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Platform Liability and Innovation*

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We study an e-commerce platform's incentives to delist IP-infringing products and the effects of introducing a liability regime that induces the platform to increase its screening intensity. We identify conditions under which platform liability is socially desirable (respectively, undesirable) by analyzing its intended and unintended effects on the innovation incentives of brand owners. We show that making the platform liable for the presence of IP-infringing products can lead to a reduction (instead of an increase) in brand owners' innovation if the platform responds to more screening by raising its commission rate. We then consider various extensions that allow us to identify additional forces that strengthen (respectively, weaken) the social desirability of liability. We conclude by presenting some implications for policymakers.

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1. Introduction

In recent years, online misconduct emerged as a fundamental problem of the free Web. A common activity is the sale of items infringing intellectual property rights (IPRs). According to the OECD (2018), counterfeits account for 3% of global trade and, for their large customer reach, "e-commerce platforms represent ideal storefronts for counterfeits". Major cases also involved popular brands like Nike and Birkenstock that decided to pull their products from Amazon due to the proliferation of counterfeits, claiming that the "open business model" adopted by the platform was prone to third parties' misconduct.[1] As a part of governance of a platform ecosystem, a platform's owner can design its policy to screen out illicit players. However, this involves a trade-off: whereas allowing low-quality merchants (possibly including IP-infringers) might lower the incentives for innovative sellers to develop new products, their presence might increase the platform's market reach and sales. It is therefore not *a priori* clear whether a platform has an incentive to delist IP-infringing sellers, especially when their products do not entail direct damage to consumers. Moreover, the enforcement of primary liability, that is the possibility to directly sue wrongdoers, is oftentimes remote in online markets, as IP-infringers may not be directly identified or may belong to a different jurisdiction. The fact that brand owners might not be able to protect their interests by themselves could motivate the introduction of a platform liability that creates incentives for more screening.[2]

We provide a theoretical framework to understand an online platform's incentives to delist IP-infringing products and the economic effects of a liability regime that makes platforms liable unless they satisfy a minimum screening requirement.[3] We first analyze how the platform chooses its screening policy and its ad valorem commission rate in a *laissez-faire* regime.[4] We then study the impact of a liability regime that induces the platform to engage in more screening on the commission rate set by the platform, brand owners'

[1] See https://www.cnbc.com/2016/07/20/birkenstock-quits-amazon-in-us-after-counterfeit-surge.html. Since then, Amazon started tackling the problem, announcing Project Zero and collaboration with the International Anti-Counterfeiting Coalition (IACC), and blocking more than 10 billion suspected listings (Amazon, 2021).

[2] Note that this is akin to the "gatekeeper liability" discussed by Kraakman (1986) for which it might be optimal to make liable intermediaries that are in the condition to prevent misconduct or withhold support to wrongdoers.

[3] For example, online intermediaries might be subject to a set of costly screening obligations in order to benefit from liability exemption for third parties' misconduct on their marketplace. Note that this is akin to a negligence-based liability regime in which a party is exempted from liability if it fulfills its duty of care, i.e., a minimum effort.

[4] Ad valorem fees are widely adopted by online marketplaces (e.g., Amazon, eBay) and mobile app stores (e.g., Apple Store, Google Play). The economic rationale for their use has been recently studied by Wang and Wright (2017, 2018).

innovation, and welfare.

To this end, we develop a tractable yet general model in which an online platform mediates interactions between sellers and buyers. For illustrative purposes, we will refer to an e-commerce platform. However, the model we propose can also be applied to an app store (e.g., Apple's App Store), which decides an ad-valorem commission and its screening policy (e.g., Apple App review). In our model, brand owners make their innovation decisions and retain IPs for their products when joining the platform. The introduction of a branded product into the marketplace creates a new product category. Once a product category is created, a low-quality seller can imitate the branded product and sell an imitation. With a certain probability, the copycat product violates IP rights (e.g., trademarks) while with the remaining probability it is legitimate and does not infringe IP rights. We consider a setting in which an IP-infringing product does not create any direct harm to buyers, who make their purchase decision knowing whether the product they buy is branded or not. The platform makes profits by charging sellers an ad valorem commission and can screen out IP-infringing products at some cost. However, the platform cannot remove legitimate low-quality sellers who compete with brand owners.[5] By removing IP-infringing products, the screening policy determines the degree of competition that each branded product faces and thereby affects brand owners' incentive to innovate. Precisely, an introduction of platform liability which raises the screening intensity reduces the likelihood that each branded product faces competition from an imitator and thereby increases brand owners' incentive to innovate, all other things being equal. However, there can be unintended consequences such that platform liability ends up reducing brand owners' innovation instead of increasing it. In this paper, we identify various intended and unintended consequences of introducing platform liability.

Our first result is that the platform's preference in terms of *ex post* market structure in a given product category crucially affects its incentive to delist IP-infringing products. Ex post (i.e., after a branded product is developed and introduced on the platform), the platform may prefer either a monopolistic structure in which the branded product faces no competition or a duopolistic structure in which the branded product faces competition from an imitator. Its incentive to screen is the highest when it prefers the monopolistic ex post market structure: in this case, raising the screening intensity generates both a dynamic gain in terms of more innovation and a static gain in terms of a higher per-

[5]This assumption is consistent with regulations existing in the European Union. Under the P2B (platform-to-business) regulation, for example, online intermediaries should ensure fair treatment to business users and contractual relations are required to be conducted in good faith and based on fair dealing (see Regulation (EU) 2019/1150). Thus, arbitrary screening of sellers, which can ideally be part of platform governance, can be considered a remote possibility.

category profit of the platform. By contrast, when the platform prefers the duopolistic market structure, it faces a trade-off between the dynamic gain and a static loss in terms of a lower per-category profit and hence tends to choose a lower (or zero) screening intensity.

The second result concerns the direct and indirect effects of introducing a platform liability that imposes a higher screening intensity compared to the privately optimal one. We establish the relationship between the screening intensity and the commission rate chosen by the platform and characterize the conditions under which raising the screening intensity increases (lowers) the platform's commission. Thus, imposing higher screening obligations affects brand owners' incentives to innovate through two different channels: it directly reduces the competitive pressure they face from IP-infringers but it indirectly affects them through the change in the commission rate set by the platform. When a higher screening intensity leads to a lower commission, the two forces complement each other and the introduction of liability leads to more innovation. However, when a higher screening intensity leads to a higher commission rate, which is an unintended negative consequence, brand owners' innovation decreases if the increase in the share of brand owner's profits captured by the platform prevails over the gain from reduced competition. We also study the impact of a liability regime that raises the platform's screening on the surplus of market participants and total welfare. In particular, we find that a sufficient condition for platform liability to be socially undesirable is that it leads to a reduction in brand owners' innovation, which is possible if there is a large increase in the commission rate. We also provide a sufficient condition under which platform liability is socially desirable.

We then provide various extensions of the baseline model. First, we consider the coexistence of new brand owners who should innovate and incumbent ones who have already made their innovations and are active on the platform. We find that the presence of incumbents tends to induce the platform to decrease the commission rate in response to a higher screening intensity, thus increasing innovation incentives by new brand owners.

Second, we study how the presence of elastic buyer participation impacts the social desirability of platform liability when buyers face per-category opportunity costs (respectively, per platform opportunity costs). We find that when buyers face per-category opportunity costs, a higher screening intensity reduces buyers' expected surplus per product category and can thereby lead to a demand contraction, generating another unintended consequence which may make platform liability less likely to be socially desirable. On the contrary, when buyers face per platform opportunity cost, a new force emerges, which may make platform liability more likely to be socially desirable.

Third, when imitators' participation is elastic, platform liability can generate an unintended negative consequence even if it reduces the commission rate as a lower commission rate may encourage entry of imitators and thereby reduce brand owners' innovation.

From a policy standpoint, we contribute to the current policy discussion on platform liability and the need to update current liability regimes. Under the current regimes (e.g., Section 230 of the Communication Decency Act in the US; E-commerce Directive in the EU), online platforms are generally granted a liability exemption. Proposals have been made in the US and in the European Union to take pro-active measures and stop online illicit behaviors. For example, the Digital Services Act, proposed by the European Commission in December 2020, presents additional obligations for very large platforms in the presence of third parties' misconduct. Similar cumulative obligations are also present in the UK Online Safety Bill, proposed in April 2021 by the UK Government. Yet as discussed in several policy-oriented non-formalized studies (Buiten et al., 2020; Lefouili and Madio, 2021), imposing liability on platforms might generate unintended effects or reinforce the intended ones. We contribute to the current debate by identifying the circumstances under which a liability regime that induces more screening ultimately leads to more innovation (respectively, less innovation), and providing insights into the impact of platform liability on market participants and total welfare.

Related literature. This article contributes to the literature on online platforms and their governance and the law & economics literature on liability.

Platform governance. This article contributes to the large economic and management literature on online platforms (Caillaud and Jullien, 2003; Rochet and Tirole, 2003) and, more specifically, to the recent literature on platform governance. Recent papers on platform governance have studied the incentives of digital platforms to choose the intensity of seller competition (Teh, 2021), to bias its innovation by trading-off one side's surplus against that of the other side (Choi and Jeon, 2020), to introduce deceptive features (Johnen and Somogyi, 2021), to moderate content (Liu et al., 2021; Madio and Quinn, 2021), to engage in curation, e.g., delisting low-quality sellers (Casner, 2020), to ensure privacy protection (Etro, 2021). In addition, this paper is related to the literature on how platforms can influence sellers' innovation (Belleflamme and Peitz, 2010; Jeon and Rey, 2021) and seller competition (Karle et al., 2020). More specifically, Karle et al. (2020) show that the degree of competition in a product category impacts the pricing strategies of competing platforms. In our paper, the intensity of competition between sellers in a given product category has a critical role in screening IP-infringers.

We contribute to the above literature by studying the platform's private incentives to screen out IP-infringing products as a part of its governance of the platform ecosystem of innovations and the economic effects of imposing stricter screening obligations. The closest papers to ours are those of Liu et al. (2021) and Madio and Quinn (2021) which however focus on the private incentives of social media platforms to moderate toxic or unsafe content. The former studies how the choice of a platform business model – subscription-based or ad-funded — influences the incentives to moderate extreme content. The latter focuses on the incentives of a social media platform to moderate content that can damage advertisers, finding that content moderation might eventually harm users when gains from a higher content moderation are offset by the disutility caused by a larger number of ads.

Law & economics. This article also contributes to the law & economics literature on liability, which has mostly dealt with product liability in traditional markets, i.e., markets wherein a firm sells its products to consumers directly and harm to consumers or other parties is caused by limited level of care. This literature has identified, for example, conditions for the introduction of liability to be socially desirable or undesirable (Daughety and Reinganum, 1995, 1997, 2006, 2008; Ganuza et al., 2016; Hua and Spier, 2020; Iossa and Palumbo, 2010; Polinsky and Shavell, 2010). We contribute to this literature by formally investigating the economic effects of liability of online intermediaries.

Until recently, the economic effects of introducing liability on online platforms have been mostly discussed in non-formalized studies (Buiten et al., 2020; Lefouili and Madio, 2021). Our paper provides a formal analysis of the possible intended and unintended effects of liability for e-commerce platforms (and app stores) on innovation and welfare. We complement the work by De Chiara et al. (2021) on the design of a liability system for online hosting platforms dealing with violation of copyright by content creators. Our paper differs from theirs in that we do not identify the optimal liability regime in a second-best environment. Rather we focus on the direct and indirect effects of introducing a liability regime that leads to a higher screening intensity on key economic variables such as the commission rate charged by the platform and brand owner's innovation and on the surplus of market participants. Our paper also relates to the literature on indirect liability and, more specifically, to Lichtman and Landes (2003) and Hay and Spier (2005). The former identifies conditions for holding a manufacturer liable for consumers *intentionally* causing harm to other consumers. The latter discusses pros and cons of making parties that are not direct wrongdoers (e.g., manufacturers) accountable for other parties' conduct (e.g., buyers). We focus instead on the economic effects of holding a platform liable for IP-infringing sellers active on the platform.

Outline. The rest of the article is organized as follows. Section 2 presents the baseline model, which is analyzed in Section 3: we study the privately optimal screening policy, the effect of a more stringent liability regime on the commission rate, brand owners' innovation and welfare. Section 4 provides several extensions of the baseline model. Finally, Section 5 gathers concluding remarks and policy implications.

2. The baseline model

Consider a monopoly e-commerce platform that allows interactions between sellers and buyers and charges the former an ad valorem commission rate τ. In the baseline model, we suppose that there is a unit mass of inelastic buyers per category and, hence, we do not explicitly model their participation decisions on the platform. Regarding buyers' valuations for different products, we assume that buyers are ex ante homogeneous but ex post heterogeneous (i.e., after joining the platform, they discover their valuations, which are independently and identically distributed).

There is a mass one of brand owners. Each can incur a fixed innovation cost to develop a product. We assume that *all brand owners are ex ante homogeneous* but for their cost of innovation, $\widetilde{k}$, which is distributed according to a cdf $F(.)$ with density $f(.) > 0$ over the interval $[0, \overline{k}]$. We assume that $f(.)$ is continuously differentiable.

Once a product is developed by a brand owner and is made available on the platform, a product category is realized. Sellers compete only within the product category they belong to. For each product category, there are (at most) two vertically differentiated sellers: a brand owner and a low-quality seller (i.e., an imitator) selling a product whose quality is inferior to that of the product of the brand owner. A low-quality seller can only sell in the marketplace if the brand owner has developed a new product and thus created the respective category in the marketplace. Throughout the baseline analysis, we refer to the level of participation of brand owners as the *amount of innovation*. For simplicity, we assume that the marginal cost is zero for all sellers.

Among low-quality sellers, there is a fraction $\nu \in (0, 1)$ of legitimate (or legal) products and a remaining fraction, $1 - \nu$, of IP-infringing products. We assume that both types of low-quality sellers are identical but for the fact that legitimate sellers do not violate IPs. Therefore, we assume that the IP-infringing products do not cause any direct harm to buyers.[6] Moreover, we assume that primary liability is not enforceable, that is, a brand

[6]We focus on benign IP-infringing products. This implies that buyers do not care about whether a

owner is not able to sue the IP-infringer or solicit a take-down request via an authority.[7]

Furthermore, we assume that imitators do not incur any imitation cost (or incur the same, sufficiently small, imitation cost). This implies that each product category, upon realization, is potentially duopolistic. However, the platform can influence the market structure within a category by deciding to delist (some) IP-infringing products. While the platform does not have legal reasons to delist legitimate sellers, it can arbitrary delist IP-infringers even in the absence of liability. We assume that the platform can identify IP-infringing products but that this is a costly action. Let ϕ denote the screening intensity, i.e., the probability that an IP-infringing imitator is screened out by the platform, with $\Omega(\phi)$ the fixed screening cost incurred by the platform. For example, a screening activity might require sunk investments in artificial intelligence to train an algorithm that filters (some) IP-infringing products. We assume that $\Omega'(\phi) > 0$, meaning that more screening requires a higher cost. Therefore, the market structure for a given product category is monopolistic if and only if the corresponding imitator is screened out by the platform because of IP-infringments.

In each category, let π^m (respectively, π^b) represent the corresponding brand owner's expected profit per buyer when it faces no competition (respectively, faces competition from an imitator). Let π^e represent an imitator's expected profit per buyer when competing with a brand owner; the superscript 'e' represents entrant. We assume the following.

