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Saruta, Fuyuki

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Private labels and platform competition*

Fuyuki Saruta†

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Abstract

This study examines the degree and manner by which first-party selling by a platform affects the profits of a third-party seller and a competing platform. After developing a model in which a third-party seller distributes goods through two competing platforms, with only one platform able to have a private label, we analyze first-party selling effects in both monopoly and duopoly platform cases. Our findings demonstrate the following. In a monopoly case, a platform consistently reduces the seller fee when introducing a private label. In a duopoly case, the two platforms will jointly raise or lower fees upon private label introduction. Additionally, first-party selling can either positively or negatively affect the competing platform's profit. Results suggest that competition among platforms might upset the influence of first-party selling on commission fees. Consequently, platforms might opt for first-party selling as a strategy to weaken commission fee competition and retail competition.

Keywords: First-party selling; Platform competition; Marketplaces; Agency contracts; Wholesale contracts

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† Graduate School of Commerce, Doshisha University; Karasuma-higashi-iru, Imadegawa-dori, Kamigyo-ku, Kyoto, 602-8580, Japan; Email: f.saruta0109@gmail.com, ORCID: 0000-0001-9998-0640

1 Introduction

Dual-role platforms, where a platform operator acts as an intermediary between sellers and buyers while also selling its own private label (*first-party selling* or *platform encroachment*), have become increasingly common in various markets. Concern has arisen that these platforms might harm or exclude third-party sellers by raising their commissions, thereby increasing rivals' costs and encouraging the sale of their own products. Competition authorities across the globe are scrutinizing the dual-role strategies enacted by platforms closely, while economists are examining the implications of the strategies.[1]

Debates over competition policy and earlier studies of first-party selling by platforms have frequently assumed a monopolistic platform environment. It remains unclear whether the findings are relevant in an environment with platform competition, or not. Although some digital platforms have achieved dominant positions, many operate on a competitive landscape. For instance, various e-commerce platforms such as Amazon, Walmart, JD.com, and Alibaba mutually compete and even compete with other local platforms. The platforms are certainly mutually influential. For example, when making commission policies for sellers, they will be concerned about those of competing platforms. Consequently, the effect of a platform's first-party selling on third-party sellers might depend on whether it is competing with its rivals, or not.

In addition, little attention has been devoted to the effects of first-party selling on competing platforms. Introducing a private label and altering the fee level by a platform will have a direct or indirect effect on competing platforms. Considering that dominant platforms typically sell their own products, the influence of first-party selling on inter-platform competition cannot be dismissed. Even in monopolistic markets, a dominant firm might affect the decision-making of potential entrants, thereby deterring them from entering the market.

To explore these aspects of such markets, a basic duopoly platform model is analyzed in which a platform chooses whether to introduce a private label. This study investigates whether a platform has an incentive to adopt a private label. If it does have such an

[1] Etro (2023a) and Kittaka et al. (2023) present reviews of the literature in economics of dual role platforms and discussion of competition policy issues.

incentive, the subsequent effects on third-party sellers and rival platforms are assessed. As a baseline model, we also examine the scenario of a monopoly platform to assess the effects of first-party selling in the presence and absence of platform competition.

Our model assumes that only one of the two competing platforms can possess a private label. This assumption is exogenous, but the author contends that it accurately represents real-life situations. For instance, Amazon has been vending its brand, Amazon Basics (Amazon Inc.), since 2009 in the e-commerce industry. By contrast, Rakuten Inc. in Japan focuses on operation in a marketplace. In other sectors, AccorHotels (Accor Group), which was initially a hotel management enterprise, began operating a hotel booking platform in 2015 that includes third-party hotels. By contrast, Airbnb Inc. has remained a pure platform.[2] Our model might represent a situation in which a platform has gained a dominant position must mutually compete with a newly entered platform.

With these settings, the following results are obtained. First, the effect of introducing a private label on seller fees varies between the monopoly and duopoly platform cases. In the monopoly case, the platform consistently reduces the fee when it introduces a private label. However, with a duopoly, the competing platforms either increase or decrease the fees in a coordinated manner when one introduces a private label. This is mostly attributable to our assumption of a single third-party seller. A monopolistic platform seeks to induce the third-party seller to lower the retail price by establishing a private label and simultaneously setting a lower commission. Without doing so, the seller could charge a very high retail price. By contrast, in a duopoly model, a competing platform can weaken the competition using fee setting by having a private label when the degree of their mutual substitution is high.

Secondly, the implementation of a private brand by a platform can either increase or decrease the profit of the competing platform. In the duopoly platform case, strategic complementarity exists between the two platforms in the fee setting stage. As described earlier, the first-party selling might increase or decrease seller fees. When competition is originally intense, a platform with a private label might raise its commission strategically

[2] A textbook by Belleflamme and Peitz (2021, Case 4.1 in Section 4.1, p.109) presents some examples of dual-role platforms.

to weaken the retail competition. This higher commission prompts the competing platform to increase its commission, thereby improving its profit. Conversely, when competition is moderate, the opposite effect occurs.

Thirdly, platform encroachment decreases the third-party seller's profit. While commissions to sellers might decrease in both monopoly and duopoly cases, competition arises at the retail pricing stage. As a result, platform encroachment does not improve third-party seller's profit.

These results are observed to change when assuming that the third-party seller and the platforms transact via wholesale contracts instead of agency contracts. Specifically in the wholesale model, introducing a private label has no effect on the competing platform's profit. This lack of effect is attributable to the competing platform's ability to adjust its retail price in response to the introduction of a private label by the other platform, thereby securing its profit.

This study also includes investigation of whether using a private label can serve as a barrier to entry in a setting where one platform is facing a potential entrant platform. Our analysis demonstrates that, in certain cases, the platform has a private label to deter entry, whereas in other cases it refrains from doing so to deter entry. As identified in the baseline model, introducing a private label might result in higher seller fees, which, in turn, might entice the entry of rival platforms.

