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# "Platform Liability and Innovation"

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# Platform Liability and Innovation*

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We study a platform's incentives to delist IP-infringing products and the effects of holding the platform liable for the presence of such products on innovation and consumer welfare. For a given number of buyers, platform liability increases innovation by reducing the competitive pressure faced by innovators. However, there can be a misalignment of interests between innovators and buyers. Furthermore, platform liability can have unintended consequences, which overturn the intended effect on innovation. Platform liability tends to increase (decrease) innovation and consumer welfare if the elasticity of participation of innovators is high (low) and that of buyers is low (high).

*Keywords*: Platform, Liability, Intellectual Property, Innovation.

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# 1 Introduction

In recent years, online misconduct emerged as a fundamental problem of the Web. A common activity is the sale of items infringing intellectual property (IP) rights, such as trademarks, designs, and copyright. According to the OECD (2018), counterfeits account for 3% of global trade and "e-commerce platforms represent ideal storefronts for counterfeits". This has prompted reputable brands such as Nike and Birkenstock to withhold products from a major marketplace like Amazon.com and the luxury brand Louboutin to initiate a legal action against Amazon.com (*Louboutin vs Amazon*) for not stopping third-party sellers advertising knock-offs of the iconic Louboutin's red-soled stilettos.[1]

As part of the governance of its marketplace ecosystem, a platform's owner can take (costly) measures to screen out illicit players. However, this involves a trade-off: whereas allowing low-quality merchants, possibly including IP infringers, on the platform may lower the incentives for innovative sellers to develop new products, it may also increase the platform's market reach and sales. Therefore, it is *a priori* unclear 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 and get compensation from wrongdoers, is oftentimes remote in online markets because illicit players may be hard to identify, may belong to a different jurisdiction, or may not have enough assets to compensate harmed parties for the damage they have suffered. This could motivate the introduction of a liability rule that increases the platform's incentives to screen and delist illegal products.

We provide a theoretical framework to understand an online platform's incentives to delist IP-infringing products and study the impact of holding platforms liable for third parties' IP-infringements on innovators and consumers. We consider a setting in which an IP-infringing product does not create any direct harm to buyers, who make their purchasing decision knowing whether the product they buy is an original product or its imitation.[2] This captures the evidence that many counterfeits are neither deceptive nor harmful and can be beneficial to consumers while harming innovators.[3] In our framework, platform liability takes the form of a negligence-

[1] On December 2022, the Court of Justice of the European Union (CJEU) ruled that online marketplaces could be held directly liable for trademark infringement under some circumstances such as for displaying advertisements of sellers that were using third-party trademarks without authorization, and for stocking and delivering the seller's infringing goods to customers.

[2] For example, a T-shirt branded *Love* that looks similar to the branded *Levi's* might attract buyer demand and not deceive consumers as the difference between the original and its copycat product is obvious. Moreover, the fact that some consumers might discover a taste for low-quality imitations, some of which infringe IP, can also be motivated by the growing success of the ultra-fast fashion industry and of platforms like Temu, a Boston-based online marketplace that is part of PDD Holdings, and Shein, which became in 2021 the "tech industry's most valuable private startup". See https://www.theguardian.com/fashion/2021/dec/21/how-shein-beat-amazon-at-its-own-game-and-reinvented-fast-fashion

[3] If the IP-infringing product was deceptive, thus pretending to be the original one, in most cases consumers would still have the possibility to return it and obtain a refund either because platforms provide such a possibility or because of consumer protection policy. Moreover, we assume that products are not harmful.

based liability rule under which platforms need to comply with two requirements to benefit from liability exemption: a minimum screening requirement and the obligation to delist any identified IP infringer. We focus on the case in which the platform finds it optimal to comply with these (binding) requirements and, therefore, platform liability leads to an increase in the screening level.[4]

We develop a tractable model in which all transactions between buyers and sellers occur on a monopoly platform.[5] There are two types of sellers: the innovators, who incur innovation costs to develop new products that give rise to new product categories; and imitators (i.e., copycats) who sell low-quality versions of innovative products. An imitator can only exist if an innovator has developed an innovative product. With a certain probability, the copycat is legitimate and with the complementary probability, it infringes IP. The platform makes profits by charging sellers an ad valorem commission,[6] and commits to a (costly) screening level, that is, the probability that an IP infringer is identified.[7] If an IP infringer is identified, it is delisted by the platform, whereas legitimate imitators cannot be delisted.[8] Therefore, the screening level determines the degree of competition that each innovative product faces and, as a result, it affects innovators' incentives to develop new products. In this framework, the introduction of platform liability that induces a higher screening level leads to an increase in the probability that an IP-infringing product is identified and delisted, thereby reducing the expected competitive pressure that each innovator faces from an imitator. This intended effect of platform liability, which we call *IP-protection effect*, gives innovators more incentives to innovate, *all other things being equal*. However, we show that platform liability can also have unintended consequences on innovation, which can be either positive or negative.

In Sections 2 and 3, we present and analyze a baseline model without network effects and with an exogenous commission rate. In this setting, a higher screening level induces more innovators

[4]For example, under the EU Electronic Commerce Directive 2000, online intermediaries benefit from liability exemption provided that they act expeditiously to remove any illegal activity or information they become aware of (artt. 13-14). The EU Digital Services Act complements the Directive by adding a list of additional requirements for "very large online platforms".

[5]For illustrative purposes, we will refer to an e-commerce platform. However, our setting also applies to app stores such as Apple's App Store and Google Play.

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

[7]In reality, a platform has repeated interactions with a large number of sellers, who can share information about the platform's behavior. This induces the platform to build a reputation. Commitment to a screening level in our static model can be a good approximation of what a platform with reputational concerns does in situations of repeated interactions. By contrast, if we assume no commitment in our static model, it induces the platform to hold up innovators (see Section 7), which corresponds to a platform with no reputation concerns stemming from repeated interactions. Furthermore, if the platform is subject to transparency obligations regarding its screening policy, then the latter should be observable to third parties, which corresponds to the commitment scenario that we consider in our main model.

[8]Note that in our model a platform always has an incentive to delist any identified IP infringer. Absent a liability regime, if the platform has invested in filtering technology to reach a certain screening level, by a revealed preference argument, it clearly has no incentive to keep any identified IP infringer in its ecosystem. In the presence of a liability regime, instead, the platform is required to delist any identified IP infringer in order to benefit from liability exemption. We assume that the platform finds it optimal to comply.

to develop new products by mitigating ex post competition from imitators and, therefore, platform liability always has a positive effect on innovation. However, this IP-protection effect may not suffice to make platform liability desirable for consumers. More specifically, platform liability has two opposite effects on consumer surplus: on the one hand, it increases innovation and hence the number of product categories, which benefits consumers but, on the other hand, it reduces consumer surplus per category by making each category more likely to be monopolistic rather than duopolistic. The net effect depends on the relative magnitude of the two effects and is negative (respectively, positive) if the elasticity of buyer surplus per category with respect to the screening level is larger (resp., smaller) in absolute value than that of the amount of innovation. This implies that platform liability benefits consumers only if its impact on innovation is sufficiently strong. Otherwise, platform liability harms consumers. We also examine the social desirability of platform liability and show that there is scope for total-welfare-enhancing platform liability whenever the latter benefits consumers.

In Section 4, we identify another channel through which platform liability may generate unintended effects on innovation. Specifically, we study how changes in the commission rate induced by platform liability affect innovation in the baseline model with inelastic buyer participation. We find that platform liability can lead to either an increase or a decrease in the commission rate. Specifically, the commission rate decreases with platform liability if the elasticity of the cost of innovation is increasing, because raising the commission would increasingly reduce the number of innovations. In this case, if the commission rate decreases, then the positive effect of platform liability identified in the baseline model with inelastic buyer participation is strengthened. On the contrary, if the commission rate increases, the overall effect of platform liability on innovation is the combination of the positive IP-protection effect and the negative effect stemming from an increase in the commission rate. We find that in the baseline model, the former dominates the latter, which means that platform liability has a positive impact on innovation. However, the effect of platform liability on consumer surplus can be either negative or positive.

The presence of cross-group network effects substantially affects the impact of platform liability on innovation and on the welfare of the participants in the platform ecosystem. In Section 5, we introduce elastic buyer participation and consider two different cases: the case of one-way network effects and that of two-way network effects. Network effects are one-way (i.e., from buyers to innovators) when a buyer's decision to join the platform is made for each product category and hence depends only on the expected surplus in each product category. In this case, the introduction of platform liability always reduces buyer participation as raising the screening level makes the monopolistic structure more likely. By contrast, network effects are two-way (i.e., they are also exerted by innovators on buyers) when buyers' decision to join the platform depends on the total expected surplus from the platform and, therefore, on the number of product categories. Then, platform liability can increase or reduce buyer participation depending on the elasticity of the participation of innovators. Even if the two cases are very different in terms of the nature of network effects, we find that the effects of platform liability on innovation and consumer surplus are remarkably similar. In both cases, platform liability is likely to increase both the amount of innovation and consumer surplus when the elasticity of participation of innovators is high and that of buyers is low. By contrast, if the elasticity of participation of innovators is low and that of buyers is high, platform liability reduces buyer participation and thereby reduces the amount of innovation as this negative effect on buyer participation outweighs the positive IP-protection effect. In this case, platform liability harms those innovators that it is supposed to protect.

In a series of extensions (Section 6), we relax some of our assumptions and identify additional effects that the introduction of platform liability generates. First, we show that platform liability can change imitators' incentive to infringe IP and thereby reduce innovation through a composition effect: it changes the composition of imitators by raising the share of legitimate imitators, which can strengthen the competition faced by innovators. Second, we establish that our finding that the effect of platform liability on the commission rate may be either positive or negative carries over to the scenario in which the platform charges sellers a fixed membership fee. Third, we consider the case in which some brand owners have strong corporate brand reputation (e.g., Louboutin) and sell their products only via their direct channel whereas imitations are sold on the marketplace. We show that, under mild conditions on the shape of the distribution of the launch cost of brands, the stronger the reputation of the brand reputation the weaker the platform's incentives to delist IP-infringing copies from the marketplace. This result provides a rationale for why Nike and Birkenstock decided to leave Amazon.com and for the lawsuit initiated by Louboutin. Finally, we generalize our analysis to the case in which there is an infinite number of periods and delisting of an imitator triggers a subsequent entry of another imitator.[9]

**Related literature.** This article contributes to the literature on online platforms (Caillaud and Jullien, 2003; Rochet and Tirole, 2003) and, more specifically, to the literature on platform governance. Recent papers on platform governance have studied non-pricing policies that distort seller competition (Karle, Peitz and Reisinger, 2020; Teh, 2022), bias their innovations by trading off one side's surplus against that of the other side (Choi and Jeon, 2023), introduce deceptive features (Johnen and Somogyi, 2024), moderate toxic content (Jiménez Durán, 2022; Liu, Yildirim and Zhang, 2022; Madio and Quinn, 2021), delist low-quality sellers (Casner,

[9] In the Online Appendix, we present additional extensions. First, we establish that our main insights still hold in the case in which sellers invest in incremental innovation. Second, we show that platform liability can induce the platform to imitate innovative products with its own imitations (i.e., can induce the platform to adopt a hybrid business model). Third, we provide an extension to the no-commitment case and show that platform liability can mitigate hold-up and thereby increase the platform's profit in this case. Fourth, we extend our analysis to the case in which a duopolistic market structure generates a higher industry profit than a monopolistic market structure.

2020), or ensure privacy protection (Etro, 2021*a*).[10] In addition, this paper is related to the literature on how platforms can influence seller innovation (Belleflamme and Peitz, 2010; Jeon and Rey, 2022).[11]

We also contribute to the law and economics literature on liability, which has mostly dealt with product liability in contexts where a firm sells its products to consumers directly and there is harm caused by an insufficient level of care.[12] We add to this literature by formally analyzing some of the intended and unintended effects of holding e-commerce platforms (and app stores) liable on innovation and consumer welfare.[13]

Two other papers study the economic effects of platform liability in the presence of IP-infringing products or content.[14] De Chiara et al. (2021) study the incentives of a hosting platform like Youtube to ex ante filter copyright infringing material and the incentives of right holders to send take-down notices to the platform. They investigate the socially optimal public intervention and find it to be a dual system combining ex ante regulation and ex post liability. There are two key differences between this paper and ours, besides the fact that De Chiara et al. (2021) do not investigate the impact of platform liability on innovation. First, they focus on different types of platforms and users. Second, they give a prominent role to right-holders in enforcing copyright protection. Lichtman and Landes (2003) instead discuss the effects of introducing indirect liability for manufacturers of products that can be used by consumers to infringe copyright. They identify circumstances in which it is desirable or undesirable to hold a manufacturer liable for consumers' copyright infringement. These conditions depend on factors such as the cost of modifying the product to reduce infringement probability, enforcement cost, and the direct benefit stemming from the lawful use of the product.

Galasso and Luo (2017) and Galasso and Luo (2022) also study the relationship between liability and innovation in the context of a supply chain. Galasso and Luo (2017) study theoretically and empirically the effect of a reduction in the malpractice liability cost on physicians' behavior and incentives to adopt innovative technologies. They show that reforms aimed at reducing liability risks for physicians may have a positive or a negative effect on innovation incentives depending on the type of technology adopted. Empirically, they also show that laws that reduce

[10] Other papers have studied quality certification and threshold in online platforms (Elfenbein, Fisman and McManus, 2015; Hui et al., 2023) and the role of certification intermediaries (Lizzeri, 1999).

[11] Our paper also shares some commonalities with recent work on platform business models (e.g., Anderson and Bedre-Defolie 2023, 2022; Etro 2021*b*; Hagiu, Teh and Wright 2022; Zennyo 2022; Shelegia and Hervas-Drane 2022), and on the platform's incentives to produce imitations (Jiang, Jerath and Srinivasan, 2011; Madsen and Vellodi, 2023). Our analysis sheds light on the incentives of platforms to copy innovative products in response to the introduction of platform liability.

[12] This literature has identified conditions for the introduction of liability to be socially desirable or undesirable (Daughety and Reinganum, 1995, 1997, 2006, 2008; Ganuza, Gomez and Robles, 2016; Polinsky and Shavell, 2010).

[13] See Buiten, de Streel and Peitz (2020) and Lefouili and Madio (2022) for a non-formalized economic analysis of platform liability.

[14] Zhang (2021) focuses instead on the effects of content takedown policies in the presence of illegal reproduction of copyrighted material. Using data from GitHub, he shows that takedown policies can be socially inefficient.

liability for physicians are likely to generate less patenting activity in medical instruments. In an empirical analysis of the effect of product liability for medical implants, Galasso and Luo (2022) provide further evidence that changes in liability risk can have cascade effects along a vertical chain, with a significant negative effect on downstream innovation. In our theoretical analysis, we show how holding platforms liable for IP-infringing products may have an adverse effect on the innovation incentives of sellers.