Assumption 1. $\pi^m > \pi^b > \pi^e$

The first part of the assumption means that a brand owner's profit is higher when it faces no competition than when it faces competition from an imitator. The second part means than when there is competition between a brand owner and an imitator, the former obtains a higher profit per buyer than the latter. These reduced form profits can be microfounded in a model with vertical product differentiation.

In terms of *ex post* market structure (i.e., after brand owners' innovation costs are incurred), two cases can arise. If $\pi^m > \pi^b + \pi^e$, sellers' total profit per buyer is larger with a monopolistic market structure. On the contrary, if $\pi^m < \pi^b + \pi^e$, sellers' total profit per buyer is larger with a duopolistic market structure. Both scenarios may arise depending on the relative magnitudes of an IP-protection effect and a market-expansion effect that an imitator creates. As the platform's profit from the ad valorem commission is a fraction

product infringes IPs but they consider all imitators' products as low-quality versions of the branded ones. In this sense, IP-infringing products should not be considered as deceptive products.

[7]For example, an infringing imitator may be active in another jurisdiction.

of the total profit of sellers, the platform prefers ex post the monopolistic structure to the duopolistic structure if and only if $\pi^m > \pi^b + \pi^e$ holds.

For a given screening intensity ϕ, a brand owner's expected profit, gross of the commission paid to the platform and the fixed innovation cost, is given by:

$$\tilde{\pi}^b \equiv (1-\nu)\phi\pi^m + [1-(1-\nu)\phi]\,\pi^b. \tag{1}$$

With probability equal to $(1-\nu)\phi$, the brand owner is the only seller in its respective product category and earns monopoly profit π^m. With the remaining probability, the brand owner competes with an imitator and earns a duopoly profit π^b. Therefore, the mass of brand owners developing an innovation is equal to $F((1-\tau)\tilde{\pi}^b)$.

Given the screening intensity ϕ, the expected per-category profit of the imitators is

$$\tilde{\pi}^e \equiv [1-(1-\nu)\phi]\,\pi^e. \tag{2}$$

The platform charges a commission rate τ to sellers and its expected profit is

$$\Pi = \tau F((1-\tau)\tilde{\pi}^b)[\tilde{\pi}^b + \tilde{\pi}^e] - \Omega(\phi). \tag{3}$$

We assume that the platform's profit function is concave in ϕ and τ. Moreover, we make the following assumption regarding the screening cost incurred by the platform.

Assumption 2. $\Omega(0) = 0 = \Omega'(0)$, *$\Omega(\phi)$ is strictly convex,* $\Omega(\phi) \underset{\phi\to 1}{\to} +\infty$.

This assumption implies that small intensity of screening costs little whereas full screening is prohibitively costly. This assumption allows us to rule out the case in which all IP-infringers are removed and focus on the most interesting scenario in which there is always a positive fraction of IP-infriging products on the platform.

We consider the following timing:

- Stage 1: The platform decides its screening intensity ϕ and the commission rate τ.
- Stage 2: Brand owners make their innovation decisions and join the marketplace platform. Imitators enter the marketplace.
- Stage 3: The unit mass of buyers participate in the platform, discover their valuations for the products and make their purchasing decisions.

The model is solved backward and the equilibrium concept is subgame perfect Nash equilibrium.

3. Analysis of the baseline model

In this section, we first consider the benchmark of no platform liability and study the platform's privately optimal screening policy. Second, we study the effect of a liability regime that induces more screening on the platform's commission rate. Finally, we investigate the impact of such a liability regime on innovation by brand owners and the welfare of market participants.

3.1. No liability

Consider a no liability benchmark in which the platform commits to the intensity of screening. Maximizing the platform's profit in (3) with respect to ϕ generates the following first-order condition:

$$\tau F((1-\tau)\tilde{\pi}^b)\frac{\partial(\tilde{\pi}^b+\tilde{\pi}^e)}{\partial\phi}+\tau f((1-\tau)\tilde{\pi}^b)(1-\tau)\frac{\partial\tilde{\pi}^b}{\partial\phi}(\tilde{\pi}^b+\tilde{\pi}^e)=\Omega'(\phi), \tag{4}$$

with $\frac{\partial\tilde{\pi}^b}{\partial\phi}=(1-\nu)(\pi^m-\pi^b)>0$ and $\frac{\partial(\tilde{\pi}^b+\tilde{\pi}^e)}{\partial\phi}=(1-\nu)(\pi^m-\pi^b-\pi^e)\lesseqgtr 0$. Specifically, $\tilde{\pi}^b+\tilde{\pi}^e$ is increasing (respectively, decreasing) in ϕ if the monopoly profit π^m is greater (respectively, smaller) than the total duopoly profits $\pi^b+\pi^e$. Both cases may arise.

Recall that our assumption $\Omega(\phi)\underset{\phi\to 1}{\to}+\infty$ precludes the possibility that the platform chooses full screening of IP-infringing products, i.e. $\phi^*=1$.[8] We are therefore left with two possible scenarios: one in which the platform chooses a positive screening intensity, i.e. $\phi^*\in(0,1)$, and one in which it does not engage in any screening, i.e. $\phi^*=0$. The following result provides the conditions under which each of these two scenarios arises.

Proposition 1. *Suppose that there is no platform liability.*

(i) If $\pi^m\geq\pi^b+\pi^e$ then the platform chooses a positive screening intensity, i.e. $\phi^*\in(0,1)$.

(ii) If $\pi^m<\pi^b+\pi^e$ then the platform does not engage in any screening, i.e. $\phi^*=0$, if the LHS of (4) is weakly negative at $\phi=0$, and chooses a positive screening intensity, i.e. $\phi^*\in(0,1)$, otherwise.

[8]This could however happen in a setting in which the cost of full screening is not prohibitively high.

The above proposition identifies the key role played by per-category total profit of sellers in shaping the platform's strategy. If $\pi^m \geq \pi^b + \pi^e$, then an increase in the intensity of screening leads to a larger number of product categories on the platform as well as a higher platform's profit per product category, which implies that the marginal benefit of screening gross of screening costs is always positive. This, combined with the fact that the marginal cost of screening is small for low levels of screening, makes the platform always choose a positive screening intensity. However, if $\pi^m < \pi^b + \pi^e$, then the marginal benefit of screening gross of screening cost is negative if the positive impact on the number of product categories is outweighed by the negative effect on the per-category profit. In that case, the platform finds it optimal to let all sellers be active in the marketplace, regardless of their nature.

3.2. Impact of platform liability on the commission rate

We now study the impact of introducing platform liability on the commission rate. We suppose that the regulator imposes a minimum screening intensity, $\underline{\phi}$, that platforms should ensure to benefit from liability exemption. We restrict attention to the case of $\phi^* < \underline{\phi}$ and assume that liability costs are so large that the platform always finds it optimal to comply with the minimum screening requirement.

Inducing the platform to raise its screening intensity will affect the commission rate chosen by the platform. Hence, we here study the relationship between the screening intensity ϕ and the commission rate τ. The first-order condition associated to the maximization of the platform's profit with respect to τ is[9]

$$F((1-\tau)\tilde{\pi}^b) - \tau\tilde{\pi}^b f((1-\tau)\tilde{\pi}^b) = 0. \tag{5}$$

Raising the commission involves a trade-off between a larger profit from existing product categories and a loss from a reduction in the amount of innovation (i.e., a reduction in the number of categories). It is important to note that the loss is proportionate to the commission rate τ.

Let τ^* be the solution of (5). Hence,

$$\frac{\tau^*\tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b)}{F((1-\tau^*)\tilde{\pi}^b)} = 1. \tag{6}$$

[9]Note that the term $\tilde{\pi}^b + \tilde{\pi}^e$, capturing the total (per-category) profit of sellers does not depend on τ, which facilitates the analysis.

The L.H.S. of the above equality can be interpreted as the elasticity of innovation supply with respect to the ad valorem commission charged by the platform.

Note that the screening intensity ϕ affects (5) only through $\tilde{\pi}^b$. Furthermore, a higher ϕ implies a higher $\tilde{\pi}^b$ for brand owners, who benefit from less competition, i.e. $\frac{\partial \tilde{\pi}^b}{\partial \phi} > 0$. Thus, the effect of a higher screening intensity on the commission rate entirely depends on the sign of $\frac{\partial \tau^*}{\partial \tilde{\pi}^b}$ as

$$\frac{\partial \tau^*}{\partial \phi} = \frac{\partial \tau^*}{\partial \tilde{\pi}^b} \frac{\partial \tilde{\pi}^b}{\partial \phi}. \tag{7}$$

Therefore, to understand the impact of a higher screening intensity ϕ on the commission rate τ, we differentiate (5) with respect to $\tilde{\pi}^b$, which leads to

$$\frac{\partial \tau^*}{\partial \tilde{\pi}^b} = \frac{(2\tau^* - 1)f((1-\tau^*)\tilde{\pi}^b) + \tau^*(1-\tau^*)\tilde{\pi}^b f'((1-\tau^*)\tilde{\pi}^b)}{-2\tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b) + \tau^* \left(\tilde{\pi}^b\right)^2 f'((1-\tau^*)\tilde{\pi}^b)}. \tag{8}$$

The denominator is negative under our assumption that the platform's expected profit is concave with respect to τ. Therefore, the sign of $\frac{\partial \tau^*}{\partial \tilde{\pi}^b}$ is the opposite of the sign of the numerator. From (8) it follows that $\frac{\partial \tau^*}{\partial \tilde{\pi}^b}$ has the same sign as

$$-2 + \frac{1}{\tau^*} - \frac{(1-\tau^*)\tilde{\pi}^b f'((1-\tau^*)\tilde{\pi}^b)}{f((1-\tau^*)\tilde{\pi}^b)}.$$

Moreover, (6) implies

$$\frac{\tau^*}{1-\tau^*} = \frac{F((1-\tau^*)\tilde{\pi}^b)}{(1-\tau^*)\,\tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b)},$$

which is equivalent to

$$\frac{1}{\tau^*} = 1 + \frac{(1-\tau^*)\,\tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b)}{F((1-\tau^*)\tilde{\pi}^b)}.$$

Since the second term on the R.H.S. of the above equality is the elasticity of brand owners' participation $F(.)$, denoted by $\varepsilon_F(.)$, the equation shows that the equilibrium commission decreases with the elasticity, which is intuitive.

Therefore, $\frac{\partial \tau^*}{\partial \tilde{\pi}^b}$ has the same sign as

$$-1 + \frac{(1-\tau^*)\,\tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b)}{F((1-\tau^*)\tilde{\pi}^b)} - \frac{(1-\tau^*)\tilde{\pi}^b f'((1-\tau^*)\tilde{\pi}^b)}{f((1-\tau^*)\tilde{\pi}^b)}$$

Denoting $\varepsilon_f(.)$ the elasticity of $f(.)$, the sign of $\frac{\partial \tau^*}{\partial \tilde{\pi}^b}$ is the same as the sign of

$$-1 + \varepsilon_F((1-\tau^*)\,\tilde{\pi}^b) - \varepsilon_f((1-\tau^*)\,\tilde{\pi}^b).$$

Thus, a sufficient condition for $\frac{\partial \tau^*}{\partial \tilde{\pi}^b}$ to be negative (positive) is that $\varepsilon_F(y) - \varepsilon_f(y)$ is smaller (greater) than 1 for any y. This result is summarized as follows.

Proposition 2. *A platform liability regime that induces a higher screening intensity leads to a lower (higher) commission rate if* $\varepsilon_F(y) - \varepsilon_f(y) < (>) 1$.

The above result shows that platform liability can lead to either an increase or decrease in the commission rate. Since an increase in $\tilde{\pi}^b$ (resulting from an increase in screening intensity) raises both the gain and the loss from an increase in the commission (captured by equation (5)), there are two opposite effects. If the former dominates the latter, the platform raises its commission as a response to an increase in the screening intensity whereas the opposite holds if the latter dominates the former. As the loss from an increase in the commission rate is proportionate to τ^* and τ^* is small if $\varepsilon_F(.)$ is large, the former dominates the latter if $\varepsilon_F(.)$ is large. This explains why a higher screening intensity increases (respectively, reduces) the commission rate if $\varepsilon_F(y) > \varepsilon_f(y) + 1$ (respectively, $\varepsilon_F(y) < \varepsilon_f(y) + 1$). Note that it is possible, under some conditions, that $\varepsilon_F(y) - \varepsilon_f(y) = 1$ holds such that the commission rate becomes independent of the screening intensity. This special case arises, for example, with the following two distributions.

Example with uniform distribution. Suppose that $F(.) \sim \mathcal{U}$. Then, (6) is equal to

$$(1 - \tau^*)\tilde{\pi}^b - \tau^* \tilde{\pi}^b = 0,$$

which is equivalent to

$$\tau^* = \frac{1}{2}.$$

Thus, the optimal commission rate does not depend on the screening activity.[10]

Example with constant-elasticity distributions. Consider the class of constant elasticity such that $\frac{dF}{dy}\frac{y}{F} = \varepsilon$. Hence,

$$\frac{f((1-\tau^*)\tilde{\pi}^b)}{F((1-\tau^*)\tilde{\pi}^b)} = \frac{\varepsilon}{(1-\tau^*)\tilde{\pi}^b}.$$

From (6),

$$\tau^* = \frac{F((1-\tau^*)\tilde{\pi}^b)}{\tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b)} = \frac{(1-\tau^*)\tilde{\pi}^b}{\tilde{\pi}^b \varepsilon}$$

[10] In Appendix A.7, we show that, with a uniform distribution of $F(.)$, this is no longer the case in the presence of a marginal (i.e., per-product) screening cost as the screening cost is partially passed onto the commission rate.

which implies that

$$\tau^* = \frac{1}{1+\varepsilon}.$$

Again, the optimal commission rate does not depend on the screening intensity and, intuitively, a higher elasticity lowers the ad valorem commission rate.

3.3. Impact of platform liability on brand owners' innovation

We first examine the effect of increasing screening intensity on the amount of innovation, that is, the participation level of those sellers that should feel protected by the removal of IP-infringers. Two effects can be identified. First, there is a positive direct effect from less business stealing; as more screening makes it less likely that a brand owner faces competition from a lower quality product, it increases a brand owner's expected profit $\tilde{\pi}^b$. We call this the *IP-protection effect*. Second, there is an indirect effect that is channeled by the change in the commission rate induced by the change in the screening intensity. We refer to this effect as the *margin effect*, as the change in the commission fee can reduce or increase the profit margin retained by a brand owner.