Based on these findings, this report describes that inter-platform competition must be considered when evaluating first-party selling by platforms in recent years. It is particularly true that first-party selling might detrimentally affect third-party sellers' profits by diminishing competition in setting fees among competing platforms. Furthermore, our results emphasize the importance of considering not only the effects of first-party selling on third-party sellers but also those on competing platforms.

1.1 Literature

Sales of private labels by retailers have been studied extensively in the fields of management science and operations research (e.g., Mills, 1995; Raju et al., 1995; Sayman et al., 2002;

Ailawadi and Keller, 2004)[3]. In recent years, a growing body of research in economics has particularly addressed the phenomenon of dominant platforms adopting a dual-role strategy. Some of those studies specifically examine marketplace platforms that sell their first-party products (Anderson and Bedre-Defolie, 2021, 2022; Etro, 2021, 2023b; Hagiu et al., 2022; Kittaka and Sato, 2022; Lam and Liu, 2022; Shopova, 2023; Zennyo, 2022).[4]

Our study is related to the literature which mainly examines effects of first-party selling by platforms on sales commissions, third-party sellers' profit, and overall welfare (Anderson and Bedre-Defolie, 2021; Etro, 2023b; Shopova, 2023). Anderson and Bedre-Defolie (2021) demonstrate that platforms introducing first-party goods tend to raise their commissions to divert demand to their own products, which results in a reduction in consumer surplus. By contrast, Etro (2023b) shows that, depending on the demand for goods, and particularly depending on the price elasticity of demand, platforms might raise or lower their fees to attract more sellers. Our study complements these findings by demonstrating that fees can either be raised or lowered because of strategic complementarity in the presence of platform competition.

Both Anderson and Bedre-Defolie (2021) and Etro (2023b) assume a monopoly platform and third-party sellers with free entry. The monopoly platform can reduce the participation of sellers by raising its commission. Therefore, when the platform introduces private labels, it raises the commission if it seeks to increase revenue from first-party selling. Alternatively, it lowers the commission if it wants to encourage sellers to enter and increase revenue from sales commissions. In our model, raising commissions has no effect on reducing sellers' entry, thereby leading to the seemingly odd result that the monopoly platform consistently lowers the commission and encourages retail competition as it introduces a private label.

Work reported by Shopova (2023) is the closest in spirit to the work presented herein. Shopova (2023) examines the effect of introducing a private label by a platform on seller

[3]Although not private label, Arya et al. (2008) for example, analyze a situation in which downstream firms make a decision to outsource the production of inputs to upstream firms or to make the inputs themselves.

[4]Among these works, several studies analyze the self-preferencing of platforms (Etro, 2021; Hagiu et al., 2022; Kittaka and Sato, 2022; Lam and Liu, 2022; Zennyo, 2022), which is beyond the scope of the study presented herein.

fees in the context of vertically differentiated goods. Additionally, Shopova (2023) compares the outcomes under a wholesale model with those under an agency model and demonstrates that the platform introduces a lower-quality private label under the agency model compared to the wholesale model. Our contribution complements Shopova (2023) by incorporating platform competition and highlighting the qualitatively distinct effects of first-party selling by a platform on a third-party seller and a competing platform across the two models.

Our analyses also contribute to the literature comparing the wholesale model and the agency model. Johnson (2017) finds that the agency model is more likely to result in lower prices because of mitigation of double marginalization. Lu (2017) observes that firms operating under the agency model tend to set lower retail prices, thereby leading to greater consumer surplus than that obtained under the wholesale model. Hagiu and Wright (2015) analyze the effect of demand uncertainty and show that platforms choose the sales mode based on which entity possesses more accurate signals, consequently allowing that entity to set the retail price. Although our study does not delve into examination of the choice of sales mode by platforms, we argue that the sales mode is crucially important for assessing whether the introduction of private labels by platforms is pro-competitive or anti-competitive.

The analysis proceeds as follows. Section 2 introduces our main model. Section 3 characterizes the equilibrium outcomes and demonstrates the effects of platform encroachment on the third-party seller and the competing platform both in the monopoly platform case and in the duopoly platform case. Section 4 presents discussion of whether our implications change if some modifications of the baseline settings are made. Section 5 concludes this presentation of our work.

2 Model

A situation is considered in which an independent upstream seller ($u = S$) distributes its goods through two downstream platforms ($d = 1, 2$). The platforms incur no distribution cost. Additionally, Platform 1 has the ability to produce a private label product (i.e., plat-

form encroachment). Both Platform 1 and the third-party seller have constant marginal costs for producing their goods, denoted respectively as c_1 and c_S. Platform 1 is assumed to have a cost disadvantage to the third-party seller, with $c_1 \geq c_S = 0$.[5]

On the demand side, a representative consumer model is adopted, following Dobson and Waterson (1996, 2007). This model, which incorporates both interfirm and intrafirm competition, is widely employed in the literature examining models with platform competition (e.g., Foros et al., 2017; Lu, 2017; Maruyama and Zennyo, 2020). Letting p_d^u and q_d^u respectively denote the prices and quantities of the good produced by $u = \{1, S\}$ and sold at platform $d = \{1, 2\}$, then the consumer utility function is

$$\begin{aligned} U(q_1^1, q_1^S, q_2^1, q_2^S) = &\sum_{d,u} q_d^u - \sum_{d,u} \frac{1}{2}(q_d^u)^2 \\ &- \delta(q_1^1 q_2^1 + q_1^S q_2^S) - \mu(q_1^1 q_1^S + q_2^1 q_2^S) - \delta\mu(q_1^1 q_2^S + q_1^S q_2^1), \end{aligned} \tag{1}$$

where $\delta \in [0, 1)$ represents the degree of substitution between platforms, and $\mu \in [0, 1)$ represents that between goods. From this utility function, one can derive the inverse demand functions as $p_d^u = 1 - q_d^u - \delta q_{-d}^u - \mu q_d^{-u} - \delta\mu q_{-d}^{-u}$.

