Platform Liability with Reputational Sanctions

Alessandro De Chiara[*] Juan José Ganuza[†] Fernando Gómez[‡] Ester Manna[§] and Adrian Segura[¶]

April 12, 2024

Abstract

This paper presents a framework where sellers, an online platform with monopoly power, and consumers transact. We study the interaction between the imposition of liability on the platform, the reputational sanctions exerted by consumers, and the internal measures adopted by the platform to keep in check the sellers, whenever a product generates losses to consumers. We show that introducing direct legal liability of the platform (i) may have both positive and negative effects for safety investments and (ii) is generally welfare-increasing albeit it may be detrimental for welfare when legal costs are sizable. Additionally, when sellers are heterogeneous with respect to either their sensitivity to consumers' or platform' sanctions, we find that platform legal liability will affect the selection of participating sellers, although the sign and size of the effect largely depend on parameter values.

Keywords: Platform liability; third-party sellers; reputation.
JEL Classification: K13; L15; L51.

[*]Department of Economics, Universitat de Barcelona, and Barcelona Economic Analysis Team (BEAT), Avinguda Diagonal 696, 08034, Barcelona. E-mail: aledechiara@ub.edu.

[†]Department of Economics, Universitat Pompeu Fabra and Barcelona School of Economics, Ramon Trias Fargas, 25-27 08005 Barcelona. E-mail: juanjo.ganuza@upf.edu.

[‡]Department of Law, Universitat Pompeu Fabra, Ramon Trias Fargas, 25-27 08005 Barcelona. E-mail: fernando.gomez@upf.edu.

[§]Professora Serra Húnter, Department of Economics, Universitat de Barcelona, and Barcelona Economic Analysis Team (BEAT), Avinguda Diagonal 696, 08034, Barcelona. E-mail: estermanna@ub.edu

[¶]Department of Economics, Universitat Pompeu Fabra, Ramon Trias Fargas, 25-27 08005 Barcelona. E-mail: adrian.segura@upf.edu.

1 Introduction

On January 2015, Heather Oberdorf returned home from work, put a retractable leash on her dog, and went for a walk. The animal suddenly lunged at an unspecified object, and the ring on the collar broke. The leash recoiled back and hit Heather Oberdorf in the eye, breaking her eyeglasses, and blinding her permanently in one eye. Heather Oberdorf, similarly to many consumers for a variety of products, had bought the collar at an online platform (Amazon). This incident gave rise to one of the most famous cases to date concerning the potential liability of online platforms vis-à-vis consumers who had visited the platform to buy from an independent (i.e., different from the platform operator) seller offering its products, alongside many other sellers, on the platform.[1]

Nowadays, online platforms play a large and increasing role in many of our activities, from shopping for all kinds of goods to entertainment, from travel and tourism to keeping track of friends and people we know. How to deal with them is a major theme in legal and regulatory policy affecting many fields of law: antitrust, consumer protection, advertising and trade, and tort liability, just to cite a few.

Whether platforms should be held liable towards consumers for third-party transactions where the platform had played, at least apparently, the role of a mere intermediary is one of the most disputed issues in this area: the existence, grounds, and scope of the liability of an online platform for the malfunction of the products bought from sellers through the platform is a key, but hotly debated, dimension of the regulatory regime of online platforms. The questions arise both with respect to minor instances of non-conformity or dissatisfaction with the product and to more serious ones involving bodily harm to consumers.

In the US, courts (both at the Federal and State levels) have struggled with the proper characterization of the role of online platforms and whether their position fits with the categories leading to the imposition of liability for online sales. Apparently, no consensus has emerged yet among courts in the US.[2] In Europe, although case law does not seem to be so agitated by controversy, a number of proposed legal rules seek to address the problem. For instance, the Proposal for a Directive on liability for defective products of September 2022 would make, according to art. 7.5 and 7.6, online platforms, serving as intermediaries between sellers and buyers, liable on a subsidiary basis for harm caused by a defective product sold through the platform. This would occur when the manufacturer, its representative agent, the importer or the fulfillment service provider cannot be identified or are located outside the EU.[3] Moreover, The Digital Services Act (DSA) has imposed

[1] It already belongs to the US Tort Law canon: Epstein and Sharkey (2020).

[2] Related US case law is briefly discussed in Section 6.

[3] Legal liability is attached when the online platform presents the information or otherwise enables the

specific protective duties on online platforms towards consumers. Still, the DSA does not contain solutions for the general issue of platform liability towards consumers for the problems (major and minor) affecting products exchanged by third-party sellers and buyers in the platform.

This is exactly what we intend to investigate developing a theoretical model of the interaction between sellers, an online platform with monopoly power, and consumers. We believe that it is more realistic to think that liability does not operate in a vacuum, but in a setting where consumers may react in the face of adverse events resulting from using goods bought on an online platform, and where platforms may take actions to discipline sellers. Even though sellers may be immune from liability in practice, for instance, because they are headquartered in foreign jurisdictions, this does not imply that the platform on which they sell goods cannot sanction them. Indeed, an online platform is in a position to adopt measures against a seller involved in an adverse event, like penalizing it in a ranking or even delisting it. This would affect the incentives of sellers who can take costly actions to improve the safety and quality of the goods they offer to consumers on the platform. Why should the platform care about the safety of the products? Firstly, the platform has an incentive to boost consumers' expected surplus by increasing the likelihood that products are safe as the fees it can charge ultimately depend on consumers' satisfaction. Secondly, consumers may impose costly reputational sanctions on the platform, like refraining from buying for a while, negative word of mouth or review.[4]

In this new framework, we look at the consequences of introducing direct liability of the platform for the harm incurred by consumers. This adds another channel that affects both directly and indirectly the platform's decision to induce sellers' investment. The threat of liability, in itself, may spur the platform to sanction sellers. However, platform liability also reduces consumers' sanctions, thereby softening the platform's incentive to discipline sellers. To understand why, consider that reputational sanctions are less severe when there is a higher degree of platform liability because consumers (i) anticipate that their sanctions are less significant in inducing the platform to discipline sellers and (ii) care less about punishing the platform since they get higher compensation for the harm they suffer. Note that only the former effect entails a substitution between liability and consumers' sanctions as a means to motivate the platform to discipline sellers. Conversely,

specific transaction at issue in a way that would lead an average consumer to believe that the information, or the product that is the object of the transaction, is provided either by the online platform itself or by someone acting under its authority or control. We briefly discuss European regulatory proposals in Section 6.

[4]There is evidence showing that consumers react, even harshly, to negative reputational shocks. For example, In 2000, Amazon.com Inc. infuriated many customers when it sold DVDs to different people for different prices. The Washington Post, December 24, 2012: "Websites Vary Prices, Deals Based on Users' Information".

the latter effect implies that a higher degree of liability attenuates the consumer's concern with receiving a safe good in the first place. Therefore, with platform liability, it may well be the case that consumers do not sanction the platform for selling defective goods, and defective goods are more likely to be sold on the platform. This is, we believe, the more counterintuitive result and a possibly unintended consequence of introducing platform liability. When discussing the merits of platform liability, one must take into account that such a policy may be beneficial only if it increases the safety of goods sold on the platform or reduces the costly reputational sanctions imposed by consumers.

In the paper, we also show how decoupling the damages paid by the platform from the compensation received by consumers can improve safety levels. When sellers are heterogeneous in the effectiveness of the platform's disciplinary actions to incentivize them, we show that increases in the legal liability of the platform affect both equilibrium safety levels and participation rates of sellers in the platform, but the overall effect depends on a number of factors, such as the substitutability between consumers' sanctions and platform legal liability. In another extension, we allow for consumers' sanctions to eventually have a direct impact on the seller. This softens the moral-hazard problem leading to higher safety investments in the product. When sellers are heterogeneous with respect to their direct sensitivity to the reputational sanctions from consumers, the legal liability of the platform has an impact on the number of sellers allowed to sell in the platform. Platform liability decreases the relevance of excluding those sellers who suffer less the impact of consumers' reputational penalties, although this effect may be outweighed, depending on the values of the parameters, by the direct effect of platform liability upon platform's profits, which has a negative sign. We also highlight that the platform is better off when the sellers can be held liable. However, we caution that this is not always socially desirable and platform liability may be preferred to seller liability.

Our model and its result can help guide the policy discussion on the benefits and downsides of platform liability, and rationalize some recent practices and strategies adopted by online platforms.

The paper is organized as follows: Section 2 provides a short literature review. Section 3 describes the basic features of the setting and the model. Section 4 contains the basic analysis and welfare results. Section 5 extends the model in different directions. In particular, we look into (i) the effects of decoupling platform liability and consumer compensation; (ii) the case in which sellers receive reputational consumers' sanctions and the one in which they can bear a share in the legal liability vis-à-vis consumers; (iii) the effectiveness of platform's disciplinary actions upon sellers. Section 6 provides some policy discussion and implications and summarizes the related US case law and the European discussion concerning platform liability and regulation. Section 7 briefly concludes.

2 Related Literature

Several authors have recently begun to examine the issue of platform liability. From a pure policy perspective, Buiten et al. (2020), Buiten et al. (2022) and Sharkey (2020) analyze the efficiency of classical liability rules in situations where a platform is involved. Lefouili and Madio (2022) discuss how a stricter liability rule for platforms affect variables such as pricing, terms and conditions, and investments. In the same vein, Sharkey (2022) overviews the recent case law addressing the imposition of liability on platforms such as Amazon, which is identified as the 'least cost avoider' in the economic relationship. De Chiara et al. (2021) studies with the help of a theoretical model the role of liability rules in the development of filtering technology to prevent the presence of copyright infringing content when the technology is inaccurate and leads to errors.

A growing line of research addresses the consequences associated with imposing a liability regime within a platform structure. Jeon et al. (2021) study the platform's incentives to delist IP-infringing products and the effects of introducing a liability regime. Grimmelmann and Zhang (2023) show the effects of different legal liability regimes on online content moderation. Hua and Spier (2023) analyze a setting in which a platform that provides a service to consumers (like Facebook or Twitter) can adopt precautions to reduce the probability of harm to consumers. They compare strict liability and negligence in the presence of indirect network effects because a higher number of active consumers boosts advertising revenues. Zennyo (2023) considers sellers that sell goods to consumers via a platform and must decide on the level of safety investments. In his model, the platform chooses the 'liability design', i.e., how to share the compensation to consumers who suffer harm when products turn out to be defective.[5] The author finds that the platform has never an incentive to voluntarily assume liability for third-party harm, and identifies conditions under which the lawmaker should step in and impose platform liability.

Our paper is close to Hua and Spier (2021) and Yasui (2022). Hua and Spier (2021) prove that holding firms liable for harm caused to consumers discourages dangerous companies from joining the platform in a setup with adverse selection. Specifically, two types of firms coexist, safe and harmful ones, where the latter have lower production costs but cause harm to consumers more often. Platform liability is an instrument to give incentives to the platform to screen sellers. They show that the desirability of platform liability depends, among other things, on whether the sellers are judgment-proof, whether it affects user participation, and the intensity of platform competition. Like Hua and Spier (2021), Yasui (2022) focuses on the case of ex-ante monitoring of sellers whose products can be defective. He also allows the platform to choose the extent to which consumers are compensated if harm occurs. Similar to us, he finds that higher platform liability

[5] In this respect, this paper is linked to the literature on platform governance, e.g., see Teh (2022).

may reduce sellers' investment because consumers would buy the product regardless of its safety. However, in his model, consumers do not strategically choose a reputational sanction on the platform or the seller to improve product safety. These two papers focus on ex-ante screening, whereas we consider an ex-post disciplining system that the platform can commit to using.

By investigating the interplay between reputation and liability, our paper is also close to Ganuza et al. (2016). They focus on the interaction between reputation and manufacturers' liability for defective products and find that these two mechanisms operate as complements to discipline producers' behavior. In addition to modeling differences (e.g., we consider a one-period model), we highlight how platform liability acts as a substitute for consumers' reputational sanctions.

3 Model

We study sellers and consumers who interact through an intermediary platform. Our set-up builds on the framework of Karle et al. (2020) but departs from it along several directions. First, we consider a monopolistic platform and we allow for only one seller for each product category. Second, sellers can make a safety investment to reduce the risk of accidents caused by the products. Third, we consider the legal liability of the platforms and sellers vis-à-vis the consumers of the products as the key variable.

Sellers. There is a unit mass of product categories, indexed by $k \in [0,1]$. Each product category is served by a single seller. Each seller privately and independently makes an investment to improve the quality of the product. The investment is binary, $e \in \{0,1\}$, and stochastically decreases the probability that the product will be defective. Specifically, the product will be defective with probability 1 if $e = 0$, whereas it will be defective with probability $1 - \eta \in (0,1)$ if $e = 1$. Accordingly, we will say that η captures the *productivity of the safety investment*. The investment costs $c > 0$. An active seller makes a profit π. In our basic setting, a seller cannot be sued for damages resulting from a faulty or non-conforming product they have sold. This may be because sellers have no assets to cover damage payments to consumers or because their location makes it impractical for consumers to sue for damages.[6]

[6]Although arts. 30 and 32 of EU regulation 2022/2065 (DSA) set mandates for platforms to allow traceability of sellers, and means of redress, they do not include requirements that would prevent sellers operating in a platform from being judgment-proof or placed outside the realistic scope of consumers' lawsuits.

Consumers. Each consumer is only interested in a product category and derives gross utility V from consuming a product in her preferred category and 0 otherwise. There is a unit mass of consumers per product category. A consumer learns her preferred product category only after visiting the platform. If the platform only lists a fraction $\alpha \in [0,1]$ of sellers, the consumer's gross expected utility is αV. If the product turns out to be defective (or harmful, we will use the two terms interchangeably),[7] a consumer incurs a loss $H > 0$. We assume that a consumer retains a fraction $1-\gamma$ of the expected gains from trading with a seller through the platform. A consumer can sue the platform if the product bought is defective. Moreover, we assume that the consumer is able to commit to inflicting a reputational punishment onto the platform as a function of (i) whether the product bought is defective and (ii) whether there is compensation for the harm resulting from the defect.[8] The punishment suffered by the platform is $R \geq 0$ and costs the consumer τR, with $\tau \in [0,1)$. In practice, this may take the form of refraining from buying through the platform for some time or creating and spreading bad reviews that tarnish the platform's reputation. These punishments entail costs for the consumers, such as those arising from the need to find products through other channels or the time spent in writing reviews.[9]

Platform. The platform has a deep pocket and is able to face damages sought by consumers. It charges a listing fee f to each seller, whereas it does not charge consumers. The platform can commit to punishing a seller if the product turns out to be defective. Let the punishment be $r \geq 0$ and the cost for the platform be ϕr with $\phi \in [0,1)$. While we are agnostic about the actual type of punishment that is carried out, in practice there seem to be many tools available to the platform to discipline an underperforming seller, ranging from an outright ban from trading to reducing its visibility on the platform, measures that will negatively affect the seller's future sales.

Timing of the game. The sequence of events is as follows.

0. Consumers commit to a punishment R at unit cost τ for the event they suffer harm.

1. The platform offers each seller a contract consisting of (f, r).

[7] Our notions do not intend to reflect specific categories in one or the other legal system. Thus, they should be understood broadly encompassing also instances of contractual non-conformity.

[8] In section 5.2 we consider the scenario in which consumers' reputational punishment may affect both the platform and the seller.

[9] Bechwati and Morrin (2003) conceptualize and find supportive evidence for the consumers' desire for retaliation against a firm in the wake of a negative purchase experience. Extensive research in consumer psychology cited therein shows that dissatisfied consumers engage in negative word-of-mouth behavior and/or switch to alternative (suboptimal) providers.

2. Each seller decides whether to sell through the platform and, if so, each seller independently chooses whether to invest or not in safety.

3. Consumers learn their preferred product and make their purchasing decisions.

4. Uncertainty resolves; if the product purchased is defective, punishments are carried out and damages are paid according to the liability regime. Players derive payoffs.

