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Tort Reform, Public Harm, and Welfare

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Abstract: A surprisingly diverse array of US manufacturers enjoy broad immunity from tort liability for public harm. We examine the consequences of such immunity with a model of buyer and manufacturer care-taking in a market relationship that features incomplete liability assignment and a probability that the representative manufacturer could lose its immunity as the public grows frustrated with increasing public harm. We find that reduced manufacturer liability can lead to less harmful products only under very restrictive conditions; and even when these conditions are met, reduced manufacturer liability leads to lower expected social welfare.

Key Words: Tort reform, liability, public harm, judgment-proof

JEL Codes: K13 (Tort law and product liability); D81 (Decision making under risk and/or uncertainty)

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1 Introduction

While tort reform in the US is most often discussed in the context of medical malpractice and related healthcare market settings such as vaccines, in fact a surprisingly diverse array of US producers—firearms, software, internet and social media platform provision, fast food, and sugar-sweetened beverages—enjoy fairly broad immunity from tort liability for public harm vis-à-vis versions of tort reform. For instance, the federal Protection of Lawful Commerce in Arms Act (PLCAA) of 2005 grants the firearms industry immunity from liability for crimes committed with its products. Software manufacturers are generally insulated from products liability (e.g., for data security breaches) on the legal theory that software is in many contexts defined as a professional service rather than a product, such that software failures are most often adjudicated according to contract law rather than products liability law.[1] Internet service and social media providers are immune from liability for the distribution of worms, viruses, other malicious code, and objectionable content on their platforms via sections of the federal Communications Decency Act of 1996 and of the Digital Millennium Copyright Act of 1998.[2] And the fast food and sugar-sweetened beverage industries are immunized from liability for private and public health damages by state-level tort reforms known as commonsense consumption acts (CCAs) in 26 US states.[3,4]

Such immunity arose primarily on the perception that these manufacturers are not reasonably culpable for harm (and culpability is necessary though not sufficient for a finding of liability). The theory of tort reform is that shifting culpability for harm from manufacturers to the buyers of their products, and relying on the fact that manufacturers and buyers are in a disciplining market relationship, should raise social welfare. We investigate the theoretical implications of immunity on care transacted in the market relationship, public harm and social welfare. We generalize an existing model of this dynamic—Hay and Spier (2005)—that features bilateral, sequential care-taking in a market relationship between a representative manufacturer and a consumer by adding two elements that appear to be overlooked in the literature. First, we allow the liability assignment to be incomplete. That is, we investigate the consequences of at least partially immunizing manufacturers when the liability for public harm is not fully assigned to buyers. This could be because buyers are partially or completely judgment-proof, but liability share incompleteness could result from a wide range of other factors including legal errors and imperfect information amongst members

[1] See Barnes (2004), Hahn and Layne-Farrar (2006), and Beard et al. (2009).

[2] See Lichtman and Posner (2006) and Katzmann (2019).

[3] See Carpenter and Tello-Trillo (2015) and Pomeranz et al. (2019)) on CCAs, particularly with respect to fast food. See Allcott et al. (2019) on sugar-sweetened beverages. Note that public harm in these contexts comprises private health care costs that are passed on to public insurance funds.

[4] Most recently the U.S. Congress is considering bills that would grant firms broad immunity from Covid-19 related lawsuits by consumers and employees, and there is vigorous public debate–indeed, protests across the nation–regarding the broad immunity from liability for public harm enjoyed by public employees such as police officers. Our work does not apply directly to these contexts but could with suitable modification.

of the public as to their rights to bring suit against buyers. Second, we add a positive probability that the manufacturer could lose its immunity, as the public, through its legislatures/courts, grows frustrated with increasing public harm, and this probability may be endogenous to the observable care exercised by manufacturers. The probability that the manufacturer loses its immunity could be increasing in its observable care if that care could be construed as an admission of culpability. That probability could be decreasing in manufacturer care if society perceives that efforts to make products safer justify continued immunity.

This possible endogeneity of culpability is important to take into account, for there is evidence that liability shares are socially contingent and therefore subject to change. For example, Currie and MacLeod (2008, 801) describe how some state medical malpractice tort law reforms were repealed by legislatures or ruled unconstitutional by courts. In the context of firearms, some legal commentators suggest that federal laws that currently shield the industry from liability for crimes committed with their products are not ironclad but rather socially contingent.[5] Regarding software, recent papers in the legal literature by Kim (2017), Chagal-Feferkorn (2019), and Choi (2019), among others, describe the increasing difficulty courts face in determining whether software defects should fall under products liability doctrine, given how embedded information processing has become within hardware such as autonomous vehicles and medical devices. Manufacturers in these information-rich industries are increasingly aware that their culpability for private and public harm is vulnerable to legislative and/or judicial revision.

