Upstream Information Sharing in Platform-Based E-Commerce with Seller Assortment Planning

Jian Zhang[a], Barrie R. Nault[a,*]

[a] *Haskayne School of Business, University of Calgary, 2500 University Ave NW, Calgary, T1N 2N4, Alberta, Canada*

Abstract

We examine the incentive of an e-commerce platform to share advanced market demand information with a seller offering an assortment of products on its platform. The platform can operate either as a reseller, setting retail prices, or as a marketplace provider, earning commission fees. The shared information comprises the preferences of the consumers who shop on the platform. With this shared information, the seller can adjust its assortment plan according to realized consumer preferences in each planning cycle. Our analysis revolves around three factors: market variability, the cost of adjusting the assortment plan, and the intensity of in-platform competition faced by the seller. Our results indicate that in the reseller setting, the platform can be either better off or worse off with information sharing in the reseller setting, whereas in the commission fee setting, the platform invariably benefits from information sharing. We propose a price ceiling mechanism to incentivize information sharing. Our findings reveal that this price ceiling mechanism is superior to the subsidization mechanism, as it yields benefits for all involved parties - the seller, the platform, and consumers - through information sharing. These results offer valuable insights to e-commerce platforms regarding strategic decisions on information sharing services and contract design to ensure mutual benefits.

Keywords: Information Sharing, E-commerce Platform, Assortment Planning, In-Platform Competition, Mechanism Design.

1. Introduction

As the volume of sales through e-commerce platforms grows, many retailers are introducing e-commerce platforms that provide marketplaces for independent (or third-party) sellers to list their products. The sellers then sell through their chosen platforms and the platform acts as a reseller or as a marketplace provider that only charges a commission fee (Mantin et al., 2014; Yan et al., 2018). For example, Best Buy, Home Depot, and Costco all have their own e-commerce platform to sell their own products as well as provide marketplaces for third-party sellers. With this new trend, many sellers, usually independent small and medium-sized businesses, are able to sell their products through more sales channels over e-commerce

*Corresponding Author
Email addresses: jianzhang@ucalgary.ca (Jian Zhang), nault@ucalgary.ca (Barrie R. Nault)

platforms at a lower cost. These independent sellers have become the main profit contributors to many e-commerce platforms. According to recent statistics, Walmart marketplace added more than 130,000 third-party sellers at the end of 2021 (Capriolo, 2022), and Amazon has 60% of its total sales contributed by independent sellers (Amazon, 2020). By selling on these e-commerce platforms, the sellers derive benefit from each platform's existing customer base and enjoy centralized logistic services provided by the platforms.

When a seller sells a variety of products on a platform it faces an *assortment planning* problem. Conventionally, a seller's assortment is defined by the set of products carried in each store in a given planning cycle. The goal of assortment planning is to specify an assortment that maximizes sales or gross margin subject to various constraints, such as a limited budget for procurement, limited shelf space for displaying products, and a variety of miscellaneous constraints (Kök et al., 2008). In our context, a seller's assortment plan determines the set of products that the seller sells on the focal platform in a planning cycle. More broadly, a seller's assortment plan determines how the seller allocates its resources between the sales channel through the focal platform and seller's other sales channels. As indicated by a SearchNode (2021) survey, assortment planning ranks among the top 10 future areas where AI will support e-commerce businesses. There are many stand-alone assortment management tools, such as Analyse, JustEnough, First Insight, Aptos, and Oracle. However, assortment planning based on consumer information through AI or similar decision support tools has not been studied in the context of the e-commerce platform economy.

When a platform's profit relies on a seller's sales, the seller's product assortment can significantly influence the platform's revenue. For instance, consider a seller who offers a range of products on a platform and maintains an inventory for each product in the platform's fulfillment centers. Should the seller's product assortment lead to stockouts or delivery delays, the seller's sales may decrease, consequently diminishing the platform's profit. Given that a retail e-commerce platform often has superior insight into the preferences of the consumers who shop on the platform, sharing this information with the seller can enhance the seller's assortment planning. For instance, Amazon provides sellers with an analytics tool, Amazon Insights, which features four product lines (Brand Pulse Assessments, Customer Motivation Assessments, Product Growth Opportunities, and Content Engagement Opportunities), backed by a dozen surveys. These tools help sellers understand market dynamics and optimize their product assortment based on consumer demand (Amazon, 2021). These reports enable sellers to better comprehend what consumers want and how to adjust their product assortment to align with market demand effectively.

Several platforms market their information sharing services to attract sellers, underlining the advantages of having more information to enhance product assortment and price optimization. However, the alignment of incentives between the platform and sellers in terms of information sharing might not always be as straightforward as platforms present it in their promotional activities. As noted by Kim (2017), the fact that Amazon can restrict sellers' access to data about their own customers raises serious concerns, potentially undermining the long-term interests of almost every brand. This raises the question: If a platform chooses not to share market information due to concerns over profitability changes and shifts in seller bargaining power, can a simple mechanism be introduced to make upstream information sharing mutually beneficial? Previewing our results, we find that the platform might not always benefit from sharing information, as this can depend on the characteristics of the seller and its product offerings. Nevertheless, our study also uncovers a straightforward mechanism that can ensure the mutual benefit of information sharing.

We focus on three factors that influence the platform's incentive to share information: the market variability, tthe cost of adjusting the assortment plan, and the intensity of the seller's in-platform competition.

Market variability reflects the degree to which the actual market demand deviates from the seller's default assortment plan, the assortment plan made without the platform's information sharing, in each planning cycle. This variability is largely determined by the seller's capacity to predict market trends. Sellers with a superior forecasting ability tend to have a default assortment plan that aligns more closely with the actual market demand, resulting in lower market variability.

In-platform competition among sellers is a common phenomenon on e-commerce platforms. For example, on platforms like Amazon and Best Buy, Microsoft Surface faces competition from similar products offered by Dell, HP, and Lenovo. Since the platform generates revenue from all its sellers, a decline in sales from one seller can potentially be offset by an increase in sales from another due to the competitive environment within the platform.

The assortment plan adjustment cost is determined by various factors such as the agility of the seller's production system and supply chain. This cost directly influences the seller's ability to adapt its assortment plan in response to shifts in market demand.

We investigate the platform's incentives for information sharing, recognizing that sharing information reduces uncertainty by enhancing channel visibility (Gong et al., 2016) and facilitates adaptive coordination of logistics activities between the platform and sellers. Our focus is on the platform's strategic decision about information sharing. This means that once the platform decides to share information with a seller, it influences the game between the seller and the platform in many planning cycles thereafter. Our analysis captures the long-term effects of information sharing by assessing its impact on the ex-ante profits of both the platform and the seller. Our findings offer valuable insights into the strategic design of decision support systems a platform offers to its sellers.

In our setup, we model the problem according to two practical settings, the reseller setting, in which the platform functions as a reseller and sets the retail price, and the commission fee setting, in which the platform functions as a marketplace provider and makes a profit through the commission fees. The platform makes the strategic decision about information sharing at the beginning of the game. At the onset of each planning cycle thereafter, the platform receives a market signal, which reflects consumer preferences for each product variant in the assortment. Without this signal from the platform, the seller makes a default assortment plan for the current planning cycle. However, if the platform shares its observed signal with the seller, the seller can then adjust its assortment plan in consideration of this shared information. While such an adjustment can boost sales through the platform, it also incurs an adjustment cost, which is shouldered by the seller. We account for the influence of the seller's in-platform competition by positing that any loss in the seller's sales through the platform can be partially compensated by the increased sales from other sellers on the same platform.

In our analysis, we establish that the platform consistently benefits from information sharing in a commission fee setting, while it can experience a disadvantage in a reseller setting. We identify the conditions that determine whether the platform chooses to share or withhold information in the reseller setting. Moreover, we shed light on how the platform's decision to share information influences the impacts of the focal factors - including market variability, in-platform competition, and assortment plan adjustment cost - on both the seller and the platform's profitability.

Our study also explores two mechanisms, namely the subsidization mechanism and the price ceiling mechanism, aimed at incentivizing the platform to share information when it stands at a disadvantage from doing so. The subsidization mechanism operates by having the seller pay a fee to the platform for its information sharing service. The price ceiling mechanism, on the other hand, involves the platform entering into a contract with the seller to set an upper limit on the wholesale price, thereby ensuring that information sharing does not adversely affect the platform. We discover that implementing a price ceiling benefits all involved parties - the seller, the platform, and consumers. However, while the subsidization mechanism can improve conditions for both the seller and the platform, it may lead to a decline in consumer welfare.

In summary, our results answer the following research questions:

1. Does an e-commerce platform always share information with sellers?
2. What factors affect an e-commerce platform's incentive to share information with sellers?
3. What strategies can be employed to encourage information sharing when the platform lacks inherent incentives to do so?

Our work is organized as follows. In Section 2, we review the relevant literature and note how our research differs from existing models. In Section 3, we describe the problem we study and provide our notation and assumptions. In Section 4, we model the games between the seller and the platform in both of the reseller setting and the commission fee setting. We derived the equilibrium for the games in both of the reseller setting (Section 4.1) and the commission fee setting (Section **??**). In Section 5, we conduct our analysis based on the equilibriums obtained in Section 4. These analysis focuses on the impact of various factors on the profitability of the seller and the platform when the information is shared or not (Section 5.1), the platform's incentive to share information (Section 5.2), the channel's profitability before and after the platform sharing information (Section 5.3), the subsidization mechanism (Section 5.4), the price ceiling mechanism (Section 5.5), and consumer welfare when the two mechanisms are implemented (Section 5.6). Finally, a summary of our conclusions and their implications are presented in Section 6,

2. Literature Review

Our work relates to the literature about retail e-commerce platforms and information sharing for channel coordination.

The literature on retail e-commerce platforms focuses on a seller's incentive to join a marketplace or a platform's incentive to function as an online reseller or as a marketplace. Ryan et al. (2012) study when a seller that sells on a marketplace faces channel conflict between the marketplace channel and its own retail channel when the marketplace owner can also sell through the marketplace. They analyze the conditions under which the seller and the marketplace owner enter each channel. Hagiu and Wright (2015) study the factors that determine whether a retail platform chooses selling as reseller, functioning as a marketplace, or both. They conclude that the optimal decision of the platform is determined by the signals observed by the platform and the sellers, but they do not consider when the platform can share information with sellers. Tian et al. (2018) consider other factors that affect the platform's choice of reseller or marketplace such as in-platform competition between sellers and the cost of order fulfillment. Jiang et al. (2011) analyze the marketplace seller's strategic behavior of lowering the sales on the platform to prevent the platform from entering the competition as a reseller. Further studies, such as those by Li et al. (2021) and Zha et al. (2022), explored the sharing of information by a retail platform where a manufacturer, the manufacturer's reseller, and the platform all sell identical products on the platform. These parties are involved in a pricing game, and the platform has the ability to share demand information. The key focus of these researchers was on determining who should receive the information - the manufacturer, the reseller, or both. Distinct from these bodies of literature, our study takes into account a setting where the platform's information sharing influences not only the dynamics of the pricing game, but also allows the seller to adjust its assortment plan to boost sales. This consideration comes into play in light of the in-platform competition from other sellers offering similar products.