Liability. In a perfectly functioning liability system, a liable platform pays fully-compensatory damages H. For now, we assume that the platform compensates the consumer for a fraction $\delta \in [0, 1]$ of the suffered harm of the consumers. This fraction may depend on the ability of courts to fully assess the harm suffered by consumers, the delay with which consumers are compensated, the uncertainty over judicial outcomes, and so on. It may also be interpreted as the legislator's choice variable as to the scope of the platform's liability. Bear in mind that $\delta = 0$ amounts to the case of no liability, whereas $\delta = 1$ is equivalent to the platform making consumers whole for the harm they suffer. Although we assume away litigation and settlement costs associated with liability towards consumers in the baseline model, when we perform the welfare analysis in Section 4.3 we will take such costs into account.

Equilibrium concept and modeling assumptions. All parties are risk-neutral and have zero outside options. As the sellers' effort is private information, consumers will form a belief about the expected harm of the product on sale on the platform. We use Perfect Bayesian Equilibrium as equilibrium concept and, being rational, consumers will correctly anticipate the true amount of safety investment the sellers make on the equilibrium path. We assume that consumers are aware of the contract terms used by the platform.[10] Throughout we assume that $V - (1 - \eta)H - c \geq 0$ and $\eta H - c > 0$, so that the sellers' safety investment is socially desirable.

3.1 Model discussion

Below, we discuss some of the key assumptions of the basic model.

Reputational sanctions. A key feature of our model is that both consumers and the platform can incur costs to punish other parties when a product turns out to be harmful/defective.[11] As consumers' interaction with sellers is mediated, the platform is

[10] Art. 3 of the EU Regulation 2019/1150 contains transparency requirements for the terms used by the platforms vis-à-vis sellers.

[11] The economics and management literatures have extensively shown that consumers react to product harm crises in a manner that can severely impact firms' profitability in the short and long haul (e.g., for

the natural starting point for consumers to punish. The platform, in turn, is able to punish sellers. These punishments are meant to capture, in a reduced form, how consumers and the platform can react to the occurrence of harm from a defective good: that is, their ability to take actions that affect the future (stream of) payoffs of other players in the game.

Consumers' commitment. As a shortcut, consumers can commit to imposing a sanction on the platform if they feel hurt by the interaction through the platform. Several competing mechanisms may justify this behavior. For instance, negative reciprocity according to which individuals are better off if they manage to punish those who have treated them unfairly even when this implies a cost.[12] Similarly, Hart and Moore (2008) argue that parties to a contract may feel aggrieved if they receive less than what they feel they are entitled to. The contract constitutes a natural reference point and, Hart and Moore argue, in the presence of multiple possible outcomes, the parties feel entitled to the best outcome the contract allows. Feelings of grievance may be partially offset by punishing the counterparty. In our environment, consumers may form the expectation that the good they have purchased should be free from defects. Should it turn out to be defective, consumers would retaliate (initially against the platform). Extensive empirical evidence has shown how rife negative reciprocity is (e.g., see Dohmen et al., 2009) and several experiments have shown that shortchanged economic agents are willing to incur costs to punish counter-parties, even when the latter are not ultimately responsible (at least fully) for the former's unpleasant outcome (e.g., see Bartling and Fischbacher, 2012 and Oexl and Grossman, 2013).

Consumers' bargaining power. The consumers' ability to obtain some positive gains from trade is necessary for them to carry out costly punishments. This assumption can be justified if consumers are heterogeneous as to the utility they obtain from the exchange and their true valuation is private information. This may be challenged in a world in which platforms may use AI to personalize prices intended to fully absorb consumers' surplus from the transaction. However, the extent to which this happens in practice is debatable (e.g., see Porat, 2022).

the impact of product recalls in the toy and automobile industries, see Freedman et al., 2012, and Liu and Shankar, 2015, respectively).

[12]For theoretical models of reciprocity, see Rabin (1993), Dufwenberg and Kirchsteiger (2004), and Falk and Fischbacher (2006).

4 Analysis

We solve the model by backward induction. In stage 4, when joining a platform, a consumer expects to get:

$$U^E := (1-\gamma)\alpha\Big[V - (1-\eta e^E)[(1-\delta)H + \tau R]\Big].$$

In stage 3, a seller willing to join the platform decides on the safety investment:

$$\max_{e\in\{0,1\}} \quad -(1-\eta e)r - ce.$$

Keep in mind that the seller's investment choice, being unobservable to consumers, does not affect their expected utility from buying the good. It is immediate to see that a seller weakly prefers to invest if r is at least as high as the following critical value $\tilde{r} := \frac{c}{\eta}$.

Consider now stage 2 and suppose that the equilibrium where sellers are induced to invest, i.e., $e = 1$, is in place. The platform chooses the contract (f, r) to maximize:

$$f - (1-\eta)[\phi r + R + \delta H],$$

subject to the sellers' participation constraint:

$$\gamma\Big[V - (1-\eta)[(1-\delta)H + \tau R]\Big] - f - (1-\eta)r - c \geq 0,$$

and the sellers' incentive compatibility constraint:

$$r \geq \tilde{r}.$$

It can be shown that when investment is induced (subscript 1 below),

$$\begin{aligned} r_1 =& \frac{c}{\eta}; \\ f_1(R) =& \gamma\Big[V - (1-\eta)[(1-\delta)H + \tau R]\Big] - (1-\eta)\frac{c}{\eta} - c. \end{aligned}$$

The platform's expected utility is:

$$\begin{aligned} \Pi_1(R) =& \gamma[V - (1-\eta)[(1-\delta)H + \tau R]] - (1-\eta)\frac{c}{\eta} - c \\ & - (1-\eta)\left(\phi\frac{c}{\eta} + R + \delta H\right), \end{aligned}$$

where the first line is the platform's revenue, and the second line represents the platform's expected loss from selling a potentially harmful good. The latter consists of the probability that an accident occurs multiplied by three terms: the platform's cost of sanctioning the under-performing seller, $\phi\frac{c}{\eta}$, the consumers' reputational punishment, R, and the damages payment to the consumer, δH. From this expression, we can infer that R cannot be too high or $\Pi_1(R)$ would be negative. In particular,

$$R \leq \bar{R} := \frac{\gamma V}{(1-\eta)(1+\gamma\tau)} - \frac{[\gamma(1-\delta)+\delta]H}{1+\gamma\tau} - \frac{[1+(1-\eta)\phi]c}{\eta(1-\eta)(1+\gamma\tau)}.$$

As for the equilibrium where sellers are not induced to invest, we distinguish between two main cases, depending on the value of V relative to H.

4.1 Relatively Low-value Goods

Suppose first that $V \in [(1-\eta)H + c, H)$. In this case, trade would optimally take place only when the sellers invest. Put differently, sellers' investment is indispensable for the market to exist. As a result, either the platform induces the sellers to invest or trade does not occur, i.e. $\Pi_0 = 0$. From inspecting $\Pi_1(R)$, it is immediate to see that consumers' sanctions would only diminish the platform's interest in inducing investment. Therefore, $R = 0$. In words, as transactions do not take place unless the goods are safe (though not necessarily accident-free), there is no need for consumers' reputational sanctions to induce the platform to punish those sellers whose goods are defective. What is the role of platform liability in this scenario? A higher degree of liability may undermine the platform's incentive to motivate investment on the sellers' part. To see this, note that $\Pi_1 \geq 0$ if and only if:

$$V \geq \frac{(1-\eta)[\gamma(1-\delta)+\delta]H}{\gamma} + \frac{[1+(1-\eta)\phi]c}{\eta\gamma}. \tag{1}$$

The right-hand side is increasing in δ. Even if investment in safety is optimal, the platform does not enjoy all the surplus it generates: it has to allow a moral-hazard rent for sellers, because their investments are unobservable, and motivating the sellers entail socially-costly sanctions. Therefore, burdening the platform with liability may result in the latter deciding not to allow socially-beneficial transactions from taking place.

Yet, if a higher δ does not deter investment, it can be used to transfer surplus from the platform to consumers: provided that $e = 1$, consumers' expected utility is increasing in δ. This is especially relevant for a legislator who attaches a larger weight to consumers' welfare than to platform's profits. In that case, such a legislator would set δ to maximize expected consumer surplus subject to satisfying (1). We summarize these observations in the following proposition.

Proposition 1. *When $V \in [(1-\eta)H + c, H)$, a higher level of δ may prevent socially-desirable transactions. If the legislator values consumer surplus more than platform's profits, it would choose the highest feasible δ that does not deter trading.*

4.2 Relatively High-value Goods

Let us now suppose that (i) consumers are still willing to buy the good when they expect it to be defective with probability 1, which requires $V \geq (1-\delta)H$, and that (ii) the platform is willing to host goods that are defective with probability 1, which requires $V \geq (1-\delta)H + \frac{\delta H}{\gamma}$. It is immediate to see that the second constraint is always at least as tight. If $\delta = 1$, the condition is $\gamma V \geq H$. In fact, to guarantee that the platform

wishes the sellers to invest and focus on the most interesting case, in the remainder of this section we will assume that $V \geq \bar{V} := \frac{H[1+\phi(1-\eta)]}{\gamma}$.

Consider the equilibrium where sellers are not induced to invest, i.e., $e = 0$. The platform chooses the contract (f, r) to maximize:

$$f - (\phi r + R + \delta H),$$

subject to the sellers' participation constraint:

$$\gamma[V - (1-\delta)H - \tau R)] - f - r \geq 0.$$

It follows that, when $e = 0$, the contract between the platform and sellers prescribes (subscript 0 below):

$$r_0 = 0;$$
$$f_0(R) = \gamma[V - (1-\delta)H - \tau R)].$$

The platform's expected utility is:

$$\Pi_0(R) = \gamma[V - (1-\delta)H - \tau R] - R - \delta H.$$

The comparison between $\Pi_1(R)$ and $\Pi_0(R)$ enables us to highlight the platform's benefits and costs of inducing sellers' investment. In particular, we find that $\Pi_1(R) - \Pi_0(R) > 0$ if

$$\gamma\eta[(1-\delta)H + \tau R] + \eta R + \eta\delta H > (1-\eta)(1+\phi)\frac{c}{\eta} + c, \tag{2}$$

where the right-hand side represents the cost of inducing sellers' investment, whereas the left-hand side captures its benefits, which include three terms. The first term, $\gamma\eta[(1-\delta)H + \tau R]$, is the *increase in the extracted consumers' surplus*. The second term, ηR, is the *reduction in the expected consumers' sanctions*. The third term, $\eta\delta H$, is the *reduction in the expected liability cost*. These three terms clarify the forces that may drive the platform to induce sellers' investment: the surplus-extraction motive, the fear of consumers' sanctions, and the threat of liability. The degree of platform liability δ will affect the desirability of inducing investment both directly and indirectly (through its impact on the consumers' choice of R).

By comparing the platform's profits when investment is induced and when it is not, we find that $e = 1$ is induced whenever consumers' punishment is sufficiently severe, i.e., when:

$$R \geq \tilde{R} := \frac{[1+\phi(1-\eta)]c}{(1+\gamma\tau)\eta^2} - \frac{[\gamma(1-\delta)+\delta]H}{1+\gamma\tau}.$$

Two points are worth highlighting. First, a higher degree of platform's legal liability δ crowds out consumers' reputational sanctions since $\frac{\partial\tilde{R}}{\partial\delta} < 0$. Second, if H is sufficiently

large as compared to c, consumers need not discipline the platform to induce $e = 1$. Specifically, this occurs if:

$$H \geq \tilde{H}_P := \frac{[1 + \phi(1 - \eta)]c}{[\gamma(1 - \delta) + \delta]\eta^2}.$$

The threshold can also be rewritten in terms of δ:

$$\tilde{\delta}_P := \frac{[1 + \phi(1 - \eta)]c - \eta^2\gamma H}{(1 - \gamma)\eta^2 H}.$$

An attractive feature of platform liability is that it may help to make socially costly consumers' sanctions redundant. To understand why, consider that the platform's incentive to induce sellers' investment is strengthened by the anticipation of legal liability towards consumers: $\frac{\partial \tilde{H}_P}{\partial \delta} < 0$.

If $\delta < \tilde{\delta}_P$, consumers must punish the platform if the product is harmful for otherwise sellers will not invest. In stage 1, consumers will choose R to maximize their expected utility. If $e = 1$, $R = \tilde{R}$, and[13]

$$U_1 = (1 - \gamma)\Big[V - (1 - \eta)[(1 - \delta)H + \tau\tilde{R}]\Big]$$

If investment is not induced, $R = 0$:

$$U_0 = (1 - \gamma)[V - (1 - \delta)H].$$

If $\delta < \tilde{\delta}_P$, consumers punish the platform to induce investment when $U_1 \geq U_0$. Under the assumption that $\eta > \tau(1 - \gamma - \eta)$, this turns out to be the case when $\delta < \tilde{\delta}_C$ where

$$\tilde{\delta}_C := \frac{\eta^2(\eta + \gamma\tau)H - (1 - \eta)\tau[1 + (1 - \eta)\phi]c}{\eta^2[\eta - \tau(1 - \gamma - \eta)]H}.$$

The following lemma shows that only one between $\tilde{\delta}_C$ and $\tilde{\delta}_P$ can be relevant, given the restriction that $\delta \in [0, 1]$.

Lemma 1. *If $\tilde{\delta}_P > \tilde{\delta}_C$, then $\tilde{\delta}_P > 1$.*

We now characterize the equilibria for relatively high-value goods.

Remark 1. *Suppose that $V \geq \bar{V}$.*

1. *If $\delta \in [0, \min\{\tilde{\delta}_C, \tilde{\delta}_P\})$, then $R = \tilde{R}$, $f = \gamma\{V - (1-\eta)[(1-\delta)H + \tau\tilde{R}]\} - (1-\eta)\frac{c}{\eta} - c$, $r = \frac{c}{\eta}$, and $e = 1$.*
2. *If $H < \frac{[1+(1-\eta)\phi]c}{\eta^2} := \hat{H}$ and $\delta \in [\tilde{\delta}_C, 1]$, then $R = 0$, $f = \gamma[V - (1 - \delta)H]$, $r = 0$, and $e = 0$.*

[13] Below, we implicitly assume that $\tilde{R} \leq \bar{R}$, for otherwise the platform would not allow trading since it would incur a loss.

3. *If* $H \geq \hat{H}$ *and* $\delta \in [\tilde{\delta}_P, 1]$, *then* $R = 0$, $f = \gamma[V - (1-\eta)[(1-\delta)H]] - (1-\eta)\frac{c}{\eta} - c$, $r = \frac{c}{\eta}$, *and* $e = 1$.

An increase in platform liability lowers consumers' reputational sanction. However, it may also lead to an equilibrium wherein sellers do not invest: on the one hand, consumers may be compensated enough if there is an accident that they do not have a sufficient incentive to sanction the platform; on the other hand, the threat of liability is not sufficient for the platform to induce the sellers to invest. We gather the observations of the previous proposition in the following corollary.

Corollary 1. *Let* $V \geq \bar{V}$. *An increase in platform liability* δ *may discourage sellers' investment.*

When consumers expect to receive little compensation through legal liability, they have a strong incentive to use reputational sanctions to motivate the platform to discipline under-performing sellers. Notably, as legal liability increases, that is, δ gets higher, consumers' benefit from purchasing a non-harmful good decreases as they would get sufficient compensation from the platform. As a consequence, platform liability weakens consumers' incentives to sanction the platform. Although this implies a lower social cost due to savings in costly sanctions, a higher degree of platform liability may increase the likelihood that the goods are harmful because it may lead to equilibria where $e = 0$. This feature of platform liability must be taken into account in the design of legal liability of platforms. It must also be noted that, when the degree of platform liability is very high, the platform has a direct incentive in inducing sellers to invest. In any case, perhaps surprisingly, platform liability is always socially desirable in our setting as we demonstrate in the next proposition.