For a final motivating example, the US Department of Interior is not considered culpable for public harm created by reintroduction of large, mammalian carnivores to their native habitats in support of the goals of the Endangered Species Act. However, Doremus (1999, 57) cautions the agency that while taking care is important for maintaining public support for the program, taking clearly observable care such as radio-collaring of wolves and fencing could provoke a court to find that Interior is culpable for public harm and to revise if not fully reverse the initial granting of immunity. The model developed in the present study shows how this real-world possibility of immunity reversal suggested by Doremus and others affects manufacturer and buyer care-taking in more general settings; we then examine the consequent levels of public harm and social welfare.

The results of our analysis are presented in a series of propositions in Section 4 and are summarized here. First, we demonstrate that reducing the manufacturer's share of liability strictly decreases the representative manufacturer's and buyer's combined expected per-unit cost of producing and using the product. Consequently, more of the good is traded and it is traded at a lower price. This output effect reduces expected social welfare because output is greater than the first-best level of output.

It is possible that this welfare-reducing output effect could be offset if reduced manufacturer

[5] See Siebel (2005, 915) and Sonner (2013, 995).

liability leads to a safer product. However, we present necessary and sufficient conditions for reduced manufacturer liability to result in a more harmful product, and argue that these conditions are not very restrictive. We demonstrate that it is possible that—as per the stated goal of tort reform—use of the product is made less harmful to the public, but the conditions under which this occurs appear to be very restrictive. In particular, it must the case that: (1) buyer and manufacturer care choices are sufficiently strong strategic substitutes in the sense that a reduction in manufacturer care motivates a sufficiently greater increase in buyer care, and (2) the probability that the manufacturer loses its immunity is strictly increasing in its care choice to a sufficient degree.

Regardless of whether reducing the manufacturer's liability share leads to a more or less harmful product, we demonstrate that expected social welfare strictly declines if liability is incompletely assigned. In addition to the reduction in expected social welfare that is due to increased production of the good, reducing manufacturer liability cannot decrease the social costs of producing and using the product, even if the product is safer. This result suggests that tort reforms that reduce manufacturer liability to as low as zero (i.e., that grant manufacturers immunity), but do not otherwise completely assign liability to buyers cannot raise social welfare. In fact, under not-very-restrictive conditions, partial or complete manufacturer immunity from damage caused by the use of the product burdens the public with greater amounts of a less safe product.

2 Literature review

Our investigation is situated within the literature that weighs the strengths and weaknesses of tort reform for motivating socially optimal care and output. The benefits of limiting tort liability as a policy instrument are described in the literature as (1) reducing frivolous lawsuits; (2) increasing the predictability of damage awards (particularly from juries and with regard to punitive damages); (3) reducing inefficiently high rates of 'defensive care'—that is, taking more than first-best care as a reaction to the possibility of facing higher than first-best damage awards; (4) reducing inefficient rent-seeking;[6] (5) incentivizing manufacturers to take more care on the theory that immunity is akin to a Good Samaritan law, where their care-taking cannot be used against them as evidence of culpability for harm;[7] and (6) incentivizing more care-taking by buyers when buyer actions are the closest proximate cause of harm.[8]

The potential weaknesses of tort reform are that buyers can be partially if not completely

[6]Rubin (2005).

[7]See, e.g., Katzmann (2019) dissent-in-part in Force v. Facebook, where he describes Congress's intent to write a law (the Communications Decency Act of 1996) that gave social media platforms immunity from civil liability for objectionable content on their platforms when they act to take down objectionable material, as per the Good Samaritan legal doctrine.

[8]For example, Carpenter and Tello-Trillo (2015, 808) indicate that the stated purpose of commonsense consumer acts is to incentivize consumers to take more care of their health, and they find evidence of this in the fast food industry.

judgment-proof (so that shifting culpability/liability from manufacturers to buyers may fail to be efficient); manufacturers may have the ability to take relatively impactful care but may not have appropriate incentive to take optimal care if immune from liability; and the multidimensional care literature reminds us that manufacturer and buyer care may be complements or substitutes, to various degrees, and these factors need to be taken into account if we are to be confident as to the care that will be taken if we immunize manufacturers from liability vis-à-vis tort reform.[9] As is immediately evident, ascertaining whether tort liability is an efficient policy instrument in various contexts is complicated.[10]

The theoretical literature regarding aspects of this topic include Wittman (1981), Miceli et al. (2001), Hay and Spier (2005), De Geest (2012) and Daughety and Reinganum (2013). Only one paper, Hay and Spier (2005)—HS, henceforth—features all of the elements we believe we need in order to analyze relatively unexplored tensions in tort reform that run through the aforementioned industries: (1) bilateral care taken sequentially by a manufacturer and buyer in a competitive market relationship; (2) public harm that is generated by the use of a product; and (3) buyers that may be judgment-proof. There are additional poignant elements that to our knowledge tort reform frameworks like HS do not consider, however, that we incorporate into the construction of a more general model for analyzing care-taking in these industries. Those additional elements are: (1) the assignment of liability may not be complete if the manufacturer is immune by statute from strict liability and if the buyer is partially or completely judgment-proof; (2) the immune manufacturer may face a probability greater than zero that its immunity could be reversed; and (3) this probability could be endogenous to the manufacturer's observable care.

