quantity competition. Given the wholesale prices $w_1$ and $w_2$, the e-tailer sets $q_1$ and $q_2$ to maximize the profit function as follows:

$$q_1 (\alpha + E[\theta|Y] - q_1 - \gamma q_2 - w_1) + q_2 (\alpha + E[\theta|Y] - q_2 - \gamma q_1 - w_2).$$

In the second stage, manufacturer 1 sets the wholesale price $w_1$ to maximize

$$E[q_1] w_1,$$

and simultaneously, manufacturer 2 sets the wholesale price $w_2$ to maximize

$$E[q_2] w_2,$$

when both manufacturers are uninformed; when both manufacturers are informed, manufacturer 1 determines the wholesale price $w_1$ to maximize

$$E[q_1|Y] w_1,$$

and simultaneously, manufacturer 2 determines the wholesale price $w_2$ to maximize

$$E[q_2|Y] w_2;$$
Table A2. Operation equilibrium under the pure reseller channel

| $(x_{m1}, x_{m2})$ | Equilibrium outcome | Ex-ante profit |
|---------------------|---------------------|----------------|
| $(N, N)$            | $w_1^{NN} = H\alpha$| $\pi_e^{NN} = \bar{\pi}_e + \frac{1}{2(1+\gamma)}$ |
|                     | $w_2^{NN} = H\alpha$|                      |
|                     | $q_1^{NN} = J\alpha + \frac{E[\theta|Y]}{2(1+\gamma)}$| $\pi_{m1}^{NN} = \bar{\pi}_{m1}$ |
|                     | $q_2^{NN} = J\alpha + \frac{E[\theta|Y]}{2(1+\gamma)}$| $\pi_{m2}^{NN} = \bar{\pi}_{m2}$ |
| $(N, I)$            | $w_1^{NI} = H\alpha$| $\pi_e^{NI} = \bar{\pi}_e + \frac{\gamma\theta}{10(1+\gamma)}$ |
|                     | $w_2^{NI} = H\alpha + \frac{1-\gamma}{2(2-\gamma)(1+\gamma)} E[\theta|Y]$| $\pi_{m1}^{NI} = \bar{\pi}_{m1}$ |
|                     | $q_1^{NI} = J\alpha + \frac{E[\theta|Y]}{2(1+\gamma)}$| $\pi_{m2}^{NI} = \bar{\pi}_{m2} + \frac{1-\gamma}{8(1+\gamma)}$ |
|                     | $q_2^{NI} = J\alpha + \frac{E[\theta|Y]}{2(1+\gamma)}$|                      |
| $(I, I)$            | $w_1^{II} = H\alpha + HE[\theta|Y]$| $\pi_e^{II} = \bar{\pi}_e (1 + \frac{\gamma}{2\alpha})$ |
|                     | $w_2^{II} = H\alpha + HE[\theta|Y]$| $\pi_{m1}^{II} = \bar{\pi}_{m1} (1 + \frac{\gamma}{2\alpha})$ |
|                     | $q_1^{II} = J\alpha + JE[\theta|Y]$| $\pi_{m2}^{II} = \bar{\pi}_{m2} (1 + \frac{\gamma}{2\alpha})$ |
|                     | $q_2^{II} = J\alpha + JE[\theta|Y]$|                      |

Note: $H = \frac{\beta - \gamma}{\beta}$, $J = \frac{1-\gamma}{(2-\gamma)(1+\gamma)}$, and $\bar{\pi}_e = \bar{\pi}_{m1} = \bar{\pi}_{m2} = \frac{1-\gamma}{2(2-\gamma)(1+\gamma)} \alpha^2$. We let $\bar{\pi}_e$, $\bar{\pi}_{m1}$ and $\bar{\pi}_{m2}$ be the deterministic payoffs (in the absence of uncertainty). Let $\delta = E\left[(E[\theta|Y])^2\right]$ for simplicity.

if manufacturer 1 is uninformed and manufacturer 2 is informed, manufacturer 1 sets the wholesale price $w_1$ to maximize

$$E[q_1] w_1,$$

and simultaneously, manufacturer 2 sets the wholesale price $w_2$ to maximize

$$E[q_2|Y] w_2.$$

Table A2 groups the equilibrium outcomes and corresponding expected ex-ante profits of the e-tailer and manufacturers across scenarios.