Liability for online intermediaries is also studied by Hua and Spier (2022), Zennyo (2023), and De Chiara et al. (2023). Unlike us, these papers focus on harmful firms that impose costs on consumers and do not investigate the effect of platform liability on innovation. Hua and Spier (2022) show that it is optimal to hold platforms liable when harmful firms are judgment proof, but that the optimal liability regime may be partial. Zennyo (2023) considers platform liability for defective products sold by third parties and shows that the introduction of liability, taking the form of ex post compensation, can alter the incentive of the platform and potentially reduce the welfare of consumers and sellers' variety on the platform. De Chiara et al. (2023) study the effects of imposing liability on online platforms in a context in which consumers can receive partial compensation from losses resulting from buying a defective product and inflict reputational punishment onto the platform.

Finally, we contribute to the literature on the economics of digital piracy.[15] This literature has shown that pirated content may have positive externalities on the original one, e.g., through sampling (Peitz and Waelbroeck, 2006*b*). In our model, the mechanism is different: the availability of an IP-infringing product is mediated by a platform and may generate a positive effect on innovators if it increases buyer participation on the platform.

**Outline.** The rest of the article is organized as follows. In Section 2, we present the baseline model with no network effects and an exogenous commission rate. In Section 3, we study the platform's private incentives to screen and the effect of platform liability on innovation, consumer surplus and total welfare in the baseline model. In Section 4, we study how the introduction of platform liability impacts the commission rate and, thereby, innovation incentives and consumer surplus. In Section 5, we study how the effects of platform liability depend on the existence and nature of cross-group network effects. In Section 6, we provide several extensions. Finally, in Section 7, we gather concluding remarks and policy implications.

# 2 Baseline setup

Consider an economy in which all transactions between sellers and buyers take place on a monopoly e-commerce platform. Sellers can be of two types: innovators or imitators.

[15] See Peitz and Waelbroeck (2006*a*) and Belleflamme and Peitz (2012) for excellent reviews.

**Innovators.** There is a mass one of innovators, who can develop an innovative product that gives rise to a new product category. We assume that innovators are heterogeneous in their cost of innovation, $k$, which is distributed according to a cdf $F(.)$ with density $f(.) > 0$ over the interval $[0, \overline{k}]$. We assume that $f(k)$ is continuously differentiable and that $\frac{f(k)}{F(k)}$ is weakly decreasing in $k$.[16] Once an innovative product is developed, the innovator sells it via the platform. For simplicity, we assume that the marginal production cost is zero.

**Imitators.** An innovative product may face competition from an imitation. Such an imitation may either be legitimate, in the sense that it is similar to the innovative product within the boundaries of the law, or infringe the IP of the owner of the innovative product. The latter scenario would happen, for instance, if the imitation features a name or logo that leads to trademark infringement.

We assume that an imitation is legitimate with probability $\nu \in (0, 1)$ and infringes the IP covering the innovative product with probability $1-\nu$. In the baseline model, we assume that $\nu$ is exogenous and the imitation cost is equal to zero, but we relax this assumption in Section 6 by allowing for endogenous infringement and heterogeneous cost of imitation. We also assume that there is perfect information so that consumers buying an imitation are not deceived, and that a legitimate imitation and one that infringes IP are perceived by consumers as homogeneous. We suppose that only a single imitator joins the platform in each realized product category.[17] Finally, we assume that primary liability is not enforceable, i.e., an innovator cannot obtain damages from an IP infringer (e.g., because it is located in another jurisdiction or is judgment proof).

**The platform.** The platform does not charge any price on the buyer side. On the seller side, the platform charges an ad valorem commission rate $\tau \in (0, 1]$ per transaction, which we assume to be exogenous in the baseline model.[18] Moreover, the platform commits to a screening level $\phi \in [0, 1]$, that is, the probability that an IP infringer is identified as such. We assume that there are no type-I errors, i.e., a legitimate imitator cannot be flagged as infringing IP. If an IP infringer is identified, it can be delisted by the platform, whereas a legitimate imitator cannot

[16]This is the case for instance for a uniform distribution.

[17]The assumption that only one imitator enters can be justified by the fact that the presence of a second imitator, entering subsequently, would drive prices to zero and thus render the second entry unprofitable. In Section 6 we generalize our analysis to the case in which there is an infinite number of periods and delisting of an imitator triggers a subsequent entry of another imitator. Our main results carry out qualitatively.

[18]We endogenize the commission rate in Section 4. Note that there are circumstances under which the commission rate can be considered exogenous. First, the commission rate can be a long-run decision and there is indeed little evidence of frequent adjustments by existing online marketplaces and app stores. Second, the commission rate can be regulated by the government or capped to avoid "excessive pricing". For instance, in the European Union, unfair or excessive pricing by dominant firms is forbidden by Article 102 TFEU as it constitutes an abuse of dominance.

be delisted.[19] We assume that screening is costly and we let $\Omega(\phi)$ denote the fixed screening cost incurred by the platform associated with a level of screening $\phi$. For example, the screening activity might require sunk investments in artificial intelligence to train an algorithm that filters IP-infringing products. Alternatively, the platform can buy a filtering technology whose cost is increasing in its accuracy rate. Finally, we make the following assumption regarding the screening cost incurred by the platform.

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

This assumption implies that the cost of achieving a very low, yet positive, screening level is very small, whereas perfect screening is prohibitively costly. Moreover, by revealed preferences, this assumption also implies that any IP infringer that is identified as such is delisted. We assume that $\phi$ is observable by all agents, which is consistent, for instance, with the transparency obligations imposed by the EU Digital Services Act. We focus on the case in which the platform can commit to $\phi$, although we also analyze the case of no commitment in the Online Appendix.

**Consumers.** There is a unit mass of consumers. To disentangle different forces at stake, in the baseline model we assume that all consumers join the platform, i.e., buyer participation is inelastic. In Section 5, we relax this assumption by introducing elastic buyer participation. We assume that consumers are ex ante homogeneous but ex post heterogeneous in the sense that it is only after joining the platform that they discover their valuations for the innovators' and the imitators' products.

**Market structure in each category.** Market structure in each product category is either duopolistic or monopolistic. It is monopolistic if and only if the imitator infringes IP and is identified and delisted by the platform. In each category, let $\pi_I^m$ (resp., $\pi_I^d$) represent the expected profit, gross of the commission paid to the platform and the fixed innovation cost, of an innovator when it faces no competition (resp., faces competition from an imitator). Let $\pi_C^d$ represent an imitator's expected profit when competing with an innovator; the subscript 'C' stands for copycats. We assume the following.

**Assumption 2.** $\pi_I^m > \pi_I^d + \pi_C^d$.

This assumption means that industry profits are larger under a monopolistic market structure than under a duopolistic market structure.[20] One implication of this assumption is that the

[19]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 can be considered a remote possibility.

[20]We relax this assumption in the Online Appendix and study the case in which a duopolistic market structure yields a higher total profit than a monopolistic one.

innovator's profit is higher when it faces no competition than when it faces competition from an imitator (i.e., $\pi_I^m > \pi_I^d$).[21]

For a given screening level $\phi$, an innovator's expected profit, gross of the commission paid to the platform and the fixed innovation cost, is given by:

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

With probability $(1-\nu)\phi$, the innovator is the only seller in its respective product category and earns monopoly profit $\pi^m$. With the remaining probability, the innovator competes with an imitator and earns a duopoly profit $\pi_I^d$. Given the screening level $\phi$, the expected gross profit of an imitator is

$$\pi_C(\phi) \equiv [1-(1-\nu)\phi]\,\pi_C^d. \tag{2}$$

For a given number $n_I$ of innovators who developed an innovative product, the expected consumer surplus is equal to $u(\phi)n_I$, with

$$u(\phi) \equiv (1-\nu)\phi u^m + (1-(1-\nu)\phi)u^d, \tag{3}$$

where $u^m$ (resp., $u^d$) represents the expected buyer surplus per category, net of price, when the product market structure is monopolistic (resp., duopolistic). Because we focus on imitations that are neither malicious nor harmful, we assume that buyer surplus per category is higher in a duopolistic market structure than in a monopolistic one. Formally, we assume the following.

**Assumption 3.** *$u^d > u^m > 0$.*

**Timing.** We consider the following timing:

- Stage 1: The platform decides its screening level $\phi$.
- Stage 2: Innovators make their innovation decisions and join the marketplace if they innovate. In each product category, an imitator joins the marketplace and is delisted with probability $\phi$ if it infringes IP.
- Stage 3: Buyers decide whether to join the marketplace. Upon joining it, they discover their valuations for the products and make their purchasing decisions: for each product category, they decide whether to buy and which product to buy if there is more than one product.

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

[21] Note that we do not put any restriction on the relationship between $\pi_I^d$ and $\pi_C^d$. However, a model with vertical differentiation is likely to imply $\pi_I^d > \pi_C^d$.

# 3 Analysis of the baseline model

In Stage 2, an innovator develops a new product if and only if her innovation cost is lower than the expected profit she makes on the platform, net of the commission paid to the platform, i.e., $(1-\tau)\pi_I(\phi)$. Therefore, the number of innovators that develop an innovative product and join the marketplace is

$$n_I(\tau, \phi) = F((1-\tau)\pi_I(\phi)).$$

Throughout the analysis, we refer to $n_I(\tau, \phi)$ as the *amount of innovation*.

In Stage 1, the platform acts as a private regulator of its innovation ecosystem by choosing the screening level $\phi$ in order to maximize the following expected profit, which we assume to be quasi-concave in $\phi$:[22]

$$\Pi(\tau, \phi) = \tau F((1-\tau)\pi_I(\phi))\Big[\pi_I(\phi) + \pi_C(\phi)\Big] - \Omega(\phi). \quad (4)$$

The first-order condition of the platform's expected profit with respect to $\phi$ can be written as

$$\frac{\partial \Pi(\tau, \phi)}{\partial \phi} = \tau\Big\{\frac{\partial n_I(\tau, \phi)}{\partial \phi}\Big[\pi_I(\phi) + \pi_C(\phi)\Big] + F((1-\tau)\pi_I(\phi))\Big[\pi_I'(\phi) + \pi_C'(\phi)\Big]\Big\} - \Omega'(\phi) = 0, \quad (5)$$

with $\pi_I'(\phi) + \pi_C'(\phi) = (1-\nu)[\pi_I^m - \pi_I^d - \pi_C^d] > 0$ by Assumption 2. Note first that an increase in the level of screening raises the expected profit of innovators and thereby leads to the development of a larger number of innovative products on the platform.[23] More precisely, a higher screening level reduces the competitive pressure faced by an innovator as each product category becomes more likely to be monopolistic, which increases the innovator's expected profit:

$$\pi_I'(\phi) = (1-\nu)(\pi_I^m - \pi_I^d) > 0. \quad (6)$$

We call this the *IP-protection effect*. This positive effect leads to an increase in the amount of innovation. In addition, (5) also identifies the key role played by total profit per category in shaping the platform's incentive to screen. This is because an increase in the level of screening raises not only the amount of innovation but also the platform's profit per product category, which implies that the marginal private benefit of screening (gross of screening costs) is always positive. This, combined with the fact that the marginal cost of screening is zero at $\phi = 0$, makes the platform always choose a positive level of screening. Denoting $\phi^\star$ the screening level that is chosen by the platform in the absence of platform liability, we state the following lemma.[24]

[22] A sufficient condition is that $f'(k)$ is sufficiently negative for any $k$ or that $C''(\phi)$ is sufficiently positive for any $\phi > 0$.

[23] This is in line with the standard rationale for IP protection.

[24] Note that our assumption $\Omega(\phi) \underset{\phi \to 1}{\to} +\infty$ precludes the possibility that the platform chooses full screening

**Lemma 1.** *Suppose that buyer participation is inelastic. For a given commission rate, the platform's optimal level screening $\phi^\star$ is strictly positive and solves* (5)*.*

**The impact of platform liability.** We now study the impact of introducing a negligence-based liability rule under which a platform benefits from liability exemption if and only if it complies with two requirements: (i) the screening level should be (weakly) above a certain threshold, denoted by $\phi^L$; (ii) the platform delists any identified IP infringer. We focus on the interesting case in which the minimum screening requirement is binding, i.e., $\phi^L > \phi^\star$ and the cost of not being exempted from liability is sufficiently large for the platform to find it optimal to comply with the two requirements. As a consequence, platform liability leads to an increase in the screening level.

We have seen previously that an increase in the screening level raises the amount of innovation through the IP-protection effect for a given commission rate. Therefore, in the baseline model, an immediate effect of introducing platform liability is that it raises the amount of innovation.

However, the fact that platform liability leads to a larger amount of innovation does not necessarily make it desirable for consumers. Because imitations benefit consumers for a given amount of innovation but exert competitive pressure on innovators, there is a potential misalignment of interests between consumers and innovators. To investigate this, we now assess the effect of platform liability on consumer surplus, which is given by $CS(\tau, \phi) \equiv u(\phi) n_I(\tau, \phi)$, with $u(\phi)$ defined in (3). Differentiating consumer surplus respect to $\phi$, we obtain

$$\frac{\partial CS(\tau, \phi)}{\partial \phi} = \underbrace{\frac{\partial n_I(\tau, \phi)}{\partial \phi} u(\phi)}_{>0} + \underbrace{n_I(\tau, \phi) u'(\phi)}_{<0}. \tag{7}$$

Two opposite effects are present. Because the amount of innovation increases as a consequence of the introduction of platform liability, consumers benefit from a larger number of product categories, holding fixed the buyer surplus per category. Yet, given an amount of innovation (and hence given a number of product categories), raising the screening level lowers buyer surplus per category as the market structure is more likely to be monopolistic. As the two effects move in opposite directions, the introduction of platform liability benefits (resp., harms) consumers only if the gains from a larger amount of innovation more than offset (resp., are dominated by) losses from the reduction in consumer surplus per category.

Denoting $\varepsilon_u(\phi) \equiv \frac{u'(\phi)}{u(\phi)} \phi$ the elasticity of buyer surplus with respect to $\phi$ and $\varepsilon_{n_I}(\tau, \phi) \equiv \frac{\frac{\partial n_I(\tau,\phi)}{\partial \phi}}{n_I(\tau,\phi)} \phi$ the elasticity of the amount of innovation with respect to $\phi$, we get the following result.

of IP-infringing products, i.e., $\phi^\star = 1$. This could, however, happen in a setting in which the cost of full screening is not prohibitively high.

**Proposition 1.** *Suppose that buyer participation is inelastic. For a given commission rate, a liability rule that induces a higher level of screening always has a positive effect on innovation, and has a positive (resp., negative) effect on consumer surplus if*

$$\varepsilon_{n_I}(\tau,\phi) > (<) - \varepsilon_u(\phi), \qquad \forall \phi \in [0,1].$$

This result suggests that if the loss in buyer surplus per category increases with the screening level at a faster rate than the increase in the amount of innovation does, there is an important trade-off that policymakers should take into account: benefits for innovators do not translate into benefits for final consumers. Proposition 1 implies that platform liability benefits consumers only if its impact on innovation is strong enough.