3 The model

3.1 Model fundamentals

As in HS (2005, 1702), we consider a representative manufacturer, m, and a representative buyer, b, in a competitive market for a good with consumption that can cause public harm for which the manufacturer or buyer or some combination of them could be found culpable and liable.[11] Both parties are risk-neutral. The manufacturer invests in a single input—care, x—in producing and selling q units to the buyer who receives declining marginal benefit $P(q)$. Both the manufacturer and the consumer take observable care, x^m and x^b, per unit of q to reduce expected harm, $H(x^m, x^b)$,

[9] See, e.g., Bartsch (1997).

[10] See Polinsky and Shavell (2009) and Hylton (2012) for comprehensive discussion of these and other points related to the efficacy of tort liability as a policy instrument.

[11] We (and HS) abstract from the possibility that consumption also causes private harm; we assume that the consumer's marginal benefit is net of expected private harm.

per unit. That is, we assume that $\partial H/\partial x^i < 0$ for $i = m, b$. The expected harm function is strictly convex. The sign of the cross-partial derivative, $\partial^2 H/\partial x^m \partial x^b$, depends upon whether manufacturer care and buyer care are substitutes or complements. In particular, $\partial^2 H/\partial x^m \partial x^b$ is positive (negative) when care types are substitutes (complements), as the marginal harm avoided decreases (increases) as the other care type increases. The marginal cost of care taken by either party is one.

The expected social welfare function is

$$SW(q, x^m, x^b) = \int_0^q [P(z) - H(x^m, x^b) - x^m - x^b] dz. \tag{1}$$

The first-order conditions for maximizing the social welfare function (assuming strictly positive amounts of the choice variables throughout) are:

$$\frac{\partial SW}{\partial x^i} = -\frac{\partial H(x^m, x^b)}{\partial x^i} - 1 = 0, \, i = m, b; \tag{2}$$

$$\frac{\partial SW}{\partial q} = P(q) - H(x^m, x^b) - x^m - x^b = 0. \tag{3}$$

These conditions identify the first-best choices of quantity, q^*, and care, x^{m*} and x^{b*}.

3.2 Equilibrium levels of care and production

We now characterize the competitive equilibrium levels of manufacturer care, buyer care and output under strict liability rules that assign liability for public harm to the buyer up to the level of her financial assets, with some residual liability assigned to the manufacturer. Thus, assume a strict liability rule for which the consumer is liable for and has assets to pay a percentage $\delta^b \in [0, 1]$ of harm and the manufacturer is liable for and has assets to pay the percentage of harm $\delta^m \in [0, 1]$. We add to the HS framework two real-world possibilities. First, liability may not be completely assigned, so we allow $\delta^m + \delta^b \leq 1$. Second, we consider the possibility that society may for various reasons grant partial or complete immunity from liability to manufacturers vis-à-vis tort reform but may also reconsider a manufacturer's initial immunity to civil liability lawsuits. Hence, suppose that there is some probability that liability shifts entirely to the manufacturer. As described earlier, since a manufacturer's observable care may be construed by a legislature or judiciary as an admission of culpability for public harm, this probability may be dependent on the manufacturer's choice of care. Denote the probability that the manufacturer's observable care crosses the threshold that triggers a finding of culpability as $\rho(x^m) \geq 0$. All of the liability (effectively, $\delta^b = 0$ and $\delta^m = 1$) shifts to the manufacturer with probability $\rho(x^m)$.