Differentiating the amount of innovations by brand owners at equilibrium, we have

$$\frac{d}{d\phi}F((1-\tau^*)\tilde{\pi}^b) = \underbrace{-\tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b)\frac{d\tau^*}{d\phi}}_{\text{margin effect (-/+)}} + \underbrace{(1-\tau^*)\frac{d\tilde{\pi}^b}{d\phi}f((1-\tau^*)\tilde{\pi}^b)}_{\text{IP-protection effect (+)}} \tag{9}$$

It is straightforward to see that the sign of this effect depends on $\frac{d\tau^*}{d\phi}$. When the commission rate decreases with screening (which holds if $\varepsilon_F(y) - \varepsilon_f(y) < 1$), the margin effect is unambiguously positive. As the IP-protection effect is positive as well, brand owners always benefit from the introduction of platform liability. On the contrary, when the commission rate increases (which holds if $\varepsilon_F(y) - \varepsilon_f(y) > 1$), the margin effect is negative and the overall effect on the level of innovation depends on the relative magnitude of the two effects. Brand owners can be worse off with the introduction of platform liability if the margin effect is larger than the IP-protection effect. Formally, this case arises if

$$\frac{\frac{d\tilde{\pi}^b}{d\phi}}{\tilde{\pi}^b} < \frac{\frac{d\tau^*}{d\phi}}{(1-\tau^*)}. \tag{10}$$

Consider the inequality obtained from (10) after multiplying both sides by ϕ. Then, the L.H.S. of the inequality represents the *elasticity of brand owners' expected profit* (gross of cost of innovation) to the screening activity of the platform and the R.H.S. represents the elasticity of the profit margin retained by the brand owners to the screening activity. The introduction of platform liability thus reduces brand owners' innovation when the profit margin decreases at a faster rate than the rate at which the profit of brand owners increases because of reduced competition. On the contrary, when the inequality in (10) does not hold, the gain from the reduced competition is larger than the loss from the reduced margin. Then, despite the higher commission rate, the level of innovation increases with a higher screening intensity. Summarizing, we obtain the following proposition.

Proposition 3. *The introduction of platform liability that increases the screening intensity above the private optimal level reduces the amount of innovation by brand owners when the commission rate increases with a higher screening intensity (which is the case if* $\varepsilon_F(y) - \varepsilon_f(y) > 1$*) and* (10) *holds at equilibrium. Otherwise, the introduction of platform liability raises the amount of innovation by brand owners.*

The above result bears important consequences for the design of a liability regime like the one currently discussed in the EU. It provides the conditions under which more screening is beneficial (or detrimental) to innovation on the marketplace of the platform as it ultimately benefits (or harms) brand owners. Interestingly, there can be unintended negative consequences for those sellers that the platform liability intends to protect from IP-infringers in the first place. This, however, requires that (i) more screening leads the platform to increase its commission rate, and (ii) this increase is sufficiently large.[11]

3.4. Welfare effects of platform liability

We can now study the welfare impact of imposing a liability regime that induces the platform to raise its screening intensity above the privately optimal one. Note that in our model, the impact of a higher screening intensity on brand owners' surplus and its impact on the amount of innovation have the same sign.[12] Thus, brand owners' surplus increases or decreases under the conditions identified in Proposition 3. Moreover, it is straightforward that unless the platform lacks commitment power, which we will consider

[11] In the special cases in which the distribution of innovation costs is uniform or has a constant elasticity, the commission rate chosen by the platform does not depend on the screening intensity and, therefore, platform liability always benefits brand owners and increases the amount of innovation.

[12] To see why, note that the expected surplus of brand owners can be written as

$$\int_0^{(1-\tau)\tilde{\pi}_b} \left[(1-\tau)\tilde{\pi}_b - x\right] f(x)dx,$$

which is an increasing function of $(1-\tau)\tilde{\pi}_b$.

in an extension, making it increase its screening intensity above the private optimum will reduce its profit. The impact on the other market participants is discussed below.

The effect of liability on legitimate imitators' surplus. Let us first consider those legitimate imitators that do not violate IPs. Recall that low-quality sellers can only join the marketplace if an innovation is developed by a brand owner in their respective product category. Moreover, these sellers cannot be delisted by the platform. As the per-category profit of a legitimate imitator is $(1-\tau^*)\nu\pi^e$, their total surplus amounts to

$$F((1-\tau^*)\tilde{\pi}^b)(1-\tau^*)\nu\pi^e.$$

Thus, a marginal increase in screening intensity leads to the following change in legitimate imitators' surplus:

$$\underbrace{\frac{dF((1-\tau^*)\tilde{\pi}^b)}{d\phi}(1-\tau^*)\nu\pi^e}_{\text{extensive margin}} + \underbrace{F((1-\tau^*)\tilde{\pi}^b)\frac{d}{d\phi}((1-\tau^*)\nu\pi^e)}_{\text{intensive margin}}$$

Firstly, there is a change in the *extensive margin* because the number of product categories can increase or decrease with a higher screening intensity (see Proposition 3). Thus, for a given commission rate, if more products are developed by brand owners, it is straightforward that legitimate sellers are better off as new business opportunities arise. Secondly, there is a change in the intensive margin resulting from the change in the commission rate chosen by the platform (see Proposition 3). Thus, for a given number of product categories, there is a loss for these sellers if the commission rate increases.

It follows that if the commission rate decreases with the screening intensity, the introduction of platform liability is unambiguously beneficial to legitimate sellers as both effects have a positive sign. By contrast, if the commission rate increases with the screening intensity and (10) holds at equilibrium, the introduction of platform liability is unambiguously detrimental to these sellers: both effects have a negative sign. In the remaining case, the extensive and intensive margin effects have opposite signs and thus the impact of platform liability on legitimate sellers' surplus depends on the prevailing effect.

The effect of liability on buyer surplus. Consider now buyer surplus. In a given category, let u^m represent the net buyer surplus when the brand owner is a monopolist and u^d the net buyer surplus when the brand owner faces competition from a low-quality seller. We assume $u^d > u^m$: the surplus buyers obtain from a category is higher in a duopolistic market structure than in a monopolistic one.[13]

Recall that we consider an inelastic buyer demand with a unit mass of buyers in each category. Given ϕ, let $u(\phi)$ denote the expected buyer surplus per category, which we write as

$$u(\phi) \equiv (1-\nu)\phi u^m + [1-(1-\nu)\phi]\, u^d. \tag{11}$$

The total buyer surplus is simply $F((1-\tau^*)\tilde{\pi}^b)u(\phi)$. Hence, the effect of a marginal increase in screening intensity on expected buyer surplus is

$$\underbrace{\frac{dF((1-\tau^*)\tilde{\pi}^b)}{d\phi}u(\phi)}_{\text{(-/+)}} + \underbrace{F((1-\tau^*)\tilde{\pi}^b)u'(\phi)}_{\text{(-)}} \tag{12}$$

where $u'(\phi) = (1-\nu)(u^m - u^d) < 0$ as $u^d > u^m$. Hence, platform liability reduces buyer surplus per category by increasing market concentration, but this surplus reduction should be weighed against the potentially positive effect through the amount of innovation. Note that when platform liability raises the commission rate such that (10) holds, brand owners' innovation decreases and thus, unambiguously, buyer surplus decreases.

The effect of liability on total welfare. We can now study whether a liability regime that leads to a higher screening intensity is socially desirable. Let w^m represent the welfare in a category in which the brand owner is a monopolist and w^d the welfare in a category in which the brand owner faces competition from a low-quality seller. We have $w^m \equiv \pi^m + u^m$ and $w^d \equiv \pi^b + \pi^e + u^d$. We assume $w^d > w^m$: the welfare per category is higher in a duopolistic market structure than in a monopolistic one. Then, total welfare is

$$W = F((1-\tau)\tilde{\pi}^b)\widetilde{w} - \int_0^{(1-\tau)\widetilde{\pi}^b} xf(x)dx - \Omega(\phi), \tag{13}$$

where $\widetilde{w} \equiv (1-\nu)\phi w^m + [1-(1-\nu)\phi]\, w^d$. Accounting for the effect on the optimal commission rate, a marginal increase in screening intensity yields the following change in total welfare:

[13] In our framework, IP-infringing products are not malicious and do not cause harm to consumers, thus it is reasonable to assume that per-category buyer surplus is higher in a duopolistic market structure.

$$\frac{d}{d\phi}F((1-\tau^*)\tilde{\pi}^b)\widetilde{w}+F((1-\tau^*)\tilde{\pi}^b)\frac{d\widetilde{w}}{d\phi}+ \\ f((1-\tau^*)\tilde{\pi}^b)(1-\tau^*)\tilde{\pi}^b\left(\tilde{\pi}^b\frac{d\tau^*}{d\phi}-(1-\tau^*)\frac{d\tilde{\pi}^b}{d\phi}\right)-\Omega'(\phi),$$

which we can rewrite as follows:

$$-\left[\widetilde{w}-(1-\tau^*)\tilde{\pi}^b\right]f((1-\tau^*)\tilde{\pi}^b)\left(\tilde{\pi}^b\frac{d\tau^*}{d\phi}-(1-\tau^*)\frac{d\tilde{\pi}^b}{d\phi}\right)+ \\ F((1-\tau^*)\tilde{\pi}^b)\frac{d\widetilde{w}}{d\phi}-\Omega'(\phi). \tag{14}$$

The first term captures the effect of a stringent liability rule on the number of product categories realized (via the participation of brand owners). It is positive whenever the commission rate decreases or it does not increase too much (Proposition 3). The second term captures the per-category welfare impact, which is negative under the assumption that per-category welfare is higher under duopoly. The third term captures the cost of raising the screening intensity. It is immediate that when the first term is negative, (14) is always negative. Thus, we can conclude the following.

Proposition 4. *A sufficient condition for platform liability to be socially undesirable is that it leads to a reduction in the amount of innovation of brand owners.*

However, there are circumstances in which inducing a higher screening intensity through platform liability is socially desirable. The welfare function in (13) can be written as

$$W=F((1-\tau)\tilde{\pi}^b)\tilde{\pi}^b-\int_0^{(1-\tau)\widetilde{\pi}^b}xf(x)dx-\Omega(\phi)+F((1-\tau)\tilde{\pi}^b)(\tilde{\pi}^e+u(\phi)),$$

which yields

$$W=\Pi+\underbrace{\int_0^{(1-\tau)\widetilde{\pi}^b}\left[(1-\tau)\tilde{\pi}^b-x\right]f(x)dx}_{\text{surplus of brand owners net of investment cost}}+\underbrace{F((1-\tau)\tilde{\pi}^b)(1-\tau)\tilde{\pi}^e}_{\text{surplus of imitators}}+\underbrace{F((1-\tau)\tilde{\pi}^b)(\tilde{\pi}^e+u(\phi))}_{\text{buyer surplus}}.$$

Therefore, the net social benefit from an increase in screening for a given commission rate is given by

$$\begin{aligned}\frac{\partial W}{\partial \phi} &= \frac{\partial \Pi}{\partial \phi} + (1-\tau)\frac{\partial \tilde{\pi}^b}{\partial \phi}F((1-\tau)\tilde{\pi}^b) + \\ &\quad +(1-\tau)\left\{(1-\tau)\frac{\partial \tilde{\pi}^b}{\partial \phi}f((1-\tau)\tilde{\pi}^b)\tilde{\pi}^e + \frac{\partial \tilde{\pi}^e}{\partial \phi}F((1-\tau)\tilde{\pi}^b)\right\} \\ &\quad + \left[-(1-\nu)(u^d-u^m)F((1-\tau^*)\tilde{\pi}^b + u(\phi)(1-\tau)\frac{\partial \tilde{\pi}^b}{\partial \phi}f((1-\tau)\tilde{\pi}^b)\right],\end{aligned} \tag{15}$$

while the net private marginal benefit from an increase in screening is

$$\frac{\partial \Pi}{\partial \phi} = \underbrace{\tau\left(\frac{\partial \tilde{\pi}^b}{\partial \phi} + \frac{\partial \tilde{\pi}^e}{\partial \phi}\right)F((1-\tau^*)\tilde{\pi}^b) + \tau(\tilde{\pi}^b+\tilde{\pi}^e)f((1-\tau^*)\tilde{\pi}^b)(1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi}}_{\text{gross private benefit}} - \Omega'(\phi). \tag{16}$$

In the subsequent analysis, we assume that the privately optimal level of screening is positive, i.e., $\phi^* > 0$. This implies that $\frac{\partial \Pi}{\partial \phi}(\phi^*, \tau^*) = 0$ and that the gross private benefit is positive at (ϕ^*, τ^*) such that

$$\begin{aligned} & \frac{\partial \tilde{\pi}^e}{\partial \phi}F((1-\tau^*)\tilde{\pi}^b) + \tilde{\pi}^e f((1-\tau^*)\tilde{\pi}^b)(1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi} \\ \geq \; & -\frac{\partial \tilde{\pi}^b}{\partial \phi}F((1-\tau^*)\tilde{\pi}^b) - \tilde{\pi}^b f(1-\tau^*)\tilde{\pi}^b)(1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi}\end{aligned}$$

Using the above inequality and (15), we get a lower bound for $\frac{\partial W}{\partial \phi}(\phi^*, \tau^*)$:

$$\frac{\partial W}{\partial \phi}(\phi^*, \tau^*) \;\geq\; -(1-\nu)(u^d-u^m)F((1-\tau^*)\tilde{\pi}^b) + \left[u(\phi) - (1-\tau^*)\tilde{\pi}^b\right](1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi}f((1-\tau^*)\tilde{\pi}^b))$$

Note that the total derivative of welfare with respect to ϕ is

$$\frac{dW}{d\phi}(\phi^*, \tau^*) = \frac{\partial W}{\partial \phi}(\phi^*, \tau^*) + \frac{\partial W}{\partial \tau}(\phi^*, \tau^*)\frac{d\tau^*}{d\phi}. \tag{17}$$

In Appendix, we show $\frac{\partial W}{\partial \tau}(\phi^*, \tau^*) < 0$, which is intuitive.

Therefore, a sufficient condition for platform liability to be socially desirable (in the neighborhood of the privately optimal screening intensity), i.e., $\frac{dW}{d\phi}(\phi^*, \tau^*) > 0$, is that:

(i) the gain in "buyer surplus net of innovation cost" (i.e., $\left[u(\phi) - (1-\tau^*)\tilde{\pi}^b\right]$) from a larger number of product categories dominates the loss from a lower buyer surplus per category, such that

$$\Big[u(\phi) - (1-\tau^*)\tilde{\pi}^b\Big](1-\tau^*)\left[\pi^m - \pi^b\right] f((1-\tau^*)\tilde{\pi}^b) > (u^d - u^m)F((1-\tau^*)\tilde{\pi}^b), \quad (18)$$

(ii) an increase in screening intensity does not lead to an increase in the commission rate, i.e., $\frac{d\tau^*}{d\phi} \leq 0$. The following proposition summarizes the above analysis.

Proposition 5. *A sufficient condition for a platform liability raising the screening intensity to be socially desirable (in the neighborhood of the privately optimal screening intensity) is that: (i) the gain in buyer surplus net of innovation cost from a larger number of product categories resulting from an increase in the screening dominates the loss from a lower buyer surplus per category (i.e.,* (18)*) and (ii) the commission rate does not increase in the screening intensity.*

Proof. See Appendix A.1. □

Finally, note that if the social planner does not take into account the economic surplus of IP-infringers, then a higher screening intensity resulting from a change in the liability regime is more likely to be socially desirable, all other things being equal. We explore this case in Appendix A.2.

4. Extensions

In this section, we relax some of the assumptions we have made, in order to identify new forces that strengthen or overturn our previous findings. First, we consider the presence of a mass of already developed products and how it impacts the optimal commission rate chosen by the platform both in the presence and in the absence of platform liability. Second, we introduce elastic buyer participation considering different directions for the gross-group network externalities. Third, we extend the baseline model to the case in which the imitators' participation is elastic. Finally, we provide an extension about the impact of platform liability when the platform lacks commitment power and another extension when its screening technology is imperfect.