In order to identify conditions on the primitives of the model under which platform liability benefits or harms consumers, we note that from (7) we have

$$\frac{\partial CS}{\partial \phi} > 0 \Longleftrightarrow \underbrace{(1-\tau)\frac{f((1-\tau)\pi_I(\phi))}{F((1-\tau)\pi_I(\phi))}\left(\pi_I^m - \pi_I^d\right) - \frac{u^d - u^m}{u(\phi)}}_{\equiv H(\phi,\tau)} > 0.$$

Recall that $\frac{f(k)}{F(k)}$ is weakly decreasing in $k$. Because $H(\phi,\tau)$ is (strictly) decreasing in $\phi$ and $H(\phi,\tau)$ is continuous in $\phi$, there exists a unique threshold $\tilde{\phi}(\tau) \in [0,1]$ such that

$$\frac{\partial CS}{\partial \phi} \lesseqgtr 0 \Longleftrightarrow \phi \gtreqless \tilde{\phi}(\tau). \tag{8}$$

The following three scenarios can possibly occur:

(i) $\tilde{\phi}(\tau) = 0$ if $H(0,\tau) \leq 0$; in this case, any increase in the screening level leads to a decrease in consumer surplus.

(ii) $\tilde{\phi}(\tau) \in (0,1)$ if $H(1,\tau) < 0 < H(0,\tau)$, in this case, a marginal increase in screening leads to an increase (resp. decrease) in consumer surplus, if the initial screening level is sufficiently low (resp. high).

(iii) $\tilde{\phi}(\tau) = 1$ if $H(1,\tau) \geq 0$; in this case, any increase in screening leads to an increase in consumer surplus.

Hence, in scenario (ii), there is scope for consumer-surplus-increasing platform liability if $\phi^\star < \tilde{\phi}(\tau)$ and no scope for consumer-surplus-increasing platform liability otherwise. In the other scenarios, platform liability either always benefits consumers (scenario (iii)) or always harms consumers (scenario (i)).[25]

Let us now turn to the effect of platform liability on total welfare, defined as the sum of the

[25]Under the assumption that the platform's profit function is quasi-concave, the inequality $\phi^\star < \tilde{\phi}(\tau)$ is

innovators' and imitators' surplus, the platform's profit, and consumer surplus:

$$W(\tau,\phi) = n_I(\tau,\phi)(1-\tau)[\pi_I(\phi)+\pi_C(\phi)] - \int_0^{(1-\tau)\pi_I(\phi)} kf(k)dk + \Pi(\tau,\phi) + CS(\tau,\phi).$$

Differentiating this with respect to $\phi$ at $\phi^\star$ yields

$$\left.\frac{\partial W(\tau,\phi)}{\partial \phi}\right|_{\phi=\phi^\star} = (1-\tau)\left[n_I(\tau,\phi)[\pi_I'(\phi)+\pi_C'(\phi)] + \pi_C(\phi)\frac{\partial n_I(\tau,\phi)}{\partial \phi}\right] + \frac{\partial CS(\tau,\phi)}{\partial \phi}, \qquad (9)$$

because $\left.\frac{\partial \Pi(\tau,\phi)}{\partial \phi}\right|_{\phi=\phi^\star} = 0$. The first term in (9) reflects the effect of a higher screening level on the aggregate surplus of innovators and imitators. This term is positive because $\frac{\partial n_I(\tau,\phi)}{\partial \phi} > 0$ and $\pi_I'(\phi)+\pi_C'(\phi) \equiv (1-\nu)[\pi_I^m - (\pi_I^d+\pi_C^d)] > 0$ (by Assumption 2). The second term in (9) captures the effect of a higher screening on consumer surplus and can be either positive or negative. If it is positive, then a marginal increase in the screening level (above the privately optimal level) leads to higher total welfare. Hence, in this case, there is scope for total-welfare-enhancing platform liability. However, if a marginal increase in the screening level leads to a decrease in consumer surplus, then it may induce either an increase or a decrease in total welfare. This is because, in that case, there is a tension between the positive effect on the surplus of innovators and imitators and the negative effect on consumer surplus. This discussion is summarized in the following proposition.

**Proposition 2.** *Suppose that buyer participation is inelastic. For a given commission rate, a liability rule that induces a marginal increase in the level of screening above the privately optimal level has a positive effect on total welfare whenever it has a positive effect on consumer surplus. Otherwise, the effect of the liability rule on total welfare can be either positive or negative.*

We illustrate the above result graphically in Figure 1 considering the example of a uniform distribution of the innovation cost in $[0,1]$, quadratic screening cost, and the following set of parameter values: $\tau = 0.5, \pi_I^d = \pi_C = 0.9, \pi_I^m = 2, u^m = 0.2, u^d = 0.9$. Figure 1 shows that both the screening level that maximizes total welfare (denoted as $\phi^W$) and the privately optimal decrease in the probability that an imitation is legitimate, $\nu$. However, the screening level that maximizes consumer surplus increases in $\nu$.[26] The figure shows that if the probability that an imitation is legitimate exceeds a certain threshold (i.e., $\nu \geq \nu^{CS}$), the platform always

equivalent to:

$$\frac{\partial \Pi}{\partial \phi}\left(\tau, \tilde{\phi}(\tau)\right) < 0.$$

Hence, in scenario (ii), for a given commission rate, there is scope for consumer-surplus-increasing platform liability if and only if the above condition (which only depends on the primitives of the model and the commission rate $\tau$) holds.

[26]Note that with a uniform distribution of the innovation cost in $[0,1]$, we have

$$\phi^\star(\nu) = \frac{(1-\nu)(1-\tau)\tau(\pi_I^m(\pi_C^d+2\pi_I^d) - 2\pi_I^d(\pi_C^d+\pi_I^d))}{2(1-\nu)^2(1-\tau)\tau(\pi_I^m-\pi_I^d)(\pi_C^d+\pi_I^d-\pi_I^m)+1}$$

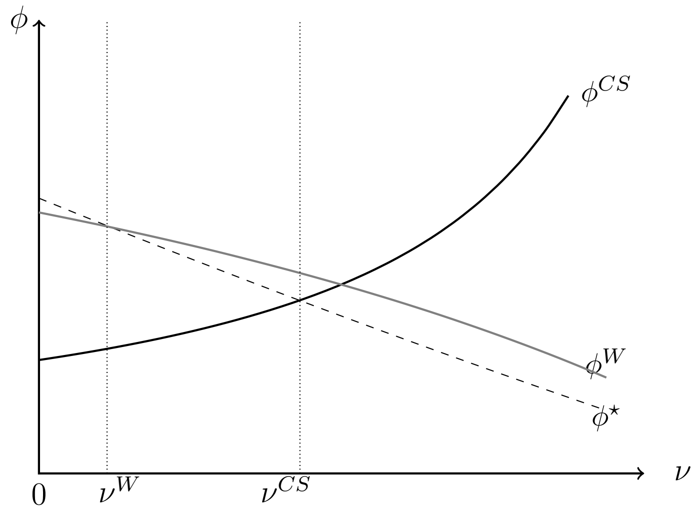


Figure 1: Comparison of the screening level that maximizes platform's profits (dashed line), consumer surplus (solid black line), and total welfare (solid gray line). Parameter values: $\tau = 0.5, \pi_I^d = \pi_C^d = 0.9, \pi_I^m = 2, u^m = 0.2, u^d = 0.9$.

provides less screening than what would be desirable for consumers. This is mainly because the marginal gain from screening is small relative to the marginal screening cost but consumers do not internalize the latter. Since in this case introducing platform liability increases consumer surplus, then in line with Proposition 2, it also increases social welfare, i.e., the dashed line of the privately optimal screening level $\phi^\star$ is below both the gray and black solid lines that identify the screening level that maximizes total welfare and consumer surplus, respectively. If the probability that an imitation is legitimate is intermediate, i.e., $\nu^W \leq \nu < \nu^{CS}$, the dashed line is above the black line and below the gray line. In this case, platform liability continues to be socially desirable even if it harms consumers. Finally, for low values of $\nu$, i.e., $\nu < \nu^W$, platform liability is socially undesirable.

# 4 Platform liability and endogenous commission rate

In this section, we consider that buyer participation is inelastic as in the baseline model but the platform endogenously decides its commission rate at the same time as its screening level. We assume that the commission rate is non-discriminatory, that is, all sellers are subject to the same commission rate $\tau$, regardless of their legal status and their quality level.[27]

which decreases in $\nu$ in scenario (ii). Moreover, the cut-off value is

$$\tilde{\phi}(\nu) \equiv \min\left\{\frac{u^d(\pi_I^m - 2\pi_I^d) + \pi_I^d u^m}{2(1-\nu)(\pi_I^m - \pi_I^d)(u^d - u^m)}, 1\right\},$$

which is increasing in $\nu$. The two conditions imply that if the probability that an imitation is legitimate increases, it is more likely that platform liability has a positive effect on consumer surplus.

[27]Note that our results hold qualitatively if the platform were allowed to discriminate against vendors on the basis of their "innovativeness". This would imply a commission rate equal to $\tau_C^\star = 1$ for the imitators and

Consider the pricing problem of the platform for a given screening level. The expected profit of the platform, which we assume to be quasi-concave in $\tau$, is given by

$$\Pi(\tau,\phi) = \tau n_I(\tau,\phi)[\pi_I(\phi)+\pi_C(\phi)] - \Omega(\phi).$$

Differentiating it with respect to $\tau$, we obtain the following first-order condition:

$$n_I(\tau,\phi)[\pi_I(\phi)+\pi_C(\phi)] + \tau\frac{\partial n_I(\tau,\phi)}{\partial\tau}[\pi_I(\phi)+\pi_C(\phi)] = 0. \tag{10}$$

There are two (standard) opposite effects. The first term represents how much the platform gains from raising $\tau$ from the inframarginal innovators and imitators, whereas the second term captures the platform's loss from having fewer product categories as the marginal innovators decide not to develop new products. Simplifying we obtain

$$n_I(\tau,\phi) + \tau\frac{\partial n_I(\tau,\phi)}{\partial\tau} = 0. \tag{11}$$

In order to understand the impact of platform liability on the optimal commission rate, which we denote by $\tau^\star(\phi)$, we need to understand how $\phi$ affects the terms in (11). The term $n_I(\tau,\phi)$ is increasing in $\phi$, whereas the term $\tau\frac{\partial n_I(\tau,\phi)}{\partial\tau}$ can be be either increasing or decreasing in $\phi$. In the next proposition, we show that what matters for the effect of platform liability on the commission is whether the elasticity of $F(.)$, defined by $\frac{kf(k)}{F(k)} \equiv \varepsilon_F(k)$, is increasing or decreasing.

**Proposition 3.** *Suppose that buyer participation is inelastic. A liability rule that induces a higher level of screening leads to a lower (resp., higher) commission rate if $\varepsilon_F(k)$ is increasing (resp. decreasing) for any $k \in [0,\overline{k}]$*

Interestingly, there are circumstances in which the platform responds to the introduction of a liability rule by reducing its commission rate. This occurs when the elasticity of $F(.)$ is increasing as in this case, raising the commission would increasingly reduce the number of innovations. In the knife-edge case in which $\varepsilon_F(k)$ is constant (which holds for a uniform distribution), the commission does not depend on $\phi$ and hence the results from the baseline model apply in full. Throughout this section, we refer to the effect that an increase in the screening level has on the commission rate (i.e., $\frac{d\tau^\star(\phi)}{d\phi}$) as the *margin effect.*

The above analysis identifies a new channel through which the introduction of platform liability that raises the screening level impacts the amount of innovation. Specifically, the impact of a

$\tau_I^\star \in [0,1)$ for the innovators. However, in practice, fee discrimination by platforms is mostly based on broad product categories (e.g., books, computer items, on Amazon) and does not occur within product categories. For an analysis of the platform's incentive to discriminate across categories, see Tremblay (2021).

higher screening level on the amount of innovation can be decomposed as follows:

$$\frac{dn_I(\tau^\star(\phi),\phi)}{d\phi} = f((1-\tau^\star(\phi))\pi_I(\phi))\Big\{\underbrace{(1-\tau^\star(\phi))\pi_I'(\phi)}_{\text{IP-protection effect}} \quad \underbrace{-\frac{d\tau^\star(\phi)}{d\phi}}_{\text{margin effect}}\Big\}.$$

If a higher level of screening leads to a lower commission rate, the margin effect is positive. In this case, the overall effect of a higher screening level on the amount of innovation is positive and greater than in the baseline model. On the contrary, if a higher level of screening leads to a higher commission rate, the margin effect goes in the opposite direction of the IP-protection effect. In principle, any of the two effects could outweigh the other. However, in the baseline model, it turns out that the IP-protection effect always dominates the margin effect. Therefore, the overall effect on the amount of innovation is still positive although it is smaller than in the baseline model. The following proposition formalizes this finding.

**Proposition 4.** *Suppose that buyer participation is inelastic. A liability rule that induces a higher level of screening leads to a higher amount of innovation, regardless of whether it leads to a higher or lower commission rate.*

Let us now study how an increase in the screening intensity affects consumer surplus. Differentiating consumer surplus with respect to $\phi$ accounting for the endogenous nature of the commission rate yields:

$$\frac{dCS(\tau^\star(\phi),\phi)}{d\phi} = \frac{\partial CS(\tau^\star(\phi),\phi)}{\partial\phi} + \frac{\partial CS(\tau^\star(\phi),\phi)}{\partial\tau}\frac{d\tau^\star}{d\phi} \tag{12}$$

The first term in (12) is the effect on consumer surplus for a given commission rate (i.e. the effect studied in the previous Section 3). From (8), we have that $\frac{\partial CS(\tau^\star(\phi),\phi)}{\partial\phi} > 0 \iff \phi < \tilde{\phi}\,(\tau^\star(\phi))$. Let us assume that the function $\tilde{\phi}\,(\tau^\star(\phi))$ has a unique fixed point, which we denote $\hat{\phi}$, that lies in the interval $(0,1)$. Under this assumption, we have the following:

$$\phi < \tilde{\phi}\,(\tau^\star(\phi)) \iff \phi < \hat{\phi}.$$

The second term in (12) is the effect on consumer surplus of the induced change in the commission rate. Since $\frac{\partial CS(\tau^\star(\phi),\phi)}{\partial\tau} < 0$ (because $n_I(\tau,\phi)$ is decreasing in $\tau$), the sign of the second term is the opposite of the sign of $\frac{d\tau^\star}{d\phi}$. Thus, the second term is positive if the commission rate decreases in $\phi$, which is the case if $\varepsilon_F(k)$ is increasing. Conversely, the second term is negative if the commission rate increases in $\phi$, which is the case if $\varepsilon_F(k)$ is decreasing.

Using the above results, we can provide sufficient conditions under which there is (resp. is no) scope for a consumer-surplus-increasing platform liability. Specifically, there is scope for consumer-surplus-increasing platform liability if the following two conditions hold: $\phi^\star < \hat{\phi}$ and $\varepsilon_F(k)$ is weakly increasing (or, equivalently, $\frac{d\tau^\star}{d\phi} \leq 0$). On the other hand, there is no scope for consumer-surplus-increasing platform liability if the following two conditions hold: $\phi^\star > \hat{\phi}$ and $\varepsilon_F(k)$ is weakly decreasing (or, equivalently, $\frac{d\tau^\star}{d\phi} \geq 0$). In the remaining scenarios, the effect of a marginal increase in the level of screening above the privately optimal level can lead to either higher or lower consumer surplus. These results are summarized in the following proposition.