In our model, Platform 1 exclusively distributes its private label product only through its own platform, meaning that $q_2^1 = 0$. When Platform 1 introduces its private label, the demand functions are the following.

$$\begin{cases} q_1^1 = \dfrac{(1-\mu) - p_1^1 + \mu p_1^S}{1-\mu^2}, \\ q_1^S = \dfrac{\mu(1-\delta^2)(p_1^1 - 1) - (1-\delta^2\mu^2)(p_1^S - 1) + \delta(1-\mu^2)(p_2^S - 1)}{(1-\delta^2)(1-\mu^2)}, \\ q_2^S = \dfrac{(1-\delta) - p_2^S + \delta p_1^S}{1-\delta^2}. \end{cases} \tag{2}$$

[5] Later we also restrict $c_1 = c_S = 0$ for simplicity, but this restriction does not affect our main findings.

If Platform 1 has no private label, the demand functions are

$$\begin{cases} q_1^S = \dfrac{(1-\delta) - p_1^S + \delta p_2^S}{1-\delta^2}, \\ q_2^S = \dfrac{(1-\delta) - p_2^S + \delta p_1^S}{1-\delta^2}. \end{cases} \tag{3}$$

From equation (2), when Platform 1 sells its first-party product, its price has no effect on the demand for the third-party seller's product on Platform 2, and vice versa: $\partial q_1^1/\partial p_2^S = \partial q_2^S/\partial p_1^1 = 0$. This result derives from the assumption that the Platform 1's private label is not available on Platform 2.[6]

Specific examination is made of the situation in which the platforms transact with the third-party seller under agency contracts, as presented in Figure 1. The following timeline is used for the game. In Stage 1, Platform 1 chooses whether or not to produce and sell its first-party good. In Stage 2, Platforms 1 and 2 set per-unit commission fees f_1 and f_2.[7] Finally, in Stage 3, the third-party seller and Platform 1, if it encroaches, set retail prices. The game is solved by backward induction.

Before explaining the analysis, the equilibrium for the case without Platform 2 is derived as a benchmark case. Both in the monopoly and duopoly platform cases, we analyze whether Platform 1 has a private label, and if so, how this affects commissions. Additionally, first-party selling effects on the third-party seller's and competing platform's profits are assessed. Comparison of the results obtained in these two cases can clarify how competition between platforms affects the influence of the platform's first-party selling.

3 Main Analysis

3.1 Monopoly platform case

In this section, as a benchmark, the monopoly platform case is considered. The third-party seller sells its goods only on Platform 1, which can introduce a private label. In this

[6] It is noteworthy that if Platform 1 was to sell its product on Platform 2 as well, a negative cross-price effect would occur between different goods on different platforms, expressed as $\partial q_d^u/\partial p_{-d}^{-u} < 0$. A detailed explanation is provided by Dobson and Waterson (2007).

[7] For tractability, fixed commission fees are assumed, following Hagiu et al. (2022), Shopova (2023), and Zennyo (2022). In fact, Amazon charges fixed fees of \$0.99 per sale for individual sellers along with additional selling fees as commission rates.

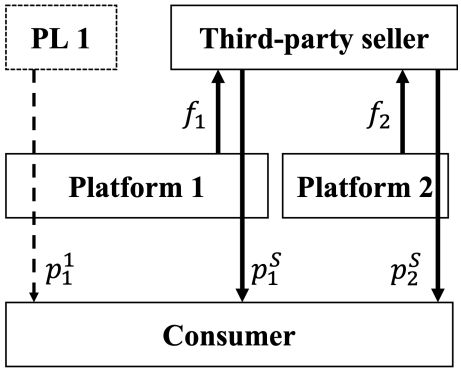

Figure 1: Platforms and the seller transact under agency contracts. PL1 stands for Platform 1's private label.

setting, we demonstrate that introduction of a private label by Platform 1 decreases the commission fee and the third-party seller's profit.

First, one can presume that Platform 1 has no private label. Then, Platform 1's profit is $\pi_1 = f_1 q_1^S$, and the third-party seller's is $\pi_S = (p_1^S - f_1)q_1^S$. In this case, in Stage 2, Platform 1 sets the fee as $f_1 = \frac{1}{2}$. In Stage 3, the seller sets the retail price as $p_1^S = \frac{3}{4}$. Their respective profits are $\pi_1 = \frac{1}{8}$ and $\pi_S = \frac{1}{16}$.

Next, if Platform 1 has a private label, then its profit function is $\pi_1 = (p_1^1 - c_1)q_1^1 + f_1 q_1^S$. The third-party seller's is the same as before. Platform 1 and the seller set the retail prices as

$$p_1^1 = \frac{2 + 2c_1 - \mu + 3\mu f_1 - \mu^2}{4 - \mu^2}, p_1^S = \frac{2 + \mu c_1 - \mu + 2f_1 + \mu^2 f_1 - \mu^2}{4 - \mu^2}. \tag{4}$$

Given the retail prices presented above, Platform 1 optimally sets the fee as $f_1 = \frac{8+\mu^3(1-c_1)}{2(8+\mu^2)}$, which is lower than $\frac{1}{2}$. Therefore, in our model, a monopoly platform would lower its commission fee when it introduces a private label.

A simple comparison between the profits obtained under the two cases engenders Lemma 1.[8]

Lemma 1 *In the monopoly platform case, Platform 1 consistently prefers to have a private label, which lowers the commission. The third-party seller's profit worsens with introduction of the private label when* $0 < c_1 < \frac{-1+\mu+\frac{8+\mu^2}{4(2+\mu^2)}\sqrt{1-\mu^2}}{\mu}$.

To follow the intuition for the result in Lemma 1, first note that the third-party seller

[8] Variables such as q_d^u, p_d^u and f_d are derived and shown in Table 1 in the Appendix. Moreover, the Mathematica file which includes the detailed proof will be made available on request.

sets a very high retail price without a private label. There are only one upstream firm and one downstream, therefore a double marginalization problem occurs. Then, Platform 1 would like to promote retail competition and gain more revenue from commissions by entering as a seller and lowering the fee. This result stands in contrast to that reported by Anderson and Bedre-Defolie (2021), by which a monopoly platform that introduced private label would raise its commission. This is because they assume free entry of sellers. The platform can reduce sellers' participation and improve the first-party sales when it raises its commission. On the other hand, our model includes the assumption of a single seller, therefore such effects of raising commissions vanishes.