4.1. Incumbent brand owners

In this section, we relax the assumption that all product categories are realized upon ex ante investments by brand owners. We assume that a certain measure $a > 0$ of incumbent brand owners already developed their products, which are present on the marketplace of the platform whereas the new brand owners have to incur innovation costs. This changes the profit function of the platform to

$$\Pi = \tau \left[a + F((1-\tau)\tilde{\pi}^b)\right] [\tilde{\pi}^b + \tilde{\pi}^e],$$

The platform's commission and screening policy affect both the products to be developed and the products already developed. The privately optimal commission rate τ^* is defined by the first-order condition

$$a + F((1-\tau)\tilde{\pi}^b) - \tau\tilde{\pi}^b f((1-\tau)\tilde{\pi}^b) = 0. \tag{19}$$

It is straightforward to show that the effect of a on the marginal benefit from increasing τ is positive, i.e. $\frac{\partial^2 \Pi}{\partial a \partial \tau} > 0$. Therefore, the optimal commission rate τ^* is increasing in a, which is very intuitive.

In order to investigate how the presence of incumbents a affects $\frac{\partial \tau^*}{\partial \tilde{\pi}^b}$, we can follow the analysis in Section 3.2 and find that $\frac{\partial \tau^*}{\partial \tilde{\pi}^b}$ has the same sign as

$$-1 - \frac{a\,(1-\tau^*)}{\tau^* F((1-\tau^*)\tilde{\pi}^b)} + \frac{(1-\tau^*)\,\tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b)}{F((1-\tau^*)\tilde{\pi}^b)} - \frac{(1-\tau^*)\tilde{\pi}^b f'((1-\tau^*)\tilde{\pi}^b)}{f((1-\tau^*)\tilde{\pi}^b)}$$

The above expression suggests that the presence of incumbents relative to their absence, captured by $a > 0$, is likely to make an increase in $\tilde{\pi}^b$ reduce the commission rate τ^*. The intuition is the following. The existence of a mass $a > 0$ of incumbent brand owners makes the marginal benefit from a change in the commission rate less sensitive to a change in screening while it does not affect the sensitivity of the marginal cost from a change in the commission rate to a change in screening.

In what follows, we illustrate this through two specific distributions of F. Consider first the case of the uniform distribution. Then, we have

$$a + (1-\tau)\tilde{\pi}^b - \tau\tilde{\pi}^b = 0,$$

which implies the following

$$\tau^* = \frac{1}{2} + \frac{a}{2\tilde{\pi}^b}.$$

Hence, τ^* increases with a and decreases with $\tilde{\pi}^b$. Similar results are obtained in the case of constant elasticity, for which we have the following first-order condition

$$\begin{aligned} & a + F((1-\tau)\tilde{\pi}^b) - \tau\tilde{\pi}^b f((1-\tau)\tilde{\pi}^b) \\ = \quad & a + \left[1 - \frac{\varepsilon\tau^*}{(1-\tau^*)}\right] F((1-\tau)\tilde{\pi}^b) = 0. \end{aligned}$$

Thus, the optimal commission rate is as follows

$$\frac{\tau^*}{(1-\tau^*)} = \frac{1}{\varepsilon}\left[1 + \frac{a}{F((1-\tau)\tilde{\pi}^b)}\right]$$

As the L.H.S. strictly increases with τ^*, τ^* increases with a and decreases with ε and $\tilde{\pi}^b$. The above results are particularly instructive for understanding how the presence of already developed products impacts the level of innovation by brand owners via the channel of the commission rate. In the baseline model, we have shown that a sufficient condition for innovation to increase is that the commission rate decreases with a higher screening intensity. In the presence of already developed products, a higher screening intensity unambiguously leads to a reduction in the commission rate charged by the platform in the case of the two distributions of F considered above. As a sufficient condition for an introduction of platform liability to raise innovation is that it reduces the commission rate, then the introduction of platform liability has a positive impact on the level of innovation by brand owners. Summarizing, we have:

Proposition 6. *Suppose there is a mass $a > 0$ of incumbent sellers who already joined the platform and assume that the distribution $F(.)$ is either uniform or has a constant elasticity. Then, the introduction of platform liability leads to a reduction in the commission rate and thereby raises the amount of innovation by brand owners.*

4.2. Elastic buyer participation

We consider two different scenarios of elastic buyer participation, depending on whether buyers incur per-category opportunity costs or incur an opportunity cost once for all categories.[14]

[14]For instance, if buyers multihome on more than one online marketplace, they are likely to incur the opportunity cost each time they buy a product. By contrast, if buyers singlehome on one platform, they are likely to incur the opportunity cost once for all categories as the major cost is the cost of adopting the platform.

4.2.1. Opportunity cost per category

Let us first consider a scenario in which each buyer incurs an opportunity cost for each category. Specifically, suppose that, for each product category, there is a unit mass of potential buyers who incurs an opportunity cost of joining the platform that is distributed according to a cdf $H(.)$, with density $h(.)$. We also suppose that buyers' valuations and their opportunity cost for joining the platform are independent.

Buyers know whether a given product is sold by the platform and know (or anticipate) the screening intensity before joining the platform. However, they discover whether the market is monopolistic or duopolistic only after joining the platform (i.e., after incurring the opportunity cost). All buyers have the same ex ante expected utility of joining the platform gross of opportunity cost, and this is given by $u(\phi)$ defined previously in (11). This implies that the potential demand for a given product, i.e., the mass of the buyers buying the product through the platform, is

$$D(\phi) \equiv H(u(\phi)).$$

Note that, under the assumption that $u^d > u^m$, $D'(\phi) < 0$. The expected profit of a brand owner (gross of the commission charged by the platform) is $\hat{\pi}^b = D(\phi)\tilde{\pi}^b$ and the expected profit of an imitator is $\hat{\pi}^e = D(\phi)\tilde{\pi}^e$, where $\tilde{\pi}^b$ and $\tilde{\pi}^e$ are the brand owner's and the imitator's profits from a unit mass of buyers and are defined in (1) and (2).

The platform's profit is

$$\Pi = \tau F((1-\tau)\hat{\pi}^b)[\hat{\pi}^b + \hat{\pi}^e] - \Omega(\phi).$$

The only difference between the platform's profit function in this setting and its counterpart in the baseline model is that $\tilde{\pi}^b$ and $\tilde{\pi}^e$ are replaced with $\hat{\pi}^b$ and $\hat{\pi}^e$, respectively.

Before proceeding with the analysis of the impact of a liability regime that induces a higher screening, we first establish the relationship between the screening intensity and the gross profit of brand owners. Specifically, we note the following

$$\frac{\partial \hat{\pi}^b}{\partial \phi} = \underbrace{D'(\phi)\tilde{\pi}^b}_{(-)} + \underbrace{D(\phi)\frac{\partial \tilde{\pi}^b}{\partial \phi}}_{(+)}. \tag{20}$$

There are two possible scenarios. If

$$\left|\frac{D'(\phi)}{D(\phi)}\right| < \frac{\frac{\partial \tilde{\pi}^b}{\partial \phi}}{\tilde{\pi}^b}, \tag{21}$$

then $\frac{\partial \tilde{\pi}^b}{\partial \phi} > 0$. After multiplying both sides of (21) by ϕ, we see that (21) holds whenever the elasticity of buyer participation with respect to screening is less than the elasticity of brand owners' expected profit per unit mass of consumers with respect to screening. On the contrary, $\frac{\partial \tilde{\pi}^b}{\partial \phi} < 0$ if (21) does not hold. Also note that the composite effect of a higher screening intensity on the commission rate is equal to (7). As in the baseline model (see Section 3.2), $\frac{\partial \tau^*}{\partial \tilde{\pi}^b}$ is positive if $\varepsilon_F(y) - \varepsilon_f(y) > 1$ for any y, and is negative if $\varepsilon_F(y) - \varepsilon_f(y) < 1$ for any y. Therefore, we have the following result.

Lemma 1. *Suppose that buyer participation is elastic such that for each given product category, each buyer who buys a product through the platform incurs an opportunity cost.*

(i) If $\left|\frac{D'(\phi)}{D(\phi)}\right| < \frac{\frac{\partial \tilde{\pi}^b}{\partial \phi}}{\tilde{\pi}^b}$*, the commission rate increases (decreases) with the screening intensity if* $\varepsilon_F(y) - \varepsilon_f(y) > (<) 1$.

(ii) If $\left|\frac{D'(\phi)}{D(\phi)}\right| > \frac{\frac{\partial \tilde{\pi}^b}{\partial \phi}}{\tilde{\pi}^b}$*, the commission rate increases (decreases) with the screening intensity if* $\varepsilon_F(y) - \varepsilon_f(y) < (>) 1$.

As the case of inelastic buyer participation is a special case in which (21) holds, Lemma1(i) generalizes Proposition 2. By contrast Lemma 1(ii) shows that Proposition 2 is overturned when (21) does not hold. This shows that the elasticity of buyer participation plays a key role in determining the impact of platform of the commission rate and, thereby, on innovation and welfare.

Suppose that a liability rule induces the platform to increase its screening effort above ϕ^*. Innovation by brand owners is thus affected via three channels, i.e.,

$$\frac{\partial F\Big((1-\tau^*)\hat{\pi}^b\Big)}{\partial \phi} = f\Big((1-\tau^*)\hat{\pi}^b\Big)\Big[\underbrace{(1-\tau^*)D(\phi)\frac{\partial \tilde{\pi}^b}{\partial \phi}}_{\text{IP-protection effect (+)}} + \underbrace{(1-\tau^*)D'(\phi)\tilde{\pi}^b}_{\text{demand contraction effect (-)}} - \underbrace{\frac{\partial \tau^*}{\partial \phi}D(\phi)\tilde{\pi}^b}_{\text{margin effect (-/+)}}\Big] \tag{22}$$

First, for a given commission rate and a given number of buyers on the platform, the liability rule leads to less competition. This direct (positive) effect of liability is the same IP-protection effect that we identified in the baseline setting. Second, for a given commission rate, an increase in screening leads to less buyer participation on the platform. This new effect, which we refer to as the *demand contraction effect*, is negative. Third, an increase in screening affects the commission rate charged by the platforms, which has an impact on the brand owner's profit (and incentive to innovate). Our analysis shows that this effect can be either positive or negative (see Proposition 2).

A sufficient condition for platform liability to increase brand owners' innovation in the baseline model is that the introduction of platform liability reduces the commission rate. One can observe that this is no longer the case in (22) as the demand contraction effect now represents a countervailing force to the IP-protection effect and the margin effect. In fact, it is possible that brand owners' innovation decreases even if platform liability lowers the commission rate. Summarizing, we have:

Proposition 7. *Suppose that buyer participation is elastic such that for each given product category, each buyer who buys a product through the platform incurs an opportunity cost. Then, the introduction of platform liability can reduce brand owners' innovation even when platform liability lowers the commission rate.*

Proof. See Appendix A.3 □

This result highlights that unintended negative effects of platform liability may emerge when buyers incur opportunity costs per category, even when the response of the platform is to lower the commission rate. In fact, as we formally show in Appendix A.3, if platform liability reduces brand owners' innovation, it is likely to reduce welfare. Specifically, the profit of the platform decreases because of the binding screening obligations; buyer surplus decreases because of a reduction in the number of product categories and a lower per-category surplus; the surplus of legitimate low-quality sellers decreases because of the demand contraction effect and a reduction in the number of product categories.

We now turn to the sufficient condition for a platform liability to be socially desirable and extend the previous condition which we provided in the baseline model (Proposition 5). For the sake of brevity, we briefly mention the main differences with respect to Proposition 5 while relegating the details to the Appendix. Let N_S denote the number of brand owners and N_B the number of buyers per category (which is the same as the number of buyers on the platform because of symmetry if the pool of buyers is the same across all categories). We have

$$N_S = F((1-\tau)\tilde{\pi}^b N_B); \qquad N_B = H(u(\phi)) = D(\phi),$$

with the number of buyers for each category decreasing in ϕ because $D'(\phi) < 0$.

After following the steps we used for the proof of Proposition 5, we find the following sufficient condition for platform liability to be socially desirable (in the neighborhood of the privately optimal screening intensity): (i)

$$\begin{aligned}\left[\int_0^{u(\phi)}\left[u(\phi)-x\right]h(x)dx-(1-\tau^*)N_B^*\tilde{\pi}^b\right](1-\tau^*)\tilde{\pi}^b\frac{\partial N_B^*}{\partial\phi}f((1-\tau^*)\tilde{\pi}^bN_B^*)\\ >(1-\nu)(u^d-u^m)F((1-\tau^*)\tilde{\pi}^bN_B^*)\end{aligned} \tag{23}$$

(ii) $\frac{\partial\tau}{\partial\phi}(\phi^*,\tau^*)\leq 0$.

Condition (23) generalizes the condition (18) we obtained in the baseline model to the case of elastic buyer participation with per-category opportunity cost but takes into account buyers' opportunity costs incurred for each category and the elastic buyer participation captured by $\frac{\partial N_B^*}{\partial\phi}<0$, which is negative; each of the two factors makes this condition more stringent relative to the condition in the baseline model.

Proposition 8. *Suppose that buyer participation is elastic such that each buyer incurs an opportunity cost per category. A sufficient condition for platform liability to be socially desirable is that the commission rate does not increase and that* (23) *holds at equilibrium.*

Proof. See Appendix A.4. □

Note that condition (23) is more stringent than its counterpart in the baseline model, namely condition (18). This suggests that buyer elasticity resulting from the existence of per-category opportunity cost creates a force that tends to make platform liability less socially desirable. In the next section, we establish, however, that this finding does not carry over to a different type of buyer opportunity cost.

4.2.2. Single opportunity cost per platform

We now consider the second scenario in which each buyer incurs only one opportunity cost for all categories (or equivalently an opportunity cost per platform). Let $H(.)$ denote the distribution of buyers' opportunity costs. We will generalize the sufficient condition for platform liability to be socially desirable obtained in the baseline model with a fixed number of buyers (i.e., Proposition 5). As elastic participation on both sides (i.e., brand owners and buyers) generate cross-group network effects from each side to the other, determining the equilibrium number of buyers requires solving for a fixed point.[15] In order to facilitate solving for the fixed point, we assume a positive number $a > 0$ of incumbent brand owners. Thus, the number of new brand owners and that of buyers are, respectively, given by

$$N_S = F((1-\tau)\tilde{\pi}^b N_B); \qquad N_B = H(u(\phi)(N_S + a)).$$

Define $g(.)$ as follows

$$g(N_B; \phi, \tau) \equiv N_B - H(u(\phi)\left[F((1-\tau)\tilde{\pi}^b N_B) + a\right]).$$

When $N_B = 0$, $g(0) = -H(u(\phi)a) < 0$. We have $g(1) = 1 - H(u(\phi)\left[F((1-\tau)\tilde{\pi}^b) + a\right]) > 0$ as long as $N_B < 1$, which is more likely when a is small. Suppose that g is strictly increasing in N_B over the relevant range, that is,

$$1 < h(.)u(\phi)f(.)(1-\tau)\tilde{\pi}^b.$$

Then, $g(N_B; \phi, \tau)$ admits a unique interior solution denoted by $N_B^e(\phi, \tau)$. As we are interested in the sufficient condition for a platform liability to be socially desirable, we focus on the case in which a small increase in ϕ around ϕ^* raises $U(\phi) \equiv u(\phi)\left[F((1-\tau)\tilde{\pi}^b N_B) + a\right]$, i.e., a buyer's total surplus. In other words, holding fixed the number of buyers, a higher screening intensity leads to an increase in buyers' total surplus because the gain from a larger number of product categories outweighs the loss from reduced per-category buyer surplus. Indeed, we assume:

Assumption B (buyer surplus): In the neighborhood of (N_B^*, ϕ^*, τ^*), given N_B,

$$\frac{\partial U(\phi)}{\partial \phi} = (1-\nu)$$
$$\left\{\left(\pi^m - \pi^b\right) u(\phi) f((1-\tau)\tilde{\pi}^b N_B)(1-\tau)N_B - \left(u^d - u^m\right)\left[F((1-\tau)\tilde{\pi}^b N_B) + a\right]\right\} > 0.$$

Under Assumption B, $g(N_B; \phi, \tau)$ decreases in ϕ. Hence, an increase in ϕ raises the equilibrium number of buyers. Note that Assumption B is weaker than condition (18) which makes platform liability socially desirable in the baseline model. More precisely, if Assumption B is satisfied for $N_B = 1$ and $a = 0$, then (18) is satisfied.