Proposition 2. *Let* $V \geq \bar{V}$. *Welfare is weakly increasing in* δ.

Intuitively, welfare (given by the sum of all players' expected payoffs) is strictly increasing in δ when it does not affect investment but reduces equilibrium reputational costs. This is the case when $H \geq \hat{H}$. Remarkably, a higher level of platform liability also benefits welfare when $H < \hat{H}$ and it leads to an equilibrium in which $e = 0$ and $R = 0$ from one in which $e = 1$ but $R = \tilde{R} > 0$. To understand why, consider that, thanks to the more generous expected compensation, consumers must prefer to give up sanctioning the platform and purchase a lower-quality good than obtain a higher-quality good but bear the sanctioning costs, i.e., $U_0(R = 0) > U_1(R = \tilde{R}^{PL} > 0)$. When this happens, it turns out to be beneficial for welfare as well, since the investment cost and the cost of disciplining under-performing sellers are also averted: in other words, the platform is strictly better off as $\pi_0(R = 0) > \pi_0(R = \tilde{R}^{PL} > 0) = \pi_1(R = \tilde{R}^{PL} > 0)$. The last equality owes

to the consumers choosing the minimum level of reputational sanctions that motivates the platform to induce the sellers to invest.[14]

4.3 Litigation Costs and Welfare Analysis

To properly conduct the welfare analysis and draw conclusions of the social desirability of introducing platform liability, it is crucial to acknowledge the existence of costs in using the court system to adjudicate claims by consumers against the platform or eventually, the seller.[15] This is even more so in an environment where the threat of consumers' reputational sanctions and the platform's ability to extract part of consumers' surplus may already be enough to induce sellers' investment. For this reason, in this section we assume that consumers bear a non-transferable loss $l_C \geq 0$ if they file a lawsuit against the platform. Similarly, the platform bears a cost l_P to defend the lawsuit. Thus, in stage 5, if the purchased product is defective, punishments are carried out but litigation takes place only if the harmed consumer finds it incentive-compatible to use the platform. We also assume that the costs l_C and l_P are fixed and independent of the fraction of harm the consumers could recover, i.e., they are independent of δ for any $\delta \in (0, 1]$.

In the analysis, there will be an additional stage, stage 5, where harmed consumers decide whether to bring a lawsuit against the platform. A harmed consumer will sue the platform only if the amount she can recover is enough to cover the litigation cost, i.e., only if $\delta H \geq l_C$ or, equivalently, if $\delta \geq \tilde{\delta}_L := \frac{l_C}{H}$. In stage 4, when joining a platform, a consumer's expected utility becomes:

$$U^E := (1-\gamma)\alpha\Big[V - (1-\eta e^E)[\min\{(1-\delta)H + l_C, H\} + \tau R]\Big].$$

In stage 2, when considering the equilibrium in which $e = 1$, we need to distinguish between two cases. Suppose first that $\delta \geq \tilde{\delta}_L$. This scenario is closer to the one examined in the previous section: the platform chooses the contract (f, r) to maximize:

$$f - (1-\eta)[\phi r + R + \delta H + l_P],$$

subject to the sellers' participation constraint:

$$\gamma\Big[V - (1-\eta)[(1-\delta)H + l_C + \tau R]\Big] - f - (1-\eta)r - c \geq 0,$$

and the sellers' incentive compatibility constraint $r \geq \tilde{r}$. While r_1 is unaltered, the fee becomes:

$$f_1(R) = \gamma\Big[V - (1-\eta)[(1-\delta)H + l_C + \tau R]\Big] - (1-\eta)\frac{c}{\eta} - c.$$

[14] Note that the sellers' participation constraint binds and, consequently, they get zero utility.

[15] We acknowledge that litigating a claim is not the only action by consumers and the platform that may entail costs. Reporting, even formally, an incident to the platform and the handling of the complaint by the platform clearly involves lower costs than litigation.

As a result, the platform's expected utility is:

$$\Pi_1(R) = \gamma[V - (1-\eta)[(1-\delta)H + l_C + \tau R]] - (1-\eta)\frac{c}{\eta} - c$$
$$- (1-\eta)\left(\phi\frac{c}{\eta} + R + \delta H + l_P\right),$$

For a fixed R, the platform's expected revenue decreases because of the consumers' litigation costs. Moreover, the platform's expected loss from selling a potentially harmful good also includes the expected litigation cost $(1-\eta)l_P$. The level of R above which $\Pi_1(R)$ would be negative becomes:

$$R \leq \bar{R}^L := \frac{\gamma V}{(1-\eta)(1+\gamma\tau)} - \frac{[\gamma(1-\delta)+\delta]H}{1+\gamma\tau} - \frac{[1+(1-\eta)\phi]c}{\eta(1-\eta)(1+\gamma\tau)} - \frac{\gamma l_C + l_P}{(1+\gamma\tau)}.$$

Following the same approach, the platform's expected utility in the equilibrium in which $e = 1$ but $\delta < \tilde{\delta}_L$ would be:[16]

$$\Pi_1'(R) = \gamma[V - (1-\eta)[H + \tau R]] - (1-\eta)\frac{c}{\eta} - c$$
$$- (1-\eta)\left(\phi\frac{c}{\eta} + R\right),$$

As before, when characterizing the equilibrium where sellers are not induced to invest, we need to distinguish between two main cases, depending on the value of V relative to H. The scenario in which goods have relatively low value, i.e., $V \in [(1-\eta)H + c, H)$, remains qualitatively unaltered. We just note that a higher degree of liability may undermine the platform's incentive to motivate investment on the sellers' part. To see this, note that Condition (1) would also include on the right-hand side the term $\frac{(1-\eta)(\gamma l_C + l_P)}{\gamma}$. Furthermore, $\Pi_1' \geq 0$ requires a milder condition.[17] As a result, Proposition 1 continues to hold.

Let us now examine the scenario in which goods are of relatively high value, $V \geq \bar{V}$. If $\delta \geq \tilde{\delta}_L$, qualitatively we obtain the same results, as we show in the appendix. The relevant thresholds can be written as follows:

$$\tilde{\delta}_P^L := \frac{[1+\phi(1-\eta)]c - \eta^2[\gamma(H+l_C)+l_P]}{(1-\gamma)\eta^2 H};$$
$$\tilde{\delta}_C^L := \frac{\eta^2(\eta+\gamma\tau)(H+l_C) + \eta^2\tau(1-\eta)l_P - (1-\eta)\tau[1+(1-\eta)\phi]c}{\eta^2[\eta - \tau(1-\gamma-\eta)]H}.$$

[16] Also, in this case, R cannot be too high and the threshold above which $\Pi_1'(R)$ would be negative can be retrieved from $\bar{R}$ by setting $l_C = l_P = 0$.

[17] Specifically, (1) would be rewritten as:

$$V \geq (1-\eta)H + \frac{[1+(1-\eta)\phi]c}{\eta\gamma}.$$

Since $(1-\delta) + \delta/\gamma > 1$ for all $\delta > 0$ and $\gamma < 1$, this condition is always easier to satisfy.

We now proceed to describe the scenario in which $\delta < \tilde{\delta}_L$. If so, when $e = 0$, the platform's profit is:

$$\Pi_0'(R) = \gamma[V - H - \tau R] - R.$$

The threshold value of R above which the platform decides to induce sellers' investment is:

$$\tilde{R}' := \frac{[1 + \phi(1-\eta)]c}{(1+\gamma\tau)\eta^2} - \frac{\gamma H}{1+\gamma\tau}$$

Importantly, even when $\delta = 0$, the platform has an incentive to decrease the probability of harm because it indirectly extracts surplus from consumers. The consumers' expected utility is:

$$U_1' = (1-\gamma)\Big[V - (1-\eta)[H + \tau\tilde{R}']\Big]$$

when $e = 1$ is induced and

$$U_0' = (1-\gamma)(V - H).$$

when $e = 0$ is induced. Investment is then induced if $H > \tilde{H}_C'$ where

$$\tilde{H}_C' := \frac{(1-\eta)\tau[1 + (1-\eta)\phi]c}{\eta^2(\eta + \gamma\tau)}.$$

When the platform is not formally or practically subject to legal liability towards consumers for defective products purchased from sellers on the platform, i.e., $\delta \in [0, \delta_L)$, there always exists a parameter region where consumers want to sanction the platform to induce the sellers' safety investment.[18] The next lemma formalizes the above observation.

Lemma 2. *Suppose that $V \geq \bar{V}$. If $\delta < \tilde{\delta}_L$, there are three cases:*

1. *If $H \leq \tilde{H}_C'$, then $R = 0$, $f = \gamma[V - H]$, $r = 0$, and $e = 0$.*
2. *If $H \in (\tilde{H}_C', \tilde{H}_P']$, then $R = \tilde{R}'$, $f = \gamma\{V - (1-\eta)[H + \tau\tilde{R}'] - (1-\eta)\frac{c}{\eta} - c$, $r = \frac{c}{\eta}$, and $e = 1$.*
3. *If $H > \tilde{H}_P'$, then $R = 0$, $f = \gamma[V - (1-\eta)(H)] - (1-\eta)\frac{c}{\eta} - c$, $r = \frac{c}{\eta}$, and $e = 1$.*

[18] To see this, let $\delta \in [0, \tilde{\delta}_L)$, then $\tilde{R}' \leq 0$ if $H > \tilde{H}_P'$, where

$$\tilde{H}_P' := \frac{[1 + \phi(1-\eta)]}{\gamma\eta^2}c.$$

Note that $\tilde{H}_P' > \tilde{H}_C'$ if

$$\begin{aligned} \frac{[1 + \phi(1-\eta)]}{\gamma\eta^2}c > \quad & \frac{(1-\eta)\tau[1 + (1-\eta)\phi]}{\eta^2(\eta + \gamma\tau)}c \\ \Leftrightarrow (\eta + \gamma\tau) > \quad & (1-\eta)\gamma\tau \Leftrightarrow \quad \eta > -\gamma\tau\eta, \end{aligned}$$

which is always verified.

Putting together the results of the above lemmata, when platform liability, measured by δ, is low enough so that consumers would not find it incentive-compatible to sue the platform if the product is harmful, reputational sanctions may be needed to induce sellers' investment. However, if H is large enough, the platform would induce investment even in the absence of consumers' sanctions, since product safety increases the equilibrium fee it can request from the sellers. When $\delta \geq \tilde{\delta}_L$, litigation occurs in equilibrium. As platform liability increases, the platform's incentive to induce sellers to invest derives less from consumers' outrage and punishment as these are replaced by the threat of legal liability. However, a higher level of liability faced by the platform discourages consumers from committing to punishments, given that their benefit from purchasing a non-defective good comparatively diminishes. Although this implies a lower social loss due to savings on costly sanctions, an increase in the degree of platform liability increases the likelihood that the goods are harmful because it may lead to equilibria in which $e = 0$. Moreover, as lawsuits take place, the welfare loss associated with their costs is borne by the parties. These are the downsides of platform liability. Its unintended consequences must be taken into account in the design of platforms' legal liability.

To determine the optimal level of platform liability when $V \geq \bar{V}$, we consider social welfare that we write as a piecewise-defined function:

$$SW = \begin{cases} V - H, & if \quad \delta < \tilde{\delta}_L \text{ and } H \leq \tilde{H}'_C; \\ V - (1-\eta)\left[H + \max\{\tilde{R}'(\delta)(1+\tau), 0\} + \frac{c}{\eta}(1+\phi)\right] - c, & if \quad \delta < \tilde{\delta}_L \text{ and } H > \tilde{H}'_C; \\ V - (1-\eta)\left[H + \tilde{R}(\delta)(1+\tau) + l_C + l_P + \frac{c}{\eta}(1+\phi)\right] - c, & if \quad \delta \in [\tilde{\delta}_L, \min\{\tilde{\delta}^L_C, \tilde{\delta}^L_P\}); \\ V - H - l_C - l_P, & if \quad \delta \in [\tilde{\delta}^L_C, \min\{\tilde{\delta}^L_P, 1\}]; \\ V - (1-\eta)\left[H + l_C + l_P + \frac{c}{\eta}(1+\phi)\right] - c, & if \quad \delta \in [\tilde{\delta}^L_P, 1] \end{cases}$$

Because of legal costs, welfare may decline when the degree of platform liability increases. To provide the intuition, if reputational sanctions and sellers' investments are very costly, it may be socially desirable to induce $e = 0$. However, if that is the case, a benevolent social planner would prefer to avoid litigation to economize on its costs. This scenario is illustrated in Figure 1 where we assume the following values for the parameters: $V = 100$, $H = 20$, $c = 2$, $\eta = 0.25$, $\gamma = 0.3$, $\tau = 0.2$, $\phi = 0.4$ and $l_C = l_P = 1$. As a result, $\tilde{\delta}_L = 0.05$, $\tilde{\delta}_C = 0.13 < 2.45 = \tilde{\delta}_P$, and $H < \tilde{H}'_C$. Moreover, if H and γ are large enough, the platform has a significant incentive to ensure product safety. Then, platform liability may be unnecessary to induce sellers' investment and may actually be welfare-reducing because it entails costly litigation. Again, a social planner would prefer to avoid litigation. This scenario is illustrated in Figure 2 where we assume the following values for the parameters: $V = 100$, $H = 20$, $c = 1$, $\eta = 0.25$, $\gamma = 0.7$, $\tau = 0.1$, $\phi = 0.2$ and $l_C = l_P = 2.5$. As a result, $\tilde{\delta}_L = 0.125$, $\tilde{\delta}_P = 0.025 < 1.226 = \tilde{\delta}_C$, and $H > \tilde{H}'_C$.

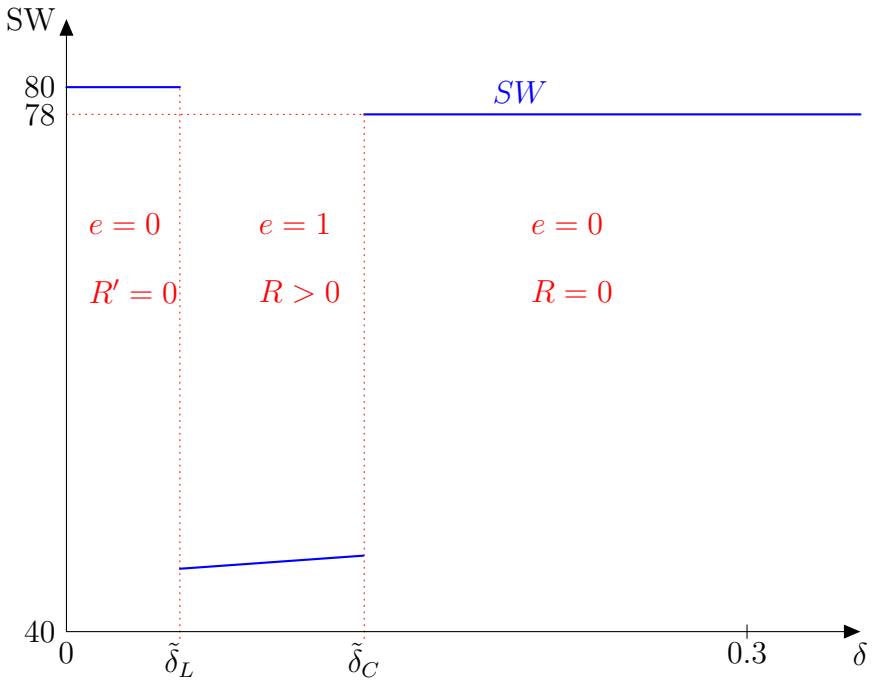

Figure 1: Social Welfare - Scenario 1

We formalize these results in the following proposition.