The literature on information sharing for channel (or supply chain) coordination is extensive and focuses on the model of a channel in which the information is unilaterally or bilaterally shared, that is, upstream or/and downstream. The information to be shared can be demand information or product quality. Directly related to our model, the research on upstream information sharing usually assumes that the information shared upstream is demand related. Li et al. (2006) study upstream information sharing in a multi-echelon supply chain and analyze the value of sharing different types of information, including demand information, shipping information, and inventory information. Lee et al. (2000) and Raghunathan (2001) study a channel with a manufacturer and a retailer, and focus on the impact of sharing demand forecasts upstream on the manufacturer's lead time for delivery and inventory level. Ren et al. (2010) also study upstream sharing of demand forecasts in a multi-period setting, concluding that a long-term supply contract encourages the downstream firm to share information upstream truthfully. Iyer and Ye (2000) examine a supply chain where the inventory and delivery of orders are maintained by the manufacturer and study upstream sharing of the retailer's promotion plan that influences the manufacturer's inventory plan. Cachon and Lariviere (2001) study how a manufacturer's upstream sharing of demand forecasts can affect its supplier's setting of production capacity. Özer and Wei (2006) and Chu et al. (2017) study upstream demand information sharing that considers both the honesty of the retailer and the manufacturer setting capacity. Shang et al. (2015) examine a case where a retailer can share demand forecasts upstream with two competing manufacturers. In addition to the sharing of demand information, Li (2002) studies upstream sharing of the retailer's cost and competition, and Gavirneni et al. (1999) study upstream sharing of the retailer's inventory level.

The research on downstream information sharing usually looks at shared as demand or quality information. Guo and Iyer (2010) study a channel where the upstream manufacturer revises its posterior estimates of consumer preferences based on sequentially acquired signals, and analyze the impact of different sharing regimes such as mandatory sharing and voluntary sharing on the manufacturer's incentive for information acquisition. Guo (2009) investigates two sharing formats where a manufacturer shares product quality information with its consumers directly or through the downstream retailers. Jiang et al. (2016) show that the downstream sharing of demand information by a manufacturer hurts the retailer because the list price for the manufacturer is higher in certain cases. Gal-Or et al. (2008) analyze a manufacturer's incentive for downstream demand information sharing by comparing the manufacturer's profitability sharing with two retailers versus sharing with only one. They find that it is not always optimal for the manufacturer to share information with all retailers. Anand and Goyal (2009) study information leakage in a setting where two retailers compete in a Cournot game and share a common upstream supplier. They analyze the supplier's incentive to leak information from the informed retailer to the uninformed one, and show that the supplier is always incentivized to leak information. Jain (2022) studies the downstream share of demand information in a setting with two competing manufacturers and a common retailer. They show how the competition in the upstream affect the manufacturers' incentive for sharing information downstream. Choi et al. (2013) investigate how the return policy between a supplier and retailer in a supply chain impacts the incentive for the upstream supplier to share demand information downstream.

The research on bilateral information sharing focuses on both upstream and downstream firms sharing information. In addition to downstream sharing from the manufacturer, Guan and Chen (2017) also consider the options in which the manufacturer can acquire the retailer's private market information at a cost. He et al. (2008) and Dukes et al. (2011) both study the channel where a manufacturer and a retailer have asymmetric information about demand signals. He et al. (2008) focus on the sharing of demand volatility and show that price coordination increases the incentive of the manufacturer and the retailer to share information. Dukes et al. (2011) show that sharing signals bilaterally only benefits the manufacturer and can harm both the retailer and consumers. Ganesh et al. (2014) study the bilateral sharing of demand information in a multi-echelon supply chain with multiple substitute products. They found that product substitution can reduce the value of information sharing.

Our research contributes to the literature pertaining to information sharing for channel coordination through the following aspects:

First, we delve into the dynamics of information sharing within the context of e-commerce platforms. These platforms come with their own set of unique features that distinguish them from conventional retail supply chains. To fully account for these unique features, we integrate factors such as assortment planning, the reseller and commission fee settings, and in-platform competition into our study. Furthermore, acknowledging that the platform's decision to share information represents a long-term strategic decision, we evaluate the impact of information sharing on the various stakeholders involved - the platform, the seller, and the consumers - through the lens of changes in long-run expected profits or welfare.

Second, we move beyond the conventional solution of subsidization and propose a price ceiling mechanism to incentivize information sharing. Our welfare analysis reveals that while both subsidization and price ceiling mechanisms can incentivize the platform to share information, the latter guarantees superior consumer welfare. This finding underscores the potential advantages of signing a wholesale price in fostering information sharing within an e-commerce context.

3. Notation and Assumptions

We model our platform-based e-commerce setting as a multi-stage game with a seller (S) and a retail e-commerce platform (P). The seller updates its assortment plan on the platform periodically. A seller's assortment plan refers to the stock levels maintained for each product variant within their offered range. These product variants may include items with distinct features catering to different consumer preferences. For instance, a seller can offer skis with the assortment of different sizes, lengths, and other features. The seller updates and implements an assortment plan periodically. We use *planning cycle* to refer a period over which the seller updates and implements an assortment plans.

Information and Uncertainty. The platform possess valuable information about consumers, such as their preferences, purchasing habits, and demographic details. With these insights, the seller can estimate its ideal assortment plan that matches the demand for consumers with various requirement. Here, we define that the seller's assortment plan misfits the consumer demand if there are loss of sales due to stockout for some product variants in the assortment. We name the seller's assortment without the platform's information sharing as the seller's *default assortment plan.* Because the seller can map the information shared by the platform to the misfit of the default assortment plan after the platform shares the market information, without loss of generality, we let the misfit of the seller's default assortment plan, denoted by θ, be the market signal privately observed by the platform at the beginning of the planning cycle. We have the following assumption about θ:

Assumption 1 (Information and Uncertainty). *In each planning cycle the misfit of the seller's default assortment plan θ is drawn from a uniform distribution $U(-v, v)$ where $v \in [0, 1]$, and the distribution is public information.*

In our stylized model, Assumption 1 can be illustrated using a Salop's circle as shown in Figure 1, where θ is distributed along the Salop's circle with a circumference of $2v$. We utilize the Salop circle in a non-traditional way, not for representing firm locations, but rather to demonstrate how the signal observed by the platform is distributed horizontally. For instance, suppose that the quantity of the total demand is public information, a seller offering skis on an e-commerce platform may benefit from the platform's knowledge of the distribution of potential buyers' height, skill level, and other preferences. The information shared by the platform is the consumers' preferences for various product variants. Lacking this information, the seller is more susceptible to stockouts or overstocks for some product variants, leading to a loss of the seller's overall sales on the platform. In other words, if the platform shares its observed signal with the seller, the seller will know how they should adjust the inventory levels of certain product variants (increasing some while reducing others) within their limited budget. The horizontally differentiated product or service has been widely studied in the literature (e.g., Meagher and Zauner, 2005; Akçay et al., 2010; Gu and Li, 2022). It is usually assumed that the distribution of consumers' preferences, or tastes, is fixed and public information, such as uniformly distributed along a unit line. Here, we focus on a case where the distribution of consumers' preferences is unknown to the seller, and the seller needs the platform to share the information to improve its assortment plan.

The parameter v characterizes the level of uncertainty in consumer preferences, signifying the market variability for the seller. This parameter reflects the seller's ability to accurately predict consumer preferences

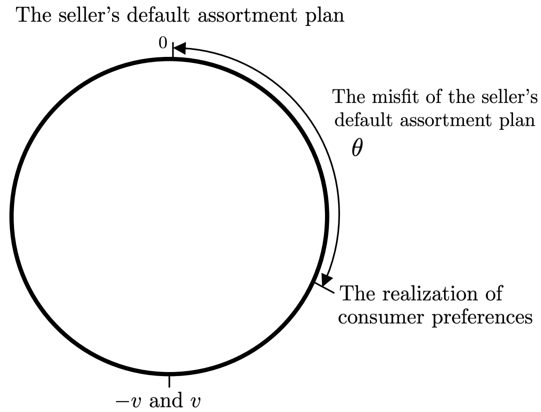

Figure 1: Demonstrating the misfit of S's default assortment using Salop's circle.

and optimize its default assortment plan in the absence of information shared by the platform. A seller with superior market analytics capacity will face lower market variability. As per our definition of the misfit of the assortment plan, θ, the value of v is also influenced by factors such as the inventory of each product variant in the seller's assortment stored at the platform's fulfillment center. If the seller maintains ample inventory for each product variant in its default assortment, then the chances of sales loss due to stockouts of certain product variants become negligible, translating to $v = 0$. However, maintaining such an assortment plan would require a substantial budget from the seller. In our study, we focus on scenarios where the seller's default assortment plan is constrained, implying $v > 0$.

Pricing. For simplicity, we assume that the product variants in the assortment are not different in quality and value, and so all the product variants in the assortment will be priced the same. As we are not focusing on the detailed pricing methodology and only interested in how the pricing behaviours affect information sharing decisions, our simplification does not affect our conclusions. We consider two modes of the platform's profit model:

Reseller Setting: In the reseller setting, the seller sets a wholesale price, denoted by $w \in \mathbb{R}_+$, for each product at the beginning of a planning cycle. Subsequently, the platform sets a retail price, denoted by $r \in \mathbb{R}_+$, for each product.

Commission Fee Setting: In the commission fee setting, the seller sets a list price, denoted by $l \in \mathbb{R}_+$, for each product. For each product sold on the platform, the platform charges a commission fee proportional to the list price, represented by γl, where $\gamma \in (0, 1)$ is the commission fee ratio. The commission fee ratio is influenced by many factors outside the purview of the game between the seller and the platform, and it is usually fixed across all sellers selling on the platform. In the present work, we consider γ as exogenous in our model.

Let p represent the price a consumer must pay for a product. In the reseller setting, this is expressed as $p = r$, while in the commission fee setting, it's expressed as $p = l$.

Sales quantity with in-platform competition. As the platform may host other sellers selling substitute products, the seller faces in-platform competition. We use $\eta \in \mathbb{R}_+$ to represent the elasticity of substitution of competitors' products for our seller's products on the same platform. From the platform's perspective the seller's loss of sales can be offset by an increase in sales of substitute products from competing sellers sold through the platform. Let $x \in (-v, +v)$ be the seller's assortment plan adjustment after the platform sharing information. Then, we have the following assumption about the form of the sales quantities of for the seller and the platform:

Assumption 2 (Sales quantity with in-platform competition). *The seller's sales quantity, denoted by $Q^S(p, x, \theta, \eta)$, is represented by $Q^S(p, x, \theta, \eta) = 1 - (1 + \eta)(p + |\theta - x|)$; the platform's sales quality, denoted by $Q^P(p, x, \theta)$, is represented by $Q^P(p, x, \theta) = 1 - (p + |\theta - x|)$.*

In Assumption 2, our stylized function for the seller's sales quantity captures two features. First, as the final price increases, more consumers choose not to purchase. We model this effect as a linear decline in price, a common formulation. Second, as the seller adjusts its default assortment plan to reduce the magnitude of misfit of assortment, the seller's sales quantity increases. The assortment plan adjustment x and the misfit of the adjusted assortment plan $\theta - x$ can be negative or positive, and the sale quality only depends on the magnitude of the misfit. A similar setting is used by Hagiu and Wright (2015) to model the gap between the market activity by the seller on a retail platform and the realized ideal market activity for that seller as a horizontally distributed signal. The setting applies in our problem as well because the seller's assortment plan is defined as a horizontal choice by a seller, which is similar to the horizontal market activity defined by Hagiu and Wright (2015). The presence of in-platform competition causes the sales quantity to become more sensitive to both the price and the misfit of the seller's assortment plan. On the platform, when the seller loses sales due to in-platform competition, represented by $\eta(p + |\theta - x|)$, these sales are replaced by those of competitors on the same platform. Note that competition from outside the platform has the same impact on sales quantity for both the platform and the seller. We normalize the effect of competition from outside the platform to 1 because it only scales the result in our analysis.