As in the baseline model, we assume $\phi^* > 0$ (which implies $\frac{\partial \Pi}{\partial \phi}(\phi^*, \tau^*) = 0$) and that the

[15] We consider here a simultaneous participation of new brand owners and buyers and solve for the fixed point in terms of buyer participation as then the condition which makes the number of buyers increase in ϕ is comparable to the sufficient condition (18) in the baseline model.

gross private benefit is strictly positive at (ϕ^*, τ^*). Then, after following the same steps as in the baseline model, we obtain the following sufficient condition for platform liability to increase social welfare (in the neighborhood of the privately optimal screening intensity): (i)

$$\begin{aligned}\left[u(\phi^*) - (1-\tau^*)N_B^*\tilde{\pi}^b\right](1-\tau^*)\tilde{\pi}^b \frac{\partial N_B^*}{\partial \phi} f((1-\tau^*)\tilde{\pi}^b N_B^*) \\ > (1-\nu)(u^d - u^m)\left(a + F((1-\tau^*)\tilde{\pi}^b N_B^*)\right)\end{aligned} \tag{24}$$

(ii) $\frac{\partial \tau}{\partial \phi}(\phi^*, \tau^*) \leq 0$.

We note that condition (ii) is the same kind of restriction required in the baseline model (Proposition 5.ii). In other words, the commission rate should not increase as a response to a higher screening intensity because $\frac{\partial W}{\partial \tau}(\phi^*, \tau^*) < 0$ holds, as is shown in the formal proof in the Appendix. Condition (i) in (24) generalizes the sufficient condition we obtained in the baseline model (18) to the case of elastic buyer participation with per platform opportunity cost.[16]

Proposition 9. *Suppose that buyer participation is elastic such that each buyer incurs an opportunity cost per platform, and that Assumption B holds. A sufficient condition for platform liability to be socially desirable is that the commission rate does not increase and* (24) *holds at equilibrium.*

See Appendix A.5

Note that equation (24) is weaker than its counterpart in the baseline model (i.e. condition (18)) because $\partial N_B^*/\partial \phi > 0$ under Assumption B. This suggests that buyer elasticity resulting from the existence of per-platform opportunity costs creates a force that tends to make platform liability more socially desirable.

A key message of this section is that depending on the source of buyers' elastic participation, i.e. the nature of buyers' opportunity costs, elastic buyer participation may create a force that either strengthens or weakens the social desirability of platform liability.

4.3. Elastic participation of imitators

In this section, we relax the assumption that, absent screening, the market structure is duopolistic while maintaining the assumption of inelastic buyer participation. Namely,

[16] Note that for a constant mass of buyers with $N_B^* = 1$ and $a = 0$, this condition becomes the same as in the baseline model.

we assume that imitators are distributed according to their imitation cost $\tilde{\xi} \in [0, \overline{\xi}]$, with cdf $Z(\cdot)$ and pdf $z(\cdot) > 0$, the latter being continuously differentiable. After having developed an imitation, an imitator discovers that her product is a legitimate imitation with probability $\nu \in (0, 1)$ and a counterfeit with probability $(1-\nu)$, with ν being *i.i.d.*.[17]

The number of imitators endogenously joining the platform, upon observing the number of product categories realized, is given by $Z\left((1-\tau)\tilde{\pi}^e\right)$, where $\tilde{\pi}^e \equiv ((1-\nu)(1-\phi)+\nu)\pi^e$. Brand owners make their innovation decisions anticipating imitators' entry decisions. Their expected profit depends on the probability of facing competition from imitators, $[1-(1-\nu)\phi]\, Z((1-\tau)\tilde{\pi}^e)$. Thus, the expected gross profit of a brand owner is given by

$$\begin{aligned} &\pi^b \left[1-(1-\nu)\phi\right] Z((1-\tau)\tilde{\pi}^e) + \pi^m \Big[1 - \left[1-(1-\nu)\phi\right] Z((1-\tau)\tilde{\pi}^e)\Big] \\ &= \pi^m - Z(\cdot)(\pi^m - \pi^b)(1-(1-\nu)\phi) \equiv \tilde{\pi}^b. \end{aligned} \tag{25}$$

The number of brand owners is $F((1-\tau)\tilde{\pi}^b)$. From simple comparative statics, we have:

Lemma 2. *Suppose that imitators' participation is elastic. Given a screening intensity, under some conditions, a lower commission rate can reduce brand owners' innovation.*

Differently from the baseline model, a lower (higher) commission rate can lead to a lower (higher) participation of brand owners. While the result might seem counter-intuitive at first, it results from the effect that a change in the commission rate has on the participation level of imitators and thereby on the participation level of brand owners. To see how, consider the following

$$\frac{\partial}{\partial \tau} F((1-\tau)\tilde{\pi}^b) = f((1-\tau)\tilde{\pi}^b)\Big(-\tilde{\pi}^b + (1-\tau)\frac{\partial \tilde{\pi}^b}{\partial \tau}\Big).$$

On the one hand, as in the baseline model, a higher (lower) commission rate reduces (raises) the brand owners' margins, thus lowering (increasing) their incentive to develop an innovative product. On the other hand, a higher (lower) commission rate deters (encourages) entry of imitators as $Z(\cdot)$ decreases in τ. Thus, there is another channel through which brand owners' innovation can be adversely affected.

These results are instructive for discussing the relationship between the commission rate and the screening intensity. Let τ^* be the equilibrium commission rate that maximizes the profit of the platform and we focus on the effect of a higher screening intensity on the

[17]Note that the above assumption implies independence between developing a counterfeit and the cost of developing an imitation.

the amount of innovation. Relegating the formal proof to the Appendix A.6, after totally differentiating the level of participation of brand owners at equilibrium τ^* with respect to ϕ, we find that the sign of $\frac{dF(\cdot)}{d\phi}$ is the same as

$$\underbrace{-\tilde{\pi}^b \frac{d\tau^*}{d\phi}}_{\text{margin effect}(+/-)} +(1-\tau^*)(\pi^m-\pi^b)\Big(\underbrace{-\frac{dZ((1-\tau^*)\tilde{\pi}^e)}{d\phi}(1-(1-\nu)\phi)}_{\text{deterrence effect}(+/-)}+\underbrace{Z((1-\tau^*)\tilde{\pi}^e)(1-\nu)}_{\text{IP-protection effect}(+)}\Big), \tag{26}$$

where the *deterrence effect* is positive (negative) if a higher screening intensity reduces (increases) the probability of entry of imitators. The sign of the deterrence effect depends on the following two forces: a direct effect of screening, which is negative; and an indirect effect via the change in the commission rate, which can be either positive or negative. Specifically,

$$\frac{dZ((1-\tau^*)\tilde{\pi}^e)}{d\phi} = z((1-\tau^*)\tilde{\pi}^e)\Big((1-\tau^*)\underbrace{\frac{d\tilde{\pi}^e}{d\phi}}_{(-)} - \tilde{\pi}^e \underbrace{\frac{d\tau^*}{d\phi}}_{(-/+)}\Big) \tag{27}$$

When the commission rate increases with screening, $\frac{d\tau^*}{d\phi} > 0$, the level of participation of imitators in a given category decreases. On the contrary, when the commission rate decreases with screening, $\frac{d\tau^*}{d\phi} < 0$, this higher profit margin should be weighed against the direct negative impact of more screening. Thus, imitators' participation increases if

$$(1-\tau^*)\frac{d\tilde{\pi}^e}{d\phi} - \tilde{\pi}^e\frac{d\tau^*}{d\phi} > 0 \Longleftrightarrow \left|\frac{\frac{d\tau^*}{d\phi}}{(1-\tau^*)}\right| > \left|\frac{\frac{d\tilde{\pi}^e}{d\phi}}{\tilde{\pi}^e}\right| \tag{28}$$

In other words, the number of imitators joining each product category increases with a higher screening intensity if the commission rate decreases and the semi-elasticity of the imitators' margin with respect to screening is larger than the semi-elasticity of their expected gross profit with respect to screening.

One can easily observe that if the commission rate decreases with more screening, then a sufficient condition for innovation to increase is that the participation of imitators decreases. Differently, when the commission rate increases, brand owners benefit from the IP-protection effect and lower participation by imitators but these benefits should be weighed against the cost of reduced profit margins. If the reduction in the profit margin is limited, brand owners' innovation increases. Summarizing, we have:

Proposition 10. *Suppose that imitators' participation is elastic.*

(i) If platform liability leads to a lower commission rate, a sufficient condition for brand owners' innovation to increase is that (28) *does not hold at equilibrium.*

(ii) If platform liability leads to a higher commission rate, brand owners' innovation increases if the increase in the commission rate induced by a higher screening intensity is not sufficiently large.

(iii) In all other cases, a liability regime that yields a higher screening intensity reduces brand owners' innovation.

This result identifies another channel through which a higher screening intensity can ultimately backfire, reducing brand owners' incentive to innovate, even if the commission rate decreases. Regarding the effect of increased screening on legitimate imitators' surplus, it is immediate that two opposite forces are present. If a higher screening intensity ultimately leads to an increase in innovation by brand owners, legitimate sellers benefit from the positive effect on the extensive margins. However, a higher screening intensity lowers imitators' incentives to develop an imitation. Depending on the prevailing effect, legitimate sellers might benefit or suffer from a higher screening intensity. The formal analysis is relegated to Appendix A.6.

4.4. Lack of commitment power

A critical assumption in our analysis is that the platform can commit to its screening policy. However, it may not necessarily be the case in reality. If it lacks commitment power, it will choose the screening policy to maximize its profit after innovation decisions of brand owners, who rationally anticipate the screening policy to be optimally chosen ex post. Suppose that the platform cannot commit to its screening policy while it can commit to an ad valorem commission rate. Given τ, let $n > 0$ be the number of brand owners who innovated and hence participate in the platform. In this case, absent liability, the platform maximizes the following profit

$$\tau n \left(\tilde{\pi}^b + \tilde{\pi}^e\right) - \Omega(\phi).$$

The first-order condition with respect to ϕ is given by

$$\tau n \frac{\partial(\tilde{\pi}^b + \tilde{\pi}^e)}{\partial \phi} = \Omega'(\phi),$$

with $\frac{\partial(\tilde{\pi}^b+\tilde{\pi}^e)}{\partial\phi} = (1-\nu)(\pi^m - \pi^b - \pi^e) \lesseqgtr 0$. It is straightforward that the platform will choose $\phi = 0$ if $\pi^m < \pi^b + \pi^e$. Even if $\pi^m > \pi^b + \pi^e$ holds, it does not internalize the benefit that a higher screening can generate by increasing the amount of innovation and hence tends to choose a lower level of screening than in the baseline model with commitment.

Suppose now liability is introduced such that it forces the platform to achieve a screening intensity greater or equal to $\underline{\phi}$ (the minimum imposed by the liability regime) in order to benefit from liability exemption. Let us focus on the case in which $\pi^m < \pi^b + \pi^e$ holds such that the platform chooses zero screening in the no liability benchmark. In this case, the platform may want to commit to a positive screening intensity (see Proposition 1). Then, a liability regime that imposes a positive level of screening can increase the platform's profit. For instance, if $\underline{\phi}^W = \phi^*$ where ϕ^* is the screening policy that would be chosen by the platform under commitment power, then the platform liability restores the commitment power of the platform and raises its profit. The same reasoning carries out to the case in which $\pi^m > \pi^b + \pi^e$ holds as long as the lack of commitment power induces the platform to choose a screening level smaller than ϕ^*, which is likely as it does not internalize the impact of screening on innovation. Summarizing, we have:

Proposition 11. *Suppose that the platform cannot commit to a screening policy. The introduction of a liability regime that induces a higher screening intensity may be beneficial to the platform.*

4.5. Imperfect Screening Technology

We below show that our results continue to be valid in the presence of an imperfect screening technology that leads to type-I and type-II errors. Suppose that the platform technology leads to an imperfect detection of IP-infringing products. Let $\alpha \in [0,1]$ denote the probability of making type-I errors and $\beta \in [0,1]$ denote the probability of making type-II errors: an IP-infringing product is delisted with probability $(1-\alpha)$ and remains listed with probability α whereas a legitimate imitation is instead delisted with probability β and is listed with the remaining probability $(1-\beta)$.

Thus, conditional on screening being applied to a product category, the brand owner faces competition from a lower-quality product with the following probability $\nu(1-\beta) + (1-\nu)\alpha \equiv \rho$. Therefore, for a given screening intensity ϕ, a brand owner's expected profit, gross of the commission paid to the platform and the fixed innovation cost, is given by:

$$\tilde{\pi}^b \equiv (1-\rho)\phi\pi^m + [1-(1-\rho)\phi]\,\pi^b;$$

the expected total per-category profit of the imitators is given by

$$\tilde{\pi}^e \equiv [1-(1-\rho)\phi]\,\pi^e;$$

The platform's expected profit is as in (3) and the welfare as in (13) where $\widetilde{w} \equiv (1-\rho)\phi w^m + [1-(1-\rho)\phi]\,w^d$.

Therefore all the previous analysis remains valid as long as we replace ν with ρ because what matters for the platform's private incentive and the innovation incentive of brand owners is only the probability of having a monopolistic or a duopolistic market structure.

For simplicity, suppose now that the prediction accuracy is such that type-I and type-II errors occur with the same probability equal to $\eta < 1/2$. Then, conditional on screening being applied to a product category, the brand owner faces competition from a lower-quality product with probability $\nu(1-\eta)+(1-\nu)\eta \equiv \rho$, which decreases (respectively, increases) in η if $\nu > 1/2$ (respectively, $\nu < 1/2$). Then, increasing prediction error η will have the following effects. If $\nu > \frac{1}{2}$, a higher probability of making errors makes brand owners face less competition ex post in a given product category. Thus, all other things being equal, a larger prediction error makes them better off compared to the case in which there is a perfect screening technology. Indeed, there are conditions under which poorer screening technology can induce more innovation by brand owners. Otherwise, if $\nu < \frac{1}{2}$, competitive pressure on brand owners becomes stronger the larger the prediction error.

5. Concluding remarks and implications

Our paper is motivated by the growing concern about the diffusion of illicit products in online markets and the mounting demands that platforms should take more responsibility in limiting (or hindering) misconduct by third parties. For example, major brand owners supported the introduction of a more stringent liability of online intermediaries in the US (i.e., the INFORM Consumers Act).[18] We analyze the intended and unintended effects of a liability regime that increases online intermediaries' screening efforts. To the best of our knowledge, our paper offers the first formal analysis of the effects of imposing liability on e-commerce platforms on their commission rate, innovation by brand owner and welfare.

