Original Article

POMS

Production and Operations Management
1–18

DOI: 10.1177/10591478241305291
journals.sagepub.com/home/pao
Sage

Product Experimentation, Information Diffusion, and Platform Encroachment

Wing Man Wynne Lam[1] and **Xingyi Liu**[2]

Abstract

Platforms provide great opportunities for independent sellers to experiment with new products. By facilitating transactions between trading parties, platforms can gather a huge amount of information about successful products and introduce their own versions of competing products. This phenomenon of platform encroachment has received attention from various stakeholders, and concerns have been raised about how it may marginalize independent sellers and hinder the development of the ecosystem. At the same time, platforms expedite the diffusion of information about successful products and facilitate learning and imitation from other independent sellers, which has received little attention in the literature. In this article, we explicitly account for this feature and consider a dynamic model to study the impact of platform encroachment on sellers' incentives to experiment with new products, when both the platform and independent sellers can imitate and introduce competing versions of products offered by the successful experimenter. We show that when a seller with successful experimentation holds a competitive advantage in the product market, platform encroachment may enhance the incentives to carry out experimentation. This enhancement effect is stronger when information diffuses faster on the platform. We further discuss the implications for the platform's optimal encroachment strategy and regulatory policies.

Keywords

Platform Encroachment, Product Experimentation, Information Diffusion, Imitation, Informational Advantage

Date received 16 September 2023; accepted 29 September 2024 after two revisions

Handling Editor: Tony Cui

1 Introduction

Online platforms have grown rapidly in recent years. By significantly lowering the cost of entry and facilitating transactions with consumers, these platforms provide unprecedented opportunities for sellers to enter and experiment with new products and ideas. Some of these sellers grow their businesses successfully and become top sellers in their product categories, which attracts other sellers to offer similar products following the success, thanks to fast information diffusion facilitated by platforms. For example, when searching for "wireless earbuds" on Amazon, we not only see Anker, which is one of the top sellers on online trading platforms across North America and Europe for peripheral products of electronic devices, but also many other competing brands.[1] At the same time, platforms provide their own versions of products and compete with these sellers on the marketplaces. For example, Amazon offers its own earbud brand, Umi. This phenomenon, commonly known as platform encroachment, has raised concerns among third party sellers as well as antitrust authorities, especially when platforms can gather a huge amount of information about individual sellers and use such information to tailor their product offerings.[2] Despite concerns about Amazon's entry and use of private information, Amazon continues to grow as the largest online retailer in the United States, with a market share of 37.6% in 2023.[3] The share of third-party sellers on Amazon has grown to more than 60% by the end of 2023.[4] Furthermore, the product categories where we witness most entry by Amazon (e.g., home products, health and beauty) are still the most popular categories where we see most new sellers and new product developments.[5] Similarly, in the mobile app market, Wen and Zhu (2019) showed that Google's entry does not stop developers from introducing new products but shifts innovation to unaffected and new apps.

[1]University of Edinburgh Business School, University of Edinburgh, Edinburgh, UK
[2]Aston Business School, Centre for Business Prosperity, Aston University, Birmingham, UK

Corresponding author:
Xingyi Liu, Aston Business School, Centre for Business Prosperity, Aston University, Aston Triangle, Birmingham B4 7ET, UK.
Email: x.liu29@aston.ac.uk

So far, studies have focused on the impact of platform encroachment on competition and profits of third party sellers, but little has been done regarding the impact on product experimentation, an important practice facilitated by online trading platforms, especially when third party sellers can also imitate and enter with their own versions of competing products. To explore this, we build a dynamic model of product experimentation on a monopolistic platform with the following features. Firstly, some sellers actively undertake product experimentation and capture a large share of the market upon success. Secondly, when a "hit" product appears in the market, thanks to developments such as sales monitoring tools, other sellers gradually learn about the success, imitate and provide their competing versions of the product. Thirdly, the platform may also enter to compete in the market and it may learn about successful experimentation faster than other sellers. The equilibrium experimentation rate is determined by the absolute value from successful experimentation and the relative value of successful experimentation compared with unsuccessful experimentation. Without platform encroachment, a free-riding problem exists among sellers: a seller can wait for successful experimentation from other sellers and then imitate instead of carrying out their own costly experimentation. This option is more valuable when information diffuses faster on the platform, which decreases both the absolute value and the relative value. Hence, the equilibrium rate of experimentation is decreasing as information becomes more readily available.

The impact of platform encroachment on experimentation incentives is two-fold. Firstly, the platform may have an informational advantage and learn about successful experimentation faster than other sellers. This allows the platform to enter the market earlier, which shortens the horizon for the successful experimenter to capitalize on its product innovation and negatively impacts the experimentation incentives. Secondly, platform encroachment affects the competitive profits of sellers in the product market. The impact of this on experimentation incentives depends largely on whether the successful experimenter holds a competitive advantage over imitators. In the absence of such an advantage, platform encroachment would affect the profits of all sellers in the same way. This means that platform encroachment does not affect the relative value but reduces the absolute value from successful experimentation because of its informational advantage and intensified competition. Therefore, platform encroachment reduces product experimentation.

If, however, the successful experimenter enjoys a competitive advantage in the product market, platform encroachment can increase product experimentation by mitigating the free-riding problem. This can be achieved via two ways. Firstly, the platform could have a disproportionate negative impact on the imitator, which enlarges the profit gap between a successful experimenter and an imitating seller, reduces the value of imitation and hence increases the relative value of successful experimentation. This could be the case when the platform competes more closely with imitators (e.g., in the earbud case above) in terms of product offerings or when the platform biases its recommendations against imitators (e.g., the alleged self-preferencing by platforms). Secondly, platform encroachment leads to more competition in the market and lowers the profits of sellers. This could deter the entry of imitators and reduce the number of sellers. Moreover, under *ad valorem* commission fee, the platform internalizes part of sellers' profits when it enters, which makes the platform a less tough competitor compared to imitators. This means that platform encroachment could alleviate the competitive pressure faced by the successful experimenter by increasing both the absolute value and the relative value of successful experimentation. In addition, this experimentation enhancement effect is stronger when information diffuses faster, as the free-riding problem is more severe.

We further consider several other important aspects. Firstly, we examine whether and how the platform should encroach into the product market. It is crucial to balance the impacts on *ex post* competition and profits from the product market and *ex ante* experimentation incentives. We show that the platform may find it most profitable to enter when its encroachment deters imitation. Moreover, it may enter with a more aggressive strategy to further stifle imitation and enhance experimentation for an intermediate range of imitation costs. Secondly, the level of commission rates could affect the extent of the experimentation enhancement effect. A higher commission rate means that a larger part of sellers' profits is captured by the platform, but it also means that platform encroachment has a larger impact on the number of imitating sellers, which could further enhance experimentation incentives. Finally, when sellers can choose to become an experimenter or an imitator, we demonstrate that platform encroachment may incentivize more sellers to become an experimenter and carry out product experimentation, which could bring additional benefits to the market.

The results find some support in the literature. For example, Wen and Zhu (2019) showed that mobile app developers shift innovation efforts to unaffected and new apps upon Google's entry into the market. This is consistent with our results that platform encroachment may not only incentivize individual sellers to invest more but also encourage sellers to become an experimenter and explore new development ideas. Similarly, Lee and Musolff (2021) examined the impact of Amazon's entry into the product market on independent sellers. They show that platform encroachment reduces entry by the least efficient sellers while benefiting consumers. The results have several managerial and regulatory implications. For the platform, the results show that platform entry does not necessarily crowd out third party sellers; it may even encourage more product experimentation by mitigating the free-riding incentives. This is more likely to be the case when it deters imitation rather than competing against the original experimenter. The experimentation enhancing effect is more significant and valuable when information diffuses at a faster rate, especially given the development of third-party monitoring tools that help sellers identify successful products. On the regulatory side, our results imply that platform entry could generate long-run benefits by encouraging more product experimentation, which brings new products, more varieties and a wider range of choices for consumers. These results suggest the importance of considering *how* firms compete and *how* information diffuses in assessing the impact of platform encroachment and weighing the benefits from enhancing experimentation against the cost arising from platforms' informational advantages.

Our approach follows the line of research on dynamic R&D incentives such as Loury (1979) and Reinganum (1982) and, more recently, Marshall and Parra (2019). A central theme in this literature is how R&D incentives depend on the market structure. We extend this approach to a setup where firms trade via a platform and examine how the market outcome is affected by the platform's strategy. Our analysis thus contributes to the recent literature studying the impact of platform encroachment. For example, Zhu and Liu (2018) showed that the entry of Amazon increases demand and reduces shipping costs but discourages sellers from growing their businesses. He et al. (2020) demonstrated that third party sellers migrate to other retailing channels in response to the entry of a Chinese e-commerce platform. An excellent overview of the empirical literature is provided by Zhu (2019). Theoretically, Jiang et al. (2011) showed that platform encroachment may induce independent sellers to reduce valuable services. The more recent literature has mainly focused on how platform entry affects competition in the market; see, for example, Anderson and Bedre-Defolie (2022), Zennyo (2022), and Hagiu et al. (2022).

There has been limited work on the dynamics of the market and the role of information usage by the platform. Madsen and Vellodi (2022) and Hervas-Drane and Shelegia (2022) considered the case when only the platform learns and imitates third party sellers' products. Lam and Liu (2023) further considered when the platform has access to information at different levels of granularity. In this article, we consider instead the impact of platform entry and information usage on the incentives of product experimentation, when both the platform and third party sellers can learn and imitate. This also distinguishes our work from the literature on private labels such as Hoch (1996) and Gabrielsen and Sørgard (2007), where only the retailers can introduce competing private labels but not other manufacturers.

The article proceeds as follows. We present the main model in Section 2 without platform encroachment and analyze the case with platform encroachment in Section 3. In Section 4, we analyze whether and how the platform should encroach into the product market, and we provide some further discussions and extensions in Section 5. The regulatory implications of our results are discussed in Section 6 and we conclude with some future research directions in Section 7. All omitted proofs are included in the E-companion.

2 Product Experimentation Without Platform Encroachment

We first present the model and study sellers' incentives to carry out product experimentation without the possibility of platform encroachment, which we will introduce in the next section.

There is a monopoly platform, M, that intermediates transactions between sellers and consumers. The platform charges sellers an *ad valorem* commission fee for its service. We consider in the main analysis the case with two experimenting sellers and show how our main results naturally extend to the case with many sellers (both experimenting and non-experimenting) in Section 5. Time is continuous and all parties have a common discount rate r. The market proceeds in three stages:

Experimentation stage: Two sellers, 1 and 2, experiment with new products in the market. At every instant of time, each seller $i = 1, 2$ chooses a Poisson experimentation rate x_i at a convex cost of $c(x_i) = x_i^2/2$. In the case of success, which arrives at a rate of x_i, the seller develops and monopolizes a new product, which generates a flow profit of π_m. The market then moves to the learning stage.