The market interaction between manufacturer and buyer set forth in the HS framework, and

that we maintain in our analysis, is that the manufacturer chooses an investment in care and then the buyer perfectly observes the manufacturer's care and chooses her buyer's care and the units of q to purchase. A competitive equilibrium can then be characterized as the price and manufacturer care that solves the following problem:

$$maxCS(p,x^m) = \int_0^q [P(z) - H(x^m,x^b)\delta^b(1-\rho(x^m)) - x^m - x^b]dz, \tag{4}$$

subject to

$$-\frac{\partial H(x^m,x^b)}{\partial x^b}\delta^b(1-\rho(x^m)) - 1 = 0; \tag{5}$$

$$P(q) = H(x^m,x^b)\delta^b(1-\rho(x^m)) + x^b + p; \tag{6}$$

$$p \geq H(x^m,x^b)(\delta^m + (1-\delta^m)\rho(x^m)) + x^m. \tag{7}$$

Some explanation of the terms above is warranted before proceeding. Eq. (4) states that expected consumer surplus CS will be maximized in a competitive equilibrium. Eq. (5) is the buyer's first-order condition dictating her privately optimal choice of care. Eq. (6) says that the buyer will purchase q units of the good where her marginal benefit of consumption equals her expected per-unit cost (which takes into account her private care cost and her expected legal liability cost). $H(x^m,x^b)\delta^b(1-\rho(x^m))$ appears in both the consumer surplus objective function (4) and the consumer's expected marginal cost function (6). This is the buyer's expected liability for harm per unit of consumption. With probability $\rho(x^m)$ the buyer's expected liability for harm is zero. The right side of Eq. (7) is the manufacturer's per-unit expected cost function, so the equation guarantees the firm non-negative profit in expectation. We note that $H(x^m,x^b)(\delta^m + (1-\delta^m)\rho(x^m))$, which appears in (7), is the manufacturer's expected liability for harm per unit of sales.

Note that (5) implicitly defines the buyer's choice of care as a function of its share of the liability for public harm and the manufacturer's choice of care; that is,

$$x^b = f(x^m, \delta^b). \tag{8}$$

Moreover, in a competitive equilibrium, (7) will hold with equality so that the price of the product is equal to the representative firm's per unit expected cost of production. With these factors, (4)

through (7) can be rewritten as

$$maxCS(p,x^m) = \int_0^q [P(z) - H(x^m, f(x^m,\delta^b))\left(\delta^m + \delta^b + (1-\delta^m-\delta^b)\rho(x^m)\right) - x^m - f(x^m,\delta^b)]dz, \tag{9}$$

subject to

$$P(q) = H(x^m, f(x^m,\delta^b))\left(\delta^m + \delta^b + (1-\delta^m-\delta^b)\rho(x^m)\right) + x^m + f(x^m,\delta^b). \tag{10}$$

The solution to this problem, which we denote as $(\widehat{x}^m, \widehat{x}^b, \widehat{q})$, satisfies the following conditions:

$$\widehat{x}^m = argmin_{x^m} H(x^m, f(x^m,\delta^b))\left(\delta^m + \delta^b + (1-\delta^m-\delta^b)\rho(x^m)\right) + x^m + f(x^m,\delta^b); \tag{11}$$

$$\widehat{x}^b = f(\widehat{x}^m,\delta^b); \tag{12}$$

$$P(\widehat{q}) = H(\widehat{x}^m, f(\widehat{x}^m,\delta^b))\left(\delta^m + \delta^b + (1-\delta^m-\delta^b)\rho(\widehat{x}^m)\right) + \widehat{x}^m + f(\widehat{x}^m,\delta^b). \tag{13}$$

Eq. (11) states that the manufacturer's care choice minimizes the manufacturer's and buyer's combined expected per-unit costs of producing and consuming the product. The first-order condition for the manufacturer's care choice, which we will use extensively in the next section, can be written as

$$\left(\delta^m + \delta^b + (1-\delta^m-\delta^b)\rho\right)\left(\frac{\partial H}{\partial x^m} + \frac{\partial H}{\partial x^b}\frac{\partial \widehat{x}^b}{\partial x^m}\right) + \frac{\partial \widehat{x}^b}{\partial x^m} + 1 + H(1-\delta^m-\delta^b)\rho' = 0. \tag{14}$$

(Note that we have dropped all the function arguments, and will do so from now on). Eq. (12) is the buyer's reaction to the manufacturer's choice of care, given its share of liability, and (13) states that the representative consumer's marginal benefit of purchases of the product is equal to the sum of the manufacturer's and buyer's expected per-unit costs of selling and using the product.

3.3 Distortions

It is straightforward to show that equilibrium care choices and level of output $(\widehat{x}^m, \widehat{x}^b, \widehat{q})$, equal their first-best values (x^{m*}, x^{b*}, q^*) if $\delta^b = 1$, $\delta^m = 0$ and $\rho = 0$. This is the same result as Proposition 1 in Hay and Spier (2005, 1702). Thus, market choices will be first-best in our framework if all the liability is assigned to the buyer, the manufacturer is immune from liability, and there is no chance that the manufacturer will lose this immunity. Of course, assigning all the liability to the buyer only works if she is not judgment proof. If the buyer is partially or completely judgment-proof,

then Hay and Spier (2005, 1702) Proposition 2 states that the second-best optimal strict liability rule pushes the residual liability to the manufacturer, who is assumed not to be judgment-proof, while maintaining $\delta^m + \delta^b = 1$ (i.e., the liability shares sum to one so that expected public harm is covered).