In the first stage, we have $\pi_e^{NN} - \pi_e^{II} = \frac{(2-\gamma)^2 - 1}{2(2-\gamma)^2(1+\gamma)} \delta > 0$, and $\pi_e^{NN} - \pi_e^{NI} = \frac{3(1-\gamma)}{16(1+\gamma)} \delta > 0$. We can also obtain $V_e^{NN} - V_e^{II} = \frac{(1-\gamma)^2}{2(2-\gamma)^2(1+\gamma)} \delta > 0$, and $V_e^{NN} - V_e^{NI} = \frac{(1-\gamma)}{16(1+\gamma)} \delta > 0$. Therefore, $\pi_e^{NN} > \pi_e^{II}$ and $\pi_e^{NN} > \pi_e^{NI}$; $V_e^{NN} > V_e^{II}$ and $V_e^{NN} > V_e^{NI}$. In addition, $V_e^{II} - V_e^{NI} = \frac{(1-\gamma)(\gamma^2 + 4\gamma - 4)}{16(2-\gamma)^2(1+\gamma)} \delta$, and thus $V_e^{NI} > V_e^{II}$ if $\gamma \in (0, 2\sqrt{2} - 2)$, otherwise, the opposite is true. $\square$

Proof of Proposition 9. When competing manufacturers adopts the marketplace channel in an e-tailer, they determine the retailing quantity $q_1$ and $q_2$, respectively and simultaneously, and then the e-tailer charges the platform usage fee from them. In this case, we also just need to consider three scenarios: $(N, N)$, $(I, I)$ and $(N, I)$. The sequence of events includes two stages. We solve the game by backward induction.

In the second stage, manufacturer 1 and manufacturer 2 are engaged in quantity competition. Manufacturer 1 sets the retail quantity $q_1$ to maximize

$$q_1 \left(\alpha + E[\theta] - q_1 - \gamma E[q_2] \right) (1 - \beta),$$
Note: $K = \frac{1}{2\pi^2}, \pi_e = \frac{2\beta}{(2+\gamma)^2} \alpha^2$, and $\bar{\pi}_m = \frac{(1-\beta)}{(2+\gamma)^2} \alpha^2$. We let $\bar{\pi}_e, \bar{\pi}_m$, and $\bar{\pi}_m$ be the deterministic payoffs (in the absence of uncertainty). Let $\delta = E\left([E[\theta|Y]]\right)^2$ for simplicity.

and simultaneously, manufacturer 2 sets the retail quantity $q_2$ to maximize

$$q_2 \left( \alpha + E[\theta] - q_2 - \gamma E[q_1] \right) (1 - \beta),$$

when both manufacturers are uninformed; when both manufacturers are informed, manufacturer 1 sets the retail quantity $q_1$ to maximize

$$q_1 \left( \alpha + E[\theta|Y] - q_1 - \gamma E[q_2|Y] \right) (1 - \beta),$$

and simultaneously, manufacturer 2 sets the retail quantity $q_2$ to maximize

$$q_2 \left( \alpha + E[\theta|Y] - q_2 - \gamma E[q_1|Y] \right) (1 - \beta);$$

if manufacturer 1 is uninformed but manufacturer 2 is informed, manufacturer 1 sets the retail quantity $q_1$ to maximize

$$q_1 \left( \alpha + E[\theta] - q_1 - \gamma E[q_2] \right) (1 - \beta),$$

and simultaneously, manufacturer 2 sets the retail quantity $q_2$ to maximize

$$q_2 \left( \alpha + E[\theta|Y] - q_2 - \gamma E[q_1|Y] \right) (1 - \beta).$$

The e-tailer’s profit comes from the platform usage fee, and its profit function is as follows:

$$E[q_1|Y] \left( \alpha + E[\theta|Y] - E[q_1|Y] - \gamma E[q_2|Y] \right) \beta$$

$$+ E[q_2|Y] \left( \alpha + E[\theta|Y] - E[q_2|Y] - \gamma E[q_1|Y] \right) \beta$$

Table A3 groups the equilibrium outcomes and corresponding expected ex-ante profits of the e-tailer and manufacturers across scenarios.