Learning stage: Once a success arrives, the other seller becomes aware of the success but only gradually learns about the details of the successful product.[6] Specifically, we assume that when one seller succeeds, the other seller stops experimenting, and learning in the market occurs at a Poisson rate of ρ. When learning occurs, the non-successful seller can imitate and enter to compete at a flow imitation cost of I and the market moves to the competition stage.[7]

Competition stage: Apart from the imitation cost, we assume that sellers are otherwise symmetrical until Section 5.1 and each earns a flow profit of π in the product market if imitation and entry occurs. To facilitate our analysis, we denote the flow profit in the competition stage of the successful experimenter, referred to as the *leader* in the following, by π_l, and that of the non-successful seller, referred to as the *follower*, by π_f. Naturally, both π_l and π_f are smaller than π_m, all depending on the fees charged by the platform, which we omit to save notations for the moment. Clearly, the follower would only imitate and enter if $I \leq \pi$, otherwise, the leader continues to monopolize the new product. That is:

$$\pi_l = \begin{cases} \pi, & \text{if } I \leq \pi; \\ \pi_m, & \text{if } I > \pi, \end{cases} \quad \text{and } \pi_f = \begin{cases} \pi - I, & \text{if } I \leq \pi; \\ 0, & \text{if } I > \pi. \end{cases}$$

Value Function for the Leader and the Follower

In the competition stage, let

$$\Pi_l = \frac{\pi_l}{r} \text{ and } \Pi_f = \frac{\pi_f}{r}$$

denote the long-run competitive profits for the leader and the follower, respectively.

In the learning stage when a seller has succeeded in product experimentation, we derive the value functions for the leader and the follower, denoted by V_l and V_f, respectively. For the leader, we have[8]:

$$rV_l = \pi_m + \rho(\Pi_l - V_l).$$

That is, if learning does not occur, the leader's value accrues by the flow profit π_m; if learning occurs, which arrives at rate of ρ, the leader's value jumps to the long-run competitive profit Π_l. This gives us:

$$V_l = \frac{\pi_m + \rho\Pi_l}{r+\rho}.$$

Similarly, for the follower, we have:

$$V_f = \frac{\rho\Pi_f}{r+\rho}.$$

Value Function Before Successful Experimentation

Before any successful experimentation arrives, each seller $i = 1, 2$ maximizes its pre-success value, denoted by V_0, by solving:

$$rV_0 = \max_{x_i} -\frac{x_i^2}{2} + x_i(V_l - V_0) + x_j(V_f - V_0), \text{ for } j \neq i. \quad (1)$$

That is, at every instant of time, the seller incurs the flow cost of experimentation. When it succeeds in product experimentation, it becomes the leader and its value jumps to V_l; however, when the other seller succeeds, it becomes the follower and its value jumps to V_f. We have:

LEMMA 1. *The equilibrium experimentation rates are given by $x_1^* = x_2^* = x^*$ with*

$$x^* = \frac{V_l - V_f - r + \sqrt{(V_l - V_f - r)^2 + 6rV_l}}{3}.$$

Hence, the experimentation rate increases with the value of being the leader and the value gap between being the leader and being the follower. The former can be interpreted as the absolute benefit from successful experimentation and the latter as the relative benefit of successful experimentation compared with unsuccessful experimentation. When sellers heavily discount the future (i.e., r is large), the experimentation rate is largely determined by the absolute benefit, particularly the profit in the monopolization stage or the learning stage. When sellers are patient (i.e., r is small), the experimentation rate depends mostly on the relative benefit, particularly the profit difference between the leader and the follower in the competition stage. Moreover, we can show that:

PROPOSITION 1. *The equilibrium experimentation rate x^* is decreasing in the information diffusion rate ρ and increasing in the imitation cost I.*

The reason is that the faster information diffuses in the market, the shorter the monopolization period for the successful experimenter, which lowers the value of becoming the leader and hence the absolute benefit. Moreover, faster information diffusion enables other sellers to learn and imitate faster, thereby narrowing the value gap between the leader and the follower and hence the relative benefit. Consequently, the equilibrium experimentation rates become lower. Similarly, an increase in the imitation cost reduces the value of the follower and hence boosts experimentation incentives. The result highlights the free-riding incentives in the market when information becomes more accessible, as sellers value more the option to wait and imitate instead of undertaking their own costly experimentation.[9]

3 Impact of Platform Encroachment

3.1 How Does Platform Encroachment Affect Product Experimentation?

Now we consider the case where the platform enters with its own version of products at no imitation cost. This could reflect the advantage of the platform in managing the supply chain or benefiting from economies of scale. We assume that the platform itself does not carry out experimentation but instead learns about successful experimentation from two information sources. Firstly, as the follower, it learns from publicly available information, which arrive at a Poisson rate of ρ. In addition, it has access to private information, which enables it to learn about success in the market independently from the follower. Learning from private information occurs at a Poisson rate of μ. Thus, we can interpret μ as the informational advantage held by the platform. Whenever learning from either public or private information occurs, the platform enters the market with its own product.

This affects sellers in two ways. Firstly, the platform's access to private information allows it to learn about successful experimentation and enter the market earlier than other sellers. We denote the leader's flow profit when the platform enters before other sellers by $\pi_l^D (< \pi_m)$. Secondly, the entry of the platform impacts the competitive profits of the leader and the follower. More importantly, it can affect the imitation and entry decisions of the follower. Let π^E be the flow profits of the leader and follower in the product market when the platform also enters. Naturally, we have $\pi^E < \pi$ as competition intensifies.[10] The follower would enter only if $I \leq \pi^E$. When $I > \pi^E$, the follower does not enter and only the leader and the platform remain active in the competition stage, and the profit of the leader in this case is π_l^D. With fewer sellers in the market, we expect $\pi_l^D > \pi^E$. However, π_l^D can be either higher or lower than π. This is because: on the one hand, the platform does not pay a commission fee and thus incurs a lower effective cost; on the other hand, the platform internalizes part of the leader's profit through the *ad valorem* commission fee, which makes it a less fierce competitor. For clarity in the following analysis, we focus on the case where $\pi_l^D > \pi$, formally stated as the following assumption.[11]

ASSUMPTION 1. $\pi_l^D > \pi$.

When sellers and the platform are symmetrical in terms of quality and cost, we always have $\pi_l^D > \pi$ if the marginal costs are zero, or more generally, when marginal costs are small relative to a consumer's value for the product. This is because in such cases, the cost advantage of the platform diminishes, and the profit of the leader is higher when competing with the platform compared to an imitating seller. However, this is just one way in which platform entry can relax competition in the market and directly benefit the leader. The literature has also identified other channels through which platform entry can benefit independent sellers, such as market expansion (Tang et al., 2024) and product differentiation (Chen and Riordan, 2008).

We can then derive the value functions of sellers with platform encroachment. In the competition stage, let:

$$\Pi_l^E = \begin{cases} \dfrac{\pi^E}{r}, & \text{if } I \le \pi^E; \\ \dfrac{\pi_l^D}{r}, & \text{if } I > \pi^E, \end{cases} \quad \text{and } \Pi_f^E = \begin{cases} \dfrac{\pi^E - I}{r}, & \text{if } I \le \pi^E; \\ 0, & \text{if } I > \pi^E, \end{cases}$$

denote the long-run competitive profits for the leader and the follower, respectively. The value function of the leader and the follower in the learning stage can be derived as (the derivation is contained in the proof of Proposition 2):

$$V_l^E = \frac{\pi_m}{r+\rho} + \frac{\mu(\pi_l^D - \pi_m)}{(r+\rho)(r+\mu+\rho)} + \frac{\rho \Pi_l^E}{r+\rho}, \tag{2}$$

and

$$V_f^E = \frac{\rho \Pi_f^E}{r+\rho}.$$

At the experimentation stage, each seller $i = 1, 2$ chooses its experimentation rate by solving:

$$rV_0^E = \max_{x_i} -\frac{x_i^2}{2} + x_i(V_l^E - V_0^E) + x_j(V_f^E - V_0^E).$$

This yields the equilibrium experimentation rate:

$$x^{*E} = \frac{V_l^E - V_f^E - r + \sqrt{(V_l^E - V_f^E - r)^2 + 6rV_l^E}}{3}.$$

We can show that:

PROPOSITION 2.

(a) *If $I \le \pi^E$, platform encroachment reduces product experimentation.*
(b) *If $I > \pi$, platform encroachment reduces experimentation.*
(c) *If $\pi^E < I \le \pi$, there exists a $\bar{\mu} > 0$ such that platform encroachment enhances product experimentation if $\mu \le \bar{\mu}$ for any r.*

As outlined above, platform encroachment has two main effects: on the one hand, the informational advantage allows the platform to enter the market early, thereby reducing the absolute benefit of product experimentation and negatively impacting the equilibrium experimentation rate, as follows:

$$\frac{\partial V_l^E}{\partial \mu} = \frac{\pi_l^D - \pi_m}{(r+\mu+\rho)^2} < 0.$$

On the other hand, platform entry reshapes the competition stage and affects the relative benefit from product experimentation. This depends on the profit gap between the leader and the follower, which, in turn, is affected by the imitation cost, that is, the competitive advantage held by the leader.

When the leader does not enjoy any competitive advantage in the product market over the follower or when the advantage is small, that is, case (a) with $I \in [0, \pi^E]$, platform encroachment always reduces product experimentation. This is because platform entry affects the two parties symmetrically and leaves the relative profits in the competition stage unchanged. In fact, we have:

$$\pi_l - \pi_f = \pi_l^E - \pi_f^E = I.$$

However, platform entry lowers the absolute benefit due to shortened monopolization and intensified competition ($\pi^E < \pi$).

When the imitation cost is high, platform encroachment again stifles experimentation incentives. In case (b), the follower never enters as $I > \pi$ and the leader would monopolize the market without platform entry. Platform entry then reduces the profit of the leader ($\pi_l^D < \pi_m$) and hence also the profit gap between the leader and the follower as $\pi_f = \pi_f^E = 0$. This, in turn, stifles experimentation incentives.