Proposition 3. *Let $V \geq \bar{V}$, $l_C > 0$ and $l_P > 0$. An increase in platform legal liability δ may be welfare-decreasing.*

Therefore, platform liability may be desirable if it (i) reduces costly reputational sanctions or (ii) leads to an equilibrium where sellers invest. Thus, if sellers already invest in equilibrium without reputational sanctions, introducing costly platform liability is welfare decreasing. In a similar fashion, if platform liability results in an equilibrium with no investment, it could be better to avoid legal costs through limitations on platform liability.

5 Extensions

In this section, we focus on the more interesting case of high-value goods and extend the baseline model in several directions to verify the robustness of our policy implications.

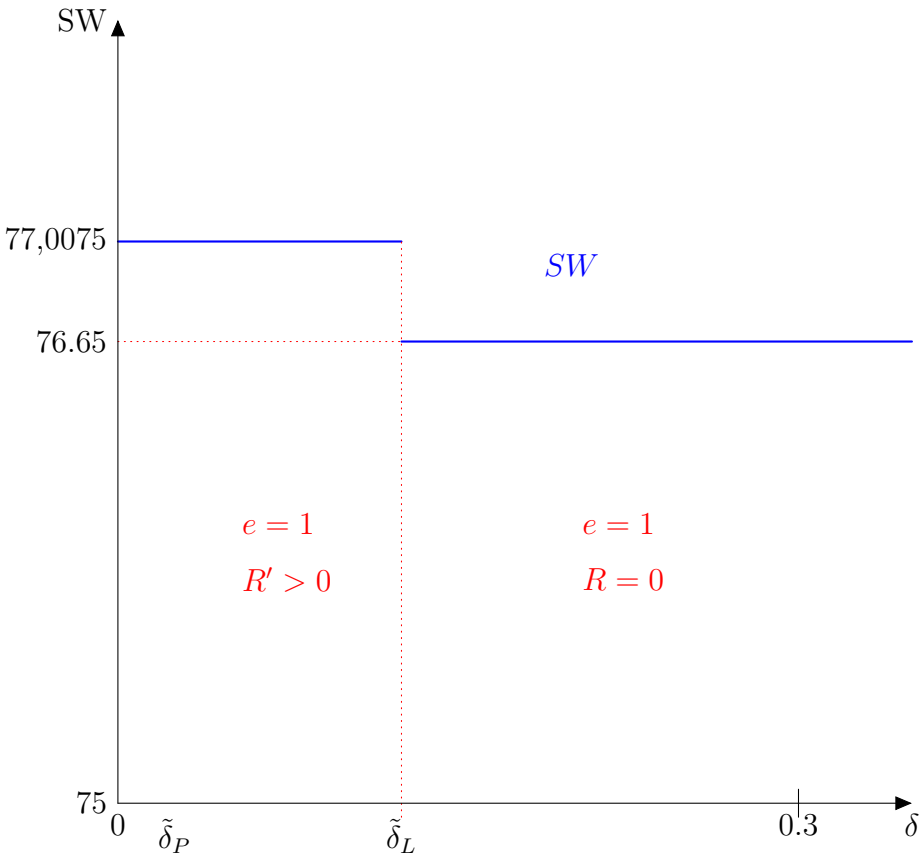

Figure 2: Social Welfare - Scenario 2

5.1 Platform liability with decoupling

One policy implication that derives from the previous section is that decoupling the payment received by the harmed consumers from the amounts paid by the platform may be desirable.[19] We now consider the case in which the platform is liable but there is decoupling. This means that the sum of the losses incurred by consumers and the liability of the platform is larger than H. In particular, we assume that consumers incur a loss of $(1-\delta)\Delta H$ with $\Delta \in [1, \frac{1}{(1-\delta)}]$. Notice that $\Delta = 1$ is the case in which liability is frictionless or not decoupled (albeit not necessarily fully compensatory, as we know). When $\Delta = \frac{1}{(1-\delta)}$, consumers suffer the harm in full and receive no damages compensation, but the platform faces a penalty δH. In this case, we denote the equilibrium values with the superscript PLD. This change in the liability regime mainly affects the expected utility of consumers from buying through the platform:

$$U^E = (1-\gamma)\alpha[V - (1-\eta e^E)[(1-\delta)\Delta H + \tau R]]$$

Again, we solve this extension of the model by backward induction, mimicking the solution of the previous section. In particular, the safety investment problem of the seller has the same solution: the seller invests if r is at least as high as $\tilde{r}^{PLD} := \frac{c}{\eta}$.

Stage 2 in which the platform chooses the contract (f, r) with the seller, has the same structure as in the baseline analysis, but the participation constraint of the seller changes. In particular, when high effort is induced, $e = 1$ ($r \geq \tilde{r}^{PLD}$), the IC becomes:

$$\gamma\Big[V - (1-\eta)[(1-\delta)\Delta H + \tau R]\Big] - f - (1-\eta)r - c \geq 0,$$

and with the optimal contract, the platform's expected utility is:

$$\Pi_1^{PLD}(R) = \gamma\Big[V - (1-\eta)[(1-\delta)\Delta H + \tau R]\Big] - (1-\eta)\frac{c}{\eta} - c - (1-\eta)\left(\phi\frac{c}{\eta} + R + \delta H\right).$$

Similarly, when no effort is induced, the sellers' participation constraint becomes:[20]

$$\gamma\Big[V - (1-\delta)\Delta H - \tau R\Big] - f - r \geq 0.$$

and the platform's expected utility becomes:

$$\Pi_0^{PLD}(R) = \gamma[V - (1-\delta)\Delta H - \tau R] - R - \delta H.$$

[19] On decoupling liability see Polinsky and Che (1991).

[20] Let us assume, as in section 4.2 above, that (i) consumers are still willing to buy the good when they expect it to be defective with probability 1, which requires $V \geq (1-\delta)H$, and that (ii) the platform is willing to host goods that are defective with probability 1, which requires $V \geq (1-\delta)H + \frac{\delta}{\gamma}H$. The second constraint is tighter.

The comparison between $\Pi_1^{PLD}(R)$ and $\Pi_0^{PLD}(R)$ allows us to clarify how decoupling affects the desirability of inducing sellers' investment. Inequality (3) is the analog of Inequality (2) in section 4 for this extension:

$$\Pi_1^{PLD}(R) > \Pi_0^{PLD}(R) \Leftrightarrow \gamma\eta[(1-\delta)\Delta H + \tau R] + \eta R + \eta\delta H > (1-\eta)(1+\phi)\frac{c}{\eta} + c. \quad (3)$$

Clearly, decoupling impacts directly on consumers' extracted surplus, and indirectly on the consumers' choice of reputational sanctions. By comparing the platform's profits when investment is induced and when it is not, we find that $e = 1$ is induced when

$$R \geq \tilde{R}^{PLD} := \left[\frac{[1+\phi(1-\eta)]c}{(1+\gamma\tau)\eta^2}\right] - \frac{[\gamma(1-\delta)\Delta + \delta]H}{1+\gamma\tau},$$

where $\tilde{R}^{PLD}$ is decreasing in Δ. The threshold value of δ above which consumers need not discipline the platform is:

$$\tilde{\delta}_P^{PLD} := \frac{[1+\phi(1-\eta)]c - \eta^2\gamma\Delta H}{(1-\gamma\Delta)\eta^2 H}.$$

When this condition does not hold, in stage 1, consumers choose $R = \tilde{R}^{PLD}$ to induce $e = 1$, which leads to

$$U_1^{PLD} = (1-\gamma)\{V - (1-\eta)[(1-\delta)\Delta H + \tau\tilde{R}^{PLD}]\}.$$

If investment is not induced, $R = 0$:

$$U_0^{PLD} = (1-\gamma)[V - (1-\delta)\Delta H].$$

Then, the cutoff $\tilde{\delta}_C^{PLD}$ for which consumers are indifferent between inducing effort or not, if investment is not induced, $R = 0$:

$$\tilde{\delta}_C^{LDP} := \frac{\eta^2(\eta+\gamma\tau)\Delta H - (1-\eta)\tau[1+(1-\eta)\phi]c}{\eta^2[\eta\Delta - \tau(1-\gamma\Delta-\eta)]H}.$$

Akin to the baseline analysis, only one threshold between $\tilde{\delta}_C^{LDP}$ and $\tilde{\delta}_P^{LDP}$ can be relevant. In particular, if the inequality $H < \frac{[1+\phi(1-\eta)]c}{\eta^2}$ holds, the threshold $\tilde{\delta}_C^{LDP}$ matters and increases in Δ; if instead the previous inequality is not satisfied, the threshold $\tilde{\delta}_P^{LDP}$ matters and decreases in Δ. In Remark 2, we summarize these results highlighting the relationship between decoupling and consumers' reputational sanctions.

Remark 2. *Suppose that $V \geq \hat{V}$.*

(i) If $H > \hat{H}$, decoupling and consumers' reputational sanctions are substitutes.

(ii) If $H < \hat{H}$, decoupling and consumers' reputational sanctions are complements.

If H is sufficiently high, investment always occurs. In this case, decoupling is welfare improving as it moves $\tilde{\delta}_P^{LDP}$ to the left increasing the region in which consumers do not use reputational sanctions. This is because a higher Δ leads to a higher increase in the consumers' surplus that can be extracted by the platform when it induces sellers' investment. As a result, a lower level of consumers' sanctions is needed to motivate the platform. If H is low enough, an increase in the decoupling term moves $\tilde{\delta}_C^{LDP}$ to the right, and its effect on social welfare is ambiguous. On the plus side, it increases the region of the parameters for which high effort is induced. Its downside is that reputational sanctions are more often needed in order to induce investment.

5.2 Sellers with reputational penalties and platform liability

In this subsection, we consider that reputational penalties triggered by consumers may affect both the platform and the seller. Specifically, let $\beta \in [0,1]$ denote the share of the reputational penalty suffered by the platform, with the seller bearing the complementary share $1-\beta$. As in the main analysis, we solve by backward induction and we denote the equilibrium values of this setting with the superscript SRL. On the consumer side nothing changes, whereas the seller's decision on the safety investment in stage 3 becomes:

$$\max_{e\in\{0,1\}} \quad -(1-\eta e)(r+(1-\beta)R) - ce.$$

Similarly to the main case, a seller weakly prefers to invest if r is at least as high as the following critical value, $\tilde{r}^{SRL} = \max\{\frac{c}{\eta} - (1-\beta)R, 0\}$. When the seller bears some reputational sanctions, the required platform penalty for inducing effort is reduced. Moreover, if $R > \frac{c}{\eta(1-\beta)}$, then the seller has incentives to provide high effort without any platform penalty. We focus on the case in which $R \leq \frac{c}{\eta(1-\beta)}$. Notice that as the reputational penalty R is costly, R higher than $\frac{c}{\eta(1-\beta)}$ is never optimal.

Consider now stage 2 and suppose that we are in the equilibrium where sellers are induced to invest, i.e., $e=1$. The platform chooses the contract (f,r) to maximize:

$$f - (1-\eta)(\phi r + \beta R + \delta H),$$

subject to the sellers' participation constraint:

$$\gamma[V - (1-\eta)((1-\delta)H + \tau R)] - f - (1-\eta)(r+(1-\beta)R) - c \geq 0,$$

and the sellers' incentive compatibility constraint:

$$r \geq \tilde{r}^{SRL}.$$

It can be shown that, when investment is induced (subscript 1 below),

$$\begin{aligned} r_1^{SRL}(R) =& \frac{c}{\eta} - (1-\beta)R; \\ f_1^{SRL}(R) =& \gamma[V - (1-\eta)(1-\delta)(H+\tau R)] - (1-\eta)\frac{c}{\eta} - c. \end{aligned}$$

The platform's expected utility is:

$$\Pi_1^{SRL}(R) = \gamma\Big[V-(1-\eta)((1-\delta)H+\tau R)\Big]-(1-\eta)\frac{c}{\eta}-c-(1-\eta)\left[\phi\left(\frac{c}{\eta}-(1-\beta)R\right)+\beta R+\delta H\right]$$

The platform's profits are decreasing in δ, $\frac{\partial \Pi_1^{SRL}(R)}{\partial \delta} = (\gamma-1)(1-\eta)H < 0$, since higher δ increases consumers surplus but the platform can appropriate only a fraction γ, and this cannot offset the cost of increased liability. The platform's profits are also decreasing in β, $\frac{\partial \Pi_1^{SRL}(R)}{\partial \beta} = -(1-\eta)(1+\phi)R < 0$. Bear in mind that the platform internalizes the impact of the consumer reputational sanction faced by the seller, since the latter has to be compensated by the platform for all its costs. However, the lower the reputational sanction falling upon the seller, the more incentives for safety effort need to be generated by the platform through another costly sanctioning mechanism. This gives rise to a sort of "double marginalization" scenario leading to lower platform profits.

As in the baseline setting, we now analyze the equilibrium where sellers are not induced to invest, i.e., $e = 0$. The platform chooses the contract (f, r) to maximize:

$$f - (\phi r + \beta R + \delta H),$$

subject to the sellers' participation constraint:[21]

$$\gamma[V - ((1-\delta)H + \tau R)] - f - r - (1-\beta)R \geq 0.$$

It follows that, when $e = 0$, the contract between the platform and the seller prescribes (subscript 0 below):

$$\begin{aligned} r_0^{SRL}(R) =& 0; \\ f_0^{SRL}(R) =& \gamma[V - ((1-\delta)H + \tau R)] - (1-\beta)R \end{aligned}$$

The platform's expected profits when high effort is not induced is equivalent to the baseline model:

$$\Pi_0^{SRL}(R) = \gamma[V - ((1-\delta)H + \tau R)] - R - \delta H.$$

Then, $\Pi_0^{SRL}(R)$ does not depend on β, and it is decreasing in δ, $\frac{\partial \Pi_0^{SRL}(R)}{\partial \delta} = (\gamma-1)H < 0$.

By comparing Π_1^{SRL} and Π_0^{SRL}, we can analyze the effects of an increase in β on the incentives to induce effort by the platform. Inequality (4) is the analog of Inequality (2) in section 4 for this extension and $\Pi_1^{SRL}(R) > \Pi_0^{SRL}(R)$ if:

$$\gamma\eta[(1-\delta)H+\tau R]+[1-\beta(1-\eta)]R+\eta\delta H > (1-\eta)(1+\phi)\frac{c}{\eta}+c-(1-\eta)\phi(1-\beta)R. \quad (4)$$

A higher $1-\beta$ has a negative effect on the right-hand side of the above inequality, as it is less costly to motivate sellers to invest. Moreover, on the left-hand side of the

[21] Let us suppose for now that the consumers are still willing to buy the good when they expect it to be defective with probability 1, which requires $V \geq H$.

inequality, a higher $1-\beta$ alleviates the platform's fear of retaliation since it reduces the double marginalization effect previously described. Hence, a higher $1-\beta$ strengthens the platform's incentive to induce sellers' investment. We find that $e=1$ is induced whenever consumers' punishment is sufficiently severe, i.e., when:

$$R \geq \tilde{R}^{SRL} := \frac{[1+\phi(1-\eta)]c}{\eta[1+\gamma\eta\tau-(1-\eta)(\beta(1+\phi)-\phi)]} - \frac{\eta[\gamma(1-\delta)+\delta]H}{1+\gamma\eta\tau-(1-\eta)(\beta(1+\phi)-\phi)},$$

where $\tilde{R}^{SRL}$ lower than zero means that consumers do not need to discipline the platform. It can be easily shown that this happens if $\delta \geq \tilde{\delta}_P^{SRL} = \tilde{\delta}_P$. In line with the baseline model, $\tilde{R}^{SRL}$ is decreasing in δ, since the platform has more incentives to induce effort as a consequence of facing legal liability. Instead, $\tilde{R}^{SRL}$ is increasing in β. However, it is less sensitive to changes in β the higher is the platform exposure to liability, δ, given that $\frac{\partial^2 \tilde{R}^{SRL}}{\partial\beta\partial\delta} < 0$.