In the first stage, we have $\pi^{II}_e - \pi^{NN}_e = \frac{2\beta}{(2+\gamma)^2} \delta > 0$, $\pi^{II}_m - \pi^{NN}_m = \frac{\beta}{4} \delta > 0$, and $\pi^{II}_m - \pi^{NN}_m = \frac{(4-\gamma^2-4\gamma)\beta}{4(2+\gamma)^2} \delta$. Therefore, we can obtain that the e-tailer will share information with both manufacturers if $\gamma \in \left(0, 2\sqrt{2} - 2\right)$, otherwise the e-tailer will only share information with any one manufacturer. In addition, we can also get $V^{II} - V^{NN} = \frac{2}{(2+\gamma)^2} \delta > 0$, $V^{II} - V^{NN} = \frac{1}{2} \delta > 0$, and $V^{II} - V^{NN} = \frac{(4-\gamma^2-4\gamma)\delta}{4(2+\gamma)^2}$. Therefore, we can acquire that if $\gamma \in \left(0, 2\sqrt{2} - 2\right)$, sharing information with both manufacturers makes the supply chain better off than others, otherwise sharing

| Equilibrium outcome | Ex-ante profit |
|---------------------|----------------|
| $(N, N)$ $q^{NN}_1 = K\alpha$, $q^{NN}_2 = K\alpha$ | $\pi^{NN}_e = \bar{\pi}_e$, $\pi^{NN}_m = \bar{\pi}_m$, $\bar{\pi}_m = \bar{\pi}_m$ |
| $(N, I)$ $q^{NI}_1 = K\alpha$, $q^{NI}_2 = K\alpha + E[\theta|Y]$ | $\pi^{NI}_e = \bar{\pi}_e + \frac{\beta}{4} \delta$, $\pi^{NI}_m = \bar{\pi}_m$, $\bar{\pi}_m = \bar{\pi}_m$ |
| $(I, I)$ $q^{II}_1 = K\alpha + KE[\theta|Y]$, $q^{II}_2 = K\alpha + KE[\theta|Y]$ | $\pi^{II}_e = \bar{\pi}_e (1 + \frac{\beta}{4\gamma})$, $\pi^{II}_m = \bar{\pi}_m (1 + \frac{\beta}{4\gamma})$, $\bar{\pi}_m = \bar{\pi}_m$ |

Table A3. Operation equilibrium
information with any one manufacturer makes the supply chain better off than others.

REFERENCES

[1] A. Y. K. Chua, How Web 2.0 supports customer relationship management in Amazon, *International J. Electronic Customer Relationship Management*, 5 (2011), 288–304.

[2] R. N. Clarke, Collusion and the incentives for information sharing, *The Bell Journal of Economics*, 14 (1983), 383–394.

[3] A. T. Coughlan and B. Wernerfelt, On credible delegation by oligopolists: A discussion of distribution channel management, *Management Science*, 35 (1989), 226–239.

[4] S. E. Fawcett, C. Wallin, C. Allred, A. M. Fawcett and G. M. Magnan, Information technology as an enabler of supply chain collaboration: A dynamic-capabilities perspective, *J. Supply Chain Management*, 47 (2011), 38–59.

[5] E. Gal-Or, Information sharing in oligopoly, *Econometrica*, 53 (1985), 329–343.

[6] A. Y. Ha, Q. Tian and S. Tong, Information sharing in competing supply chains with production cost reduction, *Manufacturing & Service Operations Management*, 19 (2017), 246–262.

[7] A. Y. Ha, S. Tong and H. Zhang, Sharing demand information in competing supply chains with production diseconomies, *Management Science*, 57 (2011), 566–581.

[8] L. Hao and M. Fan, An analysis of pricing models in the electronic book market, *MIS Quarterly*, 38 (2014), 1017–1032.

[9] S. Huang, X. Guan and Y.-J. Chen, Retailer information sharing with supplier encroachment, *Production and Operations Management*, 27 (2018), 1133–1147.

[10] A. Jain and M. Sohoni, Should firms conceal information when dealing with common suppliers?, *Naval Res. Logist.*, 62 (2015), 1–15.

[11] K. Jerath and Z. J. Zhang, Store within a store, *J. Marketing Research*, 47 (2010), 748–763.

[12] B. Jiang, K. Jerath and K. Srinivasan, Firm strategies in the “mid tail” of platform-based retailing, *Marketing Science*, 30 (2011), 757–775.