In our framework we have: (1) liability may be incompletely assigned so that $\delta^m + \delta^b < 1$; (2) there may be some probability that all the liability will shift to the manufacturer so that $\rho > 0$; and (3) the manufacturer's choice of care can change this probability. Each of these features can distort equilibrium levels of care and output.

For example, compare (2) and (5) to see that the buyer's choice of care is distorted if she faces less than complete liability for harm ($\delta^b < 1$) and if there is some probability that all the liability will shift to the manufacturer ($\rho > 0$). Both of these factors reduce her expected liability for harm, and hence, her motivation to exercise care in the use of the product. In addition, the possibility that the manufacturer's choice of care can change the probability that liability shifts to the manufacturer affects the buyer's responsiveness to the manufacturer's care choice. To see this, use (5) to calculate the buyer's strategic reaction to the manufacturer's choice of care,

$$\frac{\partial \hat{x}^b}{\partial x^m} = -\frac{\partial^2 H/\partial x^b \partial x^m}{\partial^2 H/\partial (x^b)^2} + \frac{\rho' \partial H/\partial x^b}{(1-\rho)\partial^2 H/\partial (x^b)^2}, \tag{15}$$

which reveals that $\rho' \neq 0$ can reinforce, dampen, or even reverse the buyer's strategic response to the manufacturer's care choice.

To identify the distortions to the manufacturer's care choice, rearrange terms in (14) to rewrite it as

$$\begin{aligned} -\frac{\partial H}{\partial x^m} - 1 = &-\frac{\partial H}{\partial x^m}(1-\delta^m-\delta^b)(1-\rho) + H(1-\delta^m-\delta^b)\rho' \\ &-\frac{\partial \hat{x}^b}{\partial x^m}\left(\left(\delta^m+\delta^b+(1-\delta^m-\delta^b)\rho\right)\frac{\partial H}{\partial x^b}+1\right). \end{aligned} \tag{16}$$

Comparing this to (2) reveals that the incomplete assignment of liability and the probability the manufacturer could lose its immunity (and that this may be affected by its care choice) all can distort the manufacturer's choice of care.

4 Market and welfare effects of limiting manufacturer liability

In this section we present the main results of our analysis, which are the qualitative market and social welfare effects of limiting manufacturer liability, holding the buyer's share of liability fixed, when liability is not completely assigned. We present the results of this section in a series of

propositions. Our first deals with the market quantity and price effects of limiting manufacturer liability for the public harm caused by the use of their products.

Proposition 1: A reduction in the manufacturer's share of liability leads to greater market output and the product sells at a lower price.

Proof: Consider the manufacturer's and buyer's combined expected per-unit costs of selling and using the product on the right side of (13). Eq. (11) states that the manufacturer's care is chosen to minimize these costs. Therefore, we can use the envelope theorem to calculate the marginal effect of δ^m on the right side of (13) as $H(1-\rho) > 0$, which reveals that the per-unit expected costs of selling and using the product fall as the manufacturer's liability is reduced. Since the consumer's demand for the product, $P(q)$, is strictly decreasing, output is higher and the price of the product is lower. □

Reducing manufacturer liability will always lead to a greater quantity of the product and a lower price because the manufacturer's and buyer's combined expected per-unit cost of producing and using the product is lower. This result is one key goal of tort reform, that immunization can promote economic growth and job creation in affected markets. However, we will see shortly that the increase in output reduces expected social welfare because output is pushed further away from the first-best level.

The negative welfare effect of increasing output may be offset if reduced manufacturer liability results in a safer product. To determine whether the product is more or less harmful as the manufacturer's share of liability is reduced, we need to sign the following derivative:

$$\frac{\partial H}{\partial \delta^m} = \left(\frac{\partial H}{\partial x^m} + \frac{\partial H}{\partial x^b} \frac{\partial \widehat{x}^b}{\partial x^m} \right) \frac{\partial \widehat{x}^m}{\partial \delta^m}. \tag{17}$$

The last term on the right side of (17) is the marginal effect of the manufacturer's liability share on its choice of care. The term in parentheses contains the direct effect of the manufacturer's choice of care on per-unit expected harm and the indirect effect of this choice on expected harm that works through the buyer's reaction to the manufacturer's choice of care. A reduction in the manufacturer's share of liability results in a more harmful product if (17) is strictly negative; the product is safer if (17) is positive. The following proposition reveals necessary and sufficient conditions under which a reduction in the manufacturer's liability share leads to a more harmful product.