Following similar arguments as in the baseline model, we compare the utility of the consumers when they induce high effort, $e=1$, $R=\tilde{R}^{SRL}$,

$$U_1^{SRL} = (1-\gamma)[V-(1-\eta)((1-\delta)H+\tau\tilde{R}^{SRL})].$$

and when they do not, $R=0$:

$$U_0^{SRL} = (1-\gamma)(V-(1-\delta)H).$$

Thus, consumers impose reputational punishment with an eye on inducing safety investments when:

$$\delta \leq \tilde{\delta}_C^{SRL} := \frac{\eta^2[1+\gamma\tau+\phi(1-\eta)-\beta(1-\eta)(1+\phi)]H-(1-\eta)\tau[1+(1-\eta)\phi]c}{\eta^2[1-\tau(1-\gamma-\eta)+\phi(1-\eta)-\beta(1-\eta)(1+\phi)]H},$$

with $\tilde{\delta}_C^{SRL} > \tilde{\delta}_C$ for any $\beta \in (0,1)$. In particular, if $\beta=1$, the two thresholds coincide, while if $\beta \in (0,1)$ the region in which $e=1$ and $R>0$ is larger than in the baseline model, meaning that it is more likely that the sellers' investment is induced in equilibrium. In Remark 3, we summarize these results.

Remark 3. *Suppose that $V \geq \hat{V}$.*

(i) If $H \geq \hat{H}$, a higher seller's reputational penalty does not affect sellers' investment decision, and increases welfare.

(ii) If $H < \hat{H}$, a higher seller's reputational penalty makes sellers' investment more likely, but may be detrimental for welfare.

When H is sufficiently high, although a higher $1-\beta$ does not affect sellers' investment decision, it decreases the moral-hazard cost and the consumers' reputational sanctions. As

a result, it is welfare increasing. Instead, when H is low enough, consumers' reputational penalties may induce sellers to invest more often, but they may entail a larger social loss due to reputational sanctions and moral-hazard costs.

Until now, we have considered that firms are homogeneous regarding β and that there is always possibility of trade between consumers and platforms/sellers. However, it is perhaps more realistic to consider that the utility of the consumer may eventually be negative and the platform may prefer not to offer a given product to consumers. Also, the platform may face heterogeneous sellers in terms of their β. In such a case, if $H < \hat{H}$, it may be possible that $\Pi_1^{SRL}(\delta, 0) > 0$, and $\Pi_1^{SRL}(\delta, 1) < 0$. If this is the situation, there exists a cut-off $\overline{\beta}(\delta)$ below which the product would be supplied in the platform, but not otherwise.[22]

How would the level of legal liability of the platform (δ) influence this result? Since inducing the platform to motivate the seller to invest in safety through legal liability instead of through consumers' reputational sanctions makes platform's profits less responsive to β, legal liability would make the selection of sellers active in the platform on the basis of β less appealing for the platform. On the one hand, it may reduce the overall profitability from the products. Moreover, it expands the region of H for which the platform's actions are independent of β. On the other hand, it reduces the relative cost difference of inducing effort from sellers with a lower β (more exposed to the reputational penalty from consumers) compared with those who are less sensitive to the consumers' reputational sanctions.

In sum, when reputational sanctions imposed by consumers may affect both the platform and the seller, legal liability on the platform reduces the importance of restricting access to the platform to sellers who are not impacted in a meaningful way by the punishments that consumers set in the wake of a negative event with a product bought on the platform. However, this effect may be offset by the fact that increasing liability may reduce the profits of the platform. In fact, we find that $\frac{\partial \overline{\beta}}{\partial \delta} < 0$ if $\gamma V < \frac{[1+\phi(1-\eta)]c}{\eta^2}$. Note that we are considering high-value goods, and with $\delta = 1$, $\gamma V > H$. Therefore, there could be instances in which the opposite result may arise.

5.3 Sellers with Liability Exposure

Now we will turn to a different source of heterogeneity across sellers. We refer to the ability to face compensation to consumers in case an accident involving the products they sell through the platform causes harm to consumers. This is something that has been considered in other contributions (Hua and Spier, 2021; Zennyo, 2023).

Suppose that sellers can also be liable, so that if an accident affecting a given seller's

[22] As the characterization of this threshold of β is long, we report it in the appendix.

product takes place, the platform faces an expected effective payment to consumers of $\lambda\delta H$, where $\lambda \in [0,1]$, and the seller who sold the product faces $(1-\lambda)\delta H$.

When the seller can cover the entire payment legally mandated to the consumer so that, effectively, i.e., λ can be set equal to 0, there might seem to be little room for having legal liabilities for third-party products being imposed upon the platform. This may make sense only when having the platform initially fronting claims from and payments to consumers saves administrative costs. An example may be found in settings where H is typically low, the loss to the consumer occurs shortly after the delivery of the product, and the platform is in possession of funds belonging to the seller (e.g., the purchase price from the particular transaction or from other sales through the platform) that can be used to compensate consumers. This would explain why return and reimbursement policies typically offered by intermediary platforms are generous and easily allow consumers to get their money back if they promptly claim that something is wrong with the product bought through the platform.

In fact, in our set-up, while the platform would like to set λ as low as possible, the legislator may be more hesitant to allocate all the liability to the seller, as we highlight in the next remark.

Remark 4. *Suppose that sellers can cover damages. There exists a threshold value $\hat{H}^{SL}$ such that*

1. *if $H \geq \hat{H}^{SL}$, a higher degree of seller liability is welfare beneficial;*
2. *if $H < \hat{H}^{SL}$, a higher degree of seller liability leads to safer goods, but may be detrimental to welfare.*

The platform always weakly prefers a higher degree of seller's liability.

Akin to consumers' reputational penalties suffered directly by the sellers, sellers' liability reduces the fee that the platform can charge to sellers but, simultaneously, alleviates the moral-hazard problem lowering the sanctioning cost needed to induce investment. Using the superscript SL to denote the solution, the seller's critical value of the platform's punishment that leads to $e = 1$ is $\tilde{r}^{SL} := \max\{\frac{c}{\eta} - (1-\lambda)\delta H, 0\}$. Thus, the reason why the platform would like to set λ as low as possible is twofold: it reduces the cost of inducing investment while simultaneously reducing the expected liability expenses.[23] Although safe products can be more easily obtained, welfare is not necessarily decreasing in λ. To see this, consider that when $H < \hat{H}^{SL}$ safer goods come at the cost of consumers' reputational sanctions. The latter, along with the moral-hazard rent and the investment costs, can outweigh the benefits of safer goods. In contrast, when $H \geq \hat{H}^{SL}$ investment

[23] This finding is reminiscent of Zennyo (2023).

is always induced, and seller liability is desirable as it reduces the moral-hazard rent and the consumers' reputational sanctions.

There are numerous factors, however, leading to sellers in the platform not being easily targeted by a direct claim from the consumer or a contribution claim from the platform who has initially compensated the consumer: sellers may be hard to trace, foreign-located, or lack the assets to pay compensation, especially if the harm affects a large number of consumers buying the same product.

If sellers are heterogeneous in the effective λ that they are likely to imply for the platform under a meaningful legal regime of platform liability (that is, when δ is significantly larger than 0), the platform would be in a situation broadly comparable to the one we analyzed in the previous sub-section: the platform may prefer to allow access to the platform only to those sellers who would imply a lower effective λ for the platform. This may be the case either because the seller may be directly sued by the consumer or, more probably, because the platform is able to use the possibility of "passing-on" the compensation paid to consumers to induce effort from the seller.[24] The intuition behind this result is similar to the one we observed previously in this section, and namely the kind of "double marginalization" in providing incentives for safety to sellers (now, with costly internal sanctions by the platform relative to the "passing on" of liability, and not the costly internal sanctions relative to the also costly consumers' reputational sanctions).

One could think that the legal liability regime may mandate a fixed level of platform liability that cannot be passed on to sellers ($\lambda = \bar{\lambda}$) through contribution actions or similar mechanisms. Similarly to what we noticed earlier in this section, this may make platforms less concerned with the characteristics of sellers conducive to a certain effective level of λ. However, under such a regime, in order to provide incentives to sellers the platform would need to resort to the costly internal platform sanctions, that may be less cost-effective than relying on contribution actions against sellers or other similar schemes.

5.4 Effectiveness of Platform's Sanctions upon Sellers

In this section, we let the effectiveness of the platform's sanctions upon sellers vary. In practice, there might be several reasons why this is the case. For one, some agents who are actually in charge of making the safety decisions may be harder to target because their true identity may be even unknown to the platform, if the goods are sold by a wholesaler. In addition, some sellers may care less about their reputation and long-term viability, trying to reap profits in the short term. In some occurrences, they might easily

[24] This can eventually take place ex ante through mechanisms such as the requirement to show reliable liability insurance or to post bonds to cover potential liabilities that the platform may face vis-à-vis consumers as a result of products sold over the platform by a seller.

change the business name and/or the location of their headquarters. To account for these possibilities, in this extension, we assume that the platform's cost of sanctioning sellers is heterogeneous. The platform knows the sellers' type, but this is unobservable to consumers.

Specifically, we let ϕ be distributed according to a continuous distribution $G(\cdot)$, with density $g(\cdot)$ over the support $[0, \infty)$. This implies that it will be prohibitively costly for the platform to sanction some types of sellers. If sellers may be motivated to invest only by the platform's sanction, these high-cost sellers will not invest in equilibrium. We now assume that there exists $\tilde{\phi} \in [0, \infty)$ such that a seller will not be induced to invest if $\phi > \tilde{\phi}$.Therefore, $G(\tilde{\phi}) \in [0, 1]$ will denote the fraction of participating sellers that invest in equilibrium and will be endogenously determined by the platform's contract.

In stage 4, when joining the platform, a consumer expects to get:

$$U^E := (1-\gamma)\alpha[V - (1 - \eta G(\tilde{\phi}))[(1-\delta)H + \tau R]].$$

Note that the participating sellers will extract the same fraction of the consumers' expected surplus, regardless of their type. As in the baseline model, in stage 3, a seller willing to join the platform will invest only if $r \geq \tilde{r} := \frac{c}{\eta}$.

Consider now stage 2. The platform will offer three categories of contract. First, with all participating sellers who do invest, the platform's contract (f_1, r_1) will be $r_1 = \tilde{r}$ and

$$f_1 = \gamma\alpha\Big[V - (1 - \eta G(\tilde{\phi}))[(1-\delta)H + \tau R]\Big] - \frac{c}{\eta}.$$

Second, with all participating sellers who do not invest, the platform's contract (f_0, r_0) will specify $r_0 = 0$ and

$$f_0 = \gamma\alpha\Big[V - (1 - \eta G(\tilde{\phi}))[(1-\delta)H + \tau R]\Big].$$

Participating sellers who invest pay a lower fee but may incur in sanctions if things go awry. For those sellers the platform would like to exclude, the platform will offer any contract that does not satisfy their participation constraint.

We now need to determine simultaneously the fraction of participating sellers (α) as well as which fraction of participating sellers will invest $(G(\tilde{\phi}))$, or equivalently, the threshold value $\tilde{\phi}$ below which a participating seller will invest. The platform will choose α and $\tilde{\phi}$ to maximize its expected profit:

$$\max_{\alpha\in[0,1],\tilde{\phi}\in[0,\infty)} \quad \alpha \int_0^{\tilde{\phi}} \left[f_1 - (1-\eta)\left(\phi\frac{c}{\eta} + R + \delta H\right)\right] g(\phi)d\phi$$
$$+\alpha(1 - G(\tilde{\phi}))[f_0 - (R + \delta H)],$$

Consider the first-order derivative with respect to α:

$$2f_0 - \int_0^{\tilde{\phi}} \left[\frac{c}{\eta} + (1-\eta)\left(\phi\frac{c}{\eta} + R + \delta H\right)\right] g(\phi)d\phi - (1 - G(\tilde{\phi}))(R + \delta H).$$

Note that the platform's profit may be convex in α, in which case $\alpha = 1$. This is always the case when $V \geq (1-\delta)H$.[25]

When the program is concave, α^* is determined from the first-order condition:

$$\alpha^*(\tilde{\phi}) = \frac{\int_0^{\tilde{\phi}} \left[\frac{c}{\eta} + (1-\eta)\left(\phi\frac{c}{\eta} + R + \delta H\right)\right] g(\tilde{\phi})d\phi + (1-G(\tilde{\phi}))(R+\delta H)}{2\gamma\Big[V - (1-\eta G(\tilde{\phi}))[(1-\delta)H + \tau R]\Big]}.$$

The program is always concave in $\tilde{\phi}$ and the first-order condition yields:

$$\tilde{\phi}^*(\alpha) = \frac{\eta^2}{(1-\eta)c}\Big[[\alpha\gamma(1-\delta)+\delta]H + (1+\alpha\gamma\tau)R\Big] - \frac{1}{1-\eta}.$$

If at the above value of $\tilde{\phi}$, the platform's profit is convex in α, then the solution $(\alpha, \tilde{\phi}) = (1, \tilde{\phi}^*(1))$.

Suppose that this is the case, a quick inspection reveals that the fraction of investing sellers increases with δ, H, R, and γ, whereas it decreases with c. Intuitively, when the platform suffers more severe repercussions following an accident (i.e., more liability or harsher consumers' sanctions), it is more inclined to ensure that sellers invest.

In stage 1, consumers choose R to maximize their expected utility:

$$(1-\gamma)[V - (1-\eta G(\tilde{\phi}^*(R)))[(1-\delta)H + \tau R]].$$

A higher R has two effects: its direct effect consists in increasing the sanctioning cost for the consumers, whereas its indirect effect is related to the increase in the equilibrium number of firms that invest: $\frac{\partial\tilde{\phi}^*(R)}{\partial R} > 0$. The first-order condition yields:

$$\eta g(\tilde{\phi}(R))(1+\gamma\tau)\frac{\eta^2}{(1-\eta)c}[(1-\delta)H + \tau R] - (1-\eta G(\tilde{\phi}(R)))\tau = 0$$

R is the solution to this implicit function.[26] In the following lemma we show that a higher degree of platform liability reduces consumers' sanctions.

Lemma 3. *Suppose $\alpha = 1$, an increase in δ has a negative impact on R^*.*

[25] To see why, note that the second-order derivative with respect to α yields:

$$V - (1-\eta G(\tilde{\phi}))[(1-\delta)H + \tau R].$$

If $G(\tilde{\phi}) = 0$, also $R = 0$ because consumers would anticipate that their sanctions are pointless. If $V \geq (1-\delta)H$, the platform would find it profitable to extend market size as much as possible even when no seller invests.

[26] Note that for the second-order condition to be satisfied, $g(\tilde{\phi})$ must be sufficiently monotone decreasing. One implication is that $G(\cdot)$ will be log-concave - see Corollary 1 in Bagnoli and Bergstrom (2005).

We now determine how the degree of platform liability affects social welfare, which is given by:

$$SW = V - \left(1 - \eta G(\tilde{\phi})\right)\left[H + R^*(1+\tau)\right] - \int_0^{\tilde{\phi}} \left((1-\eta)(1+\phi)\frac{c}{\eta} + c\right) g(\phi) d\phi.$$

Below, we report the first-order condition and we point out that there are opposing forces at play.

$$\frac{\partial SW}{\partial \delta} = \overbrace{\eta g(\tilde{\phi})\left[H + R^*(1+\tau)\right]\frac{\partial \tilde{\phi}}{\partial \delta}}^{>0} - \overbrace{\left(1 - \eta G(\tilde{\phi})\right)\frac{\partial R^*}{\partial \delta}(1+\tau)}^{>0}$$
$$- \underbrace{\left((1-\eta)(1+\tilde{\phi})\frac{c}{\eta} + c\right) g(\tilde{\phi})\frac{\partial \tilde{\phi}}{\partial \delta}}_{<0}.$$

As a higher δ increases the equilibrium number of sellers that invest, i.e., $\frac{\partial \tilde{\phi}}{\partial \delta} > 0$, it reduces harm and consequently consumers' sanctions. This is captured by the first term. Moreover, δ at least partially replaces costly consumers' sanctions as a means to incentivize the platform to induce investment, because $\frac{\partial R^*}{\partial \delta} < 0$. This is captured by the second term. Yet a higher proportion of sellers that invest is also socially costly, because of the investment cost and the platform's sanctions needed to induce investment. If over the support of δ, the first two terms outweigh the last one, a benevolent legislator should opt for full platform liability. Otherwise, the optimal solution will be interior. The following corollary follows.