Costs Associated with Assortment Plan Adjustments. When a seller modifies its assortment plan, various costs are associated with the adjustment process. These costs may encompass additional production expenses due to altering the production schedule, increased shipping costs, extra labour expenditures, and heightened supplier management costs. Moreover, sellers may invest in personalized communication with consumers to influence their preferences. For instance, if a consumer contacts the online customer service of a seller for assistance in making a purchase decision, the customer service representative can guide the consumer towards an alternative option if their preferred choice is unavailable. We make the following assumption regarding the cost structure of a seller's assortment plan adjustment:

Assumption 3 (Assortment Plan Adjustment Cost). *When a seller makes an assortment plan adjustment of x, they incur a cost of $\alpha|x|$, where $\alpha \in \mathbb{R}_+$ is publicly known information.*

We refer to α as *unit adjustment cost.* Both the platform and the seller can estimate α using historical data. We characterize the assortment plan adjustment cost as a linear function of the magnitude of the adjustment, which confines our results to conditions solely based on the marginal cost for making assortment plan adjustments. Factors that lead to non-linear costs, such as economies of scale, are not considered in our analysis.

4. Models

We model the game between the seller and the platform in the reseller and the commission fee settings, respectively. For each setting, we depict the sequence of events and derive the equilibrium in scenarios where the platform either shares or withholds information.

4.1. The reseller setting

In our model, when the platform functions as a reseller, it involves the platform's strategic decisions on whether to share information, and the seller's decisions regarding assortment plan adjustment, as well as both the platform and the seller's price setting. The platform's decision to share information is considered a

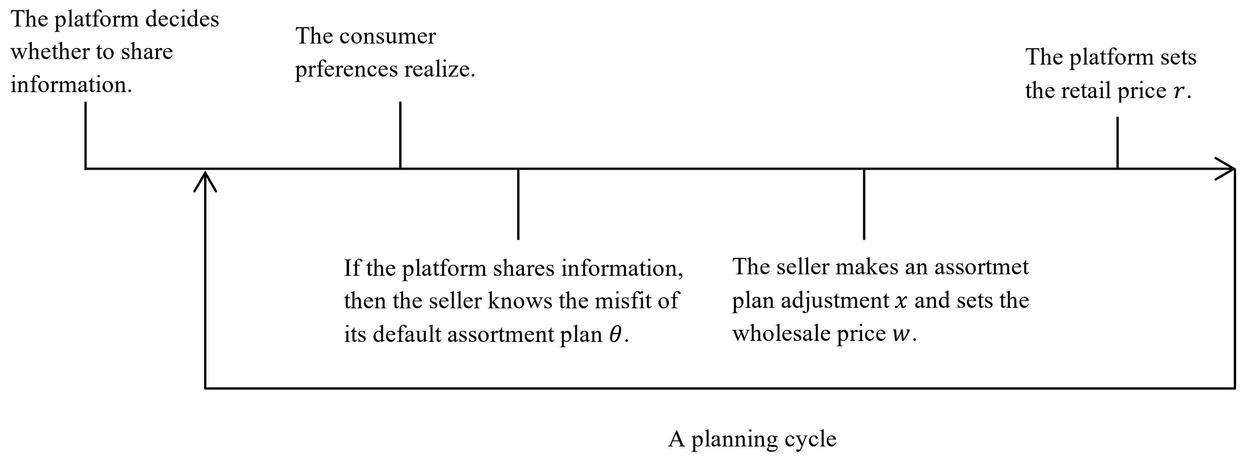

Figure 2: The timeline for the related activities of the seller and platform in a planning cycle in the reseller setting.

strategic move as, once enacted, it will have long-term implications on the pricing game between the seller and the platform in every planning cycle thereafter.

We structure our model timeline into three stages, each representing the decisions the platform and seller must make within the reseller setting. The decision-making timeline for both the seller and the platform is detailed in Figure 2. The three stages of the game can be summarized as follows:

- Stage 1: The platform decides whether or not to share information strategically, i.e., sharing the market signals with the seller in all the planning cycles thereafter.
- Stage 2: In each planning cycle depending on whether the platform shares information, the seller optimizes its assortment plan adjustment, x, and wholesale price, w.
- Stage 3: In each planning cycle after the seller has made its choices about x and w, the platform optimizes its retail price, r.

As per the usual approach, we analyze our stages using backward induction. We investigate two scenarios, one where the platform shares and one where it withholds its observed market signal in Stage 1. We use the subscript s or ns to denote the scenarios in which the platform shares or does not share information, respectively.

Stage 3: The platform chooses retail price

We use $\pi^P_{\xi,\theta}(r)$ to denote the platform's profit for the current planning cycle when the platform sets the retail price to r, given the realization of the market signal as θ and the platform's decision to share information as $\xi \in \{ns, s\}$. Based on Assumption 2 regarding the platform's effective demand function, $Q^P(r, x, \theta)$, we establish the following:

$$
\begin{aligned}
\pi^P_{\xi,\theta}(r) &= (r - w)Q^P(r, x, \theta) \\
&= (r - w)\left(1 - r - |\theta - x|\right). \qquad (1)
\end{aligned}
$$

By maximizing $\pi^P_{\xi,\theta}(r)$ with respect to r, we solve the price that the platform puts forward to consumers as a function of w and x, denoted by $r_{\xi,\theta}(w, x)$, as:

$$
r_{\xi,\theta}(w, x) = \frac{1 - |\theta - x| + w}{2}.
$$

Stage 2: The seller chooses its assortment plan adjustment and wholesale price

In Stage 2, the seller optimizes its profit, taking into account the form of $r_{\xi,\theta}(w, x)$. The particular structure of the seller's profit function hinges on whether or not the platform shares its information. We use $\pi^S_{\xi,\theta}(w, x)$ to denote the seller's profit when its choice variables are w and x, given the realization of the market signal, θ, in scenario ξ.

When the platform does not share information ($\xi = ns$), the seller's profit for the current planning cycle, $\pi^S_{ns,\theta}(w, x)$, can be obtained as its margin times demand less assortment plan adjustment cost. Based on Assumptions 2 and 3 we have

$$
\pi^S_{ns,\theta}(w, x) = \int_{-v}^{v} \frac{wQ^S\big(r_{ns,\theta}(w, x), x, \theta, \eta\big)}{2v}\, \mathrm{d}\theta - \alpha|x| \qquad (2)
$$

From the form of $\pi^S_{ns,\theta}(w, x)$, we can see that as the platform does not share information, the seller does not include θ explicitly in its profit function, and therefore has to integrate over $[-v, v]$. With the seller's and platform's profit functions as defined above in (2) and (1) we have that in the equilibrium of scenario ns, the seller's choices of w and x, denoted by $w^*_{ns,\theta}$ and $x^*_{ns,\theta}$, and the platform's choice of r, denoted by $r^*_{ns,\theta}$, can be obtained as

Equilibrium choices in scenario ns

$$
r^*_{ns,\theta} = \frac{1}{4} + \frac{1}{2(\eta + 1)} - \frac{|\theta|}{2} - \frac{v}{8}, \quad w^*_{ns,\theta} = \frac{1}{1 + \eta} - \frac{v}{4} - \frac{1}{2}, \quad \text{and} \quad x^*_{ns,\theta} = 0. \qquad (3)
$$

As the seller cannot determine the misfit of its default assortment without θ, it does not make an assortment plan adjustment. Note that if the in-platform competition, η, becomes excessively large, it may result in an absurd equilibrium with negative price(s). Our analysis focuses on situations where η falls within a range that leads to a realistic equilibrium.

Based on the equilibrium choices of the seller and the platform, as exhibited in (3), we can draw several insights. First, as the in-platform competition, η, intensifies, both the platform's retail price and the seller's wholesale price tend to decrease. However, the platform displays a reduced propensity to lower the retail price, as any demand deficit is balanced by the profits garnered from substitute products supplied by other platform sellers. Second, in response to market variability, both the seller and the platform adjust their prices downward. This is a standard tactic observed in the marketplace; for example, in the face of high consumer preference uncertainty, the likelihood of running out of specific product variants in the assortment increases. As a result, both the seller and the platform are incentivized to set a lower price to clear the inventory. Lastly, we observe that when market conditions diverge from the seller's default assortment plan, the ensuing misfit contributes to a reduction in demand. The platform can offset this decline by decreasing the retail price.

When the platform shares information ($\xi = s$), the platform shares its market information with the seller before the seller sets its wholesale price and assortment plan adjustment. Thus, the seller knows the realized misfit of its default assortment for the planning cycle, θ, before maximizing its profit choosing w and x. The seller's profit when the platform shares information, denoted by $\pi^S_{s,\theta}(w,x)$, can be obtained as its margin times demand less its assortment plan adjustment cost. Using Assumptions 2 and 3 we have

$$\pi^S_{s,\theta}(w,x) = wQ^S\big(r_{s,\theta}(w,x), x, \theta, \eta\big) - \alpha|x|, \tag{4}$$

where θ now appears explicitly.

Considering the seller's and platform's profit functions in (4) and (1), we have that when the platform shares information, the equilibrium solution for the seller's choices of w and x, denoted by $w^*_{s,\theta}$ and $x^*_{s,\theta}$ respectively, and the platform's choice of r, denoted by $r^*_{s,\theta}$, varies based on the realized market signal θ within a given planning cycle as

Equilibrium choices in scenario s

$$r^*_{s,\theta} = \begin{cases} \frac{1}{2(1+\eta)} + \frac{1}{4} & \text{if } |\theta| < \hat{\theta} \\ \frac{1}{2(1+\eta)} + \frac{1}{4} - \frac{3|\theta|}{4} & \text{if } |\theta| > \hat{\theta} \end{cases}, \quad w^*_{s,\theta} = \begin{cases} \frac{1}{1+\eta} - \frac{1}{2} & \text{if } |\theta| < \hat{\theta} \\ \frac{1}{1+\eta} - \frac{1}{2} - \frac{|\theta|}{2} & \text{if } |\theta| > \hat{\theta} \end{cases}, \quad \text{and} \quad x^*_{s,\theta} = \begin{cases} \theta & \text{if } |\theta| < \hat{\theta} \\ 0 & \text{if } |\theta| > \hat{\theta} \end{cases}, \tag{5}$$

where

$$\hat{\theta} = \frac{2(1 - 4\alpha - \eta)}{1 + \eta}.$$

Since θ is drawn from $U(-v, v)$, we know that the seller will always set $x^*_{s,\theta} = \theta$ if $\hat{\theta} > v$, or always set $x^*_{s,\theta} = 0$ if $\hat{\theta} < 0$.

By observing the equilibrium solution in scenario s, we have the following lemma:

Lemma 1. *When the platform shares information in the reseller setting, the seller is incentivized to adjust the assortment plan only when the misfit magnitude is sufficiently small ($|\theta| < \hat{\theta}$). For larger misfits ($|\theta| > \hat{\theta}$), the seller opts for wholesale price reduction rather than making assortment plan adjustments.*

Lemma 1 shows that the seller opts for assortment plan adjustments only when the misfit is relatively small, a finding that gains significance given our assumption of a linear relation between adjustment cost and the magnitude of adjustment. When no delivery adjustment is made by the seller, as the misfit magnitude increases, the seller's profit reduces at a decreasing rate. When misfit magnitude is high enough that the average profit loss per misfit unit is less than the unit adjustment cost, the seller refrains from any assortment plan adjustment. Conversely, if the misfit is sufficiently small, such that the average profit loss per unit misfit exceeds the unit adjustment cost, the seller opts to adjust the delivery to rectify the misfit.

Observing the threshold value, $\hat{\theta}$, it becomes clear that as the adjustment cost α and in-platform competition η increase, $\hat{\theta}$ decreases. This reduction signifies a corresponding decrease in the seller's incentive to make assortment plan adjustments. It is intuitive to understand that a higher adjustment cost curtails the seller's incentive to make assortment plan adjustments. Moreover, since the seller's wholesale price decreases with intensifying in-platform competition, the incentive for the seller to adjust the assortment plan is further dampened in a highly competitive environment.