Lemma 1 also indicates to us that unless Platform 1 is too inefficient in providing its private label, its entry as a seller lowers the third-party seller's profit even though it lowers the seller fee. This is because the platform encroachment brings retail competition, and the seller's retail price is expected to decrease unless c_1 is considerably high.

3.2 Duopoly platform case

Next, we derive the equilibrium under the duopoly platform case and demonstrate that, in equilibrium, Platform 1 consistently sells its first-party product. The first-party selling lowers or raises the commission fees on the platforms, which can be either beneficial or harmful to Platform 2.

Hereinafter for analytical convenience, it is assumed that $c_1 = 0$. Given this assumption, the equilibrium is derived with and without a private label. Then those results are mutually compared.

3.2.1 Without a private label

Presume that Platform 1 has no private label. Then, in Stage 3, the third-party seller sets retail prices while taking the commission as given. The seller's maximization problem is $\max_{p_1^S, p_2^S} \ \pi_S = \sum_{i=1,2}(p_i^S - f_i)q_i^S$. The optimal prices are $p_i^S = (1 + f_i)/2$.

In Stage 2, the two platforms determine the commissions to maximize their profits, $\pi_i = f_i q_i^S$ for $i = \{1, 2\}$. From first-order conditions, their best response functions are $f_i(f_j) = \frac{1-\delta(1-f_j)}{2}$ for $i = \{1, 2\}, \ j \neq i$, which implies that the commissions on the two

platforms are strategic complements. The equilibrium commissions and profits of each firm are derived and summarized in the following lemma.

Lemma 2 *In the duopoly platform case, and if Platform 1 has no private label, the two platforms set commissions as* $f_1^N = f_2^N = \frac{1-\delta}{2-\delta} \equiv f^N$. *The third-party seller sets prices as* $p_1^{SN} = p_2^{SN} = \frac{3-2\delta}{4-2\delta} \equiv p^{SN}$. *At that time, the platforms earn* $\pi_1^N = \pi_2^N = \frac{1-\delta}{2(4-3\delta^2+\delta^3)} \equiv \pi^N$ *and the third-party seller earns* $\pi_S^N = \frac{1}{2(4-3\delta^2+\delta^3)}$, *where superscript N represents no encroachment case.*

The simple partial derivatives of f^N, π^N, and π_S^N with respect to δ respectively lead to $\frac{\partial f^N}{\partial \delta} < 0$, $\frac{\partial \pi^N}{\partial \delta} < 0$, and $\frac{\partial \pi_S^N}{\partial \delta} > 0$ for any $\delta \in [0, 1)$. Higher δ corresponds to fiercer competition between the two platforms. Therefore, commissions are lower with increasing δ. The profits of the platforms also decrease with δ, and that of the third-party seller is increasing with δ.

3.2.2 With a private label

One can suppose that Platform 1 sells its private label. In Stage 3, Platform 1 and the third-party seller set retail prices. Competition arises in the retail pricing stage. The third-party seller can no longer act as a monopoly supplier. They maximize their profit as

$$\max_{p_1^1} \ \pi_1 = p_1^1 q_1^1 + f_1 q_1^S, \quad \max_{p_1^S, p_2^S} \ \pi_S = (p_1^S - f_1) q_1^S + (p_2^S - f_2) q_2^S. \tag{5}$$

Solving these maximization problems yields

$$\begin{cases} p_1^1 = \dfrac{2 - \mu - \mu^2 + 3\mu f_1}{4 - \mu^2}, \\ p_1^S = \dfrac{2 - \mu - \mu^2 + (2 + \mu^2) f_1}{4 - \mu^2}, \\ p_2^S = \dfrac{4 - 2\delta\mu - (1 + \delta)\mu^2 + 3\delta\mu^2 f_1 + (4 - \mu^2) f_2}{2(4 - \mu^2)}. \end{cases} \tag{6}$$

It is straightforward from (6) that p_1^1 is increasing in f_1. Therefore, Platform 1 with a private label can commit higher p_1^1 and can weaken retail price competition when it sets higher f_1.

In Stage 2, Platforms 1 and 2 set the commission fees to maximize their profits, $\pi_1 = p_1^1 q_1^1 + f_1 q_1^S$ and $\pi_2 = f_2 q_2^S$. From first-order conditions, the equilibrium fees are obtained.

Proposition 1 *In the duopoly platform case and if Platform 1 sells its private label, Platforms 1 and 2 set their commissions as*

$$\begin{cases} f_1^E = \dfrac{(1-\delta)\{32+4\mu^3+\delta(16+8\mu^2+4\mu^3-\mu^4)\}}{8(8+\mu^2)-\delta^2(16+32\mu^2-3\mu^4)}, \\ f_2^E = \dfrac{(1-\delta)\{32+4\mu^2+\delta(16+2\mu^3-12\delta\mu^2+2\delta\mu^3+\delta\mu^4)\}}{8(8+\mu^2)-\delta^2(16+32\mu^2-3\mu^4)}, \end{cases} \tag{7}$$

where superscript E represents the encroachment case.

Then, f_1^E, f_2^E, and f^N are mutually compared to ascertain whether first-party selling by a platform raises or lowers the commissions in the duopoly platform case. The results are summarized in the following lemma.

Lemma 3 *If δ and μ are high, then the two platforms set higher fixed fees when Platform 1 has a private label than when neither has a private label; that is, for $\mu \in [0,1)$,*

$$\begin{cases} f_1^E < f_2^E < f^N & \text{if} \quad 0 \le \delta < \delta'(\mu) \\ f_1^E > f_2^E > f^N & \text{if} \quad \delta'(\mu) < \delta < 1, \end{cases} \tag{8}$$

where $\delta'(\mu) \equiv \frac{4-4\mu}{12-2\mu-\mu^2}$.