In case (c), when the imitation cost is intermediate with $\pi^E < I \le \pi$, without platform entry, we have:

$$\pi_l - \pi_f = I \text{ and } \pi_l = \pi,$$

whereas with platform entry, we have:

$$\pi_l^E - \pi_f^E = \pi_l^D > \pi \ge I \text{ and } \pi_l^E = \pi_l^D > \pi.$$

Thus, platform entry not only widens the profit gap between the leader and the follower but also increases the profit of the leader as $\pi_l^D > \pi$. There are two key forces underlying this result, both of which depend on the imitation costs of the follower. Firstly, the leader enjoys a competitive advantage over the follower, so platform entry affects the two parties differently. Specifically, the follower could be forced out by the platform but not the leader, thus widening the profit gap between the leader and the follower even if platform entry leaves the leader's profit unchanged in the competition stage. Secondly, by deterring imitation, platform entry could relax competition and further boost experimentation incentives, as $\pi_l^D > \pi$. Overall, when the informational advantage is small, platform entry can increase experimentation rates.

In fact, when sellers are patient enough, platform entry enhances experimentation incentives regardless of the platform's informational advantage.

COROLLARY 1. *Platform encroachment always enhances product experimentation for $\pi^E < I \leq \pi$, if sellers are sufficiently patient.*

EXAMPLE 1. To give readers a more concrete idea, we consider a widely used demand system from Shubik and Levitan (1980) for competition in the product market. Specifically, suppose there are n sellers in the competition stage, each producing a different variety and competing in prices. The utility function of a representative consumer is:

$$U = \sum_{i=1}^{n} a_i q_i - \frac{1}{2}\left[2\sigma \sum_i \sum_{j>i} q_i q_j + \sum_i \left(\sigma + \frac{1-\sigma}{w_i}\right) q_i^2\right],$$

where a_i is the quality of seller i, q_i is the consumption of product sold by seller i, and w_i is the strength of seller i with $\sum_{i=1}^{n} w_i = 1$. The degree of product differentiation is represented by $\sigma \in [0, 1)$, with $\sigma = 0$ for independent products and $\sigma \to 1$ for homogeneous products. This generates a demand for product i in the competition stage, given by the following equation:

$$q_i = \frac{w_i}{1-\sigma}[a_i - p_i - \sigma(\bar{a} - \bar{p})],$$

where $\bar{a} = \sum_{i=1}^{n} w_i a_i$ is the average quality, $\bar{p} = \sum_{i=1}^{n} w_i p_i$ is the average price. Note that this demand function has the property that entry—meaning an increase in the number of firms—does not expand the market but merely reallocates market shares among firms. This would allow us to separate the impact of platform encroachment on competition and experimentation incentives from other ways in which platform encroachment may benefit independent sellers, such as market expansion (e.g., Tang et al., 2024). We assume sellers compete in prices and the platform charges sellers an *ad valorem* commission fee with a rate of s.

Consider the case of symmetric sellers, that is, $w_i = 1/n$ and $a_i = a$, and all sellers have the same marginal cost c. With only two sellers, the competitive profit, π, is given by the following equation:

$$\pi = (1-s)(2-\sigma)(1-\sigma)\left(\frac{a - \frac{c}{1-s}}{4-3\sigma}\right)^2.$$

When the platform enters to compete with both sellers, the competitive profit, π^E, is given by the following equation:

$$\pi^E = (1-s)(3-\sigma)(1-\sigma)\left(\frac{(6-\sigma)\left(a - \frac{c}{1-s}\right) - \frac{cs}{1-s}\sigma}{2(3-2\sigma)(6-\sigma) - 2\sigma^2 s}\right)^2,$$

which is always smaller than π.

When the platform enters to compete with the leader only, the profit of the leader, π_l^D, is given by the following equation:

$$\pi_l^D = (1-s)(2-\sigma)(1-\sigma)\left(\frac{(4-\sigma)\left(a - \frac{c}{1-s}\right) - \frac{cs}{1-s}\sigma}{(4-3\sigma)(4-\sigma) - \sigma^2 s}\right)^2.$$

We can show that $\pi_l^D > \pi$ if:

$$\frac{a\sigma s}{1-s}\left(\sigma - 2(2-\sigma)\frac{c}{a}\right) > 0,$$

which is always satisfied if $c = 0$, or generally when c/a is small and σ is large, reflecting relatively low costs and a high degree of substitution, consistent with observations from trading platforms such as Amazon Marketplace. Moreover, if $\sigma = 0$, we have $\pi_l^D = \pi$ as product demands are independent.

We emphasize that, since the competition stage is the last stage of the game, our analysis does not depend on how the competition stage profits are determined, as long as they satisfy the properties outlined in the analysis. We can certainly consider other types of demand functions or other factors affecting profits, such as the choice of supplier (e.g., Liao et al., 2020). We choose to present the *ex post* competitive profits from the product markets in a reduced form to focus on the impact of platform encroachment on *ex ante* experimentation incentives.

3.2 The General Case

In the above analysis, we assumed that $\pi_l^D > \pi$. In this section, we show that this assumption is not essential to our results. When sellers are patient enough, the main force driving experimentation incentives is the impact of platform encroachment on the product market. Specifically, for any given flow profits π_l and π_f without platform encroachment and π_l^E and π_f^E with platform encroachment, we can show that:

PROPOSITION 3. *If $\pi_l^E - \pi_f^E > \pi_l - \pi_f$, there exists a $\bar{r} > 0$ such that, platform encroachment boosts product experimentation if $r < \bar{r}$.*

The case for $\pi_l^D \leq \pi$ then follows immediately.

COROLLARY 2. *If $\pi_l^D \leq \pi$, we have:*

(a) *If $I \leq \pi^E$, platform encroachment reduces product experimentation.*
(b) *If $I \geq \pi_l^D$, platform encroachment reduces experimentation.*
(c) *If $\pi^E < I < \pi_l^D$, platform encroachment enhances product experimentation if r is sufficiently small.*

In the case where $\pi_l^D \leq \pi$ and $\pi^E < I < \pi_l^D$, platform entry still enlarges the profit gap between the leader and the follower as follows:

$$\pi_l^E - \pi_f^E = \pi_l^D > I = \pi_l - \pi_f.$$

However, platform entry reduces the value of the leader as $\pi_l^D \leq \pi$. Consequently, platform entry only enhances experimentation incentive when sellers are patient enough, that is, when r small, such that the former effect dominates. In other words, the results are aligned with Proposition 2 for sufficiently patient sellers. Therefore, it is without loss of generality to focus on the case of $\pi_l^D > \pi$ to streamline our analysis.

The analysis can be extended to the case where sellers differ in their experimentation costs, but doing so would significantly limit the tractability of the analysis without generating substantial insights.[12] Hence, we adopt the symmetric experimenter setup to deliver our main insights. We have also focused on the natural setup where the leader earns more profit than the follower in the competition stage. However, in some cases, the follower might earn a higher profit, such as when they have improved technology and, consequently, offer higher quality. In such cases, the free-riding problem could become so severe that no seller would invest in product experimentation if they are patient enough. Nevertheless, if information about successful experimentation diffuses sufficiently slow, sellers would still engage in product experimentation and Proposition 3 would continue to apply for small informational advantages.[13]

3.3 The Role of Information Diffusion

We can further show that the experimentation enhancement impact is stronger when information diffuses faster and the platform has no informational advantage.

PROPOSITION 4. *When the platform has no informational advantage, we have $|\frac{\partial(x^{*E}-x^{*})}{\partial\rho}| > 0$ when r is sufficiently small.*

That is, if platform encroachment enhances experimentation, this positive impact is stronger when information diffuses faster. On the contrary, if platform encroachment reduces experimentation, the negative impact is also stronger with faster information diffusion. This occurs because when information diffuses faster, the learning stage is relatively short compared to the competition stage. As a result, the value difference between the leader and the follower weighs more for driving experimentation incentives. This amplifies the impact of platform encroachment at the competition stage, which determines the direction of impact when sellers are sufficiently patient.

This implies that platform entry can effectively promote more product experimentation when imitation is deterred and information diffuses fast, mainly by alleviating free-riding incentives. This is more likely to be the case, for instance, with the emergence of third-party sales monitoring tools, which enables sellers to analyze and respond quickly to market developments.

4 Whether and How Should the Platform Enter?

4.1 When Should the Platform Enter?

To examine whether the platform should encroach into the product market, we first derive the value function for the platform. We denote τ as the ratio of commission fee to seller profit.[14] If the platform can commit not to enter the market, its value function, V_p, satisfies (the derivation is contained in the proof of Proposition 6):

$$V_p = \frac{2x^*}{r + 2x^*}\frac{1}{r}\frac{r \cdot \tau\pi_m + \rho \cdot v_p}{r + \rho}, \tag{3}$$

where v_p is the profit for the platform in the competition stage, which comes entirely from the commission fee, and we have:

$$v_p = \begin{cases} \tau\pi_m, & \text{if } I > \pi, \\ \tau \cdot 2\pi, & \text{if } I \leq \pi. \end{cases}$$

When the platform encroaches into the market, let π_p^D denote the profit of the platform from the product market when it competes only with the leader, and let π_p^E denote its profit from the product market when it competes with both the leader and the follower. The platform's value function, V_p^E, satisfies:

$$V_p^E = \frac{2x^{*E}}{r + 2x^{*E}}\frac{1}{r}\left[\frac{r \cdot \tau\pi_m + \rho \cdot v_p^E}{r + \rho} + \frac{\mu r(v_p^D - \tau\pi_m)}{(r + \rho)(r + \mu + \rho)}\right], \tag{4}$$

where $v_p^D = \pi_p^D + \tau\pi_l^D$ is the profit of the platform when it enters before the follower, including both profits from product sales and those from commission fees, and v_p^E is the profit of the platform in the competition stage, represented by the following equation:

$$v_p^E = \begin{cases} \pi_p^D + \tau\pi_l^D, & \text{if } I > \pi^E, \\ \pi_p^E + \tau \cdot 2\pi^E, & \text{if } I \leq \pi^E. \end{cases}$$

There are two effects to consider when the platform encroaches into the market. Firstly, as argued above, it changes experimentation incentives, which may either slow down or accelerate new product developments that generate profit opportunities. Secondly, it affects competition in the product market. While encroachment generates profits from direct sales, it reduces profits for independent sellers, thereby reducing commission fees. We show that when commission rate is high and competition in the market is intense, the platform only enters when it deters imitation.

Proposition 5. *If (a) $\pi_p^E+\tau\cdot 2\pi^E < \tau\cdot 2\pi$ and (b) $\pi_p^D+\tau\pi_l^D < \tau\pi_m$, the platform only enters when $\pi^E < I \leq \pi$ and it uses only public information.*

The intuition is as follows: condition (a) means that the platform does not enter when the follower always enters (i.e., $I \leq \pi^E$), as encroachment not only reduces its profit from the product market but also reduce experimentation. Condition (b) means that the platform earns a lower profit if it enters to compete with the leader only. Therefore, when the follower never enters (that is, $I > \pi$) or when the platform enters upon learning from private information, it again reduces both profits from the product market and experimentation incentives. In summary, the platform only finds it profitable to enter if it can deter the follower's entry (i.e., $\pi^E < I \leq \pi$) using only public information. This is because encroachment not only enhances experimentation incentives but also increases profit from the product market due to $\pi_p^D + \tau\pi_l^D > \tau \cdot 2\pi$ according to Assumption 1.