Stage 1: The platform decides whether to share information

In Stage 1, the platform chooses to share or withhold information strategically to maximize its long-term expected profit. Let $\pi^{S*}_{\xi,\theta}$ and $\pi^{P*}_{\xi,\theta}$ denote the equilibrium profits of the seller and the platform respectively within a planning cycle where the market signal θ is realized in scenario $\xi \in \{ns, s\}$. When θ is uniformly drawn from $U(-v, v)$ in each planning cycle, the ex-ante expected profits of the platform and the seller reflects the long-term expected profits. The ex-ante expected profits of the platform and the seller, denoted

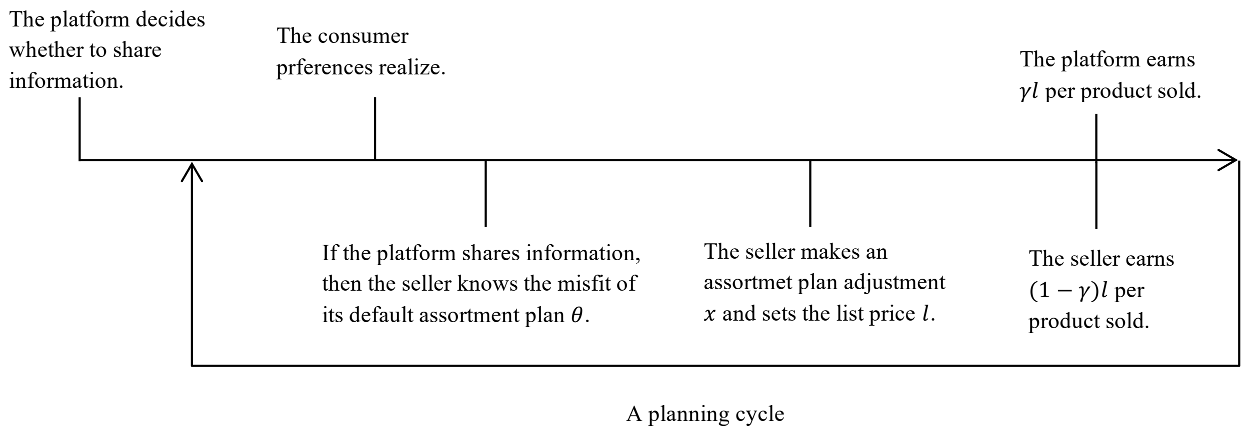

Figure 3: The timeline for the related activities of the seller and platform in a planning cycle in the commission fee setting.

by π_ξ^{S*} and π_ξ^{P*} respectively, can be obtained as

$$\pi_\xi^{S*} = E_\theta\left(\pi_{\xi,\theta}^{S*}\right) = \int_{-v}^{v} \frac{\pi_{\xi,\theta}^{S*}}{2v}\,\mathrm{d}\theta \text{ and } \pi_\xi^{P*} = E_\theta\left(\pi_{\xi,\theta}^{P*}\right) = \int_{-v}^{v} \frac{\pi_{\xi,\theta}^{P*}}{2v}\,\mathrm{d}\theta,\ \ \forall\xi \in \{ns, s\}. \tag{6}$$

(See Appendix A for the forms of π_ξ^{S*} and π_ξ^{P*} for all $\xi \in \{ns, s\}$.)

4.2. The commission fee setting

In the commission fee setting, because the rate of the commission fee, γ is fixed, we set up the timeline for our model in two stages representing decisions that the platform and seller must make when the platform functions as a marketplace provider. The timeline of decisions for the seller and the platform is detailed in Figure 3. The two stages of the game is summarized as follows:

- Stage 1: The platform decides whether or not to share information strategically, i.e., sharing the market signals with the seller in all the planning cycles thereafter.
- Stage 2: In each planning cycle based on whether or not the platform shares information, the seller optimizes its assortment plan adjustment, x, and list price, l.

In order to differentiate from the reseller setting, we use the subscript s' or ns' in the commission fee setting, representing the scenarios in which the platform shares or withhold information, respectively. Unlike the previous model, in this commission fee setting, the platform doesn't need to make an additional pricing decision, as the commission fee is imposed per sold product as a fixed proportion (γ) of the list price.

According to Assumption 2 related to the platform's effective demand function, $Q^P(r, x, \theta)$, we establish that for any planning cycle with a given market signal θ in scenario $\xi' \in ns', s'$, the platform's equilibrium profit, denoted by $\pi^{P*}_{\xi',\theta}$, can be calculated as:

$$\pi^{P*}_{\xi',\theta} = \gamma l^*_{\xi',\theta} Q^P(r, x^*_{\xi',\theta}, \theta),$$

where $l^*_{\xi',\theta}$ and $x^*_{\xi',\theta}$ denote the seller's equilibrium choices for l and x respectively in a planning cycle, with a market signal θ realized in scenario ξ'.

Stage 2: The seller chooses its assortment plan adjustment and list price

In Stage 2 the specific form of the seller's profit function depends on whether the platform shares the market signal, θ. We use $\pi^S_{\xi',\theta}(l,x)$ to denote the seller's profit when its choice variables are l and x given the realized market signal, θ, in scenario $\xi' \in \{ns', s'\}$.

When the platform does not share information ($\xi' = ms'$), the seller's profit in a planning cycle with the realization of the market signal θ, $\pi^S_{ns',\theta}(l,x)$, can be obtained as

$$\pi^S_{ns',\theta}(l,x) = \int_{-v}^{v} \frac{(1-\gamma) l Q^S\big(l, x, \theta, \eta\big)}{2v} \, \mathrm{d}\theta - \alpha |x|$$

With the seller's profit function as defined above, we have that in the equilibrium of scenario ns', the seller's choices of l and x, denoted by $l^*_{ns',\theta}$ and $x^*_{ns',\theta}$, can be obtained as

Equilibrium choices in scenario ns'

$$l^*_{ns',\theta} = \frac{1}{2(1+\eta)} - \frac{v}{4}, \quad \text{and} \quad x^*_{ns',\theta} = 0.$$

The equilibrium choices of the seller in scenario ns' above show that the seller's equilibrium list price inversely correlates with the in-platform competition and the market variability. This outcome aligns with the equilibrium wholesale price for scenario ns.

When the platform shares information ($\xi' = s'$), the seller's profit when the platform shares information, denoted by $\pi^S_{s',\theta}(l,x)$, can be obtained as

$$\pi^S_{s',\theta}(w,x) = (1-\gamma) l Q^S\big(l, x, \theta, \eta\big) - \alpha |x|. \tag{7}$$

With the seller's profit function above, we have that when the platform shares information, during any planning cycle with a realized θ, the equilibrium solution for the seller's choices of l and x, denoted by $l^*_{s',\theta}$ and $x^*_{s',\theta}$, can be obtained as

Equilibrium choices in scenario s'

$$l^*_{s',\theta} = \begin{cases} \frac{1}{2(1+\eta)} & \text{if } |\theta| < \hat{\theta}' \\ \frac{1}{2(1+\eta)} - \frac{|\theta|}{2} & \text{if } |\theta| > \hat{\theta}' \end{cases}, \quad \text{and} \quad x^*_{s',\theta} = \begin{cases} \theta & \text{if } |\theta| < \hat{\theta}' \\ 0 & \text{if } |\theta| > \hat{\theta}' \end{cases}, \tag{8}$$

where

$$\hat{\theta}' = \frac{2(1-2\alpha-\gamma)}{(1+\eta)(1-\gamma)}.$$

Like in scenario s as described in Lemma 1, the seller's equilibrium choices of l and x in scenario s' indicate that the seller adjusts the assortment plan only when the misfit of its default assortment is not very big ($|\theta| < \hat{\theta}'$). If the misfit of the default assortment is sufficiently large ($|\theta| > \hat{\theta}'$), the seller opts to decrease the list price without making an adjustment to the assortment plan. When the threshold value, $\hat{\theta}'$, is significantly low ($\hat{\theta}' < 0$) or high ($\hat{\theta}' > v$), the seller adheres to a consistent strategy: always adjusting the assortment plan in case of a low threshold or never adjusting it in case of a high threshold.

Stage 1: The platform decides whether to share information

Similarly to the reseller setting, the platform, within the commission fee setting, determines whether to share information strategically based on its ex-ante expected profit. Let $\pi^{S*}_{\xi',\theta}$ and $\pi^{P*}_{\xi',\theta}$ be the equilibrium profits of the seller and platform respectively within a planning cycle where the market signal θ is realized in scenario $\xi' \in \{ns', s'\}$. The ex-ante expected profits of the platform and seller, denoted by π^{S*}_{ξ} and π^{P*}_{ξ} respectively, can be obtained as

$$\pi^{S*}_{\xi'} = E_\theta\left(\pi^{S*}_{\xi',\theta}\right) = \int_{-v}^{v} \frac{\pi^{S*}_{\xi',\theta}}{2v}\,\mathrm{d}\theta \text{ and } \pi^{P*}_{\xi'} = E_\theta\left(\pi^{P*}_{\xi',\theta}\right) = \int_{-v}^{v} \frac{\pi^{P*}_{\xi',\theta}}{2v}\,\mathrm{d}\theta, \quad \forall \xi' \in \{ns', s'\}. \tag{9}$$

(See Appendix A for the forms of $\pi^{S*}_{\xi'}$ and $\pi^{P*}_{\xi'}$ for all $\xi' \in \{ns', s'\}$.)

5. Analysis

In this section, we initiate our discussion by examining the impact of various factors such as in-platform competition, assortment adjustment cost, and market variability on the profitability of the platform and seller across different information sharing scenarios. Subsequently, we delve into an evaluation of the platform's incentive for information sharing, achieved by contrasting its profitability before and after the enactment of information sharing within the established equilibrium. Furthermore, we scrutinize the ramifications of the platform's decision to share information on overall channel profitability. Particularly in situations where the platform shows no inclination towards information sharing, we consider two potential incentivizing mechanisms – subsidization and price ceiling – to facilitate information sharing.

5.1. The impact of various factors on profitability

Upon analyzing the game's equilibria under both the reseller and the commission fee settings, in scenarios where the platform either shares or withholds information, we can propose the following regarding the impact of our primary factors: the intensity of in-platform competition, the assortment adjustment cost, and market variability:

Proposition 1. *Irrespective of the platform's information sharing decision,*

(a) the seller's ex-ante profit decreases in the in-platform competition in both the reseller setting and commission fee settings, while the platform's ex-ante profit increases in the reseller setting but decreases in the commission fee setting;

(b) the platform's and seller's ex-ante profits decrease in market variability in both the reseller setting and commission fee settings.

When the platform shares information,

(c) The seller's ex-ante profit decreases in the unit assortment adjustment cost when the threshold for the market signal $\hat{\theta}$ or $\hat{\theta}'$ is positive, whereas the platform's ex-ante profit decreases in the same cost only when the threshold for the market signal lies within $(0, v)$.

Proof: See Appendix Appendix B.

In Proposition 1(a), the seller's worsening position with intensifying in-platform competition in both the reseller and commission fee settings aligns with intuitive expectations. As for the platform, its profit trajectory diverges depending on the setting. In the commission fee setting, the platform's profit depends significantly on the seller's profit, hence it deteriorates as the in-platform competition amplifies, mirroring the seller's experience. Conversely, in the reseller setting, the platform finds itself in a better position. This occurs because, when the seller reduces the wholesale price in response to heightened in-platform competition, the platform is not compelled to proportionally lower the retail price. Consequently, the platform can maintain a larger margin on each product sale.

Proposition 1(b) reveals that market variability adversely impacts both the seller and the platform when the platform does not share information. As mentioned earlier, market variability is influenced by the seller's ability to predict consumer preferences, and this variability is reduced if the seller can more accurately anticipate consumer preferences. Thus, Proposition 1(b) implies that both the platform and the seller would benefit from improvements in the seller's ability to predict consumer preferences. This outcome illustrates the spillover effect driven by the upstream firm's IT investment, as identified in earlier research by Cheng and Nault (2007).