**Proposition 5.** *Suppose that buyer participation is inelastic and that the platform can change the commission rate after a liability rule is introduced.*

- *If $\phi^\star < \hat{\phi}$ and $\varepsilon_F(k)$ is weakly increasing, then a liability rule that induces a marginal increase in the level of screening above the privately optimal level has a positive effect on consumer surplus.*
- *If $\phi^\star > \hat{\phi}$ and $\varepsilon_F(k)$ is weakly decreasing, then a liability rule that induces a marginal increase in the level of screening above the privately optimal level has a negative effect on consumer surplus.*

# 5 Elastic buyer participation and network effects

In this section, we consider the scenario in which buyer participation is elastic whereas the commission rate is exogenously given. We consider two different types of cross-group network effects that generate elastic buyer participation. In the first case, network effects are *one-way* in the sense that they run from buyers to innovators but not from innovators to buyers. In the second case, network effects are *two-way* in the sense that they run from buyers to innovators and from innovators to buyers.[28]

In order to microfound these two cases, we define the (ex ante) utility of a buyer as follows

$$un_I - \gamma n_I - \xi, \tag{13}$$

with $\gamma$ representing a per-category opportunity cost, and $\xi$ a platform-related opportunity cost. We assume that $\gamma$ is distributed according to a cdf $G(.)$ and pdf $g(.)> 0$ over a support $[0, \overline{\gamma}]$, whereas $\xi$ is distributed according to a cdf $H(.)$ and pdf $h(.)> 0$ over a support $[0, \overline{\xi}]$. We assume in this section that the elasticities of $F(.)$, $G(.)$, and $H(.)$, respectively $\varepsilon_F \equiv \frac{f(k)}{F(k)}k$, $\varepsilon_G \equiv \frac{g(\gamma)}{G(\gamma)}\gamma$, and $\varepsilon_H \equiv \frac{h(\xi)}{H(\xi)}\xi$, are constant.[29]

[28]These are *membership* externalities, as discussed by Rochet and Tirole (2006): participation of end users on one side affects the participation of end users on the other side and vice versa. In our setting, the participation of buyers on the platform affects the decision of innovators to develop a new product and sell it via the platform. This is the participation externality from buyers to innovators. The participation externality from innovators to buyers arises when the number of innovators on the platform affects buyer decisions to join the platform.

[29]The assumptions that $\varepsilon_F$ and $\varepsilon_H$ are constant are made for expositional reasons while the assumption that $\varepsilon_G$ is constant is needed to derive the result in Proposition 8.

Expression (13) enables us to capture different scenarios of elastic buyer participation. If $\xi = 0$ and $\gamma > 0$, a consumer incurs an opportunity cost to join each product category but does not incur any platform-related opportunity cost. In this case, a buyer's decision whether to join the platform is driven by (the sign of) $u - \gamma$, which is independent of the number of categories on the platform. This setting is akin to that of Hagiu, Teh and Wright (2022) for which what matters for buyer decisions to join the platform is the utility obtained in a given product category. In this scenario, there are cross-group network effects from buyers to innovators but no participation externality from innovators to buyers.

If $\xi > 0$ and $\gamma = 0$, then buyers incur an opportunity cost of joining the platform only once, but they do not incur any per-category opportunity cost. In this case, the decision to join the platform for a buyer depends on the number of realized product categories. In this case, there are cross-group network effects from buyers to innovators and vice versa.

Recall that buyer taste for products is assumed to be drawn upon joining the platform. We also assume that buyer valuations and their opportunity costs are independent. The gross expected profit of an innovator is given by $\pi_I(\phi)n_B(\tau,\phi)$, where $n_B(\tau,\phi)$ denotes the number of buyers who join the platform (without deriving its expression for now). Therefore, in Stage 2, the number of innovators that develop an innovative product is

$$n_I(\tau,\phi) = F((1-\tau)\pi_I(\phi)n_B(\tau,\phi)).$$

Differently from the baseline model, for a given commission rate, the introduction of platform liability has now the following impact on the amount of innovation

$$\frac{\partial n_I(\tau,\phi)}{\partial \phi} = (1-\tau)f((1-\tau)\pi_I(\phi)n_B(\tau,\phi))\Big[\underbrace{\pi_I'(\phi)}_{\text{IP-protection effect}} n_B(\tau,\phi) + \pi_I(\phi)\underbrace{\frac{\partial n_B(\tau,\phi)}{\partial \phi}}_{\text{market size effect}}\Big]. \tag{14}$$

Two effects coexist. First, there is a positive *IP-protection effect* that is similar to the one identified in the baseline model. Second, there is a new indirect effect that is channeled by the change in buyer participation in the platform. This effect, which we refer to as the *market size effect*, can be either positive or negative depending on whether the number of buyers in the marketplace increases or decreases in response to a higher screening level. If the number of buyers increases, then both effects are positive and, therefore, platform liability has a positive effect on innovation. However, if the number of buyers decreases, then the two effects have opposite signs and the net effect depends on their relative magnitudes.

To understand further the role of networks effects in the impact of platform liability on innovation, we define $\varepsilon_{n_B}(\tau,\phi) \equiv \frac{\frac{\partial n_B(\tau,\phi)}{\partial \phi}}{n_B(\tau,\phi)}\phi$ as the elasticity of the number of buyers on the platform with respect to $\phi$. From (14), we find that the elasticity of the amount of innovation with respect to $\phi$ can be written as

$$\varepsilon_{n_I}(\tau, \phi) = \varepsilon_F[\varepsilon_{\pi_I}(\phi) + \varepsilon_{n_B}(\tau, \phi)]. \tag{15}$$

The elasticity $\varepsilon_{n_I}(\tau, \phi)$ can be interpreted as the impact (in relative terms) of a marginal increase in the level of screening on the amount of innovation.[30] Three observations can be made at this point. First, the (magnitude of the) impact on the amount of innovation of an increase in the screening level critically depends on $\varepsilon_F$.[31] The larger $\varepsilon_F$, the larger the magnitude of the impact on innovation of a liability rule that induces a higher screening level, regardless of the sign of that impact. Second, if buyer participation is elastic, the impact of such a liability rule on innovation is greater (resp., less) than its impact in the baseline model with inelastic buyer participation whenever it leads to an increase (resp., decrease) in buyer participation, i.e. if $\varepsilon_{n_B} > (<) 0$.[32] Third, the sign of the impact on innovation is determined by the sign of $\varepsilon_{\pi_I}(\phi) + \varepsilon_{n_B}(\tau, \phi)$. More specifically, we have the following result.

**Proposition 6.** *Suppose that buyer participation is elastic. For a given commission rate, a liability rule that induces a higher level of screening has a positive (resp., negative) effect on innovation if*

$$\varepsilon_{\pi_I}(\phi) > (<) \; -\varepsilon_{n_B}(\tau, \phi), \qquad \forall \phi \in [0, 1].$$

In the next subsections, we study how the introduction of liability affects buyer participation, innovation, and consumer surplus both when there are one-way network effects and there are two-way network effects.[33]

[30] We can write the impact (in relative terms) of a liability rule that induces an increase in the level of screening from $\phi^\star$ to $\phi^L$ as

$$\frac{n_I(\tau, \phi^L) - n_I(\tau, \phi^\star)}{n_I(\tau, \phi^\star)} = \exp\left(\int_{\phi^\star}^{\phi^L} \varepsilon_{n_I}(\tau, \phi)\frac{d\phi}{\phi}\right) - 1 = \exp\left(\varepsilon_F \int_{\phi^\star}^{\phi^L} [\varepsilon_{\pi_I}(\phi) + \varepsilon_{n_B}(\tau, \phi)]\frac{d\phi}{\phi}\right) - 1.$$

[31] Note that two interpretations are possible. The first one, which applies when considering the term $\varepsilon_F \varepsilon_{\pi_I}(\phi)$ in (15), is that $\varepsilon_F$ captures the elasticity of the amount of innovation with respect to per-category innovator profit. For a given per-category innovator profit $\pi_I$, the number of innovators is $n_I = F((1-\tau)\pi_I n_B(\phi))$. Hence, the elasticity of the number of innovators with respect to the innovator per-category profit is: $\frac{\pi_I \partial n_I}{n_I \partial \pi_I} = \frac{(1-\tau)\pi_I n_B f((1-\tau)\pi_I n_B(\phi))}{F((1-\tau)\pi_I n_B(\phi))} = \varepsilon_F$. The second one, which applies when considering the term $\varepsilon_F \varepsilon_{n_B}(\phi)$ in (15), is that $\varepsilon_F$ captures the intensity of the network effects from buyers to innovators. For a given number of buyers on the platform $n_B$, the number of innovators is $n_I = F((1-\tau)\pi_I(\phi) n_B)$. Hence, the elasticity of the number of innovators with respect to the number of buyers –which we can interpret as a measure of the network effects from buyers to innovators– is: $\frac{n_B \partial n_I}{n_I \partial n_B} = \frac{(1-\tau)\pi_I(\phi) n_B f((1-\tau)\pi_I(\phi) n_B)}{F((1-\tau)\pi_I(\phi) n_B)} = \varepsilon_F$.

[32] This follows immediately from (15) and the fact that the baseline model corresponds to the special case in which $\varepsilon_{n_B} = 0$.

[33] The general case where both opportunity costs are present is essentially a convex combination of the two scenarios in which one of the opportunity costs is zero.

## 5.1 One-way network effects

Let us first consider the scenario in which each buyer only incurs a per-category opportunity cost, i.e., $\gamma > 0$ and $\xi = 0$. In this case, we have one-way network effects (from buyers to innovators) because the decision of buyers to join the platform does not depend on the number of product categories (whereas the latter depends on the number of buyers). All buyers have the same expected utility per product category gross of the opportunity cost, and this is given by $u(\phi)$, as previously defined.[34] This implies that the number of buyers on the platform is given by $n_B(\phi) = G(u(\phi))$. We assume that $\overline{\gamma} > u^d$, which ensures that $\overline{\gamma} > u(\phi)$ for any $\phi$ and, therefore, $n_B(\phi) < 1$ for any $\phi$.[35] The impact of a marginal increase in the screening level on the number of buyers on the platform is given by

$$n'_B(\phi) = u'(\phi)g(u(\phi)) < 0, \tag{16}$$

which means that the *market size effect* is always negative in this case. This result is stated in the following lemma.

**Lemma 2.** *Suppose that buyer participation is elastic such that each buyer incurs only a per-category opportunity cost. A liability rule that induces a higher level of screening always has a negative effect on buyer participation in the marketplace.*

Together with Proposition 6, the above lemma implies that the effect on innovation can be either positive or negative. Because $\varepsilon_{n_B}(\phi) = \varepsilon_G \varepsilon_u(\phi)$, we get the next result which follows from Proposition 6.

**Proposition 7.** *Suppose that buyer participation is elastic such that each buyer incurs only a per-category opportunity cost. A liability rule that induces a higher level of screening has a positive (resp., negative) effect on innovation if*

$$\varepsilon_{\pi_I}(\phi) > (<) \ -\varepsilon_G \varepsilon_u(\phi), \qquad \forall \phi \in [0,1].$$

This proposition shows that there are indeed conditions under which the *market size effect* dominates the *IP-protection effect*. In that case, platform liability leads to less innovation and harms the innovators that it is meant to protect. Such a scenario occurs if the elasticity of the number of buyers with respect to per-category buyer surplus $\varepsilon_G$ is relatively large because in

[34] The decision of a buyer to join a product category of the platform only depends on the comparison between the gross expected utility per category $u(\phi)$ and the opportunity cost $\gamma$, which can be interpreted as the cost of discovering the number and the characteristics (including prices) of the products in the category by conducting a search.

[35] The baseline model can be obtained by assuming that $\overline{\gamma} < u^m$, which ensures that $\overline{\gamma} < u(\phi)$ for any $\phi$ and, therefore, $n_B(\phi) = 1$ for any $\phi$.

this case platform liability leads to a substantial decrease in buyer participation. However, if $\varepsilon_G$ is relatively small, the net effect of platform liability on innovation remains positive as in the baseline model.

We now investigate the effect of platform liability on consumer surplus. The latter is given by

$$CS(\tau, \phi) = n_I(\tau, \phi) \int_0^{u(\phi)} (u(\phi) - \gamma) g(\gamma) d\gamma.$$

Differentiating this with respect to $\phi$, we find that an increase in the level of screening has a positive (resp., negative) impact on consumer surplus if

$$\frac{\frac{\partial n_I(\tau,\phi)}{\partial \phi}}{n_I(\tau, \phi)} > (<) - \frac{u'(\phi)}{u(\phi) - \gamma^e(\phi)}, \tag{17}$$

where $\gamma^e(\phi) \equiv \frac{\int_0^{u(\phi)} \gamma g(\gamma) d\gamma}{G(u(\phi))}$ is the average per-category opportunity cost of the buyers on the platform. Therefore, an increase in the level of screening has a positive (resp., negative) effect on consumer surplus if

$$\varepsilon_{n_I}(\phi) > (<) - \varepsilon_u(\phi) \frac{u(\phi)}{u(\phi) - \gamma^e(\phi)}.$$

Straightforward computations show that $\gamma^e(\phi) = \frac{\varepsilon_G}{1+\varepsilon_G} u(\phi)$,[36] which implies that the above inequality can be rewritten as

$$\varepsilon_{n_I}(\phi) > (<) - \varepsilon_u(\phi)(\varepsilon_G + 1).$$

Using the fact that $\varepsilon_{n_I}(\phi) = \varepsilon_F[\varepsilon_{\pi_I}(\phi) + \varepsilon_{n_B}(\phi)] = \varepsilon_F[\varepsilon_{\pi_I}(\phi) + \varepsilon_G \varepsilon_u(\phi)]$, we get the following result.

**Proposition 8.** *Suppose that buyer participation is elastic such that each buyer incurs only a per-category opportunity cost. A liability rule that induces a higher level of screening has a positive (resp., negative) effect on consumer surplus if*

$$\varepsilon_F[\varepsilon_{\pi_I}(\phi) + \varepsilon_G \varepsilon_u(\phi)] > (<) - (\varepsilon_G + 1)\varepsilon_u(\phi), \qquad \forall \phi \in [0, 1].$$

A key implication of the above proposition is that an increase in $\varepsilon_G$, and therefore in the elasticity of buyer participation, makes it less likely that platform liability benefits consumers.[37] To derive further insights, it is useful to examine graphically (in Figure 2) the impact of a

[36] The assumption that $\varepsilon_G$ is constant implies that $G(\gamma) = M\gamma^{\varepsilon_G}$ where $M = 1/(\overline{\gamma})^{\varepsilon_G}$ to ensure that $G(\overline{\gamma}) = 1$. This implies that $g(\gamma) = M\varepsilon_G \gamma^{\varepsilon_G - 1}$, and leads to $\frac{\int_0^{u(\phi)} \gamma g(\gamma) d\gamma}{G(u(\phi))} = \frac{\varepsilon_G}{\varepsilon_G + 1} u(\phi)$.