Conditions (a) and (b) are satisfied when the commission rate is high and competition is intense such that entry significantly reduces seller profits and commission fees. In such cases, platform encroachment is less likely. For example, on the App Store, with a 30% commission rate, encroachment by Apple does not seem to be common. Conversely, when the commission rate is lower, as seen on Amazon where most product categories have commission rates between 8% and 15%, these conditions are likely to fail. Another example where these conditions fail is when $s \leq 1/2$ and $\sigma \leq 1/2$ in Example 1. In these scenarios, without commitment, the platform always has incentives to enter upon learning from either private or public information. However, this needs to be traded-off against the potential dampening impact on experimentation incentives. We can show that, compared with committing to no encroachment, the benefit of encroachment is higher when information diffuses faster, provided sellers are patient enough and the informational advantage of the platform is not too large. More formally:

Proposition 6. *If (a') $\pi_p^E + \tau \cdot 2\pi^E > \tau \cdot 2\pi$ and (b') $\pi_p^D + \tau\pi_l^D > \tau\pi_m$, we have $\partial(V_p^E - V_p)/\partial\rho > 0$ if r and μ are sufficiently small.*

The reason is that when the informational advantage is small, the platform's profit is mainly driven by the competition stage, which, according to conditions (a') and (b'), is higher when it enters. Moreover, the competition stage arrives sooner when information diffuses faster. Although rapid information diffusion can adversely affect experimentation incentives in some cases, this impact becomes small as sellers become more patient. Consequently, the platform finds it more profitable to encroach into the product market.

4.2 How Should the Platform Enter?

We can further explore how the platform may adjust its strategies upon encroaching into the market to balance the impact on the product market and experimentation incentives. We consider the case where the platform does not have an informational advantage and assume the platform determines its encroachment strategy, denoted by α, which affects the profits of sellers in the product market. For example, α could represent the quality of the platform's product, the extent of self preferencing or the rate of commission fee. We assume this is determined at $t = 0$, reflecting the observation that strategies such as product selection are long-term choices and cannot be easily adjusted as information about successful experimentation arrives.

As mentioned above, the choice of α affects profits from the product market in the competition stage. To facilitate the following analysis, we assume that π_m is independent of α, as there is no competition from the platform. However, $\pi(\alpha)$, $\pi^E(\alpha)$ and $\pi_l^D(\alpha)$ are all decreasing in α and $\pi_p^D(\alpha)$ and $\pi_p^E(\alpha)$ are increasing in α. For example, a more premium brand offered by the platform lowers the profits of competing independent sellers and increases the platform's profit from product sales. We maintain the conditions of Proposition 6 such that the platform always finds it profitable to enter upon learning about successful experimentation. Furthermore, we assume that the platform's profit is higher when it competes only with the leader, that is, $\pi_p^D(\alpha) + \tau\pi_l^D(\alpha) > \pi_p^E(\alpha) + \tau \cdot 2\pi^E(\alpha)$. Thus, the platform always has incentives to enter the product market but prefers less competition, in line with the demand function of Example 1.

Similar to equation (4), the total expected value obtained by the platform is:

$$V_p^E(\alpha) = \frac{2x^{*E}(\alpha)}{r + 2x^{*E}(\alpha)} \frac{1}{r} \frac{r \cdot \tau\pi_m + \rho v_p^E(\alpha)}{r + \rho},$$

where we explicitly take into consideration the impact of the platform's strategy on experimentation incentives and the product market profits, and

$$v_p^E(\alpha) = \begin{cases} \pi_p^D(\alpha) + \tau\pi_l^D(\alpha), & \text{if } I > \pi^E(\alpha), \\ \pi_p^E(\alpha) + \tau \cdot 2\pi^E(\alpha), & \text{if } I \leq \pi^E(\alpha). \end{cases}$$

Clearly, for large enough imitation costs, the follower never enters. In such cases, we denote the optimal strategy of the platform by α^D, which we assume to be interior, balancing the gains from the product market and losses from dampening experimentation incentives. This strategy α^D remains optimal for any $I > I^D \equiv \pi^E(\alpha^D)$. For smaller imitation costs, the platform needs to further consider how its strategy affects the follower's entry. We can show that, for an intermediate range of imitation costs, the platform enters with a more aggressive strategy as imitation becomes easier. Specifically:

PROPOSITION 7. *There exists a $\hat{I}$ such that for $\hat{I} \leq I \leq I^D$, the optimal strategy of encroachment α^* is decreasing in the imitation cost.*

The platform could either exclude the follower from the product market with a more aggressive strategy or allow the follower to enter with a less aggressive strategy. We show that the former is optimal when the imitation cost is not too small. This is because by excluding the follower, the platform not only relaxes competition and earns more profit from the product market but also benefits from enhanced experimentation incentives. Therefore, the platform adopts a more aggressive strategy when encroaching into the market as imitation becomes easier. However, when the imitation cost is excessively low, it becomes too costly to exclude the follower. For example, the platform needs to incur significant costs associated with producing premium brands to deter imitation. Consequently, the platform chooses a less aggressive strategy to allow the follower to enter.

This relates our analysis to the literature on private labels, which explores whether and how brick-and-mortar stores should introduce private labels and how this would impact the strategies of national brands. In platform markets, two features stand out. Firstly, information about successful products become abundant and easily accessible. Secondly, not only can the dominant retailer—the platform—learn about popular products and introduce private labels, but other independent sellers can also learn and introduce their competing products. We show how the platform could adapt its product offering to accommodate these market conditions.

5 Further Discussions and Extensions

5.1 Imitation From Other Third-Party Sellers

In the above analysis with only two sellers, imitation costs capture the competitive advantage of the leader over the follower. The main way platform encroachment impacts the follower more than the leader is through complete exclusion. In this section, we show that the follower needs not be forced out of the market for a similar mechanism to work. Specifically, platform encroachment can enhance experimentation incentives by limiting the number of imitating sellers and relaxing competition, provided that the leader holds a certain competitive advantage over the follower.

EXAMPLE 2. We consider the case when the platform does not have an informational advantage and continue with Example 1, using the following demand function for n sellers:

$$q_i = \frac{1}{n(1-\sigma)}[(a_i - p_i) - \sigma(\bar{a} - \bar{p})], \text{ for } i \in \{1, 2, \ldots, n\},$$

where we replace the product strength w_i with $1/n$. We assume zero production costs for all sellers and the platform. The platform charges an *ad valorem* commission fee s and sellers compete in prices. We assume that the number of sellers in the competition stage is determined by free entry at a cost of F. The leader and the follower do not incur this cost as they are already in the market, but any other independent seller that imitates a successful product needs to incur this cost.

Clearly, if the leader does not enjoy any competitive advantage over the follower (as the imitation cost for the follower is assumed away), the impact of platform entry on experimentation incentives would be neutral, as the profits for both are pinned down to the entry cost of other third-party sellers at F. This links to a few widely used horizontal differentiation models with symmetric sellers, such as the Salop model and the Logit model. In these models, the profits of the leader and the follower remain the same in the competition stage regardless of platform entry. Moreover, this result does not depend on whether the platform enjoys an advantage in the product market or how the platform may adjust the commission fees after entry.

To investigate the role of competitive advantage, we assume that the leader has a perceived quality of $a_l = 1 + \Delta$, the follower and other third party sellers has $a_f = 1$ and the platform has $a_d = 1+\delta$, with $\delta \in [0, \Delta]$. That is, Δ can be interpreted as the competitive advantage enjoyed by the leader, and the platform may be perceived to be of a higher quality than imitators. Thus, the follower's profit is pinned down to F but the leader earns a higher profit.

For a given number of sellers, we always have $\pi_l^E - \pi_f^E < \pi_l - \pi_f$ and hence platform encroachment reduces product experimentation. This is shown in Figure 1(a).

However, when we take into account the impact platform entry has on the number of active sellers, platform encroachment can instead enhance product experimentation, as shown in Figure 1(b) (ignoring the integer constraint on the number of sellers). This is more likely to be the case when the platform has a larger advantage over the followers, as the impact on the number of active sellers is larger. This is consistent with Proposition 7 that the platform may find it optimal to behave more aggressively to exclude imitators in order to enhance experimentation incentives.

This can be more formally seen as follows. Let the number of sellers in the competition stage be $\mathbb{N}^E$ and $\mathbb{N}$ for the cases with and without platform encroachment, respectively. Naturally, as platform encroachment intensifies competition

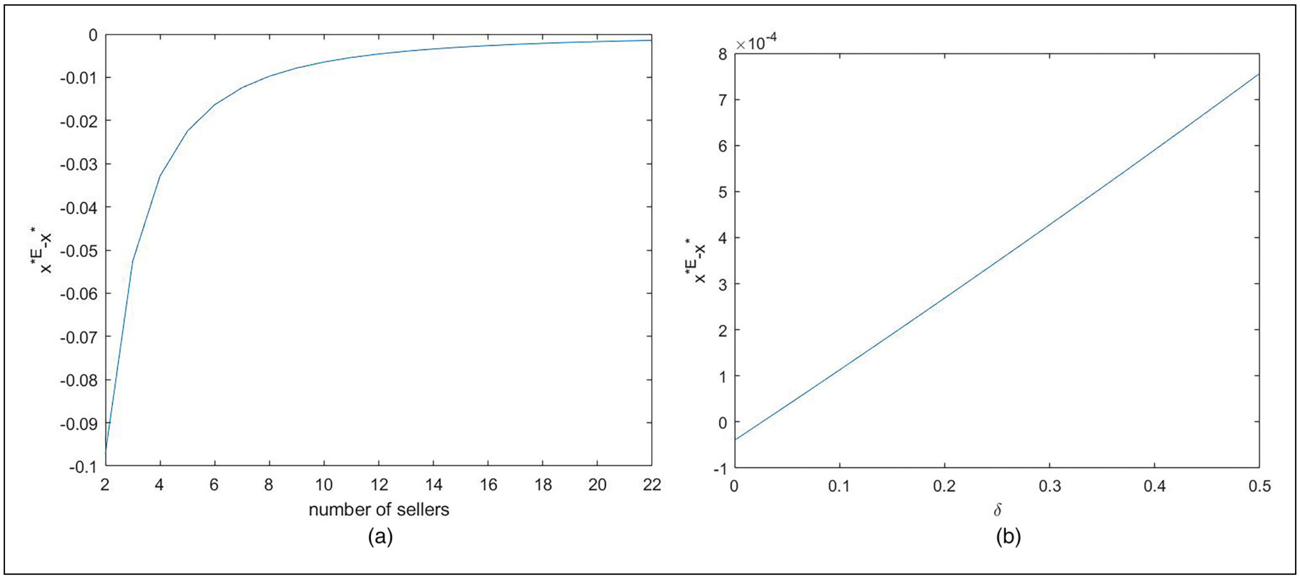

Figure 1. The impact of platform encroachment on experimentation rates ($r = 0.01, \rho = 2, s = 15\%, \Delta = 1, \sigma = 1/2$): (a) for a given n ($\delta = 0.5$); (b) endogenous n ($F = 0.01$).