Proposition 1(c) reveals the impact of assortment adjustment cost on the profitability of both the seller and the platform. From the forms of the equilibrium choices for scenarios s and s' as shown in (5) and (8), we can observe that if $\hat{\theta}$ or $\hat{\theta}'$ is less than 0, then the seller does not make assortment adjustment for any realization of θ. In this case, the magnitude of the unit assortment adjustment cost doesn't affect either the seller or the platform. If $\hat{\theta}$ or $\hat{\theta}'$ is greater than v, then the seller will make assortment plan adjustment to remove the misfit for any realization of θ.Consequently, when $\hat{\theta}$ or $\hat{\theta}'$ is greater than v, then the magnitude of the unit assortment adjustment cost only impacts the seller because the seller bears cost incurred by removing the misfit.

5.2. The platform's incentive for information sharing

We analyze the platform's incentive to share information strategically in Stage 1 of both the reseller and commission fee settings based on the ex-ante expected profits obtained in (6) and (9). We have the following proposition that determines when the platform should share information.

Proposition 2 (The platform's incentive to share information).

(a) In the reseller setting, the platform has an incentive to share information only if market variability, v, is sufficiently low, i.e.,

$$v < \frac{1}{\eta+1}\left(\frac{16(1-4\alpha-\eta)^2(1+8\alpha+11\eta)}{3}\right)^{\frac{1}{3}}. \tag{10}$$

(b) In the commission fee setting, the platform always has an incentive to share information.

Proof: See Appendix.

Proposition 2(a) shows that the platform is not always willing to share information voluntarily in the reseller setting. It is counter-intuitive in that the platform prefers to withhold information when market variability is high, which we explain as follows. In the scenario where the platform withholds information, the seller's wholesale price depends on market variability. When market variability is high, the seller sets a lower wholesale price to enhance demand. The platform benefits from the seller's lower wholesale price because it leave more room for the platform to adjust the retail price based on its private information θ.

The platform's information advantage can be demonstrated in the equilibrium of scenario ns as shown in (3), where the seller's wholesale price is determined by v and the platform's retail price is determined by both v and θ. This information advantage incentivizes the platform to withhold information. When the platform shares information, both the seller and the platform know the value of θ at the time of price setting. Depending on the realization of θ, the seller decides whether to adjust the assortment plan or lower the wholesale price. When market variability is low, the seller is more likely to adjust the assortment plan without modifying the wholesale price, which benefits the platform as sales quantity escalates due to the elimination of assortment plan misfit. However, when market variability is high, the seller tends to retain the assortment plan. In this scenario, the platform neither gains from the potential increase in the seller's sales quantity due to assortment plan adjustment nor retains its informational advantage in the pricing game as in scenario ns. Therefore, the platform chooses not to share information when the market variability is high.

Proposition 2(b) illustrates that the platform consistently benefits from information sharing under the commission fee setting. In this context, the platform's profit is closely tied to the seller's profit. When information is shared, it leads to an increase in the seller's profit, which subsequently translates into a profit increase for the platform. It is important to note that this setting already accounts for competition from other sellers on the same platform by incorporating the in-platform competition factor into the sales quantity functions.

Because threshold value as indicated in (10) is a function of η and α, we can draw the following corollary:

Corollary 1. *In the reseller setting, the platform's incentive for information sharing decreases in the in-platform competition and the unit assortment plan adjustment cost.*

Proof: See Appendix B.

Corollary 1 elucidates the influence of the seller's in-platform competition on the platform's decision to share information. As the intensity of in-platform competition rises, the detrimental effect of lost demand, attributed to the misfit of the seller's default assortment, diminishes its impact on the platform's profits. Consequently, the benefits derived from the seller's assortment plan adjustment decrease, curbing the platform's motivation to share information. This particular results serves as a guide for platforms to base their information sharing strategies on the seller's market power within the platform. In other words, sharing information with a monopolistic seller whose products have limited substitutes can be more advantageous. Corollary 1 also reveals that a higher unit assortment plan adjustment cost dampens the platform's motivation to share information, which is intuitive because the higher cost reduces the chance for the seller to make assortment plan adjustment based on the seller's equilibrium choices in scenario s as shown in (5).

5.3. The impact of the platform's information sharing on the channel's profitability

The channel's profitability is repented by the ex-ante expected profit of the channel, which is the combined ex-ante expected profit of the seller and the platform. By comparing the channel's ex-ante profit before and after information sharing, we have the following proposition:

Proposition 3 (The impact of information sharing on the channel). *Compared to when the platform does not share information, the channel is better off with information sharing only if market variability is sufficiently low, i.e.,*

$$v < \frac{1}{\eta+1}\left(\frac{16(1-4\alpha-\eta)^2(3+11\eta-8\alpha\eta-2\eta^2)}{1-2\eta}\right)^{\frac{1}{3}}.$$

Proof: See Appendix B.

Proposition 3 is counter-intuitive because usually it is believed that a channel can be more efficient and profitable with greater information sharing within the channel. Given the explanation for Proposition 2, we know the greater information sharing does not always leads to more coordination through assortment plan adjustment. The share of information can transform the pricing game between the seller and the platform to a typical double marginalization setting, where the dominance of the upstream seller not only reduces the profitability of the downstream platform, but also reduces the profitability of the entire channel. Similar to the explanation for Proposition 2, despite the negative impact on channel profitability, the platform's information sharing also has a positive impact because the seller's assortment plan adjustment increases demand in the channel. The trade-off between the negative effect and the positive effect determines how the platform's information sharing impacts channel profitability.

In illustration of Propositions 2 and 3, Figure 4 depicts the indifference curves for both the platform and the channel under the scenarios where the platform shares or withholds information. The numerical test shows the indifference curves for various values of α and v, with the seller's in-platform competition set at $\eta = 0.1$. The region bounded by the axes and the curve represents the conditions under which the platform or channel prefers upstream information sharing. When the assortment adjustment cost α exceeds certain

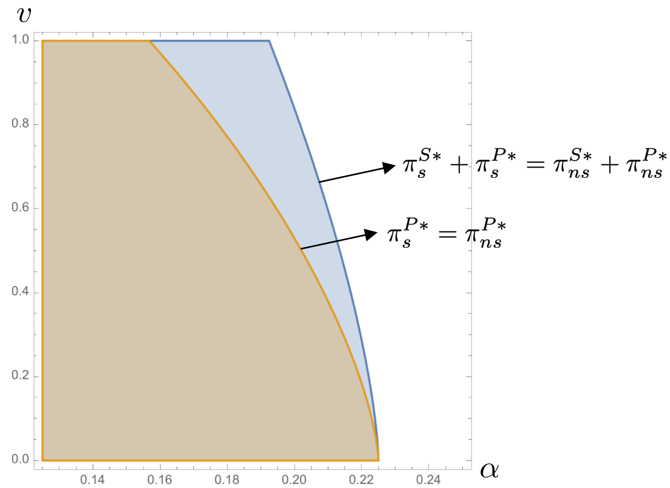

Figure 4: The indifference curves of the platform and channel when the platform shares or withholds information under different α and v when $\eta = 0.1$.

value, both the platform and the channel prefer to withhold information. This preference arises because $\hat{\theta} < 0$ implies that the seller never adjusts its assortment to mitigate misfit. As a result, sharing information becomes detrimental if it doesn't induce any assortment adjustments from the seller.

5.4. The subsidization mechanism incentivizing information sharing

Within Figure 4, the region between the two curves signifies a situation the channel is better off while the platform is worse off with information sharing. This is because that when the platform shares information, the increase in the seller's ex-ante expected profit from information sharing is greater than the decrease of the platform's ex-ante expected profit. In such circumstances, the platform lacks the incentive to voluntarily share information. However, it may be possible for the seller to incentivize information sharing by paying a fee to the platform. We name the mechanism in which the seller pays a fee to incentivize the platform to share information as the subsidization mechanism. We have the following corollary given Propositions 2 and 3:

Corollary 2. *In the reseller setting, the seller can incentivize the platform to share information through the subsidization mechanism if the market variability satisfies*

$$\frac{1}{\eta+1}\left(\frac{16(1-4\alpha-\eta)^2(1+8\alpha+11\eta)}{3}\right)^{\frac{1}{3}} < v < \frac{1}{\eta+1}\left(\frac{16(1-4\alpha-\eta)^2(3+11\eta-8\alpha\eta-2\eta^2)}{1-2\eta}\right)^{\frac{1}{3}}$$

The region between the two indifference curves in Figure 4 suggests a scenario where the platform should not provide the information sharing service for free. The acceptable range of fee for the information sharing service, subject to incentive-compatibility constraints ensuring that neither the seller nor platform is worse off with information sharing than in scenario ns, is $\left(\pi_{ns}^{P*} - \pi_s^{P*}, \pi_{ns}^{S*} + \pi_{ns}^{P*} - \pi_s^{S*} - \pi_s^{P*}\right)$. In a situation where the platform needs to establish a uniform fee for its market analytics service applicable to a multitude of sellers. Each of these sellers will have a unique estimation of π_ξ^{P*} and π_ξ^{S*} for all scenarios $\xi \in \{ns, s\}$. Under such circumstances, the fee instituted by the platform becomes a determining factor in the number of sellers who will subscribe to the service.

5.5. The price ceiling mechanism incentivizing information sharing

We now investigate an additional mechanism, namely the price ceiling mechanism, that enables information sharing when the platform is worse off sharing information.

As mentioned earlier, the platform can be worse off with information sharing in the reseller setting because as the misfit of the seller's assortment plan becomes large enough, the seller will not make assortment plan adjustments. Then, the setting becomes a typical double marginalization pricing game, in which the seller will take most of the margin. In order to protect the platform from this double marginalization effect, we consider the conditions under which the seller should commit to a price ceiling.

We name the scenario in which the seller commits to a price ceiling (upper bound) of u as scenario u, and u is public information. With the available information about u and θ, S's profit for a planning cycle with the realization of the market signal θ, denoted by $\pi_{u,\theta}^S(w,x)$, is defined as

$$\pi_{u,\theta}^S(w,x) = wD^S\big(r_{u,\theta}(w.x), x, \theta\big) - \alpha|x| \ni \{w \leq u\}.$$

Comparing $\pi_{u,\theta}^S(w,x)$ with the form of $\pi_{s,\theta}^S(w,x)$ in (4), we have the seller's optimal wholesale price, denoted by $w_{u,\theta}^*$, as

$$w_{u,\theta}^* = \min\{w_{s,\theta}^*, u\}.$$

Let π_u^{S*} and π_u^{P*} be the respective ex-ante expected profit of the seller and platform with the former committing to a price ceiling of u. Then, if there exists an u that makes the seller and the platform both better off with information sharing, then we say that u is a feasible price ceiling.

Lemma 2. *If the platform is worse off sharing information in the reseller setting, the seller's equilibrium price in scenario ns is a feasible price ceiling in scenario u.*

The reason for Lemma 2 can be explained as follows. Suppose that we introduce two additional constraints, $x = 0$ and $w = w^{S*}_{ns,\theta}$, to the seller's pricing optimization model in scenario u. Consequently, the seller's and the platform's equilibrium ex-ante profits in scenario u, denoted as π^{S*}_{u}, would equal the equilibrium ex-ante profit in scenario ns. Now, let's consider removing the constraint of $x = 0$ and relaxing the constraint $w = w^{S*}_{ns,\theta}$ to $w \leq w^{S*}_{ns,\theta}$ in scenario u. This would accordingly increase the seller's equilibrium ex-ante profit. From the platform's perspective, it would be in a more beneficial position if the seller opts to lower the price and/or makes an adjustment to the assortment plan to align the assortment plan with the demand.