Corollary 2. *When $\alpha = 1$, welfare may not be monotonically increasing in δ over its $[0,1]$ support.*

Suppose now that the program is concave in α and let us assume that a unique solution exists, that is, there exists a unique admissible pair $(\alpha^*, \tilde{\phi}^*)$ such that $\alpha^* = \alpha^*(\tilde{\phi}^*)$ and, simultaneously, $\tilde{\phi}^* = \tilde{\phi}^*(\alpha^*)$. We obtain the following remark.

Remark 5. *A higher degree of platform liability δ has an ambiguous effect on the fraction of investing sellers and the fraction of participating sellers.*

When $\alpha < 1$, a higher δ may lead to a reduction in the number of participating sellers. Intuitively, the platform does not want to allow sellers who do not invest in the platform. This occurs unless stricter liability at the same time significantly decrease consumers' sanctions. If R is highly responsive to changes in δ, a higher degree of platform liability may be conducive to more participation.

6 Regulation and Policy Implications

When new phenomena challenge existing legal frameworks, courts and commentators often resort to reinterpreting doctrines or to stretching concepts to accommodate the developments. In the US, determining online platforms' liability vis-à-vis consumers has hinged upon characterizing -or not- the platforms as "sellers" or "distributors". The European debate, with its stricter legal separation between seller and manufacturer in product liability, has focused both on the platforms' distinctive factors that would lead to platforms' liability under existing rules in contract and also on certain changes in the current legal framework.

In the US, courts have not escaped the policy debate with divergent outcomes. In Oberdorf v. Amazon, the US Court of Appeals held Amazon liable, finding that it was a "seller" with substantial control over vendors. However, in Stiner v. Amazon the Supreme Court of Ohio ruled that Amazon was not a "supplier" under the Ohio Products Liability Act, as it had no relationship with the manufacturer or entities in the seller's distribution channel. In Bolger v. Amazon, the California Court of Appeals held Amazon liable, as Amazon had placed itself between the seller and the buyer and controlled the listing, payment, and shipment of the product. Conversely, in McMillan v. Amazon, the Supreme Court of Texas determined that Amazon was not a seller under Texas law and therefore was not liable for harm caused by a third-party product. In Papataros v. Amazon, the US Dictrict Court in New Jersey found that Amazon was a seller under the New Jersey Product Liability Act in relation to the purchase of a defective scooter, as Amazon had control over the sale process and was in the position to spread the cost of defects as if it were a quasi-insurer.

In Europe, the European Law Institute Model Rules on platform liability advocate that platforms with a "predominant influence" over sellers should be liable on an equal footing as true sellers. The recent Digital Services Act intends to combat a potential weakening of consumers' rights by the intervention of platforms and requires the latter to ensure seller traceability and compliance with consumer protection laws.

Overall, the existing debate underscores the importance of properly understanding the role of platform liability on the functioning of third-party transactions in online marketplaces and how this affects the design of liability regimes. We believe that the debate should bring to the foreground the rationales for online platform liability in third-party transactions, as well as their impact on the contours and design of such liability regimes.

In the current policy controversies surrounding the liability framework for online intermediary platforms several strands of thought can be traced. One is linked to the cheapest cost avoider notion. Sharkey (2020, 2022) argues that in the world of e-commerce mediated by online platforms, the operators of the latter are the cheapest cost avoiders

with respect to the defects and unsafe features of the consumer goods transacted in the platform. In the physical marketplaces, sellers can exercise a positive role on product safety through a combination of channels and influences. The same would arguably be true about online marketplaces, who are the new "essential players" exercising control over what is transacted inside the platform. This brings the rationale for making online platforms liable close to the traditional doctrines of *respondent superior* and vicarious liability. Online platform operators occupy a key position in the governance of the interactions mediated through the platform. They are thus in the best position to police, monitor and punish behavior taking place within the platform.[27]

With our model we intend to highlight a number of factors that we believe are perhaps more relevant to understand the role that platform liability may play to improve the functioning of online markets. In this sense, obviously, we are interested in the incentives that a liability regime may create for the parties to undertake actions when there is a risk of malfunction of goods exchanged on a platform. To be sure, a number of contributions have explicitly looked into the incentives that liability may generate to platform operators in order to monitor, screen, and reduce harm from goods, services, and content that rely on the platform for their hosting and exchange: Buiten et al. (2020), Jeon et al. (2021), and Hua and Spier (2021).

Our model does not primarily look at the incentives for the platform to engage in monitoring or screening actions to increase the detection of misbehavior by the agents who offer goods, services, and content on the platform. We think that one needs to look at the overall position and behavior of the three parties: sellers who trade on the platform, the platform operator, and consumers. Platform liability is likely to influence all three of them, taking into account the parameters that define how sellers interact with consumers and how the online platform operator sets the rules for sellers to be able to offer their goods and services through the platform. Moreover, we believe that consumers' sanctions, platform internal penalties for harmful outcomes, and legal liability operate in conjunction and this combination lies at the core of the matter.

In this respect, given the sheer size and heterogeneity of goods exchanged, it can be prohibitively costly for platforms to engage in *ex ante* screening or monitoring of sellers' effort. We consider that among the circumstances that condition the way in which the three players interact in the online platform contracting game, the efficiency of organizing the complaints from consumers, and eventually providing compensation for the latter, as a result of interactions in the platform is particularly relevant in practice. For many transactions that take place on a platform, channeling through the platform the

[27]It is also argued that there are efficiency gains in relying on large businesses (such as sizable and even dominant providers of online platform services) to regulate the behavior of a multitude of unconnected sellers, when the alternative is the direct regulation by the government: Van Loo (2020).

interactions after an adverse event related to a good or service materializes is typically more efficient. It both saves administrative costs and fits the expectations of consumers who transact with third parties.[28] In such a setting the imposition of legal liability for product malfunction to the online platform may be particularly appealing.

In fact, one can empirically observe that online platforms "voluntarily" (i.e., when not legally required or beyond what is legally requested) take over the fronting of complaints vis-à-vis consumers when the stakes are not too high: lack of delivery of goods or services, even when the online platform is not involved in shipment; non-conformity of the goods or services with what the consumer expected; regrets about having bought a certain item. Here, platforms often adopt liberal return policies with no or very few questions asked, providing indemnity for minor instances of harm from the use of the products. This is especially the case for complaints arising shortly after delivery of the goods, since the platform would be using the proceeds from the transaction (that, simply deducting the platform's fee, belong to the seller) to provide redress. What are the effects of increased (from this voluntarily assumed level up to the level of complete and full) liability of the online platform for consumer harm? Our paper points out that the consequences are not straightforward. Some dilution of incentives of sellers to bring safer goods to online marketplaces may take place for low levels of consumer harm when consumers are compensated by platforms. Formal legal liability, however, at the same time allows consumers to save costly reputational sanctions over platforms and sellers.

Also, when the effectiveness of disciplinary measures by the platform over sellers is heterogeneous across sellers, platform liability may positively affect the equilibrium safety investments and the participation rate of sellers in the platform. Similarly, online platform liability also affects how platform operators select sellers who may be more or less affected by consumers' reputational sanctions when these fall both upon the platform and sellers. Depending on parameter values, one may end up with a less selective outcome in terms of sellers active on the platform.

7 Conclusions

Intermediaries have accompanied economic exchange for centuries. In our current world, online platforms are perhaps more ubiquitous and influential on economic transactions than their predecessors in the offline environment. We very often buy groceries, appliances, books, entertainment, transportation, travel, leisure, food, financial products, and many other goods and services through them. Our daily lives crucially depend on the

[28] To be sure, this may not necessarily be the case, and a fraction of consumers may prefer to deal directly with the seller.

availability and functioning of online platforms.

Not surprisingly then, their emergence and expansion have posed serious problems for several areas of law and public policy, from antitrust to data protection, from IP to consumer contracting. Legislatures, courts, and commentators struggle to capture the features of online platforms and their influence on the performance and consequences of the main principles and solutions in different legal fields. Platforms provide a natural stress test for a large portion of our legal and policy consensus.

One of the topics widely debated with respect to online platforms and their intermediary role is that of liability for transactions between (independent, that is, not controlled by the platform) sellers and buyers that, for reasons of defective quality or safety go wrong, generating negative consequences for consumers (personal harm or economic loss). Legal discussions and economic contributions have flourished with the goal of providing a better understanding and designing solutions. In this paper, we offer a new framework to think about these issues. The main distinctive feature of this framework lies in the active interaction between the three players: platform, seller, and consumers. Consumers react to product mishaps, platforms are able to discipline sellers as to their safety level through measures taken inside the seller/platform contract, and sellers may invest in safety to reduce the expected harm from their products.

In such a setting, imposing legal liability on the platform for third-party products will have a number of positive effects: substitute costly reputational sanctions by consumers, improve safety when sellers are heterogeneous on how sensitive they are on internal platform sanctions, and the possibility, under certain conditions, of expanding the range of sellers selected by the platform when the latter are diverse in how they are reached by platform's internal penalties and consumers' reputational sanctions. The counterproductive effect is linked with the decrease in safety that may follow the reduction in reputational punishments for low levels of consumer harm, as well as inducing litigation to provide incentives.

Naturally, there are many complications that would enrich the setting and the analysis: competition among platforms, platforms that compete with sellers with their own products, just to name a few. We believe, however, that the paper may illuminate some of the current legal and policy debates in Europe and the US, and we hope to provide more specific policy suggestions concerning contract, tort, and regulatory remedies in future research.

Our approach seems also to make sense of actual patterns and trends observed in the market. Let us show this claim. In recent years, online platforms have attempted to provide their own remedies for the cases of malfunctioning of products sold at the platform. To some extent, this sort of self-regulation can be seen as a deliberate response by those platforms to the potential ambitious regulation by governments, although there

may be other reasons at work as well, such as reducing costs for processing consumer claims and compensating them. Moreover, for claims and reimbursement close in time to the online transaction, the platform would merely be an "agent" using sellers' money to provide redress in a way that economizes in administrative costs.

Concerning Amazon, its policy varies depending on whether the sale takes place in the United States or in Europe. In the case of the United States, the internal Business Solution Agreement (BSA) states that third-party sellers must sign in before distributing their products, and that vendors using the Amazon selling service "*are solely responsible for any nonperformance, non-delivery, misdelivery, theft, or other mistake or act in connection with the fulfillment of Your (the sellers') products*", except in cases of credit card fraud.[29] This agreement clearly states that Amazon's obligation for any malfunction, fault, defect, or non-conformity of the goods is exclusively on the seller. Thus, the BSA excludes any liability for Amazon in relation to the quality or the condition of the product. However, it has been reported (Sharkey, 2022) that Amazon pledges to compensate consumers for bodily harm up to 1,000$ caused by products sold by third parties through the platform.

In Europe, according to article 6.1 of the Amazon Services Europe BSA, the vendor is required to indemnify Amazon for any claim or harm suffered as a result or consequence of the vendor's products.[30]

Section 8 of both the European and American BSAs requires sellers to have third-party liability insurance if sales of a specific product and over a certain period exceed a threshold (which varies depending on the region) covering products liability and bodily damage.

In the case of AliExpress, despite the fact that there are different contracting rules depending on where the seller is located, the product liability rule does not change for them: liability is transferred to sellers (see, for example, clause 6.7 of the AliExpress Service Agreement for EU Sellers) and, additionally, sellers acquire the obligation of compensating AliExpress for violations of applicable laws and regulations, contractual laws by AliExpress, and consumer's rights.[31]

Similarly, as stated in the US terms and conditions, eBay restricts its liability to a certain amount in disputes or breaches of contract between sellers and buyers, explicitly

[29] Here is the link.

[30] In particular, the third-party seller has to "*defend, indemnify, and hold harmless Amazon, and [their] officers, directors, employees, and agents, against any third-party claim, loss, damage, settlement, cost, expense, or other liability [...] arising from or related to (a) [...] non-compliance with applicable laws; (b) [the vendor's] Products, including the offer, sale, fulfillment (except [the vendor] Products fulfilled using the FBA service), refund, cancellation, return, or adjustments thereof, and any personal injury, death (to the extent the injury or death is not caused by Amazon), or property damage related thereto [...]".* Here is the link.

[31] Here is the link.

excluding the damages resulting from non-conformities or defects.[32]

The above observations seem to indicate that some platforms, at least when they can credibly resort to sanctions against sellers using their intermediary services, are willing, to some extent, to assume some "limited degree" (in time and scope) of legal liability regarding consumers beyond what is directly imposed on them by the law. The platforms, however, are reluctant to front the full range of liabilities vis-à-vis consumers and are also explicit in making sellers know that they are to be held ultimately responsible for harm to consumers buying through the platform.

[32]In particular, "(eBay) *has no responsibility or liability for the safety or performance of any product that you list or sell using our Services, including any product that is subject to a recall. You (the sellers) are solely responsible for any non-conformity or defect in, or compliance with any public or private recall of any product you list or sell using our Services".*

Acknowledgements. We express our sincere gratitude for the comments and the discussion of some features of the work to participants at the "International Workshop on Personalization of Consumer Contracts" in Barcelona, at the "2023 International Law and Economics Junior Scholar's meeting" in Chicago, the "2023 Spanish Law and Economics Association Conference", the "LiaNs online seminar", and the "Theoretical European Law & Economics Online Seminar".

Alessandro De Chiara and Ester Manna acknowledge the financial support of Ministerio de Ciencia, Innovación y Universidades through grants PID2020-114040RB-I00 and PID2021-128237OB-I00, the Ministerio de Economía y Competitividad and Fondo Europeo de Desarrollo Regional through grant ECO2016-78991-R (MINECO/FEDER, UE), and the Government of Catalonia through grant 2021SGR00678. Juan José Ganuza acknowledges financial support from the Spanish Agencia Estatal de Investigación (AEI), through the Severo Ochoa Programme for Centres of Excellence in R&D (Barcelona School of Economics CEX2019-000915-S). Fernando Gómez gratefully acknowledges the financial support of grants I00/MICIN/AEI/10.13039/501100011033/FEDER and EU, on "Responsabilidad contractual y extracontractual de las plataformas en línea" and "AlgorithmLaw" - TED2021-131472A-I00/EU/"NextGeneration EU"/PRTR, financed by the Spanish Ministry of Science and Innovation, the Spanish State Research Agency and the European Union "NextGenerationEU"/PRTR.

All errors are our sole responsibility.

References

Bagnoli, M. and Bergstrom, T. (2005). Log-concave probability and its applications. *Economic Theory*, 26(2).

Bartling, B. and Fischbacher, U. (2012). Shifting the blame: On delegation and responsibility. *The Review of Economic Studies*, 79(1):67–87.

Bechwati, N. N. and Morrin, M. (2003). Outraged consumers: Getting even at the expense of getting a good deal. *Journal of Consumer Psychology*, 13(4):440–453.

Buiten, M., de Streel, A., and Peitz, M. (2022). The law and economics of ai liability. Technical report, University of Bonn and University of Mannheim, Germany.

Buiten, M. C., De Streel, A., Peitz, and Martin (2020). Rethinking liability rules for online hosting platforms. *International Journal of Law and Information Technology*, 28(2):139–166.

De Chiara, A., Manna, E., Rubí-Puig, A., and Segura-Moreiras, A. (2021). Efficient copyright filters for online hosting platforms. *Available at SSRN 3945130*.