We show that, in the absence of liability, the platform's incentives to screen out IP infringers depend on its preferences about the ex post market structure in each given cate-

[18]See e.g., https://www.toyassociation.org/PressRoom2/News/2021-news/toy-assoc-applauds-intro-legislation-to-protect-consumers-from-counterfeits-online.aspx

gory, and that there is a scenario in which it prefers not to engage in any screening activity. When a liability rule is introduced to induce the platform to raise its screening intensity, there are direct and indirect effects. Our analysis of these effects shows that a necessary condition for platform liability to be socially desirable is that it increases incentives for brand owners to develop new products. For this to occur, the platform should not respond to the introduction of liability with a sufficiently large increase in the commission rate. Interestingly, there is a case in which platform liability harms those sellers that it intends to protect from IP infringers in the first place. This happens when the increase in the commission rate offsets brand owners' benefits from facing less intense competition due to delisting of IP-infringing sellers.

Our paper shows that policymakers should pay close attention to the impact of platform liability on key (unregulated) strategic variables of platforms as the unintended effects of platform liability substantially affect its social desirability. More specifically, our analysis generates the following policy implications. First, policymakers should be aware that platform liability may lead to either an increase or a decrease in the commission charged by a platform, which contrasts with the intuition that platform liability is likely to lead to an increase in the commission (because of an increase in marginal screening costs). This is policy-relevant because platform liability is more (less) likely to be socially desirable if it leads to a lower (higher) commission rate. Related to this, platform liability may even end up harming those economic agents that it is meant to protect, i.e. brand owners, if it leads to a large increase in the commission rate. In this case, imposing (or strengthening) liability is detrimental to social welfare. Second, policymakers should be less (more) worried about the potentially adverse impact of platform liability on social welfare if the ratio of new innovative products over old/mature products which are sold on the platform is smaller (larger). Third, the impact of platform liability on innovation and social welfare is affected by the elasticity of buyer participation with respect to screening. Interestingly, a higher elasticity of buyer participation can make platform liability either more or less socially desirable, depending on the source of buyer participation elasticity, that is, the nature of the opportunity costs that generate that elasticity. Specifically, our analysis suggests that per-category opportunity costs create a force that tends to make platform liability less likely to be socially desirable, while per-platform opportunity costs create a force that tend to make platform liability more likely to be socially desirable.

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Appendix.

A.1. Proof of Proposition 5

In the subsequent analysis, we assume that the privately optimal level of screening is positive, i.e., $\phi^* > 0$, which implies that

$$\frac{\partial \Pi}{\partial \phi}(\phi^*, \tau^*) = 0,$$

and that the gross private benefit is positive at (ϕ^*, τ^*) :

$$\tau^* \left(\frac{\partial \tilde{\pi}^b}{\partial \phi} + \frac{\partial \tilde{\pi}^e}{\partial \phi} \right) F((1-\tau^*)\tilde{\pi}^b) + \tau^*(\tilde{\pi}^b + \tilde{\pi}^e) f((1-\tau^*)\tilde{\pi}^b)(1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi} > 0,$$

The latter is equivalent to

$$\begin{aligned} & \frac{\partial \tilde{\pi}^e}{\partial \phi} F((1-\tau^*)\tilde{\pi}^b) + \tilde{\pi}^e f((1-\tau^*)\tilde{\pi}^b)(1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi} \\ \geq \quad & -\frac{\partial \tilde{\pi}^b}{\partial \phi} F((1-\tau^*)\tilde{\pi}^b) - \tilde{\pi}^b f(1-\tau^*)\tilde{\pi}^b)(1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi} \end{aligned}$$

Using the above inequality and (15), we get a lower bound for the net social benefit from an increase in the level of screening at (ϕ^*, τ^*) for a fixed commission rate:

$$
\begin{aligned}
\frac{\partial W}{\partial \phi}(\phi^*,\tau^*) &\geq (1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi}F((1-\tau^*)\tilde{\pi}^b) - (1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi}\left[F((1-\tau^*)\tilde{\pi}^b) + \tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b)(1-\tau^*)\right] \\
&\quad + \left[-(1-\nu)(u^d-u^m)F((1-\tau^*)\tilde{\pi}^b) + u(\phi)(1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi}f((1-\tau^*)\tilde{\pi}^b)\right] \\
&= -(1-\tau^*)\tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b)(1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi} \\
&\quad + \left[-(1-\nu)(u^d-u^m)F((1-\tau^*)\tilde{\pi}^b) + u(\phi)(1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi}f((1-\tau^*)\tilde{\pi}^b))\right].
\end{aligned}
$$

Note that the R.H.S simplifies to

$$
-(1-\nu)(u^d-u^m)F((1-\tau^*)\tilde{\pi}^b) + \left[u(\phi) - (1-\tau^*)\tilde{\pi}^b\right](1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi}f((1-\tau^*)\tilde{\pi}^b)) \quad \text{(A-1)}
$$

This, combined with the expression of the total derivative of welfare with respect to ϕ in (17) yields a lower bound for the net social benefit from an increase in ϕ at (ϕ^*,τ^*):

$$
\begin{aligned}
\frac{dW}{d\phi}(\phi^*,\tau^*) &\geq -(1-\nu)(u^d-u^m)F((1-\tau^*)\tilde{\pi}^b) + \qquad \text{(A-2)} \\
&\quad \left[u(\phi) - (1-\tau^*)\tilde{\pi}^b\right](1-\tau^*)\frac{\partial \tilde{\pi}^b}{\partial \phi}f((1-\tau^*)\tilde{\pi}^b) + \frac{\partial W}{\partial \tau}(\phi^*,\tau^*)\frac{d\tau^*}{d\phi}
\end{aligned}
$$

The last step to derive a sufficient condition for $\frac{dW}{d\phi}(\phi^*,\tau^*)$ to be positive is to determine the sign of $\frac{\partial W}{\partial \tau}(\phi^*,\tau^*)$. We have

$$
\begin{aligned}
\frac{\partial W}{\partial \tau}(\phi^*,\tau^*) &= \underbrace{\frac{\partial \Pi}{\partial \tau}(\phi^*,\tau^*)}_{=0} - \tilde{\pi}^b F((1-\tau^*)\tilde{\pi}^b) + \tilde{\pi}^e\left\{-(1-\tau^*)\tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b) - F((1-\tau)\tilde{\pi}^b)\right\} \\
&\quad -\tilde{\pi}^b\left\{(1-\tau)\tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b) + F((1-\tau^*)\tilde{\pi}^b)\right\} - u(\phi)\tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b),
\end{aligned}
$$

which implies that $\frac{\partial W}{\partial \tau}(\phi^*,\tau^*) < 0$. Using (A-2), a sufficient condition for platform liability to be socially desirable (in the neighborhood of the privately optimal screening intensity) is that (i) $\frac{\partial W}{\partial \phi}(\phi^*,\tau^*) > 0$, thus (A-1) is positive, which happens when $\left[u(\phi) - (1-\tau^*)\tilde{\pi}^b\right](1-\tau^*)\left[\pi^m - \pi^b\right]f((1-\tau^*)\tilde{\pi}^b) > (u^d-u^m)F((1-\tau^*)\tilde{\pi}^b N_B)$, and (ii) $\frac{d\tau^*}{d\phi} \leq 0$ given that $\frac{\partial W}{\partial \tau}(\phi^*,\tau^*) < 0$.

A.2. Narrow welfare impact

In this section, we demonstrate that when the social planner does not take into account the economic surplus of IP-infringers, then a higher screening intensity resulting from a change in the liability regime is more likely to improve social welfare than when it does. Specifically, there might be cases in which the social planner would not consider the economic surplus accruing to those agents that are committing illicit activities. Therefore, we conduct here a 'narrow' welfare analysis of liability in which the per-category social welfare function considered by the social planner is:[19]

$$\widetilde{w} \equiv (1-\nu)\phi(u^m + \pi^m) + \nu(u^d + \pi^e + \pi^b) + [1-(1-\nu)\phi - \nu](u^d + \pi^b).$$

Specifically, this term captures the welfare of brand owners and consumers in those categories subject to screening, i.e. $(1-\nu)\phi$, the welfare of brand owners, consumers and legitimate sellers in those categories in which an IP-infringer is not present, i.e ν, and finally the welfare effect of the consumers and the brand owners only when there are IP-infringers. Note that

$$\frac{d\widetilde{w}}{d\phi} = (1-\nu)(u^m + \pi^m - u^d - \pi^b)$$

which can be positive or negative. If it is negative, the welfare results of the baseline model continue to hold.[20] If it is positive, per-category welfare is higher under a monopoly market structure. Thus, this makes it less (more) likely that a higher screening intensity leads to a detrimental (positive) effect on welfare.

[19] A similar 'narrow welfare' analysis is present in De Chiara et al. (2021) who consider 'a narrow view of copyright protection' in which the social planner only considers the profit of the platform and the right-holder's harm.

[20] Note that in this case we continue to have $-\widetilde{w} + (1-\tau^*)\tilde{\pi}^b < 0$ as we can write it as follows

$$-(1-\nu)\phi(u^m + \pi^m) - \nu(u^d + \pi^e + \pi^b) - [1-(1-\nu)\phi - \nu](u^d + \pi^b) + (1-\tau^*)\Big((1-\nu)\phi\pi^m + [1-(1-\nu)\phi]\,\pi^b\Big)$$

which simplifies to

$$-(1-\nu)\phi[u^m + \pi^m\tau^*] - \nu\pi^e - [1-(1-\nu)\phi](u^d + \tau^*\pi^b) < 0.$$

A.3. Proof of Proposition 7

Suppose buyers incur a single opportunity cost per product category. In what follows, we first identify the effect of a higher screening intensity on the level of innovation by brand owners. Then, we discuss the welfare effects of a higher screening intensity and identify conditions under which it is socially undesirable.

First, consider the scenario in which $\varepsilon_F(y) - \varepsilon_f(y) < 1$ for any y. In this case, the sign of the margin effect is positive (negative) if $\left|\frac{D'(\phi)}{D(\phi)}\right| < (>) \frac{\frac{\partial \tilde{\pi}^b}{\partial \phi}}{\tilde{\pi}^b}$. This implies that the sign of the margin effect is the same as the sign of the sum of the IP-protection effect and the demand contraction effect. This in turn means that the sign of the overall effect of a more stringent liability regime on the level of innovation is the same as the sign of the margin effect. Thus, when the commission rate decreases (increases), the profit margin increases (decreases), and so does the level of innovation

Next, consider the case in which $\varepsilon_F(y) - \varepsilon_f(y) > 1$ for any y. In this case, the analysis is more complex because the margin effect has the opposite sign of the sum of the business-stealing effect and the demand contraction effect. Using (20), the three effects stemming from an increase in screening intensity on the amount of innovation are as follows

$$(1-\tau^*)D(\phi)\frac{\partial \tilde{\pi}^b}{\partial \phi} + (1-\tau^*)D'(\phi)\tilde{\pi}^b - \frac{\partial \tau^*}{\partial \hat{\pi}^b}\Big(D'(\phi)\tilde{\pi}^b + D(\phi)\frac{\partial \tilde{\pi}^b}{\partial \phi}\Big)D(\phi)\tilde{\pi}^b, \tag{A-3}$$

which then implies

$$\Big((1-\tau^*) - D(\phi)\tilde{\pi}^b\frac{\partial \tau^*}{\partial \hat{\pi}^b}\Big)\Big(D(\phi)\frac{\partial \tilde{\pi}^b}{\partial \phi} + D'(\phi)\tilde{\pi}^b\Big). \tag{A-4}$$

Recall that when $\varepsilon_F(y) - \varepsilon_f(y) > 1$, by Proposition 2, the sign of $\frac{\partial \tau^*}{\partial \hat{\pi}^b}$ is positive. Also recall that $\hat{\pi}^b \equiv D(\phi)\tilde{\pi}^b$. Thus, the first term is positive provided that

$$\frac{1}{D(\phi)\tilde{\pi}^b} \geq \frac{\frac{\partial \tau^*}{\partial \hat{\pi}^b}}{(1-\tau^*)} \Longleftrightarrow \frac{\frac{\partial \tau^*}{\partial \hat{\pi}^b}\hat{\pi}^b}{(1-\tau^*)} \leq 1 \tag{A-5}$$

In other words, the first term is positive when the elasticity of the profit margin to the gross ex ante expected profit of brand owners is less or equal to one. In other words, the profit margin is not that responsive to changes in the screening intensity.

The second term in (A-4) is instead positive whenever $\frac{\frac{\partial \tilde{\pi}^b}{\partial \phi}}{\tilde{\pi}^b} \geq |\frac{D'(\phi)}{D(\phi)}|$, which by Proposition 2 occurs when the commission rate increases.

Thus, brand owners' innovation can increase in two different cases, that is when both terms in the brackets in (A-4) are positive or negative. Specifically, innovation increases when the commission rate increases but the profit margin of the brand owners is inelastic. In other words, the commission rate has a negligible impact on the net profit of the brand owners. However, innovation can also increase when the commission rate decreases (i.e., $\frac{\frac{\partial \tilde{\pi}^b}{\partial \phi}}{\tilde{\pi}^b} < |\frac{D'(\phi)}{D(\phi)}|$ but the elasticity of the profit margin to of brand owners is larger than 1.

Differently, brand owners' innovation decreases with a higher screening intensity when there is a reduction in the commission rate but its effect on the profit margin of brand owners is negligible (i.e., the first term in (A-4) is positive, whereas the second term is negative) or when there is an increase in the commission rate that has a substantial effect on the profit margins of the brand owners (i.e., the first term in (A-4) is negative, whereas the second term is positive).

To summarize, if $\varepsilon_F(y) - \varepsilon_f(y) < 1$ holds for any y, then a higher screening intensity leads to more (less) innovation if $\left|\frac{D'(\phi)}{D(\phi)}\right| < (>) \frac{\frac{\partial \tilde{\pi}^b}{\partial \phi}}{\tilde{\pi}^b}$. If $\varepsilon_F(y) - \varepsilon_f(y) > 1$ holds for any y, then a higher screening intensity is such that there is more innovation

- if the commission rate increases and $\frac{\frac{\partial \tau^*}{\partial \tilde{\pi}^b}\tilde{\pi}^b}{(1-\tau^*)} \leq 1$
- if the commission rate decreases and $\frac{\frac{\partial \tau^*}{\partial \tilde{\pi}^b}\tilde{\pi}^b}{(1-\tau^*)} \geq 1$

In all other cases, brand owners' innovation decreases. The welfare effects are immediate. Consider first the surplus of legitimate sellers and decompose $\tilde{\pi^e} = D(\phi)\pi^e$ such that

$$\underbrace{\frac{dF((1-\tau^*)\tilde{\pi}^b)}{d\phi}(1-\tau^*)\nu D(\phi)\pi^e}_{\text{(-/+)}} + \underbrace{F((1-\tau^*)\tilde{\pi}^b)\frac{d}{d\phi}((1-\tau^*)\nu\pi^e)D(\phi)}_{\text{(-/+)}} + \underbrace{D'(\phi)(1-\tau^*)\nu F((1-\tau^*)\tilde{\pi}^b)}_{(-)}$$

The first term is the usual effect on brand owners' innovation. The second term depends on how the commission rate changes with a higher screening intensity. The third term is negative as depends on the demand contraction that a higher screening intensity entails. Compared to the baseline model, the first term decreases with platform liability more then than in the baseline model, whereas the third term is an additional (negative) effect.