From Lemma 2, we can conclude the following proposition regarding the existence of feasible price ceilings without proof:

Proposition 4. *If the platform is worse off sharing information, there exists a feasible range within which the seller's commitment to a price ceiling makes the platform better off with information sharing.*

Proposition 4 reveals that a feasible price ceiling always exists. This suggests that the platform can always negotiate a pricing contract with the seller, thereby incentivizing information sharing without necessitating a service fee. In practical terms, these contracts often take the form of fixed price contracts. However, in essence, these contracts are more akin to price ceiling contracts if their primary goal is to prevent one party from unilaterally raising the price. For instance, when the platform locks in a price via a contract with the seller, the objective is to deter the seller from hiking up the wholesale price unilaterally. However, this doesn't restrict the seller from reducing the wholesale price, which they can do either overtly or through promotions.

It should be noted that the interval for feasible price ceiling values are not necessarily continuous. In Figure 5 a numerical example using $\eta = 0.1$, $v = 0.8$ and $a = 0.18$, shows more detail about how the ex-ante expected profits of the platform (the top two lines) and seller (the bottom two lines) change when the seller commits to different price ceilings. The dashed line shows the optimal ex-ante expected profits obtained by the platform and seller when information is not shared. From the example as shown in Figure 4, we can see that the platform is worse off with information sharing if there is no price ceiling. Figure 5 shows that when the price ceiling falls in the intervals A and B, both the platform and seller are better off with information sharing. This means that if the seller commits to a price ceiling anywhere in the two intervals, then the

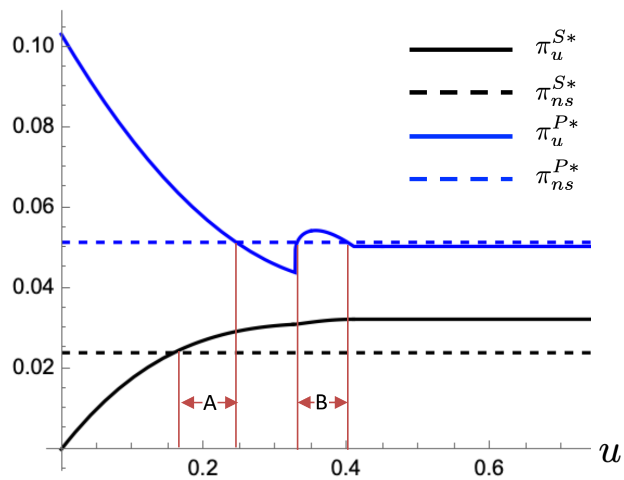

Figure 5: Comparison of seller and platform profits without the platform's information sharing and with different price ceilings ($\eta = 1/16$, $v = 3/4$ and $a = 20$).

platform has an incentive to share its information voluntarily.

Notice that the intervals A and B has different in terms of the seller assortment plan adjustment decision. In interval A, the seller does not make assortment plan adjustment for any planning cycle because the low wholesale price bounded by the price ceiling makes the benefit of making adjustment lower than the cost of making the adjustment (i.e., $\partial\pi^S_{u,\theta}(w,x)/\partial|x| < 0$). In interval A, the platform is better off because the seller's wholesale price is bounded for some realizations of θ, which prevent the problem to become a typical double marginalization problem. When the price ceiling enters into interval B, then the price ceiling is big enough incentivize the seller to make adjustment (i.e., $\partial\pi^S_{u,\theta}(w,x)/\partial|x| > 0$). In this case, the seller will make assortment plan adjustment if the realization of θ is less then the threshold for making assortment plan adjustment, $\hat{\theta}$. This assortment plan adjustment increases the platform's profit significantly, which can also make the platform better off by sharing information. From Figure 5 we can see that the sellers is better off if the price ceiling falls in B instead of A.

In our numerical test, if the price ceiling u is high enough such that it does not bind the wholesale price for any realization of θ, then the ex-ante expected profits of the seller and platform are not influenced by the setting of u. This means that scenario u is equivalent to scenario s, in which the platform is worse off by sharing information.

5.6. Consumer welfare

In order to show if the increase in the channel's profitability from the platform's information sharing comes at the expense of a decrease in consumer welfare, we compare consumer welfare when the platform shares information and when it does not. We also investigate how consumer welfare is impacted when each of the two mechanisms of motivating information sharing is implemented when the platform would otherwise withhold information. Because the platform always shares information in the commission fee setting, we only focus on the reseller setting in our welfare analysis. In the scenario where the subsidization mechanism is adopted, referred as scenario f, the seller pays the platform a subsidy or fee, f, for information sharing. Because both the seller and platform do not know the true value of θ at the time of subsidization, the seller needs to make sure that the platform's ex-ante expected profit in equilibrium with the subsidy, $\pi_f^{P*} = \pi_s^{P*} + f$, satisfies the condition that profits with the subsidy and information sharing are higher than profits without information sharing, $\pi_f^{P*} > \pi_{ns}^{P*}$.

We compare consumer welfare in the information sharing scenarios, scenarios s, u, and f, against consumer welfare when the platform does not share information, scenario ns. As the seller is always better off with information sharing, the equilibrium is determined by the change of the platform's profit after information sharing. If the platform's profit increases with information sharing, i.e., $\pi_s^{P*} > \pi_{ns}^{P*}$, then s is the equilibrium. Otherwise, if $\pi_s^{P*} < \pi_{ns}^{P*}$, then one of the mechanisms, price ceiling u or subsidy f, is used to incentivize the platform's information sharing.

Let $p^*_{\xi,\theta}$ and $x^*_{\xi,\theta}$ be the final price set by the platform and the assortment plan adjustment set by the seller, respectively, for a planning cycle with the misfit in default assortment realized as θ in scenario $\xi \in \{ns, s, u, f\}$. Let λ be a consumer's reservation value for the seller's product. From our demand function defined in Assumption 2, we have that λ is uniformly distributed between 0 and 1, $U(0,1)$. We suppose that if a consumer does not purchase from the platform, then the consumer makes a reservation value that we set to zero for simplicity. Then, we can derive consumer welfare, denoted by W_ξ, as

$$W_\xi = \int_{-v}^{v} \int_{p^*_{\xi,\theta}+|\theta - x^*_{\xi,\theta}|}^{1} \frac{\lambda - p^*_{\xi,\theta} - |\theta - x^*_{\xi,\theta}|}{2v} \,\mathrm{d}\lambda \,\mathrm{d}\theta = \int_{-v}^{v} \frac{(1 - p^*_{\xi,\theta} - |\theta - x^*_{\xi,\theta}|)^2}{4v} \,\mathrm{d}\theta. \tag{11}$$

Then, we have the following proposition:

Proposition 5. *Compared to consumer welfare when information is not shared:*

(a) If the platform is better off by sharing information, then consumer welfare is increased;

(b) If a price ceiling is used to incentivize the platform's information sharing, then consumer welfare is increased; and

(c) If a subsidy is used to incentivize the platform's information sharing, then consumer welfare is decreased.

Proof: See Appendix B.

Proposition 5 shows that downstream consumers can be worse off with the platform's information sharing if the sharing is simply enabled through the subsidization. Similar to the negative impact of information sharing on the platform described in Section 5.2, if the seller's pricing is not constrained after receiving more information, then information sharing also results in a negative impact on consumers via double marginalization. Using a price ceiling to incentivize information sharing causes the platform to set a lower price that increases consumer welfare as compared to no sharing. From Proposition 5, we also see that when using a price ceiling, the seller, platform, and the final consumers are all better off. This provides evidence that, with the seller's price ceiling commitment and the platform's information sharing, the dead-weight loss incurred by double marginalization is reduced.

6. Conclusions

We examine a two-tier e-commerce channel comprising an online trading platform and a seller. The seller offers a variety of products, facing competition from other vendors on the same platform. Our research investigates the platform's incentives to share consumer preference data with the seller, allowing the seller to adjust their assortment plan and enhance their sales on the platform based on the shared information. We explore two operational settings: one where the platform functions as a reseller and another where it functions as a marketplace provider earning profits through a fixed commission fee rate. Our investigation leads to the following conclusions:

First, we demonstrate how information sharing influences the targeted factors' impact on the seller and platform's profitability. We discover that, irrespective of whether the platform shares information with the seller, both the platform's and seller's profits increase when market variability is reduced. As market variability is determined by the seller's ability to predict market demand, this outcome underscores the spillover effect of upstream firms investing in their analytical capacity. Furthermore, we illustrate that the platform's preference towards in-platform competition varies between the reseller setting and the commission fee setting.

Next, we find that the platform can be either better off or worse off with information sharing in the reseller setting, whereas in the commission fee setting, the platform invariably benefits from information sharing. Counter-intuitively, the platform only has the incentive to share information in the reseller setting when market variability is sufficiently low, even though one might intuitively suggest that sharing is more profitable when market variability is high. Our results also suggest that an increase in in-platform competition and assortment plan adjustment cost diminishes the platform's incentive for information sharing, which aligns with intuition.

Given that the platform might be worse off by sharing information with the seller in the reseller setting, we explored two mechanisms - the subsidization mechanism and the price ceiling mechanism - to incentivize the platform to share information. We find that there is always a feasible price ceiling that the seller can commit to which supplies the platform with sufficient profit to motivate information sharing. Our findings indicate that the price ceiling mechanism is superior to a direct seller-to-platform subsidy in motivating the platform to share information. Under the price ceiling, both channel members and consumers are better off. Conversely, under the direct seller-to-platform subsidy, consumer welfare is decreased. Our price ceiling mechanism result suggests that there are distinct benefits of pricing contracts between the platform and the seller to support information sharing.

Our results yield insights into the question of whether the platform's incentive to share information upstream (about demand, consumer characteristics, etc.) is always aligned with that of the seller. Although many e-commerce platforms claim that they provide various analytics information to help sellers boost sales, our results suggest that sharing this information with sellers might harm the platform's long-run profit if the platform functions as a reseller, because with symmetric information, the seller and the platform's pricing game becomes a typical double marginalization setting in which the upstream seller has more advantage. Based on this reason, we propose a price ceiling mechanism that incentivizes the platform's information sharing, making every party better off. In practice, a price contract can be regarded as a price ceiling contract if the contract is to prevent one party from increasing the price unilaterally. We can find many examples of price ceiling, such as in the Amazon Venders Central program. Amazon aggressively suppresses the sellers' wholesale prices in contract negotiations before signing the sellers up to the vendors service that includes the advanced market analytics services. The price contract allows Amazon to share detailed market information with the seller without losing profit. Our results suggest that although many businesses have complained about platforms' negotiation strategies when negotiating wholesale prices, these strategies are actually beneficial to all parties from the perspective of information sharing, and thus increases social welfare.

Like all models, our model has some limitations. We do not include the costs of the platform's information sharing, although these costs are likely to be mostly fixed and would not change the qualitative results of our model. In addition, our model does not consider other factors that may affect the platform's information sharing. For example, we do not consider platform-level competition. That is, a platform might share information to attract sellers because another competing platform is providing similar services. However, the impact of such platform-level competition on the platform's incentive for information sharing is straight forward.

Critically, we make use of several functional form assumptions to obtain our results. These forms, effectively using linear demand and cost, are implemented in the primitives of our setting and are likely the most used forms in the literature. Thus, our functional form choices are designed to show that the platform's information sharing can happen under some common circumstances. However, it is plausible that some of our results may not hold if certain assumptions change, for instance, if the seller's assortment adjustment cost is characterized by economies of scale. Our future work is in part directed towards generalizing the characterization of our model primitives under which the platform's information sharing occurs.

However, it is plausible that some of our results may not hold if certain assumptions are not relaxed. For instance, if the seller's assortment adjustment cost is characterized by economies of scale.