and reduces seller profits, we have $\mathbb{N}^E < \mathbb{N}$. Furthermore, in most commonly used models (such as the one above), we have $\pi_l(n) - \pi_f(n)$ decreasing with the number of sellers n. If platform entry enlarges the profit gap between the leader and the follower for a fixed number of sellers, that is, $\pi_l^E(\mathbb{N}^E) - \pi_f^E(\mathbb{N}^E) > \pi_l(\mathbb{N}^E) - \pi_f(\mathbb{N}^E)$, we must have $\pi_l^E(\mathbb{N}^E) - \pi_f^E(\mathbb{N}^E) > \pi_l(\mathbb{N}) - \pi_f(\mathbb{N})$ as $\pi_l - \pi_f$ decreases with the number of sellers and $\mathbb{N}^E < \mathbb{N}$, which further means that $\pi_l^E(\mathbb{N}^E) > \pi_l(\mathbb{N})$ as $\pi_f^E(\mathbb{N}^E) = \pi_f(\mathbb{N}) = F$. Therefore, platform entry must also increases the leader's profit and hence the experimentation incentives when we take into account how it may reshape the competition stage. That is, the impact of platform entry on the number of imitators generate an additional incentive enhancement effect. Moreover, this implies that platform encroachment could enhance product experimentation even when it does not enlarge the profit gap for a fixed number of sellers, as demonstrated by this example.

5.2 *Experimentation by the Follower*

To streamline our analysis, we have assumed that the follower stops experimenting once the other seller succeeds. In this section, we allow the follower to continue experimenting in our main model with two sellers. We show that this does not change our main insights and introduces an additional channel through which platform encroachment enhances experimentation incentives.

To illustrate the main idea, we assume that the platform has no informational advantage, that is, $\mu = 0$. The experimentation stage is the same as in the main model. Once a seller succeeds and becomes the leader, the follower can continue to experiment to discover desirable product characteristics, with a success rate of y at a flow cost of $c(y) = y^2/2$. Public information about the successful product still arrives at a rate of ρ. Note that, without informational advantage, the platform only enters upon the arrival of public information. If public information arrives before the follower obtains any success, the follower can imitate and enter at a flow cost of I. Conversely, if the follower succeeds before the arrival of any public information, the follower can enter without incurring any extra cost. In either case, sellers earn a flow profit of $\hat{\pi}$ in the competition stage from the product market, where $\hat{\pi} = \pi$ without platform entry and $\hat{\pi} = \pi^E$ with platform entry. Therefore, the imitation cost not only captures the competitive advantage of the leader over the follower, as in the main model, but also the advantage of experimentation over imitation for the follower.

The main mechanism underlying Proposition 2 still works here. Specifically, if $\pi^E < I \leq \pi$ and public information arrives before the follower obtains any success in experimentation, the follower is excluded from the market due to platform encroachment, and the leader benefits further from this under Assumption 1. Taking into account the follower's experimentation incentives, it introduces an additional channel through which platform encroachment enlarges the value difference between the leader and the follower.

To see this, we consider the case of $I < \pi^E$, so platform entry does not exclude the follower from the market. The main difference from the main analysis is in deriving the value functions for the leader and the follower. If public information arrives before the follower's success, the sellers enter the competition stage and earn the flow profit $\hat{\pi}$. If the follower succeeds before the arrival of public information, the value for both the leader and the follower is given by the following equation:

$$\hat{\Pi} = \frac{1}{r}\frac{r\pi + \rho\hat{\pi}}{r+\rho}.$$

Moving backward, the value function for the follower before its own success and the arrival of public information satisfies:

$$rV_f = max_y - \frac{y^2}{2} + y(\hat{\Pi} - V_f) + \rho(\hat{\Pi}_f - V_f),$$

where $\hat{\Pi}_f = \frac{\hat{\pi}-I}{r}$. This yields:

$$y^* = -(r+\rho) + \sqrt{(r+\rho)^2 + 2r\hat{\Pi} + 2\rho(\hat{\Pi} - \hat{\Pi}_f)},$$

and

$$V_f = \frac{-(y^*)^2/2 + y^*\hat{\Pi} + \rho\hat{\Pi}_f}{r + y^* + \rho}.$$

Using envelop theorem, we have:

$$\frac{\partial V_f}{\partial \hat{\pi}} = \frac{y^*\frac{\rho}{r(r+\rho)} + \frac{\rho}{r}}{r + y^* + \rho} > 0.$$

The leader's value satisfies:

$$rV_l = \pi_m + y^*(\hat{\Pi} - V_l) + \rho(\hat{\Pi}_l - V_l),$$

where $\hat{\Pi}_l = \frac{\hat{\pi}}{r}$. This gives us:

$$V_l = \frac{\pi_m + y^*\hat{\Pi} + \rho\hat{\Pi}_l}{r + y^* + \rho}.$$

We have:

$$\frac{\partial V_l}{\partial \hat{\pi}} = \frac{y^*\frac{\rho}{r(r+\rho)} + \frac{\rho}{r}}{r + y^* + \rho} + \frac{\partial V_l}{\partial y}\frac{\partial y^*}{\partial \hat{\pi}}.$$

Therefore, $\partial(V_l - V_f)/\partial\hat{\pi} < 0$ because $\partial V_l/\partial y < 0$ (more experimentation by the follower brings forward the competition stage) and $\partial y^*/\partial\hat{\pi} > 0$ (higher profit from the competition stage motivates more experimentation by the follower). That is, by reducing the competitive profit $\hat{\pi}$, platform encroachment further enlarges the gap $V_l - V_f$. This captures the additional experimentation enhancing impact of platform encroachment: it stifles the continuing experimentation incentives of the follower and further reduces the value from being the follower.

5.3 Alternative Means to Boost Experimentation

The analysis so far assumes that upon entry, the platform competes with independent sellers on prices only. In practice, however, the platform may have other means to influence the profits of different sellers. For example, the platform can bias its product recommendations towards a particular seller. In such cases, the platform may have alternative means to boost experimentation by favoring the leader.

Example 3. We continue with the demand system used above:

$$q_i = \frac{w_i}{1-\sigma}[(a - p_i) - \sigma(a - \bar{p})], \text{ for } i \in \{1, 2, \ldots, n\}.$$

We keep the assumption that all sellers have the same quality, but we allow them to have different product strengths. Product strength can be interpreted as the market share of each seller when they all charge the same price. This can be influenced by the platform directing consumers to different sellers via product rankings or recommendations. Specifically, we assume that the leader has a strength of $w_l = \phi \geq 1/n$ and each of the other sellers has a strength of $w_f = (1-\phi)/(n-1)$. When the platform enters, it changes the product strengths of sellers already in the market, modeled as follows:

$$w_l^E = \phi(1-\beta),$$
$$w_f^E = \frac{(1-\phi)(1-\gamma)}{n-1},$$
$$w_d = \beta\phi + \gamma(1-\phi),$$

where w_d denotes the strength of the platform. This can be interpreted as follows: platform entry does not expand the market but results in a redistribution of market shares through biased recommendations, for example. A higher β means that the platform captures a larger part of the leader's market share, while a higher γ means that it captures a larger part of the followers' market shares. We continue to assume zero production costs and an *ad valorem* commission rate s. In this case, platform encroachment would enhance product experimentation when β is small and γ is large, as shown in Figure 2.

The example demonstrates how platform entry could boost experimentation via alternative means. The intuition is that platform entry hurts the follower more than the leader, similar to our main analysis where the follower is forced out instead. This is more likely when the platform's product competes more closely with the follower's rather than the leader's. This could also occur when the platform biases its product recommendations more against the followers. As discussed in Section 4, while the platform may always have incentives to enter to benefit from direct sales, it can adopt additional strategies to preserve innovation incentives.

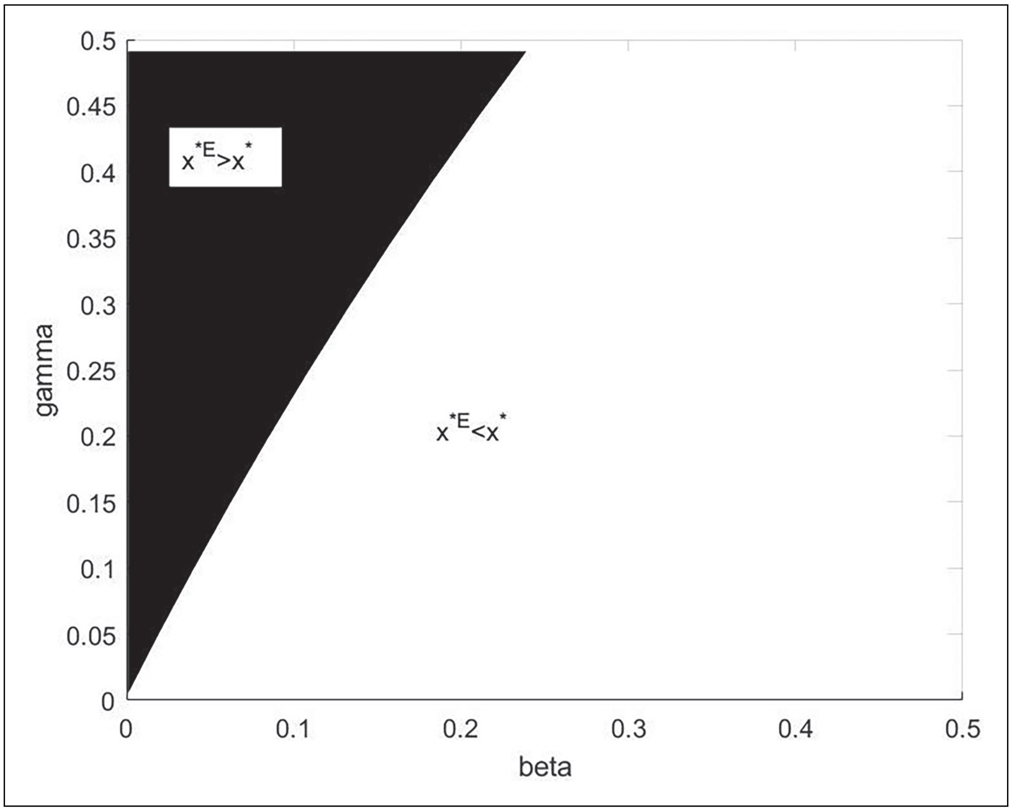

Figure 2. Comparison of equilibrium experimentation rates ($\phi = 0.2, \sigma = 1/2, r = 0.01, \rho = 2, n = 10, s = 15\%$).