[37] To see why, recall that $\varepsilon_u(\phi)$ is negative. Furthermore, note that the baseline model with inelastic buyer participation corresponds to the special case $\varepsilon_G = 0$.

marginal increase in the screening level above a given $\phi$. We need to distinguish between two scenarios. If $\varepsilon_{\pi_I}(\phi) < -\varepsilon_G \varepsilon_u(\phi)$, a marginal increase in screening leads to a decrease in innovation (by Proposition 7) and a decrease in consumer surplus (because the R.H.S. in Proposition 8 is positive). However, if $\varepsilon_{\pi_I}(\phi) > -\varepsilon_G \varepsilon_u(\phi)$, a marginal increase in screening leads to an increase in innovation, and can either benefit or harm consumers depending on the magnitude of $\varepsilon_F$. If the latter is sufficiently large (resp., small), then platform liability leads to an increase (resp., decrease) in consumer surplus.

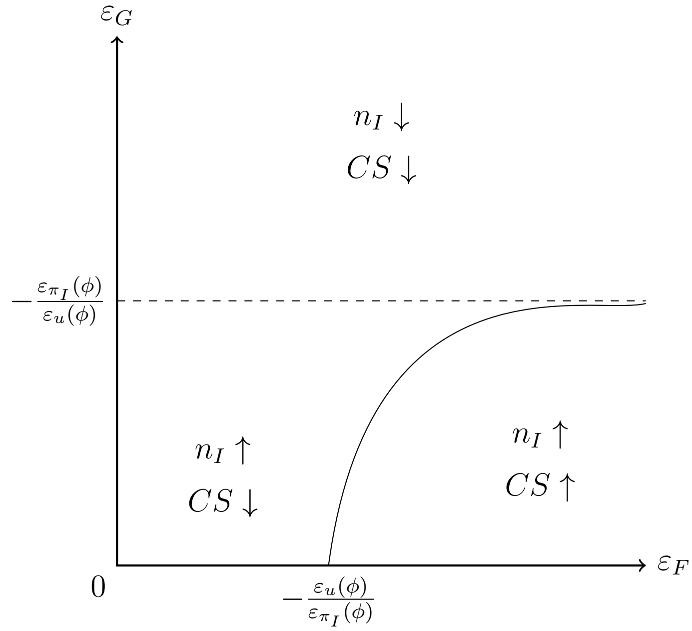


Figure 2: Impact of a marginal increase in the screening level above a given $\phi$ on innovation and consumer surplus (one-way network effects)

## 5.2 Two-way network effects

We now consider the scenario in which each buyer incurs a platform-related opportunity cost but no per-category opportunity costs ($\gamma = 0$ and $\xi > 0$).[38] This implies that buyers decide to join the platform taking into account the number of product categories present in the marketplace. As there are two-way network effects, determining the equilibrium number of buyers on the platform requires solving for a fixed point. The number of innovators and of buyers are, respectively, given by

$$n_I(\tau, \phi) = F((1-\tau)\pi_I(\phi) n_B(\tau, \phi)); \qquad n_B(\tau, \phi) = H(u(\phi) n_I(\tau, \phi)).$$

Hence,

$$n_I(\tau, \phi) = F((1-\tau)\pi_I(\phi) H(u(\phi) n_I(\tau, \phi))); \qquad n_B(\tau, \phi) = H(u(\phi) F((1-\tau)\pi_I(\phi) n_B(\tau, \phi))).$$

[38]We assume $\overline{\xi}$ to be sufficiently large for the inequality $n_B(\tau, \phi) < 1$ to hold for any $\phi$.

A sufficient condition for the existence and uniqueness of an interior and stable equilibrium is that the slopes of the functions $n_I \to F((1-\tau)\pi_I(\phi)H(u(\phi)n_I))$ and $n_B \to H(u(\phi)F((1-\tau)\pi_I(\phi)n_B))$ are less than 1. Simple algebraic manipulations show that this is satisfied if

$$\varepsilon_H \ \varepsilon_F < 1. \tag{18}$$

which we assume in this subsection. This condition means that the intensity of total network effects is not too large. Indeed, $\varepsilon_H$ is the elasticity of the number of buyers with respect to the number of innovators, which can be interpreted as a measure of the network effects from innovators to buyers.[39]

From $n_B(\tau,\phi) = H(u(\phi)F((1-\tau)\pi_I(\phi)n_B(\tau,\phi)))$ and $n_I(\tau,\phi) = F((1-\tau)\pi_I(\phi)H(u(\phi)n_I(\tau,\phi)))$, it follows that

$$\varepsilon_{n_B}(\tau,\phi) = \varepsilon_H[\varepsilon_{n_I}(\tau,\phi) + \varepsilon_u(\phi)], \qquad \varepsilon_{n_I}(\tau,\phi) = \varepsilon_F[\varepsilon_{\pi_I}(\phi) + \varepsilon_{n_B}(\tau,\phi)].$$

Solving for $\varepsilon_{n_B}(\tau,\phi)$ and $\varepsilon_{n_I}(\tau,\phi)$, we obtain

$$\varepsilon_{n_B}(\tau,\phi) = \frac{\varepsilon_H[\varepsilon_F\varepsilon_{\pi_I}(\phi) + \varepsilon_u(\phi)]}{1-\varepsilon_H\varepsilon_F}, \qquad \varepsilon_{n_I}(\tau,\phi) = \frac{\varepsilon_F[\varepsilon_{\pi_I}(\phi) + \varepsilon_H\varepsilon_u(\phi)]}{1-\varepsilon_H\varepsilon_F}. \tag{19}$$

The above conditions show how the effects (in relative terms) of a marginal increase in the level of screening on buyer participation and the amount of innovation depend on the magnitude of the cross-group network effects. Two-way network effects have an amplifying effect captured by the multiplier $\frac{1}{1-\varepsilon_H\varepsilon_F}$, which is larger than 1 and increases with the intensity of total network effects $\varepsilon_H\varepsilon_F$. Using (19), the next lemma provides a sufficient condition for platform liability to have a positive (resp., negative) effect on buyer participation.

**Lemma 3.** *Suppose that buyer participation is elastic such that each buyer incurs a platform-related opportunity cost. A liability rule that induces a higher level of screening has a positive (resp., negative) effect on buyer participation in the marketplace if*

$$\varepsilon_F \ \varepsilon_{\pi_I}(\phi) > (<) \ -\varepsilon_u(\phi), \qquad \forall\phi \in [0,1].$$

Interestingly and contrary to our previous results, platform liability can now lead to an increase in buyer participation, i.e. the *market size effect* can be positive. This occurs if $\varepsilon_F$ is relatively large. In this case, the increase in the number of product categories induced by an increase in the level of screening is relatively large and buyers benefit more from such an increase in the number of product categories than they are harmed by the decrease in the surplus they

[39] However, note that, similar to $\varepsilon_F$, the parameter $\varepsilon_H$ has an alternative interpretation: it is the elasticity of the number of buyers with respect to per-product buyer surplus.

derive in each product category. On the contrary, if $\varepsilon_F$ is relatively small, buyer participation is negatively affected by platform liability.

Using again the condition in (19) and Proposition 6, we also get the following result regarding the amount of innovation.

**Proposition 9.** *Suppose that buyer participation is elastic such that each buyer incurs a platform-related opportunity cost. A liability rule that induces a higher level of screening has a positive (resp., negative) effect on the amount of innovation if*

$$\varepsilon_{\pi_I}(\phi) > (<) \; -\varepsilon_H \; \varepsilon_u(\phi), \qquad \forall \phi \in [0,1].$$

Note that the sufficient condition for platform liability to increase innovation provided in Proposition 9 always holds if the sufficient condition for platform liability to increase buyer participation provided in Lemma 3 holds (see the proof of Proposition 9). In other words, if $\varepsilon_F$ is relatively large (i.e., $\varepsilon_F > -\frac{\varepsilon_u(\phi)}{\varepsilon_{\pi_I}(\phi)}$), then platform liability leads to an increase in both buyer participation and the amount of innovation. However, if $\varepsilon_F$ is relatively small (i.e., $\varepsilon_F < -\frac{\varepsilon_u(\phi)}{\varepsilon_{\pi_I}(\phi)}$), then platform liability lowers buyer participation and the sign of its impact on innovation depends on the magnitude of $\varepsilon_H$. If the latter is relatively small (i.e., $\varepsilon_H < -\frac{\varepsilon_{\pi_I}(\phi)}{\varepsilon_u(\phi)}$), then platform liability leads to an increase in the amount of innovation. However, if it is relatively large (i.e., $\varepsilon_H > -\frac{\varepsilon_{\pi_I}(\phi)}{\varepsilon_u(\phi)}$), then platform liability leads to a decrease in the amount of innovation.

We now investigate the effect of platform liability on consumer surplus. The latter is given by

$$CS(\tau,\phi) = \int_0^{n_I(\tau,\phi))u(\phi)} (n_I(\tau,\phi)u(\phi) - \xi)h(\xi)d\xi.$$

The derivative of $CS(\tau,\phi)$ with respect to $\phi$ is

$$\frac{\partial CS(\tau,\phi)}{\partial \phi} = H(n_I(\tau,\phi)u(\phi)) \left( u(\phi)\frac{\partial n_I(\tau,\phi)}{\partial \phi} + n_I(\tau,\phi)u'(\phi) \right),$$

and has the same sign as $u(\phi)\frac{\partial n_I(\tau,\phi)}{\partial \phi} + n_I(\tau,\phi)u'(\phi)$. The following proposition states that when there are two-way network effects, the effect of platform liability on consumer surplus has the same sign as the effect of platform liability on buyer participation.

**Proposition 10.** *Suppose that buyer participation is elastic such that each buyer incurs a platform-related opportunity cost. A liability rule that induces a higher level of screening leads to a positive (resp., negative) effect on consumer surplus if it leads to an increase (resp., decrease) in buyer participation, which is the case if*

$$\varepsilon_F \ \varepsilon_{\pi_I}(\phi) > (<) \ -\varepsilon_u(\phi), \qquad \forall \phi \in [0,1].$$

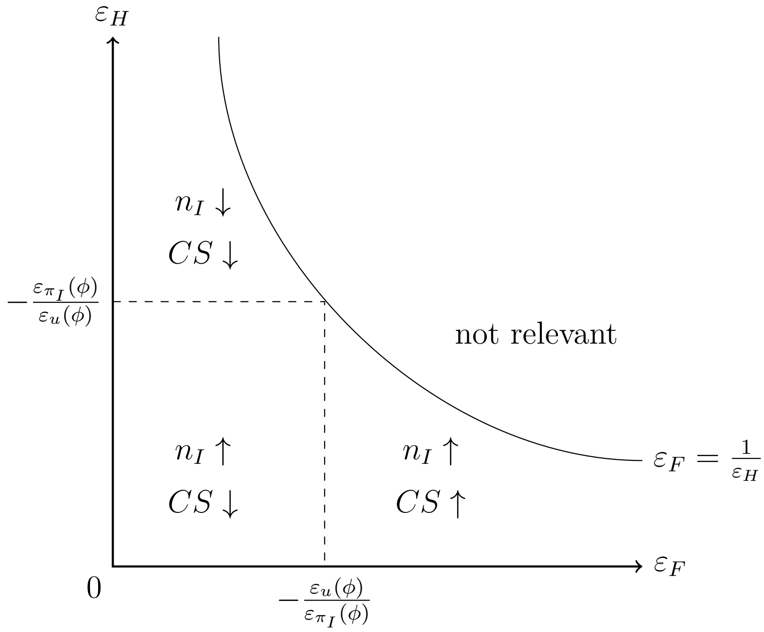


Figure 3: Impact of a marginal increase in the screening level above a given $\phi$ on innovation and consumer surplus (two-way network effects)

Figure 3 presents graphically the effect of a marginal increase in the screening level above a given $\phi$ on innovation and consumer surplus in the case of two-way network effects. If $\varepsilon_F$ is larger than the threshold $-\frac{\varepsilon_u(\phi)}{\varepsilon_{\pi_I}(\phi)}$, then from the stability assumption $\varepsilon_F \varepsilon_H < 1$, $\varepsilon_H$ is smaller than the other threshold $-\frac{\varepsilon_u(\phi)}{\varepsilon_{\pi_I}(\phi)}$. Therefore, a marginal increase in the screening level raises both the amount of innovation and consumer surplus. If $\varepsilon_F$ is smaller than the threshold $-\frac{\varepsilon_u(\phi)}{\varepsilon_{\pi_I}(\phi)}$, a marginal increase in the screening level always reduces consumer surplus and it increases the amount of innovation only if $\varepsilon_H$ is smaller than $-\frac{\varepsilon_u(\phi)}{\varepsilon_{\pi_I}(\phi)}$.

Let us now compare the case of one-way network effects with the case of two-way network effects. Figures 1 and 2 reveal that the conditions for platform liability to increase innovation or consumer surplus are remarkably similar even if the two cases exhibit very different network effects. First, the condition for platform liability to increase (or reduce) the amount of innovation is exactly the same across both cases as long as we apply the relevant elasticity on the buyer side, i.e., $\varepsilon_G$ or $\varepsilon_H$. Second, the condition for the platform liability to increase consumer surplus is similar and requires $\varepsilon_F$ to be large and $\varepsilon_G$ (or $\varepsilon_H$) to be small. One notable difference arises in terms of buyer participation. The effect of platform liability on buyer participation is always negative in the case of one-way network effects whereas in the case of two-way network effects, the effect can be either positive or negative depending on the value of $\varepsilon_F$. Another difference is the existence of a multiplier effect in the case of two-way network effects. Even when the sign of the effect on innovation or buyer participation is the same, the magnitude of the effect is larger in the case of two-way network effects than in the case of one-way network effects because the former involves the multiplier effect $\frac{1}{1-\varepsilon_H\varepsilon_F}$.

Finally, the analysis carried out in this section also identifies a sufficient condition for platform liability to be socially undesirable. To see why, suppose platform liability reduces innovation. Then, it obviously harms innovators. It also harms buyers because of a reduction in the number of product categories and a lower surplus per category. The surplus of legitimate imitators decreases too because of the demand contraction and a reduction in the number of product categories. The surplus of IP infringers decreases as well because of the higher probability of being identified and delisted, the reduced buyer participation and the reduction in the number of product categories. Finally, the platform is harmed because of the binding screening requirements to benefit from liability exemption. This highlights the relevance of cross-group network effects in affecting the social desirability of platform liability. This discussion is summarized in the following proposition that applies to the two scenarios with elastic buyer participation.