Appendix A. Forms of equilibrium profits

Scenario ns:

$$\pi_{ns}^{S*} = \frac{(\frac{1}{1+\eta} - \frac{1}{2} - \frac{v}{4})^2}{2};$$
$$\pi_{ns}^{P*} = \frac{7\eta^2 v^2 - 36\eta^2 v + 108\eta^2 + 14\eta v^2 - 48\eta v + 72\eta + 7v^2 - 12v + 12}{192(\eta+1)^2}.$$

Scenario s:

$$\pi_s^{S*} = \begin{cases} \frac{1}{24}\left(\frac{3(\eta-1)^2}{\eta+1} + (\eta+1)v^2 + 3(\eta-1)v\right) & \text{if } \hat{\theta} < 0 \\ \frac{1}{24}\left(-\frac{4(4a+\eta-1)^3}{(\eta+1)^2 v} + \frac{3(\eta-1)^2}{\eta+1} + (\eta+1)v^2 + 3(\eta-1)v\right) & \text{if } \hat{\theta} \in [0, v] \\ \frac{1}{8}\left(\eta + \frac{4}{\eta+1} - 4\alpha v - 3\right) & \text{if } \hat{\theta} > v \end{cases}$$

$$\pi_s^{P*} = \begin{cases} \frac{(3\eta+1)^3-(\eta(3-v)+1-v)^3}{48(\eta+1)^3 v} & \text{if } \hat{\theta} < 0 \\ \frac{4(4a+\eta-1)^2(8a+11\eta+1)+(\eta+1)^3v^3-3(3\eta+1)(\eta+1)^2v^2+3(3\eta+1)^2(\eta+1)v}{48(\eta+1)^3 v} & \text{if } \hat{\theta} \in [0, v] \\ \frac{(3\eta+1)^2}{16(\eta+1)^2} & \text{if } \hat{\theta} > v \end{cases}.$$

Scenario ns':

$$\pi_{ns'}^{S*} = \frac{(1-\gamma)(2-v-\eta v)^2}{16(1+\eta)};$$

$$\pi_{ns'}^{P*} = \frac{\gamma(2-v-\eta v)(2+4\eta-v-\eta v)}{16(\eta+1)^2}.$$

Scenario s':

$$\pi_{s'}^{S*} = \begin{cases} \frac{(1-\gamma)((\eta+1)v(\eta v+v-3)+3)}{12(\eta+1)} & \text{if } \hat{\theta}' < 0 \\ \frac{-6\left(8\alpha^2+4\alpha(\gamma-1)+(\gamma-1)^2\right)(2\alpha+\gamma-1)+(4\alpha+\gamma-1)^3-(\gamma-1)^3(\eta v+v-1)^3}{12(\gamma-1)^2(\eta+1)^2 v} & \text{if } \hat{\theta}' \in [0, v] \\ \frac{1-\gamma-2\alpha(\eta+1)v}{4(\eta+1)} & \text{if } \hat{\theta}' > v \end{cases}$$

$$\pi_{s'}^{P*} = \begin{cases} \frac{1}{12}\gamma\left(\frac{6\eta+3}{(\eta+1)^2}+(v-3)v\right) & \text{if } \hat{\theta}' < 0 \\ \frac{1}{12}\gamma\left(\frac{6\eta+3}{(\eta+1)^2}+v^2+\frac{4(2\alpha+\gamma-1)^2((\gamma-1)(3\eta+1)-4\alpha)}{(\gamma-1)^3(\eta+1)^3 v}-3v\right) & \text{if } \hat{\theta}' \in [0, v] \\ \frac{\gamma(2\eta+1)}{4(\eta+1)^2} & \text{if } \hat{\theta}' > v \end{cases}.$$

Appendix B. Appendix: Proofs of Lemmas and Propositions

Proof of Proposition 1

(a) When the information is not shared:

From $w_{ns,\theta}^* > 0$, we can derive that $v < \frac{2-2\eta}{1+\eta}$. From $r_{ns,\theta}^* > w_{ns,\theta}^*$, we can derive that $v < \frac{2+6\eta}{3(1+\eta)}$. Then, we have the upper bound of v as $\min\left\{\frac{2-2\eta}{1+\eta}, \frac{2+6\eta}{3(1+\eta)}\right\}$.

Calculating the partial derivative of π_{ns}^{S*} and π_{ns}^{P*}, with respect to η and substituting v with the upper bound, we have $\frac{\partial \pi_{ns}^{S*}}{\partial \eta} = \frac{(\eta v+2\eta+v-2)(\eta v+2\eta+v+6)}{32(\eta+1)^2} < 0$ and $\frac{\partial \pi_{ns}^{P*}}{\partial \eta} = \frac{-\eta v+6\eta-v+2}{8(\eta+1)^3} > 0$.

Calculating the partial derivative of $\pi_{ns'}^{S*}$ and $\pi_{ns'}^{P*}$ with respect to η and substituting v with the upper bounds, we have $\frac{\partial \pi_{ns'}^{S*}}{\partial \eta} = \frac{1}{16}(\gamma-1)\left(\frac{4}{(\eta+1)^2}-v^2\right) < 0$ and $\frac{\partial \pi_{ns'}^{P*}}{\partial \eta} = -\frac{\gamma\eta}{2(\eta+1)^3} < 0$.

When the information is shared:

From $w_{s,\theta}^* > 0$, we can derive that $1-\eta > 0$ if $|\theta| < \hat{\theta}$ and $1-\eta-|\theta|-\eta|\theta| > 0$ if $|\theta| > \hat{\theta}$.

Calculating the partial derivative of π_s^{S*} and π_s^{P*}, with respect to η and substituting v with the upper bound, we have

$$\frac{\partial \pi_{s,\theta}^{S*}}{\partial \eta} = \begin{cases} \frac{(\eta-1)(\eta+3)}{8(\eta+1)^2} < 0 & \text{if } |\theta| < \hat{\theta} \\ \frac{(\eta|\theta|+\eta+|\theta|-1)(\eta|\theta|+\eta+|\theta|+3)}{8(\eta+1)^2} < 0 & \text{if } |\theta| > \hat{\theta} \end{cases}.$$

$$\frac{\partial \pi_{s,\theta}^{P*}}{\partial \eta} = \begin{cases} \frac{3(1+\eta)}{4(1+\eta)^3} > 0 & \text{if } |\theta| < \hat{\theta} \\ \frac{(1+\eta)(3-|\theta|)}{4(1+\eta)^3} > 0 & \text{if } |\theta| > \hat{\theta} \end{cases}.$$

Calculating the partial derivative of $\pi_{s'}^{S*}$ and $\pi_{s'}^{P*}$, with respect to η and substituting v with the upper bound, we have

$$\frac{\partial \pi_{s',\theta}^{S*}}{\partial \eta} = \begin{cases} \frac{\gamma-1}{4(\eta+1)^2} < 0 & \text{if } |\theta| < \hat{\theta} \\ \frac{1}{4}(\gamma-1)\left(\frac{1}{(\eta+1)^2}-\theta^2\right) < 0 & \text{if } |\theta| > \hat{\theta} \end{cases}, \quad \forall\theta \in [-v, v].$$

$$\frac{\partial \pi^{P*}_{s',\theta}}{\partial \eta} = -\frac{\gamma\eta}{2(\eta+1)^3} < 0, \ \ \forall \theta \in [-v, v].$$

(b) When the information is not shared:

Calculating the partial derivative of π^{S*}_{ns} and π^{P*}_{ns} with respect to v and substituting v with the upper bounds, we have

$$\frac{\partial \pi^{S*}_{ns}}{\partial v} = \frac{\eta v + 2\eta + v - 2}{16} < 0 \text{ and } \frac{\partial \pi^{P*}_{ns}}{\partial v} = \frac{7\eta v - 18\eta + 7v - 6}{96(\eta+1)} < 0.$$

Calculating the partial derivative of $\pi^{S*}_{ns'}$ and $\pi^{P*}_{ns'}$ with respect to v and substituting v with the upper bounds, we have

$$\frac{\partial \pi^{S*}_{ns'}}{\partial v} = \frac{1}{8}(1-\gamma)(\eta v + v - 2) < 0 \text{ and } \frac{\partial \pi^{P*}_{ns'}}{\partial v} = \frac{1}{8}\gamma(v-2) < 0.$$

When the information is shared:

In the reseller setting, from the form of $\pi^{S*}_{s,\theta}$, we have $\pi^{S*}_{s,\theta}$ is decreasing in $|\theta|$. When v increases, there is more chances to have a higher $|\theta|$. Thus, we can conclude that π^{S*}_{s} is decreasing in v.

From the form of $\pi^{P*}_{s,\theta}$, we have $\pi^{P*}_{s,\theta}$ is decreasing in $|\theta|$ if $\hat{\theta} < v$. In this case when v increases, there is more chances to have a higher $|\theta|$. Thus, we can conclude that π^{P*}_{s} is decreasing in v if $\hat{\theta} < v$. If $\hat{\theta} > v$, then from the form of π^{P*}_{s}, we can see that π^{P*}_{s} is not affected by v.

We can draw the same conclusion following similar process for the commission fee setting, scenario s'.

(c) In the reseller setting:

$$\frac{\partial \pi^{S*}_{s}}{\partial \alpha} = \begin{cases} 0 & \text{if } \hat{\theta} < 0 \\ -\frac{2(1-4\alpha-\eta)^2}{(\eta+1)^2 v} < 0 & \text{if } \hat{\theta} \in [0, v] \\ -\frac{v}{2} < 0 & \text{if } \hat{\theta} > v \end{cases}$$

$$\frac{\partial \pi^{P*}_{s}}{\partial \alpha} = \begin{cases} 0 & \text{if } \hat{\theta} < 0 \\ -\frac{8(\alpha+\eta)(1-4\alpha-\eta)}{(\eta+1)^3 v} < 0 & \text{if } \hat{\theta} \in [0, v] \\ 0 & \text{if } \hat{\theta} > v \end{cases}$$

In the commission fee setting:

$$\frac{\partial \pi^{S*}_{s'}}{\partial \alpha} = \begin{cases} 0 & \text{if } \hat{\theta}' < 0 \\ -\frac{2(2\alpha+\gamma-1)^2}{(\gamma-1)^2(\eta+1)^2 v} < 0 & \text{if } \hat{\theta}' \in [0, v] \\ -\frac{v}{2} < 0 & \text{if } \hat{\theta}' > v \end{cases}$$

$$\frac{\partial \pi^{P*}_{s'}}{\partial \alpha} = \begin{cases} 0 & \text{if } \hat{\theta}' < 0 \\ -\frac{4\gamma(1-2\alpha-\gamma)(2\alpha-\gamma\eta+\eta)}{(1-\gamma)^3(\eta+1)^3 v} < 0 & \text{if } \hat{\theta}' \in [0, v] \\ 0 & \text{if } \hat{\theta}' > v \end{cases}$$

Q.E.D.

Proof of Proposition 2

(a) In the reseller setting, from the forms of π^{P*}_{ns} and π^{P*}_{s}, we have

$$\pi^{P*}_{s} - \pi^{P*}_{ns} = \begin{cases} -\frac{v^2}{64} & \text{if } \hat{\theta} < 0 \\ \frac{(4\alpha+\eta-1)^2(8\alpha+11\eta+1)}{12(\eta+1)^3 v} - \frac{v^2}{64} & \text{if } \hat{\theta} \in [0, v] \\ \frac{v(36\eta-7\eta v-7v+12)}{192(\eta+1)} & \text{if } \hat{\theta} > v \end{cases}.$$

When $\hat{\theta} > v$, considering the upper bound of v as shown in the proof for Proposition 1(a), we easily derive $\pi_s^{P*} - \pi_{ns}^{P*} > 0$.

When $\hat{\theta} \in [0, v]$, we determine that v has to satisfy $v < \frac{1}{\eta+1}\left(\frac{16(1-4\alpha-\eta)^2(1+8\alpha+11\eta)}{3}\right)^{\frac{1}{3}}$ to make $\pi_s^{P*} - \pi_{ns}^{P*} > 0$.