In the duopoly platform case, it can be confirmed that platforms jointly raise or lower the commissions along with the platform encroachment. Therefore, the competition in setting fees can be both weakened and stimulated by first-party selling. Platform 1 maintains a balance between revenues from the first-party selling and the seller commission. When the degree of substitution between products, μ, and that between platforms, δ, are high, then to increase revenues from the first-party selling, Platform 1 commits itself to set higher p_1^1 by setting higher f_1. Because f_1 and f_2 are strategic complements, Platform 2 also sets higher f_2.

In the monopoly case, as stated previously, Platform 1 consistently lowers the commission fee to intensify the retail competition when it introduces a private label. Therefore,

the effect that first-party selling can lead platforms into cooperation to set higher fees is unique to the duopoly platform model.

3.2.3 Effects of first-party selling

In Stage 1, Platform 1 chooses whether it will sell a private label product, or not. Comparing the profits earned without a private label to those earned with a private label yields the following proposition.

Proposition 2 *In the duopoly platform case, Platform 1 consistently chooses to have a private label. The first-party selling decreases the third-party seller's profit, but can either increase or decrease Platform 2's profit depending on μ and δ; specifically, for $\mu \in [0, 1)$,*

- $\pi_1^E \geq \pi_1^N$ *for* $\delta \in [0, 1)$,
- $\pi_2^E > \pi_2^N$ *if* $\delta'(\mu) < \delta < 1$,
- $\pi_S^E \leq \pi_S^N$ *for* $\delta \in [0, 1)$.

Proposition 2 indicates to us that Platform 1 consistently prefers to have a private label, which worsens the third-party seller's profit in the duopoly case. Moreover, the encroachment either improves or worsens Platform 2's profit depending on μ and δ. The effect on Platform 2 is presented in Figure 2.

It is noteworthy that the condition for improvement in Platform 2's profit aligns with that for the increase in the commissions stated in Lemma 3. In other words, it holds that $f_1^E > f_2^E > f^N$ and $\pi_2^E > \pi_2^N$ in region I in Figure 2, and that $f_1^E < f_2^E < f^N$ and $\pi_2^E < \pi_2^N$ in region II. Region I represents high μ and δ, i.e., fierce competition prevails among sellers and among platforms. If Platform 1 introduces a private label, then competition rises in the retail pricing stage. With fierce competition, both platforms set higher commissions to weaken the competition; Platform 2's profit will improve.

To observe effects on the profits in greater detail, one can consider the effects on prices and quantities. First, the private label introduction lowers retail prices. Especially, because Platform 1 and the third-party seller compete directly on Platform 1, they lower

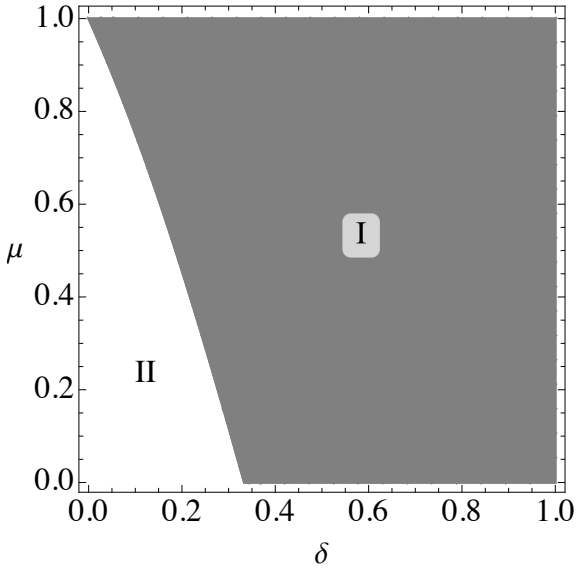

Figure 2: Platform 1's encroachment increases Platform 2's profit in region I, but decreases it in region II.

p_1^{1E} and p_1^{SE} compared to those without a private label. The third-party seller also lowers p_2^{SE} to maintain sales on Platform 2. As a result, it holds that $p_1^{1E} < p_1^{SE} < p_2^{SE} < p^{SN}$.

Second, with regard to quantity, it holds that $q_1^{SE} < q_2^{SE} < q_1^{1E}$ and that $q_1^{SE} < q^N$, where q^N represents the sales quantity of third-party seller's goods on each platform without a private label. Because of exposure to competition, demand for the third-party seller's goods on Platform 1 declines considerably. However, demand on Platform 2 might increase compared to the amount of demand when there is no private label. That is, $q_2^{SE} > q^N$ if $\delta > \delta'(\mu)$ because competition on Platform 1 is eased in that region. The third-party seller's good on Platform 2 becomes more affordable.

At last, the effects of first-party selling on consumer surplus and total surplus are clear. We define consumer surplus as $CS \equiv U$ in equation (1) and the total surplus as $TS \equiv CS + \pi_1 + \pi_2 + \pi_S$. Then, comparing the results obtained for cases with and without a private label leads to the following lemma.

Lemma 4 *In the duopoly platform case, Platform 1's encroachment improves the consumer surplus and the total surplus: for* $\mu, \delta \in [0, 1)$,

- $CS^E > CS^N$,
- $TS^E > TS^N$.

In our model, Platform 1's encroachment simply implies the expansion of the variety of goods for the representative consumer. For that reason, it always improves the consumer surplus. Moreover, although it might reduce the industrial profit ($\pi_1 + \pi_2 + \pi_S$), the encroachment improves the total surplus.

This section has analyzed the platform's decision about whether it has a private label or not, and has assessed the effects of the first-party selling in the duopoly model. Specifically, the effects on the seller fees on the platforms have been elucidated, along with the profits of the competing platform and the third-party seller, and the consumer surplus and the total surplus. In our model, Platform 1 consistently prefers to have a private label, which either raises or lowers the commissions on the platforms. First-party selling worsens the third-party seller's profit. However, it can either improve or worsen Platform 2's profit. It always improves the consumer surplus and the total surplus.

The next section presents modification of the baseline model in some directions and shows some verification of whether the results described above are changed, or not.

4 Discussion

As described in this section, we make some modifications to the main model. First, we change the setting to include the assumption that transactions between sellers and platforms are conducted under wholesale contracts rather than agency contracts. Second, we analyze first-party selling by a monopoly platform which faces a potential entrant platform. Third, we analyze platform encroachment as the vertical integration of a seller and a platform.