**Proposition 11.** *Suppose buyer participation is elastic. If platform liability leads to a reduction of innovation, it harms all parties: innovators, imitators, consumers, and the platform.*

# 6 Extensions

In this section, we first endogenize imitators' decisions to infringe IP or not. Second, we generalize our analysis to the case in which there is an infinite number of periods and delisting of an imitator triggers a subsequent entry of another imitator. Third, we study the incentives of the platform to delist IP-infringing products when some well-reputed brand owners only sell via their direct channel. Fourth, we study the effect of platform liability on the platform's choice of a fixed membership fee. Additional extensions are relegated to the Online Appendix.

## 6.1 Endogenous infringement

In this subsection, we consider a variant of the baseline model in which we relax the assumption that IP infringement is exogenous. We continue to assume that in each product category there is room for exactly one imitator. If the imitator is legitimate, it obtains $\pi_C^d - \rho$, where $\rho$ represents the cost of being legitimate and is distributed according to cdf $L(\cdot)$ and pdf $l(\cdot) > 0$. If the imitator infringes IP, it obtains $\pi_C^d$ conditional on not being delisted by the platform.

Thus, an imitator prefers to infringe IP if and only if

$$(1-\phi)\pi_C^d \geq \pi_C^d - \rho, \tag{20}$$

which can be rewritten as

$$\rho \geq \pi_C^d \phi.$$

Hence, the probability that a legitimate imitator is present in a given product category is $\nu(\phi) = L(\pi_C^d \phi)$, which increases with $\phi$, and the probability that an IP-infringing product is present in a given product category is $1 - \nu(\phi)$.

Endogenous infringement adds a new effect when the introduction of platform liability leads to a higher level of screening: it changes the *composition* of imitators by increasing the share of legitimate imitators. As a result, it is possible that the introduction of platform liability increases the probability that innovators face a competitor, which occurs if the composition effect dominates the direct effect of raising the level of screening. In this case, platform liability leads to a reduction (instead of an increase) in the amount of innovation.

More precisely, the expected gross profit of an innovator before paying the commission rate is

$$\pi_I(\phi) = \pi_I^m \Big(1 - \nu(\phi)\Big)\phi + \pi_I^d \Big(1 - (1 - \nu(\phi))\phi\Big).$$

For a given commission rate $\tau$, a higher screening level has the following effect on an innovator's profit

$$\pi_I'(\phi) = (\pi_I^m - \pi_I^d)\Big(1 - \nu(\phi) - \phi\nu'(\phi)\Big),$$

where $1 - \nu(\phi) - \phi\nu'(\phi)$ represents the change in the probability for an innovator to be a monopolist. If this term is negative, then the introduction of a liability rule that induces a higher screening level has a negative effect on an innovator's expected gross profit and, therefore, reduces the amount of innovation.[40]

## 6.2 Infinite rounds of screening

One of the assumptions in our analysis is that once an IP infringer is identified and delisted, the product category remains monopolistic and no further entry occurs. In this subsection, we allow for subsequent entry after delisting in a setting with an infinite number of periods, $t = 1, 2, ...$

Let $y(\phi) \equiv (1 - \upsilon)\phi$ denote the probability that an IP infringer is identified and delisted. Also,

[40] Recall that amount of innovation is $F((1-\tau)\pi_I(\phi))$, which implies that the effect of a higher screening level on the amount of innovation has the same sign as its effect on an innovator's expected gross profit.

let $s_t$ denote the market structure of a given product category at time $t$ with $s_t \in \{m, d\}$ and $t = 1, 2, ....$ We assume that if at $t = 1$ the entrant is identified as an IP infringer and hence delisted (i.e., $s_1 = m$), which occurs with probability $y(\phi)$, then another imitator enters at $t = 2$. By contrast, if at $t = 1$ no IP infringement is identified and hence $s_1 = d$, which occurs with probability $1 - y(\phi)$, the market structure remains duopolistic forever after. More generally, $s_t = d$ implies $s_{t+1} = d$, whereas $s_t = m$ triggers entry at $t + 1$ and, therefore, implies that $s_{t+1} = m$ with probability $y(\phi)$ and $s_{t+1} = d$ with probability $1 - y(\phi)$. Thus, the unconditional probability that $s_t = m$ is $(y(\phi))^t$.

Let $\delta \in (0, 1)$ be the discount factor (which we assume to be common to all economic agents) and let $\nu^m(\phi)$ denote the "aggregate" probability that a given category is monopolistic. In order to obtain $\nu^m(\phi)$, we sum up the probabilities that $s_t = m$ after discounting them (i.e., $(y(\phi))^1 + \delta(y(\phi))^2 + \delta^2(y(\phi))^3 + ...$) and normalize the sum by multiplying it with $1 - \delta$, which leads to $\nu^m(\phi) \equiv \frac{(1-\delta)(1-\nu)\phi}{1-\delta(1-\nu)\phi}$. Note that $\nu^m(\phi)$ increases in $\phi$. The expected profit of an innovator is

$$\pi_I(\phi) = \nu^m(\phi)\pi_I^m + (1 - \nu^m(\phi))\pi_I^d, \tag{21}$$

which increases in $\phi$, as in the baseline model. The expected profit of a whole sequence of imitators in a given category is

$$\pi_C(\phi) = (1 - \nu^m(\phi))\pi_C^d,$$

which decreases in $\phi$. The expected surplus of a buyer in a given product category is now

$$u(\phi) = \nu^m(\phi)u^m + (1 - \nu^m(\phi))u^d$$

which decreases in $\phi$ as in the baseline model. The expression for the profit of the platform remains the same as it is expressed in terms of $\pi_I(\phi)$ and $\pi_C(\phi)$. In the Appendix, we show that the results from Section 3 to Section 4 carry over.

## 6.3 Some brands do not join the marketplace

In this extension, we relax the assumption that all brand owners that develop an innovative product join the marketplace of the platform. Some brands are reluctant to join marketplace platforms because of the fear of commoditization (Hagiu and Wright, 2023). To this end, we assume that there are two types of brand owners: a portion $\lambda \in (0, 1)$ of brand owners are as in the baseline model: they only sell via the marketplace of the platform upon the development of their innovative product (as in the baseline model) and obtain $(1 - \tau)\pi_I(\phi)$ as their expected profit. The remaining share of brand owners, $1 - \lambda$, are well-known brand owners that only sells via their direct channel. These brand owners can be, for example, high-end and luxury brands (e.g., Louboutin) or brands with solid corporate reputation (e.g., Nike or Birkenstock). Because of their reputation, these brands enjoy a captive base of consumers.

We assume that the second type of brand owners, which we identify (with some abuse of natiation) with $D$ of "direct channel", are heterogeneous with respect to the cost of developing their new product (e.g., Nike's new shoes), which is distributed according to a cdf $G(\cdot)$ and a pdf $g(\cdot) > 0$. After a brand owner develops and introduces a new product, imitators can produce their own version of the product and sell it (only) via the marketplace of the platform even if the original brand owner is not present. For example, while Louboutin has never sold via Amazon.com, its copycat products were largely available on the marketplace (see the well-known *Louboutin vs Amazon* trial). However, these imitations can only partially crowd out sales of major brand owners. Formally, we assume that brand owners selling through their direct channel generate stream of revenues from two different sources: an amount $\sigma > 0$, which represents the revenues made from loyal consumers that only consider the branded product and never search for an alternative copycat, and an amount $\pi_D(\phi) \equiv (1-\nu)\phi\pi_D^m + (1-(1-\nu)\phi)\pi_D^d$ which represents the expected revenues made from the mass 1 of consumers that also consider buying the imitation on the marketplace, where $\pi_D^m$ is the profit obtained if the brand owner does not face competition from an imitation on the platform and $\pi_D^d$ is the profit obtained otherwise.[41] Moreover, we denote as $\pi_{DC}(\phi) \equiv (1-(1-\nu)\phi)\pi_{DC}^d$ the expected profit of an imitation, where $\pi_{DC}^d$ is the profit of the imitator obtained conditional on not being delisted by the platform.

Note that for our purpose what is relevant is that the expected profit of these brand owners is both increasing in $\sigma$ and $\phi$ and that the expected profit of an imitator is decreasing in $\phi$. A higher $\sigma$ implies that the brand owners have a larger captive base of consumers that do not rely on the marketplace for their purchasing decision. It captures the strength of the brand's reputation. A higher screening level by the platform implies that these brand owners benefit from the IP-protection effect featured in the baseline model, whereas the imitators are more likely to be delisted by the platform.

The number of brand owners that develop and sell their product via their direct channel is $n_D(\sigma, \phi) = G(\sigma + \pi_D(\phi))$ and the profit of the platform is now given by:

$$\Pi(\sigma, \tau, \phi) = \tau\Big\{\lambda F((1-\tau)\pi_I(\phi))\Big[\pi_I(\phi) + \pi_C(\phi)\Big] + (1-\lambda)G(\sigma + \pi_D(\phi))\pi_{DC}(\phi)\Big\} - \Omega(\phi),$$

which we assume to be quasi-concave in $\phi$. The first-order condition of the platform's expected

[41] Note that an underlying assumption is that consumers that would also consider buying an imitation face no search cost and are always able to compare products on both the marketplace (where the imitation can be available) and the direct channel of brand.

profit with respect to $\phi$ is

$$\begin{aligned}\frac{\partial\Pi(\sigma,\tau,\phi)}{\partial\phi} =&\tau\lambda\Big\{\frac{\partial n_I(\tau,\phi)}{\partial\phi}\Big[\pi_I(\phi)+\pi_C(\phi)\Big]+F((1-\tau)\pi_I(\phi))\Big[\pi_I'(\phi)+\pi_C'(\phi)\Big]\Big\}\\ &\tau(1-\lambda)\Big\{\frac{\partial n_D(\sigma,\phi)}{\partial\phi}\pi_{DC}(\phi)+G(\sigma+\pi_D(\phi))\pi_{DC}'(\phi)\Big\}-\Omega'(\phi)=0.\end{aligned} \tag{22}$$

We are interested in how brand reputation shapes the platform's incentive to screen, conditional on the optimal level of screening being an interior solution. Denoting the solution to (22) as $\phi^{\star\star}$ and totally differentiating (22) with respect to $\sigma$, we observe that

$$\frac{d\phi^{\star\star}(\sigma)}{d\sigma}=-\frac{\frac{\partial^2\Pi(\sigma,\tau,\phi^{\star\star}(\sigma))}{\partial\sigma\partial\phi}}{\frac{\partial^2\Pi(\sigma,\tau,\phi^{\star\star}(\sigma))}{\partial\phi^2}}$$

Since $\frac{\partial^2\Pi(\sigma,\tau,\phi^{\star\star}(\sigma))}{\partial\phi^2}<0$ by the second-order condition, the sign of $\frac{d\phi^{\star\star}(\sigma)}{d\sigma}$ is the same as the sign of $\frac{\partial^2\Pi(\sigma,\tau,\phi^{\star\star}(\sigma))}{\partial\sigma\partial\phi}$. Note that

$$\frac{\partial^2\Pi(\sigma,\tau,\phi)}{\partial\sigma\partial\phi}=\tau(1-\lambda)\Big\{\pi_{DC}(\phi)g'(\sigma+\pi_D(\phi))+g(\sigma+\pi_D(\phi))\pi_{DC}'(\phi)\Big\}$$

which is negative if

$$\frac{\pi_{DC}'(\phi)}{\pi_{DC}(\phi)}<-\frac{g'(\sigma+\pi_D(\phi))}{g(\sigma+\pi_D(\phi))}. \tag{23}$$

Because $\pi_{DC}'(\phi)<0$, a sufficient condition for $\frac{d\phi^{\star\star}(\sigma)}{d\sigma}<0$ is that $G(\cdot)$ is weakly concave. Note that in the case of a uniform distribution, (23) is always satisfied. Thus, in this special case, $\frac{d\phi^{\star\star}(\sigma)}{d\sigma}<0$.

The above analysis suggests that, under mild conditions on the shape of the distribution of the brand owners' cost of innovation, the greater the extent to which brand owners exclusively distribute their products through their own direct channels because of their corporate brand reputation (i.e., $\sigma$), the weaker the platform's incentives to delist IP-infringing copies from the marketplace. This result underscores the concerns of Louboutin who initiated legal action against Amazon.com for not stopping third-party sellers regularly advertising knock-offs of the iconic Louboutin's red-soled stilettos. It is important to notice that, in this simplified analysis, we considered as exogenous the decision of brand owners to join the marketplace or to use their direct channel. We relegate to future research a fully-fledged analysis of the effects of platform liability when brand owners can decide, upon development of a product, to join the marketplace and or to sell via their direct channel.

## 6.4 Fixed membership fee

Platforms can adopt alternative pricing schemes to capture value from their ecosystem. They can charge, for instance, fixed membership fees instead of (or in addition to) ad valorem commissions. In this extension, we show that our finding that the effect of platform liability on the commission rate may be either positive or negative carries over to the scenario in which the platform charges sellers a fixed membership fee rather than a commission.

Let us denote $m$ the membership fee charged by the platform. In order to determine the platform's profit, we need to distinguish four cases:

(i) If $m > \pi_I^m$, then the number of product categories is zero and, therefore, the platform's profit gross of screening cost is zero too.

(ii) If $\pi_C^d < m \leq \pi_I^m$, then imitators do not join the platform (regardless of their nature) and all innovators whose innovation costs are lower than $\pi_I^m - m$ join the platform, which implies that the number of product categories is $F(\pi_I^m - m)$ and the platform's expected profit gross of screening cost is $mF(\pi_I^m - m)$.

(iii) If $(1-\phi)\,\pi_C^d < m \leq \pi_C^d$, then legitimate imitators are willing to pay the membership fee whereas IP-infringing imitators are not. Therefore, innovators whose innovation costs are lower than $\nu\pi_I^d + (1-\nu)\pi_I^m - m$ join the platform, which implies that the number of product categories is $F(\nu\pi_I^d + (1-\nu)\pi_I^m - m)$ and that the platform's expected profit per category is $m(1+\nu)$. Thus, the platform's expected profit gross of screening cost is $m(1+\nu)F(\nu\pi_I^d + (1-\nu)\pi_I^m - m)$.

(iv) If $m \leq (1-\phi)\,\pi_C^d$, then both types of imitators are willing to pay the membership fee but a fraction $\phi$ of IP-infringing imitators is screened out. Therefore, innovators whose innovation costs are lower than $\pi_I(\phi) - m$ join the platform. This implies that the number of product categories is $F(\pi_I(\phi) - m)$ and the platform's expected profit per category is $m[2-\phi(1-\nu)]$. Hence, the platform's expected profit gross of screening cost is $m[2-\phi(1-\nu)]F(\pi_I(\phi) - m)$.