[13] B. Jiang, L. Tian, Y. Xu and F. Zhang, To share or not to share: Demand forecast sharing in a distribution channel, *Marketing Science*, 35 (2016), 800–809.

[14] L. Jiang and Z. Hao, Incentive-driven information dissemination in two-tiers supply chains, *Manufacturing & Service Operations Management*, 18 (2016), 393–413.

[15] H. L. Lee and S. Whang, Information sharing in a supply chain, *International Journal of Manufacturing Technology and Management*, 1 (2000), 79–93.

[16] L. Li, Cournot oligopoly with information sharing, *The RAND Journal of Economics*, 16 (1985), 521–536.

[17] L. Li, Information sharing in a supply chain with horizontal competition, *Management Science*, 48 (2002), 1196–1212.

[18] L. Li and H. Zhang, Confidentiality and information sharing in supply chain coordination, *Management Science*, 54 (2008), 1467–1481.

[19] T. Li and H. Zhang, Information sharing in a supply chain with a make-to-stock manufacturer, *Omega*, 50 (2015), 115–125.

[20] Z. Li, S. M. Gilbert and G. Lai, Supplier encroachment under asymmetric information, *Management Science*, 60 (2014), 449–462.

[21] W. Shang, A. Y. Ha and S. Tong, Information sharing in a supply chain with a common retailer, *Management Science*, 62 (2016), 245–263.

[22] X. Sun, W. Tang, J. Zhang and J. Chen, The impact of quantity-based cost decline on supplier encroachment, *Transportation Research Part E: Logistics and Transportation Review*, 147 (2021), 102245.

[23] Y. Tan and J. E. Carrillo, Strategic analysis of the agency model for digital goods, *Production and Operations Management*, 26 (2017), 724–741.

[24] L. Tian, A. J. Vakharia, Y. R. Tan and Y. Xu, Marketplace, reseller, or hybrid: Strategic analysis of an emerging e-commerce model, *Production and Operations Management*, 27 (2018), 1595–1610.

[25] X. Vives, Duopoly information equilibrium: Cournot and Bertrand, *J. Econom. Theory*, 34 (1984), 71–94.

[26] Y. Wang, W. Tang and R. Zhao, Information sharing and information concealment in the presence of a dominant retailer, *Computers & Industrial Engineering*, 121 (2018), 36–50.
[27] J. Wei, J. Lu and J. Zhao, Interactions of competing manufacturers’ leader-follower relationship and sales format on online platforms, *European J. Oper. Res.*, **280** (2020), 508–522.

[28] L. Wei, J. Zhang and G. Zhu, Incentive of retailer information sharing on manufacturer volume flexibility choice, *Omega*, **100** (2021), 102210.

[29] Y. Yan, R. Zhao and Z. Liu, Strategic introduction of the marketplace channel under spillovers from online to offline sales, *European J. Oper. Res.*, **267** (2018), 65–77.

[30] Y. Zennyo, Strategic contracting and hybrid use of agency and wholesale contracts in e-commerce platforms, *European J. Oper. Res.*, **281** (2020), 231–239.

[31] H. Zhang, Vertical information exchange in a supply chain with duopoly retailers, *Production and Operations Management*, **11** (2002), 531–546.

[32] J. Zhang and J. Chen, Information sharing in a make-to-stock supply chain, *J. Ind. Manag. Optim.*, **10** (2014), 1169–1189.

[33] J. Zhang, S. Li, S. Zhang and R. Dai, Manufacturer encroachment with quality decision under asymmetric demand information, *European J. Oper. Res.*, **273** (2019), 217–236.

[34] Q. Zhang, W. Tang, G. Zaccour and J. Zhang, Should a manufacturer give up pricing power in a vertical information-sharing channel?, *European J. Oper. Res.*, **276** (2019), 910–928.

[35] S. Zhang and J. Zhang, Agency selling or reselling: E-tailer information sharing with supplier offline entry, *European J. Oper. Res.*, **280** (2020), 134–151.

Received October 2020; revised July 2021; early access December 2021.

E-mail address: sgqkeyan@126.com
E-mail address: wanyongkt@126.com
E-mail address: djxia@cqu.edu.cn
E-mail address: 1941855158@qq.com