Proposition 2: A reduction in the manufacturer's share of liability results in strictly greater expected public harm per unit of output if and only if one of the following conditions holds:

$$\frac{\partial \hat{x}^b}{\partial x^m} > -\left(1 + H(1-\delta^m-\delta^b)\rho'\right); \tag{18}$$

$$\rho' < \frac{(1-\rho)}{H}\left(\frac{\partial H}{\partial x^m} + \frac{\partial H}{\partial x^b}\frac{\partial \hat{x}^b}{\partial x^m}\right). \tag{19}$$

Proof: We begin by showing how the elements of (18) and (19) determine the signs of the components of (17). In particular, we establish the following:

$$sgn\left(\frac{\partial H}{\partial x^m} + \frac{\partial H}{\partial x^b}\frac{\partial \hat{x}^b}{\partial x^m}\right) = -sgn\left(\frac{\partial \hat{x}^b}{\partial x^m} + 1 + H(1-\delta^m-\delta^b)\rho'\right); \tag{20}$$

$$sgn\left(\frac{\partial \hat{x}^m}{\partial \delta^m}\right) = sgn\left(\rho' - \frac{(1-\rho)}{H}\left(\frac{\partial H}{\partial x^m} + \frac{\partial H}{\partial x^b}\frac{\partial \hat{x}^b}{\partial x^m}\right)\right). \tag{21}$$

Eq. (20) follows directly from (14) because $\delta^m + \delta^b + (1-\delta^m-\delta^b)\rho > 0$. To establish (21), let $F(\hat{x}^m, \delta^m)$ denote the left side of (14). Then,

$$\frac{\partial \hat{x}^m}{\partial \delta^m} = -\frac{\partial F/\partial \delta^m}{\partial F/\partial x^m}.$$

Since $\partial F/\partial x^m > 0$ to satisfy the second-order condition for the choice of x^m, $sgn\left(\partial \hat{x}^m/\partial \delta^m\right) = sgn\left(-\partial F/\partial \delta^m\right)$. From (14) calculate

$$-\frac{\partial F}{\partial \delta^m} = -(1-\rho)\left(\frac{\partial H}{\partial x^m} + \frac{\partial H}{\partial x^b}\frac{\partial \hat{x}^b}{\partial x^m}\right) + H\rho'. \tag{22}$$

Eq. (21) follows from $sgn\left(\partial \hat{x}^m/\partial \delta^m\right) = sgn\left(-\partial F/\partial \delta^m\right)$, $H > 0$ and (22).

From here on let

$$\frac{\partial \widetilde{H}}{\partial x^m} = \frac{\partial H}{\partial x^m} + \frac{\partial H}{\partial x^b}\frac{\partial f}{\partial x^m} \tag{23}$$

denote the total effect of the manufacturer's care on per-unit expected harm from the product. Likewise, (17) can written as

$$\frac{\partial H}{\partial \delta^m} = \frac{\partial \widetilde{H}}{\partial x^m}\frac{\partial x^m}{\partial \delta^m}. \tag{24}$$

To establish the "if" part of the proposition, first note that (18) and (20) imply $\partial \widetilde{H}/\partial x^m < 0$,

which from (21) implies $\partial \widehat{x}^m/\partial \delta^m > 0$. Therefore, $\partial H/\partial \delta^m < 0$ if (18) holds. Moreover, (19) and (21) imply $\partial \widehat{x}^m/\partial \delta^m < 0$, which, according to (21), requires $\partial \widetilde{H}/\partial x^m > 0$. Therefore, $\partial H/\partial \delta^m < 0$ if (19) holds.

To establish the "only if" part of the proposition we demonstrate that $\partial H/\partial \delta^m < 0$ cannot be true if

$$\frac{\partial \widehat{x}^b}{\partial x^m} \leq -\left(1 + H(1-\delta^m-\delta^b)\rho'\right) \tag{25}$$

and

$$\rho' \geq \frac{(1-\rho)}{H}\frac{\partial \widetilde{H}}{\partial x^m}. \tag{26}$$

First note from (20) and (21) that if either (25) or (26) hold with equality, then $\partial H/\partial \delta^m = 0$. If (25) holds with the strict inequality, then $\partial \widetilde{H}/\partial x^m > 0$ from (20). If (26) holds with strict inequality, then $\partial \widehat{x}^m/\partial \delta^m > 0$ from (21). Together, if both (25) and (26) hold with strict inequality, then $\partial H/\partial \delta^m > 0$. Thus, $\partial H/\partial \delta^m < 0$ cannot hold if both (25) and (26) hold. This completes the proof of the proposition. □

Proposition 2 provides necessary and sufficient conditions for a reduction in manufacturer liability to lead to a more harmful product, focusing on the relative values of the buyer's strategic response to the manufacturer's care choice and the effect of the manufacturer's care choice on the probability that it may have to bear all the liability. The proposition suggests that reducing manufacturer liability can increase, decrease or leave unchanged expected public harm from the use of the product, so resolving this issue is an empirical matter to be determined on a case-by-case basis.