Dohmen, T., Falk, A., Huffman, D., and Sunde, U. (2009). Homo reciprocans: Survey evidence on behavioural outcomes. *The Economic Journal*, 119(536):592–612.

Dufwenberg, M. and Kirchsteiger, G. (2004). A theory of sequential reciprocity. *Games and economic behavior*, 47(2):268–298.

Epstein, R. A. and Sharkey, C. M. (2020). *Cases and materials on torts*. Aspen Publishing.

Falk, A. and Fischbacher, U. (2006). A theory of reciprocity. *Games and economic behavior*, 54(2):293–315.

Freedman, S., Kearney, M., and Lederman, M. (2012). Product recalls, imperfect information, and spillover effects: Lessons from the consumer response to the 2007 toy recalls. *Review of Economics and Statistics*, 94(2):499–516.

Ganuza, J. J., Gómez, F., and Robles, M. (2016). Product liability versus reputation. *The Journal of Law, Economics, and Organization*, 32(2):213–241.

Grimmelmann, J. and Zhang, P. (2023). An economic model of intermediary liability. *Berkeley Technology Law Journal (forthcoming)*.

Hart, O. and Moore, J. (2008). Contracts as reference points. *The Quarterly journal of economics*, 123(1):1–48.

Hua, X. and Spier, K. E. (2021). Holding platforms liable. *HKUST Business School Research Paper*, (2021-048).

Hua, X. and Spier, K. E. (2023). Platform safety: Strict liability versus negligence. *Available at SSRN*.

Jeon, D.-S., Lefouili, Y., and Madio, L. (2021). Platform liability and innovation. *Available at SSRN 3945132*.

Karle, H., Peitz, M., and Reisinger, M. (2020). Segmentation versus agglomeration: Competition between platforms with competitive sellers. *Journal of Political Economy*, 128(6):2329–2374.

Lefouili, Y. and Madio, L. (2022). The economics of platform liability. *European Journal of Law and Economics*, 53(3):319–351.

Liu, Y. and Shankar, V. (2015). The dynamic impact of product-harm crises on brand preference and advertising effectiveness: An empirical analysis of the automobile industry. *Management science*, 61(10):2514–2535.

Oexl, R. and Grossman, Z. J. (2013). Shifting the blame to a powerless intermediary. *Experimental Economics*, 16:306–312.

Polinsky, A. M. and Che, Y.-K. (1991). Decoupling liability: Optimal incentives for care and litigation. *The RAND Journal of Economics*, 4:562–570.

Porat, H. (2022). Behavior-based price discrimination and consumer protection in the age of algorithms. *Available at SSRN*.

Rabin, M. (1993). Incorporating fairness into game theory and economics. *The American economic review*, pages 1281–1302.

Sharkey, C. M. (2020). Holding amazon liable as a seller of defective goods: A convergence of cultural and economic perspectives. *Northwestern University Law Review*, 115:20–51.

Sharkey, C. M. (2022). Products liability in the digital age: Online platforms as' cheapest cost avoiders'. *Hastings Law Journal*, 73.

Teh, T.-H. (2022). Platform governance. *American Economic Journal: Microeconomics*, 14(3):213–254.

Van Loo, R. (2020). The revival of respondeat superior and evolution of gatekeeper liability. *Geo. lJ*, 109:141.

Yasui, Y. (2022). Platform liability for third-party defective products. *Available at SSRN 4224267*.

Zennyo, Y. (2023). Should platforms be held liable for defective third-party goods? *CPRC Discussion Paper Series, CPDP-93-E, March 2023*.

Appendix

Proof of Lemma 1

Note that $\tilde{\delta}_P > \tilde{\delta}_C$ if $H < \frac{[1+(1-\eta)\phi]c}{\eta^2}$. However, if $H < \frac{[1+(1-\eta)\phi]c}{\eta^2}$, $\tilde{\delta}_P > 1$.

□

Proof of Proposition 2

Welfare can be written as:

$$SW = \begin{cases} V - (1-\eta)\left[H + \tilde{R}(\delta)(1+\tau) + \frac{c}{\eta}(1+\phi)\right] - c, & if \quad \delta \in [0, \min\{\tilde{\delta}_C, \tilde{\delta}_P\}); \\ V - H, & if \quad H < \frac{[1+(1-\eta)\phi]c}{\eta^2} \text{ and } \delta \in [\tilde{\delta}_C, 1]; \\ V - (1-\eta)\left[H + \frac{c}{\eta}(1+\phi)\right] - c, & if \quad H > \frac{[1+(1-\eta)\phi]c}{\eta^2} \text{ and } \delta \in [\tilde{\delta}_P, 1]. \end{cases}$$

As $\tilde{R}(\delta)$ is decreasing in δ, welfare is strictly increasing in δ for $\delta \in [0, \min\{\tilde{\delta}_C, \tilde{\delta}_P\})$.

Suppose that $\tilde{\delta}_P < \tilde{\delta}_C$. An increase in δ never affects e but can only at least weakly reduce $\tilde{R}$. Hence, in this case welfare is weakly increasing in δ.

Suppose that $0 < \tilde{\delta}_C < \tilde{\delta}_P$. We now show that welfare is weakly increasing in δ. We do so by first defining some expressions and proving a series of claims. Let

$$SW_1 := V - (1-\eta)\left[H + \tilde{R}(\delta)(1+\tau) + \frac{c}{\eta}(1+\phi)\right] - c;$$
$$SW_2 := V - H;$$

Note that the above correspond to the welfare in the first two parameter regions identified in the welfare expression.

Claim 1 (Decreasing welfare condition)**.** *$SW_1 > SW_2$ if*

$$H > \frac{[1+(1-\eta)\phi][1+\tau(1-(1-\gamma)\eta)]c}{\eta^2[\eta + \delta(1-\eta)(1+\tau)(1-\gamma) + \gamma(1-\eta+\tau)]}.$$

Proof. This is obtained by comparing SW_1 and SW_2 after plugging in the former the equilibrium expression for $\tilde{R}(\delta)$. □

Claim 2 (Incompatibility of conditions)**.** *It cannot be that $\tilde{\delta}_P > \tilde{\delta}_C$ and, simultaneously, $SW_1 > SW_2$.*

Proof. For $\tilde{\delta}_P > \tilde{\delta}_C$ and $SW_1 > SW_2$ to simultaneously hold it must be that

$$H \in \left[\frac{[1+(1-\eta)\phi][1+\tau(1-(1-\gamma)\eta)]c}{\eta^2[\eta + \delta(1-\eta)(1+\tau)(1-\gamma) + \gamma(1-\eta+\tau)]}, \frac{[1+(1-\eta)\phi]c}{\eta^2}\right].$$

However,

$$\frac{[1+(1-\eta)\phi][1+\tau(1-(1-\gamma)\eta)]c}{\eta^2[\eta+\delta(1-\eta)(1+\tau)(1-\gamma)+\gamma(1-\eta+\tau)]} > \frac{[1+(1-\eta)\phi]c}{\eta^2}$$
$$\Leftrightarrow [1+\tau(1-(1-\gamma)\eta)] > [\eta+\delta(1-\eta)(1+\tau)(1-\gamma)+\gamma(1-\eta+\tau)]$$
$$\Leftrightarrow (1+\tau)(1-\gamma)(1-\eta)(1-\delta) > 0.$$

Hence, if welfare is higher when $\tilde{R} > 0$ and $e = 1$ than when $\tilde{R} = 0$ and $e = 0$, in equilibrium there is always $e = 1$. □

Welfare Analysis

Legal Costs When Goods Have Relatively High Value

Focus on the scenario in which $\delta \geq \tilde{\delta}_L$, as the other one is detailed in the main text. Consider the equilibrium where sellers are not induced to invest, i.e., $e = 0$. The platform chooses the contract (f, r) to maximize:

$$f - (\phi r + R + \delta H + l_P),$$

subject to the sellers' participation constraint:

$$\gamma[V - (1-\delta)H - l_C - \tau R)] - f - r \geq 0.$$

It follows that, when $e = 0$, the contract between the platform and sellers prescribes (subscript 0 below):

$$r_0 = 0;$$
$$f_0(R) = \gamma[V - (1-\delta)H - l_C - \tau R)].$$

The platform's expected utility is:

$$\Pi_0(R) = \gamma[V - (1-\delta)H - l_C - \tau R] - R - \delta H - l_P.$$

Hence, $e = 1$ is induced whenever consumers' punishment is sufficiently severe, i.e., when:

$$R \geq \tilde{R}^L := \frac{[1+\phi(1-\eta)]c}{(1+\gamma\tau)\eta^2} - \frac{[\gamma(1-\delta)+\delta]H}{1+\gamma\tau} - \frac{\gamma l_C + l_P}{1+\gamma\tau}.$$

Once again, if H is sufficiently large as compared to c, consumers need not discipline the platform to induce $e = 1$. Specifically, this occurs if:

$$H \geq \tilde{H}_P^L := \frac{[1+\phi(1-\eta)]c - \eta^2(\gamma l_C + l_P)}{[\gamma(1-\delta)+\delta]\eta^2}.$$

The threshold can also be rewritten in terms of δ:

$$\tilde{\delta}_P^L := \frac{[1+\phi(1-\eta)]c - \eta^2[\gamma(H+l_C)+l_P]}{(1-\gamma)\eta^2 H}.$$

The next lemma immediately follows from the above observations.

Lemma 4. *Suppose that $V \geq \bar{V}$. If $\delta \geq \tilde{\delta}_P \geq \tilde{\delta}_L$, then $R = 0$, $f = \gamma[V - (1-\eta)[(1-\delta)H + l_C]] - (1-\eta)\frac{c}{\eta} - c$, $r = \frac{c}{\eta}$, and $e = 1$.*

If $\delta \in [\tilde{\delta}_L, \tilde{\delta}_P)$, consumers must punish the platform if the product is harmful for otherwise sellers will not invest. In stage 1, consumers will choose R to maximize their expected utility. If $e = 1$, $R = \tilde{R}^L$, and[33]

$$U_1 = (1-\gamma)\Big[V - (1-\eta)[(1-\delta)H + l_C + \tau\tilde{R}^L]\Big]$$

If investment is not induced, $R = 0$:

$$U_0 = (1-\gamma)[V - (1-\delta)H - l_C].$$

Thus, if $\delta \in [\tilde{\delta}_L, \tilde{\delta}_P^L)$, consumers punish the platform to induce investment when $U_1 \geq U_0$. Under the assumption that $\eta > \tau(1-\gamma-\eta)$, this turns out to be the case when $\delta < \tilde{\delta}_C^L$ where

$$\tilde{\delta}_C^L := \frac{\eta^2(\eta+\gamma\tau)(H+l_C) + \eta^2\tau(1-\eta)l_P - (1-\eta)\tau[1+(1-\eta)\phi]c}{\eta^2[\eta - \tau(1-\gamma-\eta)]H}.$$

Notice that $\tilde{\delta}_C^L$ need not be smaller than $\tilde{\delta}_P^L$. We obtain the following lemma.

Lemma 5. *Suppose that $V \geq \bar{V}$. If $\delta \in [\tilde{\delta}_L, \tilde{\delta}_P^L)$ there are two cases:*

1. *If $\delta \in [\tilde{\delta}_L, \min\{\tilde{\delta}_C^L, \tilde{\delta}_P^L\})$, then $R = \tilde{R}^L$, $f = \gamma\{V - (1-\eta)[(1-\delta)H + l_C\tau\tilde{R}^L]\} - (1-\eta)\frac{c}{\eta} - c$, $r = \frac{c}{\eta}$, and $e = 1$.*
2. *If $\delta \in [\tilde{\delta}_C^L, \min\{\tilde{\delta}_P^L, 1\}]$, then $R = 0$, $f = \gamma[V - (1-\delta)H - l_C]$, $r = 0$, and $e = 0$.*

Proof of Proposition 3

Let $V \geq \bar{V}$ and suppose that $H < \max\{\tilde{H}'_C, \tilde{H}_P\}$ for any $\delta \in [0,1]$. Then, if $\delta < \tilde{\delta}_L$, welfare is $V - H$, whereas if $\delta \geq \tilde{\delta}$ either $e = 0$ or $e = 1$ but $R = \tilde{R}$. If $\delta \in [\tilde{\delta}_L, \tilde{\delta}_C)$, welfare is maximized for $\delta \to \tilde{\delta}_C$ because $\tilde{R}$ is decreasing in δ. If $\delta \in [\tilde{\delta}_C, 1]$, welfare is $V - H - l_P - l_C$. It is immediate to see that if

$$V - (1-\eta)\left[H + \tilde{R}(\tilde{\delta}_C)(1+\tau)l_C + L_P + \frac{c}{\eta}(1+\phi)\right] - c < V - H + l_C + l_P,$$

then, it would be better to set $\delta \in [0, \tilde{\delta}_L)$ to increase welfare. This is the case graphically illustrated in Figure 1 If the above inequality were not satisfied, welfare would not be maximized for $\delta = 1$, but for $\delta \to \tilde{\delta}_C$.

Let $V \geq \bar{V}$ and suppose that $H > \tilde{H}'_P$ so that $e = 1$ and $\tilde{R}' = 0$ when $\delta < \tilde{\delta}_L$. Then, when $\delta \geq \tilde{\delta}_L$, $e = 1$ and $R = 0$ and welfare would be maximized by setting $\delta \in [0, \tilde{\delta}_L)$.[34] □

[33] Below, we implicitly assume that $\tilde{R} \leq \bar{R}$, for otherwise the platform would not allow trading since it would incur a loss.

[34] The case graphically illustrated in Figure 2 is different in that $H \in (\tilde{H}'_C, \tilde{H}'_P]$ and as a result welfare can be higher for $\delta < \tilde{\delta}_L$ if $\tilde{R}'(\delta)(1+\tau) < l_P + l_C$ for some $\delta \in [0, \tilde{\delta}_L)$.

Proof of Remark 2

Note first that $\tilde{\delta}_P^{PLD} > \tilde{\delta}_C^{PLD}$ if $H < \frac{[1+(1-\eta)\phi]c}{\eta^2}$. However, if $H < \frac{[1+(1-\eta)\phi]c}{\eta^2}$, $\tilde{\delta}_P^{LPD} > 1$. Therefore, if $H < \frac{[1+(1-\eta)\phi]c}{\eta^2}$, then only $\tilde{\delta}_C^{PLD}$ is relevant and increases in Δ as:

$$\frac{\partial \tilde{\delta}_C^{PLD}}{\partial \Delta} = \frac{(1-\eta)\tau(\eta+\gamma\tau)[-H\eta^2+[1+\phi(1-\eta)]c]}{\eta^2 H[\Delta\eta-\tau(1-\eta-\gamma\Delta)]^2} > 0.$$

If $H > \frac{[1+(1-\eta)\phi]c}{\eta^2}$, then only $\tilde{\delta}_P^{PLD}$ is relevant and decreases in Δ as:

$$\frac{\partial \tilde{\delta}_P^{PLD}}{\partial \Delta} = \frac{\gamma[-H\eta^2+[1+\phi(1-\eta)]c]}{\eta^2 H(1-\gamma\Delta)^2} < 0.$$

□

Proof of Remark 3

When $H \geq \hat{H}$, $\tilde{\delta}_P^{SRL}$ is relevant and welfare is weakly increasing in $1-\beta$ as investment always occurs, but a higher $1-\beta$ reduces the moral-hazard costs and the reputational sanctions. When $H < \hat{H}$, $\tilde{\delta}_C^{SRL}$ is relevant and an increase in $1-\beta$ may decrease welfare. To see this, first note that $\tilde{\delta}_C^{SRL}$ is increasing in $1-\beta$. Second, compare welfare in the region where $e=1$ and $R>0$ with the region in which $e=0$ and $R=0$. In the former region, welfare is

$$SW_1(\beta) := V-(1-\eta)\left[H+\tilde{R}(\delta)(1+\tau)+\left(\frac{c}{\eta}-(1-\beta)R\right)(1+\phi)\right]-c,$$

while in the latter region welfare is: $SW_2 = V-H$. Note that $SW_1(\beta)$ is increasing in $1-\beta$. See that $SW_1(\beta) > SW_2$ when $H > \hat{H}+\frac{R(1-\eta)[\beta+\tau-(1-\beta)\phi]}{\eta}$. If $\beta+\tau-(1-\beta)\phi > 0$ this is the case only when $\tilde{\delta}_C^{SRL}$ is not the relevant threshold. Hence, reputational sanctions directed to the seller can be welfare decreasing when $H < \hat{H}$ and $\delta \in (\tilde{\delta}_C(\beta=1), \tilde{\delta}_C(\beta=0)]$, because it leads to safer goods but entails investment costs, moral-hazard costs, and reputational sanctions costs.