Consider now buyer surplus, defined as follows

$$\underbrace{\frac{dF((1-\tau^*)\tilde{\pi}^b)}{d\phi}u(\phi)}_{\text{(-/+)}} D(\phi) + \underbrace{F((1-\tau^*)\tilde{\pi}^b)u'(\phi)D(\phi)}_{\text{(-)}} + \underbrace{D'(\phi)F((1-\tau^*)\tilde{\pi}^b)u(\phi)}_{(-)}$$

Two results are immediate. First, there is an additional component with respect to (12), which is negative. Second, buyer surplus unambiguously decreases if $\frac{dF((1-\tau^*)\tilde{\pi}^b)}{d\phi} < 0$, which is more often the case under elastic buyer participation. Thus, buyer surplus is more likely to decrease with a higher screening intensity. These results suggest that, in the presence of elastic buyer participation resulting from per-category opportunity costs, platform liability is more likely to be socially undesirable compared to the inelastic buyer participation case.

A.4. Proof of Proposition 8

We provide now a sufficient condition for platform liability to be socially desirable. Suppose buyers incur a single opportunity cost per each product category. The proof follows the same steps as in the baseline model. Social welfare is given by

$$
\begin{aligned}
W &= \Pi + \underbrace{\int_0^{(1-\tau)\tilde{\pi}^b N_B} \Big[(1-\tau)\tilde{\pi}^b N_B - x\Big] f(x)dx}_{\text{surplus of brand owners net of investment cost}} \\
&\quad + \underbrace{F((1-\tau)\tilde{\pi}^b N_B) N_B (1-\tau)\tilde{\pi}^e}_{\text{surplus of imitators}} + \underbrace{F((1-\tau)\tilde{\pi}^b N_B)\int_0^{u(\phi)} [u(\phi)-x]\, h(x)dx}_{\text{buyer surplus net of opportunity costs}}
\end{aligned}
$$

The first-order derivative of W with respect to ϕ given τ is

$$
\begin{aligned}
\frac{\partial W}{\partial \phi} &= \frac{\partial \Pi}{\partial \phi} + (1-\tau)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} F((1-\tau)\tilde{\pi}^b N_B) + \\
&\quad + (1-\tau)\left\{(1-\tau)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} f((1-\tau)\tilde{\pi}^b N_B) N_B \tilde{\pi}^e + \frac{\partial \tilde{\pi}^e N_B}{\partial \phi} F((1-\tau)\tilde{\pi}^b N_B)\right\} \\
&\quad + N_B\Big[(1-\tau)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} f((1-\tau)\tilde{\pi}^b N_B)\int_0^{u(\phi)} [u(\phi)-x]\, h(x)dx \\
&\quad - (1-\nu)(u^d - u^m) F((1-\tau)\tilde{\pi}^b N_B)\Big]
\end{aligned}
$$

The first-order derivative of the platform's profit with respect to ϕ given τ is given by

$$
\frac{\partial \Pi}{\partial \phi} = \underbrace{\tau\left[\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} + \frac{\partial \tilde{\pi}^e N_B}{\partial \phi}\right] F((1-\tau)\tilde{\pi}^b N_B) + \tau N_B(\tilde{\pi}^b + \tilde{\pi}^e) f()(1-\tau)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi}}_{\text{gross private benefit}} - \Omega'(\phi).
$$

Let τ^* be the privately optimal commission rate, ϕ^* the privately optimal screening intensity. We assume $\phi^* > 0$ (which implies $\frac{\partial \Pi}{\partial \phi}(\phi^*, \tau^*) = 0$) and that the gross private benefit is strictly positive at (ϕ^*, τ^*), which implies

$$\begin{aligned} & \frac{\partial \tilde{\pi}^e N_B}{\partial \phi} F((1-\tau^*)\tilde{\pi}^b N_B^*) + N_B^* \tilde{\pi}^e f((1-\tau^*)\tilde{\pi}^b N_B^*))(1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} \\ \geq \quad & -\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} F((1-\tau^*)\tilde{\pi}^b N_B^*) - N_B^* \tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b N_B^*))(1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} \end{aligned}$$

Using the above inequality and (A-6), we get a lower bound for the net social benefit from an increase in the screening intensity at (ϕ^*, τ^*) for a fixed commission rate (where we denote $N_B^* \equiv N_B(\phi^*)$):

$$\begin{aligned} \frac{\partial W}{\partial \phi}(\phi^*, \tau^*) \quad & \geq (1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} F((1-\tau^*)\tilde{\pi}^b N_B^*) \\ & -(1-\tau^*)\left\{\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} F((1-\tau^*)\tilde{\pi}^b N_B^* + N_B^* \tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b N_B^*)(1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi}\right\} \\ & +N_B\Big[(1-\tau)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} f((1-\tau)\tilde{\pi}^b N_B) \\ & \int_0^{u(\phi)} [u(\phi) - x]\, h(x)dx - (1-\nu)(u^d - u^m)F((1-\tau)\tilde{\pi}^b N_B)\Big] \end{aligned}$$

where the R.H.S. simplifies as follows

$$N_B^* \left[\begin{array}{c} -(1-\nu)(u^d - u^m)F((1-\tau^*)\tilde{\pi}^b N_B^*) \\ + \left[\int_0^{u(\phi)} [u(\phi) - x]\, h(x)dx - (1-\tau^*)N_B^* \tilde{\pi}^b\right](1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} f((1-\tau^*)\tilde{\pi}^b N_B^*) \end{array} \right]$$

This, combined with the expression of the total derivative of the welfare with respect to ϕ in (17) yields a lower bound for the net social benefit from an increase in ϕ at (ϕ^*, τ^*)

$$\begin{aligned} \frac{dW}{d\phi}(\phi^*, \tau^*) \quad \geq \quad & N_B^* \left[\begin{array}{c} -(1-\nu)(u^d - u^m)F((1-\tau^*)\tilde{\pi}^b N_B^*) \\ + \left[\int_0^{u(\phi)} [u(\phi) - x]\, h(x)dx - (1-\tau^*)N_B^* \tilde{\pi}^b\right](1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} f((1-\tau^*)\tilde{\pi}^b N_B^*) \end{array} \right] \\ & + \frac{\partial W}{\partial \tau}(\phi^*, \tau^*)\frac{\partial \tau}{\partial \phi} \end{aligned} \tag{A-6}$$

The last step of the proof that the conditions (i) and (ii) are sufficient consist in showing that $\frac{\partial W}{\partial \tau}(\phi^*, \tau^*) < 0$. In turn, we have

$$\begin{aligned}\frac{\partial W}{\partial \tau}(\phi^*, \tau^*) &= \frac{\partial \Pi}{\partial \tau}(\phi^*, \tau^*) + \tilde{\pi}^b \left| \frac{\partial (1-\tau) N_B^*}{\partial \tau} \right|_{\tau=\tau^*} F(.) + \\ &+ \tilde{\pi}^e \left\{ (1-\tau^*) N_B^* \left| \frac{\partial (1-\tau) N_B^*}{\partial \tau} \right|_{\tau=\tau^*} \tilde{\pi}^b f(.) + \left| \frac{\partial (1-\tau) N_B^*}{\partial \tau} \right|_{\tau=\tau^*} F(.) \right\} \\ &+ \left| \frac{\partial (1-\tau) N_B^*}{\partial \tau} \right|_{\tau=\tau^*} \tilde{\pi}^b f(.) \int_0^{u(\phi)} [u(\phi) - x] \, h(x) dx\end{aligned}$$

which simplifies as follows

$$\left| \frac{\partial (1-\tau) N_B^*}{\partial \tau} \right|_{\tau=\tau^*} \left\{ \left(\tilde{\pi}^b + \tilde{\pi}^e \right) (F(.) + \left(\int_0^{u(\phi)} [u(\phi) - x] \, h(x) dx + \tilde{\pi}^e (1-\tau^*) N_B^* \right) \tilde{\pi}^b f(.) \right\}$$

where, for brevity, we did not write the element of $F(.)$ and $f(.)$, which is $(1-\tau^*)\tilde{\pi}^b N_B^*$. Since $\left| \frac{\partial (1-\tau) N_B^*}{\partial \tau} \right|_{\tau=\tau^*} = -1$ because N_B^* does not depend on τ, we then get $\frac{\partial W}{\partial \tau}(\phi^*, \tau^*) < 0$.

The rest of the proof (that compares the condition (i) in the baseline model with $N_B^* = 1$ with the condition (i) in the presence of elastic buyer participation and single opportunity cost per category) continues in the main text.

A.5. Proof of Proposition 9

Suppose buyers incur a single opportunity cost per platform. In this case, as stated in the main text, the profit of the platform is

$$\begin{aligned}\Pi &= \tau N_B \left(a + F((1-\tau)\tilde{\pi}^b N_B) \right) (\tilde{\pi}^b + \tilde{\pi}^e) - \Omega(\phi) \\ &= \left(a + F((1-\tau)\tilde{\pi}^b N_B) \right) N_B \tilde{\pi}^b - (1-\tau)\tilde{\pi}^b N_B \left[a + \int_0^{(1-\tau)\tilde{\pi}^b N_B} f(x) dx \right] \\ &\quad + \tau \left(a + F((1-\tau)\tilde{\pi}^b N_B) \right) N_B \tilde{\pi}^e - \Omega(\phi).\end{aligned}$$

Let τ^* be the privately optimal commission rate, ϕ^* the privately optimal screening intensity and $N_B^* = N_B^e(\phi^*, \tau^*)$ the number of buyers indirectly chosen by the platform.

Now fix N_B and consider the derivative of $g(.)$ with respect to ϕ.

$$\frac{\partial g}{\partial \phi} = -h(.)(1-\nu) \left\{ \left(u^m - u^d \right) \left[F((1-\tau)\tilde{\pi}^b N_B) + a \right] + \left(\pi^m - \pi^b \right) u(\phi) f((1-\tau)\tilde{\pi}^b N_B)(1-\tau) N_B \right\}$$

Also fix note that, under Assumption B, $g(.)$ decreases in ϕ.

Social welfare is given by

$$W = \Pi + \underbrace{\int_0^{(1-\tau)\tilde{\pi}^b N_B} \Big[(1-\tau)\tilde{\pi}^b N_B - x\Big] f(x)dx + a(1-\tau)\tilde{\pi}^b N_B}_{\text{surplus of brand owners net of investment cost}}$$
$$+ \underbrace{\Big(a + F((1-\tau)\tilde{\pi}^b N_B)\Big) N_B(1-\tau)\tilde{\pi}^e}_{\text{surplus of imitators}}$$
$$+ \underbrace{\int_0^{u(\phi)\left(a+F((1-\tau)\tilde{\pi}^b N_B)\right)} \Big[u(\phi)\left(a + F((1-\tau)\tilde{\pi}^b N_B)\right) - x\Big] h(x)dx}_{\text{buyer surplus net of opportunity costs}}$$

which increases with a higher screening intensity if (17) is positive, i.e. $\frac{dW}{d\phi}(\phi^*, \tau^*) > 0$.

The derivative of W with respect to ϕ given τ is

$$\begin{aligned} \frac{\partial W}{\partial \phi} &= \frac{\partial \Pi}{\partial \phi} + (1-\tau)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} F((1-\tau)\tilde{\pi}^b N_B) + a(1-\tau)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} + \\ &\quad +(1-\tau)\left\{(1-\tau)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} f((1-\tau)\tilde{\pi}^b N_B) N_B \tilde{\pi}^e + \frac{\partial \tilde{\pi}^e N_B}{\partial \phi}\left(a + F((1-\tau)\tilde{\pi}^b N_B)\right)\right\} \\ &\quad + N_B\left[-(1-\nu)(u^d - u^m)\left(a + F((1-\tau)\tilde{\pi}^b N_B)\right) + u(\phi)(1-\tau)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} f((1-\tau)\tilde{\pi}^b N_B)\right] \end{aligned} \quad \text{(A-7)}$$

The first-order derivative of the platform's profit with respect to ϕ given τ is given by

$$\frac{\partial \Pi}{\partial \phi} = \underbrace{\tau\left[\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} + \frac{\partial \tilde{\pi}^e N_B}{\partial \phi}\right]\left(a + F((1-\tau)\tilde{\pi}^b N_B)\right) + \tau N_B(\tilde{\pi}^b + \tilde{\pi}^e) f(.)(1-\tau)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi}}_{\text{gross private benefit}} - \Omega'(\phi).$$

We assume $\phi^* > 0$ (which implies $\frac{\partial \Pi}{\partial \phi}(\phi^*, \tau^*) = 0$) and that the gross private benefit is strictly positive at (ϕ^*, τ^*), which implies

$$\begin{aligned} &\frac{\partial \tilde{\pi}^e N_B}{\partial \phi}\left(a + F((1-\tau^*)\tilde{\pi}^b N_B^*)\right) + N_B^* \tilde{\pi}^e f((1-\tau^*)\tilde{\pi}^b N_B^*))(1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} \\ \geq \; & -\frac{\partial \tilde{\pi}^b N_B}{\partial \phi}\left(a + F((1-\tau^*)\tilde{\pi}^b N_B^*)\right) - N_B^* \tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b N_B^*))(1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} \end{aligned}$$

Using the above inequality and (A-7), we get a lower bound for the net social benefit from an increase in the screening intensity at (ϕ^*, τ^*) for a fixed commission rate:

$$\begin{aligned}
\frac{\partial W}{\partial \phi}(\phi^*, \tau^*) \;\; \geq \;\; & (1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} F((1-\tau^*)\tilde{\pi}^b N_B^*) + a(1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} + \\
& -(1-\tau^*)\left\{ \frac{\partial \tilde{\pi}^b N_B}{\partial \phi}\left(a + F((1-\tau^*)\tilde{\pi}^b N_B^*\right) + N_B^* \tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b N_B^*)(1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} \right\} \\
& + N_B^* \Big[-(1-\nu)(u^d - u^m)\left(a + F((1-\tau^*)\tilde{\pi}^b N_B^*\right) + \\
& u(\phi^*)(1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} f((1-\tau^*)\tilde{\pi}^b N_B^*)\Big],
\end{aligned}$$

which simplifies to

$$\frac{\partial W}{\partial \phi}(\phi^*, \tau^*) \geq N_B^* \left[\begin{array}{c} -(1-\nu)(u^d - u^m)\left(a + F((1-\tau^*)\tilde{\pi}^b N_B^*)\right) \\ + \left[u(\phi^*) - (1-\tau^*)N_B^* \tilde{\pi}^b\right](1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} f((1-\tau^*)\tilde{\pi}^b N_B^*) \end{array} \right]$$

The above expression, combined with the total derivative of welfare with respect to ϕ in (17) yields a lower bound for the net social benefit from an increase in ϕ at (ϕ^*, τ^*)

$$\begin{aligned}
\frac{dW}{d\phi}(\phi^*, \tau^*) \;\; \geq \;\; & N_B^* \left[\begin{array}{c} -(1-\nu)(u^d - u^m)\left(a + F((1-\tau^*)\tilde{\pi}^b N_B^*)\right) \\ + \left[u(\phi^*) - (1-\tau^*)N_B^* \tilde{\pi}^b\right](1-\tau^*)\frac{\partial \tilde{\pi}^b N_B}{\partial \phi} f((1-\tau^*)\tilde{\pi}^b N_B^*) \end{array} \right] \\
& + \frac{\partial W}{\partial \tau}(\phi^*, \tau^*)\frac{\partial \tau}{\partial \phi}
\end{aligned}$$

As in the baseline model, the last step to derive a sufficient condition for $\frac{dW}{d\phi}(\phi^*, \tau^*)$ to be positive is to determine the sign of $\frac{\partial W}{\partial \tau}(\phi^*, \tau^*)$. We have

$$\begin{aligned}
\frac{\partial W}{\partial \tau}(\phi^*, \tau^*) \;\; = \;\; & \frac{\partial \Pi}{\partial \tau}(\phi^*, \tau^*) + \tilde{\pi}^b \frac{\partial (1-\tau^*)N_B^*}{\partial \tau} F(.) + a\tilde{\pi}^b \frac{\partial (1-\tau^*)N_B^*}{\partial \tau} + \\
& + \tilde{\pi}^e \left\{ (1-\tau^*)N_B^* \frac{\partial (1-\tau^*)N_B^*}{\partial \tau}\tilde{\pi}^b f(.) + \frac{\partial (1-\tau^*)N_B^*}{\partial \tau}(a + F(.)) \right\} \\
& + N_B^* u(\phi^*)\frac{\partial (1-\tau^*)N_B^*}{\partial \tau}\tilde{\pi}^b f(.) \\
= \;\; & \frac{\partial (1-\tau^*)N_B^*}{\partial \tau}\left\{ \left(\tilde{\pi}^b + \tilde{\pi}^e\right)(a + F(.) + \left(u(\phi^*) + \tilde{\pi}^e(1-\tau^*)\right) N_B^* \tilde{\pi}^b f(.) \right\}
\end{aligned}$$

where, for brevity, we do not write the element of $F(.)$ and $f(.)$, which is $(1-\tau^*)\tilde{\pi}^b N_B^*$. Therefore, $\frac{\partial W}{\partial \tau}(\phi^*, \tau^*) < 0$ if and only if $\frac{\partial (1-\tau^*)N_B^*}{\partial \tau} < 0$.