5.4 The Role of Commission Fees

To streamline the presentation, we have suppressed the explicit dependence of sellers' profits on the commission fee set by the platform (except for Example 1). Our results are valid if the leader and the follower face the same commission rate, which applies well to the cases where, in practice, sellers from the same category are charged the same commission rate. Our model can also be easily adapted to accommodate scenarios where sellers in different categories are charged differently.[15] This would not change our main results but would only affect the extent to which platform encroachment enhances experimentation incentives.

Specifically, for a higher commission rate, the profit gap between the leader and follower shrinks as a larger part is taken by the platform, which weakens the experimentation incentives. However, with a higher commission rate, the impact of platform encroachment on the number of imitators is greater and the platform also internalizes more of the sellers' profits. Hence, this could lead to more relaxed competition and benefit sellers. To see this, we re-examine Example 2 in Section 5.1 with different levels of commission fees.

As shown in Figure 3, when the platform has a less premium product (δ is low), the impact of platform entry on the number of imitators is limited and a higher commission rate leads to a more negative impact on experimentation incentives. However, when the platform has a more premium product (δ is higher), the impact on the number of imitators is more significant and a higher commission rate can instead lead to a more positive impact on experimentation incentives. This is also consistent with our analysis in Section 4.2, where we show that the platform may behave more aggressively when encroaching into the market to limit imitation and enhance experimentation.

5.5 Market Structure and Seller Composition

In this section, we extend the analysis to consider more experimenters and provide further insights into how platform encroachment could change the composition of sellers.

We first generalize the analysis to $N > 2$ sellers who engage in product experimentation when the platform does not have an informational advantage. We denote the value of the successful experimenter by Π_l^N and that of all followers by Π_f^N in the competition stage.

The main difference lies in the experimentation stage. Each seller $i = 1, 2, \dots, N$ solves the following problem:

$$rV_0^N = \max_{x_i} -\frac{x_i^2}{2} + x_i(V_l^N - V_0^N) + \sum_{j \neq i} x_j(V_f^N - V_0^N),$$

where $V_l^N = (\pi_m + \rho\Pi_l^N)/(r+\rho)$ and $V_f^N = \rho\Pi_f^N/(r+\rho)$.

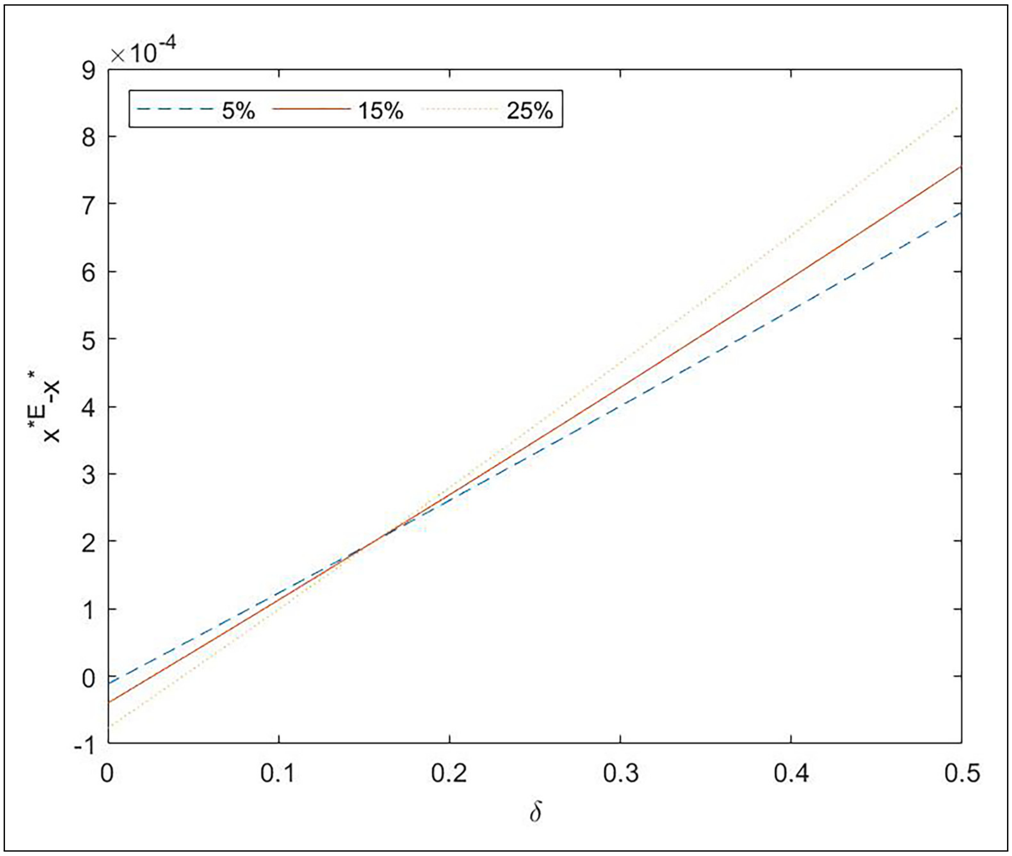

Figure 3. Comparison of equilibrium experimentation rates with different commission rates ($r = 0.01, \rho = 2, \Delta = 1, \sigma = 1/2$).

Following similar steps as Proposition 1, the equilibrium experimentation rates are such that $x_i^* = x_N^*$ for $i = 1, 2, \ldots, N$, given by the following equation:

$$x_N^* = \frac{(N-1)\left(V_l^N - V_f^N\right) - r + \sqrt{\left((N-1)\left(V_l^N - V_f^N\right) - r\right)^2 + 2r(1 + 2(N-1))V_l^N}}{1 + 2(N-1)}.$$

Similar to our main analysis, when r is small, the experimentation incentives are driven by the value difference $V_l^N - V_f^N$, which is larger when the platform competes more closely with the followers or when the platform's entry drives out more imitators. In such cases, when sellers are patient enough, platform encroachment increases product experimentation.

We can further extend the analysis to study the incentives to become an experimenter. Specifically, we assume that sellers need to incur a setup cost to become active in the market, either as an experimenter or as an imitator. To capture seller heterogeneity, we rank all sellers according to this setup cost and identify each seller by its rank. That is, for each seller $j \in [0, \infty)$, its setup cost is $c(j)$, which is increasing in j with $c(0) = 0$ and $c(\infty) \to \infty$. In addition, if a seller decides to carry out product experimentation, it needs to incur another setup cost for experimentation, denoted by $c^e(j)$, which is also increasing in j with $c^e(0) = 0$ and $c^e(\infty) \to \infty$. All sellers have the same marginal cost of experimentation as in the main model, if they decide to carry out product experimentation.

If a seller decides to become an experimenter, it generates a value of V_0^N when there are N experimenters. Alternatively, if a seller acts as a pure imitator, it does not carry out product experimentation. Instead, it enters the market and obtains the same value as a follower upon learning. This option has an expected value of:

$$V_I^N = \frac{N x_N^*}{r + N x_N^*} V_f^N.$$

The incentive to become an experimenter then depends on the difference $V_0^N - V_I^N$. When $r \to 0$, this approaches:

$$\frac{V_l^N - V_f^N}{1 + 2(N-1)},$$

which is larger whenever platform entry increases the value gap between the leader and the follower.

Therefore, the market structure is endogenously determined by two thresholds: N^e and N^i, satisfying:

$$V_0^{N^e} - V_I^{N^e} = c^e(N^e) \text{ and } V_I^{N^i} = c(N^i).$$

When the setup cost for experimentation is sufficiently higher than the setup cost for being active, the market features a mixture of experimenters and imitators with $N^e < N^i$: all sellers ($j \leq N^i$) with a setup cost below the value of being an imitator will become active in the market, and those sellers ($0 \leq j \leq N^e$) with the lowest setup costs for experimentation will carry out product experimentation.

Our analysis implies that when the platform enters, it intensifies competition and reduces V_I^N, which means that fewer sellers become active in the market. However, it also increases the value difference $V_0^N - V_I^N$, which means that there are more experimenters. Thus, platform entry changes the composition of sellers by attracting more experimenters but fewer imitators.

6 Implication for Regulatory Policies

Platform encroachment has raised concerns among policymakers about its potential negative impacts on independent sellers and consumers. In the recent case against Amazon, the European Commission investigated how Amazon used non-public data from independent sellers to leverage its market power in providing marketplace service and to favor its own products or those of sellers using its fulfillment services.[16] The main concern was that this could distort competition in the product market and marginalize independent sellers. The case was eventually settled with commitments from Amazon to not use non-public data for its retail business and to treat all sellers equally.[17]

Much attention has been focused on distortion in the product market caused by platform encroachment and the use of private information, which is undoubtedly significant. However, there has been limited discussion on how platform encroachment may impact incentives to experiment with new products, which generates long-run growth for the platform and ultimately benefits consumers. Our analysis is the first to look into these impacts with explicit consideration of imitation by both the platform and imitators. In light of our results, we discuss the implications of two widely discussed regulatory policies on the affected parties. We first derive the consumer surplus without platform encroachment in a similar way as in Section 4:

$$CS = \begin{cases} \dfrac{2x^*}{r+2x^*}\dfrac{1}{r}CS_m, & \text{if } I > \pi, \\ \dfrac{2x^*}{r+2x^*}\dfrac{1}{r}\dfrac{rCS_m + \rho CS_c}{r+\rho}, & \text{if } I \leq \pi, \end{cases} \tag{5}$$

where CS_m and CS_c represent the (flow) consumer surplus when the leader is the only active seller and when both the leader and the follower are active.