Thus, the platform's expected profit net of screening cost is given by

$$\Pi(m,\phi) = \begin{cases} m[2-\phi(1-\nu)]F(\pi_I(\phi)-m) - C(\phi) & \text{if} \quad m \leq (1-\phi)\,\pi_C^d \\ m(1+\nu)F(\nu\pi_I^d + (1-\nu)\pi_I^m - m) - C(\phi) & \text{if} \quad (1-\phi)\,\pi_C^d < m \leq \pi_C^d \\ mF(\pi_I^m - m) - C(\phi) & \text{if} \quad \pi_C^d < m \leq \pi_I^m \\ -C(\phi) & \text{if} \quad m > \pi_I^m. \end{cases}$$

Assume that $mF(\pi_I(\phi) - m)$ is quasi-concave in $m$ and denote

$$\tilde{m}(\phi) \equiv \arg\max_m \; m[2-\phi(1-\nu)]F(\pi_I(\phi)-m) - C(\phi),$$

and

$$m^{\star}(\phi) \equiv \arg\max_{m} \Pi(m, \phi).$$

If the maximum of $\Pi(m, \phi)$ is reached over the interval $\left[0, (1-\phi)\,\pi_C^d\right]$, i.e. $m^{\star}(\phi) \in \left[0, (1-\phi)\,\pi_C^d\right]$, then $m^{\star}(\phi) \in \left\{\tilde{m}(\phi), (1-\phi)\,\pi_C^d\right\}$; otherwise, $m^{\star}(\phi)$ does not depend on $\phi$. This implies that a marginal increase in $\phi$ can either lead to an increase in $m^{\star}(\phi)$, lead to a decrease in $m^{\star}(\phi)$, or have no effect on $\phi$. To see why, note that $(1-\phi)\,\pi_C^d$ decreases with $\phi$ and $\tilde{m}(\phi)$ can either increase or decrease in $\phi$ depending on the shape of $F(\cdot)$.

The analysis above shows that the impact of a higher level of screening on the membership fee can be either positive or negative.

# 7 Concluding remarks and policy 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.

From a policy standpoint, we contribute to the discussion on whether platforms should be held liable for third parties' misconduct. Our paper shows that policymakers should pay close attention to the impact of platform liability on key strategic variables of platforms as the unintended effects of platform liability substantially affect its desirability. More specifically, our analysis generates the following policy implications. First, policymakers should be aware that even when platform liability fulfills the goal of protecting IP and stimulating innovation, there might be a negative effect on consumers. Second, policymakers should account for the elasticity of participation of both innovators and buyers, which depends in particular on the strength of cross-group network effects. Platform liability is likely to increase both the amount of innovation and consumer surplus when the elasticity of participation of innovators is high and that of buyers is low. However, if the elasticity of participation of innovators is low then platform liability is likely to reduce consumer surplus and may even lead to a reduction in innovation if the elasticity of buyer participation is high. Third, the introduction of 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 the decrease in the commission rate creates a new channel through which the imposition of platform liability may spur innovation. Fourth, policymakers should foresee strategic reactions not only by the platform but also by imitators who might react by choosing to sell products that do not infringe IP. We find that such a strategic response can lead to a reduction in innovation incentives and, therefore, to a possible undesirable outcome. Finally, some brands choose not to sell their products directly on prominent online platforms (e.g., Nike and Birkenstock). Our analysis suggests that more attention should be paid to those online platforms that are not patronized by well-known brands since in this environment their incentives to deter IP-infringing imitators can be weaker.

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# Appendix

## Proof of Lemma 1

In order to show that $\phi^\star \in (0,1)$, let us evaluate the first-order condition of the platform's profit with respect to $\phi$ in (5) at $\phi = 0$. Then, we obtain

$$\frac{\partial \Pi(\tau,\phi)}{\partial \phi}\bigg|_{\phi=0} = \tau\left\{\frac{\partial n_I(\tau,0)}{\partial \phi}\bigg|_{\phi=0}\Big[\pi_I(0)+\pi_C(0)\Big] + F((1-\tau)\pi_I(0))\Big[\pi_I'(0)+\pi_C'(0)\Big]\right\}$$

Because $\frac{\partial n_I(\tau,0)}{\partial \phi}\Big|_{\phi=0} > 0$, the sign of $\frac{\partial \Pi(\tau,\phi)}{\partial \phi}\Big|_{\phi=0}$ depends on the sign of $\pi_I'(0)+\pi_C'(0) = (1-\nu)[\pi_I^m - \pi_I^d - \pi_C^d]$. By Assumption 2, we have $\pi_I^m > \pi_I^d + \pi_C^d$, meaning that $\frac{\partial \Pi(\tau,\phi)}{\partial \phi}\Big|_{\phi=0} > 0$. Therefore, $\phi^\star > 0$. Moreover, $\phi^\star < 1$ because $\Omega(\phi) \underset{\phi\to 1}{\to} +\infty$. This concludes the proof.

## Proof of Proposition 1

The proof for the effect of platform liability on innovation follows immediately from (6). The proof for the effect of platform liability on consumer surplus follows from (7), i.e.,

$$\frac{\partial CS(\tau,\phi)}{\partial \phi} = \frac{\partial n_I(\tau,\phi)}{\partial \phi} u(\phi) + n_I(\tau,\phi) u'(\phi),$$

which can be rewritten as

$$\frac{\partial CS(\tau,\phi)}{\partial \phi} = n_I(\tau,\phi) u(\phi) [\varepsilon_{n_I}(\tau,\phi) + \varepsilon_u(\phi)].$$

Thus, $\frac{\partial CS(\tau,\phi)}{\partial \phi}$ has the same sign as that of $\varepsilon_{n_I}(\tau,\phi) + \varepsilon_u(\phi)$.

## Proof of Proposition 2

The proof immediately follows from the discussion in the main text.

## Proof of Proposition 3

Consider the problem of the platform for a given screening level. The expected profit of the platform is provided by (4). Differentiating it with respect to $\tau$ and dividing by $[\pi_I(\phi) + \pi_C(\phi)]$ yields

$$F((1-\tau^\star(\phi))\pi_I(\phi)) - \tau^\star(\phi)\pi_I(\phi) f((1-\tau)^\star(\phi)\pi_I(\phi)) = 0. \tag{A-1}$$

Differentiating the above expression with respect to $\phi$, we get

$$\frac{d\tau^\star(\phi)}{d\phi} = \frac{(2\tau^\star(\phi)-1) f((1-\tau^\star(\phi))\pi_I(\phi)) + \tau^\star(\phi)(1-\tau^\star(\phi))\pi_I(\phi) f'((1-\tau^\star(\phi))\pi_I(\phi)}{-2\pi_I(\phi) f((1-\tau^\star(\phi))\pi_I(\phi)) + \tau^\star(\phi)\pi_I(\phi)^2 f'((1-\tau^\star(\phi))\pi_I(\phi))} \pi_I'(\phi). \tag{A-2}$$

The denominator is negative under our assumption that the platform's expected profit is quasi-concave with respect to $\tau$. Therefore, the sign of $\frac{d\tau^\star(\phi)}{d\phi}$ is the opposite of the sign of the numerator. It follows that $\frac{d\tau^\star(\phi)}{d\phi}$ has the same sign as that of

$$-2 + \frac{1}{\tau^\star(\phi)} - \frac{(1-\tau^\star(\phi))\pi_I(\phi) f'((1-\tau^\star(\phi))\pi_I(\phi))}{f((1-\tau^\star(\phi))\pi_I(\phi))}.$$

Moreover, (A-1) implies

$$\frac{\tau^\star(\phi)}{1-\tau^\star(\phi)} = \frac{F((1-\tau^\star(\phi))\pi_I(\phi))}{(1-\tau^\star(\phi))\,\pi_I(\phi) f((1-\tau^\star(\phi))\pi_I(\phi))},$$

which is equivalent to

$$\frac{1}{\tau^\star(\phi)} = 1 + \frac{(1-\tau^\star(\phi))\,\pi_I(\phi) f((1-\tau^\star(\phi))\pi_I(\phi))}{F((1-\tau^\star(\phi))\pi_I(\phi))}.$$

Therefore, $\frac{d\tau^\star(\phi)}{d\phi}$ has the same sign as the sign of

$$-1 + \frac{(1-\tau^\star(\phi))\,\pi_I(\phi) f((1-\tau^\star(\phi))\pi_I(\phi))}{F((1-\tau^\star(\phi))\pi_I(\phi))} - \frac{(1-\tau^\star(\phi))\pi_I(\phi) f'((1-\tau^\star(\phi))\pi_I(\phi))}{f((1-\tau^\star(\phi))\pi_I(\phi))}.$$

Denoting $\varepsilon_F(k) = k\frac{f(k)}{F(k)}$ and $\varepsilon_f(k) = k\frac{f'(k)}{f(k)}$, the sign of $\frac{d\tau^\star(\phi)}{d\phi}$ is the same as the sign of

$$\varepsilon_F(k) - \varepsilon_f(k) - 1.$$

Finally, we below show that the sign of $\varepsilon_F(k) - \varepsilon_f(k) - 1 < 0$ is if and only if $\varepsilon_F(k)$ is increasing:

$$\begin{aligned} \varepsilon_F(k) - \varepsilon_f(k) - 1 < 0 \quad &\Longleftrightarrow \quad 1 + k\frac{f'(k)}{f(k)} - k\frac{f(k)}{F(k)} > 0 \\ &\Longleftrightarrow \quad \varepsilon'_F(k) > 0. \end{aligned}$$

Thus, if $\varepsilon_F(k)$ is increasing, then $\tau^\star$ is decreasing in $\phi$, whereas if $\varepsilon_F(k)$ is decreasing, then $\tau^\star$ is increasing in $\phi$.

## Proof of Proposition 4

Totally differentiating $n_I(\tau^\star(\phi), \phi)$ with respect to $\phi$, we obtain

$$\frac{dn_I(\tau^\star(\phi),\phi)}{d\phi} = f((1-\tau^\star(\phi))\Big\{(1-\tau^\star(\phi))\pi'_I(\phi) - \frac{d\tau^\star(\phi)}{d\phi}\pi_I(\phi)\Big\} \tag{A-3}$$

Using (A-2), it follows that $\frac{dn_I(\tau^\star(\phi),\phi)}{d\phi}$ has the same sign as that of

$$(1-\tau^\star(\phi)) - \frac{(2\tau^\star(\phi)-1) f((1-\tau^\star(\phi))\pi_I(\phi)) + \tau^\star(\phi)(1-\tau^\star(\phi))\pi_I(\phi) f'((1-\tau^\star(\phi))\pi_I(\phi)}{-2\pi_I(\phi) f((1-\tau^\star(\phi))\pi_I(\phi)) + \tau^\star(\phi)\,(\pi_I(\phi))^2\, f'((1-\tau^\star(\phi))\pi_I(\phi))}\pi_I(\phi) \tag{A-4}$$

Because the denominator of the second term is negative (by the second-order condition of the platform's profit with respect to $\tau$), $\frac{dn_I(\tau^\star(\phi),\phi)}{d\phi}$ has the opposite sign of the following expression

$$\begin{aligned}&(1-\tau^\star(\phi))\Big(-2\pi_I(\phi)f((1-\tau^\star(\phi))\pi_I(\phi))+\tau^\star(\phi)\left(\pi_I(\phi)\right)^2 f'((1-\tau^\star(\phi))\pi_I(\phi))\Big)-\\ &\pi_I(\phi)\Big((2\tau^\star(\phi)-1)f((1-\tau^\star(\phi))\pi_I(\phi))+\tau^\star(1-\tau^\star(\phi))\pi_I(\phi)f'((1-\tau^\star(\phi))\pi_I(\phi)\Big)\\ =&-\pi_I(\phi)f((1-\tau^\star(\phi))\pi_I(\phi))<0.\end{aligned}$$

Therefore, $\frac{dn_I(\tau^\star(\phi),\phi)}{d\phi}>0$.

## Proof of Proposition 5

The proof immediately follows from the discussion in the main text.

## Proof of Proposition 6

The proof immediately follows from the discussion in the main text.

## Proof of Lemma 2

The proof immediately follows from (16).

## Proof of Proposition 7

The proof follows immediately from the result established in Proposition 6 and the fact that

$$\varepsilon_{n_B}(\phi)=\phi\frac{\frac{\partial n_B(\phi)}{\partial\phi}}{n_B(\phi)}=\phi\frac{u'(\phi)g(u(\phi))}{G(u(\phi))}=\phi\frac{u'(\phi)}{u(\phi)}\frac{u(\phi)g(u(\phi))}{G(u(\phi))}=\varepsilon_u(\phi)\varepsilon_G.$$

## Proof of Proposition 8

The proof follows immediately from the discussion in the main text.

## Proof of Lemma 3

First notice that

$$\begin{aligned}\frac{\partial F((1-\tau)\pi_I(\phi)H(u(\phi)n_I))}{\partial n_I} &= f((1-\tau)\pi_I(\phi)H(u(\phi)n_I))(1-\tau)\pi_I(\phi)u(\phi)h(u(\phi)n_I)\\ &= \frac{f((1-\tau)\pi_I(\phi)H(u(\phi)n_I))(1-\tau)\pi_I(\phi)H(u(\phi)n_I)}{n_I}\frac{u(\phi)n_I h(u(\phi)n_I)}{H(u(\phi)n_I)}\\ &= \frac{f((1-\tau)\pi_I(\phi)H(u(\phi)n_I))(1-\tau)\pi_I(\phi)H(u(\phi)n_I)}{F((1-\tau)\pi_I(\phi)H(u(\phi)n_I))}\frac{u(\phi)n_I h(u(\phi)n_I)}{H(u(\phi)n_I)}\\ &= \varepsilon_F\varepsilon_H.\end{aligned}$$

Similarly

$$\frac{\partial H(u(\phi)F((1-\tau)\pi_I(\phi)n_B))}{\partial n_B} = \varepsilon_H\varepsilon_F.$$

Then, the proof follows immediately from (19) in the main text.

## Proof of Proposition 9

The proof follows immediately from (19) in the main text. Note that the sufficient condition for platform liability to increase innovation, provided in Proposition 9, always holds if the sufficient condition for platform liability to increase buyer participation provided in Lemma 3 holds. To see why, suppose that $\varepsilon_{\pi_I}(\phi) > -\frac{\varepsilon_u(\phi)}{\varepsilon_F}$ so that buyer participation increases (see Lemma 3). The latter condition implies the condition in Proposition 9, $\varepsilon_{\pi_I}(\phi) > -\varepsilon_H\ \varepsilon_u(\phi)$, because $\frac{1}{\varepsilon_F} > \varepsilon_H$ (by equation (18)). This concludes the proof.

## Proof of Proposition 10

As shown in the main text, the derivative of $CS(\tau,\phi)$ with respect to $\phi$ has the same sign as $u(\phi)\frac{\partial n_I(\tau,\phi)}{\partial\phi} + n_I(\tau,\phi)u'(\phi)$. Therefore, it has the same sign as that of $\varepsilon_{n_I}(\tau,\phi) + \varepsilon_u(\phi)$. This, combined with the fact that $\varepsilon_{n_B}(\tau,\phi) = \varepsilon_H[\varepsilon_{n_I}(\tau,\phi) + \varepsilon_u(\phi)]$ implies that $\frac{\partial CS(\tau,\phi)}{\partial\phi}$ has the same sign as that of $\varepsilon_{n_B}$, which has the same sign as that of $\frac{\partial n_B(\tau,\phi)}{\partial\phi}$.

## Proof of Proposition 11

The proof follows immediately from the main text.

## Infinite rounds of screening

In what follows, we provide details regarding the claims made in Section 6.2.