To conclude the proof and show that $\frac{\partial (1-\tau^*)N_B^*}{\partial \tau} < 0$, now fix N_B and consider the derivative of $g(.)$ with respect to τ.

$$\frac{\partial g(.)}{\partial \tau} = h(.)u(\phi)f(.)\tilde{\pi}^b N_B > 0.$$

Therefore, $g(N_B;\phi,\tau)$ increases in ϕ. Hence, an increase in τ reduces N_B^e, which then implies

$$\frac{\partial(1-\tau)N_B^e}{\partial \tau} = -N_B + (1-\tau)\frac{\partial N_B^e}{\partial \tau} < 0,$$

In turn, $\frac{\partial W}{\partial \tau}(\phi^*,\tau^*) < 0$.

Finally, using (A-8), a sufficient condition for platform liability to be socially desirable (in the neighborhood of the privately optimal screening intensity) is are those identified by (i) and (ii) in the main text. Note that condition (i) generalizes the sufficient condition we obtained at the end of section 3.4. To see why, consider a constant mass of buyers with $N_B^* = 1$ and $a = 0$, then we obtain

$$\begin{aligned} & \left[u(\phi^*) - (1-\tau^*)\tilde{\pi}^b\right](1-\tau^*)(1-\nu)\left[\pi^m - \pi^b\right] f((1-\tau^*)\tilde{\pi}^b) \\ > \; & (1-\nu)(u^d - u^m)F((1-\tau^*)\tilde{\pi}^b) \end{aligned}$$

which is the sufficient condition we obtained in the baseline model. Note that the new condition (i) accounts for the cross-group network effects in a two-sided market, which in turn makes (i) weaker than condition (i) in the baseline model.

A.6. Elastic participation of imitators

In this section, we lay out some additional results not included in the main text and related to the welfare impact of a higher screening intensity in the presence of elastic participation of imitators.

Differently from the baseline model, the platform maximizes the following profit

$$\Pi = \tau F((1-\tau)\tilde{\pi}^b)\Big[\pi^m + Z((1-\tau)\tilde{\pi}^e)(\pi^b + \pi^e - \pi^m)(1-(1-\nu)\phi))\Big]. \qquad \text{(A-8)}$$

where $F((1-\tau)\tilde{\pi}^b)$ is the number of brand owners, with $\tilde{\pi}^b \equiv \pi^m - Z(\cdot)(\pi^m - \pi^b)(1 - (1-\nu)\phi)$, and $Z\left((1-\tau)\tilde{\pi}^e\right)$ the number of imitators, with $\tilde{\pi}^e \equiv ((1-\nu)(1-\phi)+\nu)\pi^e$.

As in the baseline model, we restrict attention to the impact of a liability regime that leads to a higher screening intensity on the level of participation of the sellers, that is, brand owners and imitators. As it is not possible to explicitly characterize the underlying conditions for which the commission rate increases or decreases with a higher screening intensity, we are neutral about the sign of $\frac{d\tau^*}{d\phi}$. This is also in line with what already found in the baseline model, for which the sign of $\frac{d\tau^*}{d\phi}$ can go either way. Note also that this argument is strongly supported in this setting because of the two opposite forces that a higher commission rate entails on brand owners' participation.

Let τ^* denote the equilibrium commission rate that maximizes (A-8). Differentiating t $F(.)$ at equilibrium τ^* with respect to ϕ, we have the following

$$\begin{aligned}\frac{dF(\cdot)}{d\phi} =& -\tilde{\pi}^b f((1-\tau^*)\tilde{\pi}^b)\frac{d\tau^*}{d\phi} + f((1-\tau^*)\tilde{\pi}^b)(1-\tau^*)\frac{d\tilde{\pi}^b}{d\phi} \\ =& -\tilde{\pi}^b f(((1-\tau^*)\tilde{\pi}^b)\frac{d\tau^*}{d\phi} + \\ & f(1-\tau^*)\tilde{\pi}^b)(1-\tau^*)(\pi^m - \pi^b)\Big(-\frac{dZ((1-\tau^*)\tilde{\pi}^e)}{d\phi}(1-(1-\nu)\phi) + Z((1-\tau^*)\tilde{\pi}^e)(1-\nu)\Big)\end{aligned}$$

which gives the same expression as in (26), i.e.,

$$\underbrace{-\tilde{\pi}^b\frac{d\tau^*}{d\phi}}_{\text{margin effect}(+/-)} + (1-\tau^*)(\pi^m - \pi^b)\Big(\underbrace{-\frac{dZ((1-\tau^*)\tilde{\pi}^e)}{d\phi}(1-(1-\nu)\phi)}_{\text{deterrence effect}(+/-)} + \underbrace{Z((1-\tau^*)\tilde{\pi}^e)(1-\nu)}_{\text{business stealing effect}(+)}\Big)$$

Note that the sign of the *deterrence effect* depends on the sign of (27). Thus, if $\frac{d\tau^*}{d\phi} > 0$, then $\frac{dZ((1-\tau)\tilde{\pi}^e)}{d\phi} > 0$. On the contrary, if $\frac{d\tau^*}{d\phi} < 0$, then $\frac{dZ((1-\tau)\tilde{\pi}^e)}{d\phi} > 0$ only if

$$(1-\tau^*)\frac{d\tilde{\pi}^e}{d\phi} - \tilde{\pi}^e\frac{d\tau^*}{d\phi} > 0 \Longleftrightarrow \left|\frac{\frac{d\tau^*}{d\phi}}{(1-\tau^*)}\right| > \left|\frac{\frac{d\tilde{\pi}^e}{d\phi}}{\tilde{\pi}^e}\right|$$

which is the same condition in (28). Thus, when $\frac{d\tau^*}{d\phi} < 0$ decreases, the condition for innovation by brand owners to increase is the following

$$\frac{d\tau^*}{d\phi} < (1-\tau^*)(\pi^m - \pi^b)\frac{\Big[-z((1-\tau)\tilde{\pi}^e)(1-\tau^*)\frac{d\tilde{\pi}^e}{d\phi}(1-(1-\nu)\phi) + Z((1-\tau)\tilde{\pi}^e)(1-\nu)\Big]}{\Big[\tilde{\pi}^b - (1-\tau^*)(\pi^m - \pi^b)z((1-\tau)\tilde{\pi}^e)\tilde{\pi}^e(1-(1-\nu)\phi)\Big]}$$

Otherwise, brand owners' innovation decreases. This concludes the proof of Proposition 10. In what follows, we now focus on the (other) welfare effects of a higher screening intensity.

The effect of liability on legitimate imitators' surplus. The introduction of liability also impacts legitimate imitators who do not violate IPs. It is important to recall that low-quality sellers can join the marketplace only if an innovation is developed by a brand owner in their respective productive category. Moreover, these sellers cannot be delisted by the platform. The per-category profit of the legitimate imitators is equal to $(1-\tau^*)\nu\pi^e$. Their total surplus is therefore equal to

$$F((1-\tau^*)\tilde{\pi}^b)Z((1-\tau)\tilde{\pi}^e)(1-\tau^*)\nu\pi^e.$$

It follows that an increase in the screening intensity leads to the following effects

$$(1-\tau^*)\nu\pi^e\Big\{\underbrace{\frac{dF((1-\tau^*)\tilde{\pi}^b)}{d\phi}Z((1-\tau^*)\tilde{\pi}^e)}_{\text{extensive margin}}+\underbrace{F((1-\tau^*)\tilde{\pi}^b)\frac{dZ((1-\tau^*)\tilde{\pi}^e)}{d\phi}}_{\text{intensive margin}}\Big\}$$

Two countervailing forces are present. A higher screening intensity might increase innovation under some parameter constellations. On the other hand, a higher screening intensity lowers ex-ante incentives of imitators to develop an imitation. The overall effect depends on the relative size of the two semi-elasticities to screening, with ex-post surplus of legitimate imitators increasing whenever

$$\frac{\frac{dZ((1-\tau^*)\tilde{\pi}^e)}{d\phi}}{Z((1-\tau^*)\tilde{\pi}^e)} > -\frac{\frac{dF((1-\tau^*)\tilde{\pi}^b)}{d\phi}}{F((1-\tau^*)\tilde{\pi}^b)}$$

which are two measures of the semi-elasticity of imitators and brand owners to screening. Note that both the R.H.S. and L.H.S. can be positive or negative depending on the effect that screening has on the commission rate. One can note that a sufficient condition for the extensive margins to increase is that the commission rate decreases and (28) does not hold at equilibrium. The latter implies a negative impact on the intensive margin. Thus, two countervailing forces exist. Other combinations of parameters for which imitators surplus increases when innovation increases are also possible. Also when the commission rate increases, it is possible for legitimate imitators to be overall better off as a consequence of the large effect on the extensive margin.

The effect of liability on buyer surplus. Consider now the buyer surplus. Given ϕ, let $u(\phi)$ denote the buyer surplus per category, which is given as follows:

$$u(\phi) \equiv u^d\left[1-(1-\nu)\phi\right]Z((1-\tau)\tilde{\pi}^e)+\Big[1-\left[1-(1-\nu)\phi\right]Z((1-\tau)\tilde{\pi}^e)\Big]u^m$$

which we can write as

$$(u^d - u^m)\,[1-(1-\nu)\phi]\,Z((1-\tau)\tilde{\pi}^e) + u^m$$

Let τ^* be the optimal commission rate. Then, we observe

$$\frac{du(\phi)}{d\phi} = (u^d - u^m)\Big[-(1-\nu)(1-\tau^*) + [1-(1-\nu)\phi]\,\frac{dZ((1-\tau^*)\tilde{\pi}^e)}{d\phi}\Big]$$

Two forces impact per-category buyer surplus. First, there is an impact on the ex-post buyer surplus as a higher screening intensity leads to a reduction in the number of IP-infringing imitators. Second, there is an impact on the ex ante participation level of the imitators, which can increase or decrease with a higher screening intensity as shown in (27). Note that when the number of imitators decreases (for example because of a higher commission rate), the latter effect is negative and therefore buyer surplus in a given category decreases unambiguously. When the number of imitators increases, per-category buyer surplus decreases if

$$\frac{dZ((1-\tau^*)\tilde{\pi}^e)}{d\phi} < \frac{(1-\nu)(1-\tau^*)}{1-(1-\nu)\phi}$$

that is when the number of imitators increases at a slower rate than the reduction in IP-infringing imitators. Else, per-category buyer surplus can increase.

It follows that buyer total surplus increases if

$$\frac{du(\phi)}{d\phi}F((1-\tau^*)\tilde{\pi}^b) + u(\phi)\frac{dF((1-\tau^*)\tilde{\pi}^b)}{d\phi}$$

which we can write as follows

$$\frac{\frac{dF((1-\tau^*)\tilde{\pi}^b)}{d\phi}}{F((1-\tau^*)\tilde{\pi}^b)} > \left|\frac{\frac{du(\phi)}{d\phi}}{u(\phi)}\right|$$

that is when the semi-elasticity of brand owners' participation semi-elasticity to screening is larger than the buyers' semi-elasticity to leads to a higher screening intensity.

A.7. Marginal cost of screening

We introduce now the marginal cost of engaging in the screening activity. Suppose the platform incurs a cost c for screening the imitators, then the profit of the platform is

$$\begin{aligned}\Pi &= \tau F((1-\tau)\tilde{\pi}^b)[\tilde{\pi}^b + \tilde{\pi}^e] - F((1-\tau)\tilde{\pi}^b)c\phi, \\ &= F((1-\tau)\tilde{\pi}^b)[\tau(\tilde{\pi}^b + \tilde{\pi}^e) - c\phi]\end{aligned}$$

The commission rate τ^* solves the following first-order condition

$$F((1-\tau^*)\tilde{\pi}^b)[\tilde{\pi}^b + \tilde{\pi}^e] - [\tau^*(\tilde{\pi}^b + \tilde{\pi}^e) - c\phi]f((1-\tau^*)\tilde{\pi}^b)\tilde{\pi}^b = 0, \tag{A-9}$$

which can be rewritten as

$$\frac{[\tau^*(\tilde{\pi}^b + \tilde{\pi}^e) - c\phi]f((1-\tau^*)\tilde{\pi}^b)\tilde{\pi}^b}{F((1-\tau^*)\tilde{\pi}^b)[\tilde{\pi}^b + \tilde{\pi}^b]} = 1,$$

The above expression is akin to (6) in the baseline model but it differs in the presence of the screening cost.

To have a close-form solution, suppose there is a uniform distribution of $F(.)$, then the optimal commission rate is given by

$$(1-\tau^*)[\tilde{\pi}^b + \tilde{\pi}^e] - [\tau^*(\tilde{\pi}^b + \tilde{\pi}^e) - c\phi] = 0$$

which implies

$$\tau^* = \frac{1}{2} + \frac{c\phi}{2[\tilde{\pi}^b + \tilde{\pi}^e]}$$

which is increasing in ϕ.

This simplified analysis suggests that, compared to the baseline model, the introduction of screening costs might lead to a higher commission rate as a consequence of platform liability (at least in the presence of a uniform distribution of preferences). This makes platform liability less likely to lead to an increase in brand owners' innovation and be socially desirable. However, under different distributions, results might differ and feature both the case of the commission rate increasing and decreasing with screening intensity.