(b) In the commission fee setting, from the forms of $\pi_{ns'}^{P*}$ and $\pi_{s'}^{P*}$ we have

$$\pi_{s'}^{P*} - \pi_{ns'}^{P*} = \begin{cases} \frac{\gamma v^2}{48} > 0 & \text{if } \hat{\theta} < 0 \\ \gamma\left(\frac{16(2\alpha+\gamma-1)^2((1-\gamma)(3\eta+1)+4\alpha)}{48v(1-\gamma)^3(\eta+1)^3} + \frac{v^2}{48}\right) > 0 & \text{if } \hat{\theta} \in [0, v] \\ \frac{1}{16}\gamma(4-v)v > 0 & \text{if } \hat{\theta} > v \end{cases}.$$

Q.E.D.

Proof of Proposition 3

In the reseller setting, from Proposition 2, we know that the platform is always better off with information sharing if $\hat{\theta} > v$. Thus, we can conclude that the channel is better off with information sharing when $\hat{\theta} > v$.

When $\hat{\theta} < 0$, we have that $\pi_s^{S*} + \pi_s^{P*} - \pi_{ns}^{S*} - \pi_{ns}^{P*} = \frac{1}{192}(2\eta - 1)v^2$, which means that the channel is better (or worse) off if $\eta > \frac{1}{2}$ (or $\eta < \frac{1}{2}$).

When $\hat{\theta} \in [0, v]$, we have that

$$\pi_s^{S*} + \pi_s^{P*} - \pi_{ns}^{S*} - \pi_{ns}^{P*} = \frac{(2\eta-1)v^2}{192} - \frac{16(4\alpha+\eta-1)^2(\eta(8\alpha+2\eta-11)-3)}{192v(\eta+1)^3}.$$

Q.E.D.

from the forms of π_{ns}^{S*},

π_{ns}^{P*}, π_s^{S*} and π_s^{P*}, we have

$$\pi_s^{S*} + \pi_s^{P*} - \pi_{ns}^{S*} - \pi_{ns}^{P*} = \begin{cases} \frac{1}{192}(2\eta-1)v^2 & \text{if } \hat{\theta} < 0 \\ \frac{(4\alpha+\eta-1)^2(8\alpha+11\eta+1)}{12(\eta+1)^3 v} - \frac{v^2}{64} & \text{if } \hat{\theta} \in [0, v] \\ \frac{v(36\eta-7\eta v-7v+12)}{192(\eta+1)} & \text{if } \hat{\theta} > v \end{cases}.$$

(b) Calculating the derivative of $\pi_s^{P*} - \pi_{ns}^{P*}$ with respect to η, we have

$$\frac{\partial(\pi_s^{P*} - \pi_{ns}^{P*})}{\partial\eta} = \frac{(1-4\alpha-\eta)\left(16\alpha^2+16\alpha\eta-12\alpha-9\eta+1\right)}{2(\eta+1)^4 v}.$$

From $\hat{\theta} > 0$, we have $\eta < 1 - 4\alpha$ and $\alpha < 1/4$. Thus, we have that $\frac{\partial(\pi_s^{P*}-\pi_{ns}^{P*})}{\partial\eta} < 0$ if $1 - 12\alpha + 16\alpha^2 < 0$.

From $\hat{\theta} < v$, we have $\alpha > 1/8$, which yields $1 - 12\alpha + 16\alpha^2 < 0$. Thus, we have $\frac{\partial(\pi_s^{P*}-\pi_{ns}^{P*})}{\partial\eta} < 0$. Q.E.D.

(c) Calculating the derivative of $\pi_s^{P*} - \pi_{ns}^{P*}$ with respect to α, we have

$$\frac{\partial(\pi_s^{P*} - \pi_{ns}^{P*})}{\partial\alpha} = \frac{8(\alpha+\eta)(4\alpha+\eta-1)}{(\eta+1)^3 v} < 0. \text{ Q.E.D.}$$

Proof of Proposition 5 In the reseller setting, from the forms of $\pi_{\xi,\theta}^{P*}$, we can rewrite the platform's ex-ante expected profit in scenario $\xi \in \{s, ns, u\}$, π_ξ^{P*}, as

$$\pi_\xi^{P*} = \int_{-v}^{v} \frac{(1 - r_{\xi,\theta}^* - |\theta - x_{\xi,\theta}^*|)^2}{2v}\,\mathrm{d}\theta.$$

From the form of W_ξ defined in (11), we find that

$$\pi_\xi^{P*} = 2W_\xi, \text{if } \xi \in \{s, ns, u\}.$$

As there is a linear relationship between π_ξ^{P*} and W_ξ, we can conclude (a) for the reseller setting and (b).

In the commission fee setting, from the forms of $\pi_{\xi',\theta}^{S*}$, we can rewrite the platform's ex-ante expected profit in scenario $\xi' \in \{s', ns'\}$, $\pi_{\xi',\theta}^{S*}$, as

$$\pi_{\xi',\theta}^{S*} = \frac{(1 - l_{\xi,\theta}^* - |\theta - x_{\xi,\theta}^*|)^2}{2v}.$$

From the form of W_ξ defined in (11), we find that

$$\pi_{\xi'}^{P*} = 2W_{\xi'}, \text{if } \xi \in \{s', ns'\}.$$

As there is a linear relationship between π_ξ^{P*} and W_ξ, we can conclude (a) for the reseller setting and (b).

In scenario f which the subsidization mechanism is adopted, a transfer between the seller and platform has to be accounted for. From the form of W_ξ defined in (11), we find that

$$\pi_\xi^{P*} = 2W_\xi, \text{if } \xi \in \{s, ns, u\}.$$

As there is a linear relationship between π_ξ^{P*} and W_ξ, we can conclude (a) for the reseller setting and (b).
(c) With a subsidy, f, because the final price set by the platform is equal in scenarios s and f for any realized θ, we have consumer welfare as

$$W_f = \frac{\pi_s^{P*}}{2}.$$

Because $\pi_s^{P*} < \pi_{ns}^{P*}$ when scenario s is not preferred by the platform, we can conclude

$$W_f < \frac{\pi_{ns}^{P*}}{2} < W_{ns}.$$

Q.E.D.

References

Akçay, Y., Natarajan, H.P., Xu, S.H., 2010. Joint dynamic pricing of multiple perishable products under consumer choice. Management Science 56, 1345–1361.

Amazon, 2020. Supporting small businesses with tools, insights, and data. URL: https://www.aboutamazon.com/news/how-amazon-works/supporting-small-businesses-with-tools-insights-and-

Amazon, 2021. Amazon insights. URL: https://www.amazon.com/blueprint/resource-center.

Anand, K.S., Goyal, M., 2009. Strategic information management under leakage in a supply chain. Management Science 55, 438–452.

Cachon, G.P., Lariviere, M.A., 2001. Contracting to assure supply: How to share demand forecasts in a supply chain. Management science 47, 629–646.

Capriolo, P., 2022. Walmart marketplace statistics sellers should know. URL: https://www.zentail.com/blog/walmart-marketplace-statistics.

Cheng, Z., Nault, B.R., 2007. Industry level supplier-driven it spillovers. Management Science 53, 1199–1216.

Choi, T.M., Li, J., Wei, Y., 2013. Will a supplier benefit from sharing good information with a retailer? Decision Support Systems 56, 131–139.

Chu, L.Y., Shamir, N., Shin, H., 2017. Strategic communication for capacity alignment with pricing in a supply chain. Management Science 63, 4366–4388.

Dukes, A., Gal-Or, E., Geylani, T., 2011. Who benefits from bilateral information exchange in a retail channel? Economics Letters 112, 210–212.

Gal-Or, E., Geylani, T., Dukes, A.J., 2008. Information sharing in a channel with partially informed retailers. Marketing Science 27, 642–658.

Ganesh, M., Raghunathan, S., Rajendran, C., 2014. The value of information sharing in a multi-product, multi-level supply chain: Impact of product substitution, demand correlation, and partial information sharing. Decision Support Systems 58, 79–94.

Gavirneni, S., Kapuscinski, R., Tayur, S., 1999. Value of information in capacitated supply chains. Management science 45, 16–24.

Gong, F., Nault, B.R., Rahman, M.S., 2016. Research note—an internet-enabled move to the market in logistics. Information Systems Research 27, 440–452.

Gu, Z., Li, X., 2022. Social sharing, public perception, and brand competition in a horizontally differentiated market. Information Systems Research .

Guan, X., Chen, Y.J., 2017. The interplay between information acquisition and quality disclosure. Production and Operations Management 26, 389–408.

Guo, L., 2009. Quality disclosure formats in a distribution channel. Management Science 55, 1513–1526.

Guo, L., Iyer, G., 2010. Information acquisition and sharing in a vertical relationship. Marketing Science 29, 483–506.

Hagiu, A., Wright, J., 2015. Marketplace or reseller? Management Science 61, 184–203.

He, C., Marklund, J., Vossen, T., 2008. Vertical information sharing in a volatile market. Marketing Science 27, 513–530.

Iyer, A.V., Ye, J., 2000. Assessing the value of information sharing in a promotional retail environment. Manufacturing & Service Operations Management 2, 128–143.

Jain, A., 2022. Sharing demand information with retailer under upstream competition. Management Science 68, 4983–5001.

Jiang, B., Jerath, K., Srinivasan, K., 2011. Firm strategies in the "mid tail" of platform-based retailing. Marketing Science 30, 757–775.

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

Kim, E., 2017. As amazon's dominance grows, suppliers are forced to play by its rules. URL: https://www.cnbc.com/2017/12/21/as-amazons-dominance-grows-suppliers-are-forced-to-play-by-its-rules.

Kök, A.G., Fisher, M.L., Vaidyanathan, R., 2008. Assortment planning: Review of literature and industry practice. Retail supply chain management , 99–153.

Lee, H.L., So, K.C., Tang, C.S., 2000. The value of information sharing in a two-level supply chain. Management science 46, 626–643.

Li, G., Tian, L., Zheng, H., 2021. Information sharing in an online marketplace with co-opetitive sellers. Production and Operations Management 30, 3713–3734.

Li, J., Sikora, R., Shaw, M.J., Tan, G.W., 2006. A strategic analysis of inter organizational information sharing. Decision support systems 42, 251–266.

Li, L., 2002. Information sharing in a supply chain with horizontal competition. Management Science 48, 1196–1212.

Mantin, B., Krishnan, H., Dhar, T., 2014. The strategic role of third-party marketplaces in retailing. Production and Operations Management 23, 1937–1949.

Meagher, K.J., Zauner, K.G., 2005. Location-then-price competition with uncertain consumer tastes. Economic Theory 25, 799–818.

Özer, O., Wei, W., 2006. Strategic commitments for an optimal capacity decision under asymmetric forecast information. Management Science 52, 1238–1257.

Raghunathan, S., 2001. Information sharing in a supply chain: A note on its value when demand is nonstationary. Management science 47, 605–610.

Ren, Z.J., Cohen, M.A., Ho, T.H., Terwiesch, C., 2010. Information sharing in a long-term supply chain relationship: The role of customer review strategy. Operations research 58, 81–93.

Ryan, J.K., Sun, D., Zhao, X., 2012. Competition and coordination in online marketplaces. Production and Operations Management 21, 997–1014.

SearchNode, 2021. Future areas in which ai will help e-commerce businesses according to decision makers in north america and europe in 2021. Statista Inc. URL: https://www.statista.com/statistics/1175063/ai-help-business-ecommerce-companies-worldwide/.

Shang, W., Ha, A.Y., Tong, S., 2015. Information sharing in a supply chain with a common retailer. Management Science 62, 245–263.

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

Yan, Y., Zhao, R., Liu, Z., 2018. Strategic introduction of the marketplace channel under spillovers from online to offline sales. European Journal of Operational Research 267, 65–77.

Zha, Y., Li, Q., Huang, T., Yu, Y., 2022. Strategic information sharing of online platforms as resellers or marketplaces. Marketing Science .