The consumer surplus when the platform encroaches into the market is:

$$CS^E = \begin{cases} \dfrac{2x^{*E}}{r+2x^{*E}}\dfrac{1}{r}\dfrac{r \cdot CS_m + (\mu+\rho)CS_D}{r+\mu+\rho}, & \text{if } I > \pi^E, \\ \dfrac{2x^{*E}}{r+2x^{*E}}\left(\dfrac{1}{r}\dfrac{r \cdot CS_m + \rho \cdot CS_{ce}}{r+\rho} + \dfrac{\mu(CS_D - CS_m)}{(r+\rho)(r+\mu+\rho)}\right), & \text{if } I \leq \pi^E, \end{cases} \tag{6}$$

where CS_D and CS_{ce} represent the (flow) consumer surplus when the leader and the platform are active and when all sellers are active. We expect $CS_m \leq CS_D \leq CS_c \leq CS_{ce}$ as more competition tends to drive prices down.

6.1 Limiting the Platform's Informational Advantage

As seen from the European Commission case against Amazon, a natural regulatory policy to consider is banning or limiting the use of private information by the platform, that is, reducing μ to limit the platform's informational advantage. When private information is used solely to facilitate early entry by the platform, banning its use affects only the learning stage. As shown in Proposition 2, this has a positive impact on experimentation incentives by preventing early entry by the platform and allowing the leader to profit more from its investments, as we have:

$$\frac{\partial x^{*E}}{\partial \mu} = \frac{\partial x^{*E}}{\partial V_l^E}\frac{\partial V_l^E}{\partial \mu} = \frac{\partial x^{*E}}{\partial V_l^E}\frac{\pi_l^D - \pi_m}{(r+\mu+\rho)^2} < 0.$$

However, there is also a negative impact on consumers. This is because early entry by the platform brings competition and

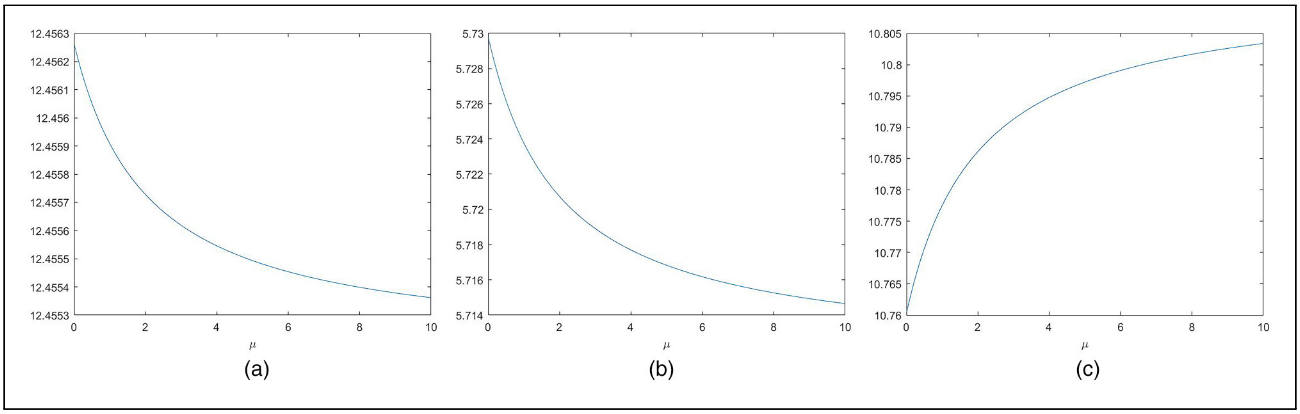

Figure 4. The impact of limiting private information usage with high differentiation ($\sigma = 0, r = 0.01, \rho = 2, s = 15\%, l = 0.02$): (a) consumers; (b) sellers; (c) platform.

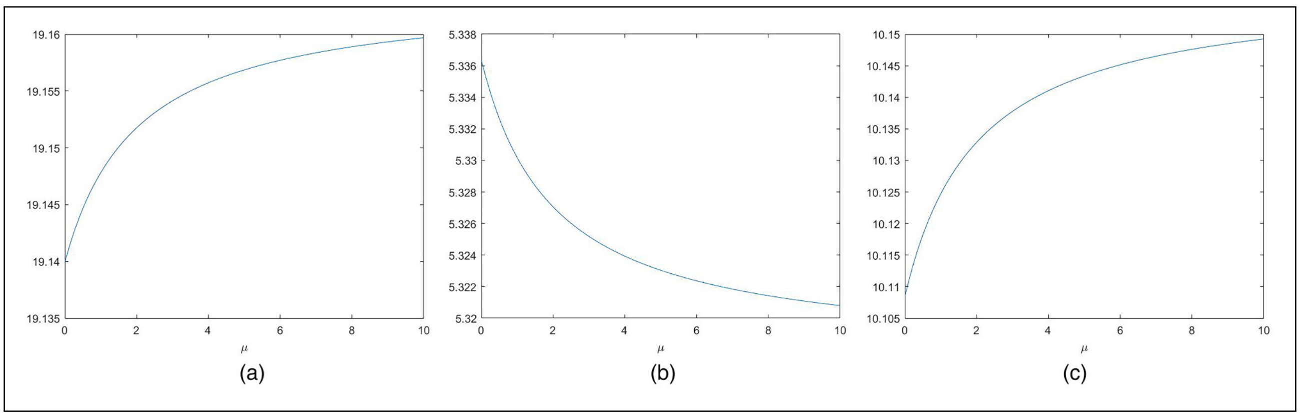

Figure 5. The impact of limiting private information usage with low differentiation ($\sigma = 0.5, r = 0.01, \rho = 2, s = 15\%, l = 0.02$): (a) consumers; (b) sellers; (c) platform.

lowers prices, which can benefit consumers. Specifically, from equation (6), we have:

$$\frac{\partial CS^E}{\partial \mu} = \frac{2x^{*E}}{r + 2x^{*E}} \frac{CS_D - CS_m}{(r + \mu + \rho)^2},$$

which is positive as $CS_D \geq CS_m$.

To illustrate these effects, we reconsider Example 1 with different parameter values. With highly differentiated products, as shown in Figure 4 for $\sigma = 0$, limiting the platform's informational advantage by lowering μ benefits both sellers and consumers but harms the platform. This highlights the positive impact of limiting the informational advantage on experimentation incentives. However, when products are less differentiated, as shown in Figure 5 for $\sigma = 0.5$, limiting the platform's information advantage still benefits sellers and harms the platform, but it also harms consumers due to the negative impact of delaying the platform's entry on prices in the product market.

However, if private information is also used to influence competition among sellers, there are additional effects that need to be evaluated. Most existing discussions emphasize how the platform uses its private information to target the most popular products. In our framework, this can be interpreted as a negative impact on the leader, for example, a higher β and a lower γ in Example 3. This clearly has additional negative impacts on experimentation incentives. However, the platform can also use its private information to improve its product offering, which allows it to more effectively deter imitation and preserve experimentation incentives (see, e.g., Sections 4.2 and 5.1), and consumers also benefit from better products. Therefore, a ban on the use of private information may unintentionally facilitate imitation and discourage experimentation. Evaluating the welfare implications of such a ban requires a more thorough analysis on how the platform uses its private information and how this may affect innovators and imitators differently. A more fine-tuned regulation on the scope of information that the platform can use might be a preferable approach. A full-fledged analysis in this direction is

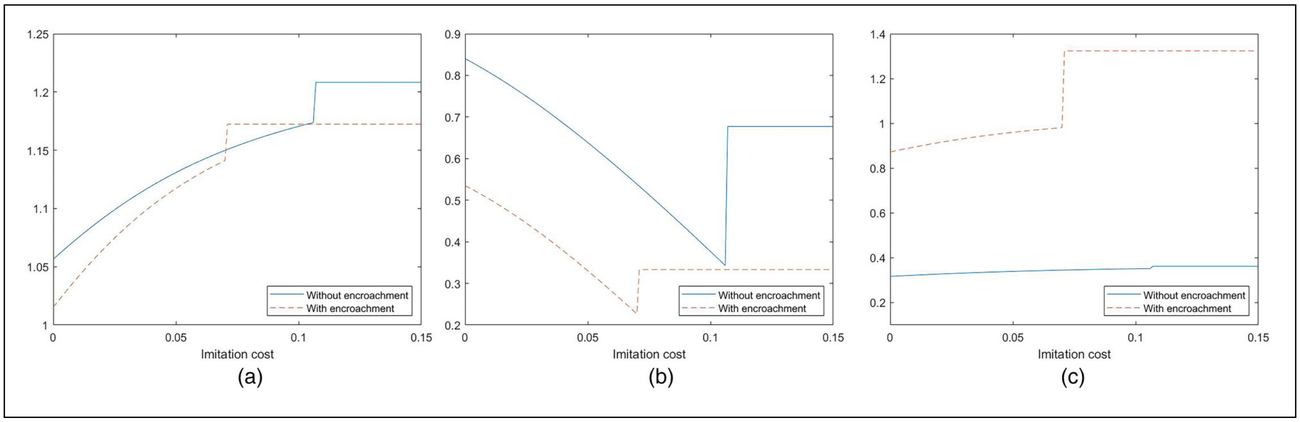

Figure 6. The impact of banning platform encroachment with high differentiation ($\sigma = 0, r = 0.1, \rho = 2, \mu = 2, s = 15\%$): (a) consumers; (b) sellers; (c) platform.

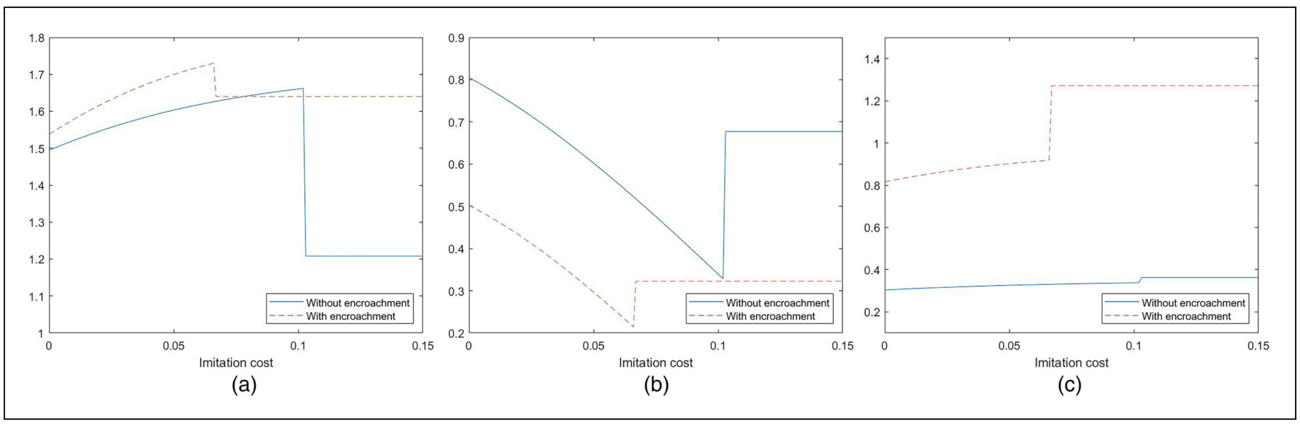

Figure 7. The impact of banning platform encroachment with low differentiation ($\sigma = 0.5, r = 0.1, \rho = 2, \mu = 2, s = 15\%$): (a) consumers; (b) sellers; (c) platform.

beyond the scope of this article and will be pursued in future research.