4.1 Wholesale contract

For the examination described in this subsection, we assume that transactions between the third-party seller and the platforms are conducted under wholesale contracts rather than under agency contracts. We demonstrate that, under the wholesale model, the first-party selling effect on Platform 2's profit is neutral.

Under a wholesale contract, the upstream seller first determines the wholesale prices

per unit of goods. Given these prices, the downstream platforms determine their retail prices.[9] Therefore, the timeline becomes the following. In Stage 1, Platform 1 chooses whether or not to produce and sell its first-party good. In Stage 2, the third-party seller sets per-unit wholesale prices to the two platforms: w_1 and w_2. In Stage 3, Platforms 1 and 2 set retail prices.

Next, one can characterize the equilibrium under this wholesale contract model. In Stage 3, given the wholesale prices, Platforms 1 and 2 set retail prices to maximize their respective profits π_1 and π_2. If Platform 1 has chosen not to sell its private label goods, then the maximization problems of platform $i = \{1, 2\}$ are $\max_{p_i^S} \ \pi_i = (p_i^S - w_i)q_i^S$. If Platform 1 has decided to sell its private label goods, then the maximization problems are

$$\max_{p_1^1, p_1^S} \ \pi_1 = p_1^1 q_1^1 + (p_1^S - w_1)q_1^S, \quad \max_{p_2^S} \ \pi_2 = (p_2^S - w_2)q_2^S. \tag{9}$$

From first-order conditions, the equilibrium prices are

$$\begin{cases} p_1^S = \dfrac{2 - \delta - \delta^2 + 2w_1 + \delta w_2}{4 - \delta^2}, \\ p_2^S = \dfrac{2 - \delta - \delta^2 + \delta w_1 + 2w_2}{4 - \delta^2}, \end{cases} \quad \text{if PF1 does Not encroach,} \tag{10}$$

and

$$\begin{cases} p_1^1 = \dfrac{4 - \delta^2 - (2 + \delta)\delta\mu + \delta^2\mu w_1 + 2\delta\mu w_2}{2(4 - \delta^2)}, \\ p_1^S = \dfrac{2 - \delta - \delta^2 + 2w_1 + \delta w_2}{4 - \delta^2}, \\ p_2^S = \dfrac{2 - \delta - \delta^2 + \delta w_1 + 2w_2}{4 - \delta^2}, \end{cases} \quad \text{if PF1 Encroaches.} \tag{11}$$

Here, p_2^S is not influenced by Platform 1's encroachment because no strategic complementarity exists between p_1^1 and p_2^S.

In Stage 2, given the retail pricing described above, the third-party seller chooses its wholesale prices to maximize its profit $\pi_S = w_1 q_1^S + w_2 q_2^S$. The optimal wholesale prices

[9] One can easily verify that the main result (the effect of the first-party selling on Platform 2's profit is neutral) remains when downstream platforms set quantities instead of prices under the wholesale model.

are $w_1^N = w_2^N = \frac{1}{2}$ if Platform 1 does not encroach, and

$$\begin{cases} w_1^E = \dfrac{2-(2-\delta^2)\mu-\delta^2\mu^2}{4-2\delta^2\mu^2}, \\ w_2^E = \dfrac{2-\delta\mu-\delta^2\mu^2}{4-2\delta^2\mu^2} \end{cases} \quad \text{if PF1 Encroaches.} \tag{12}$$

In Stage 1, Platform 1 chooses whether it introduces a private label, or not. By comparing the platforms' profits in the no encroachment case with those in the encroachment case, the following lemma can be obtained.

Lemma 5 *Under the wholesale model, Platform 1 consistently chooses to have a private label, which decreases the third-party seller's profit and which has no effect on Platform 2's profit; specifically, for all* $\mu, \delta \in [0,1)$, $\pi_1^{WE} \geq \pi_1^{WN}$, $\pi_2^{WE} = \pi_2^{WN}$, *and* $\pi_S^{WE} \leq \pi_S^{WN}$, *where superscript* W *represents the results under the wholesale model.*

In the main analysis of the agency contract model, it was found that the introduction of a private label by Platform 1 had an impact on the profit of the competing platform. However, this effect was not observed in the wholesale contract model. The overall conclusion remains that platform encroachment reduces the profit of third-party sellers.

Encroachment reduces third-party seller's profit in the wholesale model. When Platform 1 chooses to sell its private label, the third-party seller accordingly lowers the wholesale price to Platform 1, w_1, and that to Platform 2, w_2. Therefore, Platform 1's encroachment is detrimental to the third-party seller. The retail prices of the third-party seller's goods also become lower than those in the case without the private label: $p_1^{SWE} < p_2^{SWE} < p_1^{SWN} = p_2^{SWN}$. However, Platform 2 is able to maintain both its margin, $p_2^S - w_2$, and sales quantity, q_2^S because Platform 2 can adjust the retail price directly in the wholesale model.

The effect on the competing platform's profit which appeared in the agency model is absent in the wholesale model, which indicates that the effects of first-party selling by a platform might vary considerably depending on the contractual agreements. In the e-commerce industry, in which agency contracts are common, one must be particularly concerned about the effects of platforms' first-party selling on competing platforms.

4.2 Potential entrant platform

Next, we discuss whether platforms' first-party selling works as a deterrent against entry by new platforms. To analyze such a question, we modify the timeline of the baseline model as described hereinafter. In Stage 1, Platform 1 determines whether to have a private label. In Stage 2, Platform 2, a potential entrant, determines whether to enter the market by paying entry cost F. Then, in Stage 3, platforms set commissions. Finally in Stage 4, Platform 1 and the third-party seller set retail prices.

Because the equilibrium outcomes in Stages 3 and 4 are the same as before, we start the equilibrium analysis in Stage 2. In this stage, Platform 2 makes an entry decision knowing whether Platform 1 has a private label. When it enters the market, Platform 2 will get π_2^E or π_2^N. Therefore, it enters if the expected profit is higher than F. Next, in Stage 1, Platform 1 decides whether it introduces a private label with expectation of Platform 2's entry decision correctly. We examine Platform 1's equilibrium decisions by dividing them into two cases and assessing the outcomes.