However, the conditions under which reduced manufacturer liability leads to a safer product are very stringent; the conditions that result in a more harmful product are much less stringent. Condition (18) in Proposition 2 implies a more harmful product if manufacturer and buyer care are strategic complements; if they are weak substitutes so that a dollar reduction in manufacturer care induces less than a dollar increase in consumer care; if they are perfect substitutes; and even if they are strong substitutes if $\rho' > 0$. In fact, reduced liability for the manufacturer can still result in a more harmful product if buyer and manufacturer care are even stronger substitutes than allowed by condition (18) as long as the effect of the manufacturer's care choice on the probability it has to accept all liability is not too large so that (19) is satisfied.

The necessary and sufficient conditions for reduced manufacturer liability to not result in a more dangerous product are that both (25) and (26) in the proof of Proposition 2 are satisfied. Manufacturer liability does not affect how harmful the product is if either (25) or (26) hold with equality, but these are special cases that we can ignore for the purposes of our discussion. In the

absence of these special cases, Eq. (25) reveals that a less harmful product requires that the buyer considers its care and the manufacturer's care to be strong strategic substitutes so that a dollar reduction in the manufacturer's care choice motivates the buyer to increase its care choice by more than a dollar. In addition, the satisfaction of (26) and (21) reveal that a less harmful product requires that the manufacture's care be increasing in its liability share to a sufficient degree. Thus, as the manufacturer's liability share is reduced, it reduces its level of care, but the buyer more than makes up for it by significantly increasing her level of care, resulting in lower expected harm per unit. Given the strong strategic response of the buyer, the manufacturer's reduction in care as its liability is reduced requires that the probability liability shifts entirely to the manufacturer be strictly increasing in the manufacturer's care choice to a sufficient degree. This is implied by condition (26). It bears emphasizing that the existence of some probability that liability will shift entirely to the manufacturer and that this probability increases with the manufacturer's care choice are necessary conditions for a reduction in the manufacturer's liability share to result in a less harmful product. If $\rho' \leq 0$, reducing the manufacturer's share of liability cannot lead to a safer product.

Regardless of whether reducing manufacturer liability increases or decreases the expected public harm from each unit of the product, our final proposition reveals that expected social welfare falls as the manufacturer's liability is reduced.

Proposition 3: If liability for public harm is not assigned completely, then expected social welfare strictly declines if the manufacturer's share of liability is reduced.

Proof: Begin with expected social welfare (1) evaluated at the equilibrium described by (11) through (13):

$$SW(\widehat{q},\widehat{x}^m) = \int_0^{\widehat{q}} [P(z) - H(\widehat{x}^m,\widehat{x}^b) - \widehat{x}^m - \widehat{x}^b]dz. \tag{27}$$

Differentiate (27) with respect to δ^m, collect terms and suppress the function arguments to obtain

$$\frac{\partial SW}{\partial \delta^m} = \left[P - H - \widehat{x}^m - \widehat{x}^b\right] \frac{\partial \widehat{q}}{\partial \delta^m} - \int_0^{\widehat{q}} \left[\frac{\partial \widetilde{H}}{\partial x^m} + \frac{\partial \widehat{x}^b}{\partial x^m} + 1\right] \frac{\partial \widehat{x}^m}{\partial \delta^m} dz, \tag{28}$$

where recall that $\partial \widetilde{H}/\partial x^m$ is defined by (23). The first term on the right side of (28) is the change in expected social welfare that is due to the increase in the equilibrium quantity of the good as the manufacturer's liability is reduced. The second term is the effect on the expected social costs–total expected harm plus total manufacturer and buyer care–of reducing the manufacturer's liability. We will sign each of these effects separately.

To sign the first term of (28), recall that the equilibrium quantity is determined by (13). Subtract

H from both sides of (13) and collect terms to obtain

$$P - H - \widehat{x}^m - \widehat{x}^b = -H(1-\delta^m-\delta^b)(1-\rho). \tag{29}$$

The right side of (29) is strictly negative as long as liability is incompletely assigned, therefore

$$P - H - \widehat{x}^m - \widehat{x}^b < 0. \tag{30}$$

Combining (30) and $\partial\widehat{q}/\partial\delta^m < 0$ from Proposition 1 reveals that the first term of (28) is strictly positive.