6.2 Ban on Platform Entry

A more radical regulatory proposal is to ban the platform from entering the product market, or to implement an effective separation between the dual roles of hybrid platforms. While this approach would certainly address regulators' concerns about platform encroachment on independent sellers, it is unclear whether it would also lead to higher consumer welfare. For example, platform entry brings more competition and offers more choices, which can benefit consumers. As shown by Lee and Musolff (2021), consumers do sometimes prefer the platform's products. Our analysis provides another reason why completely banning platform entry may backfire.

As shown in Proposition 2, platform entry can enhance experimentation for an intermediate range of imitation costs. If products are sufficiently differentiated, the impact of platform entry on the product market is small. Therefore, banning platform entry increases consumer welfare if $I > \pi$ or $I \leq \pi^E$, but allowing platform entry improves consumer welfare for $\pi^E < I \leq \pi$. This is shown in Figure 6 for $\sigma = 0$ with Example 1. The figure shows that platform encroachment generally benefits the platform while harming sellers. For consumers, platform encroachment is beneficial when imitation costs are intermediate but is harmful when imitation costs are either very low or very high.

For larger σ, platform encroachment continues to benefit the platform and harms sellers. The impact on consumers, however, could be different as shown in Figure 7. In this case, the impact of platform encroachment on the product market is large. It benefits consumers when imitation costs are either low or high but can harm them when imitation costs are intermediate, due to softened competition in the product market.

As emphasized in this article, if platform entry primarily deters imitation, it can reduce wasteful duplication costs and generate long-run benefits through innovation. However, these benefits need to be balanced against the effects of platform entry on competition and prices in the product market. In summary, how the platform enters is more important than whether the platform should be allowed to enter.

7 Concluding Remarks

We have considered a dynamic model of product experimentation on a platform when the platform may enter to compete with third party sellers. We show that platform encroachment could enhance sellers' incentives to experiment with new products by reducing the value of imitation and mitigating the free-riding problem. Furthermore, this changes the composition of sellers by bringing more experimenting sellers but fewer imitators. Such a benefit is larger when information about successful experimentation diffuses faster on the platform, in which case the platform may optimally adjust its product offering strategies to further curb free-riding and promote product experimentation.

We conclude with a few directions for future research. Firstly, we have focused on sellers' incentives to carry out product experimentation, it would be interesting to investigate how these incentives interact with other features of the platform, such as the search environment and recommendation algorithms. Secondly, the contract between the platform and a seller often includes other terms and conditions in addition to the commission fee, and it would be valuable to study the optimal contract when taking into account the experimentation incentives.

Acknowledgments

The authors would like to thank the department editor, the senior editor and two reviewers for their detailed comments, which greatly improve this article. The authors also thank Michele Bisceglia, Amelia Fletcher, Morten Hviid, Bruno Jullien, Robert Somogyi, seminar, and conference participants at Leicester, Norwich, CRESSE 2022, RES 2023, EARIE 2023, and IIOC 2024 for useful comments.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship and/or publication of this article.

ORCID iDs

Wing Man Wynne Lam https://orcid.org/0000-0002-4614-0039
Xingyi Liu https://orcid.org/0000-0003-3816-4126

Supplemental Material

Supplemental material for this article is available online (doi: 10.1177/10591478241305291).

Notes

1. See https://bit.ly/3I4jYmp. The world's top Amazon Marketplace sellers 2021. Webretailer (accessed 1 September 2022). See also the figure in E-companion EC.10.
2. See https://on.wsj.com/3Q74uli. Amazon scooped up data from its own sellers to launch competing products. The Wall Street Journal (accessed 1 September 2022).
3. See https://www.statista.com/statistics/274255/market-share-of-the-leading-retailers-in-us-e-commerce/. Market share of leading retail e-commerce companies in the United States in 2023. Statista (accessed 10 April 2024).
4. See https://www.statista.com/statistics/259782/third-party-seller-share-of-amazon-platform/. Share of paid units sold by third-party sellers on Amazon platform. Statista (accessed 10 April 2024).
5. See https://www.junglescout.com/resources/articles/amazon-product-categories/. Top Amazon product categories in 2024. Junglescout (accessed 10 April 2024).
6. For instance, Amazon regularly publishes category sales data, which enables sellers to identify successful categories. In order to identify the successful product within a category, sellers need to analyze individual sales data, which is time-consuming. However, this may be facilitated by third party sales monitoring applications.
7. This is for convenience of the notations. We can also assume a one-off imitation cost I, which is equivalent to a flow cost of rI.
8. We derive the value functions in the proof for Lemma 1.
9. The equilibrium experimentation rate can be non-monotone in the discount rate r. On the one hand, an increase in the discount rate reduces the value from successful experimentation, which weakens experimentation incentives. On the other hand, an increase in the discount rate means that a seller is less patient and therefore focuses more on the short-run profit, which is higher in the monopolization stage. This could increase experimentation incentives. However, we can show that if the competitive profit π is not too small (i.e., $\pi/\pi_m > (4-\sqrt{13})/3 \approx 0.13$), the former effect dominates and the experimentation rate decreases with the discount rate r for any imitation cost.
10. As mentioned above, we focus for the moment on the symmetrical case, where the leader and the follower earn the same profit, excluding the imitation cost.
11. This Assumption is not essential for our results but does streamline our analysis. We present an example and discuss how our results hold without this assumption at the end of this section.
12. For example, with a slight abuse of notation, suppose the two sellers have different experimentation costs, given by $c_1(x_1) = c_1\frac{x_1^2}{2}$ and $c_2(x_2) = c_2\frac{x_2^2}{2}$, with $c_1 < c_2$. Following similar steps as in Proposition 2, the equilibrium experimentation rates without encroachment satisfy: $x_1 = -(x_2+r) + \sqrt{(x_2+r)^2 + \frac{2(x_2(V_l-V_f)+rV_l)}{c_1}}$, and $x_2 = -(x_1+r) + \sqrt{(x_1+r)^2 + \frac{2(x_1(V_l-V_f)+rV_l)}{c_2}}$. The equilibrium is then the solution to a polynomial of degree four, which is much less tractable. However, it can be easily seen that if $c_1 < c_2$, we have $x_1 > x_2$. Furthermore, both x_1 and x_2 are increasing in V_l and $V_l - V_f$. Therefore, the main property of the equilibrium carries over to this case.

13. Specifically, if $\pi_l < \pi_f$, we need $\pi_m > \frac{\rho}{r}(\pi_f - \pi_l)$ to maintain positive investment incentives for any r, that is, ρ approaches zero as quickly as r approaches zero.
14. In Example 1, if the marginal costs are zero, we have $\tau = s/(1-s)$.
15. For example, Amazon charges a referral fee of 15.3% for most of its product categories, but it can range from 5.1% to 45.9% for some categories.
16. See, Antitrust: Commission sends Statement of Objections to Amazon for the use of non-public independent seller data and opens second investigation into its e-commerce business practices; https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2077. European Commission (accessed 11 May 2024).
17. See, Antitrust: Commission accepts commitments by Amazon barring it from using marketplace seller data, and ensuring equal access to Buy Box and Prime; https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7777. European Commission (accessed 11 May 2024).

References

Anderson S and Bedre-Defolie Ö (2022) Hybrid platform model. *Available at SSRN 3867851*.

Chen Y and Riordan M (2008) Price-increasing competition. *The RAND Journal of Economics* 39(4): 1042–1058.

Gabrielsen T and Sørgard L (2007) Private labels, price rivalry, and public policy. *European Economic Review* 51(2): 403–424.

Hagiu A, Teh T-H and Wright J (2022) Should platforms be allowed to sell on their own marketplaces? *The RAND Journal of Economics* 53(2): 297–327.

He S, Peng J, Li J and Xu L (2020) Impact of platform owner's entry on third-party stores. *Information Systems Research* 31(4): 1467–1484.

Hervas-Drane A and Shelegia S (2022) Retailer-led marketplaces. *Management Science*, forthcoming.

Hoch S (1996) How should national brands think about private labels? *Sloan Management Review* 37(2): 89–102.

Jiang B, Jerath K and Srinivasan K (2011) Firm strategies in the 'mid tail' of platform-based retailing. *Marketing Science* 30(5): 757–775.

Lam WMW and Liu X (2023) Dancing with rivals: How does platform's information usage benefit independent sellers? *European Journal of Operational Research* 309(1): 421–431.

Lee KH and Musolff L (2021) Entry into two-sided markets shaped by platform-guided search. *Job Market Paper, Princeton University*

Liao B, Yano C and Trivedi M (2020) Optimizing store-brand quality: Impact of choice of producer and channel price leadership. *Production and Operations Management* 29(1): 118–137.

Loury G (1979) Market structure and innovation. *The Quarterly Journal of Economics* 93(3): 395–410.

Madsen E and Vellodi N (2022) Insider imitation. *Journal of Political Economy*, forthcoming

Marshall G and Parra A (2019) Innovation and competition: The role of the product market. *International Journal of Industrial Organization* 65: 221–247.

Reinganum J (1982) A dynamic game of R and D: Patent protection and competitive behavior. *Econometrica* 50(3): 671–688.

Shubik M and Levitan R (1980) *Market Structure and Behavior*. Cambridge, MA: Harvard University Press.

Tang C, Deng Y, Wang W and Yoo O (2024) Can an E-commerce platform and its third-party sellers benefit from each other's market entry? *Production and Operations Management* 33(1): 69–86.

Wen W and Zhu F (2019) Threat of platform-owner entry and complementor responses: Evidence from the mobile app market. *Strategic Management Journal* 40(9): 1336–1367.

Zennyo Y (2022) Platform encroachment and own-content bias. *The Journal of Industrial Economics* 70(3): 684–710.

Zhu F (2019) Friends or foes? Examining platform owners' entry into complementors' spaces. *Journal of Economics & Management Strategy* 28(1): 23–28.

Zhu F and Liu Q (2018) Competing with complementors: An empirical look at Amazon.com. *Strategic Management Journal* 39(10): 2618–2642.

How to cite this article

Lam WMW and Liu X (2024) Product Experimentation, Information Diffusion and Platform Encroachment. *Production and Operations Management* xx(x): 1–18.