Here, we report the threshold $\overline{\beta}(\delta)$ below which the product would be supplied in the platform:

$$\overline{\beta}(\delta) \equiv \frac{\eta\Big[\gamma V[1+\gamma\eta\tau+\phi(1-\eta)]-H[\gamma(1-\delta)+\delta](1-\eta)(1+\phi)\Big]-c(1+\gamma\tau)[1+(1-\eta)\phi]}{\Big[\gamma V-H[\gamma(1-\delta)+\delta]\Big](1-\eta)\eta(1+\phi)}.$$

Note that the denominator is positive as we focus on high-value goods, the numerator is positive if V is sufficiently high. □

Sellers with Liability Exposure and Proof of Remark 4

Denote the equilibrium values of this setting with the superscript SL. On the consumer side nothing changes, whereas the seller's decision on the safety investment in stage 3 becomes:

$$\max_{e\in\{0,1\}} \quad -(1-\eta e)[r+(1-\lambda)\delta H]-ce.$$

It follows that $e=1$ if $r\geq \tilde{r}^{SL}:=\max\{\frac{c}{\eta}-(1-\lambda)\delta H,0\}$.

Suppose that in stage 2 the platform wants to induce investment. The platform chooses (f,r) to maximize

$$f-(1-\eta)[\phi r+R+\lambda\delta H],$$

subject to the sellers' participation constraint:

$$\gamma\Big[V-(1-\eta)((1-\delta)H+\tau R)\Big]-f-(1-\eta)[r+(1-\lambda)\delta H]-c\geq 0,$$

and the sellers' incentive compatibility constraint $r\geq\tilde{r}^{SL}$. Let $\frac{c}{\eta}>\delta H$. The optimal contract is:

$$\begin{aligned} r_1^{SL} =& \frac{c}{\eta}-(1-\lambda)\delta H;\\ f_1^{SL} =& \gamma\Big[V-(1-\eta)(1-\delta)(H+\tau R)\Big]-(1-\eta)\frac{c}{\eta}-c. \end{aligned}$$

The platform's expected profit is:

$$\Pi_1^{SL}=\gamma\Big[V-(1-\eta)((1-\delta)H+\tau R)\Big]-(1-\eta)\frac{c}{\eta}-c-(1-\eta)\left[\phi\left(\frac{c}{\eta}-(1-\lambda)\delta H\right)+R+\lambda\delta H\right].$$

It is immediate to see that Π_1^{SL} is strictly decreasing in λ. If there exists $\lambda\in[0,1]$ such that $r_1^{SL}=0$, then for lower levels of λ Π_1^{SL} would be independent of λ. To see this notice that if $r_1^{SL}=0$, then,

$$f_1^{SL}=\gamma\Big[V-(1-\eta)(1-\delta)(H+\tau R)\Big]-(1-\eta)(1-\lambda)\delta H-c,$$

and

$$\Pi_1^{SL}=\gamma\Big[V-(1-\eta)[(1-\delta)H+\tau R]\Big]-(1-\eta)(1-\lambda)\delta H-c-(1-\eta)\left[R+\lambda\delta H\right],$$

where the terms in λ cancel out.

Suppose that in stage 2 the platform does not want to induce investment. The platform chooses (f,r) to maximize

$$f-[\phi r+R+\lambda\delta H],$$

subject to the sellers' participation constraint:

$$\gamma\Big[V-((1-\delta)H+\tau R)\Big]-f-(1-\lambda)\delta H\geq 0.$$

In this case $r_0^{SL} = 0$ and $f_0^{SL} = \gamma\Big[V - ((1-\delta)H + \tau R)\Big] + (1-\lambda)\delta H$, resulting in

$$\Pi_0^{SL} = \gamma\Big[V - ((1-\delta)H + \tau R)\Big] - R - \delta H,$$

which does not depend on λ. When r_1^{SL} is positive, a decrease in λ increases the gain from inducing sellers' investment: $\Pi_1^{SL} - \Pi_0^{SL} > 0$ if

$$\gamma\eta\Big[(1-\delta)H + \tau R\Big] + \eta R + \delta H[1 - \lambda(1-\eta)] > c + (1-\eta)\frac{c}{\eta}(1+\phi) - (1-\eta)\phi(1-\lambda)\delta H,$$

which is easier to satisfy for a lower λ.

The level of reputational sanctions that induce investment is:

$$\tilde{R}^{SL} := \frac{[1+\phi(1-\eta)]c}{(1+\gamma\tau)\eta^2} - \frac{\Big[\gamma\eta(1-\delta) + \delta[1 + (1-\eta)\phi - \lambda(1-\eta)(1+\phi)\Big]H}{(1+\gamma\tau)\eta},$$

which is decreasing in $1-\lambda$. To induce investment, punishment is required unless $\delta \geq \tilde{\delta}_P^{SL}$, which is:

$$\tilde{\delta}_P^{SL} := \frac{[1+\phi(1-\eta)]c - \eta^2\gamma H}{(1-\gamma)\eta^2 H + (1-\eta)(1-\lambda)(1+\phi)\eta H}.$$

Note that $\tilde{\delta}_P^{SL}$ is decreasing in $1-\lambda$. Thus, there might exist parameter values for which consumers' punishment is needed to induce investment only if the platform is liable: a less severe punishment is needed to induce investment because sellers are already motivated by the threat of liability.

Suppose now that $\delta < \tilde{\delta}_P^{SL}$ so that consumers' punishment is needed. Consumers compare their utility when investment is induced and when it is not.

$$U_1^{SL} = (1-\gamma)\Big[V - (1-\eta)[(1-\delta)H + \tau\tilde{R}^{SL}]\Big]$$

If investment is not induced, $R = 0$:

$$U_0^{SL} = (1-\gamma)[V - (1-\delta)H].$$

Investment is induced unless $\delta < \tilde{\delta}_C^{SL}$, which is defined as follows:

$$\tilde{\delta}_C^{SL} := \frac{\eta^2(\eta+\gamma\tau)H - (1-\eta)\tau[1+(1-\eta)\phi]c}{\eta^2[\eta - \tau(1-\gamma-\eta)]H - \eta(1-\eta)^2(1-\lambda)\tau(1+\phi)H}.$$

This threshold is increasing in $1-\lambda$. A smaller λ may increase the parameter region where investment occurs, but under the threat of consumers' reputational sanctions.

We show that only one between $\tilde{\delta}_P^{SL}$ and $\tilde{\delta}_C^{SL}$ is relevant. See that $\tilde{\delta}_P^{SL} > \tilde{\delta}_C^{SL}$, when $H < \frac{[1+(1-\eta)\phi]c}{\eta^2+\eta(1-\eta)(1+\phi)(1-\lambda)} := \hat{H}^{SL}$. However, if $H < \hat{H}^{SL}$, $\tilde{\delta}_P^{SL} > 1$.

Note that when $H \geq \hat{H}^{SL}$, $\tilde{\delta}_P^{SL}$ is relevant and welfare is weakly increasing in $1-\lambda$ as investment always occurs but a higher degree of seller liability reduces the moral-hazard

costs and the reputational sanctions. When $H < \hat{H}^{SL}$, $\tilde{\delta}_C^{SL}$ is relevant and an increase in $1-\lambda$ may decrease welfare. To see this, we compare welfare in the region where $e=1$ and $R>0$ with the region in which $e=0$ and $R=0$. In the former region, welfare is

$$SW_1(\lambda) := V - (1-\eta)\left[H + \tilde{R}(\delta)(1+\tau) + \left(\frac{c}{\eta} - (1-\lambda)\delta H\right)(1+\phi)\right] - c,$$

while in the latter region, welfare is: $SW_2 = V - H$. Note that $SW_1(\lambda)$ is increasing in $1-\lambda$. See that $SW_1(\lambda) > SW_2$ when $H > \hat{H}^{SL} + \frac{R\eta(1-\eta)(1+\tau)}{\eta^2+\eta(1-\eta)(1+\phi)(1-\lambda)}$, which is the case only when $\tilde{\delta}_C^{SL}$ is not the relevant threshold. Hence, seller liability (i.e., $\lambda=0$) is worse for welfare than platform's liability (i.e., $\lambda=1$) when $H < \hat{H}^{SL}$ and $\delta \in (\tilde{\delta}_C(\lambda=1), \tilde{\delta}_C(\lambda=0)]$, because it leads to safer goods but entails investment costs, moral-hazard costs, and reputational sanctions costs. □

Proof of Lemma 3

By applying the implicit function theorem, as the denominator corresponds to the SOC and is negative, the sign of $\frac{\partial R}{\partial \delta}$ coincides with the sign of the numerator, that is:

$$\frac{\partial R}{\partial \delta} = \eta g'(\tilde{\phi})\frac{\partial \tilde{\phi}}{\partial \delta}\frac{\eta^2}{(1-\eta)c}(1+\gamma\tau)[(1-\delta)H + \tau R] - \frac{\eta^3}{(1-\eta)c}g(\tilde{\phi})H(1-\tau+2\gamma\tau) < 0,$$

as $g'(\tilde{\phi}) < 0$ and $\frac{\partial \tilde{\phi}}{\partial \delta} > 0$. □

Proof of Remark 5

We focus now on the system of two implicit equations in three parameters in a neighborhood of $(\alpha^*, \tilde{\phi}^*)$:

$$\tilde{Z}_1(\alpha, \tilde{\phi}; R) = 0 \Leftrightarrow 2f_0 - \int_0^{\tilde{\phi}} \left[\frac{c}{\eta} + (1-\eta)\left(\phi\frac{c}{\eta} + R + \delta H\right)\right] g(\phi)d\phi - (1-G(\tilde{\phi}))(R+\delta H) = 0.$$

$$\tilde{Z}_2(\alpha, \tilde{\phi}; R) = 0 \Leftrightarrow \eta H[\alpha\gamma(1-\delta)+\delta] + \eta R(1+\alpha\gamma\tau) - \frac{c}{\eta}[1+\tilde{\phi}(1-\eta)] = 0.$$

Assuming that the determinant of the Jacobian matrix is strictly positive, we can make use of the implicit function theorem to study the effect of changes in R on the equilibrium choices of α and $\tilde{\phi}$.

$$sign\left(\frac{\partial \alpha^*}{\partial R}\right) = -\begin{vmatrix} \frac{\partial Z_1}{\partial R} & \frac{\partial Z_1}{\partial \tilde{\phi}} \\ \frac{\partial Z_2}{\partial R} & \frac{\partial Z_2}{\partial \tilde{\phi}} \end{vmatrix} = -\frac{\partial Z_1}{\partial R}\frac{\partial Z_2}{\partial \tilde{\phi}} + \frac{\partial Z_1}{\partial \tilde{\phi}}\frac{\partial Z_2}{\partial R},$$

which is lower than 0 if $\frac{\partial Z_1}{\partial \tilde{\phi}} < 0$, as $\frac{\partial Z_1}{\partial R} < 0$, $\frac{\partial Z_2}{\partial \tilde{\phi}} < 0$, while $\frac{\partial Z_2}{\partial R} > 0$. Thus, we can conclude that if a higher fraction of sellers that invest decreases the fraction that participates, then

an increase in the consumers' sanctions negatively affect sellers' participation.

$$sign\left(\frac{\partial\tilde{\phi}^*}{\partial R}\right) = -\begin{vmatrix} \frac{\partial Z_1}{\partial\alpha} & \frac{\partial Z_1}{\partial R} \\ \frac{\partial Z_2}{\partial\alpha} & \frac{\partial Z_2}{\partial\tilde{R}} \end{vmatrix} = -\frac{\partial Z_1}{\partial\alpha}\frac{\partial Z_2}{\partial R} + \frac{\partial Z_1}{\partial R}\frac{\partial Z_2}{\partial\alpha}.$$

The impact of R on $\tilde{\phi}$ is instead ambiguous because $\frac{\partial Z_1}{\partial\alpha} < 0, \frac{\partial Z_2}{\partial R} > 0, \frac{\partial Z_1}{\partial R} < 0, \frac{\partial Z_2}{\partial\alpha} > 0$. Hence, when $\alpha < 1$, more severe consumers' sanctions R do not necessarily increase the number of investing firms, because they might decrease the number of participating sellers.

We now proceed to study how δ affects the fraction of participating and investing sellers. For $\alpha < 1$, a higher δ may lead to a reduction in the number of participating sellers. Intuitively, the platform does not want to allow sellers who do not invest in the platform. This is more likely to occur if a higher fraction of sellers that invest decreases the fraction that participates, i.e., if $\frac{\partial Z_1}{\partial\tilde{\phi}} < 0$. Keeping in mind that $\frac{\partial R}{\partial\delta} \leq 0$, with strict inequality if $R > 0$, with an abuse of notation we consider:

$$sign\left(\frac{\partial\alpha^*}{\partial\delta}\right) = -\begin{vmatrix} \frac{\partial Z_1}{\partial\delta} & \frac{\partial Z_1}{\partial\tilde{\phi}} \\ \frac{\partial Z_2}{\partial\delta} & \frac{\partial Z_2}{\partial\tilde{\phi}} \end{vmatrix} = -\frac{\partial Z_1}{\partial\delta}\frac{\partial Z_2}{\partial\tilde{\phi}} + \frac{\partial Z_1}{\partial\tilde{\phi}}\frac{\partial Z_2}{\partial\delta}.$$

If δ has a small impact on R, then α is decreasing in δ if $\frac{\partial Z_1}{\partial\tilde{\phi}} < 0$ because $\frac{\partial Z_1}{\partial\delta} < 0$, $\frac{\partial Z_2}{\partial\tilde{\phi}} < 0$, and $\frac{\partial Z_2}{\partial\delta} > 0$. Therefore, when the platform faces more severe liability, it decreases participation of sellers, unless liability does not simultaneously significantly decrease consumers' sanctions. If R is highly responsive to a change in δ the result may be the opposite as $\frac{\partial Z_1}{\partial\delta} > 0$ and $\frac{\partial Z_2}{\partial\delta} < 0$. Hence, under the same assumption that $\frac{\partial Z_1}{\partial\tilde{\phi}} < 0$, a higher degree of platform liability may be conducive to more participation.

Consider now the effect of platform liability on the fraction of investing sellers:

$$sign\left(\frac{\partial\tilde{\phi}^*}{\partial\delta}\right) = -\begin{vmatrix} \frac{\partial Z_1}{\partial\alpha} & \frac{\partial Z_1}{\partial\delta} \\ \frac{\partial Z_2}{\partial\alpha} & \frac{\partial Z_2}{\partial\tilde{\delta}} \end{vmatrix} = -\frac{\partial Z_1}{\partial\alpha}\frac{\partial Z_2}{\partial\delta} + \frac{\partial Z_1}{\partial\delta}\frac{\partial Z_2}{\partial\alpha}.$$

Irrespective of whether δ has a sizable impact on R, the relationship between δ and $\tilde{\phi}$ is ambiguous because $\frac{\partial Z_1}{\partial\alpha} < 0$ and $\frac{\partial Z_2}{\partial\alpha} > 0$.

□