First, consider the private incentives of the platform. As $\pi_I'(\phi) > 0$ and

$$\frac{d(\pi_I(\phi) + \pi_C(\phi))}{d\phi} = \frac{d\nu^m(\phi)}{d\phi}(\pi_I^m - \pi_I^d - \pi_C^d)$$

is positive because by Assumption 2 we have $\pi_I^m > \pi_I^d - \pi_C^d$. Therefore, Lemma 1 fully applies. Moreover, as the expression for consumer surplus does not change, Proposition 1 fully applies as well.

What changes, however, is the analysis related to the aggregate surplus of legitimate imitators, which in the baseline model increases with a higher screening intensity because of the positive effect that a higher screening intensity has on the amount of innovation. In this extension, after some straightforward computations, we find that the aggregate surplus of legitimate imitators is now given by

$$n_I(\tau, \phi)(1 - \tau)\frac{\nu}{1 - \delta(1 - \nu)\phi}\pi_C^d.$$

As both the first term and the third term increase with $\phi$, a higher screening level increases the surplus of legitimate imitators, as is stated in Proposition 2. The third term captures a new effect: more delisting of IP infringers increases the chance for legitimate imitators to sell their products. The aggregate surplus of IP infringers is now given by

$$n_I(\tau, \phi)(1 - \tau)\frac{(1 - \nu)(1 - \phi)}{1 - \delta(1 - \nu)\phi}\pi_C^d.$$

Because the first term increases with $\phi$ but the third term decreases with it, there is a trade-off. Differentiating the above surplus with respect to $\phi$ yields a derivative, which has the same sign as that of

$$\frac{\partial n_I(\tau, \phi)}{\partial \phi}\nu^{d,I}(\phi) + n_I(\phi)\frac{\partial \nu^{d,I}(\phi)}{\partial \phi},$$

where $\nu^{d,I}(\phi) = \frac{(1-\nu)(1-\phi)}{1-\delta(1-\nu)\phi}$ represents the aggregate probability that an IP-infringing imitation is sold in a given category. The above expression is positive (resp., negative) if

$$\varepsilon_{n_I}(\tau, \phi) > (<) - \varepsilon_{\nu^{d,I}}(\phi).$$

The same kind of reasoning applies to Section 5 and Section 4: because we never rely on the specific form of $\nu^m(\phi)$, the analysis literally carries over in those sections.

# Online Appendix

In this Online Appendix, we provide additional extensions of our baseline model. We first study how platform liability impacts the provision of incremental innovation. Second, we discuss the incentives of the platform to change its business model from a pure marketplace to a hybrid one in response to the introduction of platform liability. Third, we discuss the impact of platform liability when the platform lacks commitment power. Finally, we consider the case in which a monopolistic market structure yields a lower total profit than a duopolistic market structure.

## Incremental innovation

In our baseline model, we have captured innovation in terms of new products. However, innovation can also be incremental in the sense that it increases the quality of an existing product. In this section, we show that our main insights hold qualitatively in this case.

Suppose that the mass of product categories on the platform is given by $n = 1$, without loss of generality. We assume that absent innovation there is only one seller per category that obtains a gross profit of $\tilde{\pi} > 0$.[42] Assume also that these sellers can invest in innovation at cost $\tilde{k}$, distributed in $[0, \overline{k}]$ according to a cdf $\tilde{F}(\cdot)$ with density $\tilde{f}(\cdot)$. We assume that the incremental innovation delivers a gross profit equal to $\pi_I^m$ if the innovator remains the only seller of the product and $\pi_I^d$ if the innovator competes with a copycat. Assume that $\pi_I^m > \pi_I^d \geq \tilde{\pi}$, meaning that conditional on innovation taking place, monopoly profits are larger than duopoly profits, and the latter are weakly higher than those obtained when not innovating. The expected gross profit resulting from the innovation is $\pi_I(\phi) = (1-\nu)\phi\pi_I^m + (1-(1-\nu)\phi)\pi_I^d$, as in the baseline model.

An incumbent innovates if and only if

$$(1-\tau)\pi_I(\phi) - \tilde{k} \geq \tilde{\pi}(1-\tau).$$

The share of product categories in which innovation takes place is given by $n_I(\tau,\phi) = \tilde{F}((1-\tau)(\pi_I(\phi)-\tilde{\pi}))$ and the profit of the platform is given by

$$\Pi(\tau,\phi) = \tau\Big[n_I(\tau,\phi)[\pi_I(\phi)+\pi_C(\phi)] + (1-n_I(\tau,\phi))\tilde{\pi}\Big] - \Omega(\phi).$$

It is straightforward to verify that an increase in the screening level has a positive effect on

[42] Note that this is a simplifying assumption that can be microfounded by assuming that the non-innovative product is homogeneous and it is not profitable for other homogeneous sellers to join the marketplace. However, the analysis would not change qualitatively if we assume that two sellers are in the product category and obtain $\tilde{\pi}$ each as long as one seller only innovates.

incremental innovation because of the IP-protection effect:

$$\frac{\partial n_I(\tau,\phi)}{\partial \phi} = \tilde{f}((1-\tau)(\pi_I(\phi)-\tilde{\pi}))(1-\tau)\pi_I'(\phi) > 0.$$

In this extension, consumer surplus is given by

$$CS(\tau,\phi) = \tilde{F}((1-\tau)(\pi_I(\phi)-\tilde{\pi}))u(\phi) + (1-\tilde{F}((1-\tau)(\pi_I(\phi)-\tilde{\pi}))\tilde{u}.$$

where $\tilde{u}$ is the utility obtained by the buyer in a product category in which innovation is not provided. We further assume that $\tilde{u} \le u^m < u^d$, meaning that innovation generates a (weakly) higher utility in a given product category and buyers benefit more from a duopolistic market structure than from a monopolistic one. Differentiating $CS(\tau,\phi)$ with respect to $\phi$ yields

$$\frac{\partial CS(\tau,\phi)}{\partial \phi} = \tilde{f}((1-\tau)(\pi_I(\phi)-\tilde{\pi}))(1-\tau)\pi_I'(\phi)[u(\phi)-\tilde{u}] - \tilde{F}((1-\tau)(\pi_I(\phi)-\tilde{\pi}))u'(\phi).$$

Denoting $\varepsilon_{n_I}(\tau,\phi) = \frac{\frac{\partial n_I(\tau,\phi)}{\partial \phi}}{n_I(\tau,\phi)}\phi$ and $\varepsilon_{u-\tilde{u}}(\phi) = \frac{\frac{\partial[u(\phi)-\tilde{u}]}{\partial \phi}\phi}{u(\phi)-\tilde{u}}$, the introduction of platform liability leads to the same trade-off as in the baseline model. Specifically, $\frac{\partial CS(\tau,\phi)}{\partial \phi} > (<)0$ if

$$\varepsilon_{n_I(\tau,\phi)} > (<) - \varepsilon_{u-\tilde{u}}(\phi), \tag{A-5}$$

which is as in Proposition 1. The same type of analysis would hold when considering elastic buyer participation in the two forms identified in Section 5. The only differences are that $\varepsilon_u(\phi)$ should be substituted by $\varepsilon_{u-\tilde{u}}(\phi)$ and $\varepsilon_{\pi_I}(\phi)$ should be substituted by $\varepsilon_{\pi_I-\tilde{\pi}}(\phi) = \frac{\frac{\partial[\pi_I(\phi)-\tilde{\pi}]}{\partial \phi}\phi}{\pi_I(\phi)-\tilde{\pi}}$.

## Hybrid business model

Many platforms (e.g., Amazon, Apple, Google) use a hybrid business model in that they not only enable interactions between sellers and buyers on their marketplace or app store but are also active as sellers. Imposing platform liability may induce a platform to adopt a hybrid business model instead of a pure marketplace one. We here illustrate this idea in a simple way.

We consider a variation of the baseline model in which the platform can preempt the entry of an imitator by producing its own copycat version at a fixed cost $\kappa$. Suppose that the platform's version does not infringe IP (for example, thanks to a first-rate legal team that the platform can afford to have or simply because it collects data and information from innovators). Moreover, assume that the platform's imitation and a third-party's imitation are perceived as homogeneous by consumers. Let $\beta$ represent the fraction of product categories into which the platform introduces its own imitations.

We assume that the commission rate is exogenously determined and buyer participation is inelastic. We consider the following (modified) timing.

- Stage 1: The platform announces $(\phi, \beta)$ for a given $\tau$.
- Stage 2: Innovators make innovation decisions and join the platform if they develop a new product.
- Stage 3: The platform incurs the imitation cost $\kappa$ for a fraction $\beta$ of product categories.
- Stage 4: Independent imitators enter the remaining product categories.
- Stage 5: The platform screens third-party imitators according to the screening level $\phi$.

For the sake of illustration, we assume that screening is costless and we focus on the case in which the screening level chosen under a pure marketplace business model is interior, i.e., $\phi^\star \in (0, 1)$. In addition, we focus on the special case in which $\kappa = (1 - \tau)\pi_C^d$. Then, the platform's expected total profit from a category in which its imitation is present is equal to

$$\tau\pi_I^d + \pi_C^d - \kappa = \tau(\pi_I^d + \pi_C^d),$$

which makes the platform indifferent between selling its own copycat product and letting a third party sell an imitation. This implies that the platform is indifferent between a hybrid business model and a pure marketplace business model in the absence of platform liability. In other words, what matters for the platform's profit is the probability of having a duopolistic market structure per category, which is equal to $1 - (1 - \nu)\phi^\star$ under pure marketplace. In the case of a hybrid business model, the platform can achieve the same probability by properly combining $\beta$ and $\phi$, where $\beta$ and $\phi$ need to satisfy

$$\beta + (1 - \beta)[1 - (1 - \nu)\phi] = 1 - (1 - \nu)\phi^\star.$$

Suppose now that platform liability induces the platform to raise $\phi$ to the minimum level $\phi^L (> \phi^\star)$ that ensures liability exemption. This clearly reduces the platform's profit conditional on the platform maintaining the pure marketplace business model. However, under a hybrid business model, the platform can restore the probability of a duopolistic market structure absent liability, i.e. $1 - (1 - \nu)\phi^\star$, by choosing $\beta$ such that

$$\beta + (1 - \beta)\left[1 - (1 - \nu)\phi^L\right] = 1 - (1 - \nu)\phi^\star,$$

which leads to

$$\beta = \frac{\phi^L - \phi^\star}{\phi^L} (< 1).$$

By entering the above fraction of product categories, the platform can make higher profits than under a pure marketplace business model. The reason is that, under our assumptions, what matters for the platform's profit is the probability of a duopolistic market structure per category. Under the pure marketplace business model, platform liability lowers this probability below the privately optimal one. Yet, under the hybrid business model, the platform can restore this privately optimal probability by introducing its own imitation in some product categories.

## Inability to commit

One of the assumptions in our analysis is that the platform can commit to its screening policy. However, this may not necessarily be the case in reality. If it lacks commitment power, it will choose its screening policy to maximize its profit after innovators have taken decisions to innovate and join the platform.

Suppose that the platform cannot commit to its screening policy whereas it can commit to an ad valorem commission rate.[43] For the sake of simplicity, let us consider the case in which buyer participation is inelastic and the commission rate is exogeneously given. The lack of commitment creates a hold-up problem on the part of the platform and, therefore, the introduction of a liability rule that allows the platform to commit may raise the platform's profit.

Specifically, absent platform liability, given a number $n_I(\tau)$ of innovators who have joined the platform marketplace, the platform maximizes the following expected profit

$$\tau n_I(\tau)[\pi_I(\phi) + \pi_C(\phi)] - \Omega(\phi).$$

The first-order condition with respect to $\phi$ is given by

$$\tau n_I(\tau)[\pi_I'(\phi) + \pi_C'(\phi)] = \Omega'(\phi),$$

with $\pi_I'(\phi) + \pi_C'(\phi) = (1-\nu)(\pi_I^m - \pi_I^d - \pi_C^d) > 0$ by Assumption 2. Because $n_I(\tau)$ no longer depends on $\phi$, the platform does not internalize the benefit that a higher screening level can generate by increasing the amount of innovation. Hence, it tends to choose a lower screening level than in the baseline model with commitment.

Let us denote $\phi^\star$ as the optimal screening level under commitment and $\phi^{\star\star}$ as the optimal screening level under no commitment. Suppose a liability rule is introduced such that it induces the platform to achieve $\phi^L > \phi^{\star\star}$ in order to benefit from liability exemption. Then, if $\phi^\star > \phi^L$ platform liability restores (partially) the commitment power of the platform and raises its profit. If $\phi^\star < \phi^L$, platform liability can have either a positive or negative impact on the platform's profit.

[43] The latter is necessarily part of the "Terms and Conditions" the platform sets up front.

### Higher total profit under a duopolistic market structure

In our baseline model, we have assumed that a monopolistic market structure yields a higher total profit than a duopolistic market structure. In this subsection, we consider the opposite case where $\pi_I^m < \pi_I^d + \pi_C^d$. This scenario may arise depending on the relative magnitudes of a business-stealing effect and a market-expansion effect that an imitator creates in a model with both vertical and horizontal product differentiation (see e.g., Chen and Riordan 2008).

The first-order condition of the platform's expected profit with respect to $\phi$ is the same as in (5). However, now $\pi_I'(\phi) + \pi_C'(\phi) = (1-\nu)(\pi_I^m - \pi_I^d - \pi_C^d) < 0$ meaning that, for a given screening cost, the platform faces a trade-off between the positive IP-protection effect and the negative effect on total per-category profits. This means that $\frac{\partial \Pi(\tau,\phi)}{\partial \phi}\Big|_{\phi=0}$ can be either positive or negative. If it is positive, then $\phi^\star \in (0,1)$. Otherwise, $\phi^\star = 0$ (because $\Pi(\tau,\phi)$ is quasi-concave in $\phi$) and, therefore, the platform finds it optimal to let all imitators be active in the marketplace.

It follows that, relative to the baseline model, the incentive of the platform to delist IP infringers is mitigated. As for the desirability of platform liability, consider now total welfare in (9) and let us focus on the case in which $\phi^\star \in (0,1)$. Differentiating it with respect to $\phi$ yields

$$\frac{\partial W(\tau,\phi)}{\partial \phi}\Big|_{\phi=\phi^\star\in(0,1)} = (1-\tau)\Big[n_I(\tau,\phi)[\pi_I'(\phi)+\pi_C'(\phi)] + \pi_C(\phi)\frac{\partial n_I(\tau,\phi)}{\partial \phi}\Big] + \frac{\partial CS(\tau,\phi)}{\partial \phi},$$

because $\frac{\partial \Pi(\tau,\phi)}{\partial \phi}\Big|_{\phi=\phi^\star\in(0,1)} = 0$. Unlike in (9) in the baseline model, there is a new force that tends to make platform liability less likely to be socially desirable. To see why, note even if a higher screening intensity leads to a higher consumer surplus, now $\pi_I'(\phi) + \pi_C'(\phi) < 0$ because $\pi_I^m < \pi_I^d + \pi_C^d$.