Given that the first term of (28) is strictly positive, Proposition 3 is proved if

$$\left[\frac{\partial\widetilde{H}}{\partial x^m} + \frac{\partial\widehat{x}^b}{\partial x^m} + 1\right]\frac{\partial\widehat{x}^m}{\partial\delta^m} \leq 0. \tag{31}$$

Toward demonstrating (31), recall the first order condition for determining the manufacturer's choice of care, Eq. (14). Using $\partial\widetilde{H}/\partial x^m$ as defined by (23), add and subtract $\partial\widetilde{H}/\partial x^m$ from the left side of (14), rearrange and collect terms to obtain

$$\frac{\partial\widetilde{H}}{\partial x^m} + \frac{\partial\widehat{x}^b}{\partial x^m} + 1 = \left[\frac{\partial\widetilde{H}}{\partial x^m}(1-\rho) - H\rho'\right](1-\delta^m-\delta^b). \tag{32}$$

Now, take (21) and rearrange terms to obtain

$$-sgn\left(\frac{\partial\widehat{x}^m}{\partial\delta^m}\right) = sgn\left(\frac{\partial\widetilde{H}}{\partial x^m}(1-\rho) - H\rho'\right). \tag{33}$$

Eqs. (32) and (33) imply

$$-sgn\left(\frac{\partial\widehat{x}^m}{\partial\delta^m}\right) = sgn\left(\frac{\partial\widetilde{H}}{\partial x^m} + \frac{\partial\widehat{x}^b}{\partial x^m} + 1\right),$$

which in turn implies (31). The proof of the proposition is complete. □

Proposition 3 states that expected social welfare is strictly decreasing as manufacturer liability is reduced, as long as liability is not completely assigned. In cases in which liability is completely assigned between the manufacturer and the buyer, a reduction in the manufacturer's share of liability has no effect on expected social welfare. In the more realistic case of incomplete assignment, expected social welfare falls with reduced manufacturer liability for two reasons. First, expected social welfare falls because the equilibrium quantity increases, pushing it further away from the

first-best quantity. In addition, the expected social cost of producing and using each unit of the good weakly increases, *even if the product is safer*. This result suggests that tort reforms that reduce manufacturer liability but do not otherwise completely assign liability to buyers unequivocally reduce expected social welfare.

5 Conclusion

Our analysis began with the observation that a surprisingly diverse array of US manufacturers enjoy immunity from liability for public harm as a result of tort reforms intended to reduce legal uncertainty; promote economic growth; and to incentivize care-taking by consumers who, arguably, are the closest proximate cause of public harm. One example we noted is the 2005 US federal law that immunizes manufacturers of firearms for armed criminal actions committed with their products. The tort reform argument in favor of such a law is that firearm manufacturers are far removed from—and therefore not reasonably culpable for—the appropriate acquisition, use, and secure storage of such products. The implicit argument follows that if buyers know that manufacturers are immunized from liability, they will take socially optimal precaution and the resulting expected public harm and expected social welfare will be first-best. Our concern at the start of this project was that the above argument probably does not follow in the presence of one or more distortions. The goal for our project was to closely examine the roles of two relatively overlooked distortions: (1) liability shares may not be completely assigned and (2) manufacturers may face a positive probability that the immunity from liability that they currently enjoy may be reversed, and this probability could be affected by the observable care they take.

Our analysis generates four key results. First, we find that reducing the manufacturer's share of liability strictly decreases the representative manufacturer's and buyer's combined expected per-unit cost of producing and using the product. This in turn raises market output above first-best and reduces expected social welfare. Second, while it is possible that this welfare-reducing output effect could be offset if reduced manufacturer liability leads to a safer product, we present not-very-restrictive necessary and sufficient conditions for reduced manufacturer liability to result in a more harmful product. Third, we demonstrate that it is possible that the product is made less harmful—as tort reforms are intended to yield. We hasten to emphasize, however, that the conditions under which this occurs appear to be very restrictive. In particular, this result requires that: (1) buyer and manufacturer care choices are sufficiently strong strategic substitutes, and (2) the probability that the manufacturer loses its immunity is strictly increasing in its care choice to a sufficient degree. However, regardless of whether reducing the manufacturer's liability share leads to a more or less harmful product, our fourth and final result is that expected social welfare strictly declines if liability is incompletely assigned.

Notwithstanding the increasing prevalence of tort reforms that restrict if not fully immunize manufacturers from public harm there is a surprisingly thin economic literature that focuses upon this important dynamic. Hay and Spier (2005) is one such analysis. Our paper is intended to complement theirs with results that may encourage courts and legislatures to revisit some aspects of tort reform in these markets and ensure that the full range of distortions is taken into account in policy design. We do not maintain that rolling back tort reform in and of itself is a panacea, but we are concerned that tort reform is inefficient unless liability shares are complete.

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