First, when $\pi_2^E < \pi_2^N$ or $0 \leq \delta < \delta'(\mu)$, if $F > \pi_2^N$, then Platform 1 implements first-party selling because Platform 2 never enters, irrespective of Platform 1's decision. If $F < \pi_2^E$, Platform 2 always enters. Therefore Platform 1 implements first-party selling. If $\pi_2^E < F < \pi_2^N$, then Platform 2 enters the market if Platform 1 has no private label. Then, Platform 1 introduces a private label. In summary, when $\pi_2^E < \pi_2^N$, Platform 1 implements first-party selling because it raises the hurdle to entry for Platform 2.

Next, when $\pi_2^E > \pi_2^N$ or $\delta'(\mu) < \delta < 1$, if F is higher than π_2^E or lower than π_2^N, Platform 1 finds it profitable to implement first-party selling. If $\pi_2^E > F > \pi_2^N$, then Platform 2 enters the market if Platform 1 has no private label, but it does not enter if Platform 1 has a private label. In this case, Platform 1 might not dare to implement first-party selling because it would lower the hurdle to entry for Platform 2. Particularly, Platform 1 behaves as such when $\pi_2^E > F > \pi_2^N$ and $\pi_1^E < \frac{1}{8}$.

The results presented above are summarized in the following lemma.

Lemma 6 *When Platform 1 faces a threat of entry by Platform 2, it might or might not implement first-party selling to prevent entry.*

According to Lemma 6, first-party selling by platforms may either increase or decrease the barrier to entry for new platforms. Therefore, even in markets with a monopoly platform, we should monitor the effect of first-party selling on potential rival platforms. It is also important to note that the absence of first-party selling in a monopoly platform market might also discourage entry.

4.3 First-party selling as a vertical integration

Here, we analyze a situation in which a platform introduces a private label by acquiring a third-party seller. Thereby, we demonstrate that main results obtained in the baseline model remain unchanged. One can consider a case in which there are originally two third-party sellers in the market: $S1$ and $S2$. One can then assess the potential vertical integration between Platform 1 and $S1$. If vertical integration occurs, then the good produced by $S1$ is exclusively sold on Platform 1.

The equilibrium outcomes of the non-integration case and the integration case can be compared within the agency model. It is particularly interesting that, for the changes in fees, the same results are obtained as those in Lemma 3 in the baseline model. When Platform 1 and $S1$ are not vertically integrated, then in the retail pricing stage, $S1$ sets p_1^1 and p_2^1, and $S2$ sets p_1^2 and p_2^2. The equilibrium price is given as $p_d^u = \frac{1+f_d-\mu}{2-\mu}$. Then, in the commission fee setting stage, Platforms 1 and 2 set $f_1 = f_2 = \frac{1-\delta}{2-\delta} = f_N$. Vertical integration of Platform 1 and S_1 leads to alignment with the agency model with a private label analyzed in subsection 3.2.2. Consequently, the effect of vertical integration on f_1 and f_2 is consistent with that stated in Lemma 3.

The effects on profits differ slightly from those of the baseline model. The joint profit of Platform 1 and $S1$ improves with their integration unless δ is low. However, Platform 2's profit improves with integration only when μ and δ are very high, whereas $S2$'s profit improves when μ is high. These points are illustrated in Figure 3. Introduction of a private label by Platform 1 is more likely to reduce Platform 2's profit and increase the profit of third-party seller than the baseline model because, in the baseline model, having a private label implies an increased variety of goods in Platform 1, but in the vertically integration model, it signals a reduction in the variety of goods in Platform 2.

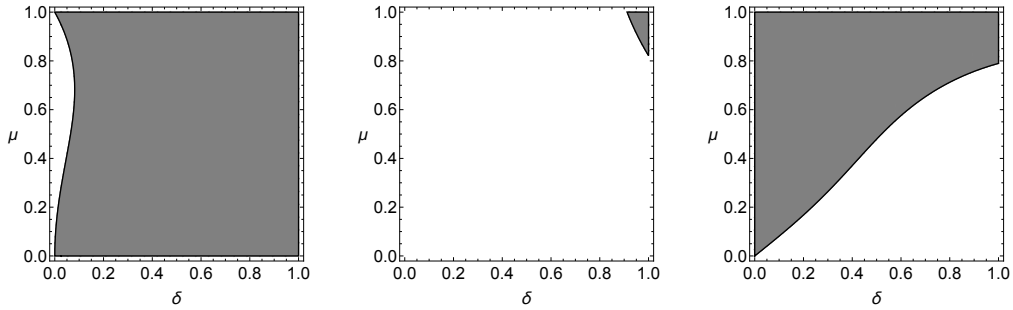

Figure 3: Platform 1 and $S1$'s joint profit (left panel), Platform 2's profit (center panel), and $S2$'s profit (right panel) improve with vertical integration between Platform 1 and S_1 in the shaded area.

5 Conclusion

This study conducted examines the effects of private label introduction by a platform on a third-party seller and on a competitor platform in a competitive platform environment. The analyses reveal that platforms can employ first-party selling to soften commission fee competition and retail competition. In our duopoly model, when a platform introduces a private label, competing platforms jointly adjust their commission fees, depending on the degree of substitution. If the competition is intense, the platforms increase the fees when there is platform encroachment. This change in the commission fee directly affects the profit of the competing platform.

Moreover, we demonstrate that the effects of first-party selling are contingent upon the contractual agreements concluded between upstream and downstream firms. In recent years, agency contracts have become the dominant form of digital platform transactions. Consequently, our research highlights the importance of examining the effects on competing platforms as well as third-party sellers when debating the benefits and shortcomings of a platform's first-party selling. From a managerial perspective, our research indicates that platform operators can potentially mitigate commission competition with rivals by introducing their own products.

Several potential avenues for future research exist. First, our model includes the assumption that that only one of the two platforms can have private labels. We should expand it to allow several platforms to have private labels and examine first-party selling effects. Additionally, it is worth investigating whether an asymmetric equilibrium, in

which some platform has a private label and others do not, can arise under the assumption that several platforms can engage in first-party selling.

Secondly, our analyses have assumed a single third-party seller. In reality, numerous sellers participate in platforms. The introduction of private labels by platforms might force some sellers to exit. Although this study primarily examines effects on competing platforms, it is important to consider the ramifications of multiple sellers freely entering and exiting the platforms.

Furthermore, self-preferencing by platforms has not been investigated adequately. Much remains unknown about how self-preferencing influences platform competition. Further inquiry into connections among self-preferencing, commission fees, and their effects on third-party sellers represents an enticing avenue for future research.

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Appendix

Equilibrium results

Tables 1 and 2 respectively present equilibrium outcomes obtained under the baseline duopoly model and the wholesale model.

Table 1: Equilibrium outcome for the agency model

	Without a private label	With a private label
f_1	$\frac{1-\delta}{2-\delta}$	$f_1^E = \frac{-4(1-\delta^2)\mu^3 c_1+(1-\delta)(32+16\delta+8\delta\mu^2+4\mu^3+4\delta\mu^3-\delta\mu^4)}{8(8+\mu^2)-\delta^2(16+32\mu^2-3\mu^4)}$
f_2	$\frac{1-\delta}{2-\delta}$	$f_2^E = \frac{-2(\delta-\delta^3)\mu^3 c_1+(1-\delta)(32+16\delta+4\mu^2-12\delta^2\mu^2+2\delta\mu^3+2\delta^2\mu^3+\delta^2\mu^4)}{8(8+\mu^2)-\delta^2(16+32\mu^2-3\mu^4)}$
p_1^1	–	$\frac{2+2c_1-\mu+3\mu f_1^E-\mu^2}{4-\mu^2}$
p_1^S	$\frac{3-2\delta}{4-2\delta}$	$\frac{2+\mu c_1-\mu-\mu^2+(2+\mu^2)f_1^E}{4-\mu^2}$
p_2^S	$\frac{3-2\delta}{4-2\delta}$	$\frac{4-2\delta\mu(1-c_1)-\mu^2-\delta\mu^2+3\delta\mu^2 f_1^E+(4-\mu^2)f_2^E}{2(4-\mu^2)}$
q_1^1	–	$\frac{-(2-\mu^2)c_1+(1-\mu)(2+\mu-\mu(1+\mu)f_1^E)}{4-5\mu^2+\mu^4}$
q_1^S	$\frac{1}{4+2\delta-2\delta^2}$	$\frac{2\mu(1-\delta^2)c_1-(1-\mu^2)(4-\delta^2\mu^2)f_1^E+\delta(4-5\mu^2+\mu^4)(f_2^E-1)+2(2-\mu-\mu^2)+\delta^2\mu(2-3\mu+\mu^3)}{2(1-\delta^2)(4-5\mu^2+\mu^4)}$
q_2^S	$\frac{1}{4+2\delta-2\delta^2}$	$\frac{1-\delta+\delta f_1^E-f_2^E}{2(1-\delta^2)}$
π_1	$\frac{1-\delta}{2(2-\delta)^2(1+\delta)}$	$p_1^1 q_1^1 + f_1^E q_1^S$
π_2	$\frac{1-\delta}{2(2-\delta)^2(1+\delta)}$	$\frac{f_2^E(1-\delta+\delta f_1^E-f_2^E)}{2(1-\delta^2)}$
π_S	$\frac{1}{8-6\delta^2+2\delta^3}$	$(p_1^S - f_1^E)q_1^S + (p_2^S - f_2^E)q_2^S$

Table 2: Equilibrium outcome for the wholesale model

	Without a private label	With a private label
w_1	$\frac{1}{2}$	$\frac{2-(1-c_1)(2-\delta^2)\mu-\delta^2\mu^2}{4-2\delta^2\mu^2}$
w_2	$\frac{1}{2}$	$\frac{2-(1-c_1)\delta\mu-\delta^2\mu^2}{4-2\delta^2\mu^2}$
p_1^1	–	$\frac{8+c_1(2-\delta)(4-\delta^2\mu^2)-2\delta(2+\mu)-6\delta^2\mu^2+\delta^3\mu^2(3+\mu)}{4(2-\delta)(2-\delta^2\mu^2)}$
p_1^S	$\frac{3-2\delta}{4-2\delta}$	$\frac{6+c_1\mu(2-\delta)-2\mu-4\delta+\delta\mu-3\delta^2\mu^2+2\delta^3\mu^2}{2(2-\delta)(2-\delta^2\mu^2)}$
p_2^S	$\frac{3-2\delta}{4-2\delta}$	$\frac{6+c_1\delta\mu(2-\delta)-4\delta-2\delta\mu+\delta^2\mu-3\delta^2\mu^2-2\delta^3\mu^2}{2(2-\delta)(2-\delta^2\mu^2)}$
q_1^1	–	$\frac{(1-\mu)(4+2\mu-\delta^2\mu^2)-c_1(4-2\mu^2-\delta^2\mu^2)}{4(1-\mu^2)(2-\delta^2\mu^2)}$
q_1^S	$\frac{1}{4+2\delta-2\delta^2}$	$\frac{2-(1-c_1)(2+\delta-\delta^2)\mu+(1-\delta)\delta\mu^2}{4(1-\mu^2)(2+\delta-\delta^2)}$
q_2^S	$\frac{1}{4+2\delta-2\delta^2}$	$\frac{1}{4+2\delta-2\delta^2}$
π_1	$\frac{1-\delta}{4(2-\delta)^2(1+\delta)}$	$p_1^1q_1^1+(p_1^S-w_1)q_1^S$
π_2	$\frac{1-\delta}{4(2-\delta)^2(1+\delta)}$	$\frac{1-\delta}{4(2-\delta)^2(1+\delta)}$
π_S	$\frac{1}{4+2\delta-2\delta^2}$	$w_1q_1^S+q_